COCHIN UNIVERSITY OF SCIENCE & TECHNOLOGY, KOCHI, KERALA, INDIA

SCHEME & SYLLABUS
(2026 Admission onwards)

B. TECH. PROGRAMME
in
Artificial Intelligence and Data Science

B.TECH. DEGREE PROGRAMME IN INFORMATION TECHNOLOGY

VISION

To become a world leader in higher education and research in the field of Information Technology.

MISSION

To impart state-of-the-art knowledge in the field of Information Technology with a focus on developing the required competencies and virtues to meet the requirements of the society and to become a centre of excellence in this field.

To attract graduate, post-graduate and research students and train them in innovative areas, so that they can impress various recruiters from industry and academia and also become entrepreneurs in Information Technology.

Programme Educational Objectives (PEOs):

After a few years of B. Tech. graduation in Information Technology, the candidate is expected to achieve the following PEOs.

PEO1: PREPARATION - To prepare students to excel in postgraduate programmes or to succeed in industry / technical profession through global, rigorous education.

PEO2: CORE COMPETENCE - To provide students with a solid foundation in mathematical, scientific, and engineering fundamentals required to solve engineering problems and also to pursue higher studies.

PEO3: BREADTH - To train students with good scientific and engineering breadth so as to comprehend, analyze, design, and create novel products and solutions for real-life problems.

PEO4: PROFESSIONALISM - To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and broader social context.

PEO5: LEARNING ENVIRONMENT - To provide students with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

Programme Outcomes (POs):

A graduate of this major should be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and

IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

Programme Specific Outcomes (PSOs)

Artificial Intelligence & Data Science graduates will be able to:

PSO1: Apply AI, machine learning, and data science techniques to analyze problems and develop intelligent solutions.

PSO2: Design and manage scalable data pipelines, models, and computational systems for effective data processing and analysis.

PSO3: Implement secure, ethical, and responsible AI practices ensuring fairness, transparency, and privacy.

Program Articulation Matrix

Mission Statement	**PEO1**	**PEO2**	**PEO3**	**PEO4**	**PEO5**
To impart state-of-the-art knowledge in the field of Information Technology with a focus on developing the required competencies and virtues to meet the requirements of the society and to become a centre of excellence in this field.	**3**	**3**	**3**	**3**	**3**
To attract graduate, post-graduate and research students and train them in innovative areas, so that they can impress various recruiters from industry and academia and also become entrepreneurs in Information Technology.	**3**	**3**	**3**	**3**	**3**

1-Slightly; 2- Moderately; 3- Substantially

Categories of Courses with the Breakup of Credits

Sl. No	Category of Courses	Credit breakup for AI & DS
1	Humanities and Social Sciences including Management Courses (HSMC)	6
2	Basic Science courses (BSC) comprising basic sciences and mathematics	20
3	Engineering Science Courses (ESC) including workshop, drawing, basics of electronics/electrical/mechanical/computer etc.,	17
4	Professional Courses (PCC) introducing the student to the foundations of the engineering in the respective programme.	83
5	Professional elective courses (PEC) enabling the student to opt and undergo a set of courses of interest to him/her.	18
6	Open Elective Courses (OEC) including technical and/or emerging subjects including muti-disciplinary and transdisciplinary courses.	6
7	Employment Enhancement Courses (EEC) including project, seminar, and industrial training and internships in industry/higher educational institutions of national eminence	20
8	Mandatory courses (MC) comprising environmental sciences, induction program, Indian Constitution, essence of Indian Knowledge Tradition etc.,	(noncredit)
	Total	170

Stream B: Computer Science and Engineering, Electrical and Electronics Engineering, Electronics and Communication Engineering , Information Technology& Artificial Intelligence and Data Science.

SEMESTER I (STREAM B)

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26-----0101B	Calculus	BSC	3	1	0	4	50	50	100
26-----0102B	Engineering Physics	BSC	3	0	1	3	50	50	100
26-----0103B	Introduction to Electronics devices & Circuits	ESC	3	1	0	4	50	50	100
26-----0104B	Introduction to Electrical Engineering	ESC	3	0	0	3	50	50	100
26-----0105B	Computer programming	ESC	3	1	0	3	50	50	100
26-----0106B	Soft Skills Development	EEC	2	0	0	2	100	-	100
26-----0107B	Computer Programming Laboratory	ESC	0	0	3	1	50	50	100
26-----0108B	Basic Electronics Lab	ESC	0	0	3	1	50	50	100
26-----0109B	Language Laboratory	EEC	0	0	2	1	50	50	100
26-----0110B	NSS/Nature conservation Activities/Yoga	MC	0	0	1	0	-	-	-
	TOTAL		**17**	**3**	**10**	**22**			

CA – Continuous Assessment SEE – Semester End Examination

SEMESTER II (STREAM B)

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26----0201B	Linear Algebra & Transform Techniques	BSC	3	1	0	4	50	50	100
26----0202B	Engineering Chemistry	BSC	3	0	1	3	50	50	100
26----0203B	Digital Electronics	ESC	3	1	0	3	50	50	100
26----0204B	Object Oriented Programming in C++	PCC	3	1	1	4	50	50	100
26----0205B	Introduction to Cyber Physical Systems	PCC	3	1	0	3	50	50	100
26----0206B	Environmental and Life Sciences	HSMC	3	0	0	3	50	50	100
26----0207B	Design Thinking Laboratory	ESC	0	0	3	1	50	50	100
26----0208B	Basic Electrical Engineering Laboratory	ESC	0	0	3	1	50	50	100
	TOTAL		**18**	**4**	**8**	**22**			

SEMESTER III

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26------0301B**	Differential Equations and Complex Variables	BSC	3	1	0	3	50	50	100
26-------0302	Artificial Intelligence	PCC	3	1	0	3	50	50	100
26--------0303	Discrete Computation and Data Structures	PCC	3	1	0	3	50	50	100
26-------0304	Data Engineering	PCC	3	1	0	3	50	50	100
26-------0305	System Programming	PCC	3	1	0	3	50	50	100
26--------0306	Hardware Architectures for Intelligent Systems	PCC	3	1	0	3	50	50	100
26-------0307	Data Structures laboratory	PCC	0	0	3	1	50	50	100
26-------0308	Smart Systems Laboratory	PCC	0	0	3	1	50	50	100
26-------0309	Internship-I	EEC	0	0	1	1	100		100
	TOTAL		**18**	**6**	**7**	**21**			

*Common for CS/EEE/ECE/IT/AI&DS

Internship-1 of a minimum duration of two weeks (10 working days) after second semester and the evaluation will take place during the III semester. For Lateral Entry students a mini project carried out can be considered equivalent to Internship-I

#Students should take Massive Open Online Courses (MOOCs) approved by the concerned Division/Board of Studies

SEMESTER IV

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26------0401	Probability and Statistics	BSC	3	1	0	3	50	50	100
26------0402	Machine Learning	PCC	3	1	0	3	50	50	100
26------0403	Data Communication & Intelligent Network	PCC	3	0	0	3	50	50	100
26------0404	Web Technologies and Internet Programming	PCC	3	0	0	3	50	50	100
26-------0405	Data Science	PCC	3	1	0	3	50	50	100
26-------0406	Ethical and Responsible AI	PCC	3	0	0	3	50	50	100
26-------0407	UHV	HSMC	2	1	0	3	50	50	100
26-------0408	Machine Learning and Data Science in Python laboratory	PCC	0	0	3	1	50	50	100
26-------0409	Capstone Project 1: Full stack Development	EEC	0	0	3	1	50	50	100
	TOTAL		**20**	**4**	**6**	**23**			

**Common for All branches

#Students should take Massive Open Online Courses(MOOCs) approved by the concerned Division/Board of Studies(BoS)

SEMESTER V

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26-----0501	Optimization Techniques	PCC	3	1	0	3	50	50	100
26------0502	Algorithmic Techniques & Analysis	PCC	3	1	0	3	50	50	100
26------0503	Big Data Analytics & Visualization	PCC	3	1	0	3	50	50	100
26------0504	Software Architecture and Design Pattern	PCC	3	1	0	3	50	50	100
26------0505	Cloud Technologies and Services	PCC	3	1	0	3	50	50	100
26----------	Professional Elective -1 /(MOOC)	PEC	0	0	0	3	-	-	100
26----------	Data Visualization and Analytics Laboratory	PCC	0	0	3	1	50	50	100
26----------	Capstone Project 2: Cloud-based AI Applications	PCC	0	0	3	1	50	50	100
26----------	Internship-II	EEC	0	0	1	1	100		100
	TOTAL		**15**	**5**	**7**	**21**			

Internship-II of a minimum duration of two weeks (10 working days) after fourth semester and the evaluation will take place during the V semester.

#Students should take Massive Open Online Courses(MOOCs) approved by the concerned Division

SEMESTER VI

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26----------	Customer Relationship Management in Artificial Intelligence	PCC	3	1	0	3	50	50	100
26----------	Digital Twinning in Intelligent Autonomous Systems	PCC	3	1	0	3	50	50	100
26----------	Deep Learning and Generative AI	PCC	3	1	0	3	50	50	100
26----------	Edge Intelligence	PCC	3	1	0	3	50	50	100
26----------	Natural language Processing and Large Language Models	PCC	3	1	0	3	50	50	100
26----------	Industry Elective -1	PEC	3	1	0	3	50	50	100
26----------	Edge AI and Networking Lab	PCC	0	0	3	1	50	50	100
26----------	Capstone Project 3 – AI based Mobile App Development	EEC	0	0	3	1	50	50	100
	TOTAL		**18**	**6**	**6**	**20**			

#Students should take Massive Open Online Courses(MOOCs) approved by the concerned Division.

SEMESTER VII

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26----------	Data Security and Privacy in Artificial Intelligence	PCC	3	1	0	3	50	50	100
26----------	Computer Vision and Image Processing	PCC	3	1	0	3	50	50	100
26----------	Professional Elective- II/ (MOOC)	PCC	3	1	0	3	50	50	100
26----------	Industry Elective -II	PEC	3	1	0	3	50	50	100
26----------	Open Elective-1	OEC	3	0	0	3	50	50	100
26----------	Multimodal Vision Laboratory	PCC	0	0	3	1	50	50	100
26----------	Capstone Project - Generative Artificial Intelligence and Applications	EEC	0	0	3	1	50	50	100
26……	Entrepreneurship Development	EEC	0	0	2	1	100	-	100
26----------	Project Phase I	EEC	0	0	3	2	100	-	100
26----------	Internship-III	EEC	0	0	1	1	100	-	100
	TOTAL		**15**	**4**	**12**	**21**			

Internship-III of a minimum duration of two weeks (10 working days) after VI semester and the evaluation will take place during the VII semester.
#Students should take Massive Open Online Courses(MOOCs) approved by the concerned Division.

SEMESTER VIII- Regular Track

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26----------	Professional Elective -III /(MOOC)	PEC	3	1	0	3	50	50	100
26----------	Professional Elective-IV/(MOOC)	PEC	3	1	0	3	50	50	100
26----------	Industry Elective -III	PEC	3	1	0	3	50	50	100
26----------	Open Elective -II	OEC	3	0	0	3	50	50	100
26----------	Seminar	EEC	0	0	3	1	100	-	100
26----------	Project -Phase-2	EEC	0	0	12	6	100	-	100
26----------	Comprehensive Viva Voce	EEC	0	0	0	1	-	100	100
	TOTAL		**12**	**3**	**15**	**20**			

SEMESTER VIII- Internship Track*

Code No.	Subject	Category	L H/ W	T H/ W	P/D H/W	C	Marks		Total
							CA	SEE	
26----------	Professional Elective – III(MOOC)	PEC	3	1	0	3	50	50	100
26----------	Professional Elective IV(MOOC)/ Open Elective - II	PEC/OEC	3	1	0	3	50	50	100
26----------	Seminar	EEC	0	0	3	1	100	-	100
26----------	Project Phase - II	EEC	0	0	12	6	100	-	100
26----------	Comprehensive Viva Voce	EEC	0	0	0	1	-	100	100
26----------	Internship-IV	EEC	0	0	0	6	100		100
	TOTAL		**6**	**2**	**15**	**20**			

PROFESSIONAL ELECTIVE -I/(MOOC)	
Code No.	**Subject**
26----------	Agile Project Methodology
26----------	Human–Computer Interaction and Intelligent Interfaces
26----------	Cognitive Networks
26----------	Operating Systems

PROFESSIONAL ELECTIVE -II/(MOOC)	
Code No.	**Subject**
26----------	Quantum Machine Learning
26----------	AI for Cybersecurity
26----------	Blockchain and Data Integrity Systems
26----------	Compiler Design

PROFESSIONAL ELECTIVE -III/(MOOC)	
Code No.	**Subject**
26----------	Semantic Web
26----------	Formal Languages and Automata Theory
26----------	Intelligent Process Automation
26----------	Reinforcement learning

PROFESSIONAL ELECTIVE -IV/(MOOC)	
Code No.	**Subject**
26----------	Distributed and Cloud Operating Systems
26----------	AI in Smart Cities and IoT Systems
26----------	Neuromorphic Computing
26----------	Advanced Python for AI

INDUSTRY ELECTIVE – I	
Code No.	**Subject**
26----------	MLOps and Model Deployment
26----------	Emerging Trends in AI applications
26----------	AI for FinTech and Business Intelligence
26----------	Federated Learning

INDUSTRY ELECTIVE – II	
Code No.	**Subject**
26----------	Multi-Agent Systems and Applications
26----------	Smart Satellite Systems and Data Analytics
26----------	Generative Artificial Intelligence and Applications
26----------	Learning Analytics

INDUSTRY ELECTIVE – III	
Code No.	**Subject**
26----------	Digital Marketing
26----------	Augmented and Virtual Reality
26----------	Agentic Artificial Intelligence
26----------	Startups and AI Entrepreneurship

OPEN ELECTIVE – I	
Code No.	**Subject**
26----------	The students shall select at least one open elective course from a domain outside their parent branch of study as MOOC with prior approval by the parent division.

OPEN ELECTIVE – I (Offered)	
Code No.	**Subject**
26----------	Ethics and Policy in Artificial Intelligence
26----------	Cognitive Computing Systems
26----------	Autonomous Systems and Vehicles
26----------	Prompt Engineering

OPEN ELECTIVE – II	
Code No.	**Subject**
26----------	AI in Healthcare Systems
26----------	Social Network Analysis
26----------	Constitutional Law
26----------	Intelligent Recommendation Systems

Industry Based Electives

Industry-based Electives are offered in the 6th, 7th and 8th Semesters

Open Electives

Open Electives are offered in the 7th and 8th Semesters. The students shall select at least one open elective course from a domain outside their parent branch of study as MOOC with prior approval by the parent division..

MOOC

Every student shall undergo at least one MOOC of minimum 3 credits during the programme (preferably before the final semester) as per the university Regulations for conducting online courses (MOOC). If the MOOC course specified in the scheme is not available during the semester, division may approve an equivalent from the list of NPTEL/SWAYAM or any other agencies approved by the university.

SEMESTER VIII Internship Track

Students who intend to go for the Internship Track should inform the division head concerned before the commencement of the 8th Semester. The student will be given the option to change the track within 30 days from the commencement of the 8th Semester. Students opting for the Internship Track have to do Project Phase II and appear for the Comprehensive Viva-Voce.

The interns may opt for courses recommended by the division from the list of NPTEL/SWAYAM courses or any other agencies approved by the university.

The students opting for the divisional courses must fulfil the Continuous Assessment (CA) and Semester End Examination (SEE) requirements.

One elective from the Open Elective pool is mandatory if they have not completed one mandatory Open Elective in the seventh semester.

Project Phase II is the continuation of Project Phase I in the seventh semester or a separate one if approved by the division.

The Internship-IV, of a minimum six weeks duration, must be done in an Industry approved by the Placement

Cell or the respective division based on a valid MOU or in any reputed organization approved by the division.

The progress of Internship-IV will be evaluated twice during the semester, along with the Continuous Assessment tests and finally after the completion of the internship.

Special Option for Outstanding Students

1. This Special Option for Outstanding Students (SOOS) enables outstanding students having CGPA 9.0 or above (CGPA up to and including IV semester) with no history of backlogs to successfully complete the mandatory elective/s earmarked for the VIII semester during the VI and VII semesters itself by making use of the equivalent MOOCs with the necessary prior approval by the concerned Division. This SOOS option enables outstanding students to fully concentrate on the project/internship during the VIII semester.

2. The interested candidates meeting the eligibility criteria as mentioned in section1 shall apply for the SOOS Option immediately after the IV semester results got published.

3. The Department/Division shall scrutinize the applications received for the SOOS option and shall publish the list of students eligible for the same along with the details of the MOOCs equivalent to the VIII semester electives within 15 days.

4. The certificates of successful completion of all the relevant VIII semester elective course/s shall be submitted by the student to the University within the stipulated time. i.e., before the beginning of the VIII semester.

5. If the student fails to submit the certificates as mentioned in section 4 above or not interested in utilizing the SOOS option, he/she has to undergo VIII semester using the regular/internship track as mentioned in the B. Tech scheme.

EVALUATION PATTERN FOR THEORY AND PRACTICAL COURSES

1. Theory Courses

Types of questions for Semester End Examination (SEE)

Part A $(\mathbf{5 \times 2 = 10}\ \boldsymbol{marks})$
Question No. I (a) to (e) – Five short answer questions of 2 marks each with at least one question from each of the four modules.

Part B $(\mathbf{4 \times 10 = 40}\ \boldsymbol{marks})$
Questions nos. II, III (from Module I) of 10 marks each with the option to answer either II or III. The questions may have sub-sections (a) and (b)
Questions nos. IV, V (from Module II) of 10 marks each with the option to answer either IV or V. The questions may have sub-sections (a) and (b)
Questions nos. VI, VII (from Module III) of 10 marks each with the option to answer either VI or VII. The questions may have sub-sections (a) and (b)
Questions nos. VIII, IX (from Module IV) of 10 marks each with the option to answer either VIII or IX. The questions may have sub-sections (a) and (b)
The maximum marks that can be awarded for the Semester End Examination (SEE) will be 50

2. Practical Courses

50% of marks are earmarked for Continuous Evaluation, and 50% of marks are for Semester End Examination. A minimum of two examiners will conduct the semester-end examination.

Pass Requirements

A candidate has to obtain a minimum of 40% marks for Continuous Assessment and Semester End Examination, put together with a minimum of 40% marks in the Semester End Examination for a pass in theory and laboratory courses.
In the case of theory/laboratory/other courses having only Continuous Assessment, a candidate has to obtain a minimum of 40% marks in Continuous Assessment for a pass.

SEMESTER I

26-----0101B CALCULUS

Course Outcomes:

On completion of this course the student will be able to:

1. Solve ordinary differential equations and linear differential equations of higher orders with constant coefficient and apply them in engineering problems
2. Determine the maxima and minima of multi variable functions.
3. Convert line integrals into surface integrals and surface integrals into volume integrals
4. Illustrate the physical meaning and application of gradient, divergence and curl

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	1	
CO2	3	2	1										2	1	
CO3	3	2											3	1	
CO4	3	3	1										3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Ordinary differential equations:
First order differential equations - exact differential equations, Bernoulli's equations--Methods of solution and Simple applications.
Linear differential equations of higher orders with constant co-efficient-Methods of solution of these equations. Cauchy's linear differential equations. Simultaneous linear differential equations- Simple applications of linear differential equations in engineering problems –Electrical Circuits, Mechanical Systems.

Module II

Partial differentiation: Partial Differentiation-Concept of partial derivative - Chain rule- Total derivative- Euler's theorem for homogeneous functions, Differentials and their applications in errors and approximations, Jacobians - Maxima minima of functions of two variables (Proof of the result not required)-Simple applications.
Co-ordinate systems: Rectangular co-ordinates-Polar co-ordinates-In plane and in Space-Cylindrical polar co-ordinates-Spherical polar co-ordinates.

Module III

Integral calculus:
Application of definite integrals: Area, Volume, Arc length, Surface area.
Multiple integral: Evaluation of double integrals-Change of order of integration. Evaluation of triple integrals-Change of Variables in integrals.
Applications of multiple integrals. Plane Area, Surface area & Volumes of solids

Module IV

Vector calculus: scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of vector point functions, their physical meaning. Evaluation of
line integral, surface integral, and volume integrals, Gauss's divergence theorem, Stoke's theorem (No proofs), conservative force fields, scalar potential. Note: Implement case study as assignments.

Textbook:

1. Erwin Kreyzig. Advanced Engineering Mathematics (Tenth edition). John Wiley& Sons, Hoboken, NJ. (2011)
2. Grewal, B.S. Higher Engineering Mathematics. (Forty third Edition). Khanna Publishers, New Delhi. (2013).

