SCHEME OF EXAMINATION

&

SYLLABI

for

Bachelor of Technology Programmes

of

Study under the aegis of

University School of Automation and Robotics offered at Affiliated Institutions of the University

(1st Year Common Scheme and Syllabus, 2nd year Scheme and Syllabus and Scheme of Studies for higher semesters)

(Applicable From Batch Admitted InAcademic Session 2022-23 Onwards)

Bachelor of Technology

in

Artificial Intelligence and Data Science (AIDS)

2nd Year Onward Scheme

and

implementation guideline

Third Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
PC	AIDS201	Data Structures	3	-	3
PC	AIDS203	Foundations of Data Science	3	-	3
PC	AIDS205	Digital Logic Design	3	-	3
PC	AIDS207	Principles of Artificial Intelligence	3	-	3
ES/BS	AIDS209	Probability, Statistics and Linear Algebra	4	-	4
HS/MS	AIDS211	Universal Human Values- II	3	-	3
HS/MS	AIDS213	Critical Reasoning and Systems Thinking	2	-	2
HS/MS (NUES)	AIDS215	Selected readings**	1	-	1
Practical/Viva-Voce					
PC	AIDS251	Data Structures Lab	-	2	1
PC	AIDS253	Foundations of Data Science Lab	-	2	1
PC	AIDS255	Digital Logic Design Lab	-	2	1
PC	AIDS257	Principles of Artificial Intelligence Lab	-	2	1
PC	AIDS259	Web Programming Lab	-	2	1
Total			**22**	**10**	**27**

***(NUES)**: *Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus.*

Fourth Semester					
Group	**Paper Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	AIDS202	Object Oriented Programming	3	-	3
PC	AIDS204	Database Management Systems	3	-	3
PC	AIDS206	Software Engineering	3	-	3
PC	AIDS208	Computer Networks and Internet Protocol	3	-	3
PC	AIDS210	Fundamentals of Machine Learning	3	-	3
ES/BS	AIDS212	Computational Methods	3	-	3
HS/MS/PC (NUES)	AIDS214	Effective Technical Writing*	1	-	1
HS/MS (NUES)	AIDS216	Emerging Trends in Technological Industries*	1	-	1
Practical/Viva-Voce					
PC	AIDS252	Object Oriented Programming Lab	-	2	1
PC	AIDS254	Database Management Systems Lab	-	2	1
PC	AIDS256	Computer Networks and Internet Protocol Lab	-	2	1
PC	AIDS258	Fundamentals of Machine Learning Lab	-	2	1
PC	AIDS260	Practicum (Integrated Project)**	-	2	1
Total			**20**	**10**	**25**

*(NUES): Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus.

FIFTH SEMESTER (AIDS)					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory papers					
PC	AIDS301	Operating Systems	4	--	4
PC	AIDS303	Design and Analysis of Algorithms	4	-	4
PC	AIDS305	Data Mining	4	-	4
PC	AIDS307	Computer Organization and Architecture	3	-	3
PC	AIDS309	Introduction to Internet of Things	3	-	3
HS/MS	AIDS311	Principles of Entrepreneurship Mindset	2	-	2
Practical/Viva-Voce					
PC	AIDS351	Operating Systems Lab	-	2	1
PC	AIDS353	Design and Analysis of Algorithms Lab	-	2	1
PC	AIDS355	Data Mining lab	-	2	1
PC	AIDS357	Introduction to Internet of Things Lab	-	2	1
PC	AIDS359	Summer Training Report-1**	-	2	1
PC (NUES)	AIDS361	Seminar on Case Study of Emerging Areas of Technology*	-	1	1
Total			**20**	**11**	**26**

Note:

* (NUES): Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus

**(NUES): Comprehensive evaluation by a committee of teachers, constituted by the Academic Programme Committee (APC), out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the school.

Sixth Semester (AIDS)					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
PC	AIDS302	Digital Image Processing	3		3
PCE		Programme Core Elective Paper (PCE –1)			4
PCE		Programme Core Elective Paper (PCE – 2)			4
PCE		Programme Core Elective Paper (PCE – 3)			4
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 1 /OAE – 1)			4
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 2 /OAE – 2)			4
Practical / Viva Voce					
PC	AIDS354	Digital Image Processing Lab		2	1
HS/MS (NUES)	HS-352	NSS / NCC / Cultural Clubs / Technical Society / Technical Club**			2
Total					**26**

****NUES:** Comprehensive evaluation of the students by the concerned coordinator of NCC / NSS / Cultural Clubs / Technical Society / Technical Clubs, out of 100 as per the evaluation schemes worked out by these activity societies, organizations; the coordinators shall be responsible for the evaluation of the same. These activities shall start from the 1st semester and the evaluation shall be conducted at the end of the 6th semester for students admitted in the first semester and for Students admitted in the 2nd year as lateral entry the activity shall start from 3rd semester. The detailed document containing the policy for the award of Marks to be prepared by APC.

Seventh Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
HS/MS	AIDS401	Principles of Management for Engineers	2		2
PCE		Programme Core Elective Paper (PCE – 4)			4
PCE		Programme Core Elective Paper (PCE – 5)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 3 / OAE – 3)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 4 / OAE – 4)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 5 / OAE – 5)			4
Practical / Viva Voce					
PC / Project	AIDS451	Minor Project**			3
PC / Internship	AIDS453	Summer Training Report - 2 *			1
Total					**26**

***NOTE:** Comprehensive evaluation of the Summer Training Report – 2 (after 6th Semester) shall be done by the committee ofteachers, constituted by the Academic Programme Committee, out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the institute.

**The student shall be allocated a supervisor / guide for project work at the end 6th semester by the department / institution, the project shall continue into the 8th semester. In the 7th semester evaluation, the criteria for evaluation shall be conceptualization of the project work, the background study / literature survey and identification of objectives and methodology to be followed for project. As per university examination norms from time to time evaluation for the Teachers' Continuous Evaluation / Internal Assessment shall be done by concerned supervisor while the term end examination of As per university examination norms from time to time shall be conducted by the supervisor concerned and the external examiner deputed by the Examinations Division. In the absence of the supervisor, the Director of the Institution / Head of the Department can assign the responsibility of the supervisor (for purpose of examinations) to anyfaculty of the Institution / Department.

Eight Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Practical / Viva Voce					
PC / Project	AIDS452	Major Project – Dissertation and Viva Voce#			18
	AIDS454	Project Progress Evaluation#			2
or					
PC / Internship	AIDS456	Internship Report and Viva Voce##			18
	AIDS458	Internship Progress Evaluation##			2
Total			**0**	**0**	**20**

***NOTE: Comprehensive evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100.**

#By default, every student shall do the project work (AIDS452 and AIDS454). The student shall be allocated a supervisor/guide for project work at the start of the semester by the school. The criteria for evaluation shall be the conceptualization of the project work, the background study/literature survey and the identification of objectives and methodology to be followed for the project. In the absence of the supervisor, the Director/ Head of the Department can assign the responsibility of the supervisor (for the purpose of examinations) to any faculty member of the institute. The internal and external bifurcation of the project marks will be as per the bifurcation of marks for the practical examination.

##Students have the option to pursue his/her Dissertation on the basis of the Live Projects in a Recognized (CIN No. Required) Company/ Organization. The proposed company/ organization must be approved by the

Director/HOD/APC.

* The mid-term test shall be coordinated by the Programme Coordination Committee.

If a student could not appear for a mid-term test due to situation beyond the control by the student, a supplementary test may be arranged towards the end of the semester, in a similar manner to the mid-term test for such students. The students must apply for this provision to the department / institution. On examination of the reason for non-appearing in the mid-term test by the Head of the Department / Institute, and with reason for allowing to appear in the supplementary test to recorded by the Head of the Department / Institute, the student may be allowed.

The attendance sheets, the question papers and the award sheets for the continuous evaluation to be retained by the concerned department / institute for at least 6 months after the declaration of the result by the Examination Division of the University.

Programme Core Electives
(AIDS)

Semester 6 (Choose Any Three)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
6	AIDS304T	Fundamentals of Deep Learning	3		3
	AIDS304P	Fundamentals of Deep Learning Lab		2	1
6	AIDS306T	Big Data Analytics	3		3
	AIDS306P	Big Data Analytics Lab		2	1
6	AIDS308T	Next Generation Databases	3		3
	AIDS308P	Next Generation Databases Lab		2	1
6	AIDS310T	Social Network analytics	3		3
	AIDS310P	Social Network analytics Lab		2	1
6	AIDS312T	Network Science	3		3
	AIDS312P	Network Science Lab		2	1
6	AIDS314T	AI and Sustainable Computing	4		4
6	AIDS316T	Biomedical Data Analysis	4		4
6	AIDS318T	Optimization Algorithm and its Application	4		4
6	AIDS320T	Cognitive Computing	4		4
Semester 7 (Choose Any Two)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
7	AIDS403T	Digital and Social Media Analytics	3		3
	AIDS403P	Digital and Social Media Analytics Lab		2	1
7	AIDS405T	Spatial Data Analysis	3		3
	AIDS405P	Spatial Data Analysis Lab		2	1
7	AIDS407T	Data Visualization	3		3
	AIDS407P	Data Visualization Lab		2	1
7	AIDS409T	Business Intelligence & Analytics	3		3
	AIDS409P	Business Intelligence & Analytics Lab		2	1
7	AIDS411T	Advances in Data Science	3		3
	AIDS411P	Advances in Data Science Lab		2	1
7	AIDS413T	Data Science for Complex Systems	3		3
	AIDS413P	Data Science for Complex Systems Lab		2	1

Note:

1. An elective shall be offered to the student for each PCE group (That is for PCE-1, PCE-2, PCE-3, PCE-4, PCE-5) based on the availability of resources and faculty at the institution and at least one third of the batch or at least 20 students must be willing to take the elective. At least two electives per PCE group must be offered to the students of the major discipline.

2. Each PCE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of PCE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required.

Open Area Electives for AIDS/AIML/IIOT

Semester 6 (Choose any Two)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
6	OAE304T	Blockchain Technology	3		3
	OAE304P	Blockchain Technology Lab		2	1
6	OAE306T	Human Computer Interaction	4		4
6	OAE308T	Quantum computing	4		4
6	OAE310T	Cryptography and Network Security	4		4
6	OAE312T	Mobile Application Development	3		3
	OAE312P	Mobile Application Development Lab		2	1
6	OAE314T	Virtual and Augmented Reality	4		4
6	OAE316T	Cloud Computing	3		3
	OAE316P	Cloud Computing Lab		2	1
6	OAE318T	Software Project Management	4		4
6	OAE320T	Nature Inspired Algorithm	4		4
6	OAE322T	Introduction to Robotics	4		4
Semester 7 (Choose any Three)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
7	OAE403T	Computer Vision	3		3
	OAE403P	Computer Vision Lab		2	1
7	OAE405T	Software Verification, Validation and Testing	3		3
	OAE405P	Software Verification, Validation and Testing Lab		2	1
7	OAE407T	Metaverse and its Applications	4		4
7	OAE409T	Web Intelligence	3		3
	OAE409P	Web Intelligence Lab		2	1
7	OAE411T	Intelligent and Expert Systems	3		3
	OAE411P	Intelligent and Expert Systems Lab		2	1
7	OAE413T	Audio and Speech Processing	3		3
	OAE413P	Audio and Speech Processing Lab		2	1
7	OAE415T	Cyber Forensics and Cyber Crime Investigation	4		4
7	OAE417T	Advanced Java Programming	3		3
	OAE417P	Advanced Java Programming Lab		2	1
7	OAE419T	Bioinformatics	4		4
7	OAE421T	Digital & Smart Cities	4		4

Note:

1. Each OAE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of OAE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required.

Implementation Rules:

1. ***The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.*.**

2. **Minimum duration** of the Bachelor of Technology programme shall be 4 years (N=4 years). A specific lateral entry students' minimum duration shall be the same as the minimum duration for the batch in which he/she is admitted as a lateral entry student in the 2nd year.

3. ***Maximum duration of the Bachelor of Technology programme shall be 6 years (N+2 years).***

4. The degree shall be awarded only after the fulfilment of all requirements of the Scheme and Syllabus of Examinations and the applicable Ordinance.

5. (a) The students shall undergo the following group of Courses / Papers as enumerated in the scheme (***For the students admitted in the First Year / First Semester).***

Group	**Semester (Credits)**							**Total Credits**	**Mandatory Credits**
	I&II	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
BS	24	4						28	14
HS/MS	6	6	2	2	2	2		20	10
ES	20		3					23	15
PC		17	20	24	4	4	20	89	76
PCE					12	12		20	16
EAE/OAE					8	8		20	16
Total	50	27	25	26	26	26	20	200	147

TABLE 1: Distribution of Credits for 1st year students

(b) The students admitted as Lateral Entry shall undergo the following group of Courses / Papers asenumerated in the scheme

6. Mandatory Credits specify the number of credits from each subject group to be mandatorily acquired by the student for the award of the degree, for students admitted as students in the 1st year and 1st semester of the degree programme is 147. While for students admitted as lateral entry in the 2nd year and 3rd semester the Mandatory Credits value is 115 and specify the number of credits from each subject group to be mandatorily acquired by the student for the award of the degree (Table 2). See clause 11 and 12 also**.**

7. Some of the papers are droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed some of the papers of these group. However, the student has to earn the minimum credits for the programme of study as specified. **See clause 11 and 12 also**.

8. To earn an Honours degree, a student may enroll for 20 credits or more through SWAYAM / NPTEL MOOCs platform. The acquisition of the credits should be completed before the 15th of the July of the admission year plus 4 years. That is, if a student is admitted in the year X, then these credits must be acquired through MOOCs by 15th July of the year (X+4), no extra duration or time shall be allocated. Honours in the degree shall be awarded if and only if at least 20 credits are acquired through MOOCs. To obtain Honours in the programme, a student must apply to the School about the same before the commencement of the 5th semester. The specific courses through MOOCs shall be registered by the student only after approval by the Academic programme committee

Group	Semester (Credits)						Total Credits	Mandatory Credits
	III	**IV**	**V**	**VI**	**VII**	**VIII**		
BS	4						4	0
HS/MS	6	2	2	2	2		14	7
ES		3					3	0
PC	17	20	24	4	4	20	89	76
PCE				12	12		20	16
EAE/OAE				8	8		20	16
Total	27	25	26	26	26	20	150	115

TABLE 2: Distribution of Credits for Lateral Entry Students

9. **Maximum Credits** is at least **200** (Table 1) for students admitted in the 1st year, these are the credits for which the student shall have to study for the non-Honours component of the curriculum. And, for lateral entry students admitted in the 2nd year, the maximum credit required to be studied is at least **150** (Table 2).

10. **Minimum Credits** required to be earned is atleast **180** for students admitted in the 1st year and, for lateral entry students admitted in the 2nd year, the minimum credit required to be earned Is at least **135**. See clause 6 also.

11. The following degree route can be taken by a student **(also refer point 8)**:
 The degree nomenclature of the degree shall be as: "***Bachelor of Technology in Artificial Intelligence and Data Science";*** if criteria / **point 8** is not satisfied for Honours. Otherwise, if criteria / **point 8** is met, then the degrees shall be an Honours degree and the nomenclature shall be as: "***Bachelor of Technology in Artificial Intelligence and Data Science (Honours)***",

12. ***Pass marks in every paper shall be 40.***

13. ***Grading System shall be as per Ordinance 11 of the University.***

14. The medium of instructions shall be English.

Bachelor of Technology
in
Artificial Intelligence and Machine Learning (AIML)
2nd Year Onward Scheme
and
implementation guideline

Third Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
PC	AIML201	Data Structures	3	-	3
PC	AIML203	Foundations of Data Science	3	-	3
PC	AIML205	Digital Logic Design	3	-	3
PC	AIML207	Principles of Artificial Intelligence	3	-	3
ES/BS	AIML209	Probability, Statistics and Linear Algebra	4	-	4
HS/MS	AIML211	Universal Human Values- II	3	-	3
HS/MS	AIML213	Critical Reasoning and Systems Thinking	2	-	2
HS/MS (NUES)	AIML215	Selected readings*	1	-	1
Practical/Viva-Voce					
PC	AIML251	Data Structures Lab	-	2	1
PC	AIML253	Foundations of Data Science Lab	-	2	1
PC	AIML255	Digital Logic Design Lab	-	2	1
PC	AIML257	Principles of Artificial Intelligence Lab	-	2	1
PC	AIML259	Web Programming Lab	-	2	1
Total			**22**	**10**	**27**

***(NUES)**: *Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus.*

Fourth Semester					
Group	**Paper Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	AIML202	Object Oriented Programming	3	-	3
PC	AIML204	Database Management Systems	3	-	3
PC	AIML206	Software Engineering	3	-	3
PC	AIML208	Computer Networks and Internet Protocol	3	-	3
PC	AIML210	Fundamentals of Machine Learning	3	-	3
ES/BS	AIML212	Computational Methods	3	-	3
HS/MS/PC (NUES)	AIML214	Effective Technical Writing*	1	-	1
HS/MS (NUES)	AIML216	Emerging Trends in Technological Industries*	1	-	1
Practical/Viva-Voce					
PC	AIML252	Object Oriented Programming Lab	-	2	1
PC	AIML254	Database Management Systems Lab	-	2	1
PC	AIML256	Computer Networks and Internet Protocol Lab	-	2	1
PC	AIML258	Fundamentals of Machine Learning Lab	-	2	1
PC	AIML260	Practicum (Integrated Project)*	-	2	1
Total			**20**	**10**	**25**

***(NUES)**: *Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus.*

FIFTH SEMESTER					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory papers					
PC	AIML301	Operating Systems	4	--	4
PC	AIML303	Design and Analysis of Algorithms	4	-	4
PC	AIML305	Fundamentals of Deep Learning	4	-	4
PC	AIML307	Computer Organization and Architecture	3	-	3
PC	AIML309	Introduction to Internet of Things	3	-	3
HS/MS	AIML311	Principles of Entrepreneurship Mindset	2	-	2
Practical/Viva-Voce					
PC	AIML351	Operating Systems Lab	-	2	1
PC	AIML353	Design and Analysis of Algorithms Lab	-	2	1
PC	AIML355	Fundamentals of Deep Learning Lab	-	2	1
PC	AIML357	Introduction to Internet of Things Lab	-	2	1
PC	AIML359	Summer Training Report-1**	-	2	1
PC (NUES)	AIML361	Seminar on Case Study of Emerging Areas of Technology*	-	1	1
Total			**20**	**11**	**26**

Note:

* (NUES): Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus

**(NUES): Comprehensive evaluation by a committee of teachers, constituted by the Academic Programme Committee (APC), out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the school.

Sixth Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
PC	AIML302	Digital Image Processing	3		3
PCE		Programme Core Elective Paper (PCE –1)			4
PCE		Programme Core Elective Paper (PCE – 2)			4
PCE		Programme Core Elective Paper (PCE – 2)			4
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 1 /OAE – 1)			4
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 2 /OAE – 2)			4
Practical / Viva Voce					
PC	AIML354	Digital Image Processing Lab		2	1
HS/MS (NUES)	HS-352	NSS / NCC / Cultural Clubs / Technical Society / TechnicalClub**			2
Total					**26**

****NUES:** Comprehensive evaluation of the students by the concerned coordinator of NCC / NSS / Cultural Clubs / Technical Society / Technical Clubs, out of 100 as per the evaluation schemes worked out by these activity societies, organizations; the coordinators shall be responsible for the evaluation of the same. These activities shall start from the 1st semester and the evaluation shall be conducted at the end of the 6th semester for students admitted in the first semester and for Students admitted in the 2nd year as lateral entry the activity shall start from 3rd semester. The detailed document containing the policy for the award of Marks to be prepared by APC.

Seventh Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
HS/MS	AIML401	Principles of Management for Engineers	2		2
PCE		Programme Core Elective Paper (PCE – 4)			4
PCE		Programme Core Elective Paper (PCE – 5)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 3 / OAE – 3)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 4 / OAE – 4)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 5 / OAE – 5)			4
Practical / Viva Voce					
PC / Project	AIML451	Minor Project**			3
PC / Internship	AIML453	Summer Training Report - 2 *			1
Total					**26**

***NOTE:** Comprehensive evaluation of the Summer Training Report – 2 (after 6th Semester) shall be done by the committee ofteachers, constituted by the Academic Programme Committee, out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the institute.

**The student shall be allocated a supervisor / guide for project work at the end 6th semester by the department / institution, the project shall continue into the 8th semester. In the 7th semester evaluation, the criteria for evaluation shall be conceptualization of the project work, the background study / literature survey and identification of objectives and methodology to be followed for project. As per university examination norms from time to time evaluation for the Teachers' Continuous Evaluation / Internal Assessment shall be done by concerned supervisor while the term end examination of As per university examination norms from time to time shall be conducted by the supervisor concerned and the external examiner deputed by the Examinations Division. In the absence of the supervisor, the Director of the Institution / Head of the Department can assign the responsibility of the supervisor (for purpose of examinations) to anyfaculty of the Institution / Department.

Eight Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Practical / Viva Voce					
PC / Project	AIML452	Major Project – Dissertation and Viva Voce#			18
	AIML454	Project Progress Evaluation#			2
or					
PC / Internship	AIML456	Internship Report and Viva Voce##			18
	AIML458	Internship Progress Evaluation##			2
Total			**0**	**0**	**20**

***NOTE: Comprehensive evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100.**

#By default, every student shall do the project work (AIML452 and AIML454). The student shall be allocated a supervisor/guide for project work at the start of the semester by the school. The criteria for evaluation shall be the conceptualization of the project work, the background study/literature survey and the identification of objectives and methodology to be followed for the project. In the absence of the supervisor, the Director/ Head of the Department can assign the responsibility of the supervisor (for the purpose of examinations) to any faculty member of the institute. The internal and external bifurcation of the project marks will be as per the bifurcation of marks for the practical examination.

##Students have the option to pursue his/her Dissertation on the basis of the Live Projects in a Recognized (CIN

No. Required)	Company/ Organization. The proposed company/ organization must be approved by the Director/HOD/APC.

* The mid-term test shall be coordinated by the Programme Coordination Committee.

If a student could not appear for a mid-term test due to situation beyond the control by the student, a supplementary test may be arranged towards the end of the semester, in a similar manner to the mid-term test for such students. The students must apply for this provision to the department / institution. On examination of the reason for non-appearing in the mid-term test by the Head of the Department / Institute, and with reason for allowing to appear in the supplementary test to recorded by the Head of the Department / Institute, the student may be allowed.

The attendance sheets, the question papers and the award sheets for the continuous evaluation to be retained by the concerned department / institute for at least 6 months after the declaration of the result by the Examination Division of the University.

Programme Core Electives

(AIML)

Semester 6 (Choose Any Three)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
6	AIML304T	Introduction to Data Mining	3		3
	AIML304P	Introduction to Data Mining Lab		2	1
6	AIML306T	Machine Learning for Intelligence Communications & Systems	3		3
	AIML306P	Machine Learning for Intelligence Communications & Systems Lab		2	1
6	AIML308T	Advances in Deep Learning	3		3
	AIML308P	Advances in Deep Learning Lab		2	1
6	AIML310T	Time Series analysis and Forecasting	3		3
	AIML310P	Time Series analysis and Forecasting Lab		2	1
6	AIML312T	Modelling Complex Systems using Machine Learning	3		3
	AIML312P	Modelling Complex Systems using Machine Learning Lab		2	1
6	AIML314T	Game Designing	3		3
	AIML314P	Game Designing Lab		2	1
6	AIML316T	Natural Language Processing	3		3
6	AIML316P	Natural Language Processing Lab		2	1
6	AIML318T	Cloud Dew Edge Fog Computing (CDEF)	4		4
6	AIML320T	Pattern Recognition	4		4
Semester 7 (Choose Any Two)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
7	AIML403T	Information Retrieval & Recommender Systems	3		3
	AIML403P	Information Retrieval & Recommender Systems Lab		2	1
7	AIML405T	Fuzzy systems: Theory and Applications	3		3
	AIML405P	Fuzzy systems: Theory and Applications Lab		2	1
7	AIML407T	Reinforcement Learning	3		3
	AIML407P	Reinforcement Learning Lab		2	1
7	AIML409T	Predictive Business Analysis	3		3
	AIML409P	Predictive Business Analysis Lab		2	1
7	AIML411T	Advances in Machine Learning	3		3
	AIML411P	Advances in Machine Learning Lab		2	1
7	AIML413T	Machine Learning in Healthcare	3		3
	AIML413P	Machine Learning in Healthcare Lab		2	1

Note:

1. An elective shall be offered to the student for each PCE group (That is for PCE-1, PCE-2, PCE-3, PCE-4, PCE-5) based on the availability of resources and faculty at the institution and at least one third of the batch or at least 20 students must be willing to take the elective. At least two elective per PCE group must be offered to the students of the major discipline.
2. Each PCE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 creditsper slot of PCE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required.

Open Area Electives for AIDS/AIML/IIOT

Semester 6 (Choose any Two)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
6	OAE304T	Blockchain Technology	3		3
	OAE304P	Blockchain Technology Lab		2	1
6	OAE306T	Human Computer Interaction	4		4
6	OAE308T	Quantum computing	4		4
6	OAE310T	Cryptography and Network Security	4		4
6	OAE312T	Mobile Application Development	3		3
	OAE312P	Mobile Application Development Lab		2	1
6	OAE314T	Virtual and Augmented Reality	4		4
6	OAE316T	Cloud Computing	3		3
	OAE316P	Cloud Computing Lab		2	1
6	OAE318T	Software Project Management	4		4
6	OAE320T	Nature Inspired Algorithm	4		4
6	OAE322T	Introduction to Robotics	4		4
Semester 7 (Choose any Three)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
7	OAE403T	Computer Vision	3		3
	OAE403P	Computer Vision Lab		2	1
7	OAE405T	Software Verification, Validation and Testing	3		3
	OAE405P	Software Verification, Validation and Testing Lab		2	1
7	OAE407T	Metaverse and its Applications	4		4
7	OAE409T	Web Intelligence	3		3
	OAE409P	Web Intelligence Lab		2	1
7	OAE411T	Intelligent and Expert Systems	3		3
	OAE411P	Intelligent and Expert Systems Lab		2	1
7	OAE413T	Audio and Speech Processing	3		3
	OAE413P	Audio and Speech Processing Lab		2	1
7	OAE415T	Cyber Forensics and Cyber Crime Investigation	4		4
7	OAE417T	Advanced Java Programming	3		3
	OAE417P	Advanced Java Programming Lab		2	1
7	OAE419T	Bioinformatics	4		4
7	OAE421T	Digital & Smart Cities	4		4

Note:

1. Each OAE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of OAE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required.
2. The Open Area Electives described / enumerated are the one offered by engineering departments. If other departments, offering minor specialization or elective papers as open area electives to engineering students (approved by the university Academic Council) are possible at the concerned institution, the same may also be offered to the engineering students studying in the major disciplines under the aegis of the USAR. The APC of the department / intuition shall allow the choice of such electives, provided they follow the credit framework of the programme of study for open area electives.

Implementation Rules:

1. ***The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.*.**

2. **Minimum duration** of the Bachelor of Technology programme shall be 4 years (N=4 years). A specific lateral entry students' minimum duration shall be the same as the minimum duration for the batch in which he/she is admitted as a lateral entry student in the 2nd year.

3. ***Maximum duration of the Bachelor of Technology programme shall be 6 years (N+2 years).***

4. The degree shall be awarded only after the fulfilment of all requirements of the Scheme and Syllabus of Examinations and the applicable Ordinance.

5. (a) The students shall undergo the following group of Courses / Papers as enumerated in the scheme (***For the students admitted in the First Year / First Semester).***

Group	**Semester (Credits)**							**Total Credits**	**Mandatory Credits**
	I&II	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
BS	24	4						28	14
HS/MS	6	6	2	2	2	2		20	10
ES	20		3					23	15
PC		17	20	24	4	4	20	89	76
PCE					12	12		20	16
EAE/OAE					8	8		20	16
Total	50	27	25	26	26	26	20	200	147

TABLE 1: Distribution of Credits for 1st year students

(b) The students admitted as Lateral Entry shall undergo the following group of Courses / Papers asenumerated in the scheme

6. Mandatory Credits specify the number of credits from each subject group to be mandatorily acquired by the student for the award of the degree, for students admitted as students in the 1st year and 1st semester of the degree programme is 147. While for students admitted as lateral entry in the 2nd year and 3rd semester the Mandatory Credits value is 115 and specify the number of credits from each subject group to be mandatorily acquired by the student for the award of the degree (Table 2). See clause 11 and 12 also**.**

7. Some of the papers are droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed some of the papers of these group. However, the student has to earn the minimum credits for the programme of study as specified. **See clause 11 and 12 also**.

8. To earn an Honours degree, a student may enroll for 20 credits or more through SWAYAM / NPTEL MOOCs platform. The acquisition of the credits should be completed before the 15th of the July of the admission year plus 4 years. That is, if a student is admitted in the year X, then these credits must be acquired through MOOCs by 15th July of the year (X+4), no extra duration or time shall be allocated. Honours in the degree shall be awarded if and only if at least 20 credits are acquired through MOOCs. To obtain Honours in the programme, a student must apply to the School about the same before the commencement of the 5th semester. The specific courses through MOOCs shall be registered by the student only after approval by the Academic programme committee

Group	Semester (Credits)						Total Credits	Mandatory Credits
	III	IV	V	VI	VII	VIII		
BS	4						4	0
HS/MS	6	2	2	2	2		14	7
ES		3					3	0
PC	17	20	24	4	4	20	89	76
PCE				12	12		20	16
EAE/OAE				8	8		20	16
Total	27	25	26	26	26	20	150	115

TABLE 2: Distribution of Credits for Lateral Entry Students

9. **Maximum Credits** is at least **200** (Table 1) for students admitted in the 1st year, these are the credits for which the student shall have to study for the non-Honours component of the curriculum. And, for lateral entry students admitted in the 2nd year, the maximum credit required to be studied is at least **150** (Table 2).

10. **Minimum Credits** required to be earned is atleast **180** for students admitted in the 1st year and, for lateral entry students admitted in the 2nd year, the minimum credit required to be earned Is at least **135**. See clause 6 also.

11. The following degree route can be taken by a student **(also refer point 8)**:
 The degree nomenclature of the degree shall be as: "***Bachelor of Technology in Artificial Intelligence and Data Science";*** if criteria / **point 8** is not satisfied for Honours. Otherwise, if criteria / **point 8** is met, then the degrees shall be an Honours degree and the nomenclature shall be as: "***Bachelor of Technology in Artificial Intelligence and Data Science (Honours)***",

12. ***Pass marks in every paper shall be 40.***

13. ***Grading System shall be as per Ordinance 11 of the University.***

14. **The medium of instructions shall be English.**

Bachelor of Technology
in
Industrial Internet of Things (IIOT)
2^{nd} Year Onward Scheme
and
implementation guideline

Third Semester					
Group	**Paper Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	IOT201	Data Structures	3	-	3
PC	IOT203	Foundations of Data Science	3	-	3
PC	IOT205	Digital Logic Design	3	-	3
PC	IOT207	Principles of Artificial Intelligence	3	-	3
ES/BS	IOT209	Probability, Statistics and Linear Algebra	4	-	4
HS/MS	IOT211	Universal Human Values- II	3	-	3
HS/MS	IOT213	Critical Reasoning and Systems Thinking	2	-	2
HS/MS (NUES)	IOT215	Selected readings*	1	-	1
Practical/Viva-Voce					
PC	IOT251	Data Structures Lab	-	2	1
PC	IOT253	Foundations of Data Science Lab	-	2	1
PC	IOT255	Digital Logic Design Lab	-	2	1
PC	IOT257	Principles of Artificial Intelligence Lab	-	2	1
PC	IOT259	Web Programming Lab	-	2	1
Total			**22**	**10**	**27**

***(NUES)**: *Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus.*

Fourth Semester					
Group	**Paper Code**	**Paper**	**L**	**T/P**	**Credits**
Theory Papers					
PC	IOT202	Object Oriented Programming	3	-	3
PC	IOT204	Database Management Systems	3	-	3
PC	IOT206	Software Engineering	3	-	3
PC	IOT208	Computer Networks and Internet Protocol	3	-	3
PC	IOT210	Internet of Things	3	-	3
ES/BS	IOT212	Computational Methods	3	-	3
HS/MS/PC (NUES)	IOT214	Effective Technical Writing*	1	-	1
HS/MS (NUES)	IOT216	Emerging Trends in Technological Industries*	1	-	1
Practical/Viva-Voce					
PC	IOT252	Object Oriented Programming Lab	-	2	1
PC	IOT254	Database Management Systems Lab	-	2	1
PC	IOT256	Computer Networks and Internet Protocol Lab	-	2	1
PC	IOT258	Internet of Things Lab	-	2	1
PC	IOT260	Practicum (Integrated Project)*	-	2	1
Total			**20**	**10**	**25**

***(NUES)**: *Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus.*

Fifth Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
PC	IOT301	Data Transmission Methodologies	4	--	4
PC	IOT303	Design and Analysis of Algorithms	4	-	4
PC	IOT305	Sensors and Control Systems	4	-	4
PC	IOT307	Computer Organization and Architecture	3	-	3
PC	IOT309	Machine Learning	3	-	3
HS/MS	IOT311	Principles of Entrepreneurship Mindset	2	-	2
Practical/Viva-Voce					
PC	IOT351	Data Transmission Methodologies Lab	-	2	1
PC	IOT353	Design and Analysis of Algorithms Lab	-	2	1
PC	IOT355	Sensors and Control Systems Lab	-	2	1
PC	IOT357	Machine Learning Lab	-	2	1
PC	IOT359	Summer Training Report-1**	-	2	1
PC (NUES)	IOT361	Seminar on Case Study of Emerging Areas of Technology*	-	1	1
Total			**20**	**11**	**26**

Note:

* (NUES): Non-University Exam Subject, Comprehensive evaluation by the concerned teacher, out of 100, as per detailed syllabus

**(NUES): Comprehensive evaluation by a committee of teachers, constituted by the Academic Programme Committee (APC), out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the school.

Sixth Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
PC	IOT302	Digital Image Processing	3		3
PCE		Programme Core Elective Paper (PCE –1)			4
PCE		Programme Core Elective Paper (PCE – 2)			4
PCE		Programme Core Elective Paper (PCE –3)			4
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 1 /OAE – 1)			4
EAE / OAE		Emerging Area/Open Area Elective Paper (EAE – 2 /OAE – 2)			4
Practical / Viva Voce					
PC	IOT354	Digital Image Processing Lab		2	1
HS/MS (NUES)	HS-352	NSS / NCC / Cultural Clubs / Technical Society / Technical Club**			2
Total					**26**

****NUES:** Comprehensive evaluation of the students by the concerned coordinator of NCC / NSS / Cultural Clubs / Technical Society / Technical Clubs, out of 100 as per the evaluation schemes worked out by these activity societies, organizations; the coordinators shall be responsible for the evaluation of the same. These activities shall start from the 1st semester and the evaluation shall be conducted at the end of the 6th semester for students admitted in the first semester and for Students admitted in the 2nd year as lateral entry the activity shall start from 3rd semester. The detailed document containing the policy for the award of Marks to be prepared by APC.

Seventh Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Theory Papers					
HS/MS	IOT401	Principles of Management for Engineers	2		2
PCE		Programme Core Elective Paper (PCE –4)			4
PCE		Programme Core Elective Paper (PCE – 5)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 3 / OAE – 3)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 4 / OAE – 4)			4
EAE / OAE		Emerging Area / Open Area Elective Paper (EAE – 5 / OAE – 5)			4
Practical / Viva Voce					
PC / Project	IOT451	Minor Project**			3
PC / Internship	IOT453	Summer Training Report - 2 *			1
Total					**26**

***NOTE:** Comprehensive evaluation of the Summer Training Report – 2 (after 6th Semester) shall be done by the committee ofteachers, constituted by the Academic Programme Committee, out of 100. The training shall be of 4 to 6 weeks duration. The training can be under the mentorship of a teacher of the institute.

**The student shall be allocated a supervisor / guide for project work at the end 6th semester by the department / institution, the project shall continue into the 8th semester. In the 7th semester evaluation, the criteria for evaluation shall be conceptualization of the project work, the background study / literature survey and identification of objectives and methodology to be followed for project. As per university examination norms from time to time evaluation for the Teachers' Continuous Evaluation / Internal Assessment shall be done by concerned supervisor while the term end examination of As per university examination norms from time to time shall be conducted by the supervisor concerned and the external examiner deputed by the Examinations Division. In the absence of the supervisor, the Director of the Institution / Head of the Department can assign the responsibility of the supervisor (for purpose of examinations) to anyfaculty of the Institution / Department.

Eight Semester					
Group	**Paper Code**	**Paper**	**L**	**P**	**Credits**
Practical / Viva Voce#					
PC / Project	IOT452	Major Project – Dissertation and Viva Voce#			18
	IOT454	Project Progress Evaluation#			2
or					
PC / Internship	IOT456	Internship Report and Viva Voce##			18
	IOT458	Internship Progress Evaluation##			2
Total			**0**	**0**	**20**

***NOTE: Comprehensive evaluation by the committee of teachers, constituted by the Academic Programme Committee, out of 100.**

#By default, every student shall do the project work (AIML452 and AIML454). The student shall be allocated a supervisor/guide for project work at the start of the semester by the school. The criteria for evaluation shall be the conceptualization of the project work, the background study/literature survey and the identification of objectives and methodology to be followed for the project. In the absence of the supervisor, the Director/ Head of the Department can assign the responsibility of the supervisor (for the purpose of examinations) to any faculty member of the institute. The internal and external bifurcation of the project marks will be as per the bifurcation of marks for the practical examination.

##Students have the option to pursue his/her Dissertation on the basis of the Live Projects in a Recognized (CIN

No. Required)	Company/ Organization. The proposed company/ organization must be approved by the Director/HOD/APC.

* The mid-term test shall be coordinated by the Programme Coordination Committee.

If a student could not appear for a mid-term test due to situation beyond the control by the student, a supplementary test may be arranged towards the end of the semester, in a similar manner to the mid-term test for such students. The students must apply for this provision to the department / institution. On examination of the reason for non-appearing in the mid-term test by the Head of the Department / Institute, and with reason for allowing to appear in the supplementary test to recorded by the Head of the Department / Institute, the student may be allowed.

The attendance sheets, the question papers and the award sheets for the continuous evaluation to be retained by the concerned department / institute for at least 6 months after the declaration of the result by the Examination Division of the University.

Programme Core Electives
(IIOT)

Semester 6 (Choose Any Three)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
6	IOT304T	Wireless Sensor Networks	3	-	3
	IOT304P	Wireless Sensor Networks Lab	-	2	1
6	IOT306T	Mobile Computing	3	-	3
	IOT306P	Mobile Computing Lab	-	2	1
6	IOT308T	Soft Computing	3	-	3
	IOT308P	Soft Computing Lab	-	2	1
6	IOT310T	Process Automation	3	-	3
	IOT310P	Process Automation Lab	-	2	1
6	IOT312T	Mechatronics: Fundamentals and Applications	3	-	3
	IOT312P	Mechatronics: Fundamentals and Applications Lab	-	2	1
6	IOT314T	Big Data in IoT	3	-	3
	IOT314P	Big Data in IoT lab	-	2	1
6	IOT316T	Cyber Physical Systems and Industry 4.0	4		4
6	IOT318T	Green IoT and Sustainable Computing	4	-	4
6	IOT320T	Smart Grid	4	-	4
Semester 7 (Choose Any Two)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
7	IOT403T	IoT Deployment, Testing & its Challenges	4	-	4
7	IOT405T	Real-Time Systems	4	-	4
7	IOT407T	Drone Applications, Components and Assembly	4	-	4
7	IOT409T	Industrial IoT & Applications	4	-	4
7	IOT411T	Remote Sensing and its Applications	4	-	4
7	IOT413T	IOT based Intelligent Automation	4	-	4

Note:

1. An elective shall be offered to the student for each PCE group (That is for PCE-1, PCE-2, PCE-3, PCE-4, PCE-5) based on the availability of resources and faculty at the institution and at least one third of the batch or at least 20 students must be willing to take the elective. At least two elective per PCE group must be offered to the students of the major discipline.

2. Each PCE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of PCE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required.

Open Area Electives for AIDS/AIML/IIOT

Semester 6 (Choose any Two)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
6	OAE304T	Blockchain Technology	3		3
	OAE304P	Blockchain Technology Lab		2	1
6	OAE306T	Human Computer Interaction	4		4
6	OAE308T	Quantum computing	4		4
6	OAE310T	Cryptography and Network Security	4		4
6	OAE312T	Mobile Application Development	3		3
	OAE312P	Mobile Application Development Lab		2	1
6	OAE314T	Virtual and Augmented Reality	4		4
6	OAE316T	Cloud Computing	3		3
	OAE316P	Cloud Computing Lab		2	1
6	OAE318T	Software Project Management	4		4
6	OAE320T	Nature Inspired Algorithm	4		4
6	OAE322T	Introduction to Robotics	4		4
Semester 7 (Choose any Three)					
Semester	**Paper Code**	**Subject Name**	**L**	**P**	**Credits**
7	OAE403T	Computer Vision	3		3
	OAE403P	Computer Vision Lab		2	1
7	OAE405T	Software Verification, Validation and Testing	3		3
	OAE405P	Software Verification, Validation and Testing Lab		2	1
7	OAE407T	Metaverse and its Applications	4		4
7	OAE409T	Web Intelligence	3		3
	OAE409P	Web Intelligence Lab		2	1
7	OAE411T	Intelligent and Expert Systems	3		3
	OAE411P	Intelligent and Expert Systems Lab		2	1
7	OAE413T	Audio and Speech Processing	3		3
	OAE413P	Audio and Speech Processing Lab		2	1
7	OAE415T	Cyber Forensics and Cyber Crime Investigation	4		4
7	OAE417T	Advanced Java Programming	3		3
	OAE417P	Advanced Java Programming Lab		2	1
7	OAE419T	Bioinformatics	4		4
7	OAE421T	Digital & Smart Cities	4		4

Note:

1. Each OAE slot is of 4 credits, if in a particular slot, the paper has no practical component, then it is of 4 credits (a pure theory paper), otherwise for purpose of examination and conduct of classes, the course is split in two papers, namely a theory paper of 3 credits and a practical paper of 1 credit. The student has to study for 4 credits per slot of OAE group. This is reflected by suffixing the paper code by T (for Theory component) and P (for Practical component), if required.
2. The Open Area Electives described / enumerated are the one offered by engineering departments. If other departments, offering minor specialization or elective papers as open area electives to engineering students (approved by the university Academic Council) are possible at the concerned institution, the same may also be offered to the engineering students studying in the major disciplines under the aegis of the USAR. The APC of the department / intuition shall allow the choice of such electives, provided they follow the credit framework of the programme of study for open area electives.

Implementation Rules:

1. ***The examinations, attendance criteria to appear in examinations, promotion and award of the degree shall be governed by the Ordinance 11 of the University.*.**

2. **Minimum duration** of the Bachelor of Technology programme shall be 4 years (N=4 years). A specific lateral entry students' minimum duration shall be the same as the minimum duration for the batch in which he/she is admitted as a lateral entry student in the 2nd year.

3. ***Maximum duration of the Bachelor of Technology programme shall be 6 years (N+2 years).***

4. The degree shall be awarded only after the fulfilment of all requirements of the Scheme and Syllabus of Examinations and the applicable Ordinance.

5. (a) The students shall undergo the following group of Courses / Papers as enumerated in the scheme (***For the students admitted in the First Year / First Semester).***

Group	Semester (Credits)							Total Credits	Mandatory Credits
	I&II	III	IV	V	VI	VII	VIII		
BS	24	4						28	14
HS/MS	6	6	2	2	2	2		20	10
ES	20		3					23	15
PC		17	20	24	4	4	20	89	76
PCE					12	12		20	16
EAE/OAE					8	8		20	16
Total	50	27	25	26	26	26	20	200	147

TABLE 1: Distribution of Credits for 1st year students

(b) The students admitted as Lateral Entry shall undergo the following group of Courses / Papers asenumerated in the scheme

6. Mandatory Credits specify the number of credits from each subject group to be mandatorily acquired by the student for the award of the degree, for students admitted as students in the 1st year and 1st semester of the degree programme is 147. While for students admitted as lateral entry in the 2nd year and 3rd semester the Mandatory Credits value is 115 and specify the number of credits from each subject group to be mandatorily acquired by the student for the award of the degree (Table 2). See clause 11 and 12 also**.**

7. Some of the papers are droppable in the sense that the student may qualify for the award of the degree even when the student has not cleared / passed some of the papers of these group. However, the student has to earn the minimum credits for the programme of study as specified. **See clause 11 and 12 also**.

8. To earn an Honours degree, a student may enroll for 20 credits or more through SWAYAM / NPTEL MOOCs platform. The acquisition of the credits should be completed before the 15th of the July of the admission year plus 4 years. That is, if a student is admitted in the year X, then these credits must be acquired through MOOCs by 15th July of the year (X+4), no extra duration or time shall be allocated. Honours in the degree shall be awarded if and only if at least 20 credits are acquired through MOOCs. To obtain Honours in the programme, a student must apply to the School about the same before the commencement of the 5th semester. The specific courses through MOOCs shall be registered by the student only after approval by the Academic programme committee

Group	Semester (Credits)						Total Credits	Mandatory Credits
	III	**IV**	**V**	**VI**	**VII**	**VIII**		
BS	4						4	0
HS/MS	6	2	2	2	2		14	7
ES		3					3	0
PC	17	20	24	4	4	20	89	76
PCE				12	12		20	16
EAE/OAE				8	8		20	16
Total	27	25	26	26	26	20	150	115

TABLE 2: Distribution of Credits for Lateral Entry Students

9. **Maximum Credits** is at least **200** (Table 1) for students admitted in the 1st year, these are the credits for which the student shall have to study for the non-Honours component of the curriculum. And, for lateral entry students admitted in the 2nd year, the maximum credit required to be studied is at least **150** (Table 2).

10. **Minimum Credits** required to be earned is atleast **180** for students admitted in the 1st year and, for lateral entry students admitted in the 2nd year, the minimum credit required to be earned Is at least **135**. See clause 6 also.

11. The following degree route can be taken by a student **(also refer point 8)**:
 The degree nomenclature of the degree shall be as: "***Bachelor of Technology in Artificial Intelligence and Data Science";*** if criteria / **point 8** is not satisfied for Honours. Otherwise, if criteria / **point 8** is met, then the degrees shall be an Honours degree and the nomenclature shall be as: "***Bachelor of Technology in Artificial Intelligence and Data Science (Honours)***",

12. ***Pass marks in every paper shall be 40.***

13. ***Grading System shall be as per Ordinance 11 of the University.***

14. **The medium of instructions shall be English.**

SYLLABUS
(2nd Year)
for

BACHELOR OF TECHNOLOGY
for

Artificial Intelligence and Data Science
Artificial Intelligence and Machine Learning
Industrial Internet of Things

Revised Syllabus of

2nd year Papers

Applicable from Batch Admitted in Academic Session 2022-23 Onwards

DETAILED SYLLABUS FOR 3rd SEMESTER

Semester: 3rd			
Paper code: AIDS201/AIML201/IOT201	**L**	**T/P**	**Credits**
Subject: Data Structures	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the basic concepts of data structures.
2.	To perform basic operations on linked list, stacks and queues.
3.	To perform sorting and searching on a given set of data items.
4.	To understand the concepts of trees, hashing, and graph theory.

Course Outcomes:

CO1	Understand and identify the concepts of fundamentals of data structures and efficient access strategies for solving a computational problem.
CO2	Apply suitable data structure for solving a given problem and differentiate the usage of data structures and their applications.
CO3	Analyse the choice of data structures and their usage for sorting and searching numbers in data structures.
CO4	Create the solution for a particular problem and gain ability to provide solutions/approaches with file handling and tree structures.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	1	1	1	1	1	1	2
CO2	2	2	2	2	1	1	1	1	1	1	1	2
CO3	2	2	2	2	1	-	-	-	-	-	1	2
CO4	2	2	2	2	1	1	-	-	-	-	1	2

Course Overview:
This subject gives an overview of data structure concepts including arrays, stack, queues, linked lists, trees, and graphs. Discussions shall be held of various implementations of these data structures in real life. This subject also examines algorithms for sorting and searching. The concepts of trees and graph-based algorithms shall be introduced.

UNIT I: [8]
Introduction- Introduction to Algorithmic Complexity, Introduction to various data structures, Arrays and Strings operations, Stacks and Queues, Operations on Stacks and Queues, Array representation of Stacks, Applications of Stacks- Recursion, Polish expression and their compilation conversion of infix expression to prefix and postfix expression, Operations of Queues, Representations of Queues Applications of Queues, Priority queues, Overview of the list, set, tuples, and dictionary data structures.

UNIT II: [8]
Searching and Sorting- Linear Search, Binary search, Insertion Sort, Quick sort, Radix sort, Merge sort, Heap sort. Linked Lists- Singly linked lists, Representation of linked list, Operations of the Linked list such as Traversing, Insertion, and Deletion, Searching, and applications of Linked List. Concepts of Circular linked list and doubly linked list and their applications. Stacks and Queues as a linked list.

UNIT III: [8]
Trees- Basic Terminology, Binary Trees and their representation, binary search trees, various operations on Binary search trees like traversing, searching, Insertion and Deletion, Applications of Binary search Trees, Complete Binary trees, Extended binary trees. General trees, AVL trees, Threaded trees, B- trees, 2-3 trees, 2-3-4 trees, B* and B+ trees.

UNIT IV: [8]
File Structure- File Organization, Indexing & Hashing, Hash Functions, Graphs-Terminology and Representations, Graphs & Multi-graphs, Directed Graphs, Representation of graphs and their Transversal, Euler and Hamiltonian paths, Spanning trees, shortest path and Transitive Closure, Topological Sort, and Critical Paths.

Text Books:
1. Tannenbaum. Data Structures, PHI, 2007 (Fifth Impression).
2. An introduction to data structures and application by Jean-Paul Tremblay & Pal G. Sorenson (McGraw Hill).

Reference Books:
1. Data Structures with C - By Schaum Series.
2. R.L. Kruse, B.P. Leary, C.L. Tondo. Data structure and program design in C, PHI, 2009 (Fourth Impression).
3. Gilberg, R. F., & Forouzan, B. A., Data structures: A pseudocode approach with C++. Brooks/Cole Publishing, 2001.

Semester: 3rd			
Paper code: AIDS251/AIML251/IOT251	**L**	**T/P**	**Credits**
Subject: Data Structures Lab	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To teach students how to analyse different types of data structures.
2.	To design applications based on different types of data structures.

Course Outcomes:

CO1	Design programs using a variety of data structures such as stacks, queues, hash tables, binary trees, search trees, heaps, graphs, B-trees, list, set, tuples, dictionary.
CO2	Implement and analyse abstract data types such as lists, graphs, search trees to solve real world problems efficiently.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

LIST OF EXPERIMENTS:

1. Perform Linear Search and Binary Search on an array.
2. Create a stack and perform Pop, Push, and Traverse operations on the stack using array.
3. Create a stack and perform Pop, Push, and Traverse operations on the stack using linked list.
4. Create a Linear Queue using Linked List and implement different operations such as insert, delete, and display the queue elements.
5. Implement the following sorting techniques:

   a. Insertion sort
   b. Merge sort
   c. Bubble sort
   d. Selection sort

6. Create a linked list with nodes having information about a student. Insert a new node at the specified position.
7. Create a doubly linked list with nodes having information about an employee and perform Insertion at front of doubly linked list and perform deletion at end of that doubly linked list.
8. Create a circular linked list having information about a college and perform Insertion at the front end and perform deletion at the end.
9. Create a Binary Tree and perform Tree Traversals (Preorder, Postorder, Inorder) using the concept of recursion.
10. Implement insertion, deletion, and display (Inorder, Preorder, Postorder) on binary search tree with the information in the tree about the details of an automobile (type, company, year of make).

Semester: 3rd			
Paper code: AIDS203/AIML203/IOT203	**L**	**T/P**	**Credits**
Subject: Foundations of Data Science	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Everyunit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required

Course Objectives:

1.	To analyse different types of data using Python and .
2.	To prepare data for analysis and perform simple statistical analysis.
3.	To create meaningful data visualizations and predict future trends from data.

Course Outcomes:

CO1	Understand and identify the basic concepts of data science for performing data analysis.
CO2	Apply & perform pre-processing steps along with data visualization to get insights from data.
CO3	Analyse and apply different modules of data science to evaluate mathematical, and scientific problems of data analysis.
CO4	Develop the model for data analysis and evaluate the model's performance to optimize business decisions and create competitive advantage with data analytics.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	1	-	-	-	-	-	1	2
CO2	2	3	3	3	3	1	1	1	1	1	1	2
CO3	2	3	3	3	1	-	-	-	-	-	2	3
CO4	3	3	3	3	1	1	1	1	1	1	2	3

Course Overview:
Foundations of Data Science is a blend of statistical mathematics, data analysis tools and visualization, domain knowledge representation, tools and algorithms and computer science applications. The hidden insights or patterns are identified and analysed to form a decision.

UNIT I: [8]
Introduction to data science, applications of data science, data scientist roles and responsibilities, skills needed to become a data scientist. Need of Python for data analysis, Introduction to Data Understanding and Pre-processing, domain knowledge, Understanding structured and unstructured data. Creation of synthetic dataset in MS Excel.

UNIT II: [8]
Basics of Python programming: Variables, printing values, if condition, arithmetic operations, loops. Data Analysis process, Dataset generation, Importing Dataset: Importing and Exporting Data, Basic Insights from Datasets, Cleaning and Preparing the Data: Identify and Handle Missing Values.

UNIT III: [8]
Basics of essential Python libraries: Introduction to NumPy, Pandas, Matplotlib, SciPy. Data Processing, Data Visualization, Basic Visualization Tools, Specialized Visualization Tools, Seaborn Creating and Plotting Maps.

UNIT IV: [8]
Mathematical and scientific applications for data Analysis, Basics of Supervised and Unsupervised Learning. Decision Making. Trend & predictive mining using Python, Recommender systems.

Text Books:
1. Wes Mckinney. Python for Data Analysis, First edition, Publisher O'Reilly Media.
2. Foundational Python for Data Science, 1st edition, Kennedy Behrman, Pearson Publication.
3. Data analytics using Python, Bharti Motwani, Wiley Publication.

Reference Books:
1. Allen Downey, Jeffrey Elkner, Chris Meyers, Learning with Python, Dreamtech Press.
2. Reema Thareja. Python Programming using Problem Solving approach, Oxford University press.

Semester: 3rd			
Paper code: AIDS253/AIML253/IOT253	**L**	**T/P**	**Credits**
Subject: Foundations of Data Science Lab	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. Atleast 8 experiments must be performed by the students.

Course Objectives:

1.	To analyse different types of data using Python.
2.	To perform statistical analysis and create meaningful data insights.

Course Outcomes:

CO1	Apply data science principles to identify meaningful solutions to actual problems.
CO2	Analyse and create programs based on statistical analysis using different libraries of Python programming language.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	2	1	1	1	2
CO2	3	3	3	3	3	1	1	2	1	1	1	2

LIST OF EXPERIMENTS:

1. Introduction and installation of Python and Python IDEs for data science (Spyder-Anaconda, Jupyter Notebook etc.)
2. Design a Python program to generate and print a list except for the first 5 elements, where the values are squares of numbers between 1 and 30.
3. Design a Python program to understand the working of loops.
4. Design a Python function to find the Max of three numbers.
5. Design a Python program for creating a random story generator
6. Create a synthetic dataset (.csv/.xlsx) to work upon and design a Python program to read and print that data.
7. Design a Python program using NumPy library functions.
8. Perform Statistics and Data Visualization in python.

9. Design a Python program to implement Linear Regression

10. Design a Python program to create a recommender system

Faculties should also motivate students to make a project on the topics taught in theory and lab.

Semester: 3rd			
Paper code: AIDS205/AIML205/IOT205	**L**	**T/P**	**Credits**
Subject: Digital Logic Design	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To teach various number systems, binary codes and their applications.
2.	To familiarize the students with the importance of error detection and error correction codes.
3.	To inculcate concepts of K-MAP to simplify a Boolean expression.
4.	To facilitate students in designing a logic circuit.

Course Outcomes:

CO1	Understand number systems and complements for the basic functionality of digital systems
CO2	Identify the importance of canonical forms in the minimization or other optimization of Boolean formulas in general and digital circuits.
CO3	Apply and evaluate circuits of minimizing algorithms (Boolean algebra, Karnaugh map or tabulation method).
CO4	Design procedures of combinational and sequential circuits.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	-	-	-	-	-	-	1
CO3	2	2	2	2	1	-	-	-	-	-	-	1
CO4	2	2	2	2	1	-	-	-	-	-	-	1

Course Overview:

The course addresses the concepts of digital systems logic design, and techniques of designing digital systems. The course teaches the fundamentals of digital systems applying the logic design and development techniques. This course forms the basis for the study of advanced subjects like Computer Organization and Architecture, Microprocessor through Interfacing, VLSI Designing.

UNIT I: [8]

Digital systems, binary numbers, number base conversions, octal and hexadecimal numbers, complements, signed binary numbers, binary codes, error detection and error correction codes. Boolean Algebra and Logic Gates: Basic definitions, axiomatic definition of Boolean algebra, basic theorems and properties of Boolean algebra, Boolean functions, canonical and standard forms, other logic operations, digital logic gates.