References:

1. Sastry, S.S. Engineering Mathematics: Vol1. (Fourth edition). PHI Learning, New Delhi. (2008).
2. Veerarajan, T. Engineering Mathematics. (Third edition). Tata McGraw Hill Publishers, New Delhi. (2011)

26-----0102B ENGINEERING PHYSICS

Course Outcomes:

On completion of this course the student will be able to:

1. Interpret modern devices and technologies based on lasers and optical fibres.
2. Explain the basic principles of crystal physics
3. Summarise the characteristics and applications superconducting materials nanomaterials and smart materials
4. Illustrate the theory of semiconductors and magnetic materials
5. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										1		
CO2	3	1	1										1	1	
CO3	3	2	1										1		
CO4	2	2	2										2	2	
CO5	3	2	2										3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Laser-properties-interaction of radiation with matter-absorption, spontaneous and stimulated emission-principle of laser--Einstein coefficients- population inversion- metastable state -Basic components of a laser- construction and working of Ruby laser and He-Ne laser -Applications.

Fibre optics - Basic structure - principle- step-index fibre and graded index fibre- single mode and multimode- Numerical aperture (no derivation) -acceptance angle and acceptance cone-propagation- Applications.

Module II

Crystallography – Space lattice- Basis- Unit cell-Bravais lattices- cubic lattices-sc, bcc, and fcc- Number of atoms per unit cell- Coordination number- Atomic Radius-Packing factor- Relation between density and crystal lattice constants-Lattice planes and Miller indices-

X rays- Production, Properties, characteristic and continuous X-rays, Moseley's law; Diffraction of X-rays- Bragg's law (derivation), Bragg's Spectrometer

Module III

Superconductor-transition temperature-Meissner effect-effect of current- isotope effect- Type 1 and type 2 superconductors –BCS theory (basic idea only)- Applications.

Nanomaterials- nanoparticle, nano ring, nano rod, nanoshells, fullerene- surface occupancy-quantum confinement effect- optical, electrical, magnetic and mechanical properties - Applications.

Smart materials-Liquid crystals, Metallic glasses, Shape memory alloys- optical, electrical magnetic and mechanical properties-applications

Module IV

Magnetic Materials-Magnetic pole strength, magnetic moment, intensity of magnetization, magnetic field, magnetic induction, magnetic susceptibility, magnetic permeability, classification. Hard and soft- Paramagnetic materials-properties, Diamagnetic materials-properties, Ferromagnetic properties- Antiferromagnetic materials, Ferrimagnetic materials- Applications.

Semiconductor Physics and Devices

Intrinsic semiconductor, Intrinsic carrier concentration, Variation of Intrinsic carrier concentration with temperature, Extrinsic semiconductor (qualitative), Fermi level in semiconductors-intrinsic and extrinsic, Formation of p-n junction, Energy band diagram of p-n

junction - Qualitative description of charge flow across a p-n junction - Forward and reverse biased p-n junctions, I-V Characteristics of p-n junction diode, Solar cells- IV Characteristics, Light Emitting Diode, Zener diode VI characteristics, Tunnel diode-VI characteristics. Semiconductor devices- Rectifiers-Full wave and Half wave.

Laboratory Experiments to be conducted in the virtual lab mode.

List of Experiments (Minimum six experiments shall be conducted)

1. Transmission grating: To find the wavelength of laser beam
2. Determination of NA of an optical fibre
3. Laser beam divergence and spot size
4. Determination of Grain size and lattice parameter using Bragg's X-ray spectrum
5. Lattice planes from X Y Z intercepts
6. LCR circuits to find the resonance frequency and quality factor.
7. Diode characteristics
8. Ohm's law
9. LED circuits to find cutting voltage.
10. Determination of Energy band gap of a given semiconductor material
11. Magnetic field along the axis of a circular coil carrying current
12. Deflection Magnetometer

Textbook:

1. Dr. B Premlet, Advanced Engineering Physics, 12th edition
2. A Nahari, Sindhu R L, Dr. Haritha V S, Sini Chandran, Physics for Engineers, McGraw Hill, 2022.

References:

1. S. Mani Naidu, A Textbook of Engineering Physics, Pearson. (2010)
2. A.S. Vasudeva, Modern Engineering Physics, S. Chand & Co. (2013)
3. Prabir K. Vasu and Hrishikesh Dhasmana, Engineering Physics, Ane books Pvt. Ltd. (2010)
4. S.O. Pillai and Sivakami, Applied Physics, New Age International (P) Ltd., Second Edition. (2008)
5. G.S. Raghuvanshi, Engineering Physics, Prentice Hall of India. (2008)

Pattern of Continuous Assessment

Test -I for the theory portions	:	30%
Test -II for the theory portions	:	30%
Assignment from the Theory	:	10%
Laboratory Record	:	10%
Viva-voce	:	10%
Attendance	:	10%

The students are required to submit the laboratory record.

26-----0103B INTRODUCTION TO ELECTRONICS DEVICES & CIRCUITS

Course Outcomes:

On completion of this course the student will be able to:

1. To understand the working principle of various semiconductor devices
2. To apply the acquired knowledge to the use of semiconductor devices in various applications.
3. To design simple electronic circuits for a given application.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2									1	1	1	
CO2	2	2	2									1	2	1	
CO3	1	3	1	1								1	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Semiconductor basics. PN junction diode and its characteristics, Diode Models Diode Applications: Rectifiers- Half wave and full wave rectifiers, Capacitive Filter Clipping and clamping circuits, Special purpose diode: Zener Diode, LED, Photo diode; Zener Shunt, Transistor series regulator

Module II

Bipolar Junction Transistors (BJT): Transistor Structure, Transistor operation, Transistor characteristics (CE & CB only) and alpha & beta Parameters, r parameter model, h parameter Transistor as an amplifier, Transistor bias circuits: DC operating point, load line, stabilization, Voltage divider bias, Thermal runaway. Transistor switch. FET, FET characteristics.

Module III

Amplifiers: classification of amplifiers as Voltage, Current, transconductance & transresistance amplifiers-properties, operation, CB, CC & CE Amplifiers, bypass and coupling capacitor, common emitter Amplifier, Amplifier Frequency Response: Basic concepts, Low frequency and High frequency response cutoff Total Amplifier frequency Response. FET amplifier (CS configuration only), Multistage amplifier (qualitative study).

Module IV

Feedback in amplifier, benefits of feedback, positive & negative feedback (qualitative study). Oscillator: RC phase shift oscillator, circuit & it's working. LC oscillator Multivibrator: astable multi vibrator, circuit & its working. Bistable multi vibrators, circuit & it's working. bistable as memory.

Textbook:

1. David M. Buchla, Thomas L. Floyd, Electronics Pearson Education Limited, Year: 2014

References:

1. K V Ramanan, Functional Electronics, Tata McGraw-Hill Publishing Company Ltd. (1984).
2. Donald Neamen, Semiconductor Physics and Devices, Tata McGraw-Hill Publishing Company Ltd., 4th edition (2021).
3. Jacob Milman & Christos C Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, McGraw Hill Education, 2 nd edition (2017).

26-----0104B INTRODUCTION TO ELECTRICAL ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Apply elementary principles for finding the DC response of Circuits.
2. Develop & solve models of basic magnetic & electromagnetic circuits.
3. Apply elementary principles for finding the sinusoidal steady state features of Circuits.
4. Familiarize with the basic engineering principles of some common electrical systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2									1		2	
CO2	2	2	2									1		1	
CO3	1	3	1	1		1						1		1	
CO4	2	1	1			2						1	1	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Elementary Concepts of Electric Circuits Elementary concepts of DC electric circuits: Basic Terminology including voltage, current, power, resistance, emf; concept of linear, non linear, unilateral, bilateral, active & passive circuit elements, independent voltage & current sources, Interconnection of Resistances- series, parallel, series-parallel, star & delta interconnection, Star-delta/delta-star transformation ; Current and Voltage Division Rules; Capacitance: Parallel plate capacitance with single dielectric, V-I relations and energy stored, Capacitances in series, parallel & series-parallel; Ohm's Law and Kirchhoff's laws-Problems.

Introduction to Dynamic Circuits: DC Sourced & Source free Response of RC series circuit, Time Constant, Concept of transient & steady state components of response.

Module II

Elementary Concepts of Magnetic & Electromagnetic Circuits, and AC fundamentals: Magnetic Circuits: MMF, field strength, flux density, reluctance - comparison between electric and magnetic circuits- Series and parallel magnetic circuits with composite materials, numerical problems.

Electromagnetic Induction: Faraday's laws, Lenz's law- statically induced and dynamically induced emfs, conductor moving in a uniform magnetic field, Self-inductance and mutual inductance, coefficient of coupling, V-I relations of self & mutual inductance, Two winding Transformer, Basic Transformer Equation connecting voltages, currents & number of turns, energy stored in a coupled coil system, Series Connection of coupled Inductances.

Alternating Current fundamentals: Representation of sinusoidal waveforms: frequency, period, cycle, phase, Average, RMS values and form factor of waveforms-Numerical Problems.

Module III

Sinusoidal Steady State Response: Sinusoidal Steady Response of Basic Elements: Phasor Representation of sinusoidal quantities, Trigonometric, Rectangular, Polar and complex forms, Response of basic R, L and C elements to a sinusoidal voltage or current –Phasor diagrams, Average power and power factor-Numerical Problems.

Series and Parallel AC Circuits: Reactances, Impedance, Admittance, Solution of series, parallel & series-parallel AC circuits, Power in AC circuits: active, reactive & apparent powers-Numerical Problems, Resonance in series and parallel circuits, Frequency dependance of impedance and admittance, frequency response function & frequency response plots, half power/cut off frequency, bandwidth

Three phase AC systems: Star and delta connected balanced three phase systems, Phasor diagram, relation between line and phase voltages, line and phase currents, active, reactive & apparent powers-Numerical problems.

Module IV

Applications: Dynamic Circuits: Use of simple first & second order resonant/non resonant RLC circuits as low pass, high pass, band pass & band stop filters, RC Differentiator & Integrator

Power Circuits of domestic/Daily Use Appliances: Concept of Linear & non linear AC loads, very basic concept of Power Quality, Functional Block Diagram of the power circuit of modern domestic/daily use appliances-LED Lamps & Tubes, BLDC Fans, Mobile & Laptop Chargers, Inverter Air Conditioner & Inverter Refrigerator, Need & methods of

galvanic isolation.
Rechargeable Batteries: Basic Terminology, Battery Capacity, SOC, SOE, SOH DOD, C-rate, Cycle Life, Cut off voltage, deep cycle, Charging Profile, self discharge, Energy Density, Power density, Specific Energy, Specific Power, Purpose & Functions of BMS.
UPS: Functional block diagram, Specifications and Applications of online & offline UPS, computation of back up time.
Power Systems: Various levels of Power Transmission/Distribution- Typical Single line diagram.

Textbook:

1. Edward Hughes. Electrical technology. Pearson Education 8th ed. 2002.
2. Robert L. Boylestad. Introductory circuit analysis. Pearson Education, 14th edition 2022

References:

1. Cotton, H. Electrical technology. CBS Publishers and Distributors, New Delhi. 7th edition
2. Leonard S. Bobrow. Fundamentals of electrical engineering. Oxford University Press. second edition, 1996

26-----0105B COMPUTER PROGRAMMING

Course Outcomes:

On completion of this course the student will be able to:

1. Identify main components of a computer system and explain its working.
2. Develop flowchart and algorithms for computational problems.
3. Write the syntax of various constructs of C language.
4. Build efficient programs by choosing appropriate decision-making statements, loops and data structures.
5. Design modular programs using functions for larger problems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											1	2	3	
CO2	2	2	3		2							1	3	1	
CO3	3											1	2	1	
CO4	3	3	3		3							2	2	2	
CO5	3	3	3		2	2						2	2	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Basics of Computer and Information Technology: Digital Computer System (CPU, Memory, I/O devices)- Working of a digital computer-Hardware and Software: Definition - Categories of Software, Application of Computers.
Problem Solving Methodology: Problem statement, Analysis, design a solution, Implement/Coding the solution, Test the solution, Design tools (Algorithm, Flow-chart, Pseudo-code)- Develop algorithms for simple problems.
Programming Languages: Types of Languages-Compiler–Interpreter-Linker–Loader– Execution of program.

Module II

Basics of C: Character set-Identifier- Keywords- Constants –Data Types- Variables and declaration –Operators and Expressions – Operator precedence and associativity – Expression Evaluation (Simple Examples) - Input and output functions – Simple computational problems involving the above constructs.
Control Statements: Selection, Conditional operator, Iteration (for, while, do-while), Branching (switch, break, continue, goto), Nesting of control statements- Problems using control statements.

Module III

Arrays: One-dimensional array: Declaration, Initializing and Accessing of Array, Operations with Array, Internal Representation of Array, Working with One-dimensional Array (searching and sorting).
Multi-dimensional array: Declaration, Initializing and Accessing of Array, Working with Two-dimensional Arrays with Matrix.
Strings: Declaration, Initialization and Accessing of String, String Functions, Working with One-dimensional character Array and String Functions.
Functions: Concept of Function, Using Function (Declaration, Definition and Calling), Parameter Passing in C, Inline Function, Recursion, Working with Functions.

Module IV

User defined data types: Structure, Union & Enumerated data type- Declaration, Initialization and Accessing of Structure, Union & Enumerated Data types, Structure versus Union, Arrays of Structure, Working with Structures.
Pointers: Declaration, Initialization & Accessing Pointer– Use of Pointers, Pointer Arithmetic, Arrays and Pointers, Structures and Pointers, Working with Pointers (Pointers to Array:
One-dimensional arrays and pointers, Passing an array to a function), Dynamic memory allocation. Command line arguments.

Textbooks:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming, Second Edition, Oxford University Press, (2013)

References:

1. Byron Gottfried, Programming with C, Fourth edition, Tata McGraw-Hill, (2018).
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2015).
3. R.G. Dromey, How to solve it by Computer, Pearson Education, (2008).

4. Kanetkar Y, Let Us C: Authentic guide to C programming language (18th Edition), BPB Publications, (2021)

26----0106B SOFT SKILLS DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Use English language at the formal and informal levels for daily conversation, presentation, group discussion and debate.
2. Demonstrate the ability to read, comprehend and answer questions based on literary, scientific and technological texts
3. Develop self-motivation, raised aspiration, belief in one's own abilities and commitment to achieving one's goal
4. Demonstrate emotional maturity and emotional health.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						1		2	2	3					
CO2						2		2	2	3					
CO3						1		2	2	2					
CO4						1		2	3	2					

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations

Module II

Fundamental grammar, Simple structures, passivating the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open – ended and close- ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing and good netiquette. Writing for internships and scholarships.

Module III

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming and activities on the same.

Different types of interviews, and presentations - oral, poster, ppt. Organizing ideas for group discussions, the difference between GD and debates.

Effective listening and seeking to understand others' perspectives. Non-violent negotiation and persuasion, communicating across age groups, cultures or identity groups.

Higher order thinking and evaluation, information-seeking, research, and independent learning, synthesis, creativity, problem analysis and problem solving. Decision making, Self-reflection and learning from experience.

Module IV

Developing positive self: Understanding oneself, A realistic awareness of oneself and one's abilities, strengths and potential, Self-esteem, Self-efficacy, steps for improvement.

Intra-personal skills – Self-control, emotional regulation and self-discipline, conscientiousness, dutifulness, reliability, truthfulness, honesty and trustworthiness. Goal orientation and initiative. Time management – prioritising work.

Interpersonal skills – cross cultural competence and valuing diversity of perspectives, respecting and expressing concern for others. Empathy and ability to notice the effect of one's actions on others, tolerance for disagreement, conflict management and resolution.

Civic engagement and social responsibility – Global and local awareness (issues, challenges, priorities). Vision, ability to imagine something new or improved. Social responsibility and willingness to take constructive action.

Textbooks:

1. Duck, Steve and David T. Macmahan. Communication in Everyday Life. 3rd Ed. Sage, (2017).
2. Gamble, Kawl Teri and Michael W. Gamble. The Public Speaking Playbook. Sage, (2015).

References:

1. Raman, Meenakshi and Sangeetha Sharma. Technical Communication: Principles and Practice, Oxford University Press, (2015).
2. Coleman, D. Emotional intelligence: Why it can matter more than IQ, Bantam Books, New York (2006).
3. Devadas Menon. Stop sleepwalking through life, Yogi Impressions Books Pvt. Ltd, Mumbai (2012).
4. Barun K Mitra. Personality Development and Soft Skills, Oxford University Press (2012).

Assessment

- 'Soft Skills Development' is a practical and activity-oriented course which has continuous assessment for 100 marks based on classroom interaction, activities, and assignments. The activities may include 'Just a Minute' (JAM) sessions, group discussion, role play, debate, and extempore speech.
- The weightages for the different components shall be as follows:
  - Classroom interaction – 20%
  - Activities – 60%
  - Assignments (from Modules I and II) – 20%
  - Semester End Examination is not envisaged.

26-----0107B COMPUTER PROGRAMMING LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Write programs using loops and decision-making statements in C language.
2. Implement different operations on arrays.
3. Solve problems using functions and recursion.
4. Design and implement C programs using the concepts of structure and pointers.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3		2							1	3	1	
CO2	3	2	1									1	3	1	
CO3	3	3	3		3	1						2	3	1	
CO4	3	3	3		2	1						2	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Cycle I

- Application Packages:
  - Text Editor
    - To create a word document like an advertisement.
  - Spreadsheet
    - To create a spreadsheet to analyse the marks of the students of a class and also to create appropriate charts.
  - Presentation Software
    - To create a presentation for the department using MS PowerPoint.
- C Programming Basics:
  - To write a program to calculate and display areas of rectangle and triangle.
  - Decision Making:
    - To write a program for electricity bill preparation.
    - To write a program to find the roots of a quadratic equation.
    - To write a simple menu driven calculator program using switch statements.
    - To write a program to find the sum of digits of a given number.

Cycle II

- Looping:
  - To write a program to print all the prime numbers of a given range.
  - To write a program to print the sine and cosine series.
  - To write a program to print Pascal's triangle.
- Arrays:
  - To write a program to print the sum and average of elements in an array.
  - To write a program to sort the given numbers using bubble sort.
  - To write a program to perform Matrix addition and matrix multiplication.
- String:
  - To write a program to perform string manipulation functions like string concatenations, comparison, find the length and string copy without using library functions.
  - To write a program to arrange names in alphabetical order.

Cycle III

- Functions:
  - To write a C program to calculate the mean, variance and standard deviation using functions.
  - To write a C program to perform sequential and binary search using functions.
- Recursion:
  - To write a program to print the Fibonacci series using a recursive function.
  - To write a program to print the factorial of the given number using a recursive function.
- Structure:
  - To print the mark sheet of N students using structures.

- Pointers:
  - To write a program using pointers to access the elements of an array and count the number of occurrences of the given number in the array.

References:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming in C, Second Edition, Oxford University Press, (2013).
2. Byron Gottfried, Programming with C, Fourth edition, Tata McGraw-Hill, (2018).
3. Smarajit Ghosh, All of C, PHI Learning Pvt. Ltd, (2009).
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2015).
5. Sukhendu Dey, Debobrata Dutta, Complete Knowledge in C, Narosa Publishing House, New Delhi, (2013).
6. R.G. Dromey, How to solve it by Computer, Pearson Education, (2008).
7. Kanetkar Y, Let Us C: Authentic guide to C programming language (18th Edition), BPB Publications, (2021).

26-----0108B BASIC ELECTRONICS LAB

Course Outcomes:

On completion of this course the student will be able to:

1. To design and implement simple hardware circuits using electronic devices and digital ICs and to test the performance and its applications.
2. To study the characteristics of diodes and transistors and implement simple circuits using them.
3. To design simple circuits and mini projects (groups) using sensors and electronic components

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1									1	2	3	
CO2	1	2	1										2	2	
CO3	1	3	1	2					1				3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Experiments:

1. Familiarization of electronic components and Electronic instruments – Power Supply, Function Generator, CRO, Multimeter.
2. VI characteristics of PN junction diode.
3. Clipping and clamping circuits
4. Design Rectifying circuits: (with and without filter)
    a. Half Wave Rectifier
    b. Full Wave Rectifier
5. Characterization of Passive Integrator and Differentiator Circuits.
6. Characterization of Transistor CE Configuration.
7. Design CE Amplifier for a particular Gain.
8. Electronic Systems Hardware Familiarization.
9. Introduction to PCB design.

Textbooks:

1. Jacob Milman & Christos C Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, McGraw Hill Education, 2 nd edition (2017).
2. David M. Buchla, Thomas L. Floyd, Electronics Pearson Education Limited, Year: 2014.