UNIT II: [8]

GATE level minimization, Logic gates and Logic families, The K-map method, four-variable map, five-variable map, product of sums simplification, don't-care conditions, NAND and NOR implementation, determination and selection of Prime Implicants, Essential and Nonessential
prime Implicants.

UNIT III: [8]

Combinational logic and their Design procedure, Binary Adder, Binary Subtractor, Binary Multiplier, Magnitude Comparator, Decoders, Encoders, Multiplexers, and Demultiplexers.
Memories such as ROM, RAM, EPROM.

UNIT IV: [12]

Sequential logic and circuits, latches, flip-flops, analysis of clocked sequential circuits, State reduction and assignment, design procedure. REGISTERS AND COUNTERS: Registers, shift registers, ripple counters, synchronous counters, counters with unused states, ring counter, Johnson counter. Random access memory, memory decoding, error detection and correction, read only memory, programmable logic array, programmable array logic, sequential programmable devices. A/D and D/A converters.

Text Books:

1. M. Morris Mano, Michael D. Ciletti (2008), Digital Design, 4th edition, Pearson Education Inc, India.
2. Donald D. Givone (2002), Digital Principles and Design, Tata McGraw Hill, India.

Reference Books:

1. C. V. S. Rao (2009), Switching and Logic Design, 3rd Edition, Pearson Education, India.
2. Roth (2004), Fundamentals of Logic Design, 5th Edition, Thomson, India.

Semester: 3rd			
Paper code: AIDS255/AIML255/IOT255	**L**	**T/P**	**Credits**
Subject: Digital Logic Design Lab	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1. To familiarize with the understanding of various aspects of designing real life applications through digital logic.
2. Design and analysis of the digital circuits and systems.

Course Outcomes:

CO1	Design an experiment to validate through hypothesis, a Boolean logic gates, truth table and circuit simulation.
CO2	Create circuits to solve real life problems via digital logic design.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	1

LIST OF EXPERIMENTS:

1. a) Introduction to Digital Logic Trainer kits and their function.

   b) Verify the truth table of Basic logic gates using their ICs.

   c) Realize logic functions of NOT, AND, OR, EX-OR, EX-NOR with the help of universal gates-NAND and NOR Gates.
2. a) Verify De-Morgan's theorem for two variables using basic gates.

   b) Realize Sum of Product (SOP) and Product of sum (POS) expressions using universal gates.
3. Realize Binary to Gray & Gray to Binary code converter and their truth table.
4. Design and test the Adder circuit.

a) Half Adder
b) Full Adder
c) Parallel Adder using 7483

5. Design and test the Subtractor circuit.
    a) Half Subtractor
    b) Full subtractor
6. Design and test the Multiplexer circuit.
    a) 8:1 Multiplexer using IC 74151
    b) 1:8 Demultiplexer circuit using IC 74138
7. Verify and test the Counter circuit.
    a) BCD Counter using ICs 7493
    b) Ring counter using 7495
    c) Johnson Ring Counter using 7495
8. Design and implement Comparator circuit.
    a) 1 bit comparator
    b) 4 bit magnitude Comparator using 7485
9. Design and implement Encoder circuit.
    a) Decimal to BCD Encoder using IC 74147
    b) Octal to Binary Encoder using IC 74148
10. Verify 2:4 Decoder using seven segment decoder and using ICs 7447.
11. Investigate the operation of various Flip-Flops using IC 7400, 7410.
    a) SR & Clocked Flip flop
    b) D flip flop
    c) T flip flop
    d) JK flip flop
12. Realize Shift Register using ICs 7495.
    a) SISO (Serial in Serial out)
    b) SIPO (Serial in Parallel out)
    c) PIPO (Parallel in Parallel out)
    d) PISO (Parallel in Serial out)

Semester: 3rd			
Paper code: AIDS207/AIML207/IOT207	**L**	**T/P**	**Credits**
Subject: Principles of Artificial Intelligence	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the basic concepts of Artificial Intelligence, its principles, and techniques.
2.	To analyse the applicability of the basic knowledge representation, reason under uncertainty, develop a plan for concrete computational problems, and learn from experiences to solve various problems
3.	To Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
4.	To devise development tools such as prediction models, expert systems, and data mining tools.

Course Outcomes:

CO1	Understand theories and concepts necessary for building an Artificial Intelligent System for knowledge representation.
CO2	Apply heuristic algorithms to develop better searching algorithms for solving real-world problems.
CO3	Analyse and understand concepts of Neural Networks and Fuzzy data to deal with uncertainty and imprecision, subsequently apply suitable soft-computing technique to do approximate reasoning and build computational models capable of learning meaningful patterns from data.
CO4	Create logic programming to build systems capable of making decision to solve real-world problems by applying critical thinking, problem-solving and AI algorithms.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	3	3	1	-	-	-	-	-	1	2
CO2	2	3	3	3	1	1	1	1	1	1	1	1
CO3	2	3	3	3	1	-	-	-	-	-	2	2
CO4	2	3	3	3	1	1	1	1	1	1	2	3

Course Overview:
Principles of artificial Intelligence is the simulation of intelligence process by computer systems. It gives understanding of the main abstractions and reasoning techniques used in artificial intelligence including understand of AI, reasoning by machines, planning techniques, and basic machine learning methods.

UNIT I: [8]
Introduction to AI, History of Artificial Intelligence, Applications of AI in the real world (Gaming, Computer Vision, Expert Systems, Natural Language Processing, Robotics & others). AI techniques, Problem Solving: Production Systems, State Space Search, Depth First Search, Breadth First Search, Heuristic Search, Hill Climbing, Best First Search, best-first search, A*, Problem Reduction, AO*, Constraint Satisfaction, Means-End Analysis.

UNIT II: [8]
Knowledge representation, Knowledge representation using Predicate logic, Propositional logic, Inferences, First-Order Logic, Inferences, Unification, Resolution, Natural Deduction, Procedural versus declarative knowledge, logic programming, forward versus backward reasoning.

UNIT III: [8]
Reasoning, Introduction to Uncertainty, Bayesian Theory, Bayesian Network, Dempster-Shafer Theory. Overview of Planning and its Components. Overview of Learning and basic Techniques. Introduction of Fuzzy Reasoning and Neural Networks.

UNIT IV: [12]
Game Playing and Current Trends in AI, MinMax search procedure, Alpha-Beta Cutoffs, Game Development using AI, Applications of AI, Emerging Trends in AI Research in various domains.

Text Books:
1. Rich and Knight. Artificial Intelligence, Tata McGraw Hill, 1992.
2. S. Russel and P. Norvig. Artificial Intelligence – A Modern Approach, Second Edition, Pearson Edu.

Reference Books:
1. Kheemani, Deepak, A First Course in Artificial Intelligence, McGraw Hill Education, 1 Edition, 2017.
2. Artificial Intelligence: foundations of computational agents, Cambridge University Press, 2017.
3. Poole, David L., and Alan K. Mackworth. Artificial Intelligence: foundations of computational agents. Cambridge University Press, 2010.
4. Luger, G.F. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson, 2008.

Semester: 3rd			
Paper code: AIDS257/AIML257/IOT257	**L**	**T/P**	**Credits**
Subject: Principles of Artificial Intelligence Lab	0	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To understand the basics of Prolog Programming.
2.	To solve different mathematical problems using Prolog Programming.
3.	To apply Prolog Programming for solving different real time problems.
4.	To determine the rules for creating Expert Systems.

Course Outcomes:

CO1	Students will be able to understand and apply Prolog Programming for solving different real-life problems.
CO2	Students will be able to create different expert systems using Prolog Programming

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	1	1	2	2	-	1	1	1	1
CO2	2	1	2	2	1	1	1	1	-	1	1	2

List of Experiments

1. Write a program to implement syntax, basic list manipulation functions and numeric functions in Prolog.
2. Write a program to implement input, output and predicates in Prolog.
3. Write a program to implement local variables and conditional statements using Prolog.
4. Write a program to calculate factorial of a given number using Prolog.
5. Write a program to solve 4-Queen problem using Prolog.
6. Write a program to solve any real-life problem using depth first search.
7. Write a program to solve TIC-TAC-TOE Problem using Prolog.
8. Write a program to solve Monkey Banana Problem using Prolog.

9. Write a program to solve Water Jug Problem using Prolog.
10. Write a program to solve 8 Puzzle Problem using Prolog
11. Write a program to solve Tower of Hanoi Problem using Prolog.
12. Write a program for medical diagnosis using Prolog.

Semester: 3rd			
Paper code: AIDS209/AIML209/IOT209	**L**	**T/P**	**Credits**
Subject: Probability, Statistics and Linear Algebra	**4**	**0**	**4**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Everyunit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To build a strong foundation on probabilistic and statistical analysis and linear Algebra.
2.	To apply tools of statistics, probability, discrete random variables and probability distributions, in various applications of engineering and technology.
3.	To analyse tools of continuous random variables and probability distributions and linear algebra in various applications of engineering and technology.
4.	To create systems using probabilistic and statistical analysis in varied applications of engineering and science like disease modeling, climate prediction and computer networks etc.

Course Outcomes:

CO1	Understand the fundamentals of probability, Conditional Probability, Baye's theorem, random variables, sampling distribution, mean, and other statistical row reduced echelon form, Solutions of system of linear equations, Vector Space, Basis, Linear Transformations, Eigen values, and Eigen Vectors techniques and apply them to various real-life problems.
CO2	Perform hypothesis testing to analyse various Engineering problems.
CO3	Analyse different distributions, systems of linear equations, and linear transformations in engineering problems.
CO4	Design network models, Markov chain, and their applications.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	2	1	1	1	1	1	1	1	1
CO2	2	2	2	2	1	1	1	1	1	1	1	1
CO3	2	2	2	2	1	1	1	1	1	1	2	-
CO4	3	2	2	2	-	-	-	-	-	-	2	-

Course Overview:

Probability, statistics and linear algebra gives and allows to access and examine the certainty of outcomes of a study or experiment that is executed. The course also addresses the statistics to gather, review, analyse and draw conclusion from raw data, as well as quantified mathematical models to understand machine learning algorithms.

UNIT I: [10]

Probability - Probability spaces, conditional probability, independence; Discrete random variables, continuous random variables and their properties, distribution functions and densities, exponential and gamma densities. Independent random variables, the multinomial distribution, Chebyshev's Inequality, Bayes' rule.

UNIT II: [10]

Basic Statistics- Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

UNIT III: [10]

Applied Statistics- Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance- large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

UNIT IV: [10]

Linear Algebra- Cramer's rule, Singular Value decomposition, Euclidian vector spaces, Projection. Hermitian and Unitary Matrix, Gram -Schmidt orthogonalization, LU-decomposition.

Text Books:

1. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003.
2. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
3. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968.

Reference Books:

1. N.P. Bali and Manish Goyal, A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
3. Veerarajan T. Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.
4. Mathematics For Machine Learning-Marc Peter Deisenroth, A. Aldo Faisal, Cheng soon ong.

Semester: 3rd			
Paper code: AIDS211/AIML211/IOT211	**L**	**T/P**	**Credits**
Subject: Universal Human Values II	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms	
1. There should be 9 questions in the end-term examination question paper 2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. 3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit. 4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.	
Course Objectives:	
1.	To expand the holistic perspective based on self-exploration about themselves (human beings), family, society, and nature/existence and to appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and the real meaning of prosperity which are the core aspirations of all human beings.
2.	To understand the harmony in the human being at all four levels- Individual, family, society, and nature/existence.
3.	To strengthen the power of self-reflection with the right understanding.
4.	To develop the right evaluation in terms of actions, reactions, and commitments towards the human goal i.e. mutual happiness and mutual prosperity.
Course Outcomes:	
CO1	Understand and become more aware of self (individual) and our surroundings (family, society, and nature).
CO2	Become more responsible in life for handling problems with sustainable solutions while keeping human relationships and human nature in mind.
CO3	Enhance critical ability for self-reflection.
CO4	Boost sensitivity to our commitment in terms of human values, human relationships, and human society.

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	-	-	-	-	-	1	-	3	2	1	-	3
CO2	-	-	-	-	-	1	-	3	2	1	-	3
CO3	-	-	-	-	-	1	-	3	2	1	-	3
CO4	-	-	-	-	-	1	-	3	2	1	-	3

Course Overview:

This course is aimed at giving inputs that will help to ensure the right understanding and right feelings in the students in their life and profession, enabling them to lead ethical life.

In this course, the students learn the process of self-exploration, the difference between the Self and the Body, the naturally acceptable feelings in relationships in a family, the comprehensive human goal in society, the mutual fulfillment in nature, and the co-existence in existence.

UNIT I: **[8]**

Introduction to Value Education - Need, Basic Guidelines, Content and Process for Value Education, Self-Exploration, Natural Acceptance, Experiential Validation as the Mechanism for Self-Exploration. Continuous Happiness and Prosperity, Basic Human Aspirations. Right Understanding, Relationship, and Physical Facilities - the basic requirements for the fulfillment of aspirations of every human being with their priority, Understanding Happiness and Prosperity, Method to fulfill the above human aspirations: Understanding and living in harmony at various levels.

UNIT II: **[8]**

Understanding Harmony in the Human Being, the human being is a Co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of the Self ('I') and 'Body', happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer, and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health, correct appraisal of Physical needs, the meaning of Prosperity, Programs to ensure Sanyam and Health.

UNIT III: **[8]**

Harmony in Human-Human Relationships, Understanding values in human-human relationships, meaning of Justice (Nine universal values in relationships) and the program for its fulfillment to ensure Mutual Happiness, Trust, and Respect as the foundational values of relationship, Understanding the meaning of Trust, Difference between Intention and Competence, Understanding the meaning of Respect, Difference between Respect and Differentiation, the other salient values in a relationship, Understanding the harmony in the society (society being an extension of the family), Resolution, Prosperity, Fearlessness (trust) and Co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society: Undivided Society, Universal order from family to world family.

UNIT IV: **[8]**

Understanding Harmony in Nature. Interconnectedness: Self-regulation and Mutual Fulfillment among the Four Orders of Nature: Recyclability and Self-regulation in Nature, Realizing Existence as Co-existence at All Levels. The Holistic Perception of Harmony in Existence. Natural Acceptance of Human Values. Definitiveness of (Ethical) Human Conduct. A Basis for Humanistic Education, Humanistic Constitution and Universal Humanistic Order.

Text Books:

1. R. R. Gaur, R. Asthana & G. P. Bagaria, A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1. 2. Teacher's Manual for A Foundation Course in Human Values and Professional Ethics, R. R. Gaur, R. Asthana & G. P. Bagaria,2nd Revised Edition, Excel Books, New Delhi, 2019, ISBN 978- 93-87034-53-2.

Reference Books:

1. A. Nagraj, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak, 1999.
2. A. N. Tripathy, Human Values, New Age International Publishers, 2004.
3. B. L. Bajpai, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
4. P. L. Dhar & R. R. Gaur, 1990, Science and Humanism, Commonwealth Publishers.

Semester: 3rd			
Paper code: AIDS259/AIML259/IOT259	**L**	**T/P**	**Credits**
Subject: Web Programming Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is only the practical subject.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. Atleast 8 experiments must be performed by the students.

Course Objectives:

1.	To apply JavaScript Language programming concepts and techniques to create web pages and develop, plan and debug web pages as per the requirement. CSS, this course will familiarize students with how browsers
2.	To understand how browsers represent webpage data using the Document Object Model (DOM), how to develop dynamic, interactive web pages using JavaScript in the browser.

Course Outcomes:

CO1	Apply different core scripting modules to design a server.
CO2	Design and develop single-page applications, interactive and dynamic websites that can be used to resolve real world issues.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	2	-	-	-	-	-	-	2
CO2	2	2	2	2	2	1	1	1	1	1	1	3

LIST OF EXPERIMENTS:

1. Create a web page that covers your CV using various HTML Tags (UL, OL , Table, etc).
2. Create a webpage that displays brief details of various Programming Languages using various types of CSS.
3. Create a webpage using JavaScript and HTML to demonstrate Simple Calculator Application.

4. Create a web page covering the basic CRUD operations (Create, Read, Update, Delete) that implements To-do/Grocery lists using JavaScript and HTML
5. Create a JavaScript application based on various Data Types, Statements, Keywords and Operators.
6. Create a JavaScript application with Window Objects and Document Object.
7. Create a JavaScript application with Object Creation and by adding methods of objects.
8. Create a JavaScript application with Loops to incorporate the concept of Iteration.
9. Create a JavaScript application for random number generation.
10. Build a unit convertor application using HTML & JavaScript.

Semester: 3rd			
Paper code: AIDS213/AIML213/IOT213	L	T/P	Credits
Subject: Critical Reasoning and Systems Thinking	2	0	2
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To inculcate critical reasoning and system thinking to take decisions.
2.	To understand Critical reasoning, examine assumptions, uncover hidden values, evaluate evidence, accomplish actions, and assess conclusions.
3.	To learn a holistic approach to analysis that focuses on the way a system's constituent parts interrelated and how systems work overtime and within the context of larger systems
4.	To formulate solutions for social and business enterprises using critical thinking and brainstorming and covert opportunities into innovation products and services.

Course Outcomes:

CO1	Apply critical reasoning so as to have clarity and wisdom while decision making.
CO2	Apply systems thinking concepts to enhance individual and collaborative skills to recognize opportunities and find innovative solutions for the same.
CO3	Apply and analyse systems thinking, critical thinking, lateral thinking, creative thinking to different real-life scenarios.
CO4	Understand how to translate broadly defined opportunities into innovation products and services and create a business or social enterprise.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	1	1	1	1	-	1	1	3
CO2	2	3	3	3	1	1	-	-	-	-	1	2
CO3	2	3	3	3	1	1	-	1	-	-	1	2
CO4	3	3	3	3	1	1	-	-	1	1	1	3

Course Overview:

This is a perspective course which exposes students to the disciplines of building and evaluating rational arguments and using a system perspective in applied engineering. Critical reasoning and system thinking enhances the though process with reasoning and critical analysis to take to the final decision in order to solve any specific problems. It enables seeing and understanding systems as wholes rather than as collections of parts, as a web of interconnections that work together to deliver an outcome.

UNIT I: [8]

Introduction, foundations and principles of critical reasoning, concepts in critical reasoning, analyzing reasoning, evaluating reasoning, Integrated reasoning, uncritical and critical reasoning, scientific reasoning, strategic reasoning, analytical reasoning, different kinds of biases, recognizing implications, drawing conclusion.

UNIT II: [8]

Arguments, structure of an argument, premises, claims, Inductive and deductive arguments, valid & invalid arguments, sound & unsound arguments, inductive and deductive arguments, descriptions, explanations, clarifications, illustrations and summary.

UNIT III: [8]

What is problem solving, steps in problem solving, problem definition, idea generation, brainstorming, fish bone analysis, thinking out of the box, lateral thinking tools & techniques, Information and data gathering and analysis, evaluating & prioritizing ideas, six thinking hats method, problem solving in teams, planning in teams, Tools and applications in project and risk management, problem solving in teams, planning in teams.

Unit IV: [8]

System structures and behavior, Abilene paradox, fallacies in reasoning, barriers in critical thinking, cognition and perception in Indian knowledge systems (Nyaya Darshana), systems thinking, operational and design thinking, system thinking for social change, critical thinking, the art of asking questions, Tools and applications in project and risk management.

Text Books:

1. Concise Guide to Critical Thinking by Lewis Vaughn
2. Critical Thinking by Tom Chatfield
3. Managing Complex Systems - Thinking Outside the Box by Howard Eisner A
4. Critical Thinking Tools for Taking Charge of Your Professional and Personal Life
   By Richard Paul, Linda Elder · 2020

Reference Books:

1. Thinking Fast and Slow by Daniel Kahneman
2. Strategies for creative problem solving by H Scott Fogler and Steven E LeBlanc
3. Critical Thinking A Concise Guide By Tracy Bowell, Gary Kemp · 2002

Semester: 3rd			
Paper code: AIDS215/AIML215/IOT215 (NUES)	**L**	**T/P**	**Credits**
Subject: Selected Readings	1	0	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university norms from time to time

Course Objectives:	
1.	To enhance comprehension skills.
2.	To learn and enhance communication including reading and speaking skills.
Course Outcomes:	
CO1	Apply and analyse comprehension and reading skills.
CO2	Develop presentation and report writing skills.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	1	1	3	-	3
CO2	1	1	1	1	1	1	1	1	1	3	-	3

Course Overview:
Reading books other than one's curriculum expands the imaginative horizon of a student. Under Selected readings, the students will be required to select a book (a non-technical book that is not related to engineering) that they want to read in the semester. Reading fiction, non-fiction and science books are beneficial for students as it is a vital means to imagine a life other than our own, which in turn makes us more empathetic beings. The students will prepare a summary of the report and will be evaluated based on the presentation that they give on the book read. The whole idea is to present the story in a customized manner. That might also include a video/poster created for the same.

Evaluation Rubrics might be based on:

- Remembering: Recalling or retrieving previously read information.
- Understanding: Comprehending the content and expressing in one's own words.
- Relating and Interpreting: Relating and interpreting the theme or message of the book with a new context or situation.
- Critical Evaluation: Making critical comments about the choice of subject, handling of the subject, author's style of writing, etc.
- Communication Skills: Speaking skills, Report writing, Presentation skills.

Sample Books (not limited to these):

S. No	Title	Authors	Language
1.	Exam Warriors	Narendra Modi	English
2.	Work Ethics	Narendra Modi	English
3.	स्टेफेन हाकिंग	महेश शर्मा	Hindi
4.	Jeff Bezos: Biography of A Billionaire Business Titan	Elliot Reynolds	English
5.	Bill Gates: A Biography	Michael B. Becraft	English
6.	स्टील किंग लक्ष्मी मित्तल	प्रतीक्षा ऍम तिवारी	Hindi
7.	फेसबुक निर्माता: मार्क जुकेरबर्ग	संजय भोला 'धीर	Hindi
8.	Stay हंगरी Stay फुलिश	रश्मि बंसल	Hindi, Gujrati, Tamil
9.	मैं, स्टीव: मेरा जीवन मेरी जुबानी	नीरू	Hindi
10.	अमीर न १ एलन मस्क की बायोग्राफी	पूर्णिमा मजूमदार	Hindi
11.	सुन्दर पिचाई : Google का भविष्य	जगमोहन भानवेरी	Hindi
12.	Dream With Your Eyes Open	Ronnie Screwvala	English
13.	डॉट्स कनेक्ट करें	रश्मि बंसल	Hindi
14.	Take Me Home	Rashmi Bansal	English
15.	Bhujia Barons: The Untold Story of How Haldiram Built A 5000 Crore Empire	Pavitra Kumar	English
16.	The Z Factor: My Journey as The Wrong Man at The Right Time	Subhash Chandra And Pranjal Sharma	English
17.	The Hard Things About Hard Things	Ben Horowitz	English
18.	Blue Ocean Strategy	Harvard Business School	English
19.	Zero to One: Notes on Start Ups, or How to Build the Future	Peter Thiel & Blake Masters	English
20.	The Holy Book of Luck	A Saed Alzein	English
21.	How To Begin	Michael Bungay Stanier	English
22.	Start-up Myths and Models	Rizwan Virk	English
23.	80/20 सिद्धांत - कम के साथ अधिक प्राप्त करने का रहस्य	रिचर्ड कोचो	Hindi
24.	Discover Your Destiny: 7 Stages of Self Awakening	Robin Sharma	English
25.	Hyper Focus	Chris Bailey	English
26.	How To Talk to Anyone	Leil Lowndes	English

27.	Never Split the Difference	Voss, Chris,Raz, Tahl	English
28.	Games People Play	Berne, Eric	English
29.	Achieving Meaningful Success Unleash the Power of Me	Dr. Vivek Mansubgh	English
30.	गेटिंग टू यस	रोजर फिशर	Hindi
31.	Your Next Five Moves	Patrick Bet-David	English
32.	बड़ी सोच का बड़ा जादू	श्वार्ट्ज, डेविड जू	Hindi
33.	How To Become a People Magnet	Marc Reklau	English
34.	सबसे मुश्किल काम सबसे पहले	ब्रायन ट्रेसी	Hindi
35.	Show Your Work	Austin Kleon	English
36.	How To Find Fulfilling Work	Roman Krznaric	English
37.	जीवन के अद्भुत रहस्य	गौर गोपाल दास	Hindi
38.	Attitude Is Everything	Jeff Keller	English
39.	The World is yours to change	Daisaku Ikeda	English
40.	The Defining Decade: Why Your 20's Matter and How the Make the Most of Them Now	Jay, Meg	English
41.	Quiet: The Power of Introvert in A World That Can't Stop Talking	Susan Cain	English
42.	Find Your Why: A Practical Guide for Discovering Purpose You and Your Team	Simon Sinek	English
43.	डीप वर्क	कैल न्यूपोर्ट	Hindi
44.	कैसे करे स्टार्ट उप बिज़नेस शुरू : बिज़नेस का सपना पूरा करने की गाइड	पंकज गोयल	Hindi
45.	Alex Adventure in Number land	Alex Bellos	English
46.	A Certain Ambiguity	Gaurav Suri	English
47.	The Everyday Hero Manifesto	Robin Sharma	English
48.	The Incredible World of Nichiren Buddhism	Suraj Jagtani	English
49.	My Life in Full: Work, Family, And Our Future (With A Special Epilogue for India)	Indra Nooyi	English
50.	India's Greatest Minds: Spiritual Masters, Philosophers, Reformers	Rao, Mukunda	English
51.	Inspiring Thoughts	Swami Vivekananda	English
52.	The Man Behind the Wheel: How Onkar S. Kanwar Created a Global	Tim Bouquet	English

	Giant		
53.	Azim Premji: The Man Beyond the Billions	Sundeep Khanna, Varun Sood	English
54.	Warren Buffett: Inside the Ultimate Money Mind Warren Buffett: Inside the Ultimate Money Mind	Robert G. Hagstrom	English
55.	Rahul Bajaj: An Extraordinary Life | Official Biography of The Chairman of Bajaj Group	Gita Piramal	English
56.	5 Am क्लब: अपनी सुबह का मालिक बनें, अपना जीवन बढ़ाएं	रॉबिन शर्मा	Hindi
57.	Happiness Becomes You: A Guide to Changing Your Life for Good	Tina Turner	English
58.	एटॉमिक हैबिट्स: छोटे बदलाव, असधरन परिनाम	जेम्स क्लियर (लेखक), डॉ सुधीर दीक्षित (अनुवादक)	Hindi
59.	हाउ टू डेवेलोप सेल्फ कॉन्फिडेंस एंड इन्फ्लुएंस पीपल बी पब्लिक स्पीकिंग	डेल कारनेगी	Hindi
60.	धन-संपत्ति का मनोविज्ञान	मॉर्गन हाउसेल	Hindi
61.	रिच डैड पुअर डैड	रॉबर्ट टी. कियोसाकी	Hindi, Bengali
62.	इकिगाई	फ्रांसेस मिरेलस हेक्टर गार्सिया	Hindi, Marathi, Bengali
63.	आपके अवचेतन मन की शक्ति	जोसेफ मर्फी	Hindi, Bengali
64.	सोचा और अमीर हो जाओ	नेपोलियन हिल	Hindi, Bengali
65.	पर्सनालिटी डेवेलोप्मेटन हैंडबुक	डीपी सभरवाल	Hindi
66.	पावर ऑफ़ पॉजिटिव ऐटिट्यूड	रोजर फ्रिट्ज	Hindi
67.	चिंता छोडो सुख से जियो	डेल कारनेगी	Hindi, Bangla, Marathi, Gujrati & Oria
68.	मुट्ठी में तकदीर	रॉबिन शर्मा	Hindi
69.	जैसे विचार, वैसा जीवन	जेम्स एलन (लेखक), डॉ. सुधीर दीक्षित (अनुवादक)	Hindi
70.	चाणक्य के टॉप 100 प्रेरक विचार	महेश शर्मा	Hindi
71.	'लोक व्यवहार'	डेल कारनेगी	Hindi, Bangla, Marathi, Gujrati & Oria
72.	रहसय	रोंडा बर्न	Hindi
73.	मेमोरी: हाउ टू डेवेलोप, ट्रैन, एंड यूज़ इट	विलियम वॉकर	Hindi

		एटकिंसन	
74.	बड़ा सोचे, बड़ा करे	अंकुर वारिकू	Hindi
75.	द लॉ ऑफ अट्रैक्शन	एस्थर और जेरीहिक्स	Hindi
76.	गोरा	रवींद्र नाथ	Hindi, Bengali
77.	सफलता शब्दों का खेल है	डॉ. सुधीर दीक्षित	Hindi
78.	पॉजिटिव थिंकिंग	नेपोलियन हिल	Hindi
79.	हाउ टू एन्जॉय योर लाइफ एंड जॉब	डेल कारनेगी	Hindi, Bengali
80.	Swami Vivekananda Bani O Rachana (Set) - 10 Volumes – Bengal	Swami Vivekananda	Bengali
81.	The Wisdom of Lotus Sutra	Daisaku Ikeda	English
82.	स्वामी विवेकानंद पुस्तक: जीवन, विचार आणि कार्य	Rajeev Ranjan, Kailas Kalkate	Marathi
83.	विश्वगुरु विवेकानंद	एम. आई. राजसवे	Hindi
84.	बिजनेस कोहिनूर रतन टाटा	बी.सी. पाण्डेय	Hindi
85.	Rattan Tata	P M Tiwari	Bengali
86.	गीतांजलि	रवींद्र नाथ	Hindi, Bengali
87.	सन्यासी जिसने अपनी संपति बीच दी	रॉबिन शर्मा	Hindi
88.	Ignited Minds: Unleashing the Power Within India: Unleashing the Power Within India	Dr APJ Abdul Kalam	English
89.	आपका भविष्य आपके हाथ में	ए पीजे कलाम	Hindi
90.	द स्टोरी ऑफ़ माय एक्सपेरिमेंट्स विथ ट्रुथ	महात्मा गांधी	Hindi
91.	मैं कलाम बोल रहा हूँ	प्रशांत गुप्ता	Hindi
92.	कौन रोयेगा आपकी मृत्यु पर	रॉबिन शर्मा	Hindi
93.	अग्नि की उड़ान	ए पीजे कलाम	Hindi
94.	आनन्द मठ	बंकिमचंद्र चटर्जी	Hindi
95.	The Science of Mind Management	Swami Mukundanadan	English
96.	Soak Education	Daisaku Ikeda	English
97.	7 Mindsets for Success Fulfilment and Happiness	Swami Mukundanadan	English
98.	Business Sutra: A Very Indian Approach to Management	Devdutt Pattanaik	English
99.	The Five Steps to Success	Yandamoori Veerendranath	English
100.	You Are Born to Blossom	Dr APJ Abdul Kalam	English

101.	7 Divine Laws to Awaken Your Best Self	Swami Mukundanadan	English
102.	The Way of Youth	Daisaku Ikeda	English
103.	बेबीलोन का सबसे अमीर आदमी	जॉर्ज एस. क्लैसन	Hindi, Telugu
104.	अमीर होना आपका अधिकारी	जोसेफ मर्फी	Hindi
105.	Buddha: Spirituality for Leadership & Success	Pranay	English
106.	सीक्रेट्स ऑफ़ द मिलियनेअर माइंड	टी. हार्व एकर	Hindi
107.	The Almanack of Naval Ravikant: A Guide to Wealth and Happiness	Eric Jorgenson	English
108.	Ananda: Happiness Without Reason	Achrya Prashant	English
109.	The Awakening of Intelligence (New Edition)	J. Krishnamurti	English
110.	दुनिया का महान सेल्समैन	ओ जी मैंडिनो	Hindi
111.	जिंदगी वो जो आप बनायें	प्रीति शेनॉय	Hindi
112.	The White Tiger	Arvind Adiga	English
113.	Inspirational Thoughts	Swami Vivekananda	English
114.	जीत आपकी: कामयाबी कीऔर ले जाने वाली सीडी	शिव खेरा	Hindi
115.	The God of Small Things	Arundhati Roy	English
116.	Buddhism A Way of Values	Prof. Lokesh Chandra and Dr. Daisaku Ikeda	English
117.	Buddha At Work: Finding Purposes, Balance, And Happiness at Your Workplace	Geetanjali Pandit	English
118.	Hope Is a Decision	Daisaku Ikeda	English

DETAILED SYLLABUS FOR 4th SEMESTER

Semester: 4th			
Paper code: AIDS202/AIML202/IOT202	**L**	**T/P**	**Credits**
Subject: Object Oriented Programming	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To Identify importance of object-oriented programming and difference between structured oriented and object-oriented programming features.
2.	To use various object oriented concepts to solve different problems.
3.	To Learn Java programming Language applying the concepts of object-oriented programming language.
4.	To design and implement programs for complex problems, making good use of the features of the language such as classes, inheritance, polymorphism.

Course Outcomes:

CO1	Ability to understand the concepts of object oriented programming i.e. abstract datatypes, encapsulation, inheritance, polymorphism.
CO2	Identify classes, objects, members of a class and relationships among them needed for resolving real world problems.
CO3	Ability to analyse a problem to develop algorithm with suitable logics and concepts of OOPs for solving real world problems.
CO4	Ability to create application or programs using OOP principles and proper program structuring.

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	3	3	1	-	-	-	-	-	-	-
CO2	2	3	3	3	1	1	1	-	1	1	1	-
CO3	2	3	3	3	1	-	-	-	-	-	-	3
CO4	2	3	3	3	1	1	1	1	1	1	1	1

Course Overview:
This course provides an introduction to object oriented programming (OOP) using the Java programming language. This course will provide the students with a solid theoretical understanding of, as well as practical skills. Its main objective is to teach the basic concepts and techniques which form the object-oriented programming paradigm. It aims to design solutions for the complex problems.

UNIT I: **[8]**
Introduction of Object-Oriented Programming, Benefits of Object Oriented Development, Classes and Objects, Inheritance, Polymorphism, Object- Oriented Design. Overview & characteristics of Java, Program Compilation, Execution Process Organization of the Java Virtual Machine and security aspects, sandbox model.

UNIT II: **[8]**
Java Fundamentals, Data Types & Literals Variables, Wrapper Classes, Arrays, Arithmetic Operators, Logical Operators, Control of Flow, Loops, Classes and Instances, Class Member Modifiers Anonymous Inner Class Interfaces and Abstract Classes, Inheritance using java, Exception Handling. Collection API Interfaces, Vector, stack, Hashtable, enumeration, set, List, Map, Iterators.

UNIT III: **[8]**
Multithreading- Extending Thread Class, Runnable Interface, Starting Threads, Thread Synchronization. GUI components in Java: AWT Components, Component Class, Container Class, Layout Managers, swing package. Event Handling: AWT Events, Event, Listeners, Class Listener, Action Event Methods, Focus Event Key Event, Mouse Event, Window Event Adapters.

UNIT IV: **[8]**
Java I/O: Input/Output Streams, Readers and Writers. JDBC (Database connectivity with MS-Access, Oracle, MS-SQL Server), Object serialization, Socket Programming, development of client Server applications, Design of multithreaded server.

Text Books:
1. Patrick Naughton and Herbertz Schidt. Java-2 the complete Reference, TMH.
2. Sierra & bates. Head First Java, O‟Reilly.

Reference Books:
1. E. Balaguruswamy. Programming with Java, TMH.
2. Horstmann. Computing Concepts with Java 2 Essentials, John Wiley.
3. Decker & Hirshfield. Programming. Java, Vikas Publication.

Semester: 4th			
Paper code: AIDS252/AIML252/IOT252	**L**	**P**	**Credits**
Subject: Object-Oriented Programming Lab	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To implement real-world entities like inheritance, hiding, polymorphism, etc in developing software applications.
2.	To understand how binding together the data and the methods operating on them helps in developing the applications.

Course Outcomes:

CO1	Apply object-oriented principles to design programming solutions to actual problems.
CO2	Analyse different packages of object-oriented programming language.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	1	1	2	1	1	1	3
CO2	2	2	2	2	1	-	-	-	-	-	-	-

LIST OF EXPERIMENTS:

1. Generate a random number up to 100 and print whether it is prime or not.
2. A. Design a program to generate first 10 terms of Fibonacci series.

   B. Find the factorial of a given number using Recursion.
3. Find the average and sum of array of N numbers entered by user.
4. Create a class to find out the Area and perimeter of rectangle.
5. Design a class that perform String operations (Equal, Reverse the string, change case).
6. Demonstrate the use of final keyword with data member, function and class.
7. Demonstrate the use of keywords try, catch, finally, throw and throws.

8. Design a program to demonstrate multi-threading using Thread Class.
9. Design a program to create game ‘Tic Tac Toe’.
10. Design a program to basic calculator using Applet and Event Handling.
11. Design a program to read a text file and after printing that on scree write the content to another text file.
12. Design a program to count number of words, characters, vowels in a text file.
13. Design a program to create simple chat application using Socket Programming.
14. Design a program to connect to access database and display contents of the table.

Semester: 4th			
Paper code: AIDS204/AIML204/IOT204	**L**	**T/P**	**Credits**
Subject: Database Management Systems	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Everyunit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce the concepts of databases, database models, and their uses.
2.	To assess the need for Database design to create a strong foundation for application.
3.	To understand the various complications & its solution for Transaction management.
4.	To understand advanced data bases and its application.

Course Outcomes:

CO1	Understand the principles of Database Management Systems.
CO2	Apply Structured Query Language to a varied range of queries and work on database using state of art tools.
CO3	Analyse various techniques and various models used for designing databases for different real-life situations.
CO4	Investigate normalized database schema and prepare a report for a real-life scenario.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	2	1	-	-	-	-	-	1	2
CO2	2	3	2	2	3	-	-	-	-	-	1	1
CO3	2	3	3	2	1	1	1	1	1	1	1	3
CO4	2	3	2	2	1	-	-	-	-	-	1	3

Course Overview:

The objective of the course is to present an introduction to database management systems with advanced topics of DBMS, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from databases. It includes Entity-Relational model, Normalization, Relational model, Relational algebra, and data access queries as well as an Introduction to SQL, MongoDB.

UNIT I: **[8]**

Introduction-Overview of Database System and various Data Models (Hierarchical, Network, and Relational Models), Views of Data, Comparison of Database Management System with File System, Architecture of DBMS, components of DBMS. Data Independence. Entity-Relationship Model- Entities, Entity Types, Attributes, Relationships, Relationship types, E/R diagram notation, Conversion of E/R diagram to relations.

UNIT II: **[8]**

Relational Data Model- Concept of Relations, Overview of Various Keys, Referential Integrity, and foreign keys. Relational Language- Relational Algebra, Tuple and Domain Relational Calculus, SQL, DDL and DML, Introduction and basic concepts of PL/SQL (Cursors, Procedures, Triggers). Basic steps in Query Processing and Optimization.

UNIT III: **[8]**

Database Design- Dependencies and Normal forms, Functional Dependencies, 1NF, 2NF, 3NF, and BCNF. Higher Normal Forms-4NF and 5NF. Transaction Management: ACID properties, Serializability, Concurrency Control (2PL, Timestamp protocol), Database recovery management – Log based recovery, checkpoints.

UNIT IV: **[8]**

Advanced Topics- CAP Theorem, Data Storage and Indexes, Hashing Techniques, NOSql, Types of NOSql databases, MongoDB: Introduction, History of MongoDB, Installation and configuration. Key Features. Core servers & tools. Basic commands, Comparison of relational databases to MongoDB, Cassendra, HBASE, etc.

Text Books:

1. Silberschatz, A., Korth, Henry F., and Sudharshan, S., Database System Concepts, 5th Edition, Tata McGraw Hill, 2016.
2. Elmasri, Ramez and Navathe, Shamkant B., Fundamentals of Database Systems 7th Edition, Pearson, 2015.

Reference Books:

1. Date, C. J, Kannan, A. and Swamynathan, S., An Introduction to Database Systems, 8th edition, Pearson Education, 2012.
2. J. D. Ullman, Principles of Database Systems, 2nd Ed., Galgotia Publications, 1999.

3. Vipin C. Desai, An Introduction to Database Systems, West Publishing Co.

Semester: 4th			
Paper code: AIDS254/AIML254/IOT254	**L**	**T/P**	**Credits**
Subject: Database Management System Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To create a database as per the proper rules.
2.	To organize, maintain and efficiently, and effectively retrieve information from a database.

Course Outcomes:

CO1	Apply Database management principles to fetch and maintain details efficiently and effectively from the databases of the real world.
CO2	Use the basics of SQL, MongoDB commands and construct queries using in database creation and interaction.

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	3	2	2	1	1	1	1	1	1	2
CO2	2	3	3	2	3	-	-	-	-	-	-	2

LIST OF EXPERIMENTS:

1. Study and practice various database management systems like MySQL/Oracle/PostgreSQL/SQL Server and others.
2. Implement simple queries of DDL and DML.
3. Implement basic queries to Create, Insert, Update, Delete and Select Statements for two different scenarios (For instance: Bank, College etc.)
4. Implement queries including various functions- mathematical, string, date etc.
5. Implement queries including Sorting, Grouping and Subqueries- like any, all, exists, not exists.
6. Implement queries including various Set operations (Union, Intersection, Except etc.).
7. Implement various JOIN operations- (Inner, Outer).

8. Write a PL/SQL program using FOR loop to insert ten rows into a database table.

9. Given the table EMPLOYEE (Emp No, Name, Salary, Designation, DeptID), write a cursor to select the five highest-paid employees from the table.

10. Illustrate how you can embed PL/SQL in a high-level host language such as C/Java And demonstrates how a banking debit transaction might be done.

The students should be motivated to make a project using MySql and MongoDb.

Semester: 4th			
Paper code: AIDS206/AIML206/IOT206	**L**	**T/P**	**Credits**
Subject: Software Engineering	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Everyunit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To familiarize students with basic Software engineering methods and practices and their applications.
2.	To explain layered technology in software engineering
3.	To teach software metrics and software risks.
4.	To familiarize students with software requirements and the SRS documents.
5.	To facilitate students in software design.

Course Outcomes:

CO1	Understand software systems of the real world and their life cycle.
CO2	Design the software solutions per the SRS requirement and proper tools.
CO3	Estimate software development cost and its maintenance.
CO4	Deploy various testing techniques to test software.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	2	3	1	1	1	1	1	1	2
CO2	2	2	2	2	3	-	-	-	-	-	1	2
CO3	2	2	2	2	3	-	-	-	-	-	1	2
CO4	3	2	2	2	3	-	-	-	-	-	1	2

Course Overview:

Software Engineering comprises the core principles consistent in software construction and maintenance: fundamental software processes and life cycles, mathematical foundations of software engineering, requirements analysis, software engineering methodologies, and standard notations, principles of software architecture and re-use, software quality frameworks and validation, software development, and maintenance environments and tools. It's an introduction to the object-oriented software development process and design.

UNIT I: **[8]**

Introduction to Software- Nature of Software, Introduction to Software Engineering, Software Engineering Layers, Software Myths, The Software Processes, Project, Product, Process Models: A Generic Process Model, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Spiral Model. COCOMO Model. UML diagrams -Sequential, Class Diagram, Activity Diagram, Component Diagram, Use-Case Diagram, State Machine Diagram.

UNIT II: **[8]**

Requirements Engineering- Functional and Non-Functional Requirements, The Software Requirements Document, Requirements Specification, Requirements Engineering, Requirements Elicitation and Analysis, Requirement Validation, Requirement Management, DFD, Data Dictionary. Introduction to ER diagrams

UNIT III: **[8]**

Software Design- Design concepts and principles - Abstraction - Refinement - Modularity Cohesion coupling, Architectural design, Detailed Design Transaction Transformation, Refactoring of designs, Object-oriented Design User-Interface Design. Software Testing: White-Box Testing, Black Box Testing. Stress Testing. Alpha, Beta, and Acceptance Testing. Debugging.

UNIT IV: **[8]**

Software Maintenance and Management- Software Maintenance, Types of Maintenance, Software Configuration Management, Overview of RE-engineering Reverse Engineering, Reliability: Failure and Faults, Reliability Models. Quality and Risk Management: Product Metrics, Software Measurements, Metrics for Software Quality, Risk Management: Software Risks, Risk Identification, Risk Projection, Risk Refinements, Risk Mitigation Monitoring and Management (RMMM). Overview Of Quality Management. CMM, ISO 9000, and Six Sigma.

Text Books:

1. Roger S. Pressman (2011), Software Engineering, A Practitioner's Approach, 7th edition, McGraw Hill International Edition, New Delhi.
2. Sommerville (2001), Software Engineering, 9th edition, Pearson Education, India.

References:

1. K. K. Aggarwal, Yogesh Singh (2007), Software Engineering, 3rd edition, New Age International Publishers, India.
2. Lames F. Peters, Witold Pedrycz (2000), Software Engineering an Engineering approach, John Wiley & Sons, New Delhi, India.
3. Shely Cashman Rosenblatt (2006), Systems Analysis and Design, 6th edition, Thomson Publications, India

Semester: 4th			
Paper code: AIDS208/AIML208/IOT208	**L**	**T/P**	**Credits**
Subject: Computer Networks and Internet Protocol	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To implement a simple LAN with hubs, bridges and switches.
2.	To describe how computer networks are organized with the concept of layered approach.
3.	To demonstrate internet protocols using the modern tools of computer networks.
4.	To design and implement a network for an organization.

Course Outcomes:

CO1	Understand concepts of computer networks and various Internet protocols.
CO2	Analyse given data segments/packets/frames and protocols in various layers of computer networks.
CO3	Design real networks using state of art components using simulation tools.
CO4:	Design and implement a network for an organization.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	2	-	-	-	-	-	-	1
CO2	2	2	2	2	2	-	-	-	-	-	-	-
CO3	2	2	2	2	3	-	-	-	-	-	-	-
CO4	2	2	2	2	2	1	1	1	1	1	1	2

Course Overview:

This course deals with fundamentals of computer networks and Internet protocols. It addresses various network models, Data link protocols, network layer protocols and implementation of computer network models and OSI layers. The course also deals with Transport layer protocols. The main emphasis of this course is on the organization and management of networks and internet protocols.

UNIT I: [8]

Introduction to Layered Network Architecture- What are computer networks, Layered models for networking, different types of communication models, ISO-OSI Model, TCP/IP.

UNIT II: [8]

Data Link Protocols- Stop and Wait protocols, Noise-free and Noisy Channels, Performance and Efficiency, Sliding Window protocols, MAC Sublayer: The Channel Allocation Problem, Carrier Sense Multiple Access Protocols, Collision Free Protocols, FDDI protocol. IEEE Standard 802.3 & 802. 11 for LANs and WLANs

UNIT III: [8]

Network Layer protocols- Design Issues: Virtual Circuits and Datagrams, Routing Algorithms, Optimality principle, shortest path routing Algorithms, Flooding and Broadcasting, Distance Vector Routing, Link State Routing, Flow-Based Routing, Multicast Routing; Flow and Congestion Control.

UNIT IV: [8]

Transport Layer Protocols- Design Issues, Quality of Services. The Internet Transport Protocols. IPV4 vs IPV6. Session Layer protocol: Dialog Management, Synchronization, Connection Establishment. Quality of service, security management, Firewalls. Application layer protocols: HTTP, SMTP, FTP, SNMP, etc.

Text Books:

1. Tanenbaum, S., C*omputer Networks, Fifth Edition*, Prentice Hall, India, 2013.
2. Behrouz A. Forouzan, Data communication and networking, 5E, Tata McGraw Hill, 2013.

Reference Book:

1. Computer networking- A top-down approach, Pearson Publications. 2017 edition.

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY, EAST DELHI CAMPUS, SURAJMAL VIHAR-110092

Semester: 4th			
Paper code: AIDS256/AIML256/IOT256	**L**	**P**	**Credits**
Subject: Computer Networks and Internet Protocol Lab	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To analyse various computer network protocols and components of computer network.
2.	To design and evaluate the challenges in building networks and as per the requirement of an organization.

Course Outcomes:

CO1	Design and analyse network protocols using state of art simulation tools.
CO2	Design, analyse and evaluate network services for homes, data centres, IoT, LANs and WANs.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	-	-	-	-	1	-	-
CO2	2	3	3	2	2	1	1	1	2	1	1	2

LIST OF EXPERIMENTS:

1. Introduction to basic networking tools: Wireshark and Network Miner.
2. Introduction to Datadog tool for data monitoring in network.
3. Running and using services/commands like ping, trace, route, nslookup, arp, ftp etc.
4. Introduction to Network Bandwidth analyser tool for network monitoring.
5. Implementation of Packet Capture and observations using packet Sniffer.
6. Explore various aspects of HTTP Protocol.
7. Tracing DNS with Wireshark.
8. Analyzing various parameters for TCP protocol in action.
9. Create Ring, Bus, Star and Mesh topology using Cisco Packet Tracer.
10. Configure a network using distance vector routing and link state vector routing protocol.

11. Implement Dijkstra’s shortest path algorithm in network routing.

Semester: 4th			
Paper code: AIDS210/AIML210	**L**	**T/P**	**Credits**
Subject: Fundamentals of Machine Learning	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Everyunit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand regression, classification and prediction algorithms to classify data.
2.	To gain knowledge about feature selection.
3.	To analyse feature engineering techniques to formulate the solutions for the complex problems
4.	To apply machine learning techniques in real world problems.

Course Outcomes:

CO1	Understand machine learning tools and techniques with their applications.
CO2	Apply machine learning techniques for classification and regression.
CO3	Perform feature engineering techniques.
CO4	Design supervised and unsupervised machine learning based solutions for real-world problems.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	1	1	1	2
CO2	3	3	3	3	2	1	1	1	1	1	1	1
CO3	3	3	3	3	2	-	-	-	-	-	-	-
CO4	3	3	3	3	2	1	1	1	1	1	1	2

Course Overview:

This course covers fundamental concepts and methods of computational data analysis, including pattern classification, prediction, visualization, and recent topics in machine learning. The course will give the student the basic ideas and intuition behind modern machine learning methods as well as a bit more formal understanding of how, why, and when they work. The underlying theme in the course is a statistical inference as it provides the foundation for most of the methods covered.

UNIT I: [8]

Introduction to Machine Learning- Basic concepts, developing a learning system, Learning Issues, and challenges. Types of Machine Learning. Feature Selection Mechanisms, Imbalanced Data, Bias in Data, Outlier Detection

UNIT II: [8]

Supervised Learning- Linear Regression, Multiple Regression, Logistic Regression, Classification; Classifier Models, K Nearest Neighbor (KNN), Naive Bayes, Decision Trees, Support Vector Machine (SVM), Random Forest

UNIT III: [8]

Unsupervised Learning- Dimensionality Reduction; Clustering; K-Means Clustering; C-Means Clustering; Fuzzy C Means Clustering, Association Analysis- Association Rules in Large Databases, Apriori Algorithm, Markov Models: Hidden Markov Models (HMMs).

UNIT IV: [8]

Reinforcement Learning- Introduction to Reinforcement Learning, Elements of Reinforcement Learning, Approaches to Reinforcement Learning, Applications of Reinforcement learning. Applications of Machine Learning in different sectors: Medical Diagnostics, Fraud Detection, Email Spam Detection

Text Books:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill, 2010.
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Pearson, Third Edition, 2014.
3. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995

Reference Books:

1. Ethem Alpaydin, (2004), Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press
2. T. Astie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer (2nd ed.), 2009
3. Bishop, C., Pattern Recognition and Machine Learning. Berlin: Springer-Verlag

Semester: 4th			
Paper code: AIDS258/AIML258	**L**	**P**	**Credits**
Subject: Fundamentals of Machine Learning Lab	**0**	**2**	**1**
Marking Scheme			

3. Teachers Continuous Evaluation: As per university examination norms from time to time
4. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms	
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.	
Course Objectives:	
3.	To formulate and analyse algorithm based on machine learning.
4.	To design the use cases of machine learning algorithms as per the user requirement.
Course Outcomes:	
CO1	Apply and differentiate machine learning algorithms for regression, classification and prediction problems.
CO2	Implement supervised and unsupervised machine learning models to analyse data for executing feature engineering and feature selection for real-life scenarios.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	1	1	1	2
CO2	3	3	3	3	3	1	1	1	1	1	2	1

LIST OF EXPERIMENTS:

1. Study and Implement Linear Regression.
2. Study and Implement Logistic Regression.
3. Study and Implement K Nearest Neighbour (KNN).
4. Study and Implement classification using SVM.
5. Study and Implement Bagging using Random Forests.
6. Study and Implement Naive Bayes.
7. Study and Implement Decision Trees.
8. Study and Implement K-means Clustering to Find Natural Patterns in Data.
9. Study and Implement Gaussian Mixture Model Using the Expectation Maximization.
10. Study and Implement Classification based on association rules.
11. Study and Implement Evaluating ML algorithm with balanced and unbalanced datasets.
12. Comparison of Machine learning algorithms based on different-different parameters.

Semester: 4th			
Paper code: IOT210	L	T/P	Credits
Subject: Internet of Things	3	0	3

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To learn fundamentals of IoT and how to build IoT based systems.
2.	To emphasize on development of Industrial IoT applications.

Course Outcomes:

CO1	Ability to understand design flow of IoT based systems.
CO2	Analyse and understand different communication protocols for connecting IoT nodes to server.
CO3	Apply design concept to IoT solutions.
CO4	Develop the state-of-the-art IoT based systems, suitable for real life and Industry applications.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	-	2	2	2	-	1	-	-	-	1	1
CO3	-	-	2	2	2	-	1	-	-	-	1	1
CO4	1	1	3	2	2	1	1	1	1	1	1	1

Course Overview:

The course enables student to understand the basics of Internet of things and protocols. It introduces some of the application areas where Internet of Things can be applied. Students will learn about the middleware for Internet of Things. The course addresses various components of Internet of things such as Sensors, internetworking, protocols. In the end students will also be able to design and implement IoT circuits and solutions.

UNIT I: **[8]**

The Internet of Things: An Overview of what is IoT? Why IoT? Explain the definition and usage of the term "Internet of Things (IOT)" in different contexts. Design Principles for Connected Devices, internet principles: internet communications-An overview, Physical Design of IoT, Logical Design of IoT, IoT standards, IoT generic architecture and IoT protocols. IoT future trends, Understand IoT Applications and Examples. Understand various IoT architectures based on applications. Understand different classes of sensors and actuators. Sensors: sensor terminology, sensor dynamics and specifications. Understand the basics of hardware design needed to build useful circuits using basic sensors and actuators.

UNIT II: **[8]**

Network protocols: Understand various network protocols used in IoT, Understand various communication protocols (SPI, I2C, UART).

Arduino Code and building circuits: Design and develop Arduino code needed to communicate the microcontroller with sensors and actuators, build circuits using IoT supported Hardware platforms such as Arduino, ESP8266 etc., Use of software libraries with an Arduino sketch that allows a programmer to use complicated hardware without dealing with complexity, Learning IoT application programming and build solutions for real life problems and test them in Arduino and Node MCU environments. Understand various wireless Technologies for IoT and its range, frequency and applications.

UNIT III: **[8]**

Importance of IEEE 802.15.4 MAC and PHY layer: Importance of IEEE 802.15.4 MAC and IEEE 802.15.4 PHY layer in constrained networks and their header format, Importance of Zigbee technology and its applications, use of IPv6 in IoT Environments, Understanding importance of IPv6 and how constrained nodes deal with bigger headers (IPv6). Understand IPv6 over Low-Power WPAN (6LoWPAN) and role of 6LoWPAN in wireless sensor network. Various routing techniques in constrained network. Understanding IoT Application Layer Protocols, HTTP, CoAP Message Queuing Telemetry Transport (MeTT).

UNIT IV: **[8]**

Role of big data, cloud computing and data analytics: Role of big data, cloud computing and data analytics in a typical IoT system. Analyze various case studies implementing IoT in real world environment and find out the solutions of various deployment issues. Smart parking system, Smart irrigation system-block diagram, sensors, modules on Arduino and Node MCU.

Text Books

1. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of things" by David Hanes, Cisco Press.
2. Internet of things with ESP 8266, Macro Schwartz, Pact publication.
3. Bahga, A., & Madisetti, V. (2014). Internet of Things: A hands-on approach. Vpt.
4. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013

Reference Books:

1. Building the Internet of Things with IPv6 and MIPv6 The Evolving World of M2M Communications, Daniel Minoli, Wiley Publications.
2. Mastering internet of things by Peter Waher, Pact publication.
3. The Internet of Things: connecting objects to the web, Hakima chaouchi, Wiley Publications.
4. Course Era: "Interfacing with the Arduino" by Ian Harris, University of Irvine, California.

Semester: 4th			
Paper code: IOT258	L	P	Credits
Subject: Internet of Things Lab	0	2	1
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which the appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To teach students how to analyse different protocols, simulation platforms and applications of IoT
2.	To design IoT systems and applications to solve real time problems.

Course Outcomes:

CO1	Apply IoT principles to design programs using a software and hardware to using variety of available resources to create IoT ecosystem
CO2	Implement applications based on IoT for solving different problems using Arduino or Raspberry PI boards.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	2	2	2	-	1	1	-	-	1	1
CO2	1	1	2	2	3	1	1	1	1	1	1	1

LIST OF EXPERIMENTS:

1. Introduction to Arduino platform and programming and Introduction to various sensors and various actuators & its applications.
2. Introduction with running a blinking LED and fading LED with PWM.
3. **A.** Arduino IDE and Operators in IDE.
   B. Frequently used Functions in Arduino IDE.
4. Control Structure writing programs for if else, for and While.
5. Custom functions that can be created for specific Needs.

6. Reading and writing digital and analog values. Digital and analog read/write demonstration.
7. Measuring light with Lux and a photoresistor demonstration
8. Measuring temperature and humidity.
9. Adding an LCD screen and sketch walkthrough.
10. Create an echo server with the Ethernet Shield over Arduino.
11. Upload data from a single sensor to ThingSpeak using ESP8266 (NodeMCU).
12. Upload data from multiple sensors to ThingSpeak using ESP8266 (NodeMCU).
13. Setting up logging and visualizing data on ThingSpeak.
14. Making Project- on real-world Problems.

Semester: 4th			
Paper code: AIDS212/AIML212/IOT212	L	T/P	Credits
Subject: Computational Methods	3	0	3

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Everyunit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To develop a practical approach to mathematical problem solving.
2.	To introduce many commonly used tools and techniques in numerical work.
3.	To convert algorithms and techniques to working computer codes.
4.	To understand the nuances of the numerical techniques and computer applications of the same.

Course Outcomes:

CO1	Ability to understand numerical techniques to find the roots of non-linear equations and solution of system of linear equations.
CO2	Ability to understand the solution of the linear simultaneous equations using iterative methods and apply them to real world applications.
CO3	Ability to understand numerical differentiation and integration and numerical solutions of ordinary and partial differential equations.
CO4	Ability to understand numerical methods to solve the ordinary differential equation and partial differential equation.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	3	-	-	-	-	-	-	-	-
CO2	3	2	3	3	1	1	1	1	1	1	1	1
CO3	3	2	3	3	-	-	-	-	-	-	-	-
CO4	3	2	3	3	-	-	-	-	-	-	-	-

Course Overview:

The Computational Methods course equips students with essential techniques for solving complex problems in various domains using computers. Students will learn numerical methods, algorithms, and data structures to perform simulations, optimization, and data analysis. The course covers topics such as numerical integration, root finding, linear algebra, and optimization algorithms. Practical implementation using programming languages and software tools will be emphasized, enhancing problem-solving skills. By the end, students will have a solid foundation in computational methods to tackle real-world challenges and support advancements in science, engineering, and technology.

UNIT I: **[8]**

Numerical solution to Linear algebraic & transcendental equations- Numerical algorithms and their complexities, Computer implementation and efficiency, Root finding- bracketing methods: Bracketing Methods, graphical methods, Bisection method, False Position (Regula Falsi), Root finding -Open Methods: Simple Fixed-Point Iteration, Newton-Raphson method, Secant methods, Brent's method

UNIT II: **[8]**

Numerical linear algebra- Gauss elimination, Pivoting, Tridiagonal systems, LU factorization, Gauss elimination as LU factorization, Cholesky factorization, Matrix inverse and condition, Error analysis and system condition. Iterative Methods: Gauss-Seidel method, Nonlinear Systems. Eigenvalues: The Power Method, Interpolations: Newton and Gauss formulas, Stirling and Bessel Formula, Lagrange's, piecewise/splines

UNIT III: **[8]**

Numerical Differentiation- High-Accuracy differentiation formulas, Richardson Extrapolation, Derivatives of unequally spaced data, Partial Derivatives. Numerical Integration: Newton-Cotes Formulas, The trapezoidal rule, Simpson’s Rules, Higher-Order Newton-Cotes formula, Romberg integration, Gauss quadrature, Adaptive quadrature

UNIT IV: **[8]**

Ordinary differential equations- Euler's Method, Runge-Kutta Methods, Adaptive methods, finite difference methods, Initial value problems, Boundary value problems, Partial differential equations.

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

2. Numerical Methods for Engineers, Steven Chapra, Raymond Canale, McGraw-Hill Higher Education, 2010

Reference Books:

1.Numerical Methods in Engineering & Science (with Programs in C,C++ & MATLAB), B. S. Grewal, Khanna Publishers.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

Semester: 4th			
Paper code: AIDS214/AIML214/IOT214 (NUES)	**L**	**T/P**	**Credits**
Subject: Effective Technical Writing	**1**	**0**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: 100

Note: Submission of Research Paper will be an evaluation parameter for the completion of course. (100 marks)	
Course Objectives:	
1.	To understand the fundamentals of effective technical writing.
2.	To develop the skill of preparing logical and persuasive technical papers/proposals/ reports.
3.	To apply standard technical formats for drafting protocol and research papers.
4.	To inculcate habits of effective technical writing applying precision, conciseness, and ucidity.
Course Outcomes:	
CO1	The concepts of effective technical writing
CO2	Apply precision, conciseness and lucidity while writing
CO3	Demonstrate by writing a technical paper/article by using global standard formats.
CO4	Develop skills to gather, evaluate, and synthesize technical information from various sources, including interviews, surveys, technical documents, and online resources.

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	-	-	-	-	2	-	-	-	1	3	-	2
CO2	-	-	-	-	2	-	-	-	1	3	-	2
CO3	1	1	1	1	2	1	1	1	1	3	1	2
CO4	1	2	1	1	3	1	1	1	1	3	1	2

Course Overview: -

Under Effective Technical Writing, students are expected to understand the process of writing technical research papers/ articles. The students are required to take up a topic of their choice and write a research paper/ article on the same using state-of-art document preparation software like Latex, overleaf, etc. Students must be familiar with all primary international template styles of a research paper like IEEE, Springer, ACM, etc. Students will also be taught various referencing formats (for example: APA). Research paper/ article writing is a must-have skill for future scientists & researchers, and it opens up their domain of knowledge. The research paper/article/proposal submitted by students will be checked for plagiarism. This will lead to the development of skills including proper paper format, proper referencing, inclusion of figures, tables, use of keywords, writing abstract, title etc.

Unit-I **[No. of Hours: 6]**

Introduction to Technical Writing: Basics and guidelines of technical writing, Layout of research/review paper, Finalization of Problem Statement, Collection of Primary and Secondary data. Processing and analysing the data. Relevance of Literature Review, Objectives of Literature Review, Sources of Literature, References, How to Conduct the Review of Literature, Precautions in Library Use, Reporting the Review of Literature. Title finalization, Abstract formulation, keywords. Citations format: APA, Harvard, Chicago, Vancouver. Proper way of writing and citing equations, Proper use of figures and tables, Writing a good review paper.

Unit-II **[No. of Hours: 6]**

Introduction to Latex: Installation of Latex software, Basics of overleaf, basic syntax, writing equations, tables, inserting figures. Page layout- Title, Abstract, Chapters, Sections, References, Equation references, Citations. Preparation of table and contents, Figure handling numbering, generating index, Creating ordered and unordered list. Packages: Geometry, maths, algorithms.

Introduction to various International template styles- IEEE, Springer, ACM, etc. Indexing- Clarivate, Scopus, Web of Science, etc.

Unit-III **[No. of Hours: 2]**

Ethics and Plagiarism: Seeking consent, ethical committees (human & animal), Ethical issues to consider relating to the researcher, IPR- intellectual property rights and patent law, commercialization, scholarly publishing, citation and acknowledgement, plagiarism, reproducibility and accountability.

Concluding the Research Paper: Writing results section, explaining the figures and tables, summarizing the result and conclusion, references. Choosing a journal.

Unit-IV **[No. of Hours: 2]**

Presenting Manuscript: Presentation of Research paper.

Semester: 4th			
Paper code: AIDS216/AIML216/IOT216 (NUES)	L	T/P	Credits
Subject: Emerging Trends in Technological Industries	1	0	1
Marking Scheme			

1. Teachers Continuous Evaluation: 100

Course Objectives:	
1.	To Understand the importance of seeking experts in the technological domain
2.	To remain technically abreast with latest developments world-wide.
Course Outcomes:	
CO1	Understand the importance of having awareness of latest technological Trends.
CO2	Apply the knowledge gained by interacting with experts in their day to day lives.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	1	-	1	3	1	1	-	-	1	-	2
CO2	2	1	1	1	3	1	1	1	1	1	1	2

Course Overview:

In this, the faculty coordinator will invite experts from the industry/ academia to give seminars/webinars/expert lectures to students on recent technological advances in the industry. In every semester, at least 8 seminars/webinars/expert lectures should be conducted. An evaluation would be conducted by the faculty coordinator based on quiz, report submissions, etc. on the seminars/webinars/expert lectures conducted. The aim is to give the latest technical and research exposure to the students.

Semester: 4th			
Paper code: AIDS260/AIML260/IOT260	**L**	**T/P**	**Credits**
Subject: Practicum (Integrated Project)	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is an Integrated Project to be created by the students on the basis of the knowledge gained by them.
2. The instructor will continuously evaluate the student's performance in the semester.
3. Practicum shall be evaluated based on the novelty, originality of work, contribution towards society.
4. Project report of the practicum will be submitted at the end of the semester

Course Objectives:

1.	To enhance experiential learning component by applying the knowledge and skills gained through various subjects in developing a solution for real-world problems.
2.	To give an exposure to multi-disciplinary domains to identify problems that exist around them to develop solutions thereby improving their technical skillset and their employability.
3.	To increase the collaboration skills.
4.	To understand the feasibility, quality, novelty, innovation and the application of the project.

Course Outcomes:

CO1	Apply engineering concepts learned so far for project identification, formulation, and a feasible solution.
CO2	Develop and demonstrate a comprehensive technical knowledge on the selected project topic.
CO3	Design novel and innovative technological solutions to real problems utilizing an integrated approach.
CO4	Apply theoretical knowledge and concepts gained from their coursework to real-world situations or projects within their field of study.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	2	2	1	2	1	1	3	3
CO2	3	3	3	3	2	2	1	2	1	1	3	3
CO3	3	3	3	3	2	2	1	2	1	1	3	3
CO4	3	3	3	3	2	2	1	2	1	1	3	3

Course Overview:

Under practicum the students will be involved in experiential learning. The students are required to apply the knowledge and skills gained through various subjects in developing a solution for solving real world problems. Interdisciplinary projects give an opportunity to students to identify problems that exist around them for which they could develop solutions. Working as a team for the project also increases their collaboration skills.

--------------------------------X---------------------------------X---------------------------------

DETAILED SYLLABUS
(THIRD YEAR)

for

BACHELOR OF TECHNOLOGY

for

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

INDUSTRIAL INTERNET OF THINGS

under the aegis of University School of Automation and Robotics offered at Affiliated Institutions of the University

from A.S. 2021-22 onwards

University School of Automation and Robotics

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY,
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Detailed SYLLABUS
(3rd Year)
Fifth Semester

for

BACHELOR OF TECHNOLOGY

for

Artificial Intelligence and Data Science
Artificial Intelligence and Machine Learning

Applicable from Batch Admitted in Academic Session 2021-2022 Onwards

Semester: 5th			
Paper code: AIDS301/AIML301	**L**	**T/P**	**Credits**
Subject: Operating Systems	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the basic concepts and functions of operating systems.
2.	To use different process scheduling algorithms and synchronization techniques to achieve better performance of a computer system.
3.	To understand Processes, Threads and Deadlocks and Memory Management algorithms of operating systems.
4.	To analyze the several operating systems and their utilities such Linux, Unix, Window to develop operating system functions in programming.

Course Outcomes:

CO1	Understand fundamental operating system abstractions such as processes, threads, files, semaphores, IPC abstractions, shared memory regions, etc.
CO2	Apply process scheduling and memory management concepts.
CO3	Analyze the operating system's resource management techniques, deadlock management techniques, memory management techniques.
CO4	Design device drivers and multi-threading libraries for a tiny OS and develop application programs using UNIX system calls.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	1	1	1	-
CO2	3	1	-	-	-	-	-	-	1	1	1	-
CO3	2	2	-	1	1	-	-	-	2	1	1	1
CO4	2	1	2	1	1	-	1	-	2	1	2	1

Course Overview:

This course covers the fundamentals of operating systems, mechanisms, and their implementations. The core of the course contains concurrent programming (threads and synchronization), inter process communication, process scheduling, memory management, input output devices and organization.

Unit I **[10]**

Introduction: Operating system and function, Evolution of operating system, Batch, Interactive, Time Sharing and Real Time System, System protection. Operating System Structure: System Components, System structure, Operating System Services.

CPU Scheduling: Scheduling Concept, process scheduling strategies- First-Come, First-Served (FCFS) Scheduling, Shortest-Job-Next (SJN) Scheduling, Priority Scheduling, Shortest Remaining Time, Round Robin (RR) Scheduling, Multiple-Level Queues Scheduling, Performance Criteria of Scheduling Algorithm, Evolution, Multiprocessor Scheduling.

Unit II **[10]**

Concurrent Processes: Process concept, Principle of Concurrency, Producer Consumer Problem, Critical Section problem, Semaphores, Binary and counting semaphores, P() and V() operations, Classical problems in Concurrency, Inter Process Communication, Process Generation, Process Scheduling.

Deadlocks: examples of deadlock, resource concepts, necessary conditions for deadlock, deadlock solution, deadlock prevention, deadlock avoidance with Bankers algorithms, deadlock detection, deadlock recovery.

Unit III **[10]**

Memory Organization & Management: Memory Organization, Memory Hierarchy, Memory Management Strategies, Contiguous versus non- Contiguous memory allocation, Partition Management Techniques, Logical versus Physical Address space, swapping, Paging, Segmentation, Segmentation with Paging Virtual Memory: Demand Paging, Page Replacement, Page-replacement Algorithms, Performance of Demand Paging, Thrashing, Demand Segmentation, and Overlay Concepts.

Unit IV **[10]**

I/O Device and the organization: I/O Device and the organization of the I/O function, I/O Buffering, Disk I/O, Disk Scheduling Algorithms, File system: File Concepts, attributes, operations, File organization and Access mechanism, disk space allocation methods, Directory structure, free disk space management, File sharing, Implementation issues. Case studies: Unix system, Windows XP.

Textbooks:

1. Abraham Silberschatz, Peter B. Galvin, Greg Gagne, “Operating System Concepts”, Wiley, 9th Edition
2. Tannenbaum, “Morden Operating Systems”, Pearson, 4th Edition, 2014

Reference Books:

1. William Stallings, "Operating Systems –Internals and Design Principles", 8/E, Pearson Publications, 2014.
2. Dietel, "An introduction to operating system", Addison Wesley, 1983

Semester: 5th			
Paper code: AIDS303/AIML303	**L**	**T/P**	**Credits**
Subject: Design and Analysis of Algorithms	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand and apply the algorithm analysis techniques to generate solution space.
2.	To critically analyze the efficiency of alternative algorithmic solutions for the same problem.
3.	To analyze different algorithm design techniques.
4.	To classify a problem as computationally tractable or intractable, and discuss strategies to address intractability

Course Outcomes:

CO1	Understand the asymptotic performance of algorithms to analyze formal correctness proof for algorithms
CO2	Apply major algorithms' knowledge and data-structures corresponding to each algorithm design paradigm
CO3	Design efficient algorithms for common computer engineering design problems
CO4	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	1	1	-	-	1	1	1	1	2
CO2	2	2	1	1	1	-	-	1	1	1	1	2
CO3	2	2	2	1	1	-	-	-	-	-	1	3
CO4	2	2	2	2	1	1	-	-	-	-	1	2

Course Overview:

This course is designed to enable the student to design and analyze algorithms for the problems. This course covers basic strategies of algorithm design: top-down design, divide and conquer, asymptotic costs, applications to sorting and searching, matrix algorithms, shortest-path and spanning tree problems, dynamic programming, greedy algorithms and graph algorithms.

UNIT I **[10]**

Introduction to Algorithms: Time Complexity and Space Complexity, Asymptotic analysis, Growth rates, some common bounds (constant, logarithmic, linear, polynomial, exponential), Complexity Analysis techniques: Master theorem, Substitution Method, Iteration Method, Time complexity of Recursive algorithms. art of problem-solving and decision making, role of data structure in algorithm design, Basic algorithmic structures of problem-solving and optimization algorithms, constraints, solution space, and feasible reasons, and representation of solution space. Sorting and searching algorithms: Selection sort, bubble sort, insertion sort, Sorting in linear time, count sort, Linear search.

UNIT II **[10]**

Divide and Conquer Algorithms: Overview of Divide and Conquer algorithms, Quick sort, Merge sort, Heap sort, Binary search, Matrix Multiplication, Convex hull and Searching, Closest Pair of Points.

Greedy Algorithms: Greedy methods with examples, Huffman Coding, Knapsack, Minimum cost Spanning trees – Prim's and Kruskal's algorithms, Single source shortest paths – Dijkstra's and Bellman Ford algorithms.

UNIT III **[10]**

Dynamic programming: Dynamic programming with examples such as Knapsack, shortest path in graph All pair shortest paths –Warshal's and Floyd's algorithms, Resource allocation problem. Backtracking, Branch and Bound with examples such as Traveling Salesman Problem, longest common sequence, n-Queen Problem.

UNIT IV: **[10]**

Graph Algorithms: Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Bipartite graphs. Graph Coloring, Hamiltonian Cycles and Sum of subsets.

Computational complexity: Problem classes: P, NP, NP-complete, NP-hard. Reduction. The satisfiability problem, vertex cover, independent set and clique problems Cook's theorem. Examples of NP-complete problems.

Textbooks:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", PHI ,4th Edition
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Third Edition, Pearson Education, 2006

Reference Books:

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, “Fundamentals of Computer Algorithms”, Second Edition, Universities Press, 2011.
2. Anany Levitin. “Introduction to the Design and Analysis of Algorithms”, Pearson.

Semester: 5th			
Paper code: AIDS305	**L**	**T/P**	**Credits**
Subject: Data Mining	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To identify the different types of data and using data pre-processing techniques applicable on the dataset.
2.	To evaluate various classification and clustering techniques on real world datasets.
3.	To apply data mining techniques on complex data types.
4.	To analyze different association rule mining and sequence mining techniques.

Course Outcomes:

CO1	Interpret the basic concepts of data mining techniques to identify interesting and relevant patterns.
CO2	Apply and perform pre-processing steps to prepare the data and get insights into the dataset.
CO3	Analyze different association rules identified using association rule mining or sequence mining on real life datasets.
CO4	Design and Develop models using classification and clustering techniques on complex data types.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	1	2	-	3	-	-	1	-	-	-	-
CO2	2	2	2	3	-	-	-	-	1	-	-	-
CO3	2	-		2	3	-	1	-	-	1	-	-
CO4	2	2		3	3	-	-	-	-		1	2

Course Overview:

The subject gives a detailed overview on data mining as a process starting from pre-processing the dataset to classification/clustering techniques on the data. The students are introduced to different techniques that can be applied to various types of complex data. Concepts like association rule mining and ensemble methods are also discussed in this subject.

UNIT I **[8]**

Data Mining Basics- What is Data Mining, Kinds of Patterns to be Mined, Tasks of Data Mining, Data Mining Applications- The Business Context of Data Mining, Data Mining as a Research Tool, Data Mining for Marketing, Benefits of Data Mining, Date Warehousing vs Data Mining.

UNIT II **[12]**

Data Pre-processing- Review of Data Pre-processing: Types of Data, Data Quality, Measurement and Data Collection Issues, Feature Subset Selection, Feature Creation, Data Discretization and Binning, Knowledge Discovery in Databases.

UNIT III **[10]**

Machine Learning in Data Mining - Types of classifiers, Rule based classifiers, Model Selection, Model Evaluation, Ensemble Methods, Bias-Variance trade-off, Handling Class Imbalance Problem, Association Rule Mining **-** Mining Frequent Patterns, Market Basket Analysis, Apriori algorithm, Data Mining using decision trees and KNN algorithm.

UNIT IV **[10]**

Cluster Analysis- Different Types of Clusters, Hierarchical Methods of Clustering, Density based Clustering: DBSCAN algorithm, Cluster Evaluation. Outlier Analysis, Outlier Detection Methods, Mining Complex Data Types, avoiding False Discoveries.

Textbooks:

1. Tan Pang- Ning, Steinbach M., Viach, Kumar V., “Introduction to Data Mining”, Second Edition, Pearson, 2013.
2. Han J., Kamber M. and Pei J., “Data Mining Concepts and Techniques”, Second Edition, Hart Court India P. Ltd., Elsevier Publications, 2001.

Reference Books:

1. Zaki M.J., Meira W., “Data Mining and Machine Learning: Fundamental Concepts and Algorithms”, Second Edition, Cambridge University Press, 2020
2. Witten, E. Frank, M. Hall, “Data Mining: Practical Machine Learning Tools and Techniques”, Morgan Kaufmann Publishers, 2011.

Semester: 5th			
Paper code: AIML305	**L**	**T/P**	**Credits**
Subject: Fundamentals of Deep Learning	**4**	**0**	**4**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To learn basic computational units inspired from biological systems (brain).
2.	To study various algorithms in deep learning for various domains.
3.	To understand fundamental machine learning concepts w.r.t. neural networks.
4.	To apply deep learning models to solve sequence and vision problems.

Course Outcomes:

CO1	Interpret the basic computational units inspired from biological systems (brain).
CO2	Identify the deep learning algorithms which are more appropriate for various types of learning tasks in various domains.
CO3	Define the fundamental machine learning concepts w.r.t. neural networks.
CO4	Apply basic deep learning models to solve sequence-based problems and vision problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	1	1	2	-	-	-	2	1	2	1
CO2	3	1	1	1	2	1	1	1	2	1	2	2
CO3	3	1	1	1	2	1	1	1	2	1	2	2
CO4	3	1	1	1	2	1	1	1	2	1	2	2

Course Overview:

The main objective of this course is to develop the understanding of key mathematical principles which are used behind the working of neural networks. Convolution Neural Networks and Recurrent Neural Networks have also been covered in this course. This course also provides the details for usage of Deep Learning for Natural Language Processing.

Unit I: [10]

Introduction to Deep Learning: Introduction to Deep Learning, Bayesian Learning, Overview of Shallow Machine Learning, Difference between Deep Learning and Shallow Learning, Linear Classifiers ,Loss Function and Optimization Techniques -Gradient Descent and batch optimization.

Unit II: [10]

Introduction to Neural Network: Introduction to Neural Network, Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation through time. Architectural Design Issues.

Unit III: [10]

Training deep neural networks: Difficulty of training deep neural networks, Activation Function, Evaluating, Improving and Tuning the ANN. Hyper parameters Vs Parameters, Greedy layer wise training, Recurrent Neural Networks, Long Short-Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

Unit IV: [10]

Convolutional Neural Networks: Convolutional Neural Networks, Building blocks of CNN, Transfer Learning , Pooling Layers , Convolutional Neural Network Architectures.Well known case studies: LeNet, AlexNet, VGG-16, ResNet, Inception Net.Applications in Vision, Speech, and Audio-Video.

Text Books

1. Richard O. Duda," Pattern classification, Wiley, 2022
2. Adam Gibson and Josh Patterson, "Deep Learning: A Practical approach", 2017
3. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

Reference Books

1. Charu C. Aggarwal, "Neural Networks and Deep Learning", 2018
2. Duda, R.O. and Hart, P.E., Pattern classification. John Wiley & Sons, 2006.

Semester: 5th			
Paper code: AIDS307/AIML307	**L**	**T/P**	**Credits**
Subject: Computer Organization & Architecture	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the basic concepts of computer operation.
2.	To analyze different memory hierarchies along with their mapping.
3.	To apply and analyze different pipelining and parallelism.
4.	To implement various signed and unsigned arithmetic operations with digital hardware.

Course Outcomes:

CO1	Interpreting the basic concepts of register transfer language and computer operations.
CO2	Apply and analyze various instruction formats for CPU/GPU together with a variety of addressing modes.
CO3	Analyze different types of Parallel Computer Models.
CO4	Implementing arithmetic operations with digital hardware.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1		1						2
CO2	2	1	1	1							1	3
CO3	3	2	3	2	1	1	1				1	3
CO4	1	1	1	1								2

Course Overview:

This course enables the students to understand the principles of computer organization and the basic architectural concepts. It begins with basic organization, design, and programming of a simple digital computer and introduces simple register transfer language to specify various computer operations. Topics include computer arithmetic, instruction set design, microprogrammed control unit, pipelining and vector processing, memory organization and I/O systems, and multiprocessors.

Unit I **[8]**

Register Transfer Language: Register transfer language, bus and memory transfer, bus architecture using multiplexer and tri-state buffer, micro-operation: arithmetic, logical, shift micro-operation with hardware implementation, arithmetic logic shift unit.

Computer Organization and Design: Instruction codes, general computer registers with common bus system, computer instructions: memory reference, register reference, input-output instructions, timing and control, instruction cycle, input-output configuration, and interrupt cycle. Levels of programming languages: Machine language, Assembly language, High level language.

Unit II **[8]**

Central processing Unit: Introduction, general register organization, stack organization, instruction format, addressing modes. Overview of GPU, CPU vs GPU computing difference.

Memory Hierarchy: Introduction, basics of cache, measuring and improving of cache performance, cache memory: associative mapping, direct mapping, set-associative mapping, cache writing and initialization, virtual memory, common framework for memory hierarchies. Case study of PIV and AMD opteron memory hierarchies.

Unit III **[8]**

Parallel Computer Models: The state of computing, classification of parallel computers, multiprocessors and multicomputers, multivector and SIMD computers. Program and Network Properties: conditions of parallelism, data and resource dependences, hardware and software parallelism, program partitioning and scheduling, grain size and latency, program flow mechanisms, control flow versus data flow, data flow Architecture, demand driven mechanisms, comparisons of flow mechanisms.

Unit IV **[8]**

Pipelining: Introduction to Flynn‘s classification, arithmetic pipeline, instruction pipeline, pipeline conflict and hazards, RISC pipeline, vector processing.

Arithmetic for Computers: Unsigned, signed 1‘s, 2‘s compliment notations, addition, subtraction, multiplication and division (hardware implementation), CPU performance and its factors, evaluating performance of CPU.

Textbooks:

1. M. Morris, Mano, “Computer System Architecture”, PHI 3rd Edition 2007.
2. Kai Hwang, “Advanced computer architecture”; TMH. 2000
3. D. A. Patterson and J. L. Hennessey, “Computer organization and design”, Morgan Kaufmann, 2nd Ed. 2002

Reference Books:

1. W. Stallings, “Computer organization and Architecture”, PHI, 7th ed, 2005.

2. Harvey G.Cragon,"Memory System and Pipelined processors"; Narosa Publication. 1998
3. V.Rajaranam & C.S.R.Murthy, "Parallel computer"; PHI. 2002
4. R.K.Ghose, Rajan Moona & Phalguni Gupta, "Foundation of Parallel Processing", Narosa Publications, 2003.

Semester: 5th			
Paper code: AIDS309/AIML309	**L**	**T/P**	**Credits**
Subject: Introduction to Internet of Things	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To learn fundamentals of IoT and how to build IoT based systems
2.	To emphasize on development of Industrial IoT applications
3.	To recognize the factors that contributed to the emergence of IoT
4.	To utilize and implement solid theoretical foundation of the IoT Platform and System Design.

Course Outcomes:

CO1	Ability to understand design flow of IoT based systems
CO2	Analyse and understand different communication protocols for connecting IoT nodes to server
CO3	Apply coding concepts to design real-time IoT solutions
CO4	Develop the state-of-the-art IoT based systems, suitable for real life and Industry applications

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	-	2	2	2	-	1	-	-	-	1	1
CO3	-	-	2	2	2	-	1	-	-	-	1	1
CO4	1	1	3	2	2	1	1	1	1	1	1	1

Course Overview:

The course enables student to understand the basics of Internet of things and protocols. It introduces some of the application areas where Internet of Things can be applied. Students will learn about the middleware for Internet of Things. The course addresses various components of Internet of things such as Sensors, internetworking, protocols. In the end students will also be able to design and implement IoT circuits and solutions.

UNIT I **[8]**

The Internet of Things: An Overview of what is IoT? Why IoT? Explain the definition and usage of the term "Internet of Things (IOT)" in different contexts. Design Principles for Connected Devices, internet principles: internet communications-An overview, Physical Design of IoT, Logical Design of IoT, IoT standards, IoT generic architecture and IoT protocols. IoT future trends, Understand IoT Applications and Examples. Understand various IoT architectures based on applications. Understand different classes of sensors and actuators. Sensors: sensor terminology, sensor dynamics and specifications. Understand the basics of hardware design needed to build useful circuits using basic sensors and actuators.

UNIT II **[8]**

Communication protocols and Arduino Programming: Understand various network protocols used in IoT, Understand various communication protocols (SPI, I2C, UART). Design and develop Arduino code needed to communicate the microcontroller with sensors and actuators, build circuits using IoT supported Hardware platforms such as Arduino, ESP8266 etc., Use of software libraries with an Arduino sketch that allows a programmer to use complicated hardware without dealing with complexity, Learning IoT application programming and build solutions for real life problems and test them in Arduino and Node MCU environments. Understand various wireless Technologies for IoT and its range, frequency and applications.

UNIT III **[8]**

Fundamentals of IEEE 802.15.4, Zigbee and 6LOWPAN: Importance of IEEE 802.15.4 MAC and IEEE 802.15.4 PHY layer in constrained networks and their header format, Importance of Zigbee technology and its applications, use of IPv6 in IoT Environments, Understanding importance of IPv6 and how constrained nodes deal with bigger headers (IPv6). Understand IPv6 over Low-Power WPAN (6LoWPAN) and role of 6LoWPAN in wireless sensor network. Various routing techniques in constrained network. Understanding IoT Application Layer Protocols: HTTP, CoAP Message Queuing Telemetry Transport (MeTT).

UNIT IV **[8]**

Application areas and Real-time Case Studies: Role of big data, cloud computing and data analytics in a typical IoT system. Analyze various case studies implementing IoT in real world environment and find out the solutions of various deployment issues. Smart parking system, Smart irrigation system-block diagram, sensors, modules on Arduino and Node MCU.

Text Books:

5. "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of things" by David Hanes, Cisco Press.
6. Internet of things with ESP 8266, Macro Schwartz, Pact publication.
7. Bahga, A., & Madisetti, V. (2014). Internet of Things: A hands-on approach. Vpt.
8. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013

Reference Books:

5. Building the Internet of Things with IPv6 and MIPv6 The Evolving World of M2M Communications, Daniel Minoli, Wiley Publications.
6. Mastering internet of things by Peter Waher, Pact publication.
7. The Internet of Things: connecting objects to the web, Hakima chaouchi, Wiley Publications.
8. Course Era: "Interfacing with the Arduino" by Ian Harris, University of Irvine, California.

Semester: 5th			
Paper code: AIDS 311/AIML 311	**L**	**T/P**	**Credits**
Subject: Principles of Entrepreneurship Mindset	**2**	**0**	**2**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Identify and apply the attitudes, values, characteristics, behaviour, and processes associated with possessing an entrepreneurial & innovation mindset and engaging in successful appropriate entrepreneurial and innovative behaviour.
2.	Understand the basic concepts of finance and marketing for first time entrepreneurs.
3.	Study Business Model Canvas and apply it for product and services area.
4.	Create and write a business plan.

Course Outcomes:

CO1	Apply the attitudes, values, characteristics, behaviour, and processes associated with possessing an entrepreneurial & innovation mindset and engaging in successful appropriate entrepreneurial and innovative behaviour.
CO2	Conceptualize the basic concepts of finance and marketing.
CO3	Evaluate the business model canvas and apply the same for product and services area.
CO4	Create and write a business plan.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	2	3	3	1	1	-	1	1	-	-	2
CO2	2	2	3	3	1	1	-	1	1	-	-	2
CO3	2	2	3	3	1	1	-	1	2	-	-	2
CO4	2	2	3	3	2	1	1	1	2	-	-	2

Course Overview:
This course gives exposure to the students for the core entrepreneurship concepts. Three real time case studies have been covered to give the students real time understanding of setting up a startup. Business canvas model has been covered under the syllabus followed by the finance and marketing skills for budding entrepreneurs. Students will be able to create and write a business plan after the completion of the course.

Unit I **[6]**
Introduction to Entrepreneurship and Innovation: Entrepreneurship: Concepts, entrepreneurship mindset, challenges; Innovation: What is innovation, role of technology, creating new ventures through innovative initiatives; Business opportunities: concepts & techniques for identifying opportunities, writing a problem statement, tools and techniques for idea generation; Introduction to social entrepreneurship. Study and Analyze at least three case studies of startups in computing (mixture of both successful and failed startups, an Indian startup, startup by a student)

Unit II **[6]**
Understanding Business Model Canvas: Introduction to Business Model Canvas; customer segments; value proposition, distribution channels; Customer Relationship, Revenue Streams, Key Resources, Key Activities, Key Partnerships, Cost Structure, Preparing a business model canvas of a problem statement

Unit III **[6]**
Finance and Marketing for early entrepreneurs: Basic understanding of P&L, Balance sheet and cash flow; Understanding of terms like CAGR, NPV, Angle funding, Venture capital, Debt funding, Equity, private equity, valuation, Break-even analysis, Return on Investment, Working Capital, Cost of Good Sold, Customer Acquisition cost, Customer life time value, profit margins.
Marketing for budding entrepreneurs: Understanding customer requirements, Customer Profiling and segmentation, Marketing strategy, 4Ps of Marketing, Network effect.

Unit IV **[6]**
Creating and writing a Business Plan: Introduction to different Business Models. Process of Business Planning - Purpose, structure and content, business plan outline, how to write Business plan, Preparing a business plan of a problem statement. Application of Business Model Canvas in creating the business plan. Understand customer needs, design and conduct a survey. Presentation of Business Plan. Process of incorporating a new company in India.

Textbooks:
1. "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers" by Alexander Osterwalder, Yves Pigneur
2. "Making Breakthrough Innovation Happen" by Porus Munshi
3. Ries Eric (2011), "The lean Start-up: How constant innovation creates radically successful businesses", Penguin Books Limited.

Reference Books:

1. Blank, Steve (2013), "The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company", K&S Ranch.
2. S. Carter and D. Jones-Evans, "Enterprise and small business- Principal Practice and Policy", Pearson Education (2006)
3. T. H. Byers, R. C. Dorf, A. Nelson, "Technology Ventures: From Idea to Enterprise", McGraw Hill (2013)
4. Osterwalder, Alex and Pigneur, Yves (2010) "Business Model Generation".
5. Kachru, Upendra, "India Land of a Billion Entrepreneurs", Pearson
6. Bagchi, Subroto, (2008), "Go Kiss the World: Life Lessons for the Young Professional", Portfolio Penguin
7. Bagchi, Subroto, (2012). "MBA At 16: a Teenager's Guide to Business", Penguin Books
8. Mitra, Sramana (2008), "Entrepreneur Journeys (Volume 1)", Booksurge Publishin
9. Abrams, R. (2006). "Six-week Start-up", Prentice-Hall of India
10. Verstraete, T. and Laffitte, E.J. (2011). "A Business Model of Entrepreneurship", Edward Elgar Publishing.
11. Johnson, Steven (2011). "Where Good Ideas comes from", Penguin Books Limited.
12. Gabor, Michael E. (2013), "Awakening the Entrepreneur Within", Primento.
13. Guillebeau, Chris (2012), "The $100 startup: Fire your Boss, Do what you love and work better to live more", Pan Macmillan
14. Kelley, Tom (2011), "The ten faces of innovation, Currency Doubleday"
15. Prasad, Rohit (2013), "Start-up sutra: what the angels won't tell you about business and life", Hachette India.

Semester: 5th			
Paper code: AIDS351/AIML351	**L**	**T/P**	**Credits**
Subject: Operating Systems Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To apply the concepts of storage management, process scheduling using programming languages.
2.	To study Several Operating systems and their commands to analyze the memory management, process scheduling concepts.

Course Outcomes:

CO1	Apply the techniques used to implement processes and threads as well as the different algorithms for process scheduling.
CO2	Implement the basic commands of the OS and will execute the various system calls, process synchronization problems using semaphore.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	-	1	1	-	-	-	1	1	1	1
CO2	3	2	2	1	1	-	1	-	2	1	2	1

List of Experiments:

1. Write a C program to implement FCFS scheduling algorithm.
2. Write a C program to implement a round robin scheduling algorithm.
3. Implementation of the following Memory Allocation Methods for fixed partition a) First Fit b) Worst Fit c) Best Fit.
4. Write a program to implement reader/writer problems using semaphore.
5. Write a program to implement Banker’s algorithm for deadlock avoidance.
6. To study of basic UNIX commands and various UNIX editors such as vi, ed, ex and EMACS

7. Process Management a) fork() b) execv() c) execlp() d) wait() and e) sleep()
    A. Program to implement the fork function using C.
    B. Program to implement execv function using C.
    C. Program to implement execlp function.
    D. Program to implement wait function using C.
    E. Program to implement sleep function using C.
8. To write simple shell programs by using conditional, branching and looping statements.
9. Write a Shell Program to swap the two integers.

Semester: 5th			
Paper code: AIDS353/AIML353	**L**	**T/P**	**Credits**
Subject: Design and Analysis of Algorithms Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To teach students how to analyses solution space of problems
2.	To design algorithms based on dynamic programming and greedy algorithms.

Course Outcomes:

CO1	Apply important algorithmic design paradigms and methods of analysis in problem solving.
CO2	Design and develop dynamic programming and greedy algorithms.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. Sort a given set of elements using the quick sort algorithm and find the time complexity for different values of n.
2. Implement merge sort algorithm using divide & conquer method to sort a given set of elements and determine the time and space required to sort the elements.
3. Write a program to implement knapsack problem using greedy method.
4. Program to implement job sequencing with deadlines using greedy method.
5. Write a program to find minimum cost spanning tree using Prim's Algorithm.
6. Write a program to find minimum cost spanning tree using Kruskal's Algorithm.
7. Implement 0/1 Knapsack problem using dynamic programming.
8. Write a program to perform Single source shortest path problem for a given graph.
9. Program for finding shortest path for multistage graph using dynamic programming.
10. Program to implement 8-queens problem using backtrack method.

Semester: 5th			
Paper code: AIDS355	**L**	**T/P**	**Credits**
Subject: Data Mining Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To perform preprocessing on real world datasets.
2.	To develop models using different data mining techniques on complex datasets.

Course Outcomes:

CO1	Analyze and apply pre-processing techniques to prepare and process real life datasets.
CO2	Implement different clustering or classification techniques for varying sets of problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	2	3	-	1	-	-	1	-	-
CO2	2	2	-	3	3	-	-	-	-	-	1	2

List of Experiments

1. Introduction and installation of WEKA tool.
2. Perform data pre-processing including cleaning, integration and transformation on ARFF files using WEKA.
3. Apply association rule mining on ARFF files using WEKA.
4. Implementation of Visualization technique on ARFF files using WEKA.
5. Implementation of Clustering technique on ARFF files using WEKA.
6. Study of DBMINER tool.
7. Apply pre-processing and classification/regression techniques on a real-world dataset.
8. Evaluate the performance of classification techniques using different parameters.
9. Implementation of Bagging and Boosting techniques on ARFF files using WEKA.
10. Apply the concept of Voting ensemble method to ARFF files and compare the results with single classifiers.

Semester: 5th			
Paper code: AIML355	**L**	**T/P**	**Credits**
Subject: Fundamentals of Deep Learning Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Implementation of deep learning models in Python and train them with real-world datasets.
2.	Implementation of Convolution Neural Network (CNN), Recurrent Neural Network (RNN) and Deep Learning NLP in Python.

Course Outcomes:

CO1	Design and Implement Convolution Neural Network for object classification from images or video.
CO2	Implement Autoencoder, Recurrent Neural Network, LSTM, its variants and Deep NLP.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping
(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	1	2	1	1	1	2	1	2	2
CO2	2	1	1	1	2	1	1	1	2	1	2	2

List of Experiments:

1. To explore the basic features of Tensorflow and Keras packages in Python
2. Implementation of ANN model for regression and classification problem in Python.
3. Implementation of Convolution Neural Network for MRI Data Set in Python.
4. Implementation of Autoencoders for dimensionality reduction in Python.
5. Application of Autoencoders on Image Dataset.
6. Improving Autocoder's Performance using convolution layers in Python (MNIST Dataset to be utilized).
7. Implementation of RNN model for Stock Price Prediction in Python
8. Using LSTM for prediction of future weather of cities in Python

9. Implementation of transfer learning using the pre-trained model (MobileNet V2) for image classification in Python.
10. Implementation of transfer learning using the pre-trained model (VGG16) on image dataset in Python.
11. NLP Analysis of Restaurant Reviews in Python.
12. Building a NLP model for Spam Detection using TFIDF (Term Frequency Inverse Document Frequency Vectorizer).

Semester: 5th			
Paper code: AIDS357/AIML357	**L**	**T/P**	**Credits**
Subject: Introduction to Internet of Things Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To teach students how to analyse different controller boards, simulation platforms and applications of IoT
2.	To design IoT based systems and applications to solve real time problems.

Course Outcomes:

CO1	Apply IoT principles to design programs using a software and hardware to using variety of available resources to create IoT ecosystem
CO2	Implement applications based on IoT for solving different problems using Arduino and Node MCU – ESP 8266

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	2	2	2	-	1	1	-	-	1	1
CO2	1	1	2	2	3	1	1	1	1	1	1	1

List of Experiments:

1. Introduction to Arduino platform and programming and Introduction to various actuators & its applications.
2. Introduction with running a blinking LED and fading LED with PWM
   A. Arduino IDE and Operators in IDE.
   B. Frequently used Functions in Arduino IDE
3. Control Structure writing programs for if else, for and while
4. Custom functions that can be created for specific Needs.
5. Reading and writing digital and analog values. Digital and analog read/write demonstration.
6. Measuring light with Lux and a photoresistor demonstration

7. Measuring temperature and humidity.
8. Adding an LCD screen and sketch walkthrough.
9. Create an echo server with the Ethernet Shield over Arduino.
10. Upload data from a single sensor to ThingSpeak using ESP8266 (NodeMCU),
11. Upload data from multiple sensors to ThingSpeak using ESP8266 (NodeMCU).
12. Setting up logging and visualizing data on ThingSpeak.
13. Making Project- on real-world Problems.
14. Introduction to Arduino platform and programming and Introduction to various actuators & its applications.

Detailed SYLLABUS
(3rd Year)

Fifth Semester

for

BACHELOR OF TECHNOLOGY

for

Industrial Internet of Things

Semester: 5th			
Paper code: IOT301	**L**	**T/P**	**Credits**
Subject: Data Transmission Methodologies	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide students with a comprehensive understanding of analog and digital communication systems and its applications in the modern world.
2.	To enable students to develop a strong foundation in analog modulation techniques including amplitude modulation (AM), frequency modulation (FM), and phase modulation (PM)
3.	To facilitate students with thorough understanding in digital modulation techniques
4.	To understand the fundamentals of data transmission and acquisition systems

Course Outcomes:

CO1	Student will be able to comprehend understanding of analog and digital communication systems and its applications in the modern world
CO2	Student will be able to develop a strong foundation in analog modulation techniques including amplitude modulation (AM), frequency modulation (FM), and phase modulation (PM)
CO3	Student will gain deep understanding of the principles of digital communication systems, including digital modulation and channel coding techniques
CO4	Student will be able to understand the fundamentals of data transmission and acquisition systems

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	2	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	-	1	-	-	2	-	-

Course Overview

Information Transmission and Methodologies is a comprehensive course that covers the fundamental principles, techniques, and technologies used in the transmission and reception of information. The course provides a solid understanding of both analog and digital communication systems, including their underlying theories, practical implementations, and relevant signal processing techniques.

Unit I **[8]**
Introduction: Communication systems and its types, elements of a communication system, types of signals. Analog and digital communication, advantages, and limitations of analog communication. Digital versus analog communication, digital modulation techniques, elements of digital communication

Unit II **[10]**
Amplitude Transmission Methodologies: Modulation index and its effect on the transmitted signal, Double sideband (DSB) modulation and its variants, Single sideband (SSB) modulation.
Frequency Modulation (FM): Modulation index and its effect on the transmitted signal, Narrowband FM (NBFM) and wideband FM (WBFM), Phase Modulation (PM).

Unit III **[12]**
Digital Transmission Methodologies: Pulse code modulation: Introduction to PCM, analog-to-digital conversion, sampling, quantizing, coding, and decoding. Companding in PCM, A-law, and μ-law, quantization noise.
Pulse Modulation: Introduction to pulse modulation, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse-position modulation (PPM), and their calculations
Digital modulation schemes: (ASK, PSK, FSK, QAM)

Unit IV **[10]**
Transmission and Acquisition Techniques: Basics of Telemetry system, Land line & radio frequency telemetering systems, Transmission channels and media, Data receiver & transmitter, Analog data acquisition system, Digital data acquisition system, Modern digital data acquisition system

Text Books
1. Digital Communications by J.G. Proakis and M. Salehi
2. Principles of Communication Systems by H. Taub and D. Schilling
3. Modern Digital and Analog Communication Systems by B.P. Lathi

Reference Books
1. Analog Communication by A.P.Godse and U.A.Bakshi
2. Electronics Communication System by G. Kennedy and B. Davis
3. Communication Systems: Analog and Digital by R.P. Singh and S.D. Sapre
4. Wireless Communications by Andrea Goldsmith.

Semester: 5th			
Paper code: IOT303	**L**	**T/P**	**Credits**
Subject: Design and Analysis of Algorithms	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand and apply the algorithm analysis techniques to generate solution space.
2.	To critically analyze the efficiency of alternative algorithmic solutions for the same problem.
3.	To analyze different algorithm design techniques.
4.	To classify a problem as computationally tractable or intractable, and discuss strategies to address intractability

Course Outcomes:

CO1	Understand the asymptotic performance of algorithms to analyze formal correctness proof for algorithms
CO2	Apply major algorithms' knowledge and data-structures corresponding to each algorithm design paradigm
CO3	Design efficient algorithms for common computer engineering design problems
CO4	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	1	1	-	-	1	1	1	1	2
CO2	2	2	1	1	1	-	-	1	1	1	1	2
CO3	2	2	2	1	1	-	-	-	-	-	1	3
CO4	2	2	2	2	1	1	-	-	-	-	1	2

Course Overview:

This course is designed to enable the student to design and analyze algorithms for the problems. This course covers basic strategies of algorithm design: top-down design, divide and conquer, asymptotic costs, applications to sorting and searching, matrix algorithms, shortest-path and spanning tree problems, dynamic programming, greedy algorithms and graph algorithms.

UNIT I **[10]**

Introduction to Algorithms: Time Complexity and Space Complexity, Asymptotic analysis, Growth rates, some common bounds (constant, logarithmic, linear, polynomial, exponential), Complexity Analysis techniques: Master theorem, Substitution Method, Iteration Method, Time complexity of Recursive algorithms. art of problem-solving and decision making, role of data structure in algorithm design, Basic algorithmic structures of problem-solving and optimization algorithms, constraints, solution space, and feasible reasons, and representation of solution space. Sorting and searching algorithms: Selection sort, bubble sort, insertion sort, Sorting in linear time, count sort, Linear search.

UNIT II **[10]**

Divide and Conquer Algorithms: Overview of Divide and Conquer algorithms, Quick sort, Merge sort, Heap sort, Binary search, Matrix Multiplication, Convex hull and Searching, Closest Pair of Points. **Greedy Algorithms:** Greedy methods with examples, Huffman Coding, Knapsack, Minimum cost Spanning trees – Prim's and Kruskal's algorithms, Single source shortest paths – Dijkstra's and Bellman Ford algorithms.

UNIT III **[10]**

Dynamic programming: Dynamic programming with examples such as Knapsack, shortest path in graph All pair shortest paths –Warshal's and Floyd's algorithms, Resource allocation problem. Backtracking, Branch and Bound with examples such as Traveling Salesman Problem, longest common sequence, n-Queen Problem.

UNIT IV: **[10]**

Graph Algorithms: Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Bipartite graphs. Graph Coloring, Hamiltonian Cycles and Sum of subsets.

Computational complexity: Problem classes: P, NP, NP-complete, NP-hard. Reduction. The satisfiability problem, vertex cover, independent set and clique problems Cook's theorem. Examples of NP-complete problems.

Textbooks:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", PHI ,4th Edition
2. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Third Edition, Pearson Education, 2006

Reference Books:

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, 2011.
2. Anany Levitin. "Introduction to the Design and Analysis of Algorithms", Pearson.

Semester: 5th			
Paper code: IOT305	**L**	**T/P**	**Credits**
Subject: Sensors and Control Systems	**4**	**0**	**4**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To make students familiar with the constructions and working principle of different types of sensors and transducers.
2.	To gain comprehensive understanding of how these devices convert physical quantities into electrical signals for measurement and control purposes.
3.	To state the performance characteristics of control systems with specific design requirements and design objectives
4.	To demonstrate applications of sensors and transducers in control systems

Course Outcomes:

CO1	To construct and apply principles of different types of sensors and transducers.
CO2	To understand of how these devices convert physical quantities into electrical signals for measurement and control purposes
CO3	Analyze and apply block diagram and signal flow graph (SFG) techniques to describe the working of different control systems and analyze the performance characteristics of control systems with specific design requirements and design objectives.
CO4	Develop applications of sensors and transducers in control systems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	2	1	-	-	2	-	-

Course Overview:

This course addresses the basic understanding about operational characteristics and applications of various sensors and actuators. This course also provides the fundamental concepts of Control systems and mathematical modeling of the system. This subject also examines the application of sensors and transducer within a control system.

UNIT I **[12]**

Sensors and Transducers: Introduction, Definition and differences of sensors and transducers, Performance terminology, static and dynamic characteristics of transducers, Sensors: Working Principles: Different types; Selection of Sensors for Practical Applications

Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT. Strain Measurement: Theory of Strain Gauges, Bridge circuit, Strain gauge based load cells and torque sensors, Velocity and Motion: Electromagnetic tachometer, photoelectric tachometer, variable reluctance tachometer, Digital Encoders. Vibration and acceleration: Eddy current type, piezoelectric type; Accelerometer: Principle of working, practical accelerometers, strain gauge based and piezoelectric accelerometers. Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors. Flow Measurement: Bernoulli flowmeter, Ultrasonic flowmeter, Magnetic flow meter, Rotameter. Miscellaneous Sensors: Leak detector, Flame detector, Smoke detector, pH sensors, Conductivity sensors, Humidity sensors, Potentiometric Biosensors and Proximity sensors. Selection of sensors

UNIT II **[8]**

Importance and Adoption of Smart Sensors, Architecture of Smart Sensors: Important components, their features, Fabrication methods of Smart Sensor: Electrode fabrication: Screen printing, Photolithography, Electroplating Sensing film deposition: Physical and chemical Vapor, Anodization, Sol-gel Interface Electronic Circuit for Smart Sensors and Challenges for Interfacing the Smart Sensor

UNIT III **[10]**

Control Systems: Basics and components, classifications and types of control systems, block diagrams and signal flow graphs. Transfer function, determination of transfer function using block diagram reduction techniques and Mason's Gain formula. Time domain analysis, performance specifications, transient response of first & second order systems, steady state errors and static error constants in unity feedback control systems, response with P, PI and PID controllers.

UNIT IV **[10]**

Applications of sensors and transducers in control systems: Two tank system, speed control of DC motor, temperature measurement with sensors and transducers with a transmitter, thermistor-controlled fan, flow meter measurement and control system, strain gauge and Wheatstone bridge, scope block with Apple iOS devices, control brightness of Arduino onboard LED from Apple iOS device.

Textbooks:

1. Patranabi, D. (2003). Sensors and Tranducers. PHI Learning Pvt. Ltd.

2. Murty, D. V. S. (2010). Transducers and Instrumentation. PHI Learning Pvt. Ltd.
3. Ogata, K. (2010). Modern control engineering (Vol. 5). Upper Saddle River, NJ: Prentice hall.

Reference Books:

1. Doebelin, E. O., & Manik, D. N. (2007). Measurement systems: application and design.
2. Bentley, J. P. (2005). Principles of measurement systems. Pearson education.
3. Gopal, M. (1993). Modern control system theory. New Age International.

Semester: 5th			
Paper code: IOT307	**L**	**T/P**	**Credits**
Subject: Computer Organization & Architecture	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the basic concepts of computer operation.
2.	To analyze different memory hierarchies along with their mapping.
3.	To apply and analyze different pipelining and parallelism.
4.	To implement various signed and unsigned arithmetic operations with digital hardware.

Course Outcomes:

CO1	Interpreting the basic concepts of register transfer language and computer operations.
CO2	Apply and analyze various instruction formats for CPU/GPU together with a variety of addressing modes.
CO3	Analyze different types of Parallel Computer Models.
CO4	Implementing arithmetic operations with digital hardware.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1		1						2
CO2	2	1	1	1							1	3
CO3	3	2	3	2	1	1	1				1	3
CO4	1	1	1	1								2

Course Overview:

This course enables the students to understand the principles of computer organization and the basic architectural concepts. It begins with basic organization, design, and programming of a simple digital computer and introduces simple register transfer language to specify various computer operations. Topics include computer arithmetic, instruction set design, microprogrammed control unit, pipelining and vector processing, memory organization and I/O systems, and multiprocessors.

UNIT I **[8]**

Register Transfer Language: Register transfer language, bus and memory transfer, bus architecture using multiplexer and tri-state buffer, micro-operation: arithmetic, logical, shift micro-operation with hardware implementation, arithmetic logic shift unit.

Computer Organization and Design: Instruction codes, general computer registers with common bus system, computer instructions: memory reference, register reference, input-output instructions, timing and control, instruction cycle, input-output configuration, and interrupt cycle. Levels of programming languages: Machine language, Assembly language, High level language.

UNIT II **[8]**

Central processing Unit: Introduction, general register organization, stack organization, instruction format, addressing modes. Overview of GPU, CPU vs GPU computing difference.

Memory Hierarchy: Introduction, basics of cache, measuring and improving of cache performance, cache memory: associative mapping, direct mapping, set-associative mapping, cache writing and initialization, virtual memory, common framework for memory hierarchies. Case study of PIV and AMD opteron memory hierarchies.

UNIT III **[8]**

Parallel Computer Models: The state of computing, classification of parallel computers, multiprocessors and multicomputers, multivector and SIMD computers. Program and Network Properties: conditions of parallelism, data and resource dependences, hardware and software parallelism, program partitioning and scheduling, grain size and latency, program flow mechanisms, control flow versus data flow, data flow Architecture, demand driven mechanisms, comparisons of flow mechanisms.

UNIT IV **[8]**

Pipelining: Introduction to Flynn‘s classification, arithmetic pipeline, instruction pipeline, pipeline conflict and hazards, RISC pipeline, vector processing.

Arithmetic for Computers: Unsigned, signed 1‘s, 2‘s compliment notations, addition, subtraction, multiplication and division (hardware implementation), CPU performance and its factors, evaluating performance of CPU.

Textbooks:

1. M. Morris, Mano, “Computer System Architecture”, PHI 3rd Edition 2007.
2. Kai Hwang, “Advanced computer architecture”; TMH. 2000
3. D. A. Patterson and J. L. Hennessey, “Computer organization and design”, Morgan Kaufmann, 2nd Ed. 2002

Reference Books:

1. W. Stallings, “Computer organization and Architecture”, PHI, 7th ed, 2005.
2. Harvey G.Cragon,”Memory System and Pipelined processors”; Narosa Publication. 1998
3. V.Rajaranam & C.S.R.Murthy, “Parallel computer”; PHI. 2002

4. R.K.Ghose, Rajan Moona & Phalguni Gupta, “Foundation of Parallel Processing”, Narosa Publications, 2003

Semester: 5th			
Paper code: IOT309	**L**	**T/P**	**Credits**
Subject: Machine Learning	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand regression, classification, and prediction algorithms to classify data.
2.	To gain knowledge about feature selection.
3.	To analyse feature engineering techniques to formulate the solutions for the complex problems
4.	To apply machine learning techniques in real world problems.

Course Outcomes:

CO1	Understand machine learning tools and techniques with their applications.
CO2	Apply machine learning techniques for classification and regression.
CO3	Perform feature engineering techniques.
CO4	Design supervised and unsupervised machine learning based solutions for real-world problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	1	1	1	1	1	1	2
CO2	3	3	3	3	2	1	1	1	1	1	1	1
CO3	3	3	3	3	2	-	-	-	-	-	-	-
CO4	3	3	3	3	2	1	1	1	1	1	1	2

Course Overview:

This course covers fundamental concepts and methods of computational data analysis, including pattern classification, prediction, visualization, and recent topics in machine learning. The course will give the student the basic ideas and intuition behind modern machine learning methods as well as a bit more formal understanding of how, why, and when they work. The underlying theme in the course is a statistical inference as it provides the foundation for most of the methods covered.

UNIT I: **[8]**
Introduction to Machine Learning: Basic concepts, developing a learning system, Learning Issues, and challenges. Types of Machine Learning. Feature Selection Mechanisms, Imbalanced Data, Bias in Data, Outlier Detection

UNIT II: **[8]**
Supervised Learning: Linear Regression, Multiple Regression, Logistic Regression, Classification; Classifier Models, K Nearest Neighbor (KNN), Naive Bayes, Decision Trees, Support Vector Machine (SVM), Random Forest

UNIT III: **[8]**
Unsupervised Learning: Dimensionality Reduction; Clustering; K-Means Clustering; C-Means Clustering; Fuzzy C Means Clustering, Association Analysis- Association Rules in Large Databases, Apriori Algorithm, Markov Models: Hidden Markov Models (HMMs).