References:

1. K V Ramanan, Functional Electronics, Tata McGraw-Hill Publishing Company Ltd(1984)
2. Donald Neamen, Semiconductor Physics and Devices, Tata McGraw-Hill Publishing Company Ltd, 4th edition(2021)

26-----0109B LANGUAGE LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Test pronunciation skills through stress on word accent, intonation, and rhythm.
2. Use the English language effectively for writing business letters, resumes, minutes of meetings and reports.
3. Use the English language effectively to face interviews, group discussions, and public speaking.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1									2	3		2			
CO2									2	3		2			
CO3									2	3		2			

1-Slightly**; 2**-Moderately**; 3**-Substantially

The following exercises are prescribed for the Language Laboratory sessions:

1. Introduction to the Sounds of English- Vowels, Diphthongs & Consonants.
2. Introduction to Stress and Intonation.
3. Preparing business letters
4. Preparing a resume
5. Conducting a meeting and writing the minutes
6. Writing a report
7. Situational Dialogues / Role Play.
8. Oral Presentations- Prepared and Extempore.
9. 'Just A Minute' Sessions (JAM).
10. Describing Objects / Situations / People.
11. Debate
12. Group discussion

Text Books:

1. Speak Well, Orient Black Swan Publishers, Hyderabad

References:

1. Cambridge English Pronouncing Dictionary, Cambridge University Press, India
2. Textbook of English Phonetics for Indian Students, T. Balasubramanian, Macmillan Publishers.

26-----0110B NSS/NATURE CONSERVATION ACTIVITIES/YOGA

NATIONAL SERVICE SCHEME (NSS)

Course Outcomes:
On completion of this course the student will be able to:

1. Identify the community in which they work
2. Utilise their knowledge in finding practical solutions to individual and community problems.

A student enrolling as a member of NSS will have to complete 10 hours of training / social service.

NATURE CONSERVATION ACTIVITIES

Course Outcomes:
On completion of this course the student will be able to:

1. Demonstrate the message of sustainable lifestyles.
2. Explain the importance of green plants in mitigating global environmental problems.
3. Identify suitable waste management practices for the local community.

A student enrolling as a member of the Nature Conservation Club will have to complete 10 hours of campus cleaning and greening activities.

YOGA

Course Outcomes:
On completion of this course the student will be able to:

1. Demonstrate the use of yoga for stress management.
2. Illustrate the different yogic postures for physical and mental wellbeing.
3. Identify suitable methods of strengthening physical, emotional, intellectual aspects of "self" based on the principles and practices of Yoga and positive psychology.

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SEMESTER II

26-----0201B LINEAR ALGEBRA & TRANSFORM TECHNIQUES

Course Outcomes:

On completion of this course the student will be able to:

1. Solve linear systems of equations and to determine Eigen values and vectors of a matrix.
2. Exemplify the concept of vector space and subspace.
3. Determine Fourier series expansion of functions and transform.
4. Solve linear differential equation and integral equation using Laplace transform.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1											3	2	
CO2	3	1											3	1	
CO3	3	3	3										2		
CO4	3	3	2										3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Linear Algebra 1: Rank of a matrix, solution of linear system of equations- existence, uniqueness, general form-Eigen values and Eigen vectors- properties of Eigen values - Diagonalization of a matrix - Cayley Hamilton theorem (without proof) Verification-Finding inverse and power of a matrix using it-Quadratic form-orthogonal reduction of quadratic form to Canonical form.

Module II

Linear Algebra 2: Vector space-subspace-Linear dependence and independence-Spanning of a subspace- Basis and Dimension. Inner product- Inner product spaces - Orthogonal and Orthonormal basis
–Gram- Schmidt Orthogonalization process. Linear Transformation.

Module III

Fourier Analysis: Periodic function, Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansion, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier Cosine and Sine Transform, Fourier Transform.

Module IV

Laplace Transforms: Gamma functions and Beta function-Definition and properties, Laplace transforms. Inverse Laplace Transform, Shifting theorem, Transform of Derivative and Integrals, Solution of differential equation and integral equation using Laplace transform, Convolution, Unit step function, Second Shifting theorem, Laplace transform of periodic function.

Textbooks:

1. Erwin Kreyzig. (2010). Advanced engineering mathematics. (tenth edition). John Wiley & Sons, Hoboken, N.J
2. Grewal, B.S. (2013). Higher engineering mathematics. (forty third edition). Khanna Publishers, New Delhi.

References:

1. Hsiung,C.Y and Mao, G. Y. (1999). Linear algebra. World Scientific, New Jersey.
2. Hoffman, K. and Kunze, R. (1971). Linear algebra. Prentice Hall of India, New Delhi.
3. Venkataraman, M. K. (1999). Linear algebra. The National Publishing Co, Chennai.

26-----0202B ENGINEERING CHEMISTRY

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the basic concepts of chemical thermodynamics, and quantum chemistry.
2. Illustrate the spectroscopic methods in characterizing materials.
3. Develop electrochemical methods to protect different metals from corrosion.
4. Interpret the chemistry of a few important engineering materials and their industrial applications.
5. Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2										2	1	
CO2	3	2	3										2		
CO3	1	1	1										1	2	
CO4	1	1	1										1	2	
CO5	2	2	3										2	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Chemical Thermodynamics: Fundamentals. First law of thermodynamics, Molecular interpretation of internal energy, enthalpy and entropy. Heat of reaction. Kirchoff's equations. Dependence on pressure and temperature. Gibbs-Helmholtz equation. Free energy changes and equilibrium constant. Chemical potential and fugacity. Thermodynamics of biochemical reactions.

Phase Rule: Terms involved in phase rule and examples, Application of phase rule to one component water system, Application of phase rule to two-component systems. (Simple eutectic systems).

Module II

Quantum Chemistry: Schrodinger wave equation – significance of Ψ, well behaved functions, Postulates of quantum mechanics, Application of quantum mechanics to simple systems - particle in 1 D box, normalization of wave function, Forms of hydrogen atom wave functions and the plots of these functions to explore their spatial variations, Quantum numbers.

Module III

Spectroscopy: Principles of spectroscopy and selection rules. Electronic spectroscopy. Vibrational and rotational spectroscopy of diatomic molecules. Applications.

1H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting - coupling constant - applications of NMR- MRI.

Module IV

Electrochemistry: Cell EMF- its measurement and applications. Nernst Equation and application, relation of e.m.f. with thermodynamic functions (ΔH, ΔF and Δ S). Lead storage battery. Corrosion; causes, effects and its prevention.

Polymers- Classifications- Thermoplastics and thermosetting plastics- A brief account of conducting polymers (polypyrrole and polythiophene) and their applications.

Lubricants- Introduction solid and liquid lubricants- Properties of lubricants-Viscosity index- flash and fire point- cloud and pour point- aniline value.

Refractories: Classifications – Properties of refractories.

Laboratory Experiments to be conducted in the virtual lab mode.

List of Experiments (Minimum six experiments shall be conducted)

1. Determination of the partition coefficient of a solute in two immiscible liquids.
2. Phase diagram of two component System (Naphthalene-diphenylamine)
3. Conductometric titration of Strong acids with Strong base.
4. Potentiometric titration: Fe2+ vs KMNO4
5. Heat of neutralization
6. Verification of Beer-Lambert's law
7. Determination of rate constant of a reaction.
8. Determination of total hardness of water by EDTA method.
9. Determination of COD of water sample.
10. Determination of alkalinity of water.
11. Determination of chloride content of water by Mohr's method.
12. Determination of dissolved oxygen in a given water sample.
13. Determination of acidity of water sample.
14. Determination of adsorption of acetic acid by charcoal.
15. Determination of acidity of water sample

Textbooks:

1. B. H. Mahan and R. J. Meyers. University Chemistry, 4th Edition, Pearson publishers. (2009).
2. B.L. Tembe, M.S. Krishnan and Kamaluddin. Engineering Chemistry (NPTEL Web Course).
3. Shashi Chawla. A Textbook of Engineering Chemistry. Dhanpat Rai & Co, New Delhi.(2013).

References:

1. Peter W. Atkins, Julio de Paula, and James Keele. Physical Chemistry, 11th Edition, Oxford publishers. (2018).
2. M. J. Sienko and R. A. Plane. Chemistry: Principles and Applications, 3rd Edition, McGraw-Hill Publishers. (1980).
3. C. N. Banwell. Fundamentals of Molecular Spectroscopy, 5th Edition, McGraw-Hill Publishers. (2013).

Pattern of Continuous Assessment		**Marks (%)**
Test -I for the theory portions	:	30%
Test -II for the theory portions	:	30%
Assignment from the Theory	:	10%
Laboratory Record	:	10%
Viva-voce	:	10%
Attendance	:	10%

The students are required to submit the laboratory record.

26-----0203B DIGITAL ELECTRONICS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental boolean functions and basic building blocks of Digital systems
2. Design Optimal digital circuits using basic building blocks
3. Analyse Basic digital circuits
4. Understand HDL models of simple circuits

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1									1	3	2	
CO2	2	2	3										3	2	
CO3	1	3	1	2									3	2	
CO4	1	1	1	1	3				1			2	2	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Digital Concepts and Techniques: Binary arithmetic, Binary coded Decimal, Excess - 3 code, Gray Code. Boolean algebra-Standard Sum of products, Standard Product of sums. Logic gates. Minimization of Boolean function :Karnaugh Map (up to 5 variables) and Quine - McClusky methods. Variable entered mapping. Design of optimal logic function from a given problem statement.
HDL: Basic concepts and modelling of simple circuits.

Module II

Combinational circuits: Half adder, Full adder, Subtractor, Ripple Carry adder, Carry look ahead adder, BCD adder, multiplexer, demultiplexer, Basic decoder and encoder circuits,Binary Multiplication.
Sequential circuits: Flip-flops – (RS /JK / MS/T / D)
Serial Adder-Difference between Parallel Adder and Serial Adder
HDL: Models of simple combinational circuits

Module III

Shift Registers: various types - Counters : Asynchronous and synchronous counters, Up-Down counter, Shift Register Counters - Sequence generators
HDL: Models of simple sequential circuits.

Module IV

Implementation of logic functions using PLA, PROM. Error Detection and Correction: Parity, (7,4) Hamming code. Practical design considerations: Logic families- Standard logic levels- Current And Voltage Parameters- fan in and fan out-Propagation delay, Noise margin, Speed power product, setup time, hold time.
TTL family NAND gate working principle, Totem pole configuration- Transfer characteristics, Tri-state logic gate.
Note*: HDL portion of each module to be evaluated based on assignments ONLY, as part of Continuous Evaluation, subject to a maximum weightage of 50% of marks allocated for assignments*

Textbooks:

1. Kumar, A. Anand. Fundamentals of digital circuits.4/e PHI Learning, 2016. 978-8120352681

References:

1. Floyd, Thomas L. Digital fundamentals, 11/e. Pearson Education India, 2017. 978-9332584600
2. Stephan Brown & Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, 2/e, McGraw-Hill, 2007, ISBN-13: 978-0077211646
3. Taub, Herbert, and Donald L. Schilling. Digital integrated electronics. McGraw Hill, India, 2016 978-0070265080
4. Roth Jr, Charles H., Larry L. Kinney, and Eugene B. John. Fundamentals of logic design. Cengage Learning, 2020. 978-9353502645

26-----0204B OBJECT ORIENTED PROGRAMMING IN C++

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the basic concepts of Object-Oriented Programming.
2. Describe the object-oriented paradigm with concepts of streams, classes, functions, data and objects.
3. Implement object-oriented programming constructs like encapsulation, inheritance and polymorphism.
4. Understand dynamic memory management techniques using pointers, constructors, destructors, etc.
5. Identify classes including data, methods and the relationship among the classes from a given problem statement and solve the problem using object-oriented constructs in C++.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3											1	3		
CO2	3	2										1	3	1	
CO3	3	2	3									2	3	2	
CO4	3											1	2	2	1
CO5	3	3	3		2	2			2			2	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Procedure oriented programming, Object oriented programming paradigm, Basic concepts of object-oriented programming, Benefits of OOP, Introduction to C++ programming, data types, variables, control statements (if, if else, switch), iteration (for, while, do...while). Console I/O operations - formatted and unformatted –managing output with manipulators. Functions in C++, call and return by reference, inline functions, default arguments, const arguments.

Module II

Classes and objects, specifying a class, defining member functions, Memory allocation for objects Static data members, Static member functions, Arrays of objects, const member functions Constructors and Destructors, Constructors: default, parameterised, with default arguments, copy constructor, destructors, Friend functions.
Introduction to pointers, new and delete operators, Pointers to objects, this pointer.

Module III

Inheritance: Defining derived classes, Single inheritance, Multilevel inheritance, multiple inheritance, Hierarchical inheritance, Hybrid inheritance, Virtual base classes, Abstract classes, Constructors in derived classes .
Polymorphism: Function overloading, operator overloading: overloading unary operators, overloading binary operators, overloading binary operators using friends, manipulation of strings using operators, Type conversions: basic to class, class to basic, class to class.

Module IV

Pointers to derived classes, virtual functions, pure virtual functions.
Working with files: classes for fstream operations, opening and closing of file, detecting end of file, file modes, file pointers and manipulators, sequential input and output operations, random access, Templates, Exception handling.

List of programs to practice:

1. Implementation of classes and objects.
2. Implementation of constructors and constructor overloading.
3. Implementation of methods and method overloading.
4. Implementation of different types of inheritance: Single Inheritance, Multilevel Inheritance, Hierarchical Inheritance, Multiple Inheritance, Hybrid Inheritance.
5. Implementation of polymorphism.
6. Implementation of File handling
7. Assignment: Design any real time application using object oriented concepts and develop the solution using the C++programming language. For this the students can form a project team with a maximum 4 members per team.The team can select a socially relevant problem from various domains such as health, safety, education,

agriculture, legal etc. At the end of the semester, the team has to demonstrate their product and submit a report. The team will be assessed through rubrics.

Textbooks:

1. Balagurusamy, E. (2020). Object oriented programming with C++ (8th ed.).Tata McGraw Hill. New Delhi.
2. Lafore, R., & Lafore, R. (2002). Object oriented programming in C++ (4th ed.).Sams Pub.Indianapolis, Indiana.

References:

1. Stroustrup, B. (2013). The C++ programming language (4th ed.). Reading, Mass.:Addison Wesley.
2. Kamthane, A. (2003). Object oriented programming with ANSI and Turbo C++.Pearson Education.Delhi, India.
3. Schildt, H. (2012). C++ the complete reference (5th ed.). Osborne McGraw Hill. Berkeley.

Pattern of Continuous Assessment		**Marks (%)**
Test -I for the theory portions	:	30%
Test -II for the theory portions	:	30%
Assignment from the Theory	:	10%
Assignment from the Practice	:	20%
Attendance	:	10%

The students are required to submit the practice record

26-----0205B INTRODUCTION TO CYBER PHYSICAL SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the features & components of Cyber Physical Systems
2. Understand the elementary constructs of Arduino Software
3. Develop optimal programs & circuits for interfacing various sensors with Arduino
4. Apply Arduino IDE for developing suitable programs for interfacing sensors & actuators with Arduino & Node MCU

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2									1	3	2	1
CO2	1	2	2										2	2	
CO3	1	2	2	2								1	3	3	2
CO4	1	1	1	1	2							1	3	3	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to CPS, Key features of CPS-reactive computation, concurrency, Feedback Control of the Physical World, real time computation, safety critical applications, general structure of a CPS, Examples of CPS.
IoT- Characteristics of IoT, Enabling Technologies, Concept of Transducers/sensors-Primary & Secondary, active & passive, analog & digital, Concept about actuators-thermal, electric & mechanical, IoT stack, Levels of IoT.

Module II

Arduino Basics: Development Boards-Arduino Uno, Node MCU, Arduino IDE, General Program Structure, Basic data types, variables & constants, Operators, control statements, loops, functions, time functions, arrays.

Module III

Arduino-I/O functions, Arduino PWM, Arduino Communication, LED Interfacing-Sinking & Sourcing methods of LED Connection, LED blinking, fading, Analog read, LED bar graph display, Seven Segment LED Display, interfacing sensors with Arduino-humidity, temperature, water detector, PIR, ultrasonic sensor, LDR, Interfacing Push Button Switch-Pull Up & Pull-Down Connection.

Module IV

Arduino for motor control- Control of DC Motor, Servo motor & Stepper Motor.
Introduction to NodeMCU/ESP32, Overview of NodeMCU and its features, Programming NodeMCU via Arduino IDE, Interfacing LED, Gas Sensor, Introduction to Wi-Fi Connectivity with Node MCU.

Textbook:

1. Rajeev Alur. Principles of Cyber-Physical Systems, MIT Press 2015
2. Edward Ashford Lee, Sanjit Arunkumar Seshia. Introduction to Embedded Systems-A Cyber-Physical Systems Approach -MIT Press 2017

References:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram.Internet of Things, WILEY 2020.
2. Srinivasa K.G, Siddesh G.M, Hanumantha Raju R.Internet of Things, CENGAGE, 2018.
3. Arduino-Tutorials point

26-----0206B ENVIRONMENTAL AND LIFE SCIENCES

Course Outcomes:

On completion of this course the student will be able to:

1. Identify the global environmental issues
2. Examine the types of pollution in society along with their sources
3. Elucidate the basic biological concepts via relevant industrial applications and case studies.
4. Evaluate the principles of design and development, for exploring novel bioengineering projects.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2				3	3						2		
CO2	2	2				2	3						2		
CO3	2	2				2	2						2	1	
CO4	2	2				3	3						3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Environment, Ecosystems and Biodiversity: Definition, scope and importance of environment — need for public awareness — concept of an ecosystem — structure and function of an ecosystem — producers, consumers and decomposers — energy flow in the ecosystem — ecological succession — food chains, food webs and ecological pyramids — Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) — Introduction to biodiversity definition: genetic, species and ecosystem diversity —biogeographical classification of India — value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values — Biodiversity at global, national and local levels — India as a mega-diversity nation — hot-spots of biodiversity — threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts — endangered and endemic species of India — conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems — pond, river, hill slopes, etc.

Module II

Natural Resources: Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people — Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems — Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies — Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies — Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies — Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification — role of an individual in conservation of natural resources. The concept of sustainable development.

Module III

Biomolecules and their Applications (Qualitative): Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), Lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, Ligninolytic enzyme in bio-bleaching).

Nature-Bioinspired Materials and Mechanisms (Qualitative): Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swimsuits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).

Module IV

Human Organ Systems and Bio Designs (Qualitative): Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease). Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye). Heart as a

pump system (architecture, electrical signaling – ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification systems (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis).
Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods.

Textbooks:

1. Rajagopalan, R. Environmental Studies: From Crisis to Cure. Oxford University Press, New Delhi, (2015).
2. Erach Bharucha. Textbook of Environmental Studies and Ethics. Universities Press (India), Hyderabad, (2013).

References:

1. Thyagarajan S., Velmurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jagannathan M.K. Biology for Engineers, Tata McGraw-Hill, New Delhi, (2012).
2. Arthur T. Johnson. Biology for Engineers, CRC Press, Taylor and Francis, (2019).
3. Sohini Singh and Tanu Allen. Biology for Engineers, Vayu Education of India, New Delhi, (2020).
4. Ibrahim Ozbolat. 3D Bioprinting: Fundamentals, Principles and Applications, Academic Press, (2016).

26-----0207B DESIGN THINKING LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Apply user research methods such as empathy mapping and persona creation to identify design opportunities and understand user needs.
2. Generate and evaluate innovative product or service ideas using creative ideation techniques like brainstorming, SCAMPER, and co-creation sessions.
3. Develop and test prototypes—both digital and physical—through rapid and experience prototyping methods to gather user feedback and refine solutions.
4. Utilize analytical tools such as user journey maps, service blueprints, and affinity diagrams to synthesize insights and improve design outcomes.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	2	1	1	3	2	1	2	3	1	
CO2	2	3	3	2	2	1	1	1	3	3	2	2	3	1	
CO3	3	3	3	3	3	2	1	1	2	2	2	2	3	1	
CO4	2	3	3	3	2	2	1	1	2	2	2	3	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Cycle I - Empathise

- Empathy Mapping for Opportunity Identification – Identify opportunities by understanding users' emotions, needs, and pain points through empathy mapping.
- User Journey Mapping – Map user experiences to identify critical touchpoints and improvement areas.
- Personas Creation Workshop – Develop detailed user personas representing different user types and their needs.

Cycle II - Define

- Defining the Design Challenge Workshop – Frame and articulate the design problem using "How Might We" questions.
- Affinity Diagramming – Organize and synthesize qualitative data to identify patterns and insights.

Cycle III - Ideate

- Brainstorming Workshop for Product/Service Ideation – Use SCAMPER and creative ideation methods to generate innovative ideas.
- Storyboarding for Communication and Animation – Visualize the product or service experience through storyboards.
- Co-Creation Sessions – Collaborate with users to ideate and co-develop possible design solutions.

Cycle IV - Prototype

- Rapid Prototyping Session – Create quick prototypes using digital or physical tools and iterate based on user feedback.
- Material Exploration for Textiles and Craft Design – Experiment with various materials to understand their design potential.
- Experience Prototyping – Simulate real or virtual environments to test user experiences.