UNIT IV: **[8]**
Reinforcement Learning: Introduction to Reinforcement Learning, Elements of Reinforcement Learning, Approaches to Reinforcement Learning, Applications of Reinforcement learning. Applications of Machine Learning in different sectors: Medical Diagnostics, Fraud Detection, Email Spam Detection

Text Books:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill, 2010.
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Pearson, Third Edition, 2014.
3. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995

Reference Books:

1. Ethem Alpaydin, (2004), Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press
2. T. Astie, R. Tibshirani, J. H. Friedman, The Elements of Statistical Learning, Springer (2nd ed.), 2009
3. Bishop, C., Pattern Recognition and Machine Learning. Berlin: Spring

Semester: 5th			
Paper code: IOT311	**L**	**T/P**	**Credits**
Subject: Principles of Entrepreneurship Mindset	**2**	**0**	**2**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Identify and apply the attitudes, values, characteristics, behaviour, and processes associated with possessing an entrepreneurial & innovation mindset and engaging in successful appropriate entrepreneurial and innovative behaviour.
2.	Understand the basic concepts of finance and marketing for first time entrepreneurs.
3.	Study Business Model Canvas and apply it for product and services area.
4.	Create and write a business plan.

Course Outcomes:

CO1	Apply the attitudes, values, characteristics, behaviour, and processes associated with possessing an entrepreneurial & innovation mindset and engaging in successful appropriate entrepreneurial and innovative behaviour.
CO2	Conceptualize the basic concepts of finance and marketing.
CO3	Evaluate the business model canvas and apply the same for product and services area.
CO4	Create and write a business plan.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	2	3	3	1	1	-	1	1	-	-	2
CO2	2	2	3	3	1	1	-	1	1	-	-	2
CO3	2	2	3	3	1	1	-	1	2	-	-	2
CO4	2	2	3	3	2	1	1	1	2	-	-	2

Course Overview:

This course gives exposure to the students for the core entrepreneurship concepts. Three real time case studies have been covered to give the students real time understanding of setting up a startup. Business canvas model has been covered under the syllabus followed by the finance and marketing skills for budding entrepreneurs. Students will be able to create and write a business plan after the completion of the course.

UNIT I **[6]**

Introduction to Entrepreneurship and Innovation: Entrepreneurship: Concepts, entrepreneurship mindset, challenges; Innovation: What is innovation, role of technology, creating new ventures through innovative initiatives; Business opportunities: concepts & techniques for identifying opportunities, writing a problem statement, tools and techniques for idea generation; Introduction to social entrepreneurship.
Study and Analyze at least three case studies of startups in computing (mixture of both successful and failed startups, an Indian startup, startup by a student)

UNIT II **[6]**

Understanding Business Model Canvas: Introduction to Business Model Canvas; customer segments; value proposition, distribution channels; Customer Relationship, Revenue Streams, Key Resources, Key Activities, Key Partnerships, Cost Structure, Preparing a business model canvas of a problem statement

UNIT III **[6]**

Finance and Marketing for early entrepreneurs: Basic understanding of P&L, Balance sheet and cash flow; Understanding of terms like CAGR, NPV, Angle funding, Venture capital, Debt funding, Equity, private equity, valuation, Break-even analysis, Return on Investment, Working Capital, Cost of Good Sold, Customer Acquisition cost, Customer life time value, profit margins.
Marketing for budding entrepreneurs: Understanding customer requirements, Customer Profiling and segmentation, Marketing strategy, 4Ps of Marketing, Network effect.

UNIT IV **[6]**

Creating and writing a Business Plan: Introduction to different Business Models. Process of Business Planning - Purpose, structure and content, business plan outline, how to write Business plan, Preparing a business plan of a problem statement. Application of Business Model Canvas in creating the business plan. Understand customer needs, design and conduct a survey. Presentation of Business Plan. Process of incorporating a new company in India.

Textbooks:

1. "Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers" by Alexander Osterwalder, Yves Pigneur
2. "Making Breakthrough Innovation Happen" by Porus Munshi
3. Ries Eric (2011), "The lean Start-up: How constant innovation creates radically successful businesses", Penguin Books Limited.

Reference Books:

1. Blank, Steve (2013), "The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company", K&S Ranch.
2. S. Carter and D. Jones-Evans, "Enterprise and small business- Principal Practice and

Policy", Pearson Education (2006)

3. T. H. Byers, R. C. Dorf, A. Nelson, "Technology Ventures: From Idea to Enterprise", McGraw Hill (2013)
4. Osterwalder, Alex and Pigneur, Yves (2010) "Business Model Generation".
5. Kachru, Upendra, "India Land of a Billion Entrepreneurs", Pearson
6. Bagchi, Subroto, (2008), "Go Kiss the World: Life Lessons for the Young Professional", Portfolio Penguin
7. Bagchi, Subroto, (2012). "MBA At 16: a Teenager's Guide to Business", Penguin Books
8. Mitra, Sramana (2008), "Entrepreneur Journeys (Volume 1)", Booksurge Publishin
9. Abrams, R. (2006). "Six-week Start-up", Prentice-Hall of India
10. Verstraete, T. and Laffitte, E.J. (2011). "A Business Model of Entrepreneurship", Edward Elgar Publishing.
11. Johnson, Steven (2011). "Where Good Ideas comes from", Penguin Books Limited.
12. Gabor, Michael E. (2013), "Awakening the Entrepreneur Within", Primento.
13. Guillebeau, Chris (2012), "The $100 startup: Fire your Boss, Do what you love and work better to live more", Pan Macmillan
14. Kelley, Tom (2011), "The ten faces of innovation, Currency Doubleday"
15. Prasad, Rohit (2013), "Start-up sutra: what the angels won't tell you about business and life", Hachette India.

Semester: 5th			
Paper code: IOT351	**L**	**T/P**	**Credits**
Subject: Data Transmission Methodologies Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To familiarize students with the basics of analog and digital communication systems and their applications in modern communication systems.
2.	To develop the students' practical skills in designing and analyzing analog and digital communication circuits, such as amplitude and frequency modulation, demodulation, sampling, and quantization.

Course Outcomes:

CO1	Demonstrate an understanding of signal processing techniques and the theory underlying various communication blocks and circuits.
CO2	Apply the basic principles of analog and digital communication systems in constructing communication circuits and equipment.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	2	-	-	-	-	-	-	1
CO2	3	2	3	2	3	-	-	-	-	-	-	1

List of Experiments:

1. Demonstration of different signals and their properties. Explore the effect of transformation of signal parameters (amplitude-scaling, time-scaling and time-shifting)
2. Identify type of system as linear or non-linear. Explore the properties of systems such as time variance, time invariance, causality and non-causality, etc.
3. Visualize the relationship between the continuous-time and discrete-time Fourier series and Fourier transform of a signal and relationship among Fourier analysis methods.
4. To demonstrate the convolution and correlation of two continuous-time and discrete-time signals.
5. Study of Sampling Process and Signal Reconstruction by familiarisation with Oscilloscope and Function Generator

6. To study the function of Amplitude Modulation & Demodulation (under modulation, perfect modulation & over modulation) and also to calculate the modulation index, efficiency
7. Generate random data for transmission and transmit it using BPSK modulation. After modulation, demodulate the data using (a) Squaring loop and (b) Costas loop
8. To virtually simulate the functioning of frequency modulation & demodulation and to calculate the modulation index.
9. Realization of different modulation schemes using I/Q modulators
10. To Simulate virtually and Interpret Amplitude shift keying Modulation and De modulation waveforms and also to demonstrate how the signal is modulated as the binary inputs are varied
11. To study the Analog to digital and digital to analog conversion of sinusoidal signal.
12. To study the Delta modulation process by comparing the present signal with the previous signal of the given modulating signal

Semester: 5th			
Paper code: IOT353	**L**	**T/P**	**Credits**
Subject: Design and Analysis of Algorithms Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To teach students how to analyses solution space of problems
2.	To design algorithms based on dynamic programming and greedy algorithms.

Course Outcomes:

CO1	Apply important algorithmic design paradigms and methods of analysis in problem solving.
CO2	Design and develop dynamic programming and greedy algorithms.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. Sort a given set of elements using the quick sort algorithm and find the time complexity for different values of n.
2. Implement merge sort algorithm using divide & conquer method to sort a given set of elements and determine the time and space required to sort the elements.
3. Write a program to implement knapsack problem using greedy method.
4. Program to implement job sequencing with deadlines using greedy method.
5. Write a program to find minimum cost spanning tree using Prim's Algorithm.
6. Write a program to find minimum cost spanning tree using Kruskal's Algorithm.
7. Implement 0/1 Knapsack problem using dynamic programming.
8. Write a program to perform Single source shortest path problem for a given graph.
9. Program for finding shortest path for multistage graph using dynamic programming.
10. Program to implement 8-queens problem using backtrack method.

Semester: 5th			
Paper code: IOT355	**L**	**T/P**	**Credits**
Subject: Sensors and Control Systems Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To demonstrate applications of sensors and transducers in control systems.
2.	To show the performance characteristics of control systems with different conditions.

Course Outcomes:

CO1	Analyze the performance characteristics of control systems with specific design requirements and design objectives.
CO2	Develop applications of sensors and transducers in control systems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. (a) To study the characteristics of inductive transducer: LVDT.
   (b) Measurement of level in a tank using capacitive type level probe.
   (c) Measurement of strain and load using Strain Gauge.
2. (a) To study and verify the characteristics of thermocouple.
   (b) Measurement of the output voltage corresponding to pressure variation using capacitive and piezoelectric pressure transducers.
   (c) To plot and analyse the characteristics of Hall Effect transducer.
3. (a)To realize transfer functions for first order and second order control system problems using MATLAB.
   (b)To plot transient response of first & second order systems using MATLAB/Simulink.
4. Plot impulse response, unit step response, unit ramp response of any 2nd order transfer function using MATLAB/Simulink.

5. Comparison of open loop & closed loop control in speed control of D.C. motor & to find the transfer function.
6. To study the performance of PID Controller on two tank system using MATLAB/Simulink.
7. To implement temperature-controlled DC fan system using Thermistor in MATLAB/Simulink.
8. Design Active Disturbance Rejection Control for Water-Tank System using MATLAB/ Simulink.
9. Temperature control of Continuously Stirred Tank Reactor (CSTR) PID controller using MATLAB/Simulink.
10. To setup a measurement system for monitoring surrounding temperature and humidity using Arduino.
11. Control Brightness of Arduino Onboard LED from Apple iOS Device using MATLAB/Simulink.
12. To implement a mini water management system for indication water levels using Arduino interface.

Semester: 5th			
Paper code: IOT357	**L**	**T/P**	**Credits**
Subject: Machine Learning Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To formulate and analyse algorithm based on machine learning.
2.	To design the use cases of machine learning algorithms as per the user requirement.

Course Outcomes:

CO1	Apply and differentiate machine learning algorithms for regression, classification and prediction problems.
CO2	Implement supervised and unsupervised machine learning models to analyse data for executing feature engineering and feature selection for real-life scenarios.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	1	1	1	1	1	1	2
CO2	3	3	3	3	3	1	1	1	1	1	2	1

List of Experiments:

1. Study and Implement Linear Regression.
2. Study and Implement Logistic Regression.
3. Study and Implement K Nearest Neighbour (KNN).
4. Study and Implement classification using SVM.
5. Study and Implement Bagging using Random Forests.
6. Study and Implement Naive Bayes.
7. Study and Implement Decision Trees.
8. Study and Implement K-means Clustering to Find Natural Patterns in Data.
9. Study and Implement Gaussian Mixture Model Using the Expectation Maximization.
10. Study and Implement Classification based on association rules.
11. Study and Implement Evaluating ML algorithm with balanced and unbalanced datasets.

12. Comparison of Machine learning algorithms based on different-different parameters

Syllabus of 3rd Year,

6th Semester

for

BACHELOR OF TECHNOLOGY

for

Artificial Intelligence and Data Science
Artificial Intelligence and Machine Learning
Industrial Internet of Things

Semester: 6th			
Paper code: AIDS302/AIML302/IOT302	**L**	**T/P**	**Credits**
Subject: Digital Image Processing	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To study basic image processing techniques of spatial and frequency domains for filtering applications.
2.	To understand digital image acquisition tools and basic operations for image enhancement.
3.	To analyze techniques such as image denoising, image segmentation, Image enhancement and edge detection.
4.	To design image compression and image segmentation algorithms.

Course Outcomes:

CO1	Understanding of the fundamental concepts of image processing, including image representation, enhancement, restoration, compression, and segmentation.
CO2	Analyze various segmentation techniques for image analysis
CO3	Outline the various feature extraction techniques for image analysis
CO4	Design image compression and image segmentation algorithms.

Course Outcomes (CO) to Programme Outcomes (PO)
Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	2	3	-	-	-	3	-	-	2
CO2	2	1	-	-	3	-	2	-	3	-	-	-
CO3	2	1	-	2	3	3	2	-	-	-	-	2
CO4	2	2	-	2	3	3	2	-	-	-	-	3

Course Overview:

To introduce the student to various image processing techniques and image fundamentals. To describe the main characteristics of digital images, how they are represented. Mathematical transforms such as such as Fourier, Cosine transforms, Singular value decomposition, 2D Wavelet transform, image enhancement techniques. Image restoration and denoising, segmentation, lossy and lossless data compression algorithms, binary and color image processing.

UNIT-I **[8]**

INTRODUCTION TO IMAGE PROCESSING: Introduction to images and its processing, Components of image processing systems, image representations, Image file formats, recent applications of digital image processing, image sampling and quantization, Image Analysis, Intensity transformations, contrast stretching, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian. Need for transform, Fourier, Cosine transforms, 2D Wavelet transform, Different properties of image transform techniques.

UNIT II **[8]**

Concept of image compression: Concept of Image compression, lossless techniques (Huffman Coding, Arithmetic and Lempel-Ziv Coding, Other Coding Techniques) and lossy compression techniques (Transform Coding & K-L Transforms, Discrete Cosine Transforms, and BTC), Enhancement in spatial and transform domain**,** histogram equalization, Directional Smoothing, Median, Geometric mean, Harmonic mean, Homo-morphic filtering

UNIT III **[8]**

Image degradation: Image degradation, Type of image blur, Classification of image restoration techniques, image restoration model, Linear and nonlinear restoration techniques, Image denoising, Median filtering.

Classification of image segmentation techniques: Boundary detection-based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Thresholding, Iterative thresholding, Otsu's method, Region-based segmentation, Watershed algorithm, Use of motion in segmentation

UNIT IV **[8]**

Binarization and Basic Set theory: Binarization, Basic Set theory, Binary morphological operations and its properties, Color Image Representation, Converting Between Color Spaces, The Basics of Color Image Processing, Color Transformations, Spatial Filtering of Color Images, Working Directly in RGB Vector Space, Applications of digital image processing**:** Case studies

Text Books:

1. Digital Image Processing, R.C. Gonzalez and R.E. Woods, 2nd edition, Pearson Prentice Hall, 2008
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989.

Reference Books:

1. Digital Image processing, S Jayaraman, TMH, 2012
2. William K. Pratt, Digital Image Processing, 3rd Edition, John Wiley, 2001.

Semester: 6th			
Paper code: AIDS354/AIML354/IOT354	**L**	**T/P**	**Credits**
Subject: Digital Image Processing Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To introduce the concepts of image processing and basic analytical methods to be used in image processing.
2.	To familiarize students with image enhancement and restoration techniques, different image compression techniques

Course Outcomes:

CO1	Analyze techniques such as image denoising, image segmentation, Image enhancement and edge detection.
CO2	Apply spatial and frequency domain filters on an image data set.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	-	2	2	2	-	-	2	-	-	2
CO2	2	2	1	2	3	3	-	-	2	-	-	3

List of Experiments:

1. Create a program to demonstrate Geometric transformations- Image rotation, scaling, and translation.
2. Display of FFT (1-D & 2-D) of an image and apply Two-dimensional Fourier transform to represent the content of an image using the discrete Fourier transform (DFT) and masking with DFT.
3. Write a Program of Contrast stretching of a low contrast image, Histogram, and Histogram Equalization and Display of bit planes of an Image.
4. Computation of Mean, Standard Deviation, Correlation coefficient of the given Image
5. Implementation of Image Smoothening Filters (Mean and Median filtering of an Image)
6. Implementation of image sharpening filters and Edge Detection using Gradient Filters.
7. Implementation of Image Compression by DCT, DPCM, HUFFMAN coding.

8. Implementation of image restoring techniques.
9. Implementation of Image Intensity slicing technique for image enhancement.
10. Study and implement Canny edge detection Algorithm to images and compare it with the existing edge detection algorithms.

Artificial Intelligence & Data Science

Subject Basket

6th Semester

Semester: 6th			
Paper code: AIDS304T	**L**	**T/P**	**Credits**
Subject: Fundamentals of Deep Learning	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the intuition and mathematical principles behind deep learning.
2.	To identify the common applications of deep learning for computer vision and NLP.
3.	To explain the strength and challenges of deep learning as compared to the other forms of machine learning.
4.	To generate images with various forms of auto-encoders

Course Outcomes:

CO1	Apply the basic building blocks and general principles for designing deep learning algorithms.
CO2	Analyze the working of Convolution Neural Network for the given application.
CO3	Implement Autoencoder, Recurrent Neural Network, LSTM and its variants for real life data-sets.
CO4	Implement concepts of Genetic Adversial Networks and text classification algorithms

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	1	1	2	-	-	-	2	1	2	1
CO2	3	1	1	1	2	1	1	1	2	1	2	2
CO3	3	1	1	1	2	1	1	1	2	1	2	2
CO4	3	1	1	1	2	1	1	1	2	1	2	2

Course Overview:

The main objective of this course is to develop the understanding of key mathematical principles which are used behind the working of neural networks. Convolution Neural Networks and Recurrent Neural Networks have also been covered in this course. This course also provides the details for usage of Deep Learning for Natural Language Processing.

UNIT I: [8]

Introduction to Deep Learning: Introduction to Deep Learning, Bayesian Learning, Overview of Shallow Machine Learning, Difference between Deep Learning and Shallow Learning, Linear Classifiers ,Loss Function and Optimization Techniques -Gradient Descent and batch optimization.

UNIT II: [8]

Introduction to Neural Network: Introduction to Neural Network, Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic Artificial Neural Networks: Single Layer Neural Network, Multilayer Perceptron, Back Propagation through time. Architectural Design Issues.

UNIT III: [8]

Training Deep Neural Networks: Difficulty of training deep neural networks, Activation Function, Evaluating, Improving and Tuning the ANN. Hyper parameters Vs Parameters, Greedy layer wise training, Recurrent Neural Networks, Long Short-Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

UNIT IV: [8]

Convolutional Neural Networks: Convolutional Neural Networks, Building blocks of CNN, Transfer Learning , Pooling Layers , Convolutional Neural Network Architectures.Well known case studies: LeNet, AlexNet, VGG-16, ResNet, Inception Net.Applications in Vision, Speech, and Audio-Video.

Text Books:

1. Richard O. Duda,” Pattern classification, Wiley, 2022
2. Adam Gibson and Josh Patterson, “Deep Learning: A Practical approach”, 2017
3. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

Reference Books :

1. Charu C. Aggarwal, “Neural Networks and Deep Learning”, 2018
2. Duda, R.O. and Hart, P.E., Pattern classification. John Wiley & Sons, 2006.

<table>
<tr><td colspan="4">Semester: 6th</td></tr>
<tr><td>Paper code: AIDS304P</td><td>L</td><td>T/P</td><td>Credits</td></tr>
<tr><td>Subject: Fundamentals of Deep Learning Lab</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td colspan="4">Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time</td></tr>
<tr><td colspan="4">INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms</td></tr>
<tr><td colspan="4">1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.</td></tr>
</table>

Course Objectives:	
1.	Implementation of deep learning models in Python and train them with real-world datasets.
2.	Implementation of Convolution Neural Network (CNN), Recurrent Neural Network (RNN) and Deep Learning NLP in Python.

Course Outcomes:	
CO1	Design and Implement Convolution Neural Network for object classification from images or video.
CO2	Implement Autoencoder, Recurrent Neural Network, LSTM, its variants and Deep NLP.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	1	2	1	1	1	2	1	2	2
CO2	2	1	1	1	2	1	1	1	2	1	2	2

List of Experiments:

1. To explore the basic features of Tensorflow and Keras packages in Python
2. Implementation of ANN model for regression and classification problem in Python.
3. Implementation of Convolution Neural Network for MRI Data Set in Python.
4. Implementation of Autoencoders for dimensionality reduction in Python.
5. Application of Autoencoders on Image Dataset.
6. Improving Autocoder's Performance using convolution layers in Python (MNIST Dataset to be utilized).
7. Implementation of RNN model for Stock Price Prediction in Python
8. Using LSTM for prediction of future weather of cities in Python
9. Implementation of transfer learning using the pre-trained model (MobileNet V2) for image

classification in Python.

10. Implementation of transfer learning using the pre-trained model (VGG16) on image dataset in Python.
11. NLP Analysis of Restaurant Reviews in Python.
12. Building a NLP model for Spam Detection using TFIDF (Term Frequency Inverse Document Frequency Vectorizer).

Semester: 6th			
Paper code: AIDS306T	**L**	**T/P**	**Credits**
Subject: Big Data Analytics	**3**	**0**	**3**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Theory Examination: As per university examination norms from time to time			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			
1. There should be 9 questions in the end term examination question paper. 2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. 3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit. 4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks. 5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.			

Course Objectives:	
1.	To introduce the concept of big data and its types.
2.	To analyze different types of virtualizations to work with big data
3.	To apply different analytics in big data
4.	To familiarize the students with Hadoop ecosystem and its distribution

Course Outcomes:	
CO1	Understand the concept of big data and its types.
CO2	Analyze different types of virtualizations to work with big data
CO3	Apply Map Reduce fundamentals and different analytics in big data
CO4	Design the Hadoop ecosystem and its distribution

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1							1	2
CO2	2	2	2	2	1						1	2
CO3	3	2	2	2	2	1			1		2	3
CO4	3	3	2	2	3	1	1	1	2		2	3

Course Overview:

Big data analytics is a field of study that focuses on the use of various analytical and statistical methods to extract insights, patterns, and trends from large and complex data sets. The goal of this course is to help businesses and organizations make more informed decisions, improve operational efficiency, and identify new business opportunities.

UNIT I: **[8]**

Introduction to Big Data- The Evolution of Data Management, Defining Big Data, Understanding the Waves of Managing Data, building a Successful Big Data Management Architecture, Examining Big Data Types: Structured Data, Unstructured Data. Putting Big Data Together. Brief History of Distributed Computing, Basics of Distributed Computing for big data.

UNIT II: **[8]**

Exploring the Big Data Stack- Layer 0: Redundant Physical Infrastructure, Layer 1: Security Infrastructure, Layer 2: Operational Databases, Layer 3: Organizing Data Services and Tools, Layer 4: Analytical Data Warehouses. Big Data Analytics, Big Data Applications.

Virtualization: Basics of Virtualization, Server virtualization, Application virtualization, Network virtualization, Processor and memory virtualization, Data and storage virtualization, Managing Virtualization with the Hypervisor, Implementing Virtualization to Work with Big Data.

UNIT III: **[8]**

Analytics and Big Data- Basic analytics, Advanced analytics, Operationalized analytics, Monetizing analytics, Text Analytics and Big Data, Social media analytics, Text Analytics Tools for Big Data, Attensity, Clarabridge, OpenText.

MapReduce Fundamentals- Understanding the map function, Adding the reduce function.
Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

UNIT IV: **[8]**

Exploring Hadoop- Hadoop & its Features, Hadoop Ecosystem, Hadoop 2.x Core Components, Hadoop Storage: Understanding the Hadoop Distributed File System, Hadoop Processing: MapReduce Framework, Different Hadoop Distributions. Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

HDFS (Hadoop Distributed File System): The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Textbooks:

1. Judith S. Hurwitz, Alan F. Nugent, Fern Halper, Marcia A. Kaufman, “Big Data For Dummies”, John Wiley & Sons, Inc.(2013)
2. Robert D. Schneider, “Hadoop For Dummies”, John Wiley & Sons, Inc. (2012)
3. Tom White “Hadoop: The Definitive Guide” Third Edit on, O’reily Media, 2012.

4. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Reference Books:

1. Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGraw Hill (2012).
2. Nathan Marz, James Warren, “Big Data: Principles and best practices of scalable realtime data systems”, Manning Publications (2015)
3. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, “Learning Spark: Lightning-Fast Big Data Analysis”, O. Reilly Media, Inc. (2015).

Semester: 6th			
Paper code: AIDS306P	**L**	**T/P**	**Credits**
Subject: Big Data Analytics Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To analyse and implement different framework tools by taking sample data sets.
2	To illustrate and implement the concepts by taking an application problem.

Course Outcomes:

CO1	Analyse the Big Data using Map-reduce programming in Hadoop framework.
CO2	Apply concepts of big data analytics to conduct experiments, as well as to analyze and interpret big data.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	2		1		1			2
CO2	2	2	2	2	2			1	1	1	2	3

List of Experiments:

1. Install Apache Hadoop.
2. Develop a map reduce program to calculate the frequency of a given word in a given file.
3. Develop a map reduce program to find the maximum temperature in each year.
4. Develop a map reduce program to find the grade of students.
5. Develop a map reduce program to implement matrix multiplication.
6. Develop a map reduce program to find the maximum electrical consumption in each year given electrical consumption for each month in each year.
7. Develop a map reduce program to analyze weather data set and print whether the day is shiny or cool day.
8. Develop a map reduce program to find the tags associated with each movie by analyzing movie lens data.
9. Develop a map reduce program to analyze Uber data set to find the days on which each basement has more trips using the following data set. The uber data set consists of four

columns they are:

Dispatching, base, no. date active, vehicle trips.

10. Develop a map reduce program to analyze titanic dataset to find the average age of the people (both male and female) who died in the tragedy. How many people survived in each class.
11. Develop a program to calculate the maximum recorded temperature year wise for the weather data set in Pig Latin.
12. Write queries to sort and aggregate the data in a table using HiveQL.

Semester: 6th			
Paper code: AIDS308T	**L**	**T/P**	**Credits**
Subject: Next Generation Databases	**3**	**0**	**3**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Theory Examination: As per university examination norms from time to time			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			
1. There should be 9 questions in the end term examination question paper 2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. 3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit. 4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks. 5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required			

Course Objectives:

1	To introduce the different database revolutions.
2	To analyze different types of relational and non-relational databases.
3	To apply different types of consistency models in MongoDB and Hbase.
4	To familiarize the students with different data models and programming languages for database revolutions.

Course Outcomes:

CO1	Understand the concepts of database revolutions and the need of Hadoop ecosystem.
CO2	Analyze different types of relational and non-relational databases.
CO3	Apply different types of consistency models
CO4	Design different databases using Spark SQL and Apache Drill.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1	2	1						2
CO2	2	2	2	2	1				1		1	2
CO3	2	2	2	2	1			1	1		1	2
CO4	3	2	2	3	2			1	1	1	2	3

Course Overview:

The subject gives a detailed overview on the next generation databases introducing the different database revolutions including the Big Data revolution and NoSQL. The students are introduced to various data models for Storage. Languages and programming interfaces like NoSQL, Spark SQL and Apache Drill are also discussed in the subject.

UNIT I: **[8]**

Database Revolutions: Early Database Systems, The First Database Revolution, The Second Database Revolution, The Third Database Revolution.

The Big Data Revolution: Cloud, Mobile, Social, and Big Data. Google: Pioneer of Big Data. Hadoop: Open-Source Google Stack: Hadoop's Origins, The Power of Hadoop, Hadoop's Architecture, HBase, Hive, Pig. The Hadoop Ecosystem.

Scaling Web 2.0: Sharding, CAP Theorem

UNIT II: **[8]**

Document Databases: XML and XML Databases, JSON Document Databases, Data Models in Document Databases, MongoDB

Graph Databases: RDBMS Patterns for Graphs, RDF and SPARQL, Property Graphs and Neo4j, Gremlin, Graph Database Internals, Graph Compute Engines

Column Databases: Data Warehousing Schemas, The Columnar Alternative, Sybase IQ, C-Store, and Vertica, Column Database Architectures

UNIT III: **[8]**

Distributed Database Patterns: Distributed Relational Databases, Nonrelational Distributed Databases, MongoDB Sharding and Replication, HBase, Cassandra.

Consistency Models: Types of Consistency, Consistency in MongoDB, HBase Consistency

UNIT IV: **[8]**

Data Models and Storage: Review of the Relational Model of Data, Key-value Stores, Data Models in BigTable and HBase, Cassandra, JSON Data Models. Typical Relational Storage Model, Log-structured Merge Trees, Secondary Indexing.

Languages and Programming Interfaces: SQL, NoSQL APIs, Impala, Spark SQL, Couchbase N1QL, Apache Drill.

Text Books:

1. Guy Harrison, "Net Generation Databases", Apress 2015

Reference Books:

1. Abraham Silberschatz, Henry F. Korth , S. Sudarshan, "Database System Concepts", McGraw Hill Education, 2013.
2. Adam Fowler, "NoSQL For Dummies", Wiley, 2015.

Semester: 6th			
Paper code: AIDS308P	**L**	**T/P**	**Credits**
Subject: Next Generation Databases Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To create NOSQL databases using proper rules.
2	To implement projection and indexing in databases.

Course Outcomes:

CO1	Use the basics of MongoDB commands and construct queries for database creation and interaction.
CO2	Apply database principles for NOSQL databases to implement database connectivity with programming languages.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	2	1			1		2	2
CO2	3	3	2	2	2	1		1	2	1	1	3

List of Experiments:

1. Study of Open Source NOSQL Database: MongoDB (Installation, Basic CRUD operations, Execution).
2. Demonstrate how to create and drop database in MongoDB.
3. Creating the Collection in MongoDB.
4. a. Creating collection with options before inserting the documents and drop the collection created.
   b. Insert Documents in MongoDB collections.
5. To show limit () ,skip(), sort() methods in MongoDB.
6. To implement MongoDB projection.
7. MongoDB indexing.

   a. Create index in MongoDB
   b. Finding the indexes in a collection
   c. Drop indexes in a collection
   d. Drop all the indexes
8. Create simple objects and array objects using JSON
9. Implement Map reduce operation with suitable example using MongoDB.
10. Write a program to implement MongoDB database connectivity with PHP/ python/Java Implement Database navigation operations (add, delete, edit etc.) using ODBC/JDBC.

Semester: 6th			
Paper code: AIDS310T	**L**	**T/P**	**Credits**
Subject: Social Network Analytics	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To Understand the components and entities of the social network
2.	To analyze social media data to comprehend user sentiments and recommend the essential information appropriately.
3.	Model and visualize the social network
4.	Detect and analyze the communities in social networks

Course Outcomes:

CO1	Understand the key concepts and theories of social network analysis.
CO2	Analyze social network data: Students should be able to collect, preprocess, and analyze social network data using various tools and software packages, such as Gephi, NetworkX, and R
CO3	Design a system to assimilate information available on the web to model and build Social Network Application
CO4	Apply social network analysis to real-world problems in various fields and develop strategies and recommendations based on their findings.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	-	1	-	-	-	-	1	-
CO2	2	1	2	1	3	1	-	1	1	1	1	1
CO3	2	1	2	1	-	1	-	1	-	1	1	-
CO4	2	1	2	1	2	2	1	1	1	1	1	1

Course Overview:

This course explores the use of social network analysis to understand the growing connectivity and complexity in the world around us on different scales-ranging from small groups to the World Wide Web. It examines how we create social, economic, and technological networks, and how these networks enable and constrain our attitudes and behavior. The course will discuss how social network concepts, theories, and visual-analytic methods are being used to map, measure, understand, and design a wide range of phenomena such as social networking sites, recommender systems, trust and reputation systems, search engines.

UNIT-I **[8]**

Fundamentals of Social Network Analysis: Social Network Perspective, Fundamentals concepts in Network Analysis: Sociogram, Sociometry. Social Network Data: Types of Networks: One-Mode, Two-Mode, Affiliation, Ego-centered and Special Dyadic Networks, Network Data, Measurement and Collection, Notations for Social Network Data: Graphs, Directed, Singed, Valued graphs, Multigraph, Relations and Matrices.

UNIT-II **[8]**

Centrality and Prestige: Prominence: Actor-Centrality, Prestige, Group-Centrality, Prestige, Non directional Relations-Degree, Closeness, Betweenness, Eigen Vector Centrality, Directional Relations-Centrality, Prestige.

Structural Balance and Transitivity: Structural Balance: Signed Non directional, Signed Directional Relations, Checking for Balance, Index for Balance, Clusterability-Theorems, Clustering Coefficient and Transitivity.

UNIT-III **[8]**

Cohesive Subgroups: Social Group and Subgroup-Notation, Subgroups Based on Complete Mutuality: Clique, Reachability and Diameter: n-cliques, n-clans and n-clubs, Subgroups Based on Nodal Degree: k-plexes, k-cores, Measures of Subgroup Cohesion, Community detection using Subgroups and Betweenness. Roles and Positions: Structural Equivalence: Definition, Social Roles and, Positional Analysis, Measuring Structural Equivalence, Representation of Network Positions, Block Models-Introduction, Network Positions and roles-Introduction

UNIT-IV **[8]**

Dyadic and Triadic Methods: Dyads: Definitions, Dyad Census, Index, Simple Distributions, Triads: Random Models and Substantive Hypotheses, Triad Census, Distribution of a Triad Census- Mean and Variance, Testing Structural Hypotheses.

Models in Social Network: Small world network- Watt Strogatz networks - statistical models for social networks - network evaluation model - Preferential attachment - power law - Random

Model: Erdos -Renyi model - Barabasi Albert model - Epidemic model - Case study: Text and opinion Analysis

Textbooks:

1. Wasserman Stanley, and Katherine Faust, Social Network Analysis: Methods and Applications, Structural Analysis in the Social Sciences. Cambridge University Press, 2012 Online Edition.
2. Albert-László Barabási, Network Science, Cambridge University Press, 1st edition, 2016.

Reference Books:

1. John Scott, "Social Network Analysis", Sage Publications Ltd., Fourth Edition, 2017.
2. David Knoke & Song Yang, "Social Network Analysis", Sage Publishing, Third Edition, 2020

Semester: 6th			
Paper code: AIDS310P	**L**	**T/P**	**Credits**
Subject: Social Network Analytics Lab	**0**	**2**	**1**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:

1	Understand the components of the social network
2	Analyze social media data to understand user sentiment and recommend the requisite information accordingly
3	Model and visualize the social network
4	Apply algorithms to solve research problems on social network and analyze the communities in social networks.

Course Outcomes:

CO1	Develop social network applications using visualization tools.
CO2	Design a system to harvest information available on the web to model and build Social Network Application

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	1	-	1	-	1	1	-
CO2	2	2	2	2	3	2	1	1	1	1	1	1

List of Experiments:

1. Study and demonstrate to find the basic properties of a Graph/Social Network.
2. Demonstrate the calculation of Centrality measures.
3. Demonstrate the ranking of web pages in a web graph.
4. Find divisions in a Social Network.
5. Implement Community Detection algorithms on a Social Network.
6. Demonstrate modeling of Social Networks.
7. Visualize a multidimensional Social Network.
8. Applications of Classification and Clustering on a Social Network.
9. Design and implement a Sentiment Analyzer.

10. Design and implement a Social Network.

Semester: 6th			
Paper code: AIDS312T	L	T/P	Credits
Subject: Network Science	3	0	3

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the underlying behaviour and properties of various types of networks with the help of mathematical tools.
2.	To apply network science principles to predict the dynamics and the topology a wide area of real networks.
3.	To understand the laws governing the error and attack tolerance of complex networks and the emergence of cascading failures.
4.	To analyze network epidemics to quantify and forecast the spread of infectious diseases.

Course Outcomes:

CO1	Identify the governing mathematical principles behind the architecture of networks emerging in various domains of science, nature and technology.
CO2	Apply the knowledge of network science to classify various types of networks to gain important inferences.
CO3	Apply relevant measures to classify the structure of networks and shows how these measures can differentiate between different types of random and real-world networks.
CO4	Analyse the network data associated with information that changes over time.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	-	1	1	2	2	-	1	1	1	1
CO2	1	1	-	1	2	2	1	-	1	2	1	2
CO3	2	3	1	2	2	1	2	-	1	1	2	2

CO4	3	3	1	2	2	2	1	1	1	2	2	2

Course Overview:

Network science course covers the topology and dynamics of complex networks, aiming to better understand the behaviour and properties of the underlying systems. In this course, algorithmic, computational, and statistical methods of network science, as well as its diverse applications are also covered. Concept implementation using NetworkX in Python is also the integral part of the syllabus. Various case studies have also been covered to understand the impact of networks and also to model epidemic and its prediction by studying the network.

UNIT I: [8]

Introduction: Vulnerabilities due to Interconnectivity, Networks and Complex Systems, Emergence of Network Science, Characteristics of Network Science, Societal and Scientific Impact of Networks, Case Studies of Various Real-World Networks and their societal/scientific impact. Graph Theory: Bridges of Konigsberg, Networks and Graphs, Degree Distribution, Network Representations, Representing Networks in NetworkX, Networks: Path Length, and Components. Drawing Directed/Undirected graphs with Weighted/Unweighted Edges in NetworkX.

UNIT II: [8]

Random Networks: Introduction, Random Network Model, Number of Links, Degree Distribution, Small World and Computing Clustering Coefficient in NetworkX. The Scale Free Property: Introduction, Power Laws and Scale Free Networks, Hubs, Universality, Ultra Small Property, Degree Exponent, Generating Networks with Arbitrary Degree Distribution. Generating random network in NetworkX.

UNIT III: [8]

The Barabasi-Albert Model: Introduction, Growth and Preferential Attachment, Degree Dynamics, Degree Distribution, Measuring Preferential Attachment, Non-Linear Preferential Attachment, Diameter and Clustering Coefficient, Evolving Networks: Introduction, Bianconi-Barabasi Model, Measuring Fitness, Bose-Einstein Condensation, Degree Correlations: Assortativity and Disassortativity, Measuring Degree Correlations, Structural Cutoffs, Correlation in Real Networks, Generating Correlation Networks.

UNIT IV: [8]

Network Robustness: Percolation Theory, Robustness of Scale Free Networks, Attack Tolerance, Modelling Cascading Failures and Building Robustness, Identifying Network Robustness using NetworkX, Communities, Spreading Phenomena: Introduction, Epidemic Modeling, Contact Networks, Immunization and Epidemic Prediction. Creating Partitions and Identifying the Modularities of Partitions, Implementation of SIS Spreading Model.

Text Books:

1. Menczer, Filippo, Santo Fortunato, and Clayton A. Davis. A First Course in Network Science. Cambridge University Press, 2020.

2. A-L. Barabási , Network Science , available online, 2015.

Reference Books:

1. M.E.J. Newman, Networks - An introduction, Oxford Univ Press, 2010.

Semester: 6th			
Paper code: AIDS312P	**L**	**T/P**	**Credits**
Subject: Network Science Lab		**2**	**1**

Marking Scheme
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.

Course Objectives:	
1	To understand the underlying behaviour and properties of various types of networks with the help of mathematical tools.
2	To apply network science principles to predict the dynamics and the topology a wide area of real networks.

Course Outcomes:	
CO1	Apply relevant measures to classify the structure of networks and shows how these measures can differentiate between different types of random and real-world networks.
CO2	Analyse the network data associated with information that changes over time.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	1	2	2	1	2	-	1	1	2	2
CO2	3	3	1	2	2	2	1	1	1	2	2	2

List of Experiments:

1. Understanding NetworkX API basics.
2. Performing network analysis of directed graphs (Weighted/Unweighted) using NetworkX in Python
3. Performing network analysis of undirected graphs ((Weighted/Unweighted)) using NetworkX in Python.
4. Computing degree centrality for a node in a network.
5. Generating subset of network using NetworkX.
6. Drawing network using matplot libraries and measuring degree of assortativity.

7. Generating networks with arbitrary degree distribution using NetworkX.
8. Finding shortest path from single node to all distant nodes using NetworkX.
9. Computing clustering coefficients of different nodes using NetworkX.
10. Computing clustering coefficients of different networks using NetworkX.
11. Implementing the model for spreading dynamics using NetworkX.

Semester: 6th			
Paper code: AIDS314T	**L**	**T/P**	**Credits**
Subject: AI & Sustainable Computing	**4**	**0**	**4**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Theory Examination: As per university examination norms from time to time			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			
1. There should be 9 questions in the end term examination question paper. 2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. 3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit. 4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks. 5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.			

Course Objectives:	
1	To understand how to distill a real-world challenge as an artificial intelligence problem, involving explicit representation and learning of symbolic and numeric models; reasoning about such models; and using such models for decision making, action selection, and interaction with humans.
2	To design, analyze, implement, and use state-of-the-art AI and machine learning techniques for dealing with real-world data, including data involving vision, language, perception, and uncertainty.
3	To recognize the social impact of artificial intelligence and the underlying responsibility to consider the ethical, privacy, moral, and legal implications of artificial intelligence technologies.
4	To inculcate the responsibilities to use AI and ethical decisions about the tools they designed.
Course Outcomes:	
CO1	Understand the significance of artificial intelligence in the society
CO2	Analyze the social and cultural aspects and implications of artificial intelligence
CO3	Attain knowledge about the potential transformative effects of the emerging technologies
CO4	Gain insights about the role of artificial intelligence in different verticals.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1		1	-	1	-	1	-	-	2	1	-	1
CO2	1	2	1	1	1	1	2	1	2	2	2	1
CO3	2	2	1	1	1	1	2	1	2	2	2	2

CO4	2	2	2	2	2	2	2	2	3	2	3	2

Course Overview:
The course will help students in exploring the relationship between Artificial Intelligence and Humanity on an overall premise. It reflects upon how the world is changing with the advent and exponential increase of Artificial Intelligence in all verticals of society. This course will assist you in students in attaining wisdom regarding the potential effects of the emerging technologies in Artificial Intelligence. Role of Artificial Intelligence in business domain, governance and marketing shall be explored in this course.

UNIT I: [10]
AI & Society: Relation of AI with Knowledge, Culture and Communication. Implications of AI: Cultural, Social, Cognitive, Economic, Ethical and Philosophical. Societal and cultural impacts of AI, New Media Technologies: Design, Use, Management, Policy of Information and Communication. Impact of AI: Impact of AI on governance, Impact of AI on information security, Impact of AI in the corporate sector and community welfare. AI in information technologies, humanities, social sciences, arts, and sciences.

UNIT II: [10]
Potential and Transformative Impacts: Critical consequences of AI, Latest technological innovations. Applications of emerging technologies in day-to-day life. Societal dimension of research: benefits, impacts, and implications on society. AI and research ethics. Forces influencing AI: trust, biases, privacy, reliability, responsibility, and competence.

UNIT III: [10]
Encashing AI: AI for Business, AI in the Organization Structure, AI-based data infrastructure, Impact of recommenders on markets Applications in Finance: Fraud Detection and Stock Market Prediction, Market adoption, and barriers. AI & Gaming Industry. AI Strategy and Governance: AI Strategy and Governance Agenda, AI-Driven Business Transformation. Developing a Portfolio of AI Projects, Lowering Barriers to AI Use

UNIT IV: [10]
Green IT and sustainability: Green IT and sustainability, ecological footprint of IT, and the issues of lifecycle, sustainability, life cycle assessment and code of conducts; energy measurement and other useful metrics for Green IT, Usage of software tools and hardware to measure and estimate energy consumption
Sustainable software: Ecological design, applying good practices to write energy efficient software; **e**nergy footprint of data centers and cloud computing, standards and good practices for energy efficiency in servers,

Text Books:

1. AI for People and Business, by Alex Castrounis, 2019, O'Reilly Media, Inc.
2. Green Computing: Tools and Techniques for Saving Energy, Money, and Resources, Bud E. Smith, Auerbach Publications
3. 2084: Artificial Intelligence, the Future of Humanity, and the God Question: Artificial Intelligence and the Future of Humanity, 2020, by John C. Lennox, Zondervan

Reference Books:

1. The Age of AI: And Our Human Future (B PB) Paperback – Import, 4 August 2022 by Daniel Huttenlocher, III Schmidt, Eric, Henry A Kissinger
2. Green Internet of Things and Machine Learning, Roshani Raut, Sandeep Kautish, Zdzislaw Polkowski, Anil Kumar, Chuan-Ming Liu, John Wiley & Sons, 10-Jan-2022.

Semester: 6th			
Paper code: DS316T	**L**	**T/P**	**Credits**
Subject: Biomedical Data Analysis	**4**	**0**	**4**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Theory Examination: As per university examination norms from time to time			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	To familiarize students with Fundamentals of Biomedical Image Processing
2	To use image processing techniques in different biomedical applications
3	To analyze Multi-Scale and Multi-Orientation Medical Image
4	To apply Feature Extraction and Selection for Decision Making in biomedical applications

Course Outcomes:

CO1	Understand the fundamentals of biomedical data analytics
CO2	Analyze image processing techniques in different biomedical applications
CO3	Apply Texture Features in biomedical applications
CO4	Design decision making based solutions for medical diagnosis

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1		1	-	1	-	1	-	-	2	1	-	2
CO2	1	2	1	1	1	1	2	1	2	2	2	2
CO3	2	2	1	1	1	1	2	1	2	2	2	2
CO4	2	2	2	2	2	2	2	2	3	2	3	3

Prerequisite: Fundamentals of Machine Learning and Data Mining Concepts.

Course Overview:

The aim of Biomedical Data Analysis is to equip students with the necessary skills and knowledge to analyze and interpret complex biomedical data. The course aims to provide students with a solid understanding of the different types of biomedical data and the methods and techniques used for their analysis.

UNIT I: [10]

Fundamentals of Biomedical Image Processing: Introduction, Medical Image Formation, Image Enhancement, Image Data Visualization, Visual Feature Extraction, Segmentation, Classification, Quantitative Measurements and Interpretation, Image Management

Fusion of PET and MRI for Hybrid Imaging: Positron Emission Tomography, Magnetic Resonance Imaging, Hybrid PET Fusion System

UNIT II: [10]

Cardiac 4D Ultrasound Imaging: The Role of Ultrasound in Clinical Cardiology, Principles of Ultrasound Image Formation, Limitations of 2D Cardiac Ultrasound, Approaches Towards 3D Cardiac Ultrasound, Validation of 3D Cardiac Ultrasound Methodologies, Remaining Challenges in 4D Cardiac Ultrasound.

Morphological Image Processing Applied in Biomedicine: Introduction, Binary Morphology, Gray-Scale Operations, Watershed Segmentation, Segmentation of Diffusion MRI

UNIT III: [10]

Texture in Biomedical Images: Characterizing the Texture of Swatches, Simultaneous Texture Segmentation, Examples of the Use of Texture Features in Biomedical Applications.

Multi-Scale and Multi-Orientation Medical Image Analysis: The Necessity of Scale, Differential Invariants, Second Order Image Structure and Features, Third Order Image Structure: T-Junctions, Adaptive Blurring and Geometry-Driven Diffusion, Edge Focusing, Orientation Analysis.

UNIT IV: [10]

Feature Extraction and Selection for Decision Making: Introduction, Image Representation, Image Features and Distance Functions, Feature Selection, Association Rule Mining. Case Study: Improving Computer-Aided Diagnosis by Association Rule Mining.

Melanoma Diagnosis: The Cutaneous Melanoma, State of the Art in CM Diagnosis, Dermoscopy Image Analysis, Commercial Systems, Evaluation Issues.

Text Books:

1. Thomas M. Deserno, “Biomedical Image Processing”, ei Springer.
2. G.R. Sinha, B.C. Patel, “Medical Image Processing: Concepts and Applications”, PHI, 2014.

3. Christo_El_Morr, Hossam_Ali-Hassan, "Analytics in Healthcare A Practical Introduction" , Springer Briefs in Health Care Management and Economics.

Reference Books:

1. Peter White, "Data-Handling in Biomedical Science", Cambridge University Press.
2. Peter Langkafel (Ed.), "Big Data in Medical Science and Healthcare Management", De Gruyter.
3. Kerstin Denecke, "Health Web Science: Social Media Data for Healthcare", Springer.

Semester: 6th			
Paper code: AIDS318T	**L**	**T/P**	**Credits**
Subject: Optimization Algorithms and its Applications	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide students with an understanding of optimization approaches and its types.
2.	To enable students to develop proficiency in solving optimization problems using classical techniques.
3.	To develop proficiency in solving optimization problems using meta-heuristics techniques.
4.	To provide understanding of heuristic and hybrid optimization approaches and develop proficiency in solving optimization problems using heuristic and hybrid optimization techniques.

Course Outcomes:

CO1	Students will be able to identify and comprehend the different optimization problems in real-world applications.
CO2	Students will be able to comprehend, analyze and solve the classical optimization problems including linear, quadratic, and integer programming problems.
CO3	Students will be able to apply and analyze the performance of meta-heuristics optimization techniques to solve different optimization problems
CO4	Students will be able to apply heuristics and hybrid optimization techniques to solve different optimization problems and analyze their performance for different problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	2	3	1	1				1		1
CO2	3	3	3	3	2	1				1		1
CO3	3	3	3	3	3	2	1			1		1
CO4	3	3	3	3	3	2	1	3		1		1

Course Overview:
The course covers developments of advanced optimization models and solution methods for technical and economical planning problems. The basis in the course is the optimization process, from a real planning problem to interpretation of the solutions of the underlying optimization problem. In the modeling part we focus on problems with discrete elements, but also knowledge about important classes of optimization problems and their properties will be highlighted

UNIT I **[10]**
Introduction to Optimization Approaches and Types: Introduction to optimization problems and their significance, Types of optimization problems: continuous, discrete, and combinatorial, Objective functions and constraints, Classification of optimization approaches, Overview of mathematical programming, heuristic, and meta-heuristic techniques

UNIT II **[8]**
Classical Approaches in Optimization: Unconstrained optimization: methods of steepest descent and Newton's method, Constrained optimization: Lagrange multipliers and KKT conditions, Linear programming: formulation, simplex method, and duality, Integer programming: branch and bound, cutting plane, and branch and cut algorithms

UNIT III **[12]**
Meta-Heuristic Approaches: Overview of meta-heuristic optimization, Genetic algorithms: representation, selection, crossover, and mutation operators, Particle swarm optimization: movement rules and parameter settings, Simulated annealing: cooling schedules and neighborhood search, Ant colony optimization: pheromone trails and decision-making, Tabu search: tabu list and aspiration criteria

UNIT IV **[10]**
Heuristics and Hybrid Approaches: Greedy algorithms and local search, Simplicial decomposition and cutting plane methods, Hybrid algorithms: combining meta-heuristics with classical approaches, Nature-inspired optimization: swarm intelligence, artificial bee colony, and harmony search

Text Books:
1. Edwin K.P. Chong and Stanislaw H. Zak, Introduction to Optimization, Wiley
2. Xinyu Ye and Ding-Zhu Du, Optimization Methods and Applications
3. Xinjie Yu, Introduction to Evolutionary Algorithms
4. Fred Glover and Gary A. Kochenberger, Handbook of Metaheuristics

Reference Books:
1. David G. Luenberger and Yinyu Ye, Linear and Nonlinear Programming
Mokhtar S. Bazaraa, Hanif D. Sherali, and C. M. Shetty, Nonlinear Programming: Theory and Algorithms Jorge Nocedal and Stephen J. Wright, Numerical Optimization

Semester: 6th			
Paper code: AIDS320T	**L**	**T/P**	**Credits**
Subject: Cognitive Computing	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	Identify how the concept of cognitive computing evolved.
2	Analyze the working of hardware and software technologies behind the cognitive computing.
3	Interpretation of how Artificial Intelligence, Natural Language Processing and Big Data Analytics contribute towards cognitive computing solutions.
4	Identify new use cases and applications of cognitive computing.

Course Outcomes:

CO1	To identify how the concept of cognitive computing evolved.
CO2	To analyze the elements that make up a cognitive computing system.
CO3	To conceptualize how Artificial Intelligence, Natural Language Processing and Big Data Analytics contribute towards cognitive computing solutions.
CO4	To implement the cognitive models that apply to different real-life scenarios.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	-	-	-	-	-	-	1	-
CO2	2	1	2	1	3	-	-	-	1	1	1	1
CO3	2	1	2	1	-	-	-	-	-	1	1	-
CO4	2	1	2	1	2	-	-	-	1	1	1	1

Course Overview:

This course has been designed to make students understand cognitive computing's underlying technologies. This course covers knowledge representation techniques and natural language processing algorithms and dynamic learning approaches based on accumulated evidence rather than reprogramming. Number of case studies have also been covered as part of this course to help the students go through step-by-step design and testing of cognitive systems. The IBM's Watson cognitive platform has also been covered in the syllabus.

UNIT I **[10]**

Introduction: Foundations of cognitive computing, Elements of cognitive system, Two systems of judgement and choice, Understanding complex relationship between systems, Design principles for cognitive systems, NLP in support of cognitive systems, Applying NLP to business problems.

UNIT II **[10]**

Relationship between big data and cognitive computing: Dealing with human generated data, Analytical data warehousing, Data in motion and streaming data, Integration of big data with traditional data, Knowledge representation models.

UNIT III **[10]**

Advanced analytics to cognitive computing: Key capabilities in advanced computing, Using advanced analytics to create value, Impact of open source tools on advanced analytics, Role of cloud and distributed computing in cognitive computing: Cloud computing models, Delivery models of cloud, Managing workloads, Security and governance, Data integration and management in cloud.

UNIT IV **[10]**

Business implications of cognitive computing: Business implications of cognitive computing, IBM's watson as a cognitive system, Process of building a cognitive application, Emerging cognitive areas and future applications, Case Studies: Cognitive healthcare application and smarter cities: cognitive computing in government.

Textbooks:

1. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley, 2015.
2. Rob High and Tanmay Bakshi, Cognitive Computing with IBM Watson: Build Smart Applications Using Artificial Intelligence as a Service (1 ed.), 2019.

Reference Books:

1. José Luis Bermúdez, Cognitive Science: An Introduction to the Science of the Mind (3 ed.), Cambridge University Press, 2020. ISBN 978-1108440349.
2. Adnan Masood and Adnan Hashmi, Cognitive Computing Recipes
3. Artificial Intelligence Solutions Using Microsoft Cognitive Services and TensorFlow, Foreword by Matt Winkler, Apress

Artificial Intelligence & Machine Learning

Subject Basket

6th Semester

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EAST DELHI CAMPUS,
SURAJMAL VIHAR-110092

Semester: 6th			
Paper code: AIML304T	**L**	**T/P**	**Credits**
Subject: Introduction to Data Mining	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To identify the different types of data and using data pre-processing techniques applicable on the dataset.
2.	To evaluate various classification and clustering techniques on real world datasets.
3.	To apply data mining techniques on complex data types.
4.	To analyze different association rule mining and sequence mining techniques.

Course Outcomes:

CO1	Interpret the basic concepts of data mining techniques to identify interesting and relevant patterns.
CO2	Apply and perform pre-processing steps to prepare the data and get insights into the dataset.
CO3	Analyze different association rules identified using association rule mining or sequence mining on real life datasets.
CO4	Design and Develop models using classification and clustering techniques on complex data types.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	3	-	-	1	-	-	-	-
CO2	2	2	2	3	-	-	-	-	1	-	-	-
CO3	2	-		2	3	-	1	-	-	1	-	-
CO4	2	2		3	3	-	-	-	-		1	2

Course Overview:

The subject gives a detailed overview on data mining as a process starting from pre-processing the dataset to classification/clustering techniques on the data. The students are introduced to different techniques that can be applied to various types of complex data. Concepts like association rule mining and ensemble methods are also discussed in this subject.

UNIT I **[8]**

Data Mining Basics- What is Data Mining, Kinds of Patterns to be Mined, Tasks of Data Mining, Data Mining Applications- The Business Context of Data Mining, Data Mining as a Research Tool, Data Mining for Marketing, Benefits of data mining.

Data Pre-processing- Review of Data Pre-processing: Types of Data, Data Quality, Measurement and Data Collection Issues, Aggregation, Sampling, Dimensionality Reduction, Feature Subset Selection, Feature Creation, Data Discretization and Binarization, Variable Transformation, Measures of Similarity and Dissimilarity.

UNIT II **[8]**

Classification- Types of classifiers, Rule based classifiers, Model Selection, Model Evaluation, Artificial Neural Networks: Activation Functions (Sigmoid, Tanh, ReLU, Leaky ReLU, Selu), Perceptron, Multilayer Feed-Forward Neural Network, Backpropagation, Semi-supervised classification, Active Learning, Ensemble Methods: Methods for Constructing an Ensemble Classifier, Bias-Variance Decomposition, Bagging, Boosting, GBM, XGBoost, Stacking, Random Forest. Metrics for Evaluating Classification Performance: Holdout method, Cross Validation, Bootstrap

Handling Class Imbalance Problem: Evaluating Performance with Class Imbalance, Finding an Optimal Score Threshold, Multiclass Problem.

UNIT III **[8]**

Association Rule Mining- Mining Frequent Patterns, Associations and correlations, Market Basket Analysis, Apriori algorithm, Support Counting, Improving the efficiency of Apriori, Rule generation in Apriori algorithm, FP growth algorithm, Eclat algorithm, Mining Various kinds of Association Rules, Maximal Frequent Itemsets, Closed Itemsets, Evaluation of Association Patterns. Handling Categorical Attributes, Handling Continuous Attributes.

Sequential Patterns- Sequential Pattern Discovery, GSP algorithm, SPADE algorithm, Timing Constraints.

UNIT IV **[8]**

Cluster detection- Different Types of Clusters, Hierarchical Methods: Agglomerative and Divisive Clustering, Density based Clustering: DBSCAN algorithm, Comparing K-means and DBSCAN, Self-Organizing Maps (SOM), Cluster Evaluation. Outlier Analysis, Outlier Detection Methods. Mining Complex Data Types.

Avoiding False Discoveries- Significance Testing, Hypothesis Testing, Multiple Hypothesis Testing, Pitfalls in Statistical Testing

Text Books:

1. Tan Pang- Ning, Steinbach M., Viach, Kumar V., "Introduction to Data Mining", Second Edition, Pearson, 2013.

2. Han J., Kamber M. and Pei J., "Data Mining Concepts and Techniques", Second Edition, Hart Court India P. Ltd., Elsevier Publications, 2001.

Reference Books:

1. Zaki M.J., Meira W., “Data Mining and Machine Learning: Fundamental Concepts and Algorithms”, Second Edition, Cambridge University Press, 2020
2. Witten, E. Frank, M. Hall, “Data Mining: Practical Machine Learning Tools and Techniques”, Morgan Kaufmann Publishers, 2011.

Semester: 6th			
Paper code: AIML304P	**L**	**T/P**	**Credits**
Subject: Introduction to Data Mining Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To perform preprocessing on real world datasets.
2.	To develop models using different data mining techniques on complex datasets.

Course Outcomes:

CO1	Analyze and apply pre-processing techniques to prepare and process real life datasets.
CO2	Implement different clustering or classification techniques for varying sets of problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	-	2	3	-	1	-	-	1	-	-
CO2	2	2	-	3	3	-	-	-	-	-	1	2

List of Experiments
1. Introduction and installation of WEKA tool.
2. Perform data pre-processing including cleaning, integration and transformation on ARFF files using WEKA.
3. Apply association rule mining on ARFF files using WEKA.
4. Implementation of Neural Network technique on ARFF files using WEKA.
5. Implementation of Bagging and Boosting techniques on ARFF files using WEKA.
6. Apply the concept of Voting ensemble method to ARFF files and compare the results with single classifiers.
7. Implementation of Visualization technique on ARFF files using WEKA.
8. Implementation of Clustering technique on ARFF files using WEKA.
9. Study of DBMINER tool.

10. Apply pre-processing and classification/regression techniques on a real-world dataset. Evaluate the performance of classification techniques using different parameters.

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY,
EAST DELHI CAMPUS,
SURAJMAL VIHAR-110092

Semester: 6th			
Paper code: AIML306T	**L**	**T/P**	**Credits**
Subject: Machine Learning for Intelligent Communication & Systems	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	To apply the area of machine learning in the context of communications Learning
2	To plan automatic modulation classification.
3	To apply iterative channel decoding
4	To familiarize with real-world case studies and examples of machine learning applications in communication

Course Outcomes:

CO1	Apply the area of machine learning in the context of communications Learning
CO2	Plan automatic modulation classification
CO3	Investigate iterative channel decoding
CO4	Apply machine learning algorithms and techniques to solve communication problems

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	-	-	3	-	-	2	-	-	-	-	2
CO2	2	-	3	-	-	2	-	-	-	1	-	-
CO3	-	2	2	3	-		-	-	-	-	1	-
CO4	2	2	3	2	2	2	-	-	-	-	-	2

Course Overview:

This course helps the student to have basic idea of machine learning techniques to various signal processing requirements for communications including channel estimation, automatic modulation classification and iterative channel decoding.

UNIT I: **[8]**

Channel estimation and prediction: Adaptive transmission systems, The Impact of Outdated CSI, Classical Channel Prediction, Neural Network Based Prediction Schemes, Flat fading SISO Prediction, Channel-Gain Prediction with Real-Valued and Complex-Valued RNN, Channel Envelope Prediction, Frequency-Selective SISO Prediction, Performance and Complexity, Computational Complexity.

UNIT-II: **[8]**

Automatic Modulation Classification: Signal Models for modulation classification, Likelihood based classifiers, Distribution Test-based classifiers, Modulation classification Features, Machine Learning models for Modulation classification.

UNIT III: **[8]**

Channel Encoding: Overview of Channel coding and Deep Learning, DNN for Channel coding and to Decoding Directly.

UNIT IV: **[8]**

Channel Decoding: DNNs for joint equalization and Channel Decoding, CNNs for Decoding, Decoding by Eliminating Correlated Channel Noise, BP-CNN Decoding.

Text Books:

1. Zhechen Zhu and Ashoke K. Nandi, (2015), Automatic Modulation Classification: Principles, Algorithms and Applications, Wiley.
2. Luo, F. L., (2020), Machine Learning for Future Wireless Communications, Wiley.

Reference Books:

1. He, R., and Ding Z., (2019), Application of Machine Learning in Wireless Communications, The Institution of Engineering and Technology, IET.

Semester: 6th			
Paper code: AIML306P	**L**	**T/P**	**Credits**
Subject: Machine Learning for Intelligent Communication & Systems Lab	**0**	**2**	**1**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:	
1	To analyze the communication system with machine learning algorithms.
2	To Familiar with the software tools and programming languages used for machine learning in communication.
Course Outcomes:	
CO1	Examine and study real-world case studies and examples of machine learning applications in communication, including chatbots, virtual assistants, and personalized content deliver.
CO2	Apply machine learning algorithms and techniques to solve communication problems, such as predicting customer behavior or optimizing ad targeting.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	2	2	3	-	-	-	-	1	2	1	2
CO2	2	2	3	2	2	2	-	-	-	2	-	2

List of Experiments:

1. Develop and evaluate a machine learning algorithm that predicts maintenance requirements of communication systems based on data such as temperature, humidity, and usage patterns.
2. Develop and test a machine learning algorithm that predicts network traffic volume based on past network usage patterns and other relevant factors, such as time of day and weather.
3. Develop and test a machine learning algorithm that detects fraudulent financial transactions, such as credit card fraud, based on transaction history and other relevant factors.

4. Develop and evaluate a machine learning algorithm that optimizes beamforming in wireless communication systems, in order to improve signal quality and reduce interference.
5. Develop and test a machine learning algorithm that optimizes network parameters, such as routing and congestion control, to improve network performance and reliability.
6. Develop and test an anomaly detection algorithm that uses machine learning techniques to identify unusual network traffic patterns that may indicate security threats or network faults.
7. Develop machine learning algorithm that optimizes resource allocation in an IoT network to maximize overall system performance.
8. Develop and evaluate a machine learning algorithm that optimizes bandwidth or power, in an IoT network.

Semester: 6th			
Paper code: AIML308T	**L**	**T/P**	**Credits**
Subject: Advances in Deep Learning	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To learn advanced concepts in deep learning.
2.	To understand different methods of optimization in deep learning.
3.	To learn practical tips in training deep learning models.
4.	To know research methods in the field of deep learning.

Course Outcomes:

CO1	Describe the advanced concepts in deep learning.
CO2	Explain different methods of optimization in deep learning.
CO3	Define practical tips in training deep learning models.
CO4	State research methods in the field of deep learning.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	-	1	1							1
CO2	2	2	-	1	1							1
CO3	2	2	-	2	2					1	1	2
CO4	3	1	3	1	2	1				1	1	2

Course overview:

Deep Learning is the most popular branch of machine learning which uses neural network-based models for solving problems in a number of domains. Therefore, it is important that after understanding the fundamental concepts of deep learning in 'Deep Learning - I', more advanced concepts are taught so that students could apply them in problem solving to solve problems effectively.

UNIT I **[8]**

Reviewing Deep Learning Concepts: Reviewing Deep Learning Concepts, NN, Regularization, Batch Normalization, Weight Initialization Strategies, Learning vs Optimization, Effective training in Deep Net ,Early Stopping, Normalization (Batch,Instance,Group), Batch Gradient Descent (GD), GD with momentum).

UNIT II **[8]**

Recent Trends in Deep Learning Architectures: Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Image Denoising, Semantic Segmentation, Object Detection etc. Neural Attention Models, Neural Machine Translation. Performance Metrics, Baseline Methods, Data Requirements, Hyperparameter Tuning: Manual vs Automatic, Grid vs Random.

UNIT III **[8]**

Improved Optimization: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

UNIT IV **[8]**

Deep Generative Models: Generative Adversarial Networks (GANs). Generating Images with Various Auto Encoders, Generative Adversial Networks (GAN), The Generator, The Discriminator, The Adversial Network, Training GAN. Introduction to Natural Language Processing (NLP), Text Classification and Deep Learning. Case study: Action recognition, shape recognition, visual instance recognition, emotion recognition.

Text Books

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville,"Deep Learning" MIT Press, 2016.

Reference Books:

1. Duda, R.O. and Hart, P.E., 2006. Pattern classification. John Wiley & Sons.

Semester: 6th			
Paper code: AIML308P	**L**	**T/P**	**Credits**
Subject: Advances in Deep Learning Lab	**0**	**2**	**1**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:	
1	To design and implement deep learning models for a variety of tasks, including image classification, object detection, natural language processing, and speech recognition.
2	To evaluate the performance of deep learning models using appropriate metrics and techniques
Course Outcomes:	
CO1	Implement deep learning models for a variety of tasks, including image classification, object detection, natural language processing, and speech recognition.
CO2	Apply deep learning algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	3	3	-	1	-	1	-	-	2
CO2	2	2	-	3	3	-	-	-	-	-	1	1

List of Experiments:

1. Implement multilayer perceptron algorithm for MNIST Hand written Digit Classification.
2. Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
3. Design a neural Network for classifying news wires (Multi class classification) using Reuters dataset.
4. Design a neural network for predicting house prices using Boston Housing Price dataset.
5. Build a Convolution Neural Network for MNIST Hand written Digit Classification.
6. Build a Convolution Neural Network for simple image (dogs and Cats) Classification

7. Use a pre-trained convolution neural network (VGG16) for image classification.
8. Implement one hot encoding of words or characters.
9. Implement word embeddings for IMDB dataset.
10. Implement a Recurrent Neural Network for IMDB movie review classification problem.
11. Image classification: Building a deep learning model that can classify images into different categories, such as animals, cars, or buildings.
12. Object detection: Developing a model that can identify and locate objects in an image, such as cars, pedestrians, or traffic signs.
13. Generative models: Creating a deep learning model that can generate new content, such as images, music, or text, based on examples provided during training.

<table>
<tr><td colspan="2">Semester: 6th</td><td></td><td></td></tr>
<tr><td colspan="2">Paper code: AIML310T</td><td>L</td><td>T/P</td><td>Credits</td></tr>
<tr><td colspan="2">Subject: Time Series Analysis and Forecasting</td><td>3</td><td>0</td><td>3</td></tr>
<tr><td colspan="5">Marking Scheme</td></tr>
<tr><td colspan="5">1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time</td></tr>
<tr><td colspan="5">INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms</td></tr>
<tr><td colspan="5">1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.</td></tr>
<tr><td colspan="5">Course Objectives:</td></tr>
<tr><td>1.</td><td colspan="4">To learn about important time series models and their applications in various fields.</td></tr>
<tr><td>2.</td><td colspan="4">To use statistical software to estimate the models from real data and draw conclusions and develop solutions from the estimated models.</td></tr>
<tr><td>3.</td><td colspan="4">To communicate the statistical analyses of substantial data sets through explanatory text, tables and graphs.</td></tr>
<tr><td>4.</td><td colspan="4">To combine and adapt different statistical models to analyze larger and more complex data.</td></tr>
<tr><td colspan="5">Course Outcomes:</td></tr>
<tr><td>CO1</td><td colspan="4">Knowledge of basic concepts in time series analysis and forecasting.</td></tr>
<tr><td>CO2</td><td colspan="4">Understanding the use of time series models for forecasting and the limitations of the methods.</td></tr>
<tr><td>CO3</td><td colspan="4">Ability to criticize and judge time series regression models.</td></tr>
<tr><td>CO4</td><td colspan="4">Compare with multivariate time series and other methods of applications.</td></tr>
</table>

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1	2	1						2
CO2	2	2	2	2	1				1		1	2
CO3	2	2	2	2	1			1	1		1	2
CO4	3	2	2	3	2			1	1	1	2	3

Course Overview:
The course will provide a basic introduction to modern time series analysis. The course will cover time series regression and exploratory data analysis, ARMA/ARIMA models, model identification/estimation/linear operators. It involves identifying patterns and trends in time-varying data and making forecasts and predictions based on these patterns.

UNIT I **[8]**
INTRODUCTION OF TIME SERIES ANALYSIS: Introduction to Time Series and Forecasting, Different types of data, Internal structures of time series. Models for time series analysis, Autocorrelation and Partial autocorrelation. Examples of Time series Nature and uses of forecasting, Forecasting Process, Data for forecasting, Resources for forecasting.
STATISTICS BACKGROUND FOR FORECASTING: Time Series Plots, Plotting Smoothed Data, Numerical Description of Time Series Data, Use of Data Transformations and Adjustments, General Approach to Time Series Modeling and Forecasting, Evaluating and Monitoring Forecasting Model Performance.

UNIT II **[8]**
TIME SERIES REGRESSION MODEL: Introduction Least Squares Estimation in Linear Regression Models, Statistical Inference in Linear Regression, Prediction of New Observations, Model Adequacy Checking, Variable Selection Methods in Regression, Generalized and Weighted Least Squares, Regression Models for General Time Series Data, Exponential Smoothing, First order and Second order.

UNIT III **[8]**
AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODELS: Autoregressive Moving Average (ARMA) Models, Stationarity and Invertibility of ARMA Models, Checking for Stationarity using Variogram, Detecting Non stationarity, Autoregressive Integrated Moving Average (ARIMA) Models, Forecasting using ARIMA, Seasonal Data, Seasonal ARIMA Models Forecasting using Seasonal ARIMA Models Introduction, Finding the “BEST” Model, Example: Internet Users DataModel Selection Criteria - Impulse Response Function to Study the Differences in Models Comparing Impulse Response Functions for Competing Models .

UNIT IV **[8]**
MULTIVARIATE TIME SERIES MODELS AND FORECASTING: Multivariate Time Series Models and Forecasting, Multivariate Stationary Process, Vector ARIMA Models, Vector AR (VAR) Models, Neural Networks and Forecasting Spectral Analysis, Bayesian Methods in Forecasting.

Textbooks:

1. Introduction To Time Series Analysis and Forecasting, 2nd Edition, Wiley Series In Probability And Statistics, By Douglas C. Montgomery, Cheryl L. Jen (2015)
2. Master Time Series Data Processing, Visualization, And Modeling Using Python Dr. Avishek Pal Dr. Pks Prakash (2017)
3. Time Series Analysis and Forecasting by Example Søren Bisgaard, Murat Kulahci, Technical University of Denmark Copyright © 2011 By John Wiley & Sons, Inc. All Rights Reserved.

Reference Books:

1. Peter J. Brockwell Richard A. Davis Introduction to Time Series and Forecasting Third Edition. (2016).
2. Multivariate Time Series Analysis and Applications William W.S. Wei Department of Statistical Science Temple University, Philadelphia, PA, SA This edition first published 2019 John Wiley & Sons Ltd.

Semester: 6th			
Paper code: AIML310P	**L**	**T/P**	**Credits**
Subject: Time Series analysis and Forecasting Lab	**0**	**2**	**1**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:	
1	To introduce a variety of statistical models for time series
2	To understand the characteristics of Time series data using different time series models.
Course Outcomes:	
CO1	Analysis of time series data and learn basic concepts in time series regression and Modeling.
CO2	Apply concepts of spectral analysis and space-time models and analysis of time series data.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	1	3	2					2	2	2
CO2	2	2	3	3	3					2	2	2

List of Experiments:

1. Exploratory analysis of time series data: Explore real world time series data set and visualize the data using various techniques, such as line charts, scatter plots, and time series decomposition.
2. Develop a program to understand Time Series Data Cleaning Model and Loading and Handling Times series data.
3. Study and differentiate several Pre-processing Techniques in Time Series analyses.
4. Write a Program to Check Stationarity of a Time Series data.
5. Create a system of Estimating & Eliminating Trend with the following:
    - Aggregation

- Smoothing
- Polynomial Fitting

6. Develop a program for Smoothing and Exponential smoothing of the Time analysis Data.
7. Write a program to check out the Time series Linear and non-linear trends.
8. Build an ARIMA model for a given time series data set, including identifying the order of differencing, selecting the appropriate AR and MA parameters, and evaluating the model's performance using various metrics, such as AIC, BIC, and MSE.
9. Write a program to demonstrate seasonal autoregressive integrated moving average model (SARIMA)
10. Create a system to demonstrate dependence Techniques using
    - Multivariate Analysis of Variance and Covariance
    - Canonical Correlation Analysis
11. Write a program to demonstrate factor analysis and cluster analysis
12. Forecasting: Create predictions and forecasts for a given time series data set using various techniques, such as ARIMA forecasting, exponential smoothing, and state space models and evaluate the accuracy of their forecasts using various metrics, such as MAPE, MAE, and RMSE.
13. Time series regression: Build a time series regression model that includes one or more explanatory variables and use it to make predictions and forecasts. Interpret the coefficients and assess the goodness of fit of the model using various metrics, such as R-squared and adjusted R-squared.

Semester: 6th			
Paper code: AIML312T	**L**	**T/P**	**Credits**
Subject: Modeling complex Systems using Machine Learning	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	Understand the nature and facets of “complex systems”.
2	Become familiar with data science tools and computational models applicable for complex systems
3	Apply data science tools and techniques to real-life “complex systems” problems
4	Understand the concepts of time- series analysis and agents in modeling designs

Course Outcomes:

CO1	To understand basic concepts of Machine learning techniques and learn about complex models
CO2	To study simulation of various models
CO3	To learn about embedded system and real-time system modeling
CO4	To understand and deploy Time series data and its statistics and to learn various categories of agent-based models

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	-	-	3	-	-	2	-	-	-	-	2
CO2	2	-	3	-	-	2	-	-	-	1	-	-
CO3	-	2	2	3	-		-	-	-	-	1	-
CO4	2	3	3	2	2	2	-	-	-	-	-	2

Course Overview:

The course focuses on the application of machine learning techniques to model complex systems in various fields such as science, engineering, economics, and social sciences. The course covers a range of topics, including the fundamentals of complex systems, different modeling approaches such as agent-based modeling, network modeling, and system dynamics modeling, and the application of machine learning algorithms to these modeling approaches.

UNIT I **[8]**

Definition of a complex system: Complex systems in engineering- Complex systems in nature & society. Modelling of complex systems-Introduction to dynamical system theory- standard models in dynamical systems-transitions in dynamical systems-bifurcations- Maps and flows- Chaos- Routes to chaos.

UNIT II **[8]**

Modeling Complex Systems: Introduction, list processing in simulation, approaches to stering lists in a computer linked storage allocation Simulation examples using any simulation language: Single-server Queuing simulation with time-shared computer model, job-shop model, and event-list manipulation.

UNIT III **[8]**

Embedded System Modeling: Embedded systems and system level design, models of computation, specification languages, hardware/software code design, system partitioning, application specific processors and memory, low power design Real-Time system modeling, Fixed Priority scheduling, Dynamic Priority Scheduling Data Communication Network modeling, IP network intradomain (e.g. OSPF, RIP) routing simulation.

UNIT IV **[8]**

Introduction to time series data analysis: Basic definitions and construction, frequency and time domain, stationary time series, autocovariance function, autoregression, GARCH model, time-series with memory: R/S analysis and hurst exponent, detrended fluctuation analysis, random matrix theory and its applications, Introduction to Agent-based modeling, types of agent-based model.

Text Books:

1. Newman, Mark, Albert-László Barabási, and Duncan J. Watts. The structure and dynamics of networks. Princeton university press, 2006.
2. Hamilton, James Douglas. Time series analysis. Princeton university press, 2020.
3. Econophysics: An Introduction. Sitabhra Sinha, Arnab Chatterjee, Anirban Chakraborti, Bikas K. Chakrabarti. Wiley, 2010.
4. Introduction to the Modelling and Analysis of Complex Systems, Hiroki Sayama, Binghamton University, SUNY, ISBN: 978-1-942341-08-6 (print edition), 2015.

Reference Books:

1. A First Course in Network Science. Filippo Menczer, and Santo Fortunato, Cambridge University Press, 2020.
2. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, Wiley, 2015.
3. Time series analysis: forecasting and control. Box, George EP, Gwilym M. Jenkins, Gregory C. Reinsel, and Greta M. Ljung, John Wiley & Sons, 2015.

4. N. Boccora, Modelling of Complex Systems, 2nd Edition, Springer 2010.

Semester: 6th			
Paper code: AIML312P	**L**	**T/P**	**Credits**
Subject: Modeling Complex Systems using Machine Learning Lab	**0**	**2**	**1**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:	
1	To familiar students with the software tools and programming languages used for modeling complex systems
2	To gain hands-on experience in applying machine learning algorithms to complex systems modeling.
Course Outcomes:	
CO1	Interpret and communicate the results of complex systems modeling to stakeholders in a clear and understandable manner.
CO2	Apply machine learning algorithms and techniques to model and simulate complex systems using real-world data sets

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	2	2	3	-		-	-	-	-	1	-
CO2	2	3	3	2	2	2	-	-	-	-	-	2

List of Experiments:

1. Develop a machine learning model to predict a specific outcome or behavior in a complex system based on historical data. For example, predicting stock market prices or weather patterns.
2. Build a model to detect anomalies or outliers in complex systems. This could involve identifying unusual behavior in network traffic, detecting fraudulent transactions, or identifying defective products in a manufacturing process.
3. Use machine learning techniques to forecast future values in time series data of a complex system. This can be applied to predict demand for products, electricity consumption, or stock market trends.

4. Design a recommendation system that suggests relevant items or content to users based on their preferences and behaviors. This could involve recommending movies, products, or news articles in a complex system.
5. Apply clustering algorithms to group similar instances or entities within a complex system. This can be used for customer segmentation, market analysis, or identifying patterns in biological data.
6. Build a generative model that can simulate complex systems based on learned patterns and parameters. This could involve generating realistic images, synthesizing music, or creating virtual characters.
7. Utilize reinforcement learning techniques to develop an intelligent agent that learns to make decisions and control a complex system. For example, training an autonomous robot to navigate in a dynamic environment.
8. Text and Language Processing: Develop models for natural language understanding and processing in complex systems. This can include sentiment analysis, text classification, or machine translation.
9. Network Analysis: Apply machine learning algorithms to analyze and model complex networks, such as social networks, transportation networks, or biological networks.
10. Deep Learning for Image Analysis: Use deep learning architectures to analyze and interpret complex visual data.

Semester: 6th			
Paper code: AIML314T	**L**	**T/P**	**Credits**
Subject: Game Designing	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	To understand the basic concepts of game designing.
2	To analyse character movement algorithms and customize car movements.
3	To understand the functioning of path finding and decision-making algorithms for game development.
4	To evaluate different game usability and user experience techniques

Course Outcomes:

CO1	Critically evaluate game designing concepts, elements, and characters.
CO2	Analyze character game movement algorithms and customize car movement using Unity's Vehicle System.
CO3	Differentiate the implementation of path finding algorithms using Waypoint and Navmesh and simulate crowded city.
CO4	Evaluate effectiveness of game design using standard models like MEEGA+

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	2	-	2	-	1	1	-	-	1	-	2
CO2	1	2	1	1	3	1	1	-	-	2	-	2
CO3	2	2	2	2	3	2	1	-	-	1	1	2
CO4	2	3	3	2	3	2	1	1	2	2	1	2

Course Overview:

This course enables students to learn game development. Movement Algorithms, Path Finding Algorithms and Decision-Making Algorithms have been covered in the course. Evaluation of existing and new games using standard methods in UI/UX have also been covered. Students will be able to apply all the covered game design concepts and develop a beta version of the game.

UNIT I **[8]**

Introduction to games: types of games, importance of game design. Introduction to latest game engines such as Unity (C#), Unreal (C++, Blueprints), Godot (GDscript). Understanding different modules of the games – depending on different game types e.g puzzle game – level designing, player journey/behavior, ui/ux, game physics, game rules, game mechanics, audio. Scenes - game objects and transforms; Entities, components.

UNIT II **[8]**

Game physics: Rigid bodies and forces, Colliders, Joints. 2D,3D and Isometric 2D Level Design and Practice. Movements – Player movements (AI) (Using Unity's Navmesh).

UNIT III **[8]**

Understanding game cameras: Perspective, Orthographic, Player interactions and game mechanics (AI) (for puzzle games and RPGs). Applying animations and animation events, UI/UX in game design (Menu design, player statistics, HUD – heads up display, GAP, MEEGA+), Adding audio and sound effects

UNIT IV **[8]**

Game Polishing: Particle effects and reactive environments. Playtesting - Game evaluation (Usability and User experience) and analytics. AI algorithms for game development.

Textbooks:

1. Felicia, Patrick. Unity 5 from Proficiency to Mastery: Artificial Intelligence: Implement challenging AI for FPS and RPG Games.

Reference Books:

1. Anders Drachen, Pejman Mirza-Babaei, and Lennart Nacke, Games User Research, Oxford University Press, 2018.
2. Colleen Macklin and John Sharp, Games, Design and Play: A Detailed Approach to Iterative Game Design, 2016.

Semester: 6th			
Paper code: AIML314P	**L**	**T/P**	**Credits**
Subject: Game Designing Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATOR: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To analyse character movement algorithms and customize car movements.
2	To understand the functioning of path finding and decision-making algorithms for game development.

Course Outcomes:

CO1	Analyze character game movement algorithms and customize car movement using Unity's Vehicle System.
CO2	Differentiate the implementation of path finding algorithms using Waypoint and Navmesh and simulate crowded city.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	2	2	1	-	1	-	-	-
CO2	3	3	3	3	3	2	2	-	2	-	-	-

LIST OF EXPERIMENTS:

1. Introduction to latest game engines such as Unity (C#), Unreal (C++, Blueprints), Godot (GDscript)
2. Installation of Unity
3. Working with interface of Unity
4. Creation of scenes and game objects using Unity
5. Applying transformations of game objects and deactivation of game objects using Unity.
6. Working with Constraints in Unity.
7. Develop 2D game projects in Unity using sprites, Tilemaps and 2D physics system.
8. Embedding various graphic features of Unity in game development.
9. Working with Buit-in 3D Physics features: Character control, Rigid body physics, Collision, Joints and Multi-scene physics.

10. Using scripting used to embed graphical effects, control the physical behaviour of objects and implement a custom AI system for characters in the game.
11. Working with Unity's Vehicle Module Feature.
12. Creating a multiplayer game using Network Manager in LAN mode and using Network Manager in Matchmaker mode.
13. Converting a single-player game to Unity Multiplayer.
14. Implementation of Crowd simulation project using Unity.

Semester: 6th			
Paper code: AIML316T	**L**	**T/P**	**Credits**
Subject: Natural Language Processing	**3**	**0**	**3**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Theory Examination: As per university examination norms from time to time			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1	To introduce the basic principles, techniques, and applications of Natural Language Processing
2	To provide an understanding of the basic phases of natural language processing like morphological analysis, syntactic analysis, semantic analysis, pragmatic analysis
3	To teach latest tools and techniques for NLP like WordNet
4	Address the issues of natural languages like ambiguities

Course Outcomes:

CO1	Understand the basics of the analysis of natural language input
CO2	Analyse the concept of semantic and syntactic analysis
CO3	To understand the applications of NLP in day-to-day life using WordNet
CO4	Identify issues and challenges in natural language processing including ambiguities

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1	1	1	-	1	-	-	-	1
CO2	2	2	1	1	2	1	-	-	-	-	-	2
CO3	2	2	1	1	3	1	-	-	-	-	-	2
CO4	2	2	2	2	1	1	1	1	1	1	1	2

Course Overview:

This course aims at teaching the basics about processing of Natural Languages. Natural language processing is the feature of 5th Generation Computer and is part of Artificial intelligence. It teaches about the different phases of natural language processing, methodologies, algorithms, data structures used for Natural Language Processing.

UNIT 1: **[10]**

Introduction: Basic concepts of Natural Language Processing, origins and evolution of NLP, language and knowledge, issues and challenges in NLP, Types of ambiguities, Word and non-word errors, Phases of Natural Language Processing.

UNIT 2: **[10]**

Key Components: Basics of morphological analysis, syntactic analysis, semantic analysis, and pragmatic analysis. Data Pre-Processing. Text tokenization. Part of Speech Tagging (POST). POS Taggers. Case study of parsers of NLP systems: ELIZA, LUNAR.

UNIT 3: **[10]**

Tools and Techniques: Word-to-Vec conversion. Term Frequency-Inverse Document Frequency. FrameNet. English WordNet and Indian WordNet. Components of WordNet. Semantic analysis using WordNet. Understanding Natural Language Tool Kit (NLTK) tool for using WordNet. NLP and Indian languages.

UNIT 4: **[10]**

Applications of NLP: Word Sense Disambiguation, Text Summarization, Optical Character Recognition, Sentiment Analysis and Opinion Mining, Chatbots and Voice Assistants, Automated Question Answering, Machine Translation.

Text Books:

1) Bird S, Klein E, Loper E. Natural language processing with Python: analyzing text with the natural language toolkit. " O'Reilly Media, Inc."; 2009.
2) Thanaki J. Python natural language processing. Packt Publishing Ltd; 2017.

Reference Books:

1) Hardeniya N, Perkins J, Chopra D, Joshi N, Mathur I. Natural language processing: python and NLTK. Packt Publishing Ltd; 2016.
2) Srinivasa-Desikan B. Natural Language Processing and Computational Linguistics: A practical guide to text analysis with Python, Gensim, spaCy, and Keras. Packt Publishing Ltd; 2018.

Semester: 6th			
Paper code: AIML316P	**L**	**T/P**	**Credits**
Subject: Natural Language Processing Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATOR: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To provide students with hands-on experience in applying NLP techniques to real-world problems. Students will learn to implement and evaluate various NLP algorithms, such as text classification, sentiment analysis, named entity recognition, and machine translation.
2	To foster critical thinking and problem-solving abilities in NLP

Course Outcomes:

CO1	Develop proficiency in implementing and evaluating NLP techniques through practical exercises and projects.
CO2	Enhance critical thinking and problem-solving abilities in NLP by analyzing, designing, and optimizing NLP models.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	1	1	1	1	-	2	2	-	1	1
CO2	2	2	2	3	3	2	1	2	2	1	-	2

LIST OF EXPERIMENTS:

1) Installation and set-up of Natural Language Tool Kit (NLTK)
2) Installation and set-up of WordNet libraries
3) Perform text tokenization using NLTK
4) Perform Part of Speech Tagging using NLTK
5) Analyzing unstructured data using Natural Language Tool Kit
6) Perform sentiment analysis on real-life data
7) Perform word sense disambiguation using WordNet
8) Perform text summarization using WordNet

Semester: 6th			
Paper code: AIML318T	**L**	**T/P**	**Credits**
Subject: Cloud, Dew, Edge and Fog [CDEF] Computing	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide an understanding of basic concepts of Cloud Computing.
2.	To familiarize students with Service Models such as SAAS, PAAS and IAAS.
3.	To introduce students to different Threats, Vulnerabilities and Attacks in Cloud computing Domain
4.	To explore MiCEF Concepts to Create Cloud Computing Problems and solve them.

Course Outcomes:

CO1	To Understand the basic concepts of Cloud Computing.
CO2	To Understand and remember the Service Models such as SAAS, PAAS and IAAS.
CO3	To Analyze the different Threats, Vulnerabilities and Attacks in Cloud computing Domain.
CO4	To Apply the MiCEF Concepts to Create Cloud Computing Problems and solve them.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	2	3	3	3	3	2	2	3
CO2	3	3	3	3	2	3	3	3	1	3	3	3
CO3	3	3	3	3	2	1	3	3	3	2	1	3
CO4	3	3	3	3	2	2	1	1	1	3	2	3

Course Overview:

This course provides an introduction to cloud computing, covering its definition, characteristics, and components. It explores different cloud service providers and their offerings, including Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). The course also delves into cloud technologies, including hypervisors, SOAP, REST, web services, and virtualization. Security considerations, such as vulnerability assessment, privacy, and architecture, are discussed. Additionally, emerging paradigms like MICEF Computing (Mist, IoT, Cloud, Edge, and Fog) and Dew Computing are explored, along with practical case studies and the use of open-source software like CloudSim and iFogSim.

UNIT I **[10]**

Introduction to Cloud Computing: Definition, Characteristics, Components, Cloud Service provider, Software As a Service(SAAS), Platform As a Service(PAAS), Infrastructure as a Service(IAAS) and Others, Load balancing and Resource optimization. Comparison among Cloud computing platforms: Amazon EC2, Platform as Service: Google App Engine, Microsoft Azure, Meghraj etc

UNIT II **[10]**

Introduction to Cloud Technologies: Study of Hypervisors, SOAP, REST, Comparison of SOAP and REST, Webservices, mashups-Web services, Mashups: user interface services, Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization, Multi-entity support, Multi-schema approach, Multi-tenancy using cloud data stores.

UNIT III **[10]**

Cloud security fundamentals: Vulnerability assessment tool for cloud, Privacy and Security in cloud, Cloud computing security architecture, Issues in cloud computing, Issues in Intercloud environments, QoS Issues in Cloud, Streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment, Inter Cloud issues.

UNIT IV **[10]**

MICEF Computing: (Mist, IOT, Cloud, Edge and FOG Computing), Dew Computing : Concept and Application;

Case Study: Design and Development of MiCEF Computing Programs using Free and Open Source Software such as : CloudSim and iFogSim

Text Books:

1. Cloud Computing Bible : Barrie Sosinsky, Wiley India, 2011
2. Cloud Computing : Principles and Paradigms Paperback, Rajkumar Buyya, James Broberg, Andrzej Goscinski, John Wiley & Sons, 2011
3. Cloud Computing Black Book : Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Deven Shah, Dreamtech Press, 2014

Reference Books:

1. Cloud Computing : A Practical Approach, Toby Velte, Anthony Velte, Robert Elsenpeter McGrawHill, 2017
2. Cloud Computing : A Complete Guide, Gerardus Blokdyk, 5 Starcooks, 2019.

Semester: 6th			
Paper code: AIML320T	**L**	**T/P**	**Credits**
Subject: Pattern Recognition	**4**	**0**	**4**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide an understanding of basic concepts of Bayesian decision theory and Bayesian learning.
2.	To familiarize students with fundamental classifiers such as linear discriminant function, quadratic discriminant function, nearest neighbor rule, neural network and SVM.
3.	To introduce students to feature selection algorithms
4.	To explore the performance of various classifiers on real-world datasets

Course Outcomes:

CO1	To understand a good knowledge of Bayesian decision theory and Bayesian learning.
CO2	To describe fundamental classifiers such as linear discriminant function, quadratic discriminant function, nearest neighbor rule, neural network and SVM
CO3	To understand and apply feature selection algorithms.
CO4	To analyze the performance of various classifiers on real-world datasets.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High)

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	1	-	-	-	2	1	2
CO2	2	2	3	3	2	1	-	-	-	2	1	2
CO3	2	3	3	3	2	1	-	-	-	2	2	3
CO4	3	3	3	2	2	1	-	-	-	1	2	3

Course Overview:

This course provides a comprehensive introduction to pattern recognition techniques, focusing on the analysis and classification of complex data patterns. Topics covered include feature extraction, statistical pattern classification, machine learning algorithms, and deep neural networks. Practical applications and hands-on experience with real-world datasets are emphasized.

UNIT I **[10]**

Basics of Probability, Random Processes and Linear Algebra: Introduction to Pattern Recognition, Feature Detection, Classification, Review of Probability Theory, Conditional Probability and Bayes Rule, Random Vectors, Expectation, Correlation, Covariance, Review of Linear Algebra, Linear Transformations, Decision Theory, ROC Curves, Coping with Missing or Noisy Features, Template-based Recognition, Feature Extraction

UNIT II **[10]**

Pattern Recognition: Typical Pattern Recognition System, Patterns and Features Extraction, Training and Learning in Pattern Recognition system, Different types of Pattern Recognition Approaches – Statistical, Syntactic, Neural. Discriminant functions.

UNIT III **[10]**

Statistical Pattern Recognition: Parametric estimation and supervised learning, Maximum likelihood estimation, Bayesian parameter estimation, Non-parametric approaches - Parzen window, k-NN estimation, Unsupervised Learning – Clustering Concepts.

UNIT IV **[10]**

Syntactic Pattern Recognition: Grammar Based Approaches, Elements of Formal Grammars, Parsing Concepts – Parsing Algorithm, Transition Networks in Parsing, Higher Dimensional Grammars, Stochastic Grammars, Graphical Approaches – Graph Isomorphism, Attributed Graphs.

Text Books:

1. O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001
2. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009

Reference Books:

1. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006
2. Cloud Computing : A Complete Guide, Gerardus Blokdyk, 5 Starcooks, 2019

Industrial Internet of Things

Subject Basket

6th Semester

Semester: 6th			
Paper code: IOT304T	L	T/P	Credits
Subject: Wireless Sensor Networks	3	0	3

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand basic concepts of wireless sensor networks.
2.	To learn about the MAC and Routing protocols.
3.	To understand the middleware architecture and network management models for WSN.
4.	To study Applications and Deployment of Wireless Sensor Networks

Course Outcomes:

CO1	Understand the WSN concepts, challenges and applications
CO2	Learn the hardware and software components and the operating environment
CO3	Learn the MAC protocols and Routing protocols used in WSN along with challenges and design issues
CO4	Learn the Middleware architecture & Network Management for WSN

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	2	2	2	2	-	1	-	-	-	1	1
CO3	-	2	2	2	2	-	1	-	-	-	1	1
CO4	1	1	2	2	2	1	1	1	-	-	1	1

Course Overview:

This course provides students with an opportunity to learn the fundamentals behind the design of wireless sensor networks. A primary focus of this course is to give students hands-on programming experience with various sensors and sensing platforms. Wireless sensor networks further contribute to the widespread use of distributed sensor systems. The miniaturization of computing and sensing technologies enables the development of tiny, low-power, and inexpensive sensors, actuators, and controllers. Further, embedded computing systems (i.e., systems that typically interact closely with the physical world and that are designed to perform only a limited number of dedicated functions) continue to find application in an increasing number of areas.

UNIT I **[8]**

Introduction: Introduction to Wireless Sensor Network (WSN), Sensor Network Architectural Elements, Challenges and Hurdles, Applications of WSN. Review of Sensor and Transmission Technology: Sensor Node Technology.

UNIT II **[8]**

Communication Protocols: MAC Protocols: Fundamentals of MAC Protocols, MAC Protocols for WSN, BMAC Protocol, IEEE 802.15.4 standard and ZigBee. Routing Protocols: Data Dissemination and Gathering, Routing Challenges and Design Issues, Routing Strategies in WSN.

UNIT III **[8]**

Transport Control Protocols: Traditional Transport Control Protocols, Design Issues in Transport Protocols, WSN Middleware Principles, Middleware Architecture.

UNIT IV **[8]**

Network Management for WSN: Network Management Requirements, Traditional Network Management Models, Network Management Design Issues.

Text Books:

1. Kazem, Sohraby, Daniel Minoli, Taieb Zanti, “Wireless Sensor Network: Technology, Protocols and Application”, John Wiley and Sons 1st Ed., 2007 (ISBN: 978-0-471-74300-2).
2. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Network”, John Wiley and Sons, 2005 (ISBN: 978-0-470-09511-9).

Reference Books:

1. Raghavendra, Cauligi S, Sivalingam, Krishna M., Zanti Taieb, “Wireless Sensor Network”, Springer 1st Ed. 2004 (ISBN: 978-4020-7883-5).
2. Feng Zhao, Leonidas Guibas, “Wireless Sensor Network”, Elsevier, 1st Ed. 2004 (ISBN: 13- 978- 1-55860-914-3).
3. B. Krishnamachari, “Networking Wireless Sensors”, Cambridge University Press.
4. N. P. Mahalik, “Sensor Networks and Configuration: Fundamentals, Standards, Platforms, and Applications” Springer Verlag.

Semester: 6th			
Paper code: IOT304P	L	T/P	Credits
Subject: Wireless Sensor Network Lab	0	2	1

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To design various topologies of Wireless networks.
2.	To demonstrate the physical and MAC layer protocols of Wireless networks.

Course Outcomes:

CO1	Analyze techniques such as image denoising, image segmentation, Image enhancement and edge detection.
CO2	Apply spatial and frequency domain filters on an image data set.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	-	-	-	-	1	-	-
CO2	2	2	2	2	2	1	1	1	2	1	1	2

List of Experiments:

1. Create a sample wireless topology using Simulation Tool using NS2/NS3/MATLAB.
2. Create a mobile Ad-hoc networks using Simulation Tool.
3. Implement a Low Energy Adaptive Hierarchy protocol using Simulation Tool.
4. Implement a Power Efficient Gathering in Sensor Information System using Simulation Tool.
5. Implement a Sensor Protocol for Information via Negotiation (SPIN) using Simulation Tool.
6. Implement a Power Efficient and Delay Aware MAC protocol using Simulation Tool.
7. Implement a Predictive Wake-up MAC protocol using Simulation Tool.
8. Implement a Proactive and Reactive based MAC protocol using Simulation Tool.
9. Implement a Transmission Control Protocol using Simulation Tool.
10. Implement a Scheduling based protocol for WSNs using Simulation Tool.

Semester: 6th			
Paper code: IOT306T	**L**	**T/P**	**Credits**
Subject: Mobile Computing	**3**	**0**	**3**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Theory Examination: As per university examination norms from time to time			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			
1. There should be 9 questions in the end term examination question paper. 2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions. 3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit. 4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks. 5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.			

Course Objectives:	
1.	To understand basic concepts of wireless sensor networks.
2.	To learn about the MAC and Routing protocols.
3.	To understand the middleware architecture and network management models for WSN.
4.	To study Applications and Deployment of Wireless Sensor Networks

Course Outcomes:	
CO1	Understand the WSN concepts, challenges and applications
CO2	Learn the hardware and software components and the operating environment
CO3	Learn the MAC protocols and Routing protocols used in WSN along with challenges and design issues
CO4	Learn the Middleware architecture & Network Management for WSN

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	2	2	2	2	-	1	-	-	-	1	1
CO3	-	2	2	2	2	-	1	-	-	-	1	1
CO4	1	1	2	2	2	1	1	1	-	-	1	1

Course Overview:

The course on Mobile Computing provides a concise yet comprehensive overview of the fundamental concepts and technologies in the field. Students will learn about the architecture of mobile computing systems, wireless communication protocols, mobile application development, and location-based services. Topics covered include mobile operating systems, mobile device hardware, mobile network infrastructure, mobile security, and emerging trends in mobile computing. Practical exercises and case studies will enhance students' understanding of mobile computing applications and their impact on various industries.

UNIT I **[8]**

Introduction: Introduction to Mobile Computing, Applications of Mobile Computing, Generations of Mobile Communication Technologies, Multiplexing, Spread spectrum, MAC Protocols, SDMA, TDMA, FDMA, CDMA. Mobile Device Operating Systems: Special Constraints & Requirements, Commercial Mobile Operating Systems.

UNIT II **[8]**

Mobile Telecommunication System: Introduction to Cellular Systems. GSM: Services & Architecture, Protocols, Connection Establishment. Frequency Allocation, Routing, Mobility Management, Security Architecture, Handover Security

UNIT III **[8]**

Mobile Network Layer: Mobile IP, DHCP, AdHoc Network, Proactive Protocol-DSDV, Reactive Routing Protocols DSR, AODV, Hybrid routing, ZRP, Multicast Routing- ODMRP, Vehicular Ad Hoc networks (VANET), MANET Vs VANET, Security.

UNIT IV **[8]**

Mobile Transport and Application Layer: Mobile TCP, WAP: Architecture, WDP, WTLS, WTP, WSP, WAE, WTA Architecture – WML. Software Development Kit: iOS, Android, BlackBerry, Windows. M-Commerce Structure: Pros & Cons. Mobile Payment System: Security Issues

Text Books:

1. Jochen Schiller, —Mobile Communications, PHI, Second Edition, 2003.
2. Prasant Kumar Pattnaik, Rajib Mall, —Fundamentals of Mobile Computing, PHI Learning.

Reference Books:

1. Dharma Prakash Agarwal, Qing and An Zeng, "Introduction to Wireless and Mobile systems", Thomson Asia Pvt Ltd, 2005.
2. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, —Principles of Mobile Computing, Springer, 2003.

Semester: 6th			
Paper code: IOT306P	L	T/P	Credits
Subject: Mobile Computing Lab	0	2	1

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To analyze different types of routing protocols
2.	To create meaningful insights in the field of MANET and VANET

Course Outcomes:

CO1	Analyze techniques such as image denoising, image segmentation, Image enhancement and edge detection.
CO2	Apply spatial and frequency domain filters on an image data set.

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	1	1	2	1	1	1	2
CO2	2	2	2	2	1	1	1	2	1	1	1	2

List of Experiments:
1. Study and install a Network Simulator (CISCO packet tracer/GNS3)
2. Study and implement Reactive Routing Protocol on a Network Simulator
3. Study and implement Dynamic Source Routing Protocol on a Network Simulator
4. Study and implement Ad-hoc On Demand Distance Vector (AODV) on a Network Simulator
5. Study and implement Hybrid routing on a Network Simulator
6. Study and implement Multicast Routing ODMRP i.e. On Demand Multi Cast Routing Protocol
7. Study and implement Vehicular Ad Hoc networks (VANET)
8. Study and implement MANET (Mobile Ad-hoc Network)
9. Prepare a case study for a comparative analysis of MANET Vs VANET
10. Compare and contrast the various routing protocols using an industrial case study.

Semester: 6th			
Paper code: IOT308T	**L**	**T/P**	**Credits**
Subject: Soft Computing	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide students with an understanding of optimization approaches and its types.
2.	To enable students to develop proficiency in solving optimization problems using classical techniques.
3.	To develop proficiency in solving optimization problems using meta-heuristics techniques.
4.	To provide understanding of heuristic and hybrid optimization approaches and develop proficiency in solving optimization problems using heuristic and hybrid optimization techniques.

Course Outcomes:

CO1	Students will be able to identify and comprehend the different optimization problems in real-world applications.
CO2	Students will be able to comprehend, analyze and solve the classical optimization problems including linear, quadratic, and integer programming problems.
CO3	Students will be able to apply and analyze the performance of meta-heuristics optimization techniques to solve different optimization problems
CO4	Students will be able to apply heuristics and hybrid optimization techniques to solve different optimization problems and analyze their performance for different problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	2	3	1	1				1		1
CO2	3	3	3	3	2	1				1		1
CO3	3	3	3	3	3	2	1			1		1
CO4	3	3	3	3	3	2	1	3		1		1

Course Overview:

Soft Computing is a multidisciplinary subject combining artificial intelligence techniques and optimization methods to solve complex real-world problems. This course provides an overview of fuzzy logic, neural networks, and genetic algorithms. Students will learn about the principles, algorithms, and applications of soft computing methods in areas such as pattern recognition, data mining, optimization, and control systems. Emphasis is placed on practical implementations and case studies to develop problem-solving skills in various domains.

UNIT I **[8]**

Introduction: What is Soft Computing? Difference between Hard and Soft computing, Requirement of Soft computing, Applications of Soft Computing, Neural Networks: History, overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, unsupervised and reinforcement Learning, ANN training Algorithms perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

UNIT II **[8]**

Deep Learning Concepts: Regularization, Bias Variance, Batch Normalization, Weight Initialization Strategies, Learning vs Optimization, Early Stopping, Mini-Batch algorithm, Methods - Batch Gradient Descent (GD), GD with momentum. Improved Optimization: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization). Deep Learning in Practice: Practical Tips for Training Deep Neural Networks, Performance Metrics, Baseline Methods, Data Requirements, Hyperparameter Tuning: Manual vs Automatic, Grid vs Random, Model based hyperparameter tuning.

UNIT III **[8]**

Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation, Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Uncertainty based Information: Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets.

UNIT IV **[8]**

Introduction of Neuro-Fuzzy Systems: Architecture of Neuro Fuzzy Networks. Application of Fuzzy Logic: Medicine, Economics etc. Genetic Algorithm: An Overview, GA in problem solving, Implementation of GA.

Text Books:

1. Hertz J. Krogh, R.G. Palmer, ―Introduction to the Theory of Neural Computation‖, Addison-Wesley, California, 1991.
2. G.J. Klir & B. Yuan, ―Fuzzy Sets & Fuzzy Logic‖, PHI, 1995.

3. Melanie Mitchell, ―An Introduction to Genetic Algorithm‖, PHI, 1998.
4. F. O. Karray and C. de Silva, ―Soft computing and Intelligent System Design‖, Pearson, 2009.

Reference Books:

1. Neural Networks-A Comprehensive Foundations‖, Prentice-Hall International, New Jersey, 1999.
2. Freeman J.A. & D.M. Skapura, ―Neural Networks: Algorithms, Applications and Programming Techniques‖, Addison Wesley, Reading, Mass, (1992).

Semester: 6th			
Paper code: IOT308P	**L**	**T/P**	**Credits**
Subject: Soft computing Lab	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To design and implement soft computing models for a variety of tasks, including image classification, object detection, natural language processing, and speech recognition.
2.	To evaluate the performance of deep learning models using appropriate metrics and techniques

Course Outcomes:

CO1	Implement soft computing models for a variety of tasks, including image classification, object detection, natural language processing, and speech recognition.
CO2	Apply deep learning algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	1	1	2	1	1	1	2
CO2	2	2	2	2	1	1	1	2	1	1	1	2

List of Experiments:

1. Create a perceptron with appropriate no. of inputs and outputs. Train it using fixed increment learning algorithm until no change in weights is required. Output the final weights.
2. Create a simple ADALINE network with appropriate no. of input and output nodes. Train it using delta learning rule until no change in weights is required. Output the final weights.
3. Implement multilayer perceptron algorithm for MNIST Hand written Digit Classification.
4. Design a neural network for classifying movie reviews (Binary Classification) using IMDB dataset.
5. Design a neural Network for classifying news wires (Multi class classification) using

Reuters dataset.

6. Design a neural network for predicting house prices using Boston Housing Price dataset.
7. Build a Convolution Neural Network for MNIST Hand written Digit Classification.
8. Build a Convolution Neural Network for simple image (dogs and Cats) Classification
9. Use a pre-trained convolution neural network (VGG16) for image classification.
10. Implement one hot encoding of words or characters.
11. Implement word embeddings for IMDB dataset.
12. Implement a Recurrent Neural Network for IMDB movie review classification problem.
13. Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform maxmin composition on any two fuzzy relations.
14. Solve Air Conditioner Controller using MATLAB Fuzzy logic toolbox
15. Implement TSP using GA.

Semester: 6th			
Paper code: IOT310T	**L**	**T/P**	**Credits**
Subject: Process Automation	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the Fundamental and basic principles of Robotics Process Automation, Applications in various Industries.
2.	To install the UiPath Studio and understand difference between different versions
3.	To use different activities while using excel sheet and automate email related activities.
4.	To understand benefits of given industrial automation systems, describe their functions and compare characteristics of given automation systems.

Course Outcomes:

CO1	Able to Map and assess some of the business processes that are fit for automation.
CO2	Able to connect to UiPath Automation Cloud, download the installer, and set up their own attended automation environment and Build an automation using StudioX.
CO3	Able to effectively automate tasks involving use of Excel files, adapt the automation project to dynamic Excel ranges.
CO4	Able to apply and map real-time application of industrial automation

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	1	-	-	-	-	-	-
CO2	3	3	3	3	3	1	-	-	-	-	-	-
CO3	3	3	3	3	3	1	-	-	-	-	-	-
CO4	3	3	3	3	3	2	-	-	-	-	-	1

Course Overview: Process and Industrial Automation specialization offers comprehensive knowledge and professional-level skills focused on developing and deploying software robots. It starts with the basic concepts of Robotic Process Automation. In the present global scenario, industries are moving towards complete automation. Hence, this course is foundation of engineers who want to specialize in industrial and process automation field.

UNIT I: **[6]**

Introduction to process automation: Definition of automation, Socio economic impacts of automation, Types of Automation, Introduction to Robot Process Automation, How is Automation Driving the Digital Transformation? Role of Automation in Business; Build first automation process with UiPath StudioX.

UNIT-II: **[8]**

Automation using StudioX: computational concepts when building an automation project, Identify the tasks that are suitable for automation, break-down a task and document it in a Robot-Path. Introduction to file and folder automation,

Introduction to UI Automation: Introduction to UI automation, recording UI interactions, using the Object Repository, UI automation activities, extracting data from an application, using of different control flow activities and its use.

UNIT III: **[8]**

Error Handling: Use StudioX tools to validate and analyze automation projects for handling and troubleshooting errors, build automations using best practices that increase reusability and readability.

Email Automation: Use actions and resources related to email automation, create automation projects using StudioX email specific activities, create email content using both text and HTML options.

Excel Automation: Automate tasks involving use of Excel files such as usage of cell activities, range activities, pivot activities, chart activities and workbook activities.

UNIT IV: **[10]**

Introduction to Industrial Automation: Need and benefits of Industrial Automation, Automation Hierarchy, Basic components of Automation systems, description of each component, types of automation systems-flexible, fixed and programmable systems

The Future Automated Factory: Future Automated Factory, Human Workers in the Future Automated Factory, The social impact.

Text Books:

1. “Robotic Process Automation using UiPath StudioX: A Citizen Developer’s Guide to Hyperautomation” Javed, A., Sundrani, A., Malik, N. and Madison, S. (2021), Apress Publishing Limited
2. “Robotic Process Automation Projects: Build real-world RPA solutions using UiPath and Automation Anywhere” Mullakara, N. and Asokan, A.K. (2020), Packt Publishing Limited
3. “Industrial Automation and Process Control”, Stenerson, J. (2002) PHI Learning, New Delhi

Reference Books:

1. “The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems”, Taulli, T. (2020), Apress Publishing Limited

2. https://academy.uipath.com/learning-plans/rpa-citizen-developer-foundation
Gopal, M. (1993). Modern control system theory. New Age International.

Semester: 6th			
Paper code: IOT310P	**L**	**T/P**	**Credits**
Subject: Process Automation Lab	**0**	**2**	**1**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:	
1.	Gain a comprehensive understanding of the fundamentals and principles of Robotic Process Automation (RPA) using UiPath.
2.	Acquire hands-on experience in designing, developing, and deploying RPA solutions using UiPath Studio.
Course Outcomes:	
CO1	Develop the ability to identify and assess automation opportunities within business processes and effectively apply UiPath tools and techniques to automate them.
CO2	Demonstrate proficiency in designing, implementing, and maintaining automated workflows using UiPath, resulting in increased operational efficiency, reduced errors, and enhanced productivity in real-world scenarios.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	2	3	2	-	1	-	-	1	-
CO2	3	2	2	2	3	3	1	1	1	1	1	-

List of Experiments:

1. Introduction to Robot Process Automation (RPA) and UiPath:
   - Understanding the concept of RPA and its applications.
   - Implementing RPA using UiPath: Installation and exploring the user interface components.
2. UiPath Studio Essentials:
   - Mastering keyboard shortcuts in UiPath Studio.
   - Customizing keyboard shortcuts for efficient workflow.
3. Automation Projects in UiPath:
   - Working with automation projects in UiPath.

- Debugging and troubleshooting techniques for automation projects.

4. Visual Workflow Design:
   - Designing visual workflows for automation.
   - Creating intuitive and easy-to-understand automation processes.
5. Error Handling in UiPath:
   - Implementing error handling mechanisms in UiPath.
   - Handling exceptions and managing error scenarios effectively.
6. Email Automation:
   - Automating email-related tasks using UiPath.
   - Sending, receiving, and processing emails automatically.
7. PDF Automation:
   - Automating PDF-related tasks with UiPath.
   - Extracting data, filling forms, and manipulating PDF documents.
8. Excel Automation:
   - Automating Excel tasks using UiPath.
   - Data extraction, manipulation, and reporting in Excel.
9. Gmail Automation:
   - Automating Gmail tasks using UiPath.
   - Managing emails, attachments, and labels in Gmail automatically.
10. Real-Time Project Automation:
    - Applying UiPath skills to automate a real-time project.
    - Designing and implementing a complete automation solution using UiPath.

Semester: 6th			
Paper code: IOT312T	**L**	**T/P**	**Credits**
Subject: Mechatronics: Foundations and Applications	**3**	**0**	**3**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To analyze the elements required to integrate the entire mechatronic systems developments.
2.	To apply the optimization concepts mechatronics elements selection and process parameter optimization.
3.	To analyze the concepts of engineering system and dynamic response of the system.
4.	To realize the concepts of real time interfacing and data acquisition.

Course Outcomes:

CO1	Analyze the elements required to integrate the entire mechatronic systems developments.
CO2	Apply the optimization concepts mechatronics elements selection and process parameter optimization.
CO3	Analyse the concepts of engineering system and dynamic response of the mechatronic system.
CO4	Realize the concepts of real time interfacing and data acquisition.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	1	1	-	-	-	-	-	-
CO2	2	3	3	3	3	1	-	-	-	-	-	-
CO3	3	3	3	3	2	1	-	-	-	-	-	-
CO4	3	2	3	3	3	2	1	-	-	-	-	1

Course Overview:

The course introduces the various elements required to design and integrate the mechatronic systems and to acquire the modelling skills to capture the system dynamics of hybrid systems and to familiar the system identification techniques and to practice the design and assembly of mechanical system in software environment for integrating various system sub-elements. It also analyzes and evaluate the functions of systems models for integrating the virtual elements of mechatronics.