Cycle V- Test / Evaluate

- Concept Testing – Validate product or service concepts with target users to gather insights.
- Service Blueprinting – Map frontstage and backstage processes to identify service improvement opportunities.
- Heuristic Evaluation – Identify usability issues using established usability and design principles.

Textbooks:

1. D. A. Norman, *The Design of Everyday Things*, revised and expanded ed., Cambridge, MA: MIT Press, 2013.
2. R. Curedale, *Design Thinking: Process & Methods Manual*, 5th ed., Topanga, CA: Design Community College Press, 2019.

References:

1. M. Lewrick, P. Link and L. Leifer, *The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods*, Hoboken, NJ: John Wiley & Sons, 2020.
2. T. Brown & B. Katz, *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*, New York, NY: HarperBusiness, 2009.

26-----0208B BASIC ELECTRICAL ENGINEERING LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Identify & choose appropriate apparatus for ON-OFF Control, protection diagnosis & instrumentation of a typical LV electrical appliance/circuit.
2. Familiarize with various types of electric motors and conventional & smart electrical systems.
3. Familiarize with the electrical characteristics of common appliances & solar panels.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2									1		1	
CO2	2	2	3											1	
CO3	1	3	2	2					1					1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Details of Experiments

1. Familiarization with various electrical apparatus like switches, relays, smart plugs, smart switches, conventional to smart switch converters, AC & DC Voltmeter, AC & DC Ammeter, Multimeter, Wattmeter, Energy meter, fuse, MCB, Isolator, RCB, ELCB, RCBO
2. Verification of Ohm's Law & Kirchoff's Laws for both DC & AC circuits.
3. Domestic Wiring Circuits with one way/two-way switches & plug point.
4. Experimental determination of V-I characteristics, MPP & predetermination of operating point of a solar panel for resistive load.
5. Measurement of Current, Power, Power Factor & Energy of:
    a. A single-phase circuit with known parameters
    b. Various domestic/daily use appliances like LED Lamps, LED Tubes, Ceiling fans, Laptop, LED Display, PC+LED Display.
6. Experimental/Simulation based study of an RLC series Circuit under resonant & non-resonant conditions.
7. Experimental determination of frequency Response of Circuits.
8. Familiarization with various types of Electrical Machines
9. Experiment on Automatic Street Lighting System.
10. Experiments on Home Automation.

Text Books:

1. K. B. Raina and S. K. Bhattacharya, Electrical Design Estimating and Costing, New Age International Publishers, 2nd edition.
2. M. K. Giridharan - Electrical Systems Design, I K International Publishing House Pvt. Ltd. 3rd Edition 2022.

References:

1. Edward Hughes. Electrical technology. Pearson Education 12th ed. 2016
2. Robert L. Boylestad Introductory circuit analysis- Pearson Education; 14th edition 2022

SEMESTER III

26----0301B DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES

Course Outcomes:

On completion of this course the student will be able to:

1. Understand key concepts like analytic functions, Conformal mapping and bilinear transformation. Apply complex analysis principles in engineering scenarios.
2. Understand Cauchy's integral theorem, Cauchy's integral formulae and contour integration Advanced application of complex analysis in Quantum mechanics and Electrical Engineering.
3. Solve partial differential equations using various methods and apply the solutions to analyze phenomena in engineering, machine learning, and computational biology.
4. Utilize advanced differential equations, including wave and heat equations, Alembert's solution, and Fourier series, for modelling and analyzing complex engineering problems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	**1**		**2**							1	2	2	
CO2	3	2	**2**		**2**							1	2		
CO3	3	2	**3**		**2**							1	2	2	
CO4	3	2	3	2	**2**								2	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Analytic Function: Analytic function, Cauchy-Riemann equation (Cartesian and polar), Harmonic function, Construction of analytic function given real or imaginary parts, Conformal mapping of standard elementary function and bilinear transformation. Applications of Analytic Functions in Signal Processing and Image Analysis.

Module II

Complex Analysis: Cauchy's integral theorem, Cauchy's integral formula and for derivatives, Taylor's and Laurent's expansion (without proof), Singularities, Residues, Cauchy's Residues theorem, Contour integration involving unit circle. Advanced Applications of Complex Analysis in Quantum Mechanics and Electrical Engineering.

Module III

Partial Differential Equations: Formation of partial differential equation eliminating arbitrary constants and function, Solution of the first-order equation, Four standard types, Lagrange's equation, Linear homogeneous partial differential equation with constant coefficient. Applications of Partial Differential Equations in Machine Learning and Computational Biology.

Module IV

Advanced Topics in Differential Equations: One-dimensional wave equation, Alembert's solution and one-dimensional heat flow equation, Solution by the method of separation of variables, Application of Fourier series solution, Solution of Laplace's equation over a rectangular region by the method of separation of variables, Recent Topics: Modern Applications of Wave and Heat Equations in Signal Processing and Materials Science.

The students should be introduced to Computer Algebra Systems (CAS) such as Matlab/Python (utilizing NumPy, SymPy, and SciPy) for both symbolic and numerical calculations. Homework and assignments should be given with the integration of CAS.

Case Studies for Assignment

Case Study 1: Complex Analysis and Partial Differential Equations with Python: Complex Numbers Arithmetic, Python Complex Numbers as 2D vectors, Solving first-order linear differential equations, Plotting Characteristic curves, Modeling Infectious disease

Case Study 2: Complex Analysis and Partial Differential Equations with MATLAB: Study of Complex functions and operations, Differential Equations – Ordinary and Partial, Solving Ordinary Differential Equations, Solving system of

Ordinary Differential Equations, Solving Partial Differential Equations

Textbook:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 11th Edition, John Wiley & Sons, (2022).

References :

1. Grewal, B. S., Higher Engineering Mathematics, 45th Edition, Khanna Publishers, (2023).
2. Churchill, R.V. and Brown, J.W., Complex Variables and Applications, 10th Edition, McGraw Hill, (2021).
3. Stroud, K.A. and Booth, D.J., Advanced Engineering Mathematics, 6th Edition, Palgrave Macmillan, (2019).

26-###-0302 ARTIFICIAL INTELLIGENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Understand foundational concepts of artificial intelligence, intelligent agents, problem-solving strategies, and search algorithms; apply them to real-world autonomous systems.
2. Apply knowledge representation schemes and reasoning techniques to design intelligent decision-making systems in AI-driven applications.
3. Analyze supervised and unsupervised learning algorithms and implement them in real-world tasks such as prediction, classification, and clustering.
4. Understand modern AI paradigms including deep learning, reinforcement learning, and generative AI; apply them in real-world applications involving NLP, vision, and robotics.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	2				1	2		2	3	2	
CO2	3	2	3	2	2				1	2		2	3	2	1
CO3	3	3	3	3	3				1	2		2	3	3	2
CO4	3	3	3	3	3				1	2		2	3	3	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Problems and Search: Define Artificial Intelligence and AI Problems, Problem as a State Space Search, Production Systems, Problem Characteristics, Production System Characteristics, Issues in the design of search programs.

Heuristic Search Techniques: Generate-and- Test, Hill Climbing, Best-First Search: OR Graphs, A* algorithm. Problem Reduction: AND-OR Graphs, AO* algorithm, Means-Ends Analysis.

Game Playing: Minimax search procedure, Alpha-beta cutoffs.

Module II

Knowledge Representation using Logic: Propositional and Predicate Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Resolution: Conversion to Clause Form, Resolution in Propositional Logic, Unification Algorithm, Resolution in Predicate Logic. Representing Knowledge Using Rules: Procedural versus Declarative knowledge, Logic Programming, Forward versus Backward Reasoning, Matching, and Control Knowledge.

Module III

Symbolic Reasoning under Uncertainty: Introduction to Nonmonotonic Reasoning, Logics for Non-monotonic Reasoning, Implementation Issues, Augmenting a Problem solver, Implementation: Depth-First Search & Breadth First Search.

Statistical Reasoning:- Probability and Baye's Theorem, Certainty Factors and Rule-Based Systems, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic. Weak Slot-and-Filler Structures: - Semantic Nets, Frames.

Strong Slot-and Filler Structures: Conceptual Dependency, Scripts, CYC. Applications in Data Science & AI: Prediction models, anomaly detection, customer segmentation

Module IV

Learning: Need of learning, Rote learning, Learning by Taking Advice, Learning in Problem-solving, Learning from example: induction, Explanation-based learning

Connectionist Models: Learning in Neural Networks, Perceptrons, Backpropagation Network, Applications of Neural Networks.

Case Studies for Assignment

Case Study 1: Python implementation of BFS, DFS, A* for a maze-solving agent

Case Study 2: Bayesian network modeling for weather or fault prediction

Case Study 3: Building a rule-based expert system for disease prediction

Case Study 4: Neural network model for handwritten digit recognition

Textbook:

1. Stuart Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach*, 4th Edition, Pearson, (2021).

References :

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, (2017).
2. Tom M. Mitchell, Machine Learning, McGraw Hill, (2017).
3. Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning, 2nd Edition, Springer, (2021).
4. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, (2020).

26-###-0303 DISCRETE COMPUTATION AND DATA STRUCTURES

Course Outcomes:

On completion of this course the student will be able to:

1. Understand foundational principles of discrete mathematics including logic, sets, relations, functions, and combinatorics, and apply them to computational problem solving.
2. Apply graph theory, trees, recurrence relations, and algebraic structures to model and analyze computational problems in AI and Data Science.
3. Implement and utilize fundamental data structures such as arrays, linked lists, stacks, queues, trees, heaps, hash tables, and graphs for efficient data handling and storage.
4. Apply algorithmic techniques including recursion, searching, sorting, hashing, and graph algorithms to design optimized solutions for real-world computational and intelligent systems applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2				1	2		2	3	2	
CO2	3	3	2	2	2				1	2		2	3	2	1
CO3	3	3	3	2	3				1	2		2	3	3	2
CO4	3	3	3	3	3				1	2		2	3	3	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Foundations of Discrete Computation: Set Theory & Algebraic Structures- Sets and set operations, Venn diagrams, Cartesian products, Relations: properties, equivalence relations, partial orders, Hasse diagrams, Functions: injective, surjective, bijective, composition, inverse, Algebraic structures: semigroups, monoids, groups (basic concepts),Applications in computing and AI

Module II

Structures for Computation: Combinatorics-Rule of sum and rule of product, Permutations and combinations, Binomial theorem and binomial coefficients, Pascal's triangle, Inclusion–exclusion principle, Pigeonhole principle, Recurrence relations: basic examples

Discrete Probability , Sample Space, Events, Conditional Probability, Bayes' Rule, Introduction to Random Variables, Applications: ML probability models

.

Module III

Linear Data Structures: Arrays and Linked Lists, Static & Dynamic Arrays, Singly, Doubly, Circular Linked Lists, Operations: Insertion, Deletion, Searching, Traversal, Memory representation, Applications: Sequential data, dynamic memory management.

Stacks and Queues: Stack operations and applications, Queue and Circular Queue, Priority Queue, Deque

Applications: DFS using stack, BFS using queue

Module IV

Non-Linear Data Structures Trees, Binary Trees, Binary Search Trees, AVL Trees (Basics), Tree Traversals (inorder, preorder, postorder), Applications: Decision Trees, Hierarchical Clustering

Graph Data Structures: Representation of Graphs, Directed and undirected graphs, BFS and DFS, Minimum Spanning Trees (Kruskal, Prim – concept only), Shortest Path Algorithms (Dijkstra – concept only)

Applications: Search algorithms in AI, Knowledge graphs

Textbook:

1. **Kenneth H. Rosen,** *Discrete Mathematics and Its Applications***, 8th Edition, McGraw Hill, (2019).**
2. **Sartaj Sahni and Ellis Horowitz,** *Fundamentals of Data Structures***, Universities Press, (2021).**

References :

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, 4th Edition, MIT Press, (2022).
2. Seymour Lipschutz and Marc Lipson, Discrete Mathematics, McGraw Hill, (2017).
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 4th Edition, Pearson, (2013).

26-###-0304 DATA ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand essential concepts of data engineering including data models, data formats, data storage, and modern data architecture.
2. Apply data ingestion, ETL/ELT processes, and workflow orchestration techniques to build scalable and reliable data pipelines.
3. Utilize relational, NoSQL, and distributed storage systems for efficient management of large-scale data required for analytics and AI workloads.
4. Apply data cleaning, transformation, indexing, query optimization, and big data processing frameworks to enable efficient analytics and machine learning workflows.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	3				1	2		2	3	2	1
CO2	3	3	3	2	3				1	2		2	3	3	2
CO3	3	3	3	2	3				1	2		2	3	3	3
CO4	3	3	3	2	3				1	2		2	3	3	3

1-Slightly**; 2**-Moderately**; 3-**Substantially

Module I

Foundations of Data Engineering & Database Systems:

Data Engineering: Role, components, and modern data ecosystems, Data types: structured, semi-structured, unstructured
Database Management Concepts: ER model: entities, attributes, relationships, Relational model: keys, constraints
Relational Algebra and Tuple Relational Calculus, SQL: DDL, DML, DCL, TCL
Integrity constraints: domain, entity, referential.
File organization: heap files, sequential files, hash-based files
Indexing: primary & secondary indexes, B/B+ trees, bitmap indexes

Module II

Data Transformation & Preprocessing;

Data transformation operations-Normalization: 1NF, 2NF, 3NF, BCNF, Multi-valued dependencies, 4NF, Discretization: binning, histogram analysis, clustering-based, Sampling techniques: random, stratified, systematic, Feature scaling and encoding, Data compression concepts ,Lossless compression (Huffman, LZ77),Columnar compression (dictionary, run-length),Handling missing data, noise removal, outlier detection, ETL and ELT processes, Data cleaning and validation workflows

Module III

Transaction Management and Concurrency Control:

Transactions: ACID properties, Schedules and serializability, Concurrency problems: lost updates, dirty reads, unrepeatable reads, Lock-based protocols, timestamps, deadlock handling, Recovery system: log-based recovery, checkpoints, Shadow paging.
File Organization and Indexing: Storage and file organization, Heap, sequential, and hashed files, Primary, secondary indexing, B-Tree, B+ Tree indexing, Bitmap indexing, Query processing and optimization basics
.

Module IV

Data Warehousing & Multidimensional Modelling: Data warehouse fundamentals and architecture, OLTP vs OLAP systems (Online Transaction Processing vs Online Analytical Processing),Data warehouse modelling-Star schema, snowflake schema, fact constellation, Multidimensional data models: dimensions, facts, Concept hierarchies for dimensions, Measures: types, categorization, and computation, OLAP operations: roll-up, drill-down, slice, dice, pivot, Data mart design, Warehouse metadata and data governance

Textbook:

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill, 3rd Edition, 2003.
2. Martin Kleppmann, Designing Data-Intensive Applications, O'Reilly Media, 2017.
3. Tyler Akidau and Slava Chernyak, Streaming Systems: The What, Where, When, and How of Large-Scale

Data Processing, O'Reilly Media, 2018.

References :

1. Jure Leskovec, Anand Rajaraman and Jeffrey Ullman, Mining of Massive Datasets, Cambridge University Press, (2020).
2. Bill Chambers and Matei Zaharia, Spark: The Definitive Guide, O'Reilly Media, (2018).
3. Pieter Hintjens, ZeroMQ: Messaging for Many Applications, O'Reilly Media, (2013).

26-###-0306 SYSTEM PROGRAMMING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the architecture of system software including assemblers, macro processors, compilers, linkers, loaders, and operating system components.
2. Apply system-level programming concepts such as memory management, file handling, and process control to develop efficient system programs.
3. Analyze the internal design and working principles of assemblers, macro processors, compilers, linkers, loaders, and OS system calls.
4. Design and implement system programs, shell utilities, and automation scripts for system management and integration.nt analytics and machine learning workflows.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	3				1	2		2	3	2	1
CO2	3	3	3	2	3				1	2		2	3	3	2
CO3	3	3	3	2	3				1	2		2	3	3	3
CO4	3	3	3	2	3				1	2		2	3	3	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

System Programming Foundations and Assemblers

System software and application software; machine architecture including CPU, registers, instruction formats, and addressing modes. Assemblers: functions of an assembler, one-pass and two-pass assembler design, symbol table, literal table, opcode table, assembly directives, and instruction processing. Applications: low-level translation and system-level program execution.

Module II

Macro Processors and Compiler Fundamentals

Macro processors: macro definition and invocation, macro expansion, nested macros, parameter passing, and the design of a simple macro processor. Compiler fundamentals: lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization, and code generation; distinctions between compilers and interpreters. Applications: preprocessing, optimization, and translation processes in programming systems.

Module III

Linkers, Loaders and Operating System Components

Linkers: static and dynamic linking, relocation, and symbol resolution. Loaders: absolute loader, relocating loader, and direct linking loader. Operating system concepts: system calls, process states, PCB, context switching, memory allocation, fragmentation, paging, and file system structures involving file descriptors and directory organization. Applications: executable generation, runtime library loading, and OS-level resource management.

Module IV

System Utilities, Shell Scripting and Device Interaction

File operations using system calls such as open, read, write, and close; directory handling and file attributes. Shell programming: shell variables, operators, loops, conditions, and shell functions; filters and pipelines including grep, sed, and awk. Task automation using cron and system logs; introduction to device drivers, I/O control, and interrupt handling concepts. Modern applications include DevOps scripting, automation tools, and embedded system programming.

Case Studies for Assignment

Case Study 1: Design a two-pass assembler with symbol table and literal handling.

Case Study 2: Implement a macro processor supporting macro expansion and nested macros.
Case Study 3: Develop a shell-script–based automation system for process monitoring and file management.

Textbook:

1. D.M. Dhamdhere, Systems Programming and Operating Systems, 2nd Edition, McGraw Hill, (2017).
2. A. Silberschatz, P.B. Galvin and G. Gagne, Operating System Concepts, 10th Edition, Wiley, (2018).

References :

1. John J. Donovan, Systems Programming, McGraw Hill, (1988).
2. Randal E. Bryant and David R. O'Hallaron, Computer Systems: A Programmer's Perspective, Pearson, (2016).
3. Alfred V. Aho, Monica Lam, Ravi Sethi and Jeffrey Ullman, Compilers: Principles, Techniques, and Tools, Pearson, (2007).

26-###-0306 HARDWARE ARCHITECTURES FOR INTELLIGENT SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the architectural foundations of computer systems and specialized hardware used in intelligent systems including CPUs, GPUs, TPUs, and edge AI devices.
2. Analyze memory hierarchies, interconnects, parallel processing models, and hardware accelerators for efficient execution of AI and Data Science workloads.
3. Evaluate hardware architectures such as multicore systems, SIMD/MIMD models, and distributed computing frameworks for performance, scalability, and energy efficiency.
4. Apply knowledge of digital systems, embedded platforms, and specialized AI accelerators to design and deploy intelligent systems for real-world applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1	3				1	2		2	3	2	1	
CO2	3	3	3	2	3				1	2		2	3	3	2	
CO3	3	3	3	2	3				1	2		2	3	3	3	
CO4	3	3	3	2	3				1	2		2	3	3	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Foundations of Computer

Basic structure of computers: Functional units, Basic operational concepts, Bus structures Instructions & instruction sequencing. Hardware and software, Addressing modes, Assembly language, Stacks & Subroutines. Computer arithmetic, Two's complement Number representation and arithmetic. Multiplication: Booth's algorithm, Fast multiplication, Integer division, Floating point numbers and operations.

Module II

Processing Unit Fundamental concepts –Execution of a complete instruction, Hardwired control unit, Microprogrammed control, Control signals, Micro instructions, Microprogram sequencing Emulation.

Memory organization - Semiconductor RAM memories, internal organization of memory chips Static and Dynamic memories, cache memories, mapping functions, replacement algorithms, virtual memory, address translations – performance considerations. Interleaving, Secondary storage.

Module III

Input output organizations, Interrupts Enabling & Disabling interrupts, handling multiple devices, device identification, vectored interrupts, interrupt nesting Simultaneous requests DMA, Buses, I/O interface circuits –Standard I/O interfaces. Basic Concepts of Pipelining: Basic Concepts, Role of Cache memory, Pipeline performance, Data Hazards, Instruction Hazards.

Module IV

Multicore: Basic Concept, Interconnection: NoC

Specialized Hardware for AI: GPUs, TPUs and Accelerators

GPU architecture; streaming multiprocessors, warps, memory model, and execution model for parallel computation. Tensor Processing Units (TPUs) and systolic array architecture. AI accelerators – FPGAs.

Performance, scalability, and energy-efficiency considerations in modern computing systems.

Case Studies for Assignment

Case Study 1: Performance comparison of CPU, GPU and TPU for deep learning inference on a benchmark dataset.
Case Study 2: Design and simulation of a memory hierarchy model for optimizing AI workload performance.

Textbook:

1. Hamacher, Vranesic, & Zaky. (2017). Computer Organization (5th ed.). McGraw Hill Education
2. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 6th Edition, Morgan Kaufmann, (2021).
3. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, 6th Edition, Morgan Kaufmann, (2019).

References :

1. Manoj Franklin, Parallel Computer Architecture, Elsevier, (2020).
2. Sudeep Pasricha and Nikil Dutt, On-Chip Communication Architectures, Morgan Kaufmann, (2008).
3. Kashif Rasul, Deep Learning with Edge AI, Apress, (2023).

26-###-0307 DATA STRUCTURES LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Use linear and nonlinear data structures for a given application.
2. Perform data manipulation in a given application using searching and sorting techniques.
3. Develop application to solve the real-world problem by selecting the suitable data structure.
4. Improve communication and team building skills.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1					1			1	3	3
CO2	3	3	2	1					1			1	3	3
CO3	3	2	2	1					1			1	3	2
CO4	3	2	2	2					1			1	3	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Lab Cycle

- Implementation of classes and objects in C++.
- Implementation of inheritance in C++.
- Implementation of polymorphism: function overloading and overriding.
- Implementation of operations on arrays: insertion, deletion, traversing, and displaying.
- Implementation of Linear Search and Binary Search on an array.
- Implementation of sorting techniques: bubble sort, selection sort, and insertion sort.
- Implementation of singly linked list and its operations.
- Implementation of doubly linked list and its operations.
- Implementation of circular linked list and its operations.
- Implementation of stack and queue using linked list.
- Implementation of stack and queue using arrays.
- Implementation of circular queue and its operations.
- Implementation of binary search tree and its operations: insertion, deletion, and searching.
- Implementation of tree traversals: preorder, inorder, and postorder.
- Implementation of a hash table with collision handling.
- Implementation of a priority queue using heap.
- Graph representation and traversal using BFS and DFS.

Assignment:

Design of any real time application:

Instructions:

Students can form a project team with around 5 members per team.

The team can select the problem(s) from societal, health, safety and legal domains. Using C++ programming language for application development, the team has to identify and use a suitable data structure to implement the project.

At the end of the semester, the team has to present their project, submit a report in their lab record. The team is assessed through rubrics.

References :

1. Aho, A. V., Hopcroft, J. E., & Ullman, J. D. (2009). Data Structures and algorithms. Delhi: Dorling Kindersly.
2. Langsam, Y., Augenstein, M., & Tenenbaum, A. M. (2000). Data structures using C and C++. New Delhi: Prentice Hall of India.
3. Horowitz, E., Sahni, S., & Mehta, D. P. (2008). Fundamentals of data structures. Summit, NJ: Silicon Press.
4. Samantha D(2009). Classic Data Structures : Prentice Hall India Learning Private Limited
5. Venkatesan, R., & Rose, S. L. (2019). Data Structures (2nd ed.). Wiley.
6. Karuppiah. (2020). Fundamentals of Data Structures and Algorithms. Lambert Academic Publishing.
7. Balagurusamy, E. (2020). Object oriented programming with C++ (8th ed.).Tata McGraw Hill. New Delhi.
8. Lafore, R., & Lafore, R. (2002). Object oriented programming in C++ (4th ed.).Sams Pub.Indianapolis, Indiana.

26-###-0308 SMART SYSTEMS LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Familiarize with troubleshooting, maintenance and Assembling a PC.
2. Demonstrate proficiency in writing and testing assembly language programs for 8086 microprocessors, utilizing data transfer, arithmetic, logical, and program control instructions to solve basic computational problems.
3. Acquire practical skills in interfacing sensors, actuators, and displays with Arduino boards, implementing programming constructs to build applications such as temperature monitoring, motion detection, and environmental sensing.
4. Develop competence in designing and simulating combinational and sequential logic circuits using FPGA development tools and hardware, culminating in the creation of digital systems including calculators, digital clocks, and gaming applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		1									1	2	3	
CO2	2	1	1		2							2	3	1	
CO3	1	3	1	2	3								3	2	
CO4	1	2	2	1	1				1			2	2	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

PC HARDWARE:

Computer peripherals - Keyboard, mouse, monitor, printers
Motherboard components - CPU, chipset, BIOS, memory, storage, ports
Power supply unit and cabling
Assembling and troubleshooting a PC

8086 MICROPROCESSOR PROGRAMMING

Familiarization 8086 kit, addressing modes and instruction set, Assembly language programming
Write and test simple assembly language programs using data transfer and arithmetic instructions

8086 addressing modes

Write programs using different addressing modes like immediate, direct, register, memory-based
Learn assembler directives for allocation of memory

Logical instructions

Write programs using logical instructions like AND, OR, XOR, NOT
Use logical instructions in a program for specific applications

Program control instructions

Use conditional and unconditional jump instructions
Write and execute program loops using looping instructions
(Eg.: Here are 4 sample lab experiments for an 8086 basic programming lab cycle:

- Write an 8086-assembly language program to add two 8-bit numbers and store the result in a register. Use data transfer and arithmetic instructions.
- Write a program to find the largest number in an array of 8-bit numbers stored in memory. Use conditional jump instructions and loops.
- Write a program to convert a hexadecimal number to its equivalent BCD (Binary Coded Decimal) number. Use logical and data transfer instructions.
- Write a program with procedures to calculate the factorial of a number entered by the user. Pass parameters to procedures properly)

ARDUINO PROGRAMMING

Arduino boards and IDE, Digital and analog I/O, Programming constructs, Interfacing sensors, motors, LCD

- Communication protocols (Eg.: Interface a DHT11 temperature and humidity sensor with Arduino. Display readings on an LCD screen.
- Read data from a PIR motion sensor. Turn on an LED and buzzer when motion is detected.
- Interface a soil moisture sensor and display the moisture levels on the serial monitor.
- Connect an ultrasonic sensor and use it to calculate distance to an object. Display the distance on an LCD screen.

FPGA PROGRAMMING

Introduction to FPGA board: Learn how to setup the FPGA board and development tools. Get familiar with the board interfaces like switches, buttons, LEDs, 7-segment display
Combinational logic circuits: Design and implement basic combinational logic circuits using HDL such as VHDL or Verilog

- Implementing basic logic gates (AND, OR, NOT, XOR, etc.).
- Designing and simulating sequential circuits like counters, shift registers, etc.
- Creating a digital clock.
- Building a simple calculator or arithmetic logic unit (ALU).
- Developing simple embedded applications like digital thermometers, traffic light controllers, etc.
- Creating simple gaming applications.
- Image and Video Processing: Implementing edge detection, binarization, color detection, object detection etc.

References:

1. Gilster. (2001). PC Hardware: A Beginner's Guide. Tata McGraw-Hill Education.
2. Smith, A. (2011). Introduction to Arduino. CreateSpace Independent Publishing
3. Hall, D. V. (2017). Microprocessors And Interfacing. (3rd ed) McGraw Hill Education
4. Ayala, K. (2021). The 8051 Microcontroller. Cengage.
5. M.Geddes (2017). Arduino Project Handbook. No Starch Press
6. Mazidi, M. A., & Mazidi, J. G. (2020). The 8051 Microcontroller and Embedded Systems. VISIONIAS
7. Russell Merrick (2023). Getting Started with FPGAs: Digital Circuit Design, Verilog, and VHDL for Beginners. No Starch Press

26-###-0309 INTERNSHIP-I

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the real time technical/managerial skills required and relevant to the subject of area of internship
2. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organization of the information gained during the internship.
3. Conceive the pros and cons of working in a real time industrial/incubation/ innovation /entrepreneurship/lab environment and the wonderful results which could evolve through team-work.
4. Present and defend self-prepared and corrected internship report (with the help of internship guide) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1			2	1		2	2	2	
CO2	2	3	1	2	2	1			2	2	1	1	2	2	
CO3	2	2	3	2	2	1			2	2	1	1	2	1	
CO4	2	2	2	3	2	1			2	2	1	1	2	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Internship Guidelines

During the summer vacations, after the 2nd Semester, students are required to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the University; contribution at incubation/ innovation /entrepreneurship cell of the University; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working for consultancy/ research project within the institutes and Participation in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc. A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review. Training Certificate from the Inter/Intra Institutional Activities from the concerned department/lab as mentioned above for the prescribed period shall be submitted at the end of the internship which can be considered as evidence for the the Internship-1.

Guidelines for evaluation:	**Marks (%)**
1. Regularity and progress of work	20%
2. Work knowledge and Involvement	20%
3. Semester End presentation and oral examination	20%
4. Level of completion of the internship	20%
5. Internship Report – Presentation style and content	20%

SEMESTER IV

26-###-0401 PROBABILITY AND STATISTICS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand and apply fundamental probability concepts, including conditional probability, Bayes' rule, and axioms of probability.
2. Analyze discrete and continuous random variables, compute expectations, and work with major probability distributions.
3. Apply principles of sampling and estimation to perform basic statistical inference.
4. Model real-world systems using stochastic processes such as Bernoulli processes, Poisson processes, and Markov chains.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1						1	2		
CO2	2	3	1	2	2	1						1	2	2	
CO3	2	2	3	2	2	1						1	2	2	
CO4	2	2	2	3	2	1						1	2	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Probability -Events, outcomes, and sample space, Types of events, Probability rules and the axioms of probability, Conditional probability, Independence of events, Bayes' Rule, Law of Total Probability, Elementary theorems of probability

Module II

Random Variables & Distributions -Discrete Random Variables-Definition, PMF, Joint and marginal distributions, Expectation, variance, covariance, Bernoulli, Binomial, Geometric, Poisson distributions. Continuous Random Variables-PDF, CDF, Uniform, Exponential, Gamma, Normal distributions, Law of Large Numbers (LLN),Central Limit Theorem (CLT) and Normal approximations

Module III

Sampling & Statistical Inference -Introduction to sampling, Sampling distributions of mean and variance, Point estimation: properties of estimators, Interval estimation: confidence intervals for mean and proportion

Module IV

Stochastic Processes -Basic concepts and classifications of stochastic processes, Bernoulli process, Poisson process, Markov chains, Transition probability matrix, Steady-state (stationary) distribution.

Textbooks:

1. Ross, S. M. (2014). Introduction to probability and statistics for engineers and scientists (5th ed.). Elsevier.

References:

1. Trivedi, K. S. (2002). Probability and statistics with reliability, queuing, and computer science applications (2nd ed.). Wiley.
2. Devore, J. L. (2020). Probability and Statistics: For Engineering and the Sciences (9th ed.). Cengage India Private Limited.
3. Papoulis, A., & Pillai, S. U. (2002). Probability, random variables, and stochastic processes. Tata McGraw-Hill Education.Muller, A. C., & Guido, S. (2018). Introduction to Machine Learning with Python: A Guide for Data Scientists. O'Reilly Media.

26-###-0402 MACHINE LEARNING

Course Outcomes:

On completion of this course the student will be able to:

1. To Understand the fundamentals of ML and key challenges in model design.
2. To Apply supervised learning models for predictive tasks and understand model tuning.
3. To Understand unsupervised learning approaches.
4. To Understand the structure and components of an RL problem

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2		3								3	2	
CO2	3	3	3	1	3		3						2	2	
CO3	3		3		3								2	2	1
CO4	3	3	3	1	3		3						2	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction: machine learning, Types of machine learning– supervised, unsupervised, semi- supervised and reinforcement learning, machine learning activities, applications of machine learning. Types of data in machine learning, exploring structure of data, Data pre-processing, Model selection and training, Evaluating machine learning algorithms and performance enhancement of models.

Module II

Supervised Learning Algorithms-Regression Models- Introduction of regression, Regression algorithms: Simple linear regression, Multiple linear regression, Polynomial regression model, Logistic regression, Maximum likelihood estimation. Introduction of supervised learning, Classification model and learning steps, Classification algorithms: Naïve Bayes classifier, k-Nearest Neighbour (KNN), Decision tree, Support vector machines, Random Forest

Module III

Unsupervised Learning: Introduction of unsupervised learning, Unsupervised vs supervised learning, Application of unsupervised learning, Clustering and its types, Partitioning method: k- Means and K-Medoids, Hierarchical clustering, Density-based methods – DBSCAN.

Module IV

Reinforcement learning (RL) – RL Framework – Markov Decision Process – Exploration Vs Exploitation - Polices, Value Functions and Bellman Equations – Solution Methods – Q-learning.

Textbook:

1. Tom M. Mitchell, Machine Learning, Fourth Edition, Prentice Hall, 2020.
2. Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.
3. Reinforcement Learning: An Introduction (Adaptive Computation and Machine Learning series) 2 nd edition, Richard S. Sutton and Andrew G. Barto, A Bradford Book; 2018

References:

1. Saikat Dutt, S. Chandramouli, and Das, Machine Learning, Pearson..
2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Second Edition, O'Reilly Media.

26-###-0403 DATA COMMUNICATION AND INTELLIGENT NETWORKS

Course Outcomes:

On completion of this course the student will be able to:

1. Demonstrate an understanding of the functionalities and implementations of network protocols.
2. Evaluate the functionalities and protocols within the ISO/OSI Network model.
3. Describe intelligent network architectures including SDN, NFV, and cognitive networks.
4. Apply AI/ML techniques for intelligent network management, traffic prediction, anomaly detection, and evaluate emerging technologies such as 5G/6G and IoT networks.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2										3	3	
CO2	3	2	3										3	3	
CO3	**3**	3	3	2	1								3	3	
CO4	**3**	2	3	2	1								2	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

The Internet, Protocols and Standards. Network Models, ISO/OSI Reference Model, TCP/IP Reference Model. Physical Layer and Media:, Data and Signals: Analog and Digital, Digital to Digital Conversion, Analog to Digital Conversion, Digital to Analog Conversion, Analog to Analog Conversion. Data Link Layer: Error Detection and Correction Types of Errors, Redundancy, Detection Vs Correction, Retransmission, Cyclic Codes, CRC, Polynomials, Checksum. Data Link Control: Framing, Flow and Error Control, Protocols

Module II

Introduction to Network Layer: Logical Addressing, Internet Protocol, IPV4, Address Mapping, Routing Algorithms – Distance Vector Routing, Link State Routing. Transport Layer: Process to Process Delivery–TCP & UDP Segment Format, TCP Connection, Congestion Control.
Application Layer Services: Domain Name System, Electronic Mail, File transfer, WWW & HTTP.

Module III

Introduction to Intelligent Networks: Basic idea, need for intelligent features in modern networks.
Intelligent Network Architecture: Main components and their functions.
Software Defined Networking (SDN): Control plane vs data plane, role of SDN controller, simple idea of OpenFlow.
Network Function Virtualization (NFV): What virtualization means in networks, VNFs, advantages.

Module IV

Machine Learning in Networks: Simple applications—traffic classification, congestion prediction, basic routing improvements, anomaly detection. Reinforcement Learning: Basic idea of learning from interaction for better routing or optimization. Autonomous Networks: Concepts of self-configuration, self-healing and self-protection.
AI for Network Security: Using AI for detecting threats and intrusions.

Textbook:

1. Forouzan, B., & Fegan, S. (2007). Data communications and networking (4th ed.). McGraw Hill Higher Education. Boston.
2. Kurose, J., & Ross, K. (2013). Computer networking: A top down approach (6th ed.).Pearson. Boston.

References

1. Kreutz, D., Ramos, F. M. V., Veríssimo, P. E., Rothenberg, C. E., Azodolmolky, S., & Uhlig, S. (2015). Software-defined networking: A comprehensive survey. Proceedings of the IEEE, 103(1), 14–76.
2. Sharma, S., & Nag, A. (2023). Cognitive Software Defined Networking and Network Function Virtualization and Applications. Future Internet, 15(2), 78. https://doi.org/10.3390/fi15020078

3. Akyildiz, I. F., Lin, S.-C., & Wang, P. (2015). Wireless software-defined networks (W-SDNs) and network function virtualization (NFV) for 5G cellular systems: An overview and qualitative evaluation. Computer Networks, 93, 66–79
4. Gude, N., Kohler, M., & McKeown, N. (2016). Software Defined Networking: Design and Deployment. Morgan & Claypool Publishers.
5. Tanenbaum, A. S., Wetherall, D., & Feamster, N. (2020). Computer Networks (6th ed.). Pearson

26-###-0404 WEB TECHNOLOGIES AND INTERNET PROGRAMMING

Course Outcomes:

On completion of this course the student will be able to:

1. Develop functional client-side web interfaces using standard HTML, CSS, and JavaScript.
2. Implement basic database connectivity and data manipulation in Java applications using JDBC and SQL.
3. Create dynamic, server-side web applications using Java Servlets and JSP adhering to the MVC pattern.
4. Describe modern web development paradigms, including RESTful services, and database connectivity.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1					**2**		2	3	2	
CO2	3	2	3	2	2	1				1	**2**	1	2	1	
CO3	2	2	**2**			3				2		1	3	2	1
CO4	2	2	3	3	3	1					**2**	1	3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Web: Internet, WWW, W3C, Web 2.0, web servers. HTML 5: Basic syntax, Standard document structure, Basic text markup, Images, Hypertext Links, Lists, Tables, Forms, internal linking. Cascading Style Sheets: Introduction to CSS3-Basic syntax and structure (colours, background, borders, margin, padding, font, display, position), Inline Styles, Embedded Style Sheets, Conflict Resolution, Linking External Style Sheets, CSS Box model, CSS responsiveness (media queries).

Module II

Introduction to Java Programming: Features of Java, Data types, Variables, Class, Objects, Constructors, Methods, Organizing Classes and Interfaces with Packages, Inheritance, Organizing Object Behaviour with Interfaces, Polymorphism, Abstract classes. Implementation of method overloading and overriding.

Module III

JavaScript: Overview of JavaScript, Screen output and keyboard input, Input with Dialogs, Memory concepts, operators, decision making, control statements, counter-controlled repetition, Arrays, Functions, objects, events. Document Object Model (DOM): DOM nodes and trees, DOM tree, DOM Collections, dynamic styles, Case Study-Implementing Client-Side Interactivity with JavaScript

Module IV

Node.js: Introduction to node, node.js, installation, Node.js Modules and NPM, building a RESTful API: Understanding REST Concepts, Routing HTTP Requests, Connecting to Database, Modeling Data, CRUD Operations in database (Create, Read, Update, Delete), Introduction to Express.js, create a simple server using express. User authentication using express, connecting to the frontend.

Textbooks:

1. Deitel & Nieto , Internet and World Wide Web - How to Program, PHI/Pearson
2. Schildt, H. (2017). Java 2: The Complete Reference (10th ed.). Oracle Press.

References:

1.Duckett, J. (2014). HTML & CSS: Design and build websites. John Wiley & Sons.

2.Tilkov, S., & Vinoski, S. (2010). Node.js: Using JavaScript to build high-performance network programs. IEEE Internet Computing, 14(6), 80–83.

26-###-0405 DATA SCIENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Understand and apply data preprocessing techniques.
2. Implement machine learning algorithms.
3. Utilize statistical methods for data interpretation.
4. Design visualizations to effectively communicate findings.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1								3	2	
CO2	3	2	3	2	2								3	2	
CO3	2	2	2										2	1	
CO4	2	2	3	3	2							1	3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Mathematical & Statistical Foundations -Linear algebra: vectors, matrices, matrix–vector product, Rank, null space, Over-determined systems and pseudo-inverse, Distance measures and projections, Eigenvalue decomposition, Statistical modelling & descriptive statistics, Probability basics: random variables & distributions, Mean, variance, covariance, covariance matrix, Hypothesis testing fundamentals, One-tailed & two-tailed tests, Type I and Type II errors, Test statistics

Module II

Python Programming for Data Science -Introduction to Python, Variables and data types, Operators, Sequence data types, Control structures and functions, Reading and handling data, Python libraries: NumPy, Pandas ,SciPy, Matplotlib

Module III

Data Preparation & Dimensionality Reduction -Types of data: structured, unstructured, semi-structured, Data preprocessing: Missing value handling, Outlier detection, Normalization & standardization , Feature engineering techniques: Encoding, Scaling, Transformation, Singular Value Decomposition (SVD),Principal Component Analysis (PCA)

Module IV

Predictive Modeling & Optimization -Predictive modeling concepts, Linear regression & multiple linear regression, Logistic regression for classification, Cross-validation, k-Nearest Neighbors (kNN),k-Means clustering, Typology of data science problems & solution framework, Optimization techniques: Unconstrained optimization, Equality-constrained optimization, Inequality-constrained optimization, Gradient descent & cost functions

Textbook:

1. Davy Cielen, Arno D. B. Meysman, and Mohamed Ali, Introducing Data Science, First Edition, Ebury Press, 2023

References:

1. B. Uma Maheswari and R. Sujatha, Introduction to Data Science: Practical Approach with R and Python, First Edition, Wiley, 2021.
2. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning, Second Edition, Springer, 2009.
3. Wes McKinney, Python for Data Analysis, Third Edition, Shroff/O'Reilly, 2022

26-###-0406 ETHICAL AND RESPONSIBLE AI

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental ethical principles, theories, and the need for responsible practices in artificial intelligence systems.
2. Understand global AI governance frameworks, policies, and legal regulations that guide ethical AI development and deployment.
3. Apply technical methods—such as fairness metrics, explainability techniques, privacy-preserving ML, and robustness measures—for building responsible and trustworthy AI models.
4. Analyze real-world AI applications for ethical risks and develop responsible, inclusive, and sustainable AI solutions for society.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1								1	3	3	
CO2	3	3	2	1								1	3	3	
CO3	3	2	2	1								1	3	2	
CO4	3	2	2	2								1	3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Foundations of Ethics & Responsible AI Introduction to AI ethics: need, scope, and importance, Ethical theories: consequentialism, deontology, virtue ethics, Principles of responsible AI: fairness, transparency, accountability, privacy, safety, Bias in AI systems: sources of bias, types of bias -data bias, algorithmic bias, societal bias, Ethical frameworks by major AI organizations

Module II

Governance, Policies & Legal Frameworks -Global AI governance landscape, AI ethics guidelines -EU AI Act, NIST Framework, India's AI policy landscape, OECD Principles, Privacy laws: GDPR, data protection principles, consent & data rights, Algorithmic accountability and transparency requirements, Intellectual property issues in AI (copyright, generated content rights),Ethical considerations in data collection, annotation, storage, and usage, Risk assessment and impact evaluation for AI systems.