UNIT I: **[8]**

Introduction: Introduction to Mechatronics System, Elements of mechatronics system, mechatronics in manufacturing, product and design, Measurement Systems, Control System, comparison between traditional and mechatronics approach.

Applications of Mechatronics system: Mechatronic approach to design, motion control using dc motor, ac motor and servomotor, temperature control of hot/cold reservoir, Boat Auto pilot, Pick and place robots, high speed tilting train, automatic car park system, coin counter, engine management system, automated guided vehicle, autonomous mobile system, antilock brake system control, Auto-Focus Camera, Printer, Domestic Washing Machine, Optical Mark Reader, Bar Code Reader

UNIT-II: **[8]**

System Models: Mathematical models, Mechanical, Electrical, hydraulic and Thermal Systems, Modelling of dynamic systems.

Design of Mechatronics systems: Stages in designing mechatronics system, Traditional and Mechatronic design.

UNIT III: **[8]**

Mechanical Actuation System: Cams, Gear trains, Ratchet and Pawl, Belt and chain drives, Bearings.

Hydraulic and Pneumatic Actuation System: Introduction to Hydraulic and Pneumatic Systems, Directional Control valves, Flow control valves.

Electrical Actuation System: Electrical systems, Solid State Switches, Solenoids, D.C. motors, A.C. motors, Stepper motors.

UNIT IV: **[8]**

Programmable logic controllers: Programmable logic controllers (PLC) Structure, Input / Output Processing, principles of operation, PLC versus computer, Programming Languages, programming using Ladder Diagrams, Logic Functions, Latching, Sequencing, Timers, Internal Relays And Counters, Shift Registers, Master and Jump Controls, Jumps, Data Movement, Code Conversion, Data handling and manipulation, selecting a PLC.

Text Books:

1. W.Bolton, (2003) Mechatronics, Pearson education, second edition, fifth Indian Reprint.
2. Smaili, A., & Mrad, F. (2008). Mechatronics: Integrated technologies for intelligent machines. Oxford University Press.
3. Alciatore, D. G. (2007). Introduction to mechatronics and measurement systems. Tata McGraw-Hill Education.

Reference Books:

1. R.K Rajput, (2007) A textbook of mechatronics, S. Chand & Co.
2. D. A. Bradley, Dawson D., Buru N.C. and. Loader A.J, (1993) Mechatronics, Chapman and Hall.
3. Necsulescu, D. S. (2002). Mechatronics. Pearson College Division.
4. Kamm, L. J. (1995). Understanding electro-mechanical engineering: an introduction to mechatronics (Vol. 3). John Wiley & Sons.
5. Nitaigour Premchand Mahadik, (2003) Mechatronics, Tata McGraw-Hill publishing Company Ltd, 2003.

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY, EAST DELHI CAMPUS, SURAJMAL VIHAR-110092

Semester: 6th			
Paper code: IOT312P	**L**	**T/P**	**Credits**
Subject: Mechatronics: Foundations and Applications Lab	**0**	**2**	**1**
Marking Scheme			
1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			
Course Objectives:			
1	To apply a suitable sensor and image processing technique for Mechatronics systems		
2	To develop a model of pneumatic and hydraulic circuits by using simulation software		
Course Outcomes:			
CO1	Applying a suitable sensor and image processing technique for Mechatronics systems		
CO2	Developing a model of pneumatic and hydraulic circuits by using simulation software		

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	1	1	2	1	1	1	2
CO2	2	2	2	2	1	1	1	2	1	1	1	2

Lab Experiments:

1. Study and demonstration of mechatronics system and its components.
2. Demonstrate Data Logger device and analyse
3. Air Compressor with Storage Tank
4. Multi Flow Process Trainer with Computerized Data Logging System
5. DC Servo Motor with PID Controller
6. Study and Demonstration of PLC Hardware and Software.
7. Demonstrate different mechanical components and their working in the automation system.
8. Study of the following equipment:
    a) Flow Control Valves
    b) Directional Control Valves
    c) Pressure Control Valves

9. Circuits for reciprocating motion of a single acting and double acting pneumatic cylinders.
10. Circuits for speed control of a
11. (a) Single acting pneumatic cylinder.
    (b) Double acting Pneumatic cylinder.

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY, EAST DELHI CAMPUS, SURAJMAL VIHAR-110092

Semester: 6th			
Paper code: IOT314T	**L**	**T/P**	**Credits**
Subject: Big Data in IOT	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce the concept of big data and its types.
2.	To analyze different types of virtualizations to work with big data
3.	To apply different analytics in big data
4.	To familiarize the students with Hadoop ecosystem and its distribution

Course Outcomes:

CO1	Understand the concept of big data and its types.
CO2	Analyze different types of virtualizations to work with big data
CO3	Apply Map Reduce fundamentals and different analytics in big data
CO4	Design the Hadoop ecosystem and its distribution

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	2	1	-	-	2	-	-

Course Overview:

Big data analytics is a field of study that focuses on the use of various analytical and statistical methods to extract insights, patterns, and trends from large and complex data sets. The goal of this course is to help businesses and organizations make more informed decisions, improve operational efficiency, and identify new business opportunities.

UNIT I: **[8]**

Introduction to Big Data- The Evolution of Data Management, Defining Big Data, Understanding the Waves of Managing Data, building a Successful Big Data Management Architecture, Examining Big Data Types: Structured Data, Unstructured Data. Putting Big Data Together. Brief History of Distributed Computing, Basics of Distributed Computing for big data.

UNIT II: **[8]**

Exploring the Big Data Stack- Layer 0: Redundant Physical Infrastructure, Layer 1: Security Infrastructure, Layer 2: Operational Databases, Layer 3: Organizing Data Services and Tools, Layer 4: Analytical Data Warehouses. Big Data Analytics, Big Data Applications.

Virtualization: Basics of Virtualization, Server virtualization, Application virtualization, Network virtualization, Processor and memory virtualization, Data and storage virtualization, Managing Virtualization with the Hypervisor, Implementing Virtualization to Work with Big Data.

UNIT III: **[8]**

Analytics and Big Data- Basic analytics, Advanced analytics, Operationalized analytics, Monetizing analytics, Text Analytics and Big Data, Social media analytics, Text Analytics Tools for Big Data, Attensity, Clarabridge, OpenText.

MapReduce Fundamentals- Understanding the map function, Adding the reduce function.

Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.

UNIT IV: **[8]**

Exploring Hadoop- Hadoop & its Features, Hadoop Ecosystem, Hadoop 2.x Core Components, Hadoop Storage: Understanding the Hadoop Distributed File System, Hadoop Processing: MapReduce Framework, Different Hadoop Distributions. Pig: Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators.

HDFS (Hadoop Distributed File System): The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.

Textbooks:

1. Judith S. Hurwitz, Alan F. Nugent, Fern Halper, Marcia A. Kaufman, “Big Data For Dummies”, John Wiley & Sons, Inc.(2013)

2. Robert D. Schneider, “Hadoop For Dummies”, John Wiley & Sons, Inc. (2012).
3. Tom White “Hadoop: The Definitive Guide” Third Edit on, O’reily Media, 2012.
4. Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Reference Books:

1. Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGraw Hill (2012).
2. Nathan Marz, James Warren, “Big Data: Principles and best practices of scalable realtime data systems”, Manning Publications (2015)
3. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, “Learning Spark: Lightning-Fast Big Data Analysis”, O. Reilly Media, Inc. (2015).

Semester: 6th			
Paper code: IOT314P	**L**	**T/P**	**Credits**
Subject: Big Data in IOT Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To analyse and implement different frame work tools by taking sample data sets.
2	To illustrate and implement the concepts by taking an application problem.

Course Outcomes:

CO1	Analyse the Big Data using Map-reduce programming in Hadoop framework.
CO2	Apply concepts of big data analytics to conduct experiments, as well as to analyze and interpret big data.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	1	1	2	1	1	1	2
CO2	2	2	2	2	1	1	1	2	1	1	1	2

List of Experiments:

1. Install Apache Hadoop.
2. Develop a map reduce program to calculate the frequency of a given word in a given file.
3. Develop a map reduce program to find the maximum temperature in each year.
4. Develop a map reduce program to find the grade of students.
5. Develop a map reduce program to implement matrix multiplication.
6. Develop a map reduce program to find the maximum electrical consumption in each year given electrical consumption for each month in each year.
7. Develop a map reduce program to analyze weather data set and print whether the day is shiny or cool day.
8. Develop a map reduce program to find the tags associated with each movie by analyzing movie lens data.
9. Develop a map reduce program to analyze Uber data set to find the days on which each

basement has more trips using the following data set. The uber data set consists of four columns they are:

Dispatching, base, no. date active, vehicle trips.

10. Develop a map reduce program to analyze titanic dataset to find the average age of the people (both male and female) who died in the tragedy. How many people survived in each class.
11. Develop a program to calculate the maximum recorded temperature year wise for the weather data set in Pig Latin.
12. Write queries to sort and aggregate the data in a table using HiveQL.

Semester: 6th			
Paper code: IOT316T	**L**	**T/P**	**Credits**
Subject: Cyber Physical Systems and Industry 4.0	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the need for Cyber Physical Systems (CPS) and foundations and components of CPS
2.	To analyze the role of Data Analytics in CPS
3.	To understand architecture and functioning of CPS
4.	To understand the different case studies of CPS and use experiential learning to create digital twins.

Course Outcomes:

CO1	Explain the components of Cyber Physical Systems (CPS) and Industry 4.0.
CO2	Apply the trends and best practices for developing and deploying industry 4.0 solutions.
CO3	Analyze the integration of AI, ML and IOT to CPS.
CO4	Design and develop a digital twin.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	2	1	-	-	2	-	-

Course Overview:

The course Cyber Physical Systems and Industry 4.0 is all about the integration of cyber-physical systems in and outside of organization. This course covers the foundations and characteristics of CPS with respect to fourth industrial revolution. CPS adoption by industries has also been covered in the course. Description of Digital Twin as digital representation of the physical object has also been given followed by various case studies such as Smart Manufacturing, Agriculture, Healthcare etc.

UNIT I **[10]**

Review: Internet of Things: Applications, Vulnerabilities and Need for Cyber Resilience, Fourth Industrial Revolution, Foundations of Cyber Physical Systems (CPS), Elements of Industry 4.0 Solution, Data Analytics and its Application in CPS.

UNIT II **[10]**

Mapping of Operational and Business Goal with Industry 4.0: Mapping of Operational and Business Goal with Industry 4.0, Challenges of Industrial CPS, Handling and Analyzing IoT Data-ML, AI, AR/VR, Architecture of Industrial CPS, Schematic Functioning of Industrial CPS, Complimenting Concepts & Technologies to Industrial CPS. Industrial CPS as Socio-Technical System.

UNIT III **[10]**

Cyber physical System Adoption and Application: Cyber physical System Adoption and Application, Value Creation based on Industrial CPS, Organization Integration and Strategic Alliances based on Industrial CPS. Case Studies: Moving from individual process to operation and supply chain management, Secure Data Aggregation Using Cyber Physical Systems for Environment Monitoring.

UNIT IV **[10]**

Manufacturing and CPS: Digital Connectivity and Sensors, Digital Engineering and Digital Operation, Digital Twins: Product, Manufacturing and Performance Twins, Developing a Digital Twin, Case Studies: Energy Management in Smart Grid, Medical Cyber Physical System Security, Agriculture and CPS, Smart Manufacturing.

Text Books:

1. D. Goyal, S. Balamurugan, K. Senthilnathan, I. Annapoorani, M. Israr, “Cyber-Physical Systems and Industry 4.0: Practical Applications and Security Management”, Feb 2022, CRC Press

Reference Papers:

1. https://blog.isa.org/cyber-physical-systems-the-core-of-industry-4.0
2. https://www.rinf.tech/digital-twin-development-why-when-and-how/

Semester: 6th			
Paper code: IOT318T	**L**	**T/P**	**Credits**
Subject: Green IoT and Sustainable Computing	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the good practices of sustainability.
2.	To design Green IT, sustainability solutions.
3.	To recognize the impact of IoT on environment
4.	To inculcate the ecological footprint of IT, and the issues of lifecycle, sustainability, life cycle assessment and code of conducts.

Course Outcomes:

CO1	Understand the good practices of sustainability.
CO2	Design Green IT, sustainability solutions.
CO3	Recognize the impact of IoT on environment
CO4	Inculcate the ecological footprint of IT, and the issues of lifecycle, sustainability, life cycle assessment and code of conducts.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	2	1	-	-	2	-	-

Course Overview:

Green IoT and Sustainable Computing is a course that explores the intersection of Internet of

Things (IoT) and sustainable practices. It focuses on designing and implementing energy-efficient IoT systems, minimizing environmental impact, and promoting sustainability in computing. Students will learn about green technologies, energy harvesting, renewable energy sources, and eco-friendly approaches to data storage and processing. The course also covers strategies for reducing e-waste and implementing sustainable computing practices in various industries.

UNIT I: **[10]**
Green IoT, Green IoT based Technologies: Identification, sensing, communication technologies, computation, services, semantic, life cycle of Green IoT, Impact of IoT on Healthcare, Impact of IoT on environment monitoring: agriculture, smog control, waste management, smart water, Impact of IoT on suburban sector. Impact of IoT on People and Goods Transportation: smart parking, Smart Traffic Congestion Detection, Smart Logistics/Shipment, Recycling

UNIT II: **[10]**
IoT and Energy Generation, Smart Metropolises, Smart Grid, Smart Buildings Structures, Difficulties of relation IoT: Energy Consumption in IoT, Synchronization of IoT with Subsystems, Client Privacy

UNIT III: **[10]**
Challenges and Opportunities for Green IoT, Architecture of Green IoT, Green Infrastructure, Green Spectrum Management, Green Communication, Green Security and Servicing Provisioning, Future of G-IoT, Green Radio-Frequency, Green Data Centers, green RFID Tags, cloud based smart parking system, smart traffic signal

UNIT IV: **[10]**
Green IoT and sustainability, ecological footprint of IT, and the issues of lifecycle, sustainability, life cycle assessment and code of conducts; energy measurement and other useful metrics for Green IoT, Usage of software tools and hardware to measure and estimate energy consumption; Sustainable software: Ecological design, applying good practices to write energy efficient software; energy footprint of data centers and cloud computing, standards and good practices for energy efficiency in servers

Text Books:

1. Green Internet of Things and Machine Learning, Roshani Raut, Sandeep Kautish, Zdzislaw Polkowski, Anil Kumar, Chuan-Ming Liu, John Wiley & Sons, 10-Jan-2022.
2. Green Computing: Tools and Techniques for Saving Energy, Money, and Resources, Bud E. Smith, Auerbach Publications

Reference Books:

1. Green Computing Approach Towards Sustainable Development, M Afshar, Sapna Jain, Hena Parveen, Dreamtech Press
2. The Age of AI: And Our Human Future (B PB) Paperback – Import, 4 August 2022 by Daniel Huttenlocher, III Schmidt, Eric, Henry A Kissinger

Semester: 6th			
Paper code: IOT320T	**L**	**T/P**	**Credits**
Subject: Smart Grid	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide an understanding of the basics concepts of conventional and smart grid
2.	To familiarize students with protection devices and sensors in the smart grid
3.	To introduce students with basics concepts of smart meters and their application for monitoring & protection
4.	To enable students to understand about the basics concepts of power quality management and computing in smart grid.

Course Outcomes:

CO1	Ability of students to understand the basics concepts of conventional and smart grid
CO2	Ability of students to understand, apply and analyze the protection devices and sensors in the smart grid
CO3	Ability of students to understand basics concepts of smart meters and their application for monitoring & protection
CO4	Ability of students to understand the basics concepts of power quality management and computing in smart grid

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	2	3	-	-	-	-	1	1	2
CO2	3	3	3	3	3	-	-	-	-	1	2	2
CO3	3	3	3	3	3	-	-	-	-	1	2	3
CO4	3	3	3	3	3	-	-	-	-	1	2	3

Course Overview:

This course offers a comprehensive understanding of smart grid systems and the role of sensors in enabling efficient energy management. Topics covered include sensor technologies, data acquisition, communication protocols, energy monitoring, grid optimization, and cybersecurity. Practical implementation and case studies are incorporated to develop skills in IoT-based smart grid design and management.

UNIT I **[8]**

Introduction to Smart Grid: Evolution of the electric grid, Concept, Definitions and need for smart grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International initiatives in smart grid.

UNIT II **[12]**

Smart Grid Protection Devices and Sensors: Protective Relays/sensors–Requirement of relays, Primary & backup protection, Desirable qualities of relays, classification of relays, Over Current, Over Voltage, Directional, Differential and Distance relays Impedance mho & reactance relay, Analog & digital relays. Circuit Breakers– An operation of Bulk oil and Minimum oil circuit breakers, Air circuit breaker, SF6 and vacuum circuit breakers, DC circuit breakers, HRC fuses, current limiting reactors & their design features, Testing of circuit breaker.

UNIT III **[10]**

Smart Meters and Advanced Metering Infrastructure: Introduction to SmartMeters, Advanced Metering Infrastructure (AMI) drivers and benefits, AMI protocols, standards, and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) and their application for monitoring & protection.

UNIT IV **[10]**

Power Quality Management and Computing in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of grid-connected renewable energy sources, Power quality conditioners for Smart Grid, Web-based power quality monitoring, Power quality audit. Local Area Networks (LAN), House Area Networks (HAN), Wide Area Networks (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD computing to make Smart Grids smarter, Cyber Security for Smart Grid.

Text Books:

1. Stuart Borlase “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley 2012

Reference Books:

1. VehbiC. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, “Smart Grid Technologies: Communication Technologies and Standards” IEEE Transactions on Industrial Informatics, Vol.7, No.4, November 2011
2. James Momohe “Smart Grid: Fundamentals of Design and Analysis,”, Wiley-IEEE Press, 2012

Open Area Elective subject Basket

6th Semester

AIDS/ AIML/ IIOT

Semester: 6th			
Paper code: OAE304T	**L**	**T/P**	**Credits**
Subject: Blockchain Technology	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To articulate the fundamentals of blockchain and able to explain cryptographic concepts underlying blockchain technology.
2.	To make use of wallet transactions, crypto tokens, analyse the block details and Ethereum blockchain transactions.
3.	To study smart contracts and to examine various types of Blockchain networks and consensus algorithms.
4.	To study and implement solidity.

Course Outcomes:

CO1	Study the concept of money, fundamentals of blockchain and to explain cryptographic concepts underlying blockchain technology.
CO2	Apply the central concept of the blockchain ecosystem and PoW, and to study the advanced concepts of Ethereum
CO3	Design and build smart contracts and examine various types of Blockchain networks and consensus algorithms
CO4	Apply the concept of Solidity (language used in Ethereum)

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

The widespread popularity of digital cryptocurrencies has led the foundation of Blockchain, which is fundamentally a public digital ledger to share information in a trustworthy and secure way. This course includes the fundamental design and architectural primitives of Blockchain, consensus protocols, types of the Blockchain system and the security aspects, methods to deploy smart contracts on different platforms, along with various use cases from different application domains in real life.

UNIT I **[8]**

Background leading blockchain, Shortcoming of current transaction system, The emergence of Blockchain, Bitcoin blockchain, Blockchain Architecture, Conceptualization, Blockchain components, Cryptocurrencies, Characteristics of cryptocurrencies, Alt coins, Crypto wallets, Creation of Blocks, Wallet Transactions, Transaction details in a Block, Merkle Tree, Hash functions, pseudo random numbers, public key cryptosystem, Generation of keys, Digital signatures.

UNIT II **[8]**

Blockchain types: Public Blockchain, Private Blockchain, Federated Blockchain, Ethereum blockchain, Go Ethereum, Gas, Gas price, Gas Limit, ETH, MetaMask, Public Test Networks, set up a Ethereum node using Geth, Mining in Blockchain, Double spending, Consensus algorithms: Proof of Work, Proof of Stake, Attacks on Bitcoin (Sybil Attacks, 51% Attack, etc.), Byzantine fault, Node failure.

UNIT III **[8]**

Byzantine General Problem: Byzantine General Problem, BFT (Byzantine fault tolerance), PBFT (Practical Byzantine fault tolerance), Delegated Proof of Stack, Paxos Consensus algorithm, Raft Algorithm, Solo Miner, Pool Miners, Deployment of Smart contracts in Blockchain, Remix, Compilation of smart contracts, Deployment environments, JavaScript Environment

UNIT IV **[8]**

Solidity: Data types in solidity, Operators, State variables, Global Variables, Local variables.
Solidity arrays, Solidity functions, Structs in solidity, Inheritance, Special variables, Solidity mapping, Function overloading, Personal Blockchain network, Ganache, Contract deployment to Ganache network, Modifiers in solidity, Events, Emerging applications of Blockchain.

Text Books:

1. Bettina Warburg, Bill Wanger and Tom Serres, Basics of Blockchain (1 ed.), Independently published, 2019. ISBN 978-1089919445.
2. Holbrook and Joseph, Architecting enterprise blockchain solutions (1 ed.), John Wiley & Sons, 2020. ISBN 978- 00000000.

3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.

Reference Books:

1. Bashir and Imran, Mastering blockchain: "Distributed ledger technology, decentralization, and smart contracts explained (1 ed.), Packt Publishing Ltd, 2018. ISBN 978- 11111111.
2. Andreas M. Antonopoulos. 2017. Mastering Bitcoin: Unlocking Digital Crypto-Currencies (2nd. ed.). O'Reilly Media, Inc.

Semester: 6th			
Paper code: OAE304P	**L**	**T/P**	**Credits**
Subject: Blockchain Technology Lab	**0**	**2**	**1**
Marking Scheme			
Teachers Continuous Evaluation: As per university examination norms from time to time End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:	
1	To study Remix, how to design and build smart contracts on various platforms
2	To understand the concept of Solidity (language used in Ethereum)
3	To study installation of Ganache suit and deploy various applications of Blockchain
4	Perform and defend blockchain analysis of realworld systems and present relevant findings and arguments in a structured, logical and compelling manner.
Course Outcomes:	
CO1	To work with Remix, design and build smart contracts
CO2	To make use of Solidity, work with ethers and study about Metamask

Course Outcomes (CO) to Programme Outcomes (PO) Mapping
(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	3	3	-	1	-	1	-	-	2
CO2	2	2	-	3	3	-	-	-	-	-	1	1

List of Experiments:
1. Study and implementation of hash functions and digital signatures
2. Conversion of Byte Code to Op-Code using etherscan.io
3. Deployment of Solidity Smart Contracts and Viewing Transaction Status on etherscan
4. Working with Remix IDE and Execution of Solidity Code
5. Execution of Smart Contracts on Goerli Testnet after getting Test ETHERS from Faucet
6. Creating a New Cryptocurrency and Importing in Metamask
7. Transferring new cryptocurrency to other accounts
8. Installation of Ganache Suite and Deployment of Smart Contracts on Ganache
9. Using Web3 GUI to interface Ganache and importing methods of smart contracts
10. Study of Metaverse and NFT in Blockchain

11. Setup of Testnets and Integration with Metamask.

Semester: 6th			
Paper code: OAE306T	**L**	**T/P**	**Credits**
Subject: Human Computer Interaction	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To learn basics concepts of Human Computer Interaction.
2.	To design the features of an interactive system- usability from the human perspective.
3.	To develop various HCI models and techniques.
4.	To apply different data gathering and analysis techniques.

Course Outcomes:

CO1	Apply core theories, models and framework from the field of HCI
CO2	Gather, Analyze and Interpret the data
CO3	Design, Develop and Evaluate user interface
CO4	Create Interactive Prototypes

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	-	-	-	-	1	1	1	1	-	-	1
CO2	1	3	-	2	-	1	1	1	1	-	-	1
CO3	1	-	3	-	1	1	1	1	1	1	1	1
CO4	1	2	3	2	2	1	1	1	1	1	1	1

Prerequisites: Critical Reasoning and Problem solving, Web designing

Course Overview:

This course will focus on how we can design human-centered systems that people find useful and usable. This course provides an introduction to designing, prototyping, and evaluating user interfaces. It will involve understanding the foundation elements of human computer interaction, understanding the design process and various design issues, performing contextual inquiry and task analysis, using sketching and prototyping tools, fundamentals of visual design, usability engineering, usability evaluation.

UNIT I **[10]**

Introduction to basic concepts of Human Computer Interaction: Understanding Design Issues, User Needs and User Experience (UX), Process of Interaction Design, Usability goals, User Experience Goals, Principles of Usability Design Conceptualizing Interaction, Conceptual Models, Framework, Cognitive models, Interaction Types, Paradigm for Interaction.

UNIT II **[10]**

Understanding Stakeholder Requirements: Social Interaction, Understanding Stakeholder Requirements, Emotional Interactions, Cognitive Models, Design Principles, Design frameworks, Design processes

UNIT III **[10]**

Natural User Interface (UI): Interface Types, Natural User Interface (UI), Data Gathering Issues, Data Recording, Interviews, Questionnaires, Observation, Choosing and Combining Data Gathering Techniques. Quantitative and Qualitative Data Analysis, Tools to support Data Analysis, Interpret and Presenting the Finding Approaches for collecting and analyzing data, Visualizing and Exploring Data, Ethical Design Concerns.

UNIT IV: **[10]**

Introduction to Design Requirements: Introduction to Design Requirements, Establish Requirements, Data Gathering for Requirements, Task Analysis, Task Decomposition, Comparison between Task Analysis Techniques, Prototyping, Tools for Interaction Designs, Evaluation Techniques, Usability Testing, Create Interactive Prototypes using proto.io, Case Studies on Usability and User experience.

Text Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, ―Human Computer Interaction‖, 3rd Edition, Pearson Education, 2004.
2. H. Sharp, Y. Rogers and J. Preece – Interaction Design Beyond Human-Computer Interaction, 3rd Edition, John Wiley & Sons.

Reference Books:

1. J. M. Caroll (ed.), HCI Models, Theories and Frameworks: Towards a Multidisciplinary Science (Interactive Technologies), Morgan Kauffman 2003.
2. C. Stephanidis (ed.), User Interface for All: Concepts, Methods and Tools, Lawrence Erlbaum Associates, 2001.
3. B. Shneiderman, Designing the User Interface, Addison Wesely,2000.

4. S. Bhattacharya, Human-Computer Interaction, MC Graw Hill India, 2019.

Semester: 6th			
Paper code: OAE308T	**L**	**T/P**	**Credits**
Subject: Quantum Computing	**4**	**0**	**4**
Marking Scheme			
Teachers Continuous Evaluation: As per university examination norms from time to time **End term Theory Examination: As per university examination norms from time to time**			
INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms			

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To enable the students to understand the quantum computing and quantum information in depth.
2.	To analyze quantum algorithms and compare effectiveness versus classical algorithm
3.	To impart knowledge about the quantum-mechanical phenomena such as superposition and entanglement to perform computation
4.	To apply elementary operations to develop more sophisticated applications of quantum computing.

Course Outcomes:

CO1	Analyse the behavior of basic quantum algorithms.
CO2	Implement simple quantum algorithms and information channels in the quantum circuit model.
CO3	Simulate a simple quantum error-correcting code.
CO4	Gain insights into quantum security.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	-	1	-	-	-	-	1	-
CO2	2	1	2	1	3	1	-	1	1	1	1	1
CO3	2	1	2	1	-	1	-	1	-	1	1	-
CO4	2	1	2	1	2	2	1	1	1	1	1	1

Course Overview:
The course will help students not only in specialising in the existing and changing technologies but also in various fields of R&D and electronic manufacturing. Since Quantum computers can solve computational problems faster than classical computers, Quantum Computing will help you surge ahead in your career. Quantum Computing course will help you solve problems above a specific size and complexity.

UNIT I: [10]
Introduction to Quantum Measurements: Introduction to Quantum Mechanics and Quantum Computing, Applications and Future of Quantum computing, Quantum Gates and Circuits. Optical approaches to Quantum Computing. Limits of approaches

UNIT II: [10]
Quantum Basics and Principles: No cloning theorem & Quantum Teleportation, Bell's inequality and its implications, Quantum Algorithms & Circuits. Quantum Measurements Density Matrices, Fragility of quantum information: Decoherence, Quantum Superposition, and Entanglement

UNIT III: [10]
Algorithms: Deutsch and Deutsch–Jozsa algorithms, Grover's Search Algorithm, Quantum Fourier Transform, Shore's Factorization Algorithm. Quantum Computing Models: NMR Quantum Computing, Spintronics, Linear Optical MODEL, Nonlinear

UNIT IV: [10]
Performance, Security and Scalability: Performance, Security and Scalability, Quantum Error Correction: Fault tolerance; Quantum Cryptography, Implementing Quantum Computing: issues of fidelity; Scalability in quantum computing.

Text Books:
1. Eric R. Johnston, Nic Harrigan, Mercedes and Gimeno-Segovia "Programming Quantum Computers: Essential Algorithms and Code Samples, SHROFF/ O'Reilly.
2. V.K Sahni, Quantum Computing (with CD), TATA McGraw-Hill.

Reference Books:
1. Chris Bernhardt, Quantum Computing for Everyone (The MIT Press).
2. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information", Cambridge (2002).
3. Riley Tipton Perry, "Quantum Computing from the Ground Up", World Scientific Publishing Ltd (2012).
4. Scott Aaronson, "Quantum Computing since Democritus", Cambridge (2013).
5. P. Kok, B. Lovett, "Introduction to Optical Quantum Information Processing", Cambridge.

Semester: 6th			
Paper code: OAE310T	**L**	**T/P**	**Credits**
Subject: Cryptography and Network Security	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To understand the fundamentals of cryptography
2.	To acquire knowledge on standard algorithms used to provide confidentiality. Integrity and authenticity
3.	To analyze concepts, issues, principles of security related properties and validate using model checking
4.	To apply knowledge of a range of computer security technologies as well as Design techniques to achieve differential privacy for linear queries

Course Outcomes:

CO1	Understand the knowledge about security services, data privacy and mechanisms.
CO2	Analyse about Symmetrical and Asymmetrical cryptography.
CO3	Analyse and Understand about the concept of Data integrity, Authentication, Digital Signatures.
CO4	Investigate Various network security applications and Design mechanisms for query release problem using online learning algorithms.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	2	1	-	-	2	-	-

Course Overview:

Cryptography and Network Security is a comprehensive course covering the fundamentals of secure communication and information protection in computer networks. Students will explore encryption techniques, cryptographic algorithms, and protocols used to ensure confidentiality, integrity, and authentication. The course also delves into network security concepts such as firewalls, intrusion detection systems, and secure network design. Practical applications and case studies are included to enhance understanding of securing data transmission, securing network infrastructure, and addressing emerging security challenges.

UNIT - I **[12]**

Security Concepts: Introduction, The need for security and Data Privacy, Security approaches, Principles of security, Types of Security attacks, Security services and mechanisms, A model for Network Security, Social Aspects of Privacy, Legal Aspects of Privacy and Privacy Regulations, Database Security, Statistical Database security, Inference Control, Hippocratic databases.

Cryptography Concepts and Techniques: Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, steganography, key range and key size, possible types of attacks.

UNIT - II **[8]**

Symmetric key Ciphers: Block Cipher principles, DES, AES, RC5, IDEA, Block cipher operation, Stream ciphers, RC4.

Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Elgamal Cryptography, Diffie-Hellman Key Exchange.

UNIT-III **[10]**

Cryptographic Hash Functions: Message Authentication, Secure Hash Algorithm (SHA-512), Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures, Elgamal Digital Signature Scheme.

Key Management and Distribution: Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos, X.509 Authentication Service, Public – Key Infrastructure

UNIT-IV **[10]**

Anonymization: Linkage and re-identification attacks, k-anonymity, l-diversity, t-closeness, implementing anonymization, Anonymizing complex data, Privacy and anonymity in mobile environments, Database as a service, Privacy in Cloud infrastructure

Differential Privacy (DP): Formalism and interpretation of DP, Fundamental DP mechanisms and properties, Interactive and non-interactive DP, DP for complex data Local Differential Privacy (LDP)

Text Books:

1. Cryptography and Network Security - Principles and Practice: William Stallings, Pearson Education, 6th Edition
2. Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition
3. C. Dwork and A. Roth, The Algorithmic Foundations of Differential Privacy, now Publishers, 2014.

Reference Books:

1. Cryptography and Network Security: C K Shyamala, N Harini, Dr T R Padmanabhan, Wiley India, 1st Edition.
2. Cryptography and Network Security: Forouzan Mukhopadhyay, Mc Graw Hill, 3rd Edition
3. Information Security, Principles, and Practice: Mark Stamp, Wiley India.
4. Charu C. Aggarwal, Privacy-Preserving Data Mining: Models and Algorithms, 1st Edition, Springer, 2008.

Semester: 6th			
Paper code: OAE312T	**L**	**T/P**	**Credits**
Subject: Mobile Application Development	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Understand the fundamentals of mobile application development, including the different platforms, frameworks, and tools available.
2.	Apply programming languages and technologies commonly used in mobile app development, such as Java/Kotlin for Android and Swift/Objective-C for iOS.
3.	Implement mobile app features like user authentication, social media integration, push notifications, and location-based services.
4.	Develop skills in integrating APIs and web services into mobile applications to enable data retrieval and real-time functionality.

Course Outcomes:

CO1	Understand the fundamentals of mobile application development, including the different platforms, frameworks, and tools available.
CO2	Analyze emerging trends and technologies in the field of mobile application development.
CO3	Implement core functionalities in mobile applications, such as data storage, network communication, and integration with external services.
CO4	Design and develop mobile applications for specific platforms (Android or iOS) using appropriate programming languages and frameworks.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

The Mobile Application Development course provides comprehensive knowledge and practical skills required to design, develop, and deploy mobile applications for various platforms, such as Android and iOS. This course covers the entire mobile app development lifecycle, including user interface design, programming languages, frameworks, data storage, integration with web services, testing, and deployment.

UNIT – I **[8]**

Introduction to Android: The Android Platform, Android SDK, Eclipse Installation, Android Installation, Building you First Android application, Understanding Anatomy of Android Application, Android Manifest file.

UNIT – II **[8]**

Android Application Design Essentials: Anatomy of an Android applications, Android terminologies, Application Context, Activities, Services, Intents, Receiving and Broadcasting Intents, Android Manifest File and its common settings, Using Intent Filter, Permissions.

UNIT – III **[8]**

Android User Interface Design Essentials: User Interface Screen elements, Designing User Interfaces with Layouts, Drawing and Working with Animation.

UNIT – IV **[8]**

Testing Android applications, Publishing Android application, Using Android preferences, Managing Application resources in a hierarchy, working with different types of resources.
Using Common Android APIs: Using Android Data and Storage APIs, managing data using Sqlite, Sharing Data between Applications with Content Providers, Using Android Networking APIs, Using Android Web APIs, Using Android Telephony APIs, Deploying Android Application to the World.

Text Books:

1. Lauren Darcey and Shane Conder, "Android Wireless Application Development", Pearson Education, 2nd ed. (2011)

Reference Books:

1. Reto Meier, "Professional Android 2 Application Development", Wiley India Pvt Ltd
2. Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd
3. Android Application Development All in one for Dummies by Barry Burd, Edition: I

Semester: 6th			
Paper code: OAE312P	**L**	**T/P**	**Credits**
Subject: Mobile Application Development Lab	**0**	**2**	**1**

Marking Scheme

Teachers Continuous Evaluation: As per university examination norms from time to time
End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	To provide hands-on experience in designing, developing, and testing mobile applications for various platforms.
2	To apply the concepts and techniques learned in the theoretical aspects of mobile application development and gain proficiency in mobile app development tools and technologies.

Course Outcomes:

CO1	Integrate mobile applications with web services and APIs to enhance functionality and access remote data.
CO2	Design and develop mobile applications that demonstrate efficient data storage and retrieval using various techniques, such as local storage, databases, and cloud storage

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	3	3	-	1	-	1	-	-	2
CO2	2	2	-	3	3	-	-	-	-	-	1	1

List of Experiments:

1. Design a simple user interface for a mobile application using a design tool or framework like Sketch, Adobe XD, or Flutter.
2. Hello World Application: Create a basic "Hello World" application for a mobile platform of your choice (Android or iOS) using the respective development environment.

3. Implement data storage functionality in your mobile application using local storage options like SQLite database or shared preferences.
4. Develop a mobile application that interacts with a RESTful API to fetch and display data from a remote server.
5. Integrate sensors such as accelerometer, gyroscope, or GPS into your mobile application to capture and utilize sensor data.
6. Add multimedia functionality to your mobile application, such as capturing photos/videos, playing audio files, or integrating with social media sharing.
7. Implement user authentication and authorization features in your mobile application, allowing users to register, log in, and access personalized content.
8. Incorporate push notifications into your mobile application, enabling the delivery of real-time alerts or messages to users.
9. Develop a mobile application that utilizes location services to provide location-based information, such as finding nearby places or tracking user movements.
10. Mobile App Testing and Debugging: Learn and apply various testing techniques, including unit testing, integration testing, and debugging, to ensure the quality and stability of your mobile application.

Semester: 6th			
Paper code: OAE314T	**L**	**T/P**	**Credits**
Subject: Virtual and Augmented Reality	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Understand how the design of VR technology relates to human perception and cognition
2.	Discuss applications of VR to the conduct of scientific research, training, and industrial design
3.	Learn the fundamental aspects of designing and implementing rigorous empirical experiments using VR.
4.	Learn about multimodal virtual displays for conveying and presenting information and techniques for evaluating good and bad virtual interfaces.

Course Outcomes:

CO1	Understanding the fundamental concepts and technologies of AR and VR.
CO2	Designing and developing AR and VR applications using appropriate software and hardware.
CO3	Analyzing and evaluating the usability and effectiveness of AR and VR applications.
CO4	Applying AR and VR to solve real-world problems in different fields such as education, Healthcare, entertainment, and training.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	3	3	-	-	-	-	-
CO2	3	3	3	3	3	3	2	-	-	-	-	-
CO3	3	3	3	3	3	3	3	-	-	-	-	-
CO4	3	3	3	3	3	3	3	-	-	-	-	-

Course Overview:
The aim of the course is to provide students with the necessary skills and knowledge to understand, design, develop, and apply AR and VR technologies in various fields. This Course aims to introduce students to the fundamental concepts and technologies of AR and VR, including the hardware and software used to create and experience these immersive environments.

UNIT I **[10]**
Introduction of Virtual Reality: Fundamental Concept and Components of Virtual Reality - Primary Features and Present Development on Virtual Reality - Multiple Models of Input and Output Interface in Virtual Reality: Input - Tracker - Sensor - Digital Glove - Movement Capture - Video-based Input - 3D Menus & 3DScanner – Output - Visual /Auditory / Haptic Devices.

UNIT II **[10]**
Visual Computation in Virtual Reality: Fundamentals of Computer Graphics - Software and Hardware Technology on Stereoscopic Display - Advanced Techniques in CG: Management of Large-Scale Environments & Real Time Rendering.

UNIT III **[10]**
Interactive Techniques in Virtual Reality: Body Track - Hand Gesture - 3D Manus - Object Grasp. Development Tools and Frameworks in Virtual Reality: Frameworks of Software Development Tools in VR. X3D Standard; Vega - MultiGen - Virtools.

Application of VR in Digital Entertainment: VR Technology in Film & TV Production - VR Technology in Physical Exercises and Games - Demonstration of Digital Entertainment by VR.

UNIT IV **[10]**
Augmented and Mixed Reality: Taxonomy - technology and features of augmented reality - difference between AR and VR - Challenges with AR - AR systems and functionality - Augmented reality methods - visualization techniques for augmented reality - wireless displays in educational augmented reality applications - mobile projection interfaces - marker-less tracking for augmented reality - enhancing interactivity in AR environments - evaluating AR systems.

Text Books:
1. Burdea, G. C., P. Coffet., “Virtual Reality Technology”, Second Edition, Wiley-IEEE Press, 2003/2006.
2. Alan B. Craig, “Understanding Augmented Reality, Concepts and Applications”, Morgan Kaufmann, 2013.

Reference Books:
1. Alan Craig, William Sherman, Jeffrey Will, “Developing Virtual Reality Applications, Foundations of Effective Design”, Morgan Kaufmann, 2009.

Semester: 6th			
Paper code: OAE316T	**L**	**T/P**	**Credits**
Subject: Cloud Computing	**3**	**0**	**3**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	This course introduces about the cloud environment.
2.	Building software systems and components that scale to millions of users in modern internet.
3.	Cloud concepts capabilities across the various cloud service models including IaaS, PaaS, SaaS, and developing cloud based software applications on top of cloud platforms.
4.	This course also introduces about the data intensive computing and studies about different cloud applications.

Course Outcomes:

CO1	Understands the basic concepts and terminologies in cloud computing, parallel and distributed computing
CO2	Demonstrate the knowledge in virtualization and different technology examples of virtualization
CO3	Understands the cloud computing architecture and how to build Aneka clouds.
CO4	Able to design data intensive applications using Map-Reduce programming.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	1	1	-	-	2	-	-
CO2	3	3	3	3	3	-	-	-	-	2	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	-
CO4	3	3	3	2	3	2	1	-	-	2	-	-

Course Overview:
This course explains various cloud computing and virtualization concepts and goes on to discuss the popular cloud providers.

UNIT I **[6]**
Introduction: Cloud Computing at a Glance, Historical Developments, Building Cloud Computing Environments, Computing Platforms and Technologies.
Principles of Parallel and Distributed Computing: Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel Computing, Elements of Distributed Computing, Technologies for Distributed Computing

UNIT II **[8]**
Virtualization: Introduction, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples.
Cloud Computing Architecture: Introduction, Cloud Reference Model, Types of Clouds, Economics of the Cloud, Open Challenges

UNIT III **[10]**
Cloud Application Platform: Anatomy of the Aneka Container, Building Aneka Clouds, Cloud Programming and Management High-Throughput Computing: Task Programming: Task Computing, Task-based Application Models, Aneka Task-Based Programming.
Data Intensive Computing: Map-Reduce Programming: What is Data-Intensive Computing? Technologies for Data-Intensive Computing.

UNIT IV **[8]**
Cloud Applications: Scientific Applications, Healthcare: ECG Analysis in the Cloud, Biology: Protein Structure Prediction, Biology: Gene Expression Data Analysis for Cancer Diagnosis, Business and Consumer Applications, Multiplayer Online Gaming.
Advanced Topics in Cloud Computing: Energy Efficiency in Clouds, Market Based Management of Clouds

Text/Reference Books:
1. Mastering Cloud Computing: by Rajkumar Buyya, Christian Vecchiola and S. Thamarai Selvi, McGraw Hill Education.
2. Cloud Computing: by Rajkumar Buyya, TMH

Semester: 6th			
Paper code: OAE316P	**L**	**T/P**	**Credits**
Subject: Cloud Computing Lab	**0**	**2**	**1**
Marking Scheme			

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To demonstrate the use of virtualization and cloud computing
2.	Understanding of virtualization technologies such as hypervisors, virtual machines, and containers used in cloud computing.

Course Outcomes:

CO1	Deploy and manage virtual machines and containers on a cloud platform.
CO2	Configure and manage cloud storage, network, and security services.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	-	-	-	-	1	-	-
CO2	2	2	2	2	1	1	1	-	1	1	1	2

List of Experiments:

1. Install virtualbox/vmware workstation 45 5 install a c compiler in the virtual machine and execute a sample program
2. Create type 2 virtualization in vmware. Allocate memory and storage space as per requirement. Install guest os on that vmware.
3. Adding a new virtual disk to a virtual machine. Convert basic disc to dynamic disc and vice versa
   a. Shrink and extend virtual disk
   b. Create, manage, configure and schedule snapshots
   c. Create spanned, mirrored and striped volume
   d. Create raid 5 volume

4. Sharing and data transfer between the virtual machines
5. Create type 2 virtualization on esxi 6.5 server
6. Create a vlan in cisco packet tracer
7. Create a vpn from one virtual machine to another virtual and pass data secure way
8. Find procedure to set up the one node hadoop cluster
9. Simulate a cloud scenario using cloudsim and run a scheduling algorithm that is not present in cloudsim.
10. Data analytics in the cloud: Perform data analytics and processing in a cloud environment using services such as AWS EMR, Google Cloud Dataproc, or Azure Hdinsight.
11. Implement cloud security controls such as encryption, access management, and network security using cloud-native services.

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Semester: 6th			
Paper code: OAE318T	**L**	**T/P**	**Credits**
Subject: Software Project Management	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide an understanding of fundamental concepts of software project management and explain the differences between software projects and other types of projects.
2.	To familiarize students with project selection criteria and identify project scope, objectives, infrastructure, products, and activities.
3.	To introduce students develop skills in activity planning, network diagramming, and critical path analysis to create project schedules and identify the critical path.
4.	To understand the nature of resources, identify resource requirements, and use visual tools and tracking mechanisms to monitor project progress..

Course Outcomes:

CO1	Understand the principles and practices of software project management, including project planning, estimation, scheduling, risk management, team collaboration, and quality assurance.
CO2	Apply various techniques for project estimation, evaluation, and cost-benefit analysis to make informed decisions in software project management.
CO3	Develop skills in activity planning, including sequencing and scheduling activities using network planning models such as CPM, Bar Charts, Gantt Chart, and PERT.
CO4	Gain knowledge and techniques for resource allocation, monitoring, and control to effectively manage project progress, track milestones, and ensure efficient resource utilization.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	1	1	1	1
CO2	3	3	3	3	2	-	-	-	1	2	1	2
CO3	3	3	3	3	2	-	-	-	1	1	1	1
CO4	3	3	3	3	3	-	-	-	1	1	1	1

Course Overview:

This course focuses on principles and practices for effectively managing software development projects. Topics covered include project planning, estimation, scheduling, risk management, team collaboration, and quality assurance. Students will gain practical knowledge in managing software projects through case studies and hands-on exercises.

UNIT I [10]

Introduction to Software Project Management (SPM): Definition of a Software Project (SP), SP Vs. other types of projects activities covered by SPM, categorizing SPs, project as a system, management control.

Software Project scheduling and planning: Basic concepts, project scheduling, defining a task set and task network, scheduling, earned value analysis indicators, Project elements, WBS [Work Breakdown Structure]. Selecting a project, identifying project scope and objectives, identifying project infrastructure, analyzing project characteristics, identifying project products and activities

UNIT II [10]

Project Estimation and Evaluation: software project estimation, decomposition techniques,empirical estimation models, estimation for object oriented projects, estimation for Agile development and Web engineering projects. Cost benefit analysis, cash flow forecasting, cost

benefit evaluation techniques, risk evaluation. Selection of an appropriate project report; choice of process model, structured methods, rapid application development, water fall, spiral models, Prototyping delivery, Albrecht function point analysis.

UNIT III [10]

Activity planning: Objectives of activity planning, project schedule, projects and activities, sequencing and scheduling activities, Network planning model; Network Diagrams : CPM, Bar Charts, Gantt Chart , PERT [Activity-on-arrow network; Activity on Node network Precedence network; Forward pass; Backward pass; Critical path.

Risk Analysis and Management: Risk and risk types, Risk Break down Structure, Risk management process, Evaluating schedule risk using PERT.

UNIT IV [10]

Resource allocation & Monitoring the control: Introduction, the nature of resources, identifying resource requirements, visualizing progress, Project Tracking, Status Reports, Milestone Analysis, Actual Versus Estimated Analysis of Effort and Schedule.

Software quality and project closure: Defining software quality attributes, ISO 9126, Software quality measures, Project Closure Analysis, The Role of Closure Analysis, Performing Closure Analysis.

Text Books:

1. Software Project Management (2nd Edition), by Bob Hughes and Mike Cottrell, 1999, TMH
2. Software Project Management, Walker Royce, 1998, Addison Wesley.

Reference Books:

1. R. S. Pressman, Software Engineering, TMH, 7th ed.
2. Pankaj Jalote, Software project management in practice, Addison-Wesley
3. Robert T. Futrell, Donald F. Shafer, and Linda I. Shafer, “Quality Software Project Management”, 2002, Pearson Education Asia.
4. Ramesh Gopalaswamy, “Managing Global Software Projects”, 2003, Tata McGraw-Hill
5. S. A. Kelkar, “Software Project Management”

Semester: 6th			
Paper code: OAE320T	**L**	**T/P**	**Credits**
Subject: Nature Inspired Algorithm	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide an understanding of bio sensors and the principles of nature-inspired computing.
2.	To familiarize students with evolutionary algorithms and their application in nature-inspired computing
3.	To introduce students to swarm intelligence and its application in nature-inspired computing
4.	To explore non-swarm intelligence bio-inspired algorithms and their applications in nature-inspired computing.

Course Outcomes:

CO1	Students will be able to explain the concepts of bio sensors and apply nature-inspired computing techniques to solve computational problems.
CO2	Students will be able to design and implement evolutionary algorithms for solving optimization problems
CO3	Students will be able to apply swarm intelligence algorithms to solve optimization problems
CO4	Students will be able to design and implement bio-inspired algorithms for solving optimization problems.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	3	3	-	-	-	3	-	-	2
CO2	2	2	3	3	3	-	2	-	3	-	-	-
CO3	2	2	3	3	3	3	2	-	-	-	-	2
CO4	3	3	3	3	3	3	2	-	-	-	-	3

Course Overview:

The Course focuses on introducing the principles and applications of computational algorithms that are inspired by natural processes and phenomena. These algorithms draw inspiration from biological systems, physical processes, and social interactions in nature to solve complex optimization, decision-making, and prediction problems

Unit I **[10]**

Introduction to Bio Sensors and Nature-Inspired Computing Techniques: Introduction to bio sensors, Principles of nature-inspired computing, Applications of nature-inspired computing techniques, Bio-inspired algorithms overview, Introduction to optimization problems, Optimization techniques inspired by natural systems.

Unit II **[10]**

Evolutionary Algorithms based Nature-Inspired Algorithms: Introduction to evolutionary algorithms, Genetic algorithm, Evolutionary strategies, Differential evolution, Multi-objective optimization using evolutionary algorithms

Unit III **[10]**

Swarm Intelligence based Nature-Inspired Algorithms: Introduction to swarm intelligence, Particle swarm optimization, Ant colony optimization, Artificial bee colony algorithms, Firefly algorithms, Applications of swarm intelligence algorithms

Unit IV **[10]**

Bio-inspired (Non-Swarm Intelligence) Nature-Inspired Algorithms: Artificial immune systems Neural networks and Neurocomputing, Memetic algorithms, Immune-inspired algorithms, Applications of non-swarm intelligence bio-inspired algorithms

Human Activities or Scientific Laws based Nature-Inspired Algorithms: Introduction to nature-inspired algorithms based on human activities or scientific laws. Applications of nature-inspired algorithms based on human activities or scientific laws.

Text Books :

1. "Nature-Inspired Optimization Algorithms" by Xin-She Yang
2. "Introduction to Bio-inspired Computing" by Bernadette Murgue
3. Swarm Intelligence: From Natural to Artificial Systems" by Eric Bonabeau, Marco Dorigo, and Guy Theraulaz

Reference Books:

1. "Bio-Inspired Computation in Telecommunications" by Xin-She Yang and Richard Everson
2. "Nature-Inspired Computing: Algorithms, Applications, and Emerging Applications" by Khaled F. Hussain, Abdulrahman H. Altalhi, and Adel A. M. S. Abdelaziz

Semester: 6th			
Paper code: OAE320P	**L**	**T/P**	**Credits**
Subject: Nature Inspired Algorithms Lab	**0**	**2**	**1**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1	Develop basic knowledge of Nature Inspired Computing Techniques and their working principle.
2	Generate the possible ways of solution to a certain real world problem using Nature Inspired Computing Techniques

Course Outcomes:

CO1	Design and modify different Nature Inspired algorithms in terms of Initialization, Processing and Stopping Criteria
CO2	Apply Nature Inspired algorithms to different set of practical problems.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	2	2	2	2		-	1	-	-	2
CO2	3	3	3	3	3	2		-	2	-	-	2

List of Experiments:

1. Programs based on Concept of Optimization
2. Programs based on Concept of Meta heuristics
3. Implementing reproduction techniques such as crossover and mutation.
4. Programs showing Implementation of GA
5. Programs using Problem solving approach of GA
6. Programs showing Implementation of ACO algorithm
7. Programs using Problem solving approach of ACO algorithm
8. Programs showing Implementation of PSO algorithm

9. Programs using Problem solving approach of PSO algorithm
10. Programs showing Implementation of Honey-bee algorithm
11. Programs using Problem solving approach of Honey-bee algorithm
12. Programs showing Implementation of Bat algorithm
13. Programs using Problem solving approach of Bat algorithm
14. Programs showing Implementation of Harmony Search
15. Programs using Problem solving approach of Harmony Search
16. Implementing basic DNA computing algorithms such as Adleman's experiment and test tube programming language.

Semester: 6th			
Paper code: OAE322T	**L**	**T/P**	**Credits**
Subject: Introduction to Robotics	**4**	**0**	**4**

Marking Scheme

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Ability of students to implement the mechanisms of robot along with its grippers. Furthermore to understand kinematics of robot using DH representation
2.	Ability of students to utilize the differential motion and velocities of robot using jacobian.
3.	Ability of students to use the dynamic analysis of forces using Lagrangian and Newtonian method.
4.	Ability of students to implement the online and offline programming of robots.

Course Outcomes:

CO1	Student will be able to implement the mechanisms of robot along with its grippers and understand kinematics of robot using DH representation
CO2	Student will be able to utilize the differential motion and velocities of robot using jacobian.
CO3	Student will be able to use the dynamic analysis of forces using Lagrangian and Newtonian method.
CO4	Student will be able to implement the online and offline programming of robots

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	2	2	3	3	2	1	-	1	3	1	2
CO2	3	3	3	3	3	1	1	-	2	3	1	2
CO3	3	3	3	3	3	1	1	-	3	3	2	3
CO4	3	3	3	3	3	3	2	-	3	3	2	3

Course Overview:
This course provides an overview of robot mechanisms, dynamics, and intelligent controls. Topics include planar and spatial kinematics, and motion planning; mechanism design for manipulators and mobile robots, multi-rigid-body dynamics, 3D graphic simulation; control design, actuators, and sensors; wireless networking, task modeling, human-machine interface, and embedded software.

UNIT I **[10]**
Fundamentals of Robot Technology: Robot definition, automation and robotics, Robot anatomy, Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission
End effectors: Mechanical and other types of grippers, Tools as end effectors, Robot and effector interface, Gripper selection and design.
Sensors and actuators used in robotics: Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots

UNIT II **[10]**
Kinematics of Robots: Transformation Matrices, Inverse transformation matrices, Forward and Inverse kinematic equation for position and orientation, Denavit-Hartenberg representation of robot, inverse kinematic solution for articulated robot, Numericals.
Differential Motions and velocities: Jacobian, Differential motions of a frame, Differential motion between frames, Calculation of the Jacobian, Inverse Jacobian, Numericals.

UNIT III **[10]**
Dynamic analysis of Force: Lagrangian and Newtonian mechanics, Dynamic equations form multiple –DOF Robots, Static force analysis of Robots, Transformation of forces and moments between coordinate frames, Numericals.
Trajectory Planning: Basics of Trajectory planning, Joint space trajectory planning, Cartesian Space trajectories, Numericals.

UNIT IV **[10]**
Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.
Off-line programming systems: Introduction, central issues in on-line and offline programming, Programming examples.
Application of robots: Typical applications of robots in material transfer, machine loading/unloading; processing operations; assembly and inspection.

Text Books:
1. Saha, S. K. (2014). *Introduction to robotics*. Tata McGraw-Hill Education.
2. Mittal, R. K., & Nagrath, I. J. (2003). *Robotics and control*. Tata McGraw-Hill.
3. Fu, K. S., Gonzalez, R., & Lee, C. G. (1987). *Robotics: Control Sensing. Vis*. Tata McGraw-Hill

Education.
4. Niku, S. B. (2001). *Introduction to robotics: analysis, systems, applications* (Vol. 7). New Jersey: Prentice hall.

Reference Books:

1. Spong, M. W., & Vidyasagar, M. (2008). *Robot dynamics and control*. John Wiley & Sons.
2. Choset, H., Lynch, K. M., Hutchinson, S., Kantor, G. A., & Burgard, W. (2005). *Principles of robot motion: theory, algorithms, and implementations*. MIT press.
3. Bhaumik, A. (2018). *From AI to robotics: mobile, social, and sentient robots*. CR Press

DETAILED SYLLABUS
(FOURTH YEAR)

for

BACHELOR OF TECHNOLOGY

for

ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

INDUSTRIAL INTERNET OF THINGS

under the aegis of University School of Automation and Robotics offered at Affiliated Institutions of the University

from A.S. 2021-22 onwards

University School of Automation and Robotics

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY,
EAST DELHI CAMPUS, SURAJMAL VIHAR-110092

Semester: 7th			
Paper code: AIDS401/AIML401/IOT401	**L**	**T/P**	**Credits**
Subject: Principles of Management for Engineers	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce students to the principles and functions of management in engineering environments.
2.	To develop the skills and knowledge required for effective decision-making in engineering contexts.
3.	To understand the dynamics of organizational behavior and its impact on engineering teams and projects.
4.	To equip students with project management skills for successful execution of engineering projects.