Module III

Technical Approaches to Responsible AI -Fairness-aware machine learning: metrics for fairness, bias mitigation techniques, Explainable AI (XAI): interpretable models, model-agnostic explanations (LIME, SHAP),Robustness and safety in AI systems: adversarial attacks, stress testing, safe model deployment, Privacy-preserving ML: differential privacy, federated learning, secure multi-party computation, Ethical evaluation tools and frameworks used in industry

Module IV

Technical Approaches to Responsible AI -Fairness-aware machine learning: metrics for fairness, bias mitigation techniques, Explainable AI (XAI): interpretable models, model-agnostic explanations (LIME, SHAP),Robustness and safety in AI systems: adversarial attacks, stress testing, safe model deployment, Privacy-preserving ML: differential privacy, federated learning, secure multi-party computation, Ethical evaluation tools and frameworks used in industry.

Textbooks:

1. Dignum, V. (2019). Responsible artificial intelligence: Developing and using AI in a responsible way. Springer.
2. Floridi, L. (Ed.). (2021). The ethics of artificial intelligence. Oxford University Press.

References:

1. Mittelstadt, B. D., Allo, P., Taddeo, M., Wachter, S., & Floridi, L. (2016). The ethics of algorithms: Mapping the debate. Big Data & Society, 3(2), 1–21.
2. 5. Jobin, A., Ienca, M., & Vayena, E. (2019). The global landscape of AI ethics guidelines. Nature Machine Intelligence, 1(9), 389–399.
3. 6. Russell, S. J., & Norvig, P. (2021). Artificial intelligence: A modern approach (4th ed.). Pearson.

26-###-0407 UNIVERSAL HUMAN VALUES

Course Outcomes:

On completion of this course the student will be able to:

1. Recognize needs, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity.
2. Understand human being as the co-existence of two realities, self and body and harmony in the individual level.
3. Verify the possibility of ensuring within the naturally acceptable feelings and express those to the others with an expectation of mutual happiness and mutual prosperity.
4. Identify the harmony in society, nature and existence and ensuring them through the effort to fulfil the human goal.
5. Apply the understanding of ethical human conduct to formulate strategies for ethical life and profession.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			1			2	2	1	2	2	2	2			
CO2			1			2	3	1	3	1	2	2			
CO3			1			2	2	3	3	3	2	2			
CO4			1			3	3	3	3	3	3	3			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education.

Purpose and motivation for the course, recapitulation from Universal Human Values-I.

Self-Exploration–what is it? – Its content and process; 'Natural Acceptance' and experiential Validation- as the process for self-exploration.

Continuous Happiness and Prosperity – A look at basic Human Aspirations.

Right understanding, Relationship and Physical Facility – the basic requirements for the fulfilment of aspirations of every human being with their priority.

Understanding Happiness and Prosperity rightly- A critical appraisal of the current Scenario.

Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human beings as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than arbitrariness in choice based on liking-disliking.

Module II

Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human beings as a co-existence of the sentient 'I' and the material 'Body'.

Understanding the needs of 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: Self-regulation (Sanyam) and Health; correct appraisal of Physical needs, the meaning of Prosperity in detail.

Programs to ensure Self-regulation (Sanyam) and Health.

Include practice sessions to discuss the role others have played in making material goods available to one self, identifying from own life. Differentiate between prosperity and accumulation. Discuss a program for ensuring health vs dealing with a disease.

Module III

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

Understanding values in a human-human relationship; the meaning of Justice (nine universal values in relationships) and the program for its fulfilment 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, the 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.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real-life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module IV

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence
Understanding the Harmony in Nature.
Interconnectedness and mutual fulfilment among the four orders of nature – recyclability and self-regulation in nature.
Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
Holistic perception of harmony at all levels of existence.
Include practice sessions to discuss human beings as the cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Implications of the above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values, Definitiveness of Ethical Human Conduct.
Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
Competence in professional ethics: a. Ability to utilize professional competence for augmenting universal human order, b. Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for the above production systems.
Case studies of typical holistic technologies, management models and production systems.
Strategy for the transition from the present state to Universal Human Order: a. At the level of the individual: as socially and ecologically responsible engineers, technologists and managers, b. At the level of society: as mutually enriching institutions and organizations.
Sum up.
Include practice exercises and case studies to discuss the conduct as an engineer or scientist etc.

Textbook:

1. Gaur, R. R., Asthana, R., & Bageria, G. P. (2022). Human values and professional ethics (3rd rev. ed.). Excel Books..

References:

1. Nagaraj, A. (2022). Jeevan Vidya: Ek Parichaya (3rd ed.). Jeevan Vidya Prakashan.
2. Tripathi, A. N. (2022). Human values (5th ed.). New Age Intl. Publishers.

26-###-0408 MACHINE LEARNING AND DATA SCIENCE IN PYTHON LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Learn Python tools for data handling, analysis, and visualization.
2. Implement machine learning algorithms using real datasets.
3. Perform preprocessing, model building, evaluation, and tuning.
4. Develop end-to-end data science solutions.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	3				1	2		1	3	2	
CO2	2	2	3	2	3				1	2		1	3	2	1
CO3	2	2	3	2	3				1	2		1	3	3	
CO4	2	2	3	2	3				1	2		1	3	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Experiments

1. Introduction to Python Environment-Jupyter Notebook / Google Colab setup, Python basics, importing libraries.
2. NumPy for Data Computation-Array creation, slicing, indexing, mathematical & matrix operations..
3. Pandas for Data Manipulation-DataFrame creation, reading CSV/Excel, filtering, grouping, merging.
4. Data Visualization: Basic and advanced plotting using Matplotlib and Seaborn.
5. For a given set of training data examples stored in a .CSV file, demonstrate Data Preprocessing
6. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample
7. Build a linear regression model using python for a particular data set
8. Implement K-Means, Hierarchical Clustering and PCA .
9. Implement KNN and SVM.
10. Implement Random Forest Algorithm using Python.

References:

1. Géron, A. (2019). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow (2nd ed.). O'Reilly Media.
2. McKinney, W. (2017). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython (2nd ed.). O'Reilly Media.
3. Müller, A. C., & Guido, S. (2016). Introduction to machine learning with Python: A guide for data scientists. O'Reilly Media.

26-###-0409 CAPSTONE PROJECT 1: FULL STACK DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Create REST APIs and integrate them with custom storage layers
2. Develop a complete, functional full stack application
3. Apply design, coding, debugging, testing, and documentation best practices
4. Deploy end-to-end applications

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3							1	2		2	3	3	1
CO2	2	3	3		3				1	2		2	3	3	1
CO3	2	3	2		3				1	2		2	3	2	
CO4	2	3	3		3				1	2		1	3	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A

Project Description

It is required to design and develop a complete end-to-end software application using either Python or Java as the primary development technology. The project must include a well-structured front-end interface (HTML, CSS, JAVA SCRIPT), a robust backend application (Django / Spring / Node.js), and a properly designed database layer(SQL / NoSQL). Students are expected to apply concepts from software engineering, web development, database systems, and APIs to build a functional, scalable, and user-friendly full-stack solution.

Presentation

You will be required to present your project. Your presentation will include a description of your design (e.g. using diagrams) in each increment, difficulties encountered and solved in the design and implementation processes, tools used, advanced techniques supported by your DBMS, and a demonstration of your implemented project.

Notes:

All modules developed will have an extensible design for further additions. All code will be fully documented.

Guidelines for evaluation:	***Marks(%)***
1. Regularity and progress of work (CA)	10%
2. Work knowledge and Involvement (CA)	10%
3. Semester End presentation and assessment (SEE)	40%
4. Level of completion and demonstration of Functionality/Specifications (CA: 10% + SEE: 10%)	20%
5. Presentation style and content(CA)	20%

References:

1. Smith, J. (2022). Comparative Analysis of NoSQL and MySQL in a Database Management System Project.
2. Lutz, M. (2013). Learning Python (5th ed.). O'Reilly Media.
3. Bloch, J. (2018). Effective Java (3rd ed.). Addison-Wesley.
4. Duckett, J. (2014). HTML & CSS: Design and build websites. John Wiley & Sons.
5. Sommerville, I. (2016). Software engineering (10th ed.). Pearson.

SEMESTER V

26-###-0501 OPTIMIZATION TECHNIQUES

Course Outcomes:

On completion of this course the student will be able to:

5. Understand and formulate linear and classical optimization models, including duality and sensitivity analysis.
6. Apply unconstrained and constrained nonlinear optimization techniques using gradient-based and numerical methods.
7. Analyze optimization methods used in Artificial Intelligence and Machine Learning, including SGD variants, regularization, and convex optimization.
8. Design and implement evolutionary, swarm, and meta-heuristic optimization algorithms for AI and Data Science applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	1	
CO2	3	2	1										2	1	
CO3	3	2											3	1	
CO4	3	3	1										3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Linear Programming & Classical Optimization:

Role of optimization in AI, Data Science, Operations Research. Formulation of optimization problems: objective function, variables, constraints. Linear Programming Problem (LPP): standard form, canonical form. Feasible region, convexity, graphical method. Simplex method, degeneracy, Big-M method, Two-Phase method. Duality theory, primal–dual relationships. Sensitivity analysis and interpretation.

Module II

Unconstrained Optimization: Optimality conditions (first and second order). Gradient Descent, Steepest Descent, Newton's Method. Quasi-Newton methods: BFGS, DFP. Conjugate Gradient Methods.

Constrained Optimization: Equality and inequality constraints. Lagrangian function, Lagrange multipliers. Karush–Kuhn–Tucker (KKT) conditions. Penalty and Barrier methods. Sequential Quadratic Programming (SQP).

Module III

Optimization in Artificial Intelligence & Data Science:

Optimization viewpoint in AI/ML model training. Loss function minimization; regularization (L1, L2, Elastic Net). Convex optimization and significance in machine learning.

Optimization algorithms for ML: Stochastic Gradient Descent (SGD), Mini-batch Gradient Descent, Momentum, Adagrad, RMSProp, Adam, AdamW, Nadam.

Optimization in models: Logistic Regression, Support Vector Machines (hinge loss optimization), Neural network training and convergence behaviour.

PCA as an optimization problem (eigenvalue/eigenvector computation), Hyperparameter optimization: Grid search, Random search, Bayesian intuition.

Module IV

Evolutionary, Swarm & Meta-heuristic Techniques:

Need for heuristics in complex AI search spaces. Evolutionary Algorithms: Genetic Algorithms – selection, crossover, mutation, fitness functions. Swarm Intelligence: Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO). Meta-heuristics: Simulated Annealing, Tabu Search, Differential Evolution, Artificial Bee Colony. Multi-objective optimization, Pareto optimality, basics of NSGA-II. Applications in AI/DS: feature selection, clustering, neural architecture tuning, robotics path planning.

Note: Students must implement a case-study–based assignment using Python or MATLAB, applying the optimization techniques learned across all modules.

Textbook:

3. Rao, S. S. Engineering Optimization: Theory and Practice. Wiley, 4th Edition.
4. Boyd, S., & Vandenberghe, L. Convex Optimization. Cambridge University Press, 2004.
5. Taha, H. A. Operations Research: An Introduction. Pearson, 10th Edition.

References:

3. Nocedal, J., & Wright, S. Numerical Optimization. Springer, 2nd Edition.
4. Deb, K. Optimization for Engineering Design: Algorithms and Examples. PHI Learning, 2nd Edition.
5. Goldberg, D. E. Genetic Algorithms in Search, Optimization, and Machine Learning. Addison-Wesley, 1989.
6. Russell, S., & Norvig, P. Artificial Intelligence: A Modern Approach. Pearson, 4th Edition.

26-###-0502 ALGORITHMIC TECHNIQUES & ANALYSIS

Course Outcomes:

On completion of this course the student will be able to:

1. Describe algorithmic fundamentals, asymptotic notations, recurrence-solving techniques, and classical & randomized design strategies.
2. Apply divide and conquer, greedy, dynamic programming, graph algorithms, heuristic search, and backtracking to computational and AI/DS problems.
3. Analyze the performance, complexity, and suitability of algorithms for real-world data-driven applications.
4. Evaluate algorithmic complexity classes (P/NP/NP-Complete) and justify the use of approximation and heuristic methods in AI and DS workflows.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	1	
CO2	3	2	1										2	1	
CO3	3	2											3	1	
CO4	3	3	1										3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Analyzing algorithms and problems. Asymptotic notations and growth of functions.
Recurrence equations: Substitution Method, Change of Variables, Recursion Tree, Master Theorem.
Algorithm design techniques: Divide and Conquer, Dynamic Programming, Greedy, Backtracking. Introduction to Randomized Algorithms.

Module II

Divide and Conquer: Analysis of Binary Search, Quick Sort, Merge Sort.
Greedy Method: Job Sequencing with Deadlines, Fractional Knapsack, Single Source Shortest Path (Dijkstra).
Graph Algorithms: Breadth-First Search (BFS), Depth-First Search (DFS), Minimum Spanning Trees (Kruskal/Prim), Topological Sorting.

Module III

Dynamic Programming: 0/1 Knapsack, All-Pairs Shortest Path, Travelling Salesperson Problem.
Backtracking: Sum of Subsets, Graph Colouring, Hamiltonian Cycles.
AI Search Foundations: A* Search, Greedy Best-First Search; Introduction to Constraint Satisfaction Problems (CSPs).

Module IV

Branch and Bound: Travelling Salesperson Problem, 0/1 Knapsack.
Complexity Theory: Introduction to P, NP, NP-Complete Problems.
Approximation Algorithms (Vertex Cover, Set Cover basics), Local Search and Hill Climbing, Algorithmic complexity in ML (training cost, feature selection as NP-hard).

Textbook:

1. Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. Introduction to Algorithms. 4th Edition, MIT Press, 2022.
2. Horowitz, E., Sahni, S., & Rajasekaran, S. Fundamentals of Computer Algorithms. Universities Press, 2007.
3. Kleinberg, J., & Tardos, É. Algorithm Design. Addison-Wesley, 2006.

References:

1. Aho, A. V., Hopcroft, J. E., & Ullman, J. D. The Design and Analysis of Computer Algorithms. Addison-Wesley, 1974.
2. Dasgupta, S., Papadimitriou, C. H., & Vazirani, U. V. Algorithms. McGraw-Hill, 2008.
3. Sridhar, S. Design and Analysis of Algorithms. Oxford University Press, 2014.
4. Russell, S., & Norvig, P. Artificial Intelligence: A Modern Approach. 4th Edition, Pearson, 2021.

26-###-0503 BIG DATA ANALYTICS & VISUALIZATION

Course Outcomes:

On completion of this course the student will be able to:

1. Understand big data characteristics, data models, storage systems, and distributed processing concepts.
2. Apply big data processing frameworks and tools (such as Hadoop, Spark) to ingest, transform, and manage large-scale datasets.
3. Analyze datasets using scalable analytics techniques, machine learning pipelines, and data exploration methods.
4. Create effective dashboards and visual analytics solutions using modern visualization tools and storytelling principles.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	1	
CO2	3	2	1										2	1	
CO3	3	2											3	1	
CO4	3	3	1										3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Big Data:

Big Data: definition, characteristics (5V/7V model), types of data. Traditional data processing vs. big data processing.

Data models: structured, semi-structured, unstructured data; NoSQL database concepts (key-value, document, columnar, graph).

Data storage: HDFS architecture, blocks, replication, namenode/datanode operations.

Basics of distributed computing, RDD concepts, and scalability requirements.

Module II

Big Data Processing Frameworks:

Hadoop ecosystem: MapReduce programming model, YARN, HDFS I/O patterns.

Apache Spark: RDDs, DataFrames, Spark SQL, transformations and actions, lazy evaluation.

Data ingestion tools: Sqoop, Flume, Kafka – basics and use cases.

Introduction to cloud-based big data platforms (AWS EMR, Azure HDInsight, Google Dataproc).

Module III

Big Data Analytics:

Machine learning with Spark MLlib: regression, classification, clustering pipelines.

Dimensionality reduction for big data: PCA, feature hashing, sampling methods.

Handling large-scale datasets: streaming analytics (Spark Streaming / Kafka Streaming), window operations.

Graph analytics basics: PageRank, connected components, graph representations.

Case studies in AI/DS: recommendation systems, anomaly detection, social network analytics.

Module IV

Data Visualization & Storytelling

Principles of visual perception, design guidelines, colour theory, chart selection.

Tools: Tableau, Power BI, Python visualization (Matplotlib, Seaborn, Plotly), dashboards. Interactive visualization, geospatial visualization, time-series visualization.

Visual storytelling: narrative structures, insights presentation, ethics in visualization. User-centered data product design and reporting standards.

Textbook:

1. Raj, P. Big Data Analytics. Springer, 2018.
2. Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. Learning Spark: Lightning-Fast Big Data Analytics. O'Reilly Media, 2015.
3. White, T. Hadoop: The Definitive Guide (4th ed.). O'Reilly Media, 2015.

References:

1. Lin, J., & Dyer, C. Data-Intensive Text Processing with MapReduce. Morgan & Claypool, 2010.
2. O'Neil, C., & Schutt, R. Doing Data Science. O'Reilly Media, 2013.
3. Kumar, V., & Singh, A. Big Data Analytics with Spark. Wiley, 2018.

26-###-0504 SOFTWARE ARCHITECTURE AND DESIGN PATTERN

Course Outcomes:

On completion of this course the student will be able to:

1. Identify appropriate UML diagrams to model software, data-driven, and AI-enabled systems.
2. Apply suitable design patterns to improve software quality, maintainability, and scalability in both traditional and AI-based applications.
3. Analyze alternative software architectures and architectural styles for building large-scale, distributed, and AI-centric systems.
4. Evaluate architectural trade-offs involving performance, security, usability, and reliability in modern data-intensive and AI system architectures.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	1	
CO2	3	2	1										2	1	
CO3	3	2											3	1	
CO4	3	3	1										3	1	

1-Slightly**; 2**-Moderately**; 3-**Substantially

Module I

Introduction to software architecture: Definition and importance of software architecture, Role of the architect. Architectural Styles: Monolithic Architecture, Client-server architecture, Layered architecture, Pipe and Filter Architecture, Model-View-Controller (MVC) architecture, Microservices architecture, Event-driven architecture.
Architecture Description Language (ADL) and Unified Modeling Language (UML). Architecture modeling with UML: UML diagrams: Structural and Behavioral Diagrams: Class diagrams, Component diagrams, Deployment diagrams; Use case diagrams, Activity diagrams, Interaction diagrams, State Machine Diagrams.

Module II

Architectural Analysis: Identifying architectural risks based on nonfunctional requirements - Performance analysis, Security analysis, Usability analysis, Architecture Tradeoff Analysis Method (ATAM). Case Studies to analyse existing software architectures (AI/ML systems focusing on scalability, performance,security, data/model drift management, reproducibility, fairness and bias considerations).

Module III

Introduction to Design Patterns: Understanding of object-oriented design principles as a foundation for design patterns. SOLID principles. Categories of design patterns (Creational, Structural, Behavioral). Design pattern selection and application in real-world scenarios. Importance of design patterns in software development.
Design patterns for Data Engineering and ML pipelines, model-serving and inference patterns, pipeline orchestration patterns, and avoidance of anti-patterns in AI-based applications.

Module IV

Emerging Architectures for AI/DS Systems: Cloud-Native & Serverless Architectures, Decentralized & Event-Driven Patterns, Edge AI and TinyML Architectures, AI-Driven & Resilient Architectures (AI for Architecture)
Big-data and analytics architectures (Lambda, Kappa), Architectures for large-scale AI applications. Architectural patterns used in real-world AI platforms such as recommendation systems, NLP systems, and autonomous systems.

Textbook:

1. Bass, L., Clements, P., & Kazman, R. Software Architecture in Practice. Addison-Wesley, 4th Edition, 2021.
2. Larman, C. Applying UML and Patterns. Pearson, 3rd Edition, 2004.
3. Gamma, E., Helm, R., Johnson, R., & Vlissides, J. Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley, 1994.

References:

1. Pressman, R. S., & Maxim, B. Software Engineering: A Practitioner's Approach. McGraw-Hill, 9th Edition, 2020.
2. Richards, M., & Ford, N. Fundamentals of Software Architecture. O'Reilly, 2020.
3. Hohpe, G. The Software Architect Elevator: Redefining the Architect's Role. O'Reilly, 2020.
4. Kleppmann, M. Designing Data-Intensive Applications. O'Reilly, 2017.
5. Shalloway, A., & Trott, J. Design Patterns Explained: A New Perspective on Object-Oriented Design. Addison-Wesley, 2nd Edition, 2004.
6. Robert C. Martin, Clean Architecture: A Craftsman's Guide to Software Structure and Design, PrenticeHall, 2018.

26-###-0505 CLOUD TECHNOLOGIES AND SERVICES

Course Outcomes:

On completion of this course the student will be able to:

1. Identify cloud computing models, architectures, and virtualization concepts relevant to building scalable systems.
2. Apply distributed, parallel, and concurrent programming principles to cloud-based applications and data-intensive workloads.
3. Analyze cloud resource management, security mechanisms, and virtualization strategies for modern analytics and AI-driven systems.
4. Evaluate cloud-based solutions, performance trade-offs, and architectures supporting large-scale data processing and AI/DS applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	1	
CO2	3	2	1										2	1	
CO3	3	2											3	1	
CO4	3	3	1										3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Cloud Computing: Defining a Cloud, Cloud Computing Reference Model- , IaaS, PaaS, SaaS, Types of Clouds, Characteristics and Benefits, Historical Developments, Computing Platforms and Technologies.

Elements of Parallel Computing: Parallel Processing, Hardware Architectures for Parallel Processing, Approaches to Parallel Programming, Levels of Parallelism.

Cloud environments for AI workloads, parallel computing for ML training, distributed training basics for large models.

Module II

Elements of Distributed Computing: General Concepts, Components of a Distributed System, Architectural Styles for Distributed Computing, Models for Inter Process Communication, Technologies for Distributed Computing.

Virtual Machines and Virtualization of Clusters and Data Centres: Implementation Levels of Virtualization, Virtualization Structures/Tools and Mechanisms, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data Centre Automation.

Virtualization support for AI/ML workloads, distributed storage for large datasets, cluster management for data science and analytics.

Module III

Cloud Computing Architecture: Economics of the Cloud, Open Challenges. Inter-cloud Resource Management, Extended Cloud Computing Services, Resource Provisioning and Platform Deployment, Virtual Machine Creation and Management, Global Exchange of Cloud Resources.

Cloud Security and Trust Management, Cloud Security Defence Strategies, Distributed Intrusion/Anomaly Detection, Data and Software Protection Techniques, Reputation-Guided Protection of Data Centres.

Cloud-based ML services (Auto ML, managed AI platforms), GPU/TPU provisioning, ML model deployment on cloud, AI-enabled anomaly detection for cloud security.

Module IV

Concurrent Computing: Thread Programming, Introducing Parallelism for Single Machine Computation, Programming Applications with Threads, Thread APIs, Techniques for Parallel Computation with Threads.

High Throughput Computing: Task Computing, Characterizing a Task, Computing Categories, Frameworks for Task Computing, Workflow Applications with Task Dependencies.

Data Intensive Computing: MapReduce Programming, Characterizing Data Intensive Computations, Data Clouds and Big Data, Technologies for Data Intensive Computing, Storage Systems, Programming Platform.

Distributed data processing frameworks (Hadoop/Spark) for AI pipelines, data-parallel ML workloads, cloud big-data platforms for analytics and model training.

Textbook:

1. Buyya R., Vecchiola C., Selvi S. T. – Mastering Cloud Computing – McGraw Hill – 2013.
2. Tanenbaum A. S., Van Steen M. – Distributed Systems: Principles and Paradigms – Pearson – 2nd Edition,

2007.
3. Hirsch M. – Distributed Systems and Cloud Computing – Springer – 2020.

References:

1. Kleppmann M. – Designing Data-Intensive Applications – O'Reilly – 2017.
2. Thomas E., Liu K., Jaramillo D. – Cloud Computing: Concepts, Technology & Architecture – Prentice Hall – 2013.
3. White T. – Hadoop: The Definitive Guide – O'Reilly – 4th Edition, 2015.
4. Zaharia M. et al. – Learning Spark: Lightning-Fast Data Analytics – O'Reilly – 2020.
5. Foster I., Gannon D., Zhang J. – Cloud Computing for Science and Engineering – MIT Press – 2017.

26-###----- PROFESSIONAL ELECTIVE – I/MOOC

26-###---- DATA VISUALIZATION AND ANALYTICS LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

6. Perform data handling, cleaning, preprocessing, and exploratory analysis using Python/R.
7. Apply advanced visualization techniques for multivariate, time-series, geospatial and high-dimensional data.
8. Develop interactive dashboards and visual narratives using modern visualization tools (Plotly Dash / Tableau / Power BI).
9. Implement applied analytics and visual interpretation of machine learning models, clustering, text analytics, and real-world datasets.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										1		
CO2	3	1	1										1	1	
CO3	3	2	1										1		
CO4	2	2	2										2	2	
CO5	3	2	2										3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A – Fundamentals of Data Handling & Preprocessing (Python / R)

Students will perform experiments to understand the basics of data manipulation and preprocessing:

1. Importing datasets; handling CSV, JSON, Excel files.
2. Data cleaning: missing values, outliers, type conversions.
3. Exploratory data analysis: summary statistics, grouping, aggregations.
4. Data preprocessing: normalization, scaling, encoding, feature extraction.
5. Visualizing basic distributions: histograms, bar charts, box plots, scatter plots.
6. Introduction to visualization libraries: Matplotlib, Seaborn, Plotly (or R's ggplot2).

Part B – Advanced Visual Analytics

1. Multivariate visualization: heatmaps, pair plots, correlation matrices.
2. Time-series visualization: line plots, rolling statistics, anomaly highlighting.
3. Geospatial visualization using Python/R (Folium/Plotly/GeoPandas).
4. Interactive visual dashboards using Plotly Dash / Tableau / Power BI.
5. Visualizing high-dimensional data: PCA plots, t-SNE, UMAP.
6. Designing effective visual narratives: chart choices, color theory, storytelling.

Part C – Applied Analytics & Real-World Visualization

(Implementations using Python / R / Tableau / Power BI)

Set I – Data Analytics

1. Building visual analytics for regression and classification models.
2. Model evaluation visualization: ROC, precision-recall, confusion matrix.
3. Data pipeline visualization: ML workflow dashboards.
4. Visualizing clustering outputs: K-Means, DBSCAN, hierarchical dendrograms.
5. Text analytics visualization: word clouds, n-gram plots, sentiment timelines.

Set II – Mini Projects / Case Studies

(Any one from below or similar real-world datasets)

1. Sales/retail analytics dashboard with KPIs and forecasting visuals.
2. Health analytics: disease trends, patient clustering, anomaly detection visualization.
3. Social media analytics: sentiment, engagement trends, network graphs.
4. Financial analytics: stock patterns, volatility plots, portfolio visualizations.
5. Transportation/mobility analytics: route efficiency, heatmaps, congestion analysis.

Textbook:

3. VanderPlas J. – Python Data Science Handbook – O'Reilly – 2016.
4. Wickham H. – ggplot2: Elegant Graphics for Data Analysis – Springer – 2nd Edition, 2016.
5. Knaflic C. N. – Storytelling with Data: A Data Visualization Guide for Business Professionals – Wiley – 2015.

References:

6. McKinney W. – Python for Data Analysis – O'Reilly – 3rd Edition, 2022.
7. Sievert C. – Interactive Web-Based Data Visualization with R, plotly, and shiny – Chapman & Hall/CRC – 2020.
8. Healy K. – Data Visualization: A Practical Introduction – Princeton University Press – 2018.
9. Tennekes M., Keim D. – Visual Analytics – Springer – 2023.
10. Few S. – Show Me the Numbers: Designing Tables and Graphs to Enlighten – Analytics Press – 2nd Edition, 2012.

Pattern of Continuous Assessment

Test -I for the theory portions	:	30%
Test -II for the theory portions	:	30%
Assignment from the Theory	:	10%
Laboratory Record	:	10%
Viva-voce	:	10%
Attendance	:	10%

The students are required to submit the laboratory record.

26-###---- CAPSTONE PROJECT 2:
CLOUD-BASED AI APPLICATIONS

Course Outcomes:

On completion of this course the student will be able to:

1. Apply cloud platforms (AWS / Azure / Google Cloud / IBM Cloud) for deploying scalable AI/DS applications.
2. Build, train, evaluate, and optimize AI/ML models for real-world problem statements.
3. Design end-to-end data pipelines using cloud storage, databases, and streaming/ETL tools.
4. Demonstrate professional project development practices through documentation, deployment, and presentations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	1	
CO2	3	2	1										2	1	
CO3	3	2											3	1	
CO4	3	3	1										3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Project Requirements (MANDATORY)

Every student/team must use:

1. Cloud Computing Components (At least 3 required)

Examples:

- Cloud Compute (EC2, VM, Functions, Kubernetes, IBM Code Engine, etc.)
- Cloud Storage (S3, Blob Storage, Cloud SQL/NoSQL DBs)
- Cloud-based API hosting / serverless
- Cloud MLOps tools (SageMaker, Azure ML Studio, Vertex AI, WatsonX, etc.)
- Cloud monitoring & logging

2. Artificial Intelligence / Data Science Components

At least one major AI/DS area must be implemented:

- Machine Learning (Regression, Classification, Clustering)
- Deep Learning (CNN, RNN, Transformers)
- NLP (Sentiment, NER, Text Analytics)
- Computer Vision
- Time-Series Forecasting
- Recommender Systems
- Generative AI (LLMs, diffusion models, retrieval pipelines)

3. Data Science Pipeline

Must include:

- Data ingestion / preprocessing
- Model building and evaluation
- Visualization & dashboard/report
- Cloud deployment / API or UI

Sample Project Themes

- Cloud-based health analytics & disease prediction
- AI-powered customer behavior forecasting on cloud
- NLP/LLM service deployed as cloud microservices
- Smart mobility analytics with cloud dashboards
- Vision-based quality inspection system deployed via cloud
- Cloud-native recommender system (Retail/Media/etc.)

Evaluation Scheme (100 Marks)

1. Problem Definition & Proposal – 10 marks
   - — Novelty, clarity, objective formulation
2. Implementation of Cloud Services – 25 marks

- NOTE: Marks strictly depend on genuine usage of cloud resources
- (Compute, storage, API hosting, serverless functions, monitoring, etc.)

3. Implementation of AI & Data Science – 25 marks
   - Quality of ML/DL model
   - Correctness, evaluation metrics
   - Data pipeline maturity
4. System Integration & Deployment – 15 marks
   - End-to-end working application
   - CI/CD, MLOps, or automation (if used)
5. Results, Visualization & Analysis – 10 marks
   - Dashboards / reports / model insights
6. Documentation & Presentation – 15 marks
   - Project report, architecture diagrams
   - Demo, viva, question handling

Textbook:

1. Ian Goodfellow, Yoshua Bengio & Aaron Courville, Deep Learning, MIT Press.
2. Tom M. Mitchell, Machine Learning, McGraw Hill.
3. Thomas Erl, Cloud Computing: Concepts, Technology & Architecture, Pearson.
4. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly.

References:

1. AWS, Azure, GCP, IBM Cloud official documentation.
2. François Chollet, Deep Learning with Python, Manning.
3. Jeff Smith, Machine Learning Systems: Designs and Practices, O'Reilly.
4. Building Machine Learning Pipelines – Hannes Hapke & Catherine Nelson, O'Reilly.
5. Research papers from IEEE / ACM related to cloud-based AI systems.

26-###---- INTERNSHIP-II

Course Outcomes:

On completion of this internship, the student will be able to:

1. Apply AI and Data Science techniques to real-world industry problems using appropriate tools and datasets.
2. Utilize cloud platforms and services for data processing, model development, deployment, and analytics workflows.
3. Demonstrate professional skills through effective technical communication, teamwork, and project documentation.
4. Develop end-to-end solutions that integrate AI/DS methods, cloud resources, and industry-standard practices.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1			2	1		2	2	1	1
CO2	2	3	1	2	2	1			2	2	1	1	2	1	
CO3	2	2	3	2	2	1			2	2	1	1	2	1	
CO4	2	2	2	3	2	1			2	2	1	1	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Internship Guidelines

- An internship plan has to be prepared by the interns incorporating the job description / internship duties, name of the project (if any), AI–DS tools and platforms to be used, internship schedule, and expected learning outcomes, in consultation with the industry supervisor/mentor and institute faculty.
- A detailed Training Report in the prescribed format shall be submitted at the end of the internship.
- A Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
- The work shall be reviewed and evaluated periodically by the faculty mentor.
- Orientation of interns, resource requirement of interns, monitoring of interns' progress on a daily basis shall be carried out by the industry offering internship, in addition to ensuring safety and welfare of the interns.

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

	Guidelines for evaluation:	**Marks (%)**
1.	Regularity and progress of work Includes attendance, adherence to schedule, timely completion of assigned tasks, and regular updates.	20%
2.	Work knowledge and Involvement Assessed based on the student's technical engagement in: — Artificial Intelligence / Machine Learning — Data Science workflows — Cloud tools (AWS/Azure/GCP/IBM Cloud) — Data engineering, model deployment, analytics dashboards, etc.	20%
3.	Semester End presentation and oral examination Assessed on clarity, depth of understanding, demonstration of AI/DS components, and ability to explain datasets, algorithms used, cloud services, and results.	20%
4.	Level of completion of the internship Based on completion of assigned tasks, implementation quality, usage of AI/DS methods, and cloud-based tools or platforms.	20%
5.	Internship Report – Presentation style and content Quality of documentation, structure, use of AI/DS techniques, proper explanation of workflow, results, dashboards, cloud integration, etc.	20%

SEMESTER VI

26-###-0601 CUSTOMER RELATIONSHIP MANAGEMENT IN ARTIFICIAL INTELLIGENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Demonstrate knowledge of CRM principles, processes, and strategies.
2. Analyze the role of AI technologies in enhancing customer relationships.
3. Design AI-based CRM solutions for various business contexts.
4. Evaluate CRM performance using data analytics tools and customer insights

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1							2		2	1	
CO2	3	2	3						1		3	1	2	1	
CO3	3	3	3	2	3				3		2		3	2	
CO4	3	3	1	3				3	3		3	2	1	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Customer Relationship Management, Introduction to CRM: Concept, evolution, and importance, Components and functions of CRM, CRM types: Operational, Analytical, and Collaborative CRM, Customer lifecycle and retention strategies, Role of technology in CRM systems

Module II

Artificial Intelligence Foundations for CRM, Basics of AI and Machine Learning: Concepts and techniques, Data mining and predictive analytics, Natural Language Processing (NLP) and sentiment analysis for customer feedback, Chatbots, virtual assistants, and automated service systems, Integrating AI-driven insights into CRM strategies

Module III

AI Applications in CRM, Personalization and recommendation engines, Customer segmentation and targeting through AI, Predictive modeling for customer churn and lifetime value, Social CRM and AI-enabled marketing automation, Case studies: Use of AI in retail, banking, and e-commerce CRM

Module IV

Designing AI-integrated CRM Systems: Architecture and tools, CRM analytics dashboards and performance measurement, Data privacy, security, and ethical considerations, Emerging trends: Generative AI, voice-based CRM, and predictive service models,

Case Studies: Capstone project: Developing a mini AI-powered CRM prototype

Textbooks:

1. Shanmugasundaram, S. (2016). Customer Relationship Management (1st ed.). PHI Learning Pvt. Ltd.
2. Kumar, V., & Reinartz, W. (2018). Customer Relationship Management: Concept, Strategy, and Tools (3rd ed.). Springer

References:

1. Sharma, Chhavi Bhargava (2021). Customer Relationship Management: Concepts and Cases (2nd ed.). Dreamtech Press.
2. Subramanian, C. S., & Anandan, C. (2011). Customer Relationship Management (1st ed.). Himalaya Publishing House.
3. Rajesh, S. J., & Sharma, A. K. (2022). Artificial Intelligence and Data Analytics for Business Applications (1st ed.). Wiley India.

26-###-0602 DIGITAL TWINNING IN INTELLIGENT AUTONOMOUS SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the principles and components of digital twinning systems.
2. Design digital twin models integrating AI, IoT, and sensor data.
3. Implement digital twins for predictive maintenance and system optimization.
4. Evaluate security, scalability, and ethical aspects of digital twinning applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2									3	2	3
CO2	3	2	2	2									3	2	3
CO3	2	2	2	2									3	2	3
CO4	2	2	2	2									3	2	3
CO5	1	1	1	1									3	2	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Digital Twinning,
Concept, definition, and history of digital twins, Types of twins: component, system, and process twins, Relationship between digital twins, cyber-physical systems, and IoT, Architecture and life cycle of a digital twin, Benefits and challenges of digital twin adoption in industries

Module II

Enabling Technologies for Digital Twins: Internet of Things connectivity and data exchange, Edge and cloud computing for twin integration, AI and machine learning models for predictive simulation, Big data analytics and data pipelines, Sensor networks, telemetry, and real-time data streaming

Module III

Digital Twins in Intelligent Autonomous Systems:Role of digital twins in autonomous vehicles, robots, and drones, Virtual prototyping and performance optimization, Digital twins for fault detection, diagnostics, and predictive maintenance, Human-in-the-loop and adaptive learning systems, Case studies: Smart manufacturing, autonomous transportation, and smart cities

Module IV

Tools and platforms: MATLAB Simulink, Siemens Twin, ANSYS Twin Builder, Azure Digital Twins, Interoperability, standards, and integration frameworks, Data security, privacy, and trustworthiness issues, Digital twin sustainability and scalability, Research frontiers: Self-learning twins, generative twins, metaverse-based simulation.

Textbook:

1. Sarangapani, J. & Puthal, D. (2021), Digital Twin Technologies and Intelligent Autonomous Systems, CRC Press.
2. Rajiv Chopra (2022) Artificial Intelligence and Internet of Things, Khanna Book Publishing Co.

References:

1. Kumar, T. V. Vijay(2023) Emerging Technologies for Digital Twin Infrastructure, Springer India.
2. Mourtzis, D(2021)– Design and Operation of Production Networks with Digital Twin Technology, Academic Press.
3. S. S. Iyengar & S. Misra – Intelligent Systems and Applications, Wiley India.

26-###-0603 DEEP LEARNING AND GENERATIVE AI

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the principles of deep neural networks and design suitable architectures for diverse machine learning tasks.
2. Apply convolutional, recurrent, and attention-based models to solve complex real-world problems.
3. Develop, train, and implement generative AI models such as GANs and VAEs for applications like image synthesis, text generation, and data augmentation.
4. Analyze and evaluate AI models with respect to performance, ethical implications, biases, and responsible AI practices.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1								2	3	2	
CO2	2	1	2	2								2	3	2	
CO3	1	1	2	3								2	3	2	
CO4	1	1	1	2								2	3	2	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Deep Learning:Introduction to neural networks and perceptrons, Activation functions and loss functions, Gradient descent and backpropagation algorithms, Overfitting, regularization, and dropout techniques, Frameworks for deep learning: TensorFlow, PyTorch, and Keras

Module II

Advanced Deep Learning Architectures:Convolutional Neural Networks (CNNs): Architecture and image applications, Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks, Transformers and attention mechanisms, Autoencoders and dimensionality reduction, Practical uses in computer vision, NLP, and speech recognition

Module III

Generative AI Foundations, Basics of generative modeling :Generative Adversarial Networks (GANs): Architecture and training process, Variational ,Autoencoders (VAEs) and diffusion models, Data synthesis and augmentation using generative models, Challenges in stability and evaluation metrics for generative models

Module IV

Generative AI in text, image, and audio creation , Large Language Models (LLMs) and multimodal generation, Evaluation of content authenticity and deepfake detection Responsible AI: Ethical, legal, and societal implications, Capstone project: Implementing a generative AI model for a selected application

Textbook:

1. Panchal, C. & Arora, M. – Deep Learning: Principles and Applications, Khanna Book Publishing Co.
2. Bhattacharjee, A. & Chakraborty, D. – Introduction to Artificial Intelligence and Deep Learning, Cengage India.
3. Goodfellow, I., Bengio, Y., & Courville, A. – Deep Learning, MIT Press.

References:

1. Aggarwal, C. C. – Neural Networks and Deep Learning, Springer.
2. Rao, K. & Dastidar, S. – Generative AI: Concepts and Applications, Wiley India.