Course Outcomes:

CO1	Understand the fundamental principles of management, its evolution, and the roles of managers in engineering contexts.
CO2	Apply various decision-making models and techniques to solve engineering problems and make effective decisions.
CO3	Analyze individual and group behavior, motivation, leadership, and communication in engineering organizations.
CO4	Acquire project management skills and techniques to plan, execute, monitor, and control engineering projects effectively.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	-	2	2	2	-	1	-	-	-	1	1
CO3	-	-	2	2	2	-	1	-	-	-	1	1
CO4	1	1	3	2	2	1	1	1	1	1	1	1

Course Overview:
Principles of Management for Engineers is an essential course providing a comprehensive understanding of management principles, leadership, decision-making, and organizational behavior in engineering contexts.

Unit I **[8]**
Definition of management: Science or art, manager vs entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management.

Unit II **[8]**
Nature and purpose of Planning: types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes. Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management.

Unit III **[8]**
Organizational Behavior: Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.

Unit IV **[8]**
Controlling, system and process of controlling : Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Textbooks:
1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999

Detailed SYLLABUS
(4th Year)
Seventh Semester

for

BACHELOR OF TECHNOLOGY

for

Artificial Intelligence and Data Science

Applicable from Batch Admitted in Academic Session 2021-2022 Onwards

Semester: 7th			
Paper code: AIDS403T	**L**	**T/P**	**Credits**
Subject: Digital and Social Media Analytics	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Understand the fundamental concepts and principles of digital and social media analytics.
2.	Apply data analytics techniques to analyze and interpret digital and social media data.
3.	Develop skills in using tools and software for digital and social media analytics.
4.	Apply digital and social media analytics techniques to solve real-world business problems

Course Outcomes:

CO1	Apply data analytics techniques to analyze digital and social media data and derive meaningful insights.
CO2	Utilize digital and social media analytics tools and software effectively.
CO3	Design and implement digital and social media analytics strategies for business decision-making.
CO4	Communicate the results of digital and social media analytics effectively to stakeholders.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	2	-	-	1	-	-	-	-	1	-
CO2	2	1	2	1	3	1	-	1	1	1	1	1
CO3	2	1	2	1	-	1	-	1	-	1	1	-
CO4	2	1	2	1	2	2	1	1	1	1	1	1

Course Overview:

This course provides an in-depth understanding of digital and social media analytics, focusing on the application of data analytics techniques to analyze and derive insights from digital and social media data. Students will learn various concepts, tools, and methodologies used in digital and social media analytics and develop skills to apply these techniques to real-world scenarios.

Unit I **[8]**

Introduction to Digital and Social Media Analytics: Introduction to digital and social media analytics, Role and significance of digital and social media analytics in business, Types of data in digital and social media analytics, Ethical considerations in digital and social media analytics. Predictive Versus Descriptive: Predictive Analytics, Descriptive Analytics

Unit II **[8]**

Data Collection and Preprocessing for Digital and Social Media Analytics: Data collection methods for digital and social media analytics, Data preprocessing techniques for digital and social media data, Text mining and sentiment analysis in digital and social media analytics, Handling missing data and outliers in digital and social media analytics

Unit III **[8]**

Analyzing Digital and Social Media Data: Exploratory data analysis techniques for digital and social media data, Predictive modeling for digital and social media analytics, Social network analysis and community detection in social media data, Recommender systems in digital and social media analytics

Unit IV **[8]**

Applying Digital and Social Media Analytics: Marketing analytics using digital and social media data, Customer segmentation and targeting using digital and social media analytics, Brand monitoring and reputation management in social media, Case studies and practical applications of digital and social media analytics.

Textbooks:

1. "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media" by Matthew Ganis (2018).
2. "Digital Marketing Analytics: Making Sense of Consumer Data in a Digital World" by Chuck Hemann and Ken Burbary (2018).
3. "Data Mining for Business Analytics: Concepts, Techniques, and Applications with JMP Pro" by Galit Shmueli, Peter C. Bruce, Mia L. Stephens, and Nitin R. Patel (2020).

Reference Books:

1. "Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Instagram, GitHub, and More" by Matthew A. Russell and Mikhail Klassen (2019).
2. "Social Media Mining: An Introduction" by Reza Zafarani, Mohammad Ali Abbasi, and Huan Liu (2014).
3. "Web and Network Data Science: Modeling Techniques in Predictive Analytics" by Thomas W. Miller (2018).

Semester: 7th			
Paper code: AIDS403P	**L**	**T/P**	**Credits**
Subject: Digital and Social Media Analytics Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Gain hands-on experience in collecting, processing, and analyzing digital and social media data using appropriate tools and techniques.
2.	Apply analytical methods to derive meaningful insights and make data-driven decisions in the context of digital and social media analytics.

Course Outcomes:

CO1	Understand the principles and techniques of digital and social media analytics and their applications in real-world scenarios.
CO2	Develop proficiency in using relevant tools and technologies for analyzing and interpreting digital and social media data.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	1	-	1	-	1	1	-
CO2	2	2	2	2	3	2	1	1	1	1	1	1

<u>List of Experiments:</u>

1. To perform sentiment analysis on Twitter data using Python (libraries: Tweepy, NLTK, TextBlob) to understand the sentiment and opinion of users towards specific topics or brands.
2. To extract data from social media platforms using web scraping techniques in Python (libraries: BeautifulSoup, Selenium) for further analysis and insights.
3. To analyze the network structure and relationships within social media data using Gephi or Python (libraries: NetworkX) to identify key influencers, communities, and patterns of information flow.
4. To apply topic modeling techniques in Python (libraries: Gensim, LDA, LSA) to uncover latent topics and themes within online discussions on social media platforms.
5. To visualize and present social media data through interactive dashboards using tools like Tableau or Python (libraries: Matplotlib, Seaborn) to gain insights and facilitate data-driven

decision-making.

6. To identify influential users and opinion leaders in social media networks using Python (libraries: NetworkX, centrality measures) to understand their impact and reach.
7. To develop predictive models using Python (libraries: scikit-learn, XGBoost) to forecast and optimize social media engagement based on historical data and relevant features.
8. To classify and categorize social media posts using Python (libraries: NLTK, scikit-learn) to automatically assign labels or tags based on the content and context of the posts.
9. To analyze and optimize social media campaigns using Python (libraries: pandas, NumPy) by examining key metrics, identifying trends, and making data-driven recommendations for improved campaign performance.
10. To apply NLP techniques in Python (libraries: NLTK, spaCy) to extract insights, perform sentiment analysis, entity recognition, and other advanced text analysis tasks on social media data.

Semester: 7th			
Paper code: AIDS405T	**L**	**T/P**	**Credits**
Subject: Spatial Data Analysis	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Gain a comprehensive understanding of spatial data analysis theories and methodologies.
2.	Acquire proficiency in using GIS software and tools for spatial data visualization and analysis.
3.	Apply spatial data analysis techniques to address spatial problems and generate insights.
4.	Develop critical thinking and problem-solving skills in the context of spatial data analysis.

Course Outcomes:

CO1	Understand the fundamental concepts and techniques of spatial data analysis.
CO2	Develop skills in using GIS tools and software for spatial data visualization and analysis.
CO3	Apply spatial data analysis methods to solve real-world problems in various domains.
CO4	Demonstrate the ability to interpret and communicate spatial data analysis results effectively.

Course Outcomes (CO) to Programme Outcomes (PO)
Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	2	1	-	-	2	-	-	-
CO3	1	2	3	2	3	1	-	-	-	-	-	-
CO4	2	2	3	2	3	2	-	-	-	3	-	-

Course Overview:
This course provides an introduction to spatial data analysis, covering topics such as spatial data models, visualization techniques, clustering, interpolation, geostatistics, spatial regression, and GIS tools. Students will develop skills in analyzing and interpreting spatial data, with applications in environmental sciences, urban planning, epidemiology, and business.

Unit I **[8]**

Introduction to Spatial Data Analysis: Overview of spatial data and its characteristics, Introduction to spatial data models and formats, spatial data visualization techniques, spatial data preprocessing and cleaning.

Unit II **[8]**

Spatial Data Analysis Techniques: Spatial clustering and pattern analysis: Spatial interpolation and prediction methods, Geostatistics and spatial autocorrelation analysis, Spatial regression and modeling, Spatial data mining and machine learning algorithms

Unit III **[8]**

Spatial Data Visualization and GIS Tools: Geographic Information Systems (GIS) concepts and applications, Spatial data visualization using GIS software, GIS tools for spatial analysis and query, Web-based mapping and interactive visualization

Unit IV **[8]**

Applications of Spatial Data Analysis: Spatial data analysis in environmental sciences, Urban planning and transportation analysis, Spatial epidemiology and health-related studies, Spatial analysis in business and marketing

Textbooks:

1. "GIS Fundamentals: A First Text on Geographic Information Systems" by Paul Bolstad
2. "Spatial Data Analysis: Theory and Practice" by Robert Haining

Reference Books:

1. "Geospatial Analysis: A Comprehensive Guide" by Michael J. de Smith, Michael F. Goodchild, and Paul A. Longley
2. "Spatial Statistics and Geostatistics: Theory and Applications for Geographic Information Science and Technology" by Yongwan Chun and Daniel A. Griffith
3. "GIS and Spatial Analysis for the Social Sciences: Coding, Mapping, and Modeling" by Robert Nash Parker and Emily K. Asencio

Semester: 7th			
Paper code: AIDS405P	**L**	**T/P**	**Credits**
Subject: Spatial Data Analysis Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:	
1.	Develop proficiency in utilizing GIS software and spatial analysis tools for visualizing and analyzing spatial data.
2.	Apply spatial data analysis techniques and methodologies to solve complex spatial problems and derive meaningful insights from spatial datasets.

Course Outcomes:	
CO1	Understand the fundamental concepts and techniques of spatial data analysis through hands-on practical applications.
CO2	Develop skills in using GIS software and spatial analysis tools to analyze and interpret spatial data for real-world problems in various domains.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	1	-	-	2	1	-	-	2	-	-	-
CO2	1	2	3	2	3	1	-	-	-	-	-	-

List of Experiments:

1. To visualize spatial data using GIS software (ArcGIS or QGIS) to effectively represent and communicate spatial patterns and relationships.
2. To apply spatial clustering and hotspot analysis techniques using R (libraries: sp, spdep, cluster) to identify spatial clusters and hotspots of interest in the dataset.
3. To utilize Python (libraries: arcpy, GeoPandas) to perform spatial interpolation techniques for estimating values at unobserved locations based on the values of surrounding known locations.
4. To conduct geostatistical analysis and kriging using R (libraries: gstat, automap) to model and predict spatial phenomena based on statistical properties and spatial relationships.
5. To analyze and optimize network-based spatial data using ArcGIS Network Analyst or osmnx (Python) for efficient routing and analysis of transportation networks.

6. To perform spatial regression modeling using R (libraries: spdep, spreg) to explore the relationship between spatially referenced variables and predict outcomes based on spatial dependencies.
7. To create interactive web maps and visualizations using tools like Leaflet.js, Mapbox, or ArcGIS Online to effectively present and explore spatial data on web platforms.
8. To analyze point patterns and measure spatial autocorrelation using R (libraries: spatstat, spdep) to understand the spatial distribution and clustering of point features.
9. To apply spatial data mining techniques and machine learning algorithms using Python (libraries: scikit-learn, PySAL) for discovering patterns and making predictions in spatial datasets.
10. To assess the environmental impact of spatial phenomena using spatial analysis techniques in ArcGIS or QGIS, enabling effective decision-making and mitigation strategies.

Semester: 7th			
Paper code: AIDS407T	**L**	**T/P**	**Credits**
Subject: Data Visualization	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce students to the fundamental concepts and principles of data visualization.
2.	To develop practical skills in using popular data visualization libraries and tools.
3.	To enable students to create interactive and dynamic visualizations for effective data exploration and analysis.
4.	To explore advanced topics in data visualization, including multidimensional visualization, network visualization, and visualizing large datasets.

Course Outcomes:

CO1	Understand the principles and importance of data visualization in data analysis and decision-making processes.
CO2	Develop skills in using various data visualization tools and techniques to effectively present and communicate complex data.
CO3	Apply interactive visualization methods to explore and analyze data, enabling user interaction and exploration.
CO4	Gain knowledge of advanced data visualization techniques and their applications for visualizing complex and large datasets.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	2	2	2	2	2	3	2	3
CO2	1	2	3	2	3	2	1	2	2	3	2	3
CO3	1	2	3	2	3	2	1	2	2	3	2	3
CO4	1	2	2	2	3	2	1	2	2	3	2	3

Course Overview:
This course introduces students to the principles, techniques, and tools of data visualization. Students will learn to effectively present and communicate data using popular libraries and tools. Topics include exploratory data analysis, interactive visualization, advanced techniques, and visualizing complex and large datasets.

Unit I **[8]**
Introduction to Data Visualization: Importance and principles of data visualization, Data types and data visualization techniques, Exploratory data analysis and storytelling through data visualization

Unit II **[8]**
Data Visualization Tools and Techniques: Introduction to data visualization libraries and tools (e.g., Matplotlib, Seaborn, Tableau), Basic plotting techniques: line plots, bar plots, scatter plots, and histograms, Advanced visualization techniques: heatmaps, treemaps, parallel coordinates, and geospatial visualization

Unit III **[8]**
Interactive Data Visualization: Introduction to interactive visualization tools (e.g., D3.js, Plotly), Creating interactive plots and dashboards, Animation and dynamic visualization techniques

Unit IV **[8]**
Advanced Topics in Data Visualization: Multidimensional visualization: dimensionality reduction techniques (e.g., PCA, t-SNE), Network visualization and graph analysis, Visualizing large datasets: sampling, aggregation, and data reduction techniques

Textbooks:

1. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney
2. "Interactive Data Visualization for the Web: An Introduction to Designing with D3" by Scott Murray
3. "Data Visualization: A Practical Introduction" by Kieran Healy

Reference Books:

1. "The Visual Display of Quantitative Information" by Edward R. Tufte
2. "Storytelling with Data: A Data Visualization Guide for Business Professionals" by Cole Nussbaumer Knaflic
3. "Information Visualization: Perception for Design" by Colin Ware.

Semester: 7th			
Paper code: AIDS407P	**L**	**T/P**	**Credits**
Subject: Data Visualization Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:	
1.	To gain hands-on experience in using different data visualization tools and libraries.
2.	To apply appropriate data visualization techniques for different types of data and analysis tasks.

Course Outcomes:	
CO1	Understand the principles and importance of data visualization in data analysis and decision-making processes.
CO2	Develop skills in using various data visualization tools and techniques to effectively present and communicate complex data.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	1	2	3	2	3	2	1	2	2	3	2	3
CO2	1	2	3	2	3	2	1	2	2	3	2	3

List of Experiments:

1. To familiarize with the basic principles and concepts of data visualization using Matplotlib library in Python.
2. To create interactive and dynamic visualizations using Plotly library, emphasizing user interaction and exploration of data.
3. To introduce with geographic data visualization techniques using Folium library, allowing them to create maps and explore spatial patterns in data.
4. To develop an understanding of network visualization concepts and techniques using NetworkX library, enabling students to analyze and visualize complex network structures.
5. To provide skills to effectively visualize and analyze time series data using Seaborn library, focusing on identifying patterns and trends.
6. To explore the realm of 3D data visualization using Mayavi library, to visualize and interpret complex three-dimensional datasets.

7. Introduce students to visualizing large-scale datasets using Apache Spark, emphasizing the handling and visualization of big data for analysis and insights.
8. Enable students to design and create interactive dashboards using Tableau, emphasizing the effective communication of data-driven insights.
9. Familiarize students with D3.js library and its capabilities to create interactive and dynamic web-based visualizations, enhancing their skills in web-based data presentation.
10. Enable students to visualize machine learning models and their results using Python libraries like scikit-learn and matplotlib, enhancing their understanding of model performance and interpretation.

Semester: 7th			
Paper code: AIDS409T	**L**	**T/P**	**Credits**
Subject: Business Intelligence & Analytics	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Gain a comprehensive understanding of Business Intelligence and Analytics concepts, techniques, and tools.
2.	Develop skills to analyze and interpret data, perform statistical analysis, and visualize data effectively.
3.	Acquire knowledge of machine learning algorithms and their applications in business analytics.
4.	Stay updated with emerging trends and technologies in the field of Business Intelligence and Analytics.

Course Outcomes:

CO1	Understand the fundamental concepts of Business Intelligence and Analytics and their application in AI and Data Science.
CO2	Analyze and interpret data using various statistical techniques and develop actionable insights for business decision-making.
CO3	Apply machine learning algorithms for business analytics, including regression, classification, clustering, and recommendation systems.
CO4	Explore emerging trends in Business Intelligence and Analytics, such as Big Data Analytics, real-time analytics, and streaming data.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	-	-	-	-	-	-	2
CO2	3	3	3	3	3	-	-	-	-	-	-	3
CO3	3	3	3	3	3	-	-	-	-	-	1	2
CO4	3	3	3	3	3	-	-	-	-	-	2	3

Course Overview:
This course provides an in-depth understanding of Business Intelligence (BI) and Analytics concepts, techniques, and tools, with a focus on their application in the field of Artificial Intelligence (AI) and Data Science. Students will learn to analyze and interpret data, develop BI solutions, and apply analytics to make informed business decisions.

Unit I **[8]**
Introduction to Business Intelligence and Analytics: Introduction to Business Intelligence and Analytics, Data Warehousing and Data Mining, Data Extraction, Transformation, and Loading (ETL), Introduction to Analytics: Descriptive, Predictive, and Prescriptive Analytics.

Unit II **[8]**
Data Analysis and Visualization: Exploratory Data Analysis (EDA), Statistical Analysis for Business Intelligence, Data Visualization Techniques and Tools, Interactive Dashboards and Reports

Unit III **[8]**
Machine Learning for Business Analytics: Supervised and Unsupervised Learning Algorithms, Regression and Classification Models, Clustering Techniques for Customer Segmentation, Recommendation Systems

Unit IV **[8]**
Big Data Analytics and Emerging Trends: Introduction to Big Data Analytics, Hadoop and Map Reduce, Real-time Analytics and Streaming Data, Emerging Trends in Business Intelligence and Analytics

Textbooks:
1. "Business Intelligence: A Managerial Perspective on Analytics" by Ramesh Sharda, Dursun Delen, Efraim Turban
2. "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking" by Foster Provost, Tom Fawcett
3. "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney

Reference Books:
1. "The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling" by Ralph Kimball, Margy Ross
2. "Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die" by Eric Siegel
3. "Big Data Analytics: Methods and Applications" by Chang Liu, Quan Z. Sheng, Jian Yu, Yongrui Qin

Semester: 7th			
Paper code: AIDS409P	**L**	**T/P**	**Credits**
Subject: Business Intelligence and Analytics Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Understand the fundamental concepts and techniques of business intelligence and analytics.
2.	Gain hands-on experience in applying business intelligence and analytics methods to real-world datasets and interpret the results.

Course Outcomes:

CO1	Apply business intelligence and analytics techniques to solve real-world problems in various domains.
CO2	Develop skills in using tools and technologies for data cleaning, analysis, modeling, and visualization in the context of business intelligence and analytics.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	1	-	-	-	-	1	1	1
CO2	2	2	2	1	1	-	-	-	-	1	1	1

List of Experiments:

1. To provide students with hands-on experience in applying data cleaning and preprocessing techniques for business analytics.
2. To develop skills in exploring and analyzing data using exploratory data analysis methods for market research.
3. To understand and apply predictive modeling techniques, such as regression analysis, for business analytics.
4. To segment customers and perform cluster analysis to gain insights for targeted marketing strategies.
5. To forecast future sales using time series analysis and evaluate the accuracy of the predictions.

6. To mine association rules from transactional data for market basket analysis and cross-selling opportunities.
7. To analyze customer sentiment from text data and derive insights for improving products and services.
8. To build decision tree and random forest models for predicting customer churn and identify factors influencing it.
9. To implement recommender systems for personalized product recommendations based on user preferences.
10. To create interactive dashboards and reports using Power BI for effective communication and decision-making in business intelligence.

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Semester: 7th			
Paper code: AIDS411T	**L**	**T/P**	**Credits**
Subject: Advances in Data Science	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Gain a comprehensive understanding of deep learning architectures, training techniques, and advanced topics.
2.	Develop skills in NLP for text analysis, classification, and language modeling.
3.	Learn the principles and techniques of big data analytics, including distributed computing and scalable machine learning.
4.	Understand the ethical implications of data science and implement techniques for model interpretability, fairness, and privacy.

Course Outcomes:

CO1	Apply advanced techniques in deep learning and neural networks for solving complex data analysis problems.
CO2	Develop expertise in natural language processing (NLP) and apply it to text-based data for tasks such as sentiment analysis, named entity recognition, and language generation.
CO3	Analyze and process big data using distributed computing frameworks like Hadoop and Spark, and apply machine learning algorithms to large-scale datasets.
CO4	Understand the importance of explainable AI and ethical considerations in data science, and apply techniques to address model interpretability, bias, fairness, privacy, and security.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	1	2	-	3	-	-	1	-	-	-	-
CO2	2	2	2	3	-	-	-	-	1	-	-	-
CO3	2	-		2	3	-	1	-	-	1	-	-
CO4	2	2		3	3	-	-	-	-		1	2

Course Overview:
This course explores advanced topics in data science, including deep learning, natural language processing, big data analytics, and ethical considerations. Students will gain practical skills in applying these techniques to solve complex problems, analyze large-scale datasets, and address interpretability, fairness, privacy, and security in AI applications.

Unit I **[8]**
Deep Learning and Neural Networks: Introduction to deep learning, Neural network architectures: CNNs, RNNs, and Transformers, Training deep learning models, Transfer learning and fine-tuning, Advanced topics in deep learning: Generative models, GANs, and reinforcement learning.

Unit II **[8]**
Natural Language Processing (NLP): Basics of NLP: Tokenization, POS tagging, and parsing Text classification and sentiment analysis, Named Entity Recognition (NER) and entity linking, Word embedding's and language modeling, Neural machine translation and language generation.

Unit III **[8]**
Big Data Analytics: Introduction to big data analytics, Distributed computing and storage: Hadoop and Spark, Processing big data: MapReduce and Spark programming, Machine learning on big data: Scalable algorithms and frameworks, Stream processing and real-time analytics

Unit IV **[8]**
Explainable AI and Ethical Considerations: Interpretable machine learning models, Model explainability and feature importance, Bias, fairness, and accountability in AI, Privacy and security in data science, Ethical guidelines and responsible AI practices

Textbooks:

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
2. "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper
3. "Big Data: A Revolution That Will Transform How We Live, Work, and Think" by Viktor Mayer-Schönberger and Kenneth Cukier

Reference Books:

1. "Interpretable Machine Learning: A Guide for Making Black Box Models Explainable" by Christoph Molnar
2. "Fairness and Machine Learning: Limitations and Opportunities" edited by Solon Barocas, Moritz Hardt, and Arvind Narayanan
3. "Privacy and Big Data: The Players, Regulators, and Stakeholders" by Terence Craig and Mary Ludloff

Semester: 7th												
Paper code: AIDS411P									**L**	**T/P**	**Credits**	
Subject: Advances in Data Science Lab									**0**	**2**	**1**	
Marking Scheme: 1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time												
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms												
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.												
Course Objectives:												
1.	Gain hands-on experience in building and training deep learning models and applying them to various domains.											
2.	Understand the challenges and considerations in natural language processing tasks and analyze the performance of NLP algorithms.											
Course Outcomes:												
CO1	Develop practical skills in advanced data science techniques such as deep learning, NLP, and distributed computing for real-world applications.											
CO2	Analyze and interpret the behavior of complex machine learning models, address issues of fairness and bias, and apply privacy-preserving methods to ensure ethical data science practices											
Course Outcomes (CO) to Programme Outcomes (PO) Mapping (Scale 1: Low, 2: Medium, 3: High)												
CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. To implement and train deep learning models (e.g., CNN, RNN) on real-world datasets for various applications.
2. To perform text classification tasks using NLP techniques and compare different algorithms for accuracy and efficiency.
3. To process large-scale datasets using Spark's distributed computing capabilities and run machine learning algorithms on them.
4. To build and train GAN models for generating realistic images and evaluate the quality of the generated samples.
5. To implement and train sequence-to-sequence models for language translation tasks using attention mechanisms.

6. To apply various anomaly detection techniques on time series data and evaluate their effectiveness.
7. To assess and mitigate bias in machine learning models using fairness indicators and AIF360.
8. To interpret and explain the predictions of complex machine learning models using LIME and SHAP techniques.
9. To design and train reinforcement learning agents to play games and achieve high scores.
10. To apply differential privacy techniques to protect sensitive information while performing data analysis.

Semester: 7th			
Paper code: AIDS413T	**L**	**T/P**	**Credits**
Subject: Data Science for Complex Systems	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Understand the fundamental concepts and challenges of analyzing complex systems using data science techniques.
2.	Develop skills in applying network analysis to study complex system structures and identify key components.
3.	Apply time series analysis to analyze temporal data in complex systems and make predictions.
4.	Use simulation methods to model complex phenomena and evaluate system behavior under different scenarios.

Course Outcomes:

CO1	Analyze and model complex systems using network analysis, time series analysis, and simulation techniques.
CO2	Apply data science methodologies to make data-driven decisions and predictions in complex system contexts.
CO3	Utilize optimization and recommendation techniques for efficient resource allocation and personalized recommendations.
CO4	Interpret and visualize data from complex systems to gain insights into their behavior and dynamics.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	1	1	2	-	-	-	2	1	2	1
CO2	3	1	1	1	2	1	1	1	2	1	2	2
CO3	3	1	1	1	2	1	1	1	2	1	2	2
CO4	3	1	1	1	2	1	1	1	2	1	2	2

Course Overview:
This course introduces students to data science techniques for analyzing complex systems, such as social networks, IoT networks, and financial systems. Students will learn network analysis, time series analysis, and simulation methods to gain insights into complex system behavior and make data-driven decisions.

Unit I **[8]**
Introduction to Complex Systems and Network Analysis: Introduction to complex systems, characteristics, and challenges, Network theory and representation of complex systems as graphs, Network analysis metrics: centrality, connectivity, and community detection.

Unit II **[8]**
Time Series Analysis in Complex Systems: Time series data representation and pre-processing, Time series forecasting techniques: ARIMA, Exponential Smoothing, and LSTM, Detecting anomalies and patterns in time series data.

Unit III **[8]**
Simulation Methods for Complex Systems: Simulation modeling and techniques (e.g., Monte Carlo simulation, agent-based modeling), Analyzing epidemic spread, traffic flow, and other complex phenomena using simulations, Evaluating system behavior under different scenarios and parameter settings

Unit IV **[8]**
Data-Driven Decision Making in Complex Systems: Predictive modeling for decision-making in complex systems, Optimization techniques for resource allocation and scheduling, Recommender systems and their applications in personalized recommendations

Textbooks:
1. "Network Science" by Albert-Laszlo Barabasi
2. "Time Series Analysis and Its Applications: With R Examples" by Robert H. Shumway and David S. Stoffer
3. "Simulation Modeling and Analysis" by Averill M. Law and W. David Kelton

Reference Books:
1. "Complex Networks: Structure, Robustness, and Function" by Ernesto Estrada and Philip A. Knight
2. "Forecasting: Principles and Practice" by Rob J Hyndman and George Athanasopoulos
3. "Agent-Based and Individual-Based Modeling: A Practical Introduction" by Steven F. Railsback and Volker Grimm

Semester: 7th			
Paper code: AIDS413P	**L**	**T/P**	**Credits**
Subject: Data Science for Complex Systems Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Gain hands-on experience in analyzing and modeling complex systems using network analysis, time series analysis, and simulation techniques. Understand the challenges and approaches for handling big data in complex systems and apply machine learning algorithms for predictions and decision-making.
2.	Explore the application of data science techniques in interdisciplinary fields to address complex challenges in today's interconnected world.

Course Outcomes:

CO1	Develop practical skills in data science techniques for analyzing complex systems and understanding their behavior.
CO2	Apply data science methodologies to solve real-world problems in various domains, such as social networks, finance, and healthcare, and gain insights into complex system dynamics.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. To analyze and visualize social media data as a network to understand user interactions and identify key influencers.
2. To build predictive models using machine learning algorithms to forecast stock market prices and evaluate their performance.
3. To simulate the spread of an epidemic in complex networks and analyze the impact of different parameters on the spread.
4. To perform sentiment analysis on textual data (e.g., product reviews, tweets) and classify sentiments as positive, negative, or neutral.

5. To apply clustering algorithms to detect communities in networks and analyze their structure.
6. To analyze time series data from IoT sensors, perform forecasting, and identify patterns and anomalies.
7. To use optimization techniques to allocate resources efficiently in complex systems, such as workforce scheduling or supply chain management.
8. To build collaborative filtering-based recommender systems to suggest movies based on user preferences.
9. To apply anomaly detection algorithms on network traffic data and identify abnormal behavior indicative of cyber-attacks.
10. To simulate game theory scenarios and analyze decision-making strategies in complex systems.

Detailed SYLLABUS
(4^{th} Year)
Seventh Semester

for

BACHELOR OF TECHNOLOGY

for

Artificial Intelligence and Machine Learning

Applicable from Batch Admitted in Academic Session 2021-2022 Onwards

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY,
EAST DELHI CAMPUS,
SURAJMAL VIHAR-110092

Semester: 7th			
Paper code: AIML403T	**L**	**T/P**	**Credits**
Subject: Information Retrieval & Recommender Systems	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:	
1.	To introduce students to the principles and techniques of information retrieval and recommendation.
2.	To develop students' skills in designing and implementing search algorithms and query optimization methods.
3.	To enable students to build recommender systems using collaborative filtering and content-based filtering approaches.
4.	To familiarize students with advanced topics like web search, topic modeling, and context-aware recommendations.

Course Outcomes:	
CO1	Understand the underlying algorithms and techniques used in generating recommendations.
CO2	Analyze the challenges and considerations involved in designing and deploying these systems.
CO3	Analyze and evaluate the performance of different retrieval algorithms
CO4	Develop practical skills in implementing information retrieval and recommender system algorithms.

Course Outcomes (CO) to Programme Outcomes (PO)
Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	1	1		-	-	-	-	-	-	-	-	-
CO2	1	2	-	3	3	-	-	-	-	-	-	-
CO3	2	2	2	3	3	-	1	-	1	-	-	2
CO4	2	2	2	3	3	-	1	-	1	1	1	2

Course Overview:

This course provides an in-depth understanding of information retrieval techniques and recommender systems. Students will learn about search algorithms, indexing, query optimization, collaborative filtering, and content-based filtering to build efficient information retrieval and recommendation systems for various applications.

Unit I **[8]**

Introduction of Information Retrieval: Basic Concepts, Information need vs. Query, Modern Search Interface requirements, Information Retrieval System Architecture, Preprocessing techniques, Tokenizing, Indexing, Classic IR Models for unstructured data, Inverted Index, Vector Space Model, Best Match models, Probabilistic models Implementation of IR models, Structured IR models.

Unit II **[8]**

Information Retrieval Systems: Multimedia IR, Experimental Evaluation of IR Systems, Implicit and Explicit Relevance Feedback techniques, Document/Query Properties and Representations, Web Search and Link analysis algorithms.

Unit III **[8]**

Introduction to Recommender Systems: Eliciting Ratings and other Feedback Contributions, Implicit Ratings, Non-Personalized Recommenders Content-Based Recommenders, Collaborative Filtering- User-User Collaborative Filtering

Unit IV **[8]**

Taxonomy of Recommender Systems: Taxonomy, Evaluation Item Based Collaborative Filtering, Evaluation, Dimensionality Reduction, Advanced Topics: Matrix Factorization, Diversity and Accuracy trade-off, Factorizing Machines.

Textbooks:

1. "Information Retrieval: Algorithms and Heuristics" by Sourav S. Bhowmick and S. Borah
2. "Recommender Systems" by D. Sivakumar and K. Srinivasan

Reference Books:

1. "Information Retrieval: Concepts and Techniques" by S. K. Sarkar and Sudip Kumar Naskar
2. Donald Metzler, Trevor Strohman, and W. Bruce Croft, "Search Engines: Information Retrieval in Practice", Pearson Education, 2010.
3. Francesco Ricci , Lior Rokach , Bracha Shapira, 1. Francesco Ricci , Lior Rokach , Bracha Shapira, Springer 2011 edition

Semester: 7th			
Paper code: AIML403P	**L**	**T/P**	**Credits**
Subject: Information Retrieval & Recommender Systems Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Gain hands-on experience in implementing information retrieval algorithms and building recommender systems using relevant tools and libraries.
2.	Develop skills in evaluating the performance of information retrieval and recommender systems through appropriate metrics and techniques.

Course Outcomes:

CO1	Apply information retrieval techniques to retrieve relevant information from large text collections and build recommender systems to suggest relevant items to users.
CO2	Implement and evaluate different algorithms and models used in information retrieval and recommender systems to enhance the accuracy and effectiveness of search and recommendation processes.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	1	1	-	3	3	-				-	-	1
CO2	2	2	2	3	3	-	1	-	1	-	1	2

List of Experiments:

1. Compare the effectiveness of different retrieval models, such as vector space models, probabilistic models (e.g., Okapi BM25), and language models (e.g., Dirichlet smoothing).
2. Implement and evaluate a relevance feedback mechanism in an information retrieval system. (Use techniques like Rocchio's algorithm to incorporate user feedback and improve the retrieval results).
3. Implement and evaluate query expansion techniques, such as pseudo-relevance feedback or WordNet-based expansion, to improve retrieval effectiveness.
4. Build a recommender system using collaborative filtering or content-based filtering techniques. Evaluate the system's performance using metrics like accuracy, coverage, and

diversity. Compare the effectiveness of different recommendation algorithms.

5. Design and implement a hybrid recommender system that combines multiple recommendation techniques, such as collaborative filtering and content-based filtering.
6. Implement and evaluate personalized ranking algorithms for search engines or recommendation systems.
7. Build a recommender system that can provide recommendations in one domain (e.g., books) based on the user's behavior in a different domain (e.g., movies).
8. Implement and compare different diversity-aware recommendation algorithms. Evaluate the trade-off between accuracy and diversity in the recommendations.
9. Develop a recommender system that takes into account the temporal aspects of user preferences.
10. Build a recommendation system that leverages social connections. Implement algorithms that consider the social influence of users in generating recommendations.
11. Implement and evaluate query suggestion techniques for search engines.
12. Implement features like query reformulation, result diversification, or faceted search and evaluate their impact on user satisfaction and retrieval effectiveness.

Semester: 7th			
Paper code: AIML405T	**L**	**T/P**	**Credits**
Subject: Fuzzy systems: Theory and Applications	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Explain the fundamentals of fuzzy set theory and its relation to classical set theory.
2.	Implement fuzzy logic rules and perform fuzzy inference using different methods.
3.	Design and analyze fuzzy control systems for different applications.
4.	Apply fuzzy systems to solve practical problems in pattern recognition, time series analysis, and intelligent systems.

Course Outcomes:

CO1	Understand the principles of fuzzy set theory and its applications in modeling uncertainty.
CO2	Apply fuzzy reasoning and inference methods to solve real-world problems in various domains.
CO3	Design fuzzy control systems for dynamic and complex systems.
CO4	Explore the applications of fuzzy systems in data analysis, time series forecasting, and artificial intelligence.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

This course provides a comprehensive understanding of fuzzy systems, covering fuzzy set theory, fuzzy logic, fuzzy reasoning, and their applications in artificial intelligence and machine learning. Students will explore real-world use cases and learn to design fuzzy systems for solving complex problems in various domains.

UNIT I **[8]**

Classical and fuzzy sets: Introduction, Introduction to fuzzy logic and fuzzy sets, Fuzzy set operations and membership functions, Fuzzy rules and linguistic variables, Fuzzy reasoning and inference methods, Fuzzy systems architecture and components Operations and Properties, Fuzzy Relations: Cardinality, Operations and Properties, Equivalence and tolerance relation, Value assignment: cosine amplitude and max-min method

UNIT II **[8]**

Fuzzification: Membership value assignment- Inference, rank ordering, angular fuzzy sets, Defuzzification methods, Fuzzy measures, Fuzzy integrals, Fuzziness and fuzzy resolution; possibility theory and Fuzzy arithmetic; composition and inference; Considerations of fuzzy decision-making.

UNIT III **[8]**

Fuzzy Systems Design and Optimization: Fuzzy system structure and design approaches (e.g., Mamdani, Takagi-Sugeno), Fuzzy system identification and parameter estimation techniques, Fuzzy system rule base optimization and refinement, Fuzzy system performance evaluation and tuning, Fuzzy system integration with other computational methods, Fuzzy clustering and pattern recognition

UNIT IV **[8]**

Introduction of Neuro-Fuzzy Systems: Architecture of Neuro Fuzzy Networks., Fuzzy Logic in Databases, Information Retrieval with Fuzzy Logic, Fuzzy Intelligent Agents, Fuzzy Clusters, Fuzzy Hierarchical Control, Fuzzy Decision Trees

Textbooks:

1. "Fuzzy Sets and Applications: Selected Papers by L. A. Zadeh" by Lotfi A. Zadeh
2. "Fuzzy Logic with Engineering Applications" by T. J. Ross and S. Rajasekaran

Reference Books:

1. "Fuzzy Logic: Algorithms, Techniques and Implementations" by Elbert A. Walker
2. "Fuzzy Logic Techniques for Autonomous Vehicle Navigation" by Tuhin Subhra Das and Paramartha Dutta
3. "An Introduction to Fuzzy Logic Applications" by Rajjan Shinghal and G. S. Mahapatra

Semester: 7th			
Paper code: AIML405P	**L**	**T/P**	**Credits**
Subject: Fuzzy systems: Theory and Applications Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Explore the concepts and techniques of fuzzy logic and its role in AI and ML applications.
2.	Apply fuzzy systems to solve practical problems and analyze their performance in various domains.

Course Outcomes:

CO1	Understand the principles and applications of fuzzy systems in solving real-world problems.
CO2	Design and implement fuzzy logic solutions for decision-making, control, and optimization tasks.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	3	3	-	1	-	1	-	-	2
CO2	2	2	-	3	3	-	-	-	-	-	1	1

List of Experiments:

1) Implement and evaluate fuzzy set operations, such as union, intersection, complement, and difference.
2) Analyze different membership functions and fuzzy sets to observe the effects of these operations.
3) Experiment with various membership function shapes (e.g., triangular, trapezoidal, Gaussian)
4) Design and evaluate fuzzy rule bases for different applications. Experiment with the number of rules, antecedent membership functions, and consequent values to observe their impact on system behavior.
5) Compare and evaluate different fuzzy inference methods (e.g., Mamdani, Sugeno) in terms of accuracy, interpretability, and computational complexity.
6) Build fuzzy systems for specific applications, such as temperature control or speed regulation.

7) Develop fuzzy rules, design membership functions, and implement the inference mechanism. Evaluate the system's performance under different scenarios.
8) Optimize fuzzy systems by tuning membership function parameters, adjusting rule weights, or optimizing the rule base.
9) Implement fuzzy logic-based decision-making systems for complex scenarios, such as portfolio optimization or medical diagnosis.
10) Develop neuro-fuzzy systems by combining fuzzy logic with artificial neural networks. Train and optimize the network parameters using appropriate learning algorithms and compare their performance with traditional fuzzy systems.
11) Implement and evaluate fuzzy control systems for various applications, such as temperature control or speed regulation.
12) Apply fuzzy systems to real-world problems in different domains, such as engineering, finance, or healthcare. Develop fuzzy models and systems tailored to specific applications and evaluate their performance and effectiveness.

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY,
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Semester: 7th			
Paper code: AIML407T	**L**	**T/P**	**Credits**
Subject: Reinforcement Learning	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Explain the core concepts and components of reinforcement learning.
2.	Design and implement dynamic programming algorithms for solving RL problems.
3.	Apply TD learning and Q-learning techniques to train agents in different environments.
4.	Explore and analyze the state-of-the-art methods in RL for handling complex scenarios.

Course Outcomes:

CO1	Define reinforcement learning tasks and the core principals behind the RL, including policies, value functions, deriving Bellman equations
CO2	Apply reinforcement learning techniques to real-world problems and domains
CO3	Analyze fairness, bias, and responsible AI in the context of reinforcement learning applications.
CO4	Implement various reinforcement learning algorithms such as Q-learning, policy gradient methods, actor-critic methods, and deep reinforcement learning algorithms.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

This course introduces the fundamentals of reinforcement learning (RL), focusing on Markov Decision Processes (MDPs), dynamic programming, Monte Carlo methods, and Temporal Difference (TD) learning. Students will explore various RL algorithms and their applications, equipping them to design intelligent systems capable of making sequential decisions in complex environments.

UNIT I **[8]**

Foundation: Introduction and Basics of RL, Defining RL Framework and Markov Decision Process, Polices, Value Functions and Bellman Equations, Exploration vs. Exploitation, Code Standards and Libraries used in RL (Python/Keras/Tensorflow)

UNIT II **[8]**

Tabular methods and Q-networks: Planning through the use of Dynamic Programming and Monte Carlo, Temporal-Difference learning methods (TD(0), SARSA, Q-Learning), Deep Qnetworks (DQN, DDQN, Duelling DQN, Prioritised Experience Replay)

UNIT III **[8]**

Policy optimization: Introduction to policy-based methods, Vanilla Policy Gradient, Reinforce algorithm and stochastic policy search, Actor-critic methods (A2C, A3C), Advanced policy gradient (PPO, TRPO, DDPG) .

UNIT IV **[8]**

Recent Advances and Applications: Model based RL, Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Ethics in RL, Applying RL for real-world problems.

Text Books:

1. Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition.
2. Sutton, Richard S., and Andrew G. Barto. “Reinforcement learning: An introduction,” First Edition, MIT press.
3. Sugiyama, Masashi. “Statistical reinforcement learning: modern machine learning approaches,” First Edition, CRC Press.
4. Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van Otterlo, Eds

Reference Books:

1. Boris Belousov, Hany Abdulsamad, Pascal Klink, Simone Parisi, and Jan Peters “Reinforcement Learning Algorithms: Analysis and Applications,”First Edition, Springer
2. Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville.

Swyam/NPTEL:

https://onlinecourses.nptel.ac.in/noc20_cs74/preview

Semester: 7th			
Paper code: AIML407P	**L**	**T/P**	**Credits**
Subject: Reinforcement Learning Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Acquire hands-on experience in designing and implementing various reinforcement learning algorithms and approaches.
2.	Develop the skills to evaluate and analyze the performance of reinforcement learning agents in different environments.

Course Outcomes:

CO1	Apply reinforcement learning techniques to real-world problems and domains such as robotics, autonomous driving, game playing, or recommendation systems.
CO2	Implement various reinforcement learning algorithms such as Q-learning, policy gradient methods, actor-critic methods, and deep reinforcement learning algorithms.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	2	2	3	3	-	1	-	1	-	-	2
CO2	2	2	-	3	3	-	-	-	-	-	1	1

<u>List of Experiments:</u>

1. Write a program to train agents with different gamma values on a grid-world task and analyze their performance and convergence.
2. Write a program to compare the performance of different exploration strategies (e.g., epsilon-greedy, Boltzmann exploration, UCB) on a continuous control problem.
3. Write a program to perform hyperparameter tuning for a reinforcement learning algorithm, such as learning rate, exploration rate, or network architecture.
4. Experiment with different reward shaping functions in a navigation or maze-solving task.
5. Study the transferability of learned policies by training an agent on one environment and then evaluating its performance on a related but different environment.
6. Write a program to examine the exploration-exploitation trade-off by gradually changing the exploration strategy during training.

7. Compare the performance of different value function representations, such as tabular, tile coding, or radial basis functions, on a continuous control task.
8. Write a program to explore the influence of reward design on the agent's learning.
9. Study meta-reinforcement learning algorithms by training an agent on a set of related tasks with varying difficulties.
10. Write a program to apply reinforcement learning to a real-world problem, such as autonomous vehicle control, inventory management, or resource allocation. Design an RL agent and evaluate its performance in a simulated or controlled environment.

Semester: 7th			
Paper code: AIML409T	**L**	**T/P**	**Credits**
Subject: Predictive Business Analysis	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Understand the fundamentals of predictive business analysis and its applications in various industries.
2.	Acquire skills in data preprocessing, exploratory data analysis, and feature engineering for business insights.
3.	Master predictive modeling techniques and evaluation metrics for accurate business forecasting.
4.	Explore customer analytics, market sentiment analysis, and ethical considerations in business data usage.

Course Outcomes:

CO1	Apply statistical and machine learning techniques to analyze business data and predict trends for making informed decisions.
CO2	Implement predictive models, including regression, classification, and time series analysis, to solve real-world business problems.
CO3	Design and develop recommender systems and customer analytics solutions for personalized business recommendations.
CO4	Create data-driven business intelligence dashboards and reports to support strategic decision-making processes.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

This course introduces B.Tech AI and Machine Learning students to predictive business analysis, focusing on using data-driven approaches to make informed business decisions. Students will learn statistical and machine learning techniques to analyze business data, predict trends, and recommend strategies for organizational success.

UNIT I **[8]**

Introduction to Predictive Business Analytics: Overview, applications in various industries, predictive modeling, data preprocessing, and evaluation metrics, structured and unstructured data, data lifecycle, data quality and preprocessing, data manipulation and exploration

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

UNIT II **[8]**

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT III **[8]**

Organization Structures of Business analytics: Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, Predictive Analytics, Predicative Modelling, Predictive analytics analysis.

UNIT IV **[8]**

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables. Case studies: customer segmentation, churn prediction, fraud detection, and demand forecasting.

Text Books:

1. Business analytics Principles, Concepts, and Applications FT Press Analytics, Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, 1st Edition, 2014, ISBN-13: 978-0133989403, ISBN-10: 0133989402.

2. The Value of Business Analytics: Identifying the Path to Profitability, Evan Stubs , John Wiley & Sons, ISBN:9781118983881 |DOI:10.1002/9781118983881,1st Edition 2014

Reference Books:

1. Business Analytics, James Evans, Pearsons Education 2nd Edition, ISBN-13: 978-0321997821 ISBN10: 0321997824
2. Predictive Business Analytics Forward Looking Capabilities to Improve Business, Gary Cokins and Lawrence Maisel, Wiley; 1st Edition, 2013

Semester: 7th			
Paper code: AIML409P	**L**	**T/P**	**Credits**
Subject: Predictive Business Analysis Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To equip students with the necessary knowledge and skills to perform predictive analysis on business-related datasets.
2.	To enable students to apply machine learning algorithms and tools effectively for solving business prediction tasks.

Course Outcomes:

CO1	Gain practical expertise in applying predictive analysis techniques to solve real-world business problems.
CO2	Develop the ability to analyze and interpret business data, make data-driven decisions, and present actionable insights.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	1	-	-	-	-	1	1	1
CO2	2	2	2	1	1	-	-	-	-	1	1	1

List of Experiments:

1. Write a program to analysis of a business dataset to identify patterns, correlations, and trends. Visualize the data using techniques such as histograms, scatter plots, and box plots to gain insights into the data distribution and relationships between variables.
2. Build a regression model to predict a business metric, such as sales or customer churn, based on relevant features.
3. Write a program to apply different regression algorithms, such as linear regression, decision trees, or random forests, and compare their performance using evaluation metrics like Mean Squared Error (MSE) or R-squared.
4. Perform a classification analysis to predict a binary or multi-class business outcome, such as customer segmentation or product categorization. Experiment with classification algorithms like logistic regression, support vector machines (SVM), or decision trees.

Evaluate the models using metrics such as accuracy, precision, recall, and F1-score.

5. Write a program to apply time series forecasting techniques to predict future business trends or demand for a product or service.
6. Write a program to Investigate the impact of feature selection and engineering techniques on predictive modeling performance.
7. Write a program to experiment with different methods such as correlation analysis, stepwise regression, or Recursive Feature Elimination (RFE) to identify the most relevant features. Compare the performance of models with and without feature engineering.
8. Write a program to explore the effectiveness of ensemble methods, such as bagging, boosting, or stacking, in improving predictive performance.
9. Write a program to Analyze textual data, such as customer reviews or social media comments, to extract sentiment and gain insights into customer opinions. Apply techniques like Natural Language Processing (NLP), text preprocessing, and sentiment analysis algorithms to classify text into positive, negative, or neutral sentiments.
10. Write a program to analyze the resulting customer segments based on demographic, behavioral, or transactional characteristics to identify distinct customer groups and target them with tailored marketing strategies.
11. Write a program to design an A/B test to evaluate the impact of a business intervention or change on key metrics.
12. Simulate different business scenarios, such as pricing strategies, inventory optimization, or resource allocation, using predictive models.

Semester: 7th			
Paper code: AIML411T	**L**	**T/P**	**Credits**
Subject: Advances in Machine Learning	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Explore and comprehend advanced ML algorithms, their strengths, and weaknesses.
2.	Master techniques to interpret and explain ML model predictions for transparency and trust.
3.	Build and train deep learning models to address specific tasks and datasets.
4.	Apply the acquired knowledge to tackle real-world challenges in AI and ML domains.

Course Outcomes:

CO1	Analyze and apply advanced machine learning algorithms to solve complex real-world problems.
CO2	Evaluate and interpret ML models to understand their decision-making processes.
CO3	Implement deep learning architectures for tasks like image analysis, language processing, and sequence modeling.
CO4	Develop expertise in applying cutting-edge ML techniques to various AI applications and domains.

Course Outcomes (CO) to Programme Outcomes (PO)
Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	1	2	3	3	1	1	-	1	1	-	-	2
CO2	2	2	3	3	1	1	-	1	1	-	-	2
CO3	2	2	3	3	1	1	-	1	2	-	-	2
CO4	2	2	3	3	2	1	1	1	2	-	-	2

Course Overview:
This course explores advanced topics in machine learning for B.Tech AI and ML students. It covers recent developments in algorithms, model interpretability, deep learning architectures, and applications. Students gain hands-on experience with cutting-edge ML tools and frameworks.

Unit I **[8]**

Advanced ML Algorithms: Ensemble Learning and Ensemble methods: Bagging, Boosting, and Stacking, and Kernel Methods.

Reinforcement Learning: Q Learning, HMM model, Deep Reinforcement Learning

Unit II **[8]**

Model Interpretability and Explainability: Feature importance and SHAP values, LIME (Local Interpretable Model-agnostic Explanations), Explainable AI (XAI) techniques,

Unit III **[8]**

Deep Learning Architectures: Convolutional Neural Networks (CNN) for image analysis, Recurrent Neural Networks (RNN) for sequence data, Transformers and Attention mechanisms

Unit IV **[8]**

Applications of Advanced ML: Natural Language Processing (NLP) with BERT and GPT, Generative Adversarial Networks (GANs) for image synthesis, Transfer learning and domain adaptation

Textbooks:

1. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
2. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
3. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

Reference Books:

1. "Interpretable Machine Learning" by Christoph Molnar
2. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto
3. "Natural Language Processing in Action" by Lane, Howard, and Hapke

Semester: 7th			
Paper code: AIML411P	**L**	**T/P**	**Credits**
Subject: Advances in Machine Learning Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:	
1.	Explore and analyze state-of-the-art machine learning approaches.
2.	Develop practical skills in implementing advanced ML models and solving complex AI challenges.

Course Outcomes:	
CO1	Understand the latest advancements in machine learning algorithms and techniques.
CO2	Apply advanced ML methods to real-world problems, demonstrating proficiency in using cutting-edge tools.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. Implement a deep neural network from scratch using TensorFlow or PyTorch, gaining hands-on experience in building complex neural architectures.
2. Utilize pre-trained models and perform transfer learning to solve real-world problems efficiently.
3. Implement a GAN to generate synthetic data and explore its applications in image generation and data augmentation.
4. Apply NLP techniques to process and analyze textual data, including sentiment analysis and named entity recognition.
5. Build RL agents and train them using OpenAI Gym or Stable Baselines to solve challenging tasks.
6. Understand the interpretability of ML models by using LIME or SHAP to explain model predictions.

7. Use AutoML and Hyperparameter tuning tools to automate the model selection and optimization process.
8. Analyze time series data, perform forecasting, and evaluate model performance using Prophet or statsmodels.
9. Compress and quantize large ML models to make them suitable for deployment on resource-constrained devices.
10. Explore federated learning concepts and implement distributed ML models using TensorFlow Federated.
11. Generate adversarial attacks on ML models and implement defense mechanisms to enhance model robustness.
12. Utilize Ray Tune to perform hyperparameter search and optimize ML models efficiently.

Semester: 7th			
Paper code: AIML413T	**L**	**T/P**	**Credits**
Subject: Machine Learning in Healthcare	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Explain the role of machine learning in healthcare and its impact on medical decision-making.
2.	Apply machine learning algorithms to real-world healthcare datasets for predictive analysis.
3.	Evaluate the performance of machine learning models for medical applications using appropriate metrics.
4.	Develop healthcare solutions that utilize medical image analysis and provide interpretable results.

Course Outcomes:

CO1	Understand the fundamental machine learning algorithms and techniques used in healthcare applications.
CO2	Apply machine learning models to medical data for predictive modeling and disease diagnosis.
CO3	Analyze medical images using deep learning techniques for classification and segmentation tasks.
CO4	Design and develop healthcare decision support systems with ethical considerations in mind

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	-	2	2	2	-	1	-	-	-	1	1
CO3	-	-	2	2	2	-	1	-	-	-	1	1
CO4	1	1	3	2	2	1	1	1	1	1	1	1

Course Overview:

This course introduces students to the applications of machine learning in healthcare. It covers fundamental machine learning algorithms, data preprocessing for healthcare data, predictive modeling, medical image analysis, and healthcare decision support systems. Students will gain insights into using ML techniques for medical diagnosis, treatment recommendation, and disease prediction.

Unit I **[8]**

Introduction to Healthcare Data and Machine Learning: Overview of healthcare data types and sources, Introduction to machine learning algorithms for healthcare, Data preprocessing and feature engineering for medical data

Unit II **[8]**

Supervised learning techniques for medical diagnosis: Unsupervised learning methods for clustering and anomaly detection, Evaluation metrics for healthcare predictions

Unit III **[8]**

Image processing and analysis in medical imaging: Deep learning for medical image classification and segmentation, Case studies: applications of ML in radiology and pathology,

Unit IV **[8]**

Building healthcare decision support systems using ML: Model interpretability and explainability in medical applications, Ethical considerations and challenges in ML healthcare deployments

Textbooks:

1. "Machine Learning in Medicine - A Complete Overview" by Ton J. Cleophas and Aeilko H. Zwinderman
2. "Healthcare Analytics Made Simple: Techniques in Healthcare Computing Using Machine Learning" by Aboelela E. Mady and Taposh Roy
3. "Machine Learning for Healthcare" by Le Lu, Yefeng Zheng, Gustavo Carneiro, and Lin Yang

Reference Books:

1. "Artificial Intelligence in Medicine" edited by Lei Xing and Alessandro Rizzo
2. "Machine Learning and Medical Imaging" edited by Guorong Wu, Dinggang Shen, Mert R. Sabuncu, and Pew-Thian Yap
3. "Healthcare Data Analytics" by Chandan K. Reddy, Charu C. Aggarwal, and Haesun Park

Semester: 7th			
Paper code: AIML413P	**L**	**T/P**	**Credits**
Subject: Machine Learning in Healthcare Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Gain hands-on experience in analyzing and modeling complex systems using network analysis, time series analysis, and simulation techniques. Understand the challenges and approaches for handling big data in complex systems and apply machine learning algorithms for predictions and decision-making.
2.	Explore the application of data science techniques in interdisciplinary fields to address complex challenges in today's interconnected world.

Course Outcomes:

CO1	Develop practical skills in data science techniques for analyzing complex systems and understanding their behavior.
CO2	Apply data science methodologies to solve real-world problems in various domains, such as social networks, finance, and healthcare, and gain insights into complex system dynamics.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. Data Preprocessing and Cleaning for Electronic Health Records (EHR) Data
2. Exploratory Data Analysis (EDA) on Medical Imaging Datasets
3. Building a Binary Classification Model for Disease Diagnosis
4. Implementing Multiclass Classification for Disease Severity Prediction
5. Applying Time Series Analysis for Patient Vital Sign Forecasting
6. Developing a Convolutional Neural Network (CNN) for Medical Image Classification
7. Building a Recurrent Neural Network (RNN) for Predicting Patient Readmission
8. Implementing Transfer Learning for Medical Image Feature Extraction

9. Evaluating Model Fairness and Bias in Healthcare Data
10. Applying Reinforcement Learning for Personalized Treatment Recommendations
11. Building an Explainable AI Model for Medical Diagnosis
12. Developing a Predictive Analytics System for Hospital Resource Management.

Detailed SYLLABUS
(4th Year)
Seventh Semester

for

BACHELOR OF TECHNOLOGY

for

Industrial Internet of Things

Applicable from Batch Admitted in Academic Session 2021-2022 Onwards

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY, EAST DELHI CAMPUS, SURAJMAL VIHAR-110092

Semester: 7th			
Paper code: IOT403T	**L**	**T/P**	**Credits**
Subject: IoT Deployment, Testing & its Challenges	**4**	**0**	**4**

Marking Scheme:

3. Teachers Continuous Evaluation: As per university examination norms from time to time
4. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

6. There should be 9 questions in the end term examination question paper.
7. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
8. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
9. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
10. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

5.	Explain the key components and communication protocols used in Industrial IoT deployments.
6.	Conduct testing and quality assurance to ensure the effectiveness and efficiency of Industrial IoT solutions.
7.	Evaluate and address challenges specific to industrial settings for successful IoT deployment.
8.	Analyze the impact of emerging technologies on the future of Industrial IoT applications.

Course Outcomes:

CO1	Understand the fundamentals of Industrial IoT architecture, protocols, and sensors for effective deployment.
CO2	Apply testing methodologies to ensure the reliability, security, and performance of Industrial IoT solutions.
CO3	Identify and address real-world challenges in deploying IoT in industrial environments.
CO4	Analyze the scalability and future trends in Industrial IoT, including predictive maintenance and edge computing.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	-	-	2	2	2	-	1	1	-	-	1	1
CO2	-	-	2	2	2	-	1	-	-	-	1	1
CO3	-	-	2	2	2	-	1	-	-	-	1	1
CO4	1	1	3	2	2	1	1	1	1	1	1	1

Course Overview:

This course focuses on the deployment and testing aspects of the Industrial Internet of Things (IoT) ecosystem. Students will learn about IoT architecture, protocols, real-world deployment challenges, and testing methodologies for ensuring the reliability, security, and scalability of IoT solutions in industrial settings.

Unit I **[10]**
Introduction to Industrial IoT: Overview of Industrial IoT and its applications, IoT architecture for industrial environments, Selection of sensors and actuators for industrial deployments

Unit II **[10]**
IoT Deployment and Challenges in Industrial Settings: Real-world challenges and considerations for IoT deployment in industries, Connectivity and communication protocols for Industrial IoT, Edge computing and fog computing in industrial environments

Unit III **[10]**
IoT Testing and Quality Assurance: Testing methodologies for Industrial IoT systems, Performance testing and optimization for industrial applications, Reliability and security testing of IoT solutions

Unit IV **[10]**
Scaling and Future Trends in Industrial IoT: Scalability challenges and solutions in large-scale industrial deployments, Predictive maintenance and anomaly detection in Industrial IoT, Emerging trends and technologies shaping the future of Industrial IoT.

Textbooks:

3. "Industrial Internet of Things: Cybermanufacturing Systems" by Sabina Jeschke, Christian Brecher, and Houbing Song
4. "Industrial IoT Technologies and Applications" by Chin-Feng Lai and Hsiao-Hwa Chen
5. "Internet of Things for Industry 4.0: Challenges and Solutions" by Houbing Song, Ravi Srinivasan, and Tamim Sookoor

Reference Books:

3. "Industrial Internet of Things: Volume G1: Reference Architecture and Framework" by Robert C. Richardson and Stephen F. Hill
4. "IoT Solutions in Microsoft's Azure IoT Suite: Data Acquisition and Analysis in the Real World" by Scott Klein and Manisha Yadav
5. "Architecting the Industrial Internet" by Francisco da Costa and Stephen Clougherty

Semester: 7th			
Paper code: IOT405T	**L**	**T/P**	**Credits**
Subject: Real-Time Systems	**4**	**0**	**4**

Marking Scheme:

3. Teachers Continuous Evaluation: As per university examination norms from time to time
4. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

6. There should be 9 questions in the end term examination question paper.
7. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
8. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
9. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
10. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

5.	Familiarize students with the concepts and challenges of real-time systems and their relevance in IoT.
6.	Provide hands-on experience in using real-time operating systems and scheduling algorithms.
7.	Enable students to design and implement real-time communication protocols for IoT networks.
8.	Develop skills to apply real-time strategies in IoT applications to meet critical timing constraints.

Course Outcomes:

CO1	Understand the principles and characteristics of real-time systems and their significance in IoT applications.
CO2	Evaluate and select suitable real-time operating systems and scheduling algorithms for IoT devices and systems.
CO3	Design and implement real-time communication protocols for IoT networks to ensure timely data transmission.
CO4	Apply real-time techniques to develop IoT applications with strict timing requirements for critical tasks.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	1	1	1	2	-	-	-	-	-	-	2
CO2	2	2	2	2	1	-	-	-	1	-	1	2
CO3	2	2	2	2	1	-	-	-	1	-	1	2
CO4	2	2	2	2	2	-	-	-	1	1	2	3

Course Overview:

This course introduces B.Tech IoT students to real-time systems, covering fundamental concepts, design principles, and applications. Students will gain insights into real-time operating systems, scheduling algorithms, and synchronization techniques to develop IoT applications requiring timely and predictable responses.

Unit I **[10]**

Introduction to Real-Time Systems: Definition and characteristics of real-time systems, Types of real-time tasks: periodic, sporadic, aperiodic, Challenges and design constraints in real-time systems

Unit II **[10]**

Real-Time Operating Systems (RTOS): Features and components of RTOS, Task scheduling and priority-based algorithms, Inter-process communication and synchronization in RTOS

Unit III **[10]**

Real-Time Communication Protocols: Time-sensitive networking (TSN) protocols, MQTT-SN (MQTT for Sensor Networks), CoAP (Constrained Application Protocol)

Unit IV **[10]**

Real-Time Applications in IoT: Real-time data processing for IoT devices, Control systems and automation applications, Real-time analytics and decision-making in IoT

Textbooks:

1. "Real-Time Systems Design and Analysis: Tools for the Practitioner" by Phillip A. Laplante
2. "Real-Time Operating Systems: The Engineering of Real-Time Embedded Systems and Operating Systems" by Andy Wellings
3. "Real-Time Concepts for Embedded Systems" by Qing Li and Caroline Yao

Reference Books:

1. C. Siva Ram Murthy, G. Manimaran, “Resource management in real-time systems and networks”, PHI, 2009.
2. "Real-Time Communication Protocols for Multi-hop Wireless Networks" by Rong Zheng and Ying Zhang
3. "Real-Time Systems: Design Principles for Distributed Embedded Applications" by Hermann Kopetz

Semester: 7th			
Paper code: IOT407T	**L**	**T/P**	**Credits**
Subject: Drone Applications, Components and Assembly	**4**	**0**	**4**

Marking Scheme:

3. Teachers Continuous Evaluation: As per university examination norms from time to time
4. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

6. There should be 9 questions in the end term examination question paper.
7. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
8. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
9. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
10. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

5.	To understand fundamental concepts of drone.
6.	To explore drones' technology through their significant learning of the Components, Assembly and Calibrations
7.	To acquire practical skills in assembling and configuring drones, including frame assembly, motor installation, electronic connections, and flight controller setup.
8.	To Identify the specific requirements and challenges associated with each application.

Course Outcomes:

CO1	Understand UAV (Unmanned Aerial Vehicles) and its application along with Law enforcement required for deployment and testing
CO2	Analyze various design model used in drone assembly.
CO3	Gain the knowledge about the components required for UAV
CO4	Simulate and deploy Drone for real life applications by conducting experiments that facilitates drones' programming with computer vision, artificial intelligence, control algorithms.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	2	-	1	1	2	2	-	1	1	1	1
CO2	1	1	-	1	2	2	1	-	1	2	1	2
CO3	2	3	1	2	2	1	2	-	1	1	2	2
CO4	3	3	1	2	2	2	1	1	1	2	2	2

Course Overview:

This course provides a comprehensive understanding of the applications, components, and assembly processes related to drones. the course focuses on the components and systems of drones and also covers the assembly and configuration processes of drones. Students will learn hands-on skills in drone assembly, including frame construction, motor installation, electronic connections, and payload integration.

UNIT I **[10]**

Introduction of Unmanned Aerial Vehicles: Introduction, Typical physical parameter, Categories of UAV, Law and Deployment Restriction on UAV, Small Unmanned Aerial Vehicle, Civilian and Military Application of UAV's.

Introduction to Drones: Overview of drones and their evolution, Drone applications in agriculture, surveillance, and delivery, Legal and ethical considerations in drone usage

Unit II **[10]**

Drone Components and Systems: Understanding drone components: frame, motors, propellers, and battery, Drone sensors: GPS, IMU, camera, and altimeter, Drone communication systems: WiFi, Bluetooth, and radio control.

UNIT III **[10]**

Drone Assembly and Configuration: Procedure to build and assemble a drone, Drone flight controller and firmware setup, Calibration and testing of drone components

Design Models: Autopilot model, Kinematic Model of Controlled Flight, Kinematic Guidance Models, Dynamic Guidance Model.

UNIT IV **[10]**

Path Planning and Navigation: Path Planning: Point to Point Algorithm, Coverage Algorithm, Vision Guided Navigation: Glimbal and Camera Frames and Projective Geometry.

Drone Applications in IoT: Integration of drones with IoT systems, Drone data collection and analysis, IoT-based drone automation and control

Textbooks:

1. A. R. Jha, Theory, Design, and Applications of Unmanned Aerial Vehicles (1st Edition), CRC Press, 2016. ISBN 978-1315371191.
2. Syed Omar FarukTowaha, Building Smart Drones with ESP8266 and Arduino: Build exciting drones by leveraging the capabilities of Arduino and ESP8266, Packt Publishing, 2018.
3. Randal W. Beard and Timothy W. McLain: Small Unmanned Aircraft: Theory and Practice, Princeton University Press, 2012.

Reference Books:

1. Kenneth Munson, Jane's Unmanned Aerial Vehicles and Targets, (1st Edition), Jane's Information Group, United Kingdom ,1995, ISBN 978-0710612571.
2. Rafael Yanushevsky, Guidance of Unmanned Aerial Vehicles (1st Edition), CRC Press 2011. ISBN 978-0429109898.

Semester: 7th			
Paper code: IOT409T	**L**	**T/P**	**Credits**
Subject: Industrial IoT & Applications	**4**	**0**	**4**

Marking Scheme:

3. Teachers Continuous Evaluation: As per university examination norms from time to time
4. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

6. There should be 9 questions in the end term examination question paper.
7. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
8. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
9. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
10. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

5.	Explain the core concepts and components of Industrial IoT systems and their role in transforming industries.
6.	Apply data analytics techniques to extract insights from industrial data for predictive maintenance and optimization.
7.	Evaluate the potential of IoT applications in various industrial sectors to improve efficiency and productivity.
8.	Analyze security vulnerabilities and devise strategies to mitigate risks in Industrial IoT deployments.

Course Outcomes:

CO1	Understand the principles and architecture of Industrial IoT and its applications in Industry 4.0.
CO2	Analyze and apply data acquisition and analytics techniques for industrial data in IoT systems.
CO3	Identify and evaluate real-world industrial applications of IoT for smart manufacturing, supply chain, and energy efficiency.
CO4	Address security challenges and scalability issues for successful Industrial IoT implementations.

Course Outcomes (CO) to Programme Outcomes (PO)
Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	2	3	3	1	1	-	1	1	-	-	2
CO2	2	2	3	3	1	1	-	1	1	-	-	2
CO3	2	2	3	3	1	1	-	1	2	-	-	2
CO4	2	2	3	3	2	1	1	1	2	-	-	2

Course Overview:

This course introduces students to the concepts and applications of the Industrial Internet of Things (IoT) in industrial settings. It covers IoT architecture, communication protocols, data analytics, and real-world applications such as predictive maintenance, smart manufacturing, and supply chain optimization.

Unit I **[10]**

Introduction to Industrial IoT: Overview of Industrial IoT and its significance in Industry 4.0, IoT architecture and communication protocols for industrial applications, Sensors and actuators in Industrial IoT.

Unit II **[10]**

Data Acquisition and Analytics in Industrial IoT: Data acquisition methods in industrial environments, Big Data analytics and machine learning for industrial data, Predictive maintenance and anomaly detection

Unit III **[10]**

Industrial IoT Applications: Smart manufacturing and process optimization, Supply chain management and logistics with IoT, Industrial IoT for energy efficiency and environmental monitoring

Unit IV **[10]**

Security and Challenges in Industrial IoT: Security considerations in Industrial IoT deployments, Challenges and solutions for scalable and reliable Industrial IoT systems, Case studies and real-world examples of successful Industrial IoT implementations

Textbooks:

3. "Industrial Internet of Things: Cybermanufacturing Systems" by Sabina Jeschke, Christian Brecher, and Houbing Song
4. "Industry 4.0: The Industrial Internet of Things" by Alasdair Gilchrist
5. "Internet of Things for Industry 4.0: Challenges and Solutions" by Houbing Song, Ravi Srinivasan, and Tamim Sookoor

Reference Books:

4. "Architecting the Industrial Internet" by Francisco da Costa and Stephen Clougherty
5. "Industrial IoT Technologies and Applications" by Chin-Feng Lai and Hsiao-Hwa Chen
6. "Internet of Things for Industry and Human: New Advances" by Nilanjan Dey, Amira S. Ashour, and Chintan Bhatt

Semester: 7th			
Paper code: IOT411T	**L**	**T/P**	**Credits**
Subject: Remote Sensing and its Applications	**4**	**0**	**4**

Marking Scheme:

3. Teachers Continuous Evaluation: As per university examination norms from time to time
4. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

6. There should be 9 questions in the end term examination question paper.
7. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
8. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
9. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
10. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

5.	Familiarize students with the fundamentals of remote sensing technology and its applications in IoT.
6.	Develop practical skills in processing and analyzing remote sensing data using image processing techniques.
7.	Explore the diverse applications of remote sensing in agriculture, environment, and disaster management.
8.	Enable students to integrate remote sensing with IoT to create innovative and sustainable solutions.

Course Outcomes:

CO1	Understand the principles and methods of remote sensing and its role in IoT systems.
CO2	Analyze and process remote sensing data for various applications, including agriculture and disaster management.
CO3	Apply remote sensing techniques to monitor and assess environmental changes and land cover analysis.
CO4	Integrate remote sensing data with IoT platforms to develop smart applications for real-world scenarios.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	1	1	-	1	-	-	-	-	2	1	-	2
CO2	1	2	1	1	1	-	-	-	2	2	2	2
CO3	2	2	1	1	1	1	1	1	2	2	2	2
CO4	2	2	2	2	2	1	1	2	3	2	3	3

Course Overview:
This course introduces B.Tech IoT students to remote sensing technology, focusing on data acquisition from satellites and UAVs. Students will learn image processing techniques, data interpretation, and its applications in agriculture, environmental monitoring, and disaster management, enabling them to integrate remote sensing with IoT for advanced analytics.

Unit I **[10]**
Introduction to Remote Sensing: Fundamentals of remote sensing and its significance in IoT applications, Remote sensing platforms: satellites, UAVs, and ground-based sensors, Remote sensing data acquisition and data types

Unit II **[10]**
Remote Sensing Image Processing: Image pre-processing: calibration, rectification, and enhancement, Image classification techniques for land cover analysis, Feature extraction and object recognition from remote sensing data

Unit III **[10]**
Remote Sensing Applications: Agriculture monitoring and precision farming using remote sensing, Environmental assessment and forest monitoring applications, Disaster management and remote sensing-based damage assessment

Unit IV **[10]**
Integration with IoT: Integrating remote sensing data with IoT platforms, Data fusion techniques for enhanced analytics, IoT-enabled remote sensing applications for smart cities and environmental monitoring

Textbooks:
1. “Remote Sensing and Geographical Information Systems”, Anji Reddy, M., B S Publications, 2008.
2. “Basics of Remote Sensing and GIS” Kumar. S., Laxmi Publications,

Reference Books:
1. "Remote Sensing and GIS" by Basudeb Bhatta
2. "Principles of Remote Sensing" by Shefali Agrawal and Priti Maheshwari

Semester: 7th			
Paper code: IOT413T	**L**	**T/P**	**Credits**
Subject: IOT based Intelligent Automation	**4**	**0**	**4**

Marking Scheme:

3. Teachers Continuous Evaluation: As per university examination norms from time to time
4. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

6. There should be 9 questions in the end term examination question paper.
7. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
8. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
9. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
10. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

5.	Introduce students to the integration of IoT with intelligent automation technologies.
6.	Develop hands-on skills in building intelligent systems using IoT devices and ML algorithms.
7.	Enable students to apply IoT-based automation in healthcare and smart home scenarios.
8.	Encourage students to explore advanced concepts and project development in IoT-based intelligent automation.

Course Outcomes:

CO1	Understand the principles and concepts of IoT-based intelligent automation and its significance in various industries.
CO2	Apply AI, ML, and robotics techniques to develop intelligent systems for real-time decision-making and control.
CO3	Design and implement IoT-based automation solutions for industrial, healthcare, and smart home applications.
CO4	Analyze ethical and security aspects of IoT-enabled intelligent automation and explore future trends in the field.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	2	1	2	-	-	-	-	-	-	-	2
CO2	1	2	1	1	3	-	-	-	-	1	1	2
CO3	2	2	2	2	3	1	1	-	-	1	2	2
CO4	2	3	3	2	3	2	1	1	2	2	1	2

Course Overview:
This course explores the integration of IoT with intelligent automation techniques like AI, ML, and robotics to develop smart systems. Students will learn how to design and implement IoT-enabled automated solutions for industrial, healthcare, and smart home applications, improving efficiency and productivity.

Unit I **[10]**
Introduction to IoT-based Automation: Fundamentals of intelligent automation and its role in IoT systems, Integration of AI, ML, and robotics with IoT for automation, Industrial automation and smart manufacturing using IoT

Unit II **[10]**
IoT-enabled Intelligent Systems: Building intelligent systems with IoT devices and sensors, Machine learning algorithms for real-time data analysis, AI-based decision-making and control in IoT environments

Unit III **[10]**
Automation in Healthcare and Smart Homes: IoT applications in healthcare for remote patient monitoring, Smart home automation using IoT devices and voice assistants, Security and privacy considerations in IoT-based intelligent systems

Unit IV **[10]**
Future Trends and Project Development: Emerging trends in IoT-based intelligent automation, Project development: designing and implementing an IoT-enabled automated system, Ethical considerations and social impact of intelligent automation in IoT

Textbooks:
1. "Internet of Things: Principles and Paradigms" by Rajkumar Buyya, Amir Vahid Dastjerdi, and Srirama Krishnan
2. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
3. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy

Reference Books:
1. "Robotics: Modelling, Planning, and Control" by Bruno Siciliano and Lorenzo Sciavicco
2. "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry" by Maciej Kranz
3. "Smart Homes and Health Telematics: 6th International Conference, ICOST 2008 Ames, IA, USA, June 28-July 2, 2008 Proceedings" by Mounir Mokhtari, Nada Matta, and Jean-Pierre Cahier

DETAILED SYLLABUS
(FOURTH YEAR)

for

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for

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for

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Artificial Intelligence and Data Science
Artificial Intelligence and Machine Learning
Industrial Internet of Things

Applicable from Batch Admitted in Academic Session 2021-2022 Onwards

Semester: 7th			
Paper code: OAE403T	**L**	**T/P**	**Credits**
Subject: Computer Vision	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce students the major ideas, methods and techniques of computer vision and pattern recognition.
2.	Become familiar with the major technical approaches involved in computer vision. Describe various methods used for registration, alignment, and matching in images.
3.	Perform shape analysis and extract features form Images and do analysis of Images
4.	Get an exposure to advanced concepts, including state of the art deep learning architectures, in all aspects of computer vision.

Course Outcomes:

CO1	Describe different image representation, their mathematical representation and different data structures used.
CO2	Classify different segmentation algorithm for given input.
CO3	Detect a moving object in video using the concept of motion analysis.
CO4	Recognize the object using the concept of computer vision

Course Outcomes (CO) to Programme Outcomes (PO)
Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:
Computer Vision introduces B.Tech students to the fascinating world of visual perception through machines. This course explores algorithms and techniques that enable computers to understand and interpret images and videos. Students will delve into image processing, feature

extraction, object recognition, and deep learning models for computer vision tasks. Practical applications such as facial recognition, autonomous vehicles, and medical imaging will be discussed, preparing students for exciting opportunities in AI-driven visual systems.

UNIT I **[8]**

Digital Image Formation and low, level processing: Overview and State of the art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc, Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing. Depth estimation and Multi camera views: Perspective, Binocular Stereopsis: Camera and Epipolar Geometry, Homography, Rectification, DLT, RANSAC, 3D reconstruction framework, Auto calibration.

UNIT II **[8]**

Feature Extraction: Edges , Canny, LOG, DOG, Line detectors (Hough Transform), Corners , Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale, Space Analysis, Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT. Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph, Cut, Mean, Shift, MRFs, Texture Segmentation, Object detection.

UNIT III **[8]**

Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio, Temporal Analysis, Dynamic Stereo, Motion parameter estimation. Shape from X: Light at Surfaces, Phong Model, Reflectance Map, Albedo estimation, Photometric Stereo, Use of Surface Smoothness Constraint, and Shape from Texture, color, motion and edges.

UNIT IV **[8]**

Miscellaneous: Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics, stitching and document processing, Modern trends, super-resolution, GPU, Augmented Reality, cognitive models, fusion and SR&CS.

Text Books:

1. Szeliski, R., Computer Vision: Algorithms and Applications, Springer, Verlag London .
2. Forsyth, A., D. and Ponce, J., Computer Vision: A Modern Approach, Pearson Education.

Reference Books:

1. Hartley, R. and Zisserman, A., Multiple View Geometry in Computer Vision Cambridge University Press.
2. Fukunaga, K., Introduction to Statistical Pattern Recognition, Academic Press, Morgan Kaufmann.

Semester: 7th			
Paper code: OAE403P	**L**	**T/P**	**Credits**
Subject: Computer Vision Lab	**0**	**2**	**1**
Marking Scheme: 1. Teachers Continuous Evaluation: As per university examination norms from time to time 2. End term Examination: As per university examination norms from time to time			
INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms			
1. This is the practical component of the corresponding theory paper. 2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below. 3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important. 4. At least 8 experiments must be performed by the students.			

Course Objectives:	
1.	Understand the fundamentals of computer vision algorithms and their use cases.
2.	Develop practical skills in using popular computer vision tools and frameworks to solve real-world problems.
Course Outcomes:	
CO1	Gain expertise in computer vision techniques and applications, including object detection, segmentation, and facial recognition.
CO2	Acquire hands-on experience in building computer vision models and deploying them on edge devices for real-world applications.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	3	1	-	1	-	1	1	-
CO2	2	2	2	2	3	2	1	1	1	1	1	1

List of Experiments:

1. Learn to preprocess images by applying techniques such as resizing, filtering, and histogram equalization.
2. To implement object detection algorithms to identify and localize objects in images and video streams.
3. To use semantic segmentation models to segment objects in an image and understand pixel-level classification.
4. To build a facial recognition system to detect and recognize faces in images and video.
5. To implement OCR techniques to recognize text from images and scanned documents
6. To apply neural style transfer to blend the style of one image onto the content of another image.
7. To use pose estimation models to detect and track human body keypoints in images and videos.
8. To implement super-resolution algorithms to upscale low-resolution images.

9. To fine-tune pre-trained models like VGG, ResNet, or MobileNet for image classification tasks.
10. To develop an image captioning system to generate textual descriptions of images.
11. To combine computer vision and natural language processing to create a model that answers questions about images.
12. To optimize object detection models for deployment on edge devices with real-time performance.

Semester: 7th			
Paper code: OAE405T	**L**	**T/P**	**Credits**
Subject: Software Verification, Validation and Testing	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Explain the importance of software verification and validation in the context of AI, ML, IoT, and Data Science.
2.	Apply different testing techniques and methodologies to identify and resolve software defects effectively.
3.	Implement automated testing and utilize test automation tools for efficient and continuous testing.
4.	Evaluate and validate AI/ML models and perform data validation in Data Science projects.

Course Outcomes:

CO1	Understand the concepts of software verification, validation, and testing and their significance in AI, ML, IoT, and Data Science applications.
CO2	Develop expertise in applying various testing methodologies, automated testing, and test automation tools to ensure software quality and reliability.
CO3	Demonstrate the ability to use test management and bug tracking tools effectively to plan, monitor, and manage the testing process.
CO4	Assess the trade-offs between different testing approaches and make informed decisions to ensure comprehensive software testing.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	1	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	2	1	-	-	2	-	-	-
CO3	1	2	3	2	3	1	-	-	-	-	-	-
CO4	2	2	3	2	3	2	-	-	-	3	-	-

Course Overview:
This course introduces students to the principles and techniques of software verification, validation, and testing. It covers the various testing methodologies, tools, and best practices used to ensure the quality and reliability of software in the context of Artificial Intelligence, Machine Learning, Industrial Internet of Things, and Data Science applications.

UNIT I **[8]**
Introduction: Terminology, evolving nature of area, Errors, Faults and Failures, Correctness and reliability, Testing and debugging, Static and dynamic testing, Exhaustive testing: Theoretical foundations: impracticality of testing all data, impracticality of testing all paths, no absolute proof of correctness.

UNIT II **[8]**
Software Verification and Validation Approaches and their Applicability: Software technical reviews; Software testing: levels of testing - module, integration, system, regression; Testing techniques and their applicability-functional testing and analysis, structural testing and analysis, error-oriented testing and analysis, hybrid approaches, integration strategies, transaction flow analysis, stress analysis, failure analysis, concurrency analysis, performance analysis; Proof of correctness; simulation and prototyping; Requirement tracing.

UNIT III **[8]**
Test Generation: Test generations from requirements, Test generation pats, Data flow analysis, Finite State Machines models for flow analysis, Regular expressions based testing, Test Selection, Minimizations and Prioritization, Regression Testing.

UNIT IV **[8]**
Mutation and mutants: Introduction, Mutation and mutants, Mutation operators, Equivalent mutants, Fault detection using mutants, Types of mutants, Mutation operators for C and Java.

Text Books:

1. Software Verification and Validation: An Engineering and Scientific Approach, Marcus S. Fisher, Springer, 2007
2. Foundations of Software Testing, Aditya P. Mathur,Pearson Education, 2008
3. Software Testing: Principles and Practices,SrinivasanDesikan, Gopalaswamy Ramesh, Pearson Education India,2006

Reference Books:

1. "Software Testing: Principles, Techniques, and Tools" by K. K. Aggarwal and Yogesh Singh
2. "Software Testing" by Ron Patton
3. "Testing Computer Software" by Cem Kaner, Jack Falk, and Hung Q. Nguyen

4. "The Art of Software Testing" by Glenford J. Myers, Corey Sandler, and Tom Badgett

Semester: 7th			
Paper code: OAE405P	**L**	**T/P**	**Credits**
Subject Software Verification, Validation and Testing Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To familiarize students with different types of software testing and verification methods.
2.	To provide hands-on experience with industry-standard testing tools and practices.

Course Outcomes:

CO1	Understand the principles and techniques of software testing and validation.
CO2	Develop proficiency in using various software testing tools for different testing scenarios.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	1	-	-	2	1	-	-	2	-	-	-
CO2	1	2	3	2	3	1	-	-	-	-	-	-

List of Experiments:

1. To understand the importance of static code analysis and utilize SonarQube to identify code quality issues, bugs, and vulnerabilities in software projects.
2. To learn the fundamentals of unit testing and practice writing and executing JUnit test cases to ensure individual units of code function correctly.
3. To explore the concepts of integration testing and use Selenium to automate browser-based testing, ensuring seamless interactions between components.
4. To familiarize students with test case management using TestRail and learn to design, execute, and track test cases effectively.
5. To gain hands-on experience in performance testing with JMeter, measuring system responsiveness, scalability, and stability under varying workloads.
6. To understand the significance of security testing and utilize OWASP ZAP to identify and address security vulnerabilities in web applications.
7. To learn model-based testing techniques with Spec Explorer and generate effective test cases from models, improving test coverage.

8. To explore usability testing concepts and use UserTesting to evaluate the user-friendliness and user experience of software applications.
9. To understand mutation testing principles and utilize PIT to assess the effectiveness of test suites in detecting code mutations.
10. To experience load testing with LoadRunner, simulating real-world user loads to assess application performance under stress.
11. To learn to measure code coverage using JaCoCo and assess the effectiveness of test suites in covering code paths.
12. To utilize Postman to automate the testing of APIs, ensuring their functionality, reliability, and compatibility.

Semester: 7th			
Paper code: OAE407T	**L**	**T/P**	**Credits**
Subject: Metaverse and its Applications	**4**	**0**	**4**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To Understand the social and cultural implications of the metaverse, including issues related to identity, representation, and community-building.
2.	To analyze and evaluate the opportunities and limitations of the metaverse in various domains, such as gaming, social interaction, business, and education.
3.	To Stay updated with the latest developments and emerging trends in the field of the metaverse and its applications.
4.	To Apply critical thinking and problem-solving skills to address real-world scenarios and challenges in the context of the metaverse.

Course Outcomes:

CO1	To Understand the social and cultural implications of the metaverse, including issues related to identity, representation, and community-building.
CO2	Identify and analyze the technologies enabling the metaverse, such as virtual reality, augmented reality, and blockchain.
CO3	Examine the economic aspects of the metaverse, including virtual economies, digital assets, and monetization strategies.
CO4	Apply critical thinking and problem-solving skills to address real-world scenarios and challenges in the context of the metaverse.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	-	-	-	-	-	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	-	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

This course provides an in-depth exploration of the concept, technologies, and applications of the metaverse. The metaverse refers to a virtual universe where individuals can interact with digital environments and each other in real or simulated time.

UNIT I **[10]**

Introduction: definition of Metaverse applications, design dimensions, Metaverse application ecology and economy, design and development process

Immersive Techniques and Functionality: SDKs, tools, and services for augmented reality, virtual reality, extended reality (XR), human computer interactions, devices and internet of things, and digital twins.

UNIT II **[10]**

UIUX: SDKs, tools, and services for avatar systems, spatial user interface, multimodal user interface, locomotion, UI prototyping, and accessible and inclusive UX design

UNIT III **[10]**

Metaverse Privacy Security and Ethics: SDKs, tools, and services for cyberspace encryption, blockchain, and federated learning.

Metaverse Intelligence: SDKs, tools, and services for nature language processing, machine learning, data mining, and recommendation systems.

UNIT IV **[10]**

Meat Entertainment: Metaverse prototypes for entertainment, including multiplayer VR gaming, social VR, live performance in Metaverse.

Metaverse in Web Learning: Metaverse prototypes for education, including avatar-mediated teaching and learning, immersive learning, experiential learning, collaborative learning, etc.

Metaverse in Healthcare: Metaverse prototypes for healthcare and mental well-being, including teletherapy, teleoperation, rehabilitation.

Text Books:

1. LaViola Jr, J. J., Kruijff, E., McMahan, R. P., Bowman, D., & Poupyrev, I. P. (2017). 3D user interfaces: theory and practice. Addison-Wesley Professional.
2. LaValle, M. (2019). Virtual reality. Cambridge University Press.

Reference Books:

1. Metaverse Roadmap (2007) https://www.metaverseroadmap.org/overview/

Semester: 7th			
Paper code: OAE409T	**L**	**T/P**	**Credits**
Subject: Web Intelligence	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce students to the fundamental concepts and challenges of Web Mining, Recommendation Systems, NLP, and Semantic Web.
2.	To familiarize students with various techniques and algorithms used in Web Intelligence applications.
3.	To enable students to develop AI-driven web-based applications using intelligent techniques.
4.	To encourage students to critically analyze and evaluate the performance of Web Intelligence solutions for real-world scenarios.

Course Outcomes:

CO1	Understand the core concepts and principles of web mining, recommendation systems, NLP, and semantic web technologies, and their significance in web-based applications.
CO2	Apply various intelligent techniques, algorithms, and models to analyze web data, build recommendation systems, and process natural language in web-related tasks.
CO3	Design and develop AI-driven web applications using web mining, recommendation systems, NLP, and semantic web technologies to improve user experience and personalization.
CO4	Evaluate and compare different web intelligence approaches, models, and algorithms to make informed decisions for building efficient and effective web-based solutions.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	3	3	3	3	-	-	-	-	-	-	2
CO2	3	3	3	3	3	-	-	-	-	-	-	3
CO3	3	3	3	3	3	-	-	-	-	-	1	2
CO4	3	3	3	3	3	-	-	-	-	-	2	3

Course Overview:
Web Intelligence is an advanced course for B.Tech AI, ML, IIoT, and Data Science students to explore the integration of AI and intelligent techniques in web-related applications. The syllabus covers web mining, recommendation systems, natural language processing, and semantic web technologies.

UNIT I **[8]**
Introduction to Web Mining: History of web mining, state-of-art for web mining, web scraping, Web Databases, Knowledge Discovery in Databases, Similarity search in textual data, Text processing, Similarity functions: Jaccard, Euclidean, Cosine

UNIT II **[8]**
Key Components: Benchmarking, Click, Conversion, Direct Traffic, Filter, Funnel, Goal, Impression, Keyword, Landing Page, Organic Traffic, Paid Traffic, Types of Visitors, Tracking Code, Time on Site.

UNIT III **[8]**
Web Mining Essentials: Automated Reporting, Actionable Reporting, Web Testing, Dashboards, Segmentation, Classification and Regression for web mining, Ensemble learning for web data analytics.

UNIT IV **[8]**
Web Data Analytics: Significance of Web Mining, Web Analytics Process, Web Document Ranking: Graph Analysis with PageRank. Google Analytics: Acquisition analysis, Behavior Analysis, conversation Analysis

Textbooks:
1. Web Analytics 2.0: The Art of Online Accountability and Science of Customer Centricity, 1st Edition, Avinash Kaushik
2. Google Analytics: Understanding Visitor Behavior 1st Edition, Justin Cutroni

Reference Books:
1. Google Analytics Breakthrough: From Zero to Business Impact 1st Edition, Feras Alhlou, Shiraz Asif, Eric Fettman

Semester: 7th			
Paper code: OAE409P	**L**	**T/P**	**Credits**
Subject: Web Intelligence Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To understand elements of web intelligence and scraping
2.	To provide knowledge on tools and techniques involved in web data analytics

Course Outcomes:

CO1	Understand the elements of web intelligence
CO2	Gain knowledge about web analytics techniques

Course Outcomes (CO) to Programme Outcomes (PO) Mapping
(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	1	1	-	-	-	-	1	1	1
CO2	2	2	2	1	1	-	-	-	-	1	1	1

List of Experiments:

1. To gain insights into web traffic patterns, user behavior, and popular content on a live website using web analytics tools.
2. To understand the presence and impact of Adwords on a website, and explore their relevance for marketing and revenue generation.
3. To learn to set up and configure Google Analytics for tracking website performance and user interactions.
4. To explore various open-source features of Google Analytics and utilize them to analyze website traffic and user engagement.
5. To apply advanced data mining techniques to extract valuable insights and patterns from web data, aiding decision-making and business intelligence.
6. To implement algorithms to rank web documents based on relevance and importance, improving search engine efficiency.
7. To apply knowledge discovery techniques to uncover valuable patterns and trends from web databases in practical applications.

8. To understand the Jaccard Similarity measure and implement it to compare sets, useful in various data analysis tasks.
9. To implement the Euclidean Similarity measure to quantify the similarity between data points, valuable in clustering and classification tasks.
10. To implement the Cosine Similarity measure to determine the similarity between documents and vectors, essential for text analysis and information retrieval.

Semester: 7^{th}			
Paper code: OAE411T	**L**	**T/P**	**Credits**
Subject: Intelligent and Expert Systems	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce students to the core concepts and principles of intelligent systems and expert systems.
2.	To equip students with the knowledge and skills to design and develop rule-based expert systems.
3.	To enable students to apply intelligent systems in different domains and understand their practical applications.
4.	To create awareness among students about the ethical considerations and future trends in the field of intelligent systems.

Course Outcomes:

CO1	Understand the Basics of Artificial Intelligence and Expert Systems
CO2	Analyze the programming Logic in Artificial Intelligence
CO3	Evaluate various search methods in Artificial Intelligence
CO4	Gain Knowledge about the Expert Systems and the latest developments in Knowledge

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	1	2	3	3	1	1	-	1	1	-	-	2
CO2	2	2	3	3	1	1	-	1	1	-	-	2
CO3	2	2	3	3	1	1	-	1	2	-	-	2
CO4	2	2	3	3	2	1	1	1	2	-	-	2

Course Overview:

Intelligent and Expert Systems is an advanced course for B.Tech AI, ML, IIoT, and Data Science students, covering the principles and applications of AI-based intelligent systems and expert systems. Topics include knowledge representation, reasoning, rule-based systems, and applications in various domains.

Unit I **[8]**

Introduction: Expert systems and their history, Expert systems in daily life, Case study of expert systems. Emulation of human cognitive process, knowledge search trade-off, stored knowledge, semantic nets. An abstract view of modeling, elementary knowledge. Computational logic, analysis of compound statements using simple logic connectives, predicate logic, knowledge organization and manipulation, and knowledge acquisition.

Unit II **[8]**

Search methods and knowledge representation: Introduction to Fuzzy logic with examples, Bayesian probabilistic inference, possible world, representation, Structure knowledge: Graph, frames, and related structures. Object-oriented, representation- object classes, messages, and methods. Search and control strategies - Concepts, search problems, searching AND – OR graphs.

Unit III **[8]**

Knowledge organization and communication in expert systems: Knowledge organization- Indexing and retrieval techniques, integration of knowledge in memory organization systems, Perception and communication in expert systems. Overview of Linguistics, Basic passim techniques, semantic analysis and representation structures, natural language generation, and system.

Unit IV **[8]**

Pattern recognition and learning techniques: Pattern recognition system- understanding speech recognition, Image transformation, low-level processing, medium and high-level processing, vision system architecture, Rule-based system architecture, knowledge acquisition and validation, knowledge system building tools

Textbooks:

1. Russel (Stuart), 'Artificial Intelligence- Modern approach, Pearson Education series in AI', 3rd Edition, 2009.
2. Dan W Patterson, 'Introduction to Artificial intelligence and Expert systems', Prentice Hall of India Pvt. Ltd,2001

Reference Books:

1. Eugene Charniak, Drew Mc Dermot, 'Introduction to Artificial intelligence', Addison Wesley Longman Inc.,2009
2. George. F, William. A. Stubblefield, 'Artificial intelligence and the design of expert systems', The Benjamin Cummins Publishing Co., Inc 2nd Edition, 1992.

Semester: 7th			
Paper code: OAE411P	**L**	**T/P**	**Credits**
Subject: Intelligent and Expert Systems Lab	**0**	**2**	**1**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms
1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To understand elements of Expert Systems.
2.	To gain knowledge on techniques and tools involved in developing expert systems

Course Outcomes:

CO1	Understand the Basics of Artificial Intelligence and Expert Systems
CO2	Gain Knowledge about the Expert Systems and the latest developments in Knowledge

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:
1. To familiarize students with installing and configuring essential Python libraries for data analysis, visualization, and scientific computing.
2. To develop practical applications that simulates human cognitive processes using artificial intelligence techniques to solve real-world problems.
3. To introduce students to fuzzy sets theory and its application in decision-making and pattern recognition tasks using Python libraries.
4. To create knowledge graphs to represent complex relationships between entities and enable effective data representation and analysis.
5. To enable students to visualize and analyze network graphs using Python libraries for understanding network structures and properties.
6. To apply pattern recognition techniques on textual data for tasks like sentiment analysis, topic modeling, and text classification.
7. To apply pattern recognition techniques on numerical datasets for tasks like anomaly detection, clustering, and regression.
8. To apply pattern recognition algorithms on medical datasets to assist in diagnosis, treatment planning, and medical research.

Faculties can motivate students to make a project on real life expert systems.

Semester: 7th			
Paper code: OAE413T	**L**	**T/P**	**Credits**
Subject: Audio and Speech Processing	**3**	**0**	**3**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To introduce students to the basics of audio and speech signals and their pre-processing.
2.	To provide insights into speech recognition and the techniques involved in automatic speech recognition systems.
3.	To familiarize students with speech synthesis methods and the process of converting text to speech.
4.	To enable students to apply audio feature extraction techniques for various audio processing tasks.

Course Outcomes:

CO1	Understand the fundamentals of audio and speech signals, their characteristics, and the challenges in processing and analyzing them.
CO2	Learn the techniques for building automatic speech recognition systems and comprehend their real-world applications and limitations.
CO3	Gain the knowledge of developing text-to-speech synthesis systems using different approaches and evaluate their quality.
CO4	Apply various audio feature extraction techniques for classification, music information retrieval, and audio event detection in AI-based systems.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:
Audio and Speech Processing is an advanced course for B.Tech AI, ML, IIoT, and Data Science students to explore the principles and techniques for analyzing and processing audio and speech data. The syllabus covers speech recognition, synthesis, audio feature extraction, and applications in AI-based systems.

UNIT I **[8]**

Basic Concepts: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

UNIT II **[8]**

Speech Analysis: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

UNIT III **[8]**

Speech Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

UNIT IV **[8]**

Speech Recognition: Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – ngrams, context dependent sub-word units; Applications and present status.

Speech Synthesis: Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody.

Text Books:

1. Lawrence Rabinerand Biing-Hwang Juang, “Fundamentals of Speech Recognition”, Pearson Education, 2003.
2. Ben gold and Nelson Morgan, “Speech and audio signal processing”, processing and perception of speech and music, Wiley- India Edition, 2006 Edition.
3. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education.

Reference Books:

1. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing”, California Technical Publishing.
2. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education.
3. Claudio Becchetti and Lucio Prina Ricotti, “Speech Recognition”, John Wiley and Sons.

Semester: 7th			
Paper code: OAE413P	**L**	**T/P**	**Credits**
Subject: Audio and Speech Processing Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	To provide hands-on experience in audio data handling, preprocessing, and feature extraction.
2.	To enable students to apply machine learning and signal processing techniques to real-world speech-related problems and evaluate their performance.

Course Outcomes:

CO1	Gain practical experience in processing and analyzing audio signals for various applications, including speech recognition and emotion analysis.
CO2	Develop skills in implementing machine learning models for audio and speech-related tasks, and understanding their limitations and challenges.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	2	1	-	-	-	-	-	-	1
CO2	2	2	2	2	1	1	1	1	1	1	1	2

List of Experiments:

1. To visualize audio signals in the time and frequency domains, understanding the characteristics of audio data.
2. To preprocess audio data, remove noise, and apply techniques like normalization and filtering.
3. To extract relevant features (e.g., MFCC, Mel spectrogram) from audio data for speech recognition tasks.
4. To implement a basic speech recognition system using HMM and observe its performance.
5. To identify speakers from a dataset using methods like Gaussian Mixture Models (GMM) or Support Vector Machines (SVM).
6. To classify the emotional state of speakers from audio data using machine learning techniques.

7. To compress audio files using MPEG audio compression standards and analyze the trade-offs between size and quality.
8. To convert text into speech using TTS systems and evaluate the synthesized speech quality.
9. To automatically segment an audio recording and identify distinct speakers present in it.
10. To develop a deep learning model for detecting specific keywords or commands in an audio stream.
11. To optimize a speech emotion recognition model for running on edge devices like Raspberry Pi or Arduino.
12. To apply deep learning techniques to enhance the quality of noisy speech signals.

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Semester: 7th			
Paper code: OAE415T	**L**	**T/P**	**Credits**
Subject: Cyber Forensics and Cyber Crime Investigation	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	Compare and contrast the differences between digital evidence and traditional evidence
2.	Discuss the ways in which digital evidence is authenticated
3.	Describe and critique digital forensics process models
4.	Critically evaluate standards and good practices for digital evidence and digital forensics

Course Outcomes:

CO1	Understand the fundamentals of cybercrime and issues.
CO2	Analyze different investigation tools for cybercrime.
CO3	Understand basics of Forensic Technology and Practices.
CO4	Apply different laws, ethics and evidence handling procedures to design AI based modules and Technologies.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

Cyber Forensics and Cyber Crime Investigation is an essential course for B.Tech AI, ML, IIoT, and Data Science students to understand the principles, techniques, and legal aspects of investigating cybercrimes. The syllabus covers digital evidence acquisition, analysis, and cybercrime investigation methodologies.

UNIT I **[10]**

Cybercrimes and related offences and penalties: Introduction to Cybercrimes, Classification of cybercrimes, Distinction between cyber crime and conventional crimes, Reasons for commission of cyber crime, Kinds of cyber crimes – cyber stalking; cyber pornography; forgery and fraud; crime related to IPRs; Cyber terrorism; Spamming, Phishing, Privacy and National Security in Cyberspace, Cyber Defamation and hate speech, computer vandalism etc.

UNIT II **[10]**

Digital Forensics: Introduction to Digital Forensics, Forensic Software and Hardware, Analysis and Advanced Tools, Forensic Technology and Practices, Forensic Ballistics and Photography, Face, Iris and Fingerprint Recognition, Audio Video Analysis, Windows System Forensics, Linux System Forensics, Network Forensics.

UNIT III **[10]**

Cyber Crime Investigation: Introduction to Cyber Crime Investigation, Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Hands on Case Studies. Encryption and Decryption Methods, Search and Seizure of Computers, Recovering Deleted Evidences, Password Cracking.

UNIT IV **[10]**

Cyber Laws: Provisions in Indian Laws in dealing with Cyber Crimes and its critical analysis, Information Technology Act, 2000, Penalties under IT Act, Offences under IT Act, Offences and Analysis related with Digital Signature and Electronic Signature under IT Act, Statutory Provisions, Establishment of Authorities under IT Act and their functions, powers. Cyber crimes under IPC.

Text Books:

1. Nelson Phillips and Enfinger Steuart, "Computer Forensics and Investigations", Cengage Learning, New Delhi, 2009.
2. Kevin Mandia, Chris Prosise, Matt Pepe, "Incident Response and Computer Forensics ", Tata McGraw -Hill, New Delhi, 2006.

Reference Books:

1. Robert M Slade," Software Forensics", Tata McGraw - Hill, New Delhi, 2005.
2. Bernadette H Schell, Clemens Martin, "Cybercrime", ABC – CLIO Inc, California, 2004.
3. "Understanding Forensics in IT ", NIIT Ltd, 2005.

Semester: 7th			
Paper code: OAE417T	**L**	**T/P**	**Credits**
Subject: Advanced Java Programming	**3**	**0**	**3**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide students with a strong foundation in advanced Java programming concepts and their practical applications.
2.	To enable students to design and implement multithreaded applications and handle exceptions effectively.
3.	To equip students with networking and database connectivity skills for building networked applications with database interaction.
4.	To introduce students to GUI development using JavaFX and explore web development concepts with Java Servlets, JSP, and Spring.

Course Outcomes:

CO1	Develop expertise in advanced Java concepts, including multithreading, networking, database connectivity, and GUI development.
CO2	Apply advanced Java knowledge to create real-world applications involving networking, database interaction, and graphical user interfaces.
CO3	Utilize design patterns and principles to solve complex programming challenges and optimize application performance.
CO4	Gain an understanding of web development concepts with an introduction to Java Servlets, JSP, and the Spring Framework.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	1	2	3	3	1	1	-	1	1	-	-	2
CO2	2	2	3	3	1	1	-	1	1	-	-	2
CO3	2	2	3	3	1	1	-	1	2	-	-	2
CO4	2	2	3	3	2	1	1	1	2	-	-	2

Course Overview:

Advanced Java Programming is designed for B.Tech AI, ML, IIoT, and Data Science students to enhance their Java skills, focusing on advanced topics like multithreading, networking, database connectivity, and GUI development. The syllabus covers Java's latest features and applications in real-world scenarios.

UNIT I **[8]**

JDBC Architecture: JDBC Architecture, a Relational Database Overview, Processing SQL Statements with JDBC Establishing a Connection, Connecting with DataSource Objects, Handling SQLExceptions, Retrieving and Modifying Values from Result Sets, Using Prepared Statements, Using Transactions, Using RowSet Objects

UNIT II **[8]**

Generics & Collection Framework APIs: Introduction to Design Patterns: the Factory Design Pattern, the Singleton Design Pattern.

UNIT III **[8]**

Why use Servlets & JSPs: an introduction to web servers & clients, HTML, HTTP Protocol, HTTP GET and POST requests, HTTP responses. Web App Architecture: high-level overview. A ModelView-Controller (MVC) overview and example, life cycle of a servlet, request & response objects, Init Parameters and ServletConfig, JSP init parameters, Context init parameters, attributes and listeners, session management.

UNIT IV **[8]**

Scriptless JSP: Create a simple JSP using "out" and a page directive, JSP expressions, variables, and declarations, implicit objects, The Lifecycle and initialization of a JSP, other directives. Standard actions, Expression Language, The EL implicit objects & EL functions, using JSTL.

Text Books:

1. Dietel & Deitel, Java How to Program, Pearson Education, 10th Ed., 2015.
2. Bryan Basham, Kathy Sierra, Bert Bates, Head First Servlets & JSPs , O'REILLY, 2nd Ed., 2008.

Reference Books:

1. Eric Freeman , Elisabeth Freeman, Kathy Sierra and Bert Bates, Head First Design Patterns, O'REILLY, 1st Ed., 2004.

Semester: 7th			
Paper code: OAE417P	**L**	**T/P**	**Credits**
Subject: Advanced Java Programming Lab	**0**	**2**	**1**

Marking Scheme:

1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End term Examination: As per university examination norms from time to time

INSTRUCTIONS TO EVALUATORS: Maximum Marks: As per university norms

1. This is the practical component of the corresponding theory paper.
2. The practical list shall be notified by the teacher in the first week of the class commencement under the intimation to the office of the HOD/ Institution in which they appear is being offered from the list of practicals below.
3. Instructors can add any other additional experiments over and above the mentioned in the experiment list which they think is important.
4. At least 8 experiments must be performed by the students.

Course Objectives:

1.	Develop a deep understanding of advanced Java concepts, such as multi-threading, networking, and database connectivity, to build robust and efficient applications
2.	Gain practical experience by working on real-world Java projects, which involve solving complex problems and implementing solutions using advanced Java features.

Course Outcomes:

CO1	Achieve proficiency in utilizing advanced Java features, including multithreading, socket programming, JDBC, and JavaFX, to develop high-performance applications.
CO2	Be capable of designing and building robust, scalable, and secure applications that leverage advanced Java programming techniques for real-world use cases.

Course Outcomes (CO) to Programme Outcomes (PO) Mapping

(Scale 1: Low, 2: Medium, 3: High)

CO/PO	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	2	2	2	3	3	-	1	-	1	-	-	2
CO2	2	2	-	3	3	-	-	-	-	-	1	1

List of Experiments:

1. Write a java program of thread synchronization, inter-thread communication, and thread pooling.
2. Implement a client-server application using Java's networking APIs.
3. Design a calculator, a simple text editor, or a graphical game with user interaction and visual components. Explore event handling, layout managers, and UI design principles.
4. Implement functionalities like data retrieval, insertion, deletion, and updating records. Explore concepts like JDBC, SQL queries, and database transactions.
5. Utilize third-party libraries or frameworks in Java programming. Choose a popular library (e.g., Apache Commons, Gson, Log4j) and develop programs that showcase its features and functionality.
6. Write a java program to writes objects to a file in a serialized format and then reads and reconstructs the objects from the file.

7. Write a java program that uses reflection to inspect and modify the behavior of objects based on user input or external configuration.
8. Implement generic methods to perform operations like sorting, searching, or filtering on generic collections.
9. Design custom annotations and use them in a Java program to provide additional metadata and define behavior.
10. Write a java program to Integrate Java with native code by using the JNI (with native libraries written in C/C++).
11. Implement functional programming concepts and solve problems related to data manipulation, filtering, or mapping.

Semester: 7th			
Paper code: OAE419T	**L**	**T/P**	**Credits**
Subject: Bioinformatics	**4**	**0**	**4**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:

1.	To provide exposure to the Data Science and Machine Learning within the context of its importance in biology.
2.	To learn various methodologies and techniques in biology using Data Science.
3.	To learn various tools for bioinformatics data analytics.
4.	To learn deep learning approaches for bioinformatics applications.

Course Outcomes:

CO1	To understand the importance of Data Science and machine learning in biology
CO2	To acquire knowledge of different data science and machine learning techniques in biology.
CO3	Apply various tools for bioinformatics data analytics.
CO4	Learn and applying deep learning approaches for bioinformatics applications.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:

Bioinformatics is designed for B.Tech AI, ML, IIoT, and Data Science students to explore the application of computational methods in analyzing biological data. The syllabus covers biological databases, sequence analysis, protein structure prediction, and gene expression analysis using bioinformatics tools and algorithms.

UNIT I **[10]**

Introduction to Bioinformatics: Definition, scope, and applications of bioinformatics, Role of bioinformatics, computational methods and tools used in bioinformatics.

Biological Databases and Data Retrieval: biological databases (e.g., GenBank, UniProt, NCBI), Data types and formats in bioinformatics, Database search and retrieval techniques, Need for Data Science in Biology and Healthcare, Visualization tools for biological and bioinformatics datasets, data handling, transformations of data.

UNIT II **[10]**

AI and Data Science in Sequence Analysis and Genomics: Introduction, Sequence alignment using machine learning algorithms, DNA and protein sequence classification and clustering, Data Science in genomics, from genetics to genomes, Alignment, and phylogenetic trees.

UNIT III **[10]**

Prediction and Design: Structural bioinformatics, Storage in Protein Data Bank, 1D, 2D, 3D Structure Prediction, Secondary Structure Prediction, Proteomics, Protein structure prediction, integrative structural modeling, and structure-based drug design.

UNIT IV **[10]**

Bioinformatics System: AI algorithms, statistical tools, graph algorithms for bioinformatics data analytics. Deep learning algorithms in perspective of bioinformatics applications, contact prediction, GANs for biological applications, Whole-cell modeling approaches.

Text Books:

1. Arthur M. Lesk, "Introduction to Bioinformatics", Oxford University Press) (Fifth Edition)
2. Jeil Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media Inc. (Second Edition,)

Reference Books:

1. Vince Buffalo, "Bioinformatics Data skills", O'Reilly Media Inc.
2. Neil C. Jones and Pavel A. Pevzner, "An introduction to Bioinformatics Algorithms", The MIT Press.

Semester: 7th			
Paper code: OAE421T	**L**	**T/P**	**Credits**
Subject: Digital & Smart Cities	**4**	**0**	**4**

Marking Scheme:
1. Teachers Continuous Evaluation: As per university examination norms from time to time
2. End Term Theory Examination: As per university examination norms from time to time

INSTRUCTIONS TO PAPER SETTERS: Maximum Marks: As per university norms

1. There should be 9 questions in the end term examination question paper.
2. Question No. 1 should be compulsory and cover the entire syllabus. This question should have objective or short answer type questions.
3. Apart from Question No. 1, the rest of the paper shall consist of four units as per the syllabus. Every unit should have two questions. However, students may be asked to attempt only 1 question from each unit.
4. The questions are to be framed keeping in view the learning outcomes of course/paper. The standard/ level of the questions to be asked should be at the level of the prescribed textbooks.
5. The requirement of (scientific) calculators/ log-tables/ data-tables may be specified if required.

Course Objectives:	
1.	To familiarize students with the fundamental concepts and components of smart cities.
2.	To explore the role of AI, ML, and IoT in building innovative smart city solutions.
3.	To provide insights into the challenges and opportunities in the digital infrastructure of smart cities.
4.	To promote an understanding of the social, ethical, and governance aspects of smart city development.

Course Outcomes:	
CO1	Acquire a comprehensive understanding of the concepts, technologies, and challenges associated with smart cities.
CO2	Develop the ability to apply AI and IoT technologies in designing smart city solutions and addressing urban challenges.
CO3	Gain knowledge of digital infrastructure components necessary for building smart cities, including data management and cybersecurity.
CO4	Appreciate the importance of sustainable and inclusive development principles in smart city planning and implementation.

Course Outcomes (CO) to Programme Outcomes (PO)

Mapping (Scale 1: Low, 2: Medium, 3: High

CO/ PO	**PO01**	**PO02**	**PO03**	**PO04**	**PO05**	**PO06**	**PO07**	**PO08**	**PO09**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	-	-	1	1	1	1	1	1	2
CO2	2	2	-	3	3	-	-	-	-	-	-	2
CO3	2	2	2	3	3	-	1	-	1	-	-	-
CO4	2	2	-	3	3	-	-	-	-	-	1	-

Course Overview:
This course provides students with an in-depth understanding of digital and smart cities. It covers the fundamental concepts of smart cities, the role of AI, ML, and IoT in enabling smart solutions, and the importance of digital infrastructure and governance. Through case studies and real-world examples, students will gain insights into the challenges and opportunities in building sustainable and inclusive smart cities in the context of Indian and global scenarios.

UNIT I **[10]**

Unit 1: Introduction to Smart Cities: Introduction to smart cities: Concepts, components, and characteristics, Role of AI, ML, and IoT in enabling smart city solutions. Case studies of successful smart city implementations in India and worldwide.

UNIT II **[10]**

Digital Infrastructure for Smart Cities: Urban sensing and data collection technologies. Cloud computing, edge computing, and data centers in smart cities. Cybersecurity and privacy challenges in smart city infrastructures.

UNIT III **[10]**

AI and IoT Applications in Smart Cities: Smart transportation systems and traffic management. Energy-efficient buildings and smart grids. Healthcare and public safety solutions. Waste management and environmental monitoring.

UNIT IV **[10]**

Smart Governance and Citizen Engagement: E-governance and digital services for citizens. Open data initiatives and data-driven decision-making. Community engagement and participatory platforms. Social and ethical considerations in smart city development.

Text Books:

1. "Smart Cities: Digital Transformations, Smart Urban Infrastructures and Digital Innovation" by Matteo Zignani, Vincenzo Mighali, and Raffaele Giaffreda.
2. "Smart Cities: Foundations, Principles, and Applications" by Hossam Gabbar.

Reference Books:

1. "Smart Cities: Big Data Prediction Methods and Applications" by Robert J. Howlett and Lakhmi C. Jain.
2. "Internet of Things for Smart Cities: Technologies, Big Data and Security" by Fadi Al-Turjman.
3. "Artificial Intelligence and IoT for Smart Cities: Applications and Security" by Fahim Ahmed Shaikh.

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