26-###-0604 EDGE INTELLIGENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Comprehend fundamental concepts of Edge Computing and Edge Intelligence.
2. Develop AI/ML models optimized for resource-constrained edge devices.
3. Implement real-time edge analytics and deploy AI applications on edge platforms.
4. Identify security, privacy, and ethical issues in Edge Intelligence systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1										3	2	
CO2	2	3	3	2	3		2						3	3	
CO3	2	2	3	3	3								3	2	
CO4	2	2	2	1	3	3	3				3		2	3	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Edge Intelligence

Introduction to Edge Computing and Edge Intelligence, Differences between Cloud AI and Edge AI, Overview of IoT and edge devices (Raspberry Pi, NVIDIA Jetson), Basic AI and ML related to edge computing.

Module II

AI and Machine Learning for Edge

Basics of Artificial Neural Networks (ANN), CNNs, TinyML, Model optimization & compression techniques, Federated learning and distributed intelligence, Hands-on basics: AI models on Raspberry Pi or similar edge devices

Module III

Edge Analytics and Real-Time Systems

Data acquisition, preprocessing, and analytics on edge, Edge architectures and IoT communication protocols (MQTT, CoAP), Security, privacy, and ethics in edge AI, Case studies: smart cities, healthcare, industrial IoT applications.

Module IV

AI model deployment & performance tuning on edge devices, Energy-efficient Edge AI and hardware accelerators, Fault tolerance, explainability, and ethical AI in Edge Intelligence.

Textbooks:

1. Mahalle, P. N., Diwakar, M. P., Ghule, V. R., & Ingle, Y. S. (2025). Edge Artificial Intelligence: Algorithms, Applications, Challenges and Ethical Issues (1st ed.). Elsevier.
2. Rajaraman, V. (2014). Machine Learning with Python (1st ed.). PHI Learning Pvt. Ltd..

References:

1. Murthy, C. S. R. (2020). IoT and Edge Computing for Engineers (1st ed.). Wiley India.
2. Padhy, N. P. (2005). Artificial Intelligence: A Guide for Beginners (1st ed.). Ane Books Pvt. Ltd.
3. Buyya, R., et al. (2019). Fundamentals of Edge Computing (1st ed.). Cambridge University Press

26-###-0605 NATURAL LANGUAGE PROCESSING AND LARGE LANGUAGE MODELS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals of Natural Language Processing (NLP) including linguistic and statistical models.
2. Apply machine learning techniques to NLP problems such as tokenization, parsing, and semantic analysis.
3. Develop and fine-tune Large Language Models (LLMs) and use them for real-world applications like chatbots, translation, and summarization.
4. Assess and address ethical, privacy, and bias issues in NLP and LLM systems.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1		2							1	3	2	
CO2	2	3	3	3	2							1	3	2	2
CO3	2	2	3	2	3							1	3	3	
CO4	2	2	3	3	3							1	3	3	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fundamentals of Natural Language Processing

Introduction to NLP: history, challenges, and applications, Linguistic essentials: morphology, syntax, semantics, Text preprocessing: tokenization, stemming, lemmatization, stopword removal, Language modeling: n-grams, smoothing techniques

Module II

Syntax and Semantics in NLP

Part-of-speech tagging: rule-based and stochastic approaches, Parsing techniques: Context-Free Grammars, dependency parsing, probabilistic parsers, Semantic analysis: word sense disambiguation, lexical semantics, semantic role labeling, Introduction to word embeddings (Word2Vec, GloVe) and contextual embeddings (BERT)

Module III

Machine Learning and Deep Learning for NLP

Supervised and unsupervised learning in NLP, Sequence models: RNNs, LSTMs, GRUs, Transformer architecture fundamentals, Training and fine-tuning Large Language Models (GPT, BERT, T5)

Module IV

NLP applications: sentiment analysis, machine translation, information retrieval, chatbots Deployment of NLP models and real-time inference challenges, Ethical considerations: fairness, bias, privacy, explainability in LLMs, Emerging trends: multimodal models, multilingual LLMs, federated learning in NLP

Textbooks:

1. Bharati, A., Chaitanya, V., & Sangal, R. (1995). Natural Language Processing: A Paninian Perspective (1st ed.). PHI Learning Pvt. Ltd.
2. Raschka, S. (2024). Build a large language model (from scratch): From data to deployment. Addison-Wesley Professional.

References:

1. Pulari, S. R., Maramreddy, U., & Vasudevan, S. K. (2025). Natural Language Processing (1st ed.). OUP India.
2. Padhy, N. P. (2025). Artificial Intelligence: A Guide for Beginners (1st ed.). Oxford University Press.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning (1st ed.). MIT Press.
4. Russell, S., & Norvig, P. (1995). Artificial Intelligence: A Modern Approach (1st ed.). Prentice Hall.
5. Indurkhya, N., & Damerau, F. J. (2010). Handbook of Natural Language Processing (1st ed.). Chapman & Hall/CRC Press.
6. Tunstall, L., von Werra, L., & Wolf, T. (2022). *Natural Language Processing with Transformers: Building language applications with Hugging Face* (Revised ed.). O'Reilly Medi

INDUSTRY ELECTIVE – I

26-###-### MLOps AND MODEL DEPLOYMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Implement reproducible ML pipelines using MLOps tools.
2. Containerize and deploy models using Docker and Kubernetes.
3. Design and implement CI/CD/CT for ML model release.
4. Monitor live models for drift and ensure governance.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	2			1			2	3	2	1
CO2	3	2	3	2	3				2		1	2	3	3	1
CO3	3	3	3	2	3		1		2	1	2	3	3	3	2
CO4	2	2	1	3	2	2	2	3	2	2	1	3	2	2	3

1-Slightly; 2-Moderately; 3-Substantially

Module I

MLOps Foundations: Definition, maturity levels (Level 0, 1, 2), and key differences from DevOps. Data Versioning and Features: Importance of data version control (DVC) and Feature Store concepts for training/serving consistency. Experiment Tracking: Using MLflow for logging parameters, metrics, and artifacts to ensure complete training reproducibility and managing the model lifecycle (staging to production).

Module II

Model API and Containerization: Building REST API endpoints (FastAPI/Flask) for inference. Using Docker to containerize the model and its environment dependencies. Scalable Deployment: Introduction to Kubernetes (K8s) architecture (Pods, Deployments, Services). Deploying model containers on K8s and configuring basic load balancing and auto-scaling. Investigating serverless vs. cluster deployment patterns.

Module III

Continuous Integration (CI): Implementing testing for ML projects, including code quality, data validation, and model performance validation. Continuous Delivery/Deployment (CD): Automating the full pipeline from code check-in to production deployment. Implementing zero-downtime strategies: Canary and Blue/Green releases, including automated rollbacks. Continuous Training (CT): Establishing triggers for automated model retraining based on performance or data signals.

Module IV

Monitoring and Observability: Tracking essential production metrics (latency, throughput). Setting up dashboards (Prometheus/Grafana). Drift Detection: Monitoring and alerting for Data Drift (input data changes) and Concept Drift (model relationship changes). Model Governance and XAI: Auditing models for bias and fairness. Implementing Explainability (XAI) techniques (SHAP/LIME) for transparency and maintaining regulatory compliance.

Textbook:

1. Humble, J., & Farley, D. (2010). Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation. Addison-Wesley.
2. Chandarana, K. (2021). Building Production-Ready Machine Learning Systems: Effective MLOps Solutions. Packt Publishing.
3. Shipp, F. (2022). Machine Learning Engineering in Action. Manning Publications.

References:

1. Richards, M., & Ford, N. (2020). Fundamentals of Software Architecture. O'Reilly.
2. Kleppmann, M. (2017). Designing Data-Intensive Applications. O'Reilly.
3. Hohpe, G. (2003). Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions. Addison-Wesley.
4. Richards, M. (2015). Microservices Patterns: Designing Fine-Grained Systems. O'Reilly.
5. Kreimer, G. (2021). Practical MLOps: How to Take Models from Zero to Hero. Packt Publishing..

26-###-### EMERGING TRENDS IN AI DEPLOYMENT

Course Outcomes:

On completion of this course the student will be able to:

5. Analyze the core concepts and architectures of Generative AI and Large Language Models (LLMs).
6. Design and integrate AI solutions for edge computing and specialized domains like healthcare and finance.
7. Evaluate advanced techniques in Reinforcement Learning and Multi-Modal AI for complex decision-making tasks.
8. Assess the ethical, governance, and security challenges posed by emerging AI technologies in real-world deployment.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	1			1	1	2	3	3	1
CO2	3	2	3	2	2	3	1			2	2	2	3	2	1
CO3	3	3	2	3	2	2	1			2		3	2	3	1
CO4	2	2	1	2	1	1	3	3	3	2	1	3	1	2	3

1-Slightly; 2-Moderately; 3-Substantially

Module I

Foundations of Generative AI: Understanding VAEs, GANs, and Flow-based models. Diffusion Models and their application in image and video synthesis. Large Language Models (LLMs): Transformer architecture recap, pre-training objectives, and fine-tuning techniques (e.g., LoRA). Application of LLMs: Prompt engineering, Retrieval-Augmented Generation (RAG), agents, and ethical considerations in text generation. Generative Applications: Code generation, synthetic data creation, and music/audio synthesis.

Module II

AI in Edge/IoT Devices: Challenges of deploying AI models on resource-constrained devices (latency, power, size). Model Optimization: Techniques like model quantization, pruning, and knowledge distillation for smaller footprints. Frameworks for Edge: Introduction to TensorFlow Lite, ONNX Runtime, and specialized hardware accelerators (e.g., TPUs, FPGAs). Domain-Specific AI: Current trends in Medical Imaging Analysis (e.g., foundation models for healthcare) and AI in Finance (e.g., algorithmic trading, fraud detection using graph neural networks).

Module III

Reinforcement Learning (RL) Trends: Review of core RL (Policy Gradients, Q-learning). Advanced topics: Deep Q-Networks (DQN), Proximal Policy Optimization (PPO), and Multi-Agent Reinforcement Learning (MARL). Applications of RL: Robotics, complex game playing, and optimization of industrial control systems. Multi-Modal AI: Fusing and processing information from diverse sources (e.g., text, image, video, time series). Architectures for multi-modal learning (e.g., CLIP, Vision-Language Models). Self-Supervised Learning (SSL): Techniques like masked autoencoders and contrastive learning to reduce reliance on large labeled datasets.

Module IV

Trustworthy AI: Principles of fairness, transparency, and accountability. AI Safety and Alignment: Techniques for ensuring AI systems operate within intended ethical boundaries, including LLM alignment methods. AI Governance and Regulation: Overview of regulatory frameworks (e.g., EU AI Act) and their impact on deployment. Adversarial AI and Security: Understanding adversarial attacks on models (e.g., generating misclassified inputs) and defensive measures. Future Trends: Discussion on Neuromorphic Computing, Quantum ML (QML), and societal implications.

Textbook:

1. Geron, Aurélien. *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*. O'Reilly. (Focus on DL foundations for advanced topics)
2. Molnar, Christoph. *Interpretable Machine Learning: A Guide for Making Black Box Models Explainable*. (Open source resource, essential for CO4)

3. Wong, V., et al. *Generative AI with Python and TensorFlow 2*. Packt Publishing, 2023.

References:

6. Sutton, Richard S., & Barto, Andrew G. *Reinforcement Learning: An Introduction*. MIT Press.
7. Li, C., et al. *Generative AI: The Complete Guide*. O'Reilly, 2024.
8. Richards, M., & Ford, N. *Fundamentals of Software Architecture*. O'Reilly, 2020. (Relevant for specialized/edge deployment architecture)
9. Buda, M., et al. *Adversarial Attacks and Defences in Machine Learning*. Springer, 2023.
10. Aylor, P., & Parente, T. *Engineering MLOps: The Path to Building and Running Better Models*. Manning Publications, 2024. (Focus on practical deployment)
11. Various Research Papers/ArXiv Preprints on Diffusion Models, LLMs, and Multi-Agent RL (as guided by the instructor).

26-###-### AI FOR FINTECH AND BUSINESS INTELLIGENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals of AI and its applications in Fintech and Business Intelligence.
2. Apply machine learning and data analytics techniques to drive business decisions in Fintech.
3. Analyze and design data-driven solutions for financial services and applications.
4. Evaluate the role of AI in Fintech and Business Intelligence.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	1								2	1	1
CO2	3	2	1	2	1								3	2	1
CO3	3	2	3	1									2	3	2
CO4	3	3	1	3	1	1							3	1	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Fintech Fundamentals and AI Applications

Introduction to Fintech: Evolution of financial services, Key technologies (blockchain, AI, cloud), Regulatory landscape; AI applications in Fintech: Payment systems, Credit scoring, Risk management; Overview of Fintech and Business Intelligence; Case study: AI-powered payment systems

Module II

Business Intelligence in Fintech

Financial Data Management: Data sources (market data, transaction data), Data warehousing and ETL, Data governance and quality; Business Intelligence tools and techniques: Reporting, Dashboards, Data visualization; Case study: BI dashboard for financial performance analysis.

Module III

AI-driven Financial Analytics

AI-driven Financial Analytics: Financial reporting and dashboards, Risk analysis and management, Portfolio management and optimization; Machine learning techniques: Regression, Classification, Clustering; Case study: AI-driven financial performance analysis.

Module IV

Advanced AI Applications in Fintech

AI-powered trading and portfolio management; Natural language processing (NLP) in Fintech: Sentiment analysis, Text analysis; Ethical considerations in AI for Fintech: Fairness, Transparency, Accountability; Case study: AI-powered robo-advisory systems.

Textbooks:

1. Chishti, S., & Barberis, J. (2016). The Fintech Book. Wiley.
2. Turban, E., Sharda, R., & Chen, D. (2018). Business Intelligence: A Managerial Approach. Pearson.

References:

1. Tapscott, D., & Tapscott, A. (2016). Blockchain Revolution. Penguin.
2. Provost, F., & Fawcett, T. (2013). Data Science for Business. O'Reilly.
3. Bennett, M. J., & Van den Poel, D. (2015). Financial Analytics with R. Cambridge University Press.
4. Sironi, P. (2016). Fintech: The Future of Finance. Palgrave Macmillan.
5. Ammous, S. (2018). The Bitcoin Standard. Wiley.

26-###-### FEDERATED LEARNING

Course Outcomes:

On completion of this course the student will be able to:

1. Explain the fundamental concepts, terminology, architectures, and types of Federated Learning
2. Analyze the design and working principles of Horizontal and Vertical Federated Learning frameworks, and evaluate key algorithms
3. Apply and interpret optimization strategies for federated systems under Non-IID settings, including stratification techniques, adaptive learning rates, momentum, and weight decay.
4. Examine privacy-preserving and security-enhancing mechanisms in Federated Learning, including homomorphic encryption and secret-sharing based approaches, and assess their effectiveness.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2										3	1	
CO2	3	2	1										2	1	
CO3	3	2											3	1	
CO4	3	3	1										3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Federated Learning – Overview of Federated Learning: Definition, History, and Applications – Concepts and Terminology – Types of Federated Learning: Cross-device, Cross-silo-Federated Learning Architecture -Machine Learning Perspective -Security & Privacy in Federated Learning – Federated Learning vs Centralized Learning: Comparison and Contrast

Module II

Horizontal Federated Learning (HFL) -Definition and Architecture of Horizontal Federated Learning – Federated Averaging (FedAvg) Algorithm – Improvements on the FedAvg Algorithm

Module III

Vertical Federated Learning (VFL) – Definition and Architecture of Vertical Federated Learning – VFL Algorithms: Secure Federated Linear Regression, Secure Federated Tree Boosting

Module IV

Federated Learning with Non-IID Data – Heterogeneity in Federated Learning -Stratification and Local Updated Rules – Advanced Optimization Techniques in Federated Learning -Adaptive Learning Rate -Momentum and Weight Decay Federated Transfer Learning (FTL) – Framework of Federated Transfer Learning – Homomorphic Encryption in FTL – FTL Training Process -FTL Prediction Process – Security Analysis of FTL – Secret Sharing based FTL

Textbook:

1. Yang, Q., Liu, Y., Cheng, Y., Kang, Y., Chen, T., & Yu, H. (2019). Federated learning. Morgan & Claypool Publishers

References:

1. Federated learning comprehensive overview of methods and applications Springer Nature Switzerland AG; 1st ed. 2022 edition By Heiko Ludwig (Editor), Nathalie Baracaldo.
2. Federated Learning with Python by Kiyoshi Nakayama PhD, George Jeno, O'Reilly Media, Inc. Pub.
3. What-is-federated learning? By Emily Glanz, Nova Fallen, O'Reilly Media, Inc. Pub Hohpe, G. The Software Architect Elevator: Redefining the Architect's Role. O'Reilly, 2020.

26-###----- EDGE AI AND NETWORKING LAB

Course Outcomes:

On completion of this course the student will be able to:

1. Configure and operate edge AI platforms like Raspberry Pi and NVIDIA Jetson.
2. Deploy and optimize AI/ML models on resource-constrained edge devices.
3. Interface sensors and perform real-time data acquisition and analytics on edge devices.
4. Implement MQTT and IoT protocols for edge device communication.
5. Measure and analyze network latency and throughput in edge environments.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1			1				1			1	2	2	
CO2	2	1	2	2	1				1	1		2	3	2	
CO3	2	1	3	3	2				1	1		2	3	2	
CO4	2		3	3	3				1	1		2	3	2	
CO5	2		2	3	3				1	1		2	2	1	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Details of Experiments

1. Setup and Programming of Edge Device (Raspberry Pi or NVIDIA Jetson)
2. Install OS, setup Python environment, and perform basic sensor reading
3. Implement Gradient Descent on Edge for Simple Neural Networks
4. Deploy a Pretrained CNN Model for Image Classification on Edge Device
5. Run inference using MobileNet or ResNet on Jetson Nano/Raspberry Pi.
6. Object Detection Using SSD or YOLO on Edge Device Camera Feed
7. Utilize a camera connected to the edge device and implement real-time object detection
8. Sensor Data Acquisition and Predictive Analytics on Edge
9. Interface temperature/humidity sensor, collect data, and predict future values with regression model on device
10. Implement MQTT Protocol for Edge Device Communication
11. Set up MQTT broker, publish sensor data from edge device, visualize in dashboard.
12. Edge Device Networking and Latency Measurement
13. Measure network latency and throughput in local edge network vs cloud connectivity
14. Implement Federated Learning Simulation on Multiple Edge Devices
15. Simulate federated averaging across two or more Raspberry Pi devices.
16. Build an Edge AI-Based Smart Surveillance System
17. Capture video feed using edge device, run person detection, and generate alerts.
18. Security and Privacy Setup for Edge AI Communication
19. Implement basic encryption for MQTT messages and analyze security challenges.

References:

1. Mahalle, P. N., et al. (2025). Edge Artificial Intelligence: Algorithms, Applications, Challenges and Ethical Issues (1st ed.). Elsevier.
2. Mahajan, S., & Munirathinam, S. (Eds.). (2025). Edge of Intelligence: Exploring the Frontiers of AI at the Edge (1st ed.). CRC Press.
3. Vyas, S., et al. (Eds.). (2025). Edge AI in Future Computing (1st ed.). Routledge.
4. Indurkhya, N., & Damerau, F. J. (2010). Handbook of Natural Language Processing (1st ed.). Chapman & Hall/CRC Press.
5. Singh, A., et al. (Eds.). (2024). Machine Learning for Edge Computing: Frameworks, Patterns and Best Practices (1st ed.). Springer.

26-###----CAPSTONE PROJECT 3 -AI BASED MOBILE APP DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Design and develop a working AI-driven mobile application prototype.
2. Integrate mobile frameworks with cloud or on-device AI solutions.
3. Apply and evaluate AI models for real-world use cases in mobile apps.
4. Demonstrate effective UI/UX best practices in app development.
5. Present and document the project, highlighting problem-solving and innovation

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	3				1	2		1	3	2	1
CO2	2	1	1		3				1	2		1	3	3	
CO3	2	3	3	3	3				1	2		1	3	2	
CO4	2	1	1		3				1	2		1	3	1	
CO5	2	3	3	3	3				1	2		1	3	2	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

The goal is to design and prototype an intelligent mobile application leveraging AI technologies—such as machine learning, NLP, image processing, or prediction models.

•Students will plan, design, and implement the app following material design/user experience standards.

•The project requires backend integration; this may utilize cloud-based or on-device AI inference as appropriate.

•The resulting app must address a real-world problem or user need, demonstrating how AI enhances mobile functionalities (e.g., recommendation, classification, automation, conversational UI).

Part A: Mobile and AI Fundamentals

•Introduction to mobile frameworks (Flutter, React Native, or Android/iOS Native)

•Basic app setup and UI development; navigation, views, event handling

•API connection for data flow; local and remote storage

•Basics of integrating AI models (using TensorFlow Lite, Core ML, or cloud APIs)

Part B: AI Integration

•Fundamentals of AI for mobile (NLP, computer vision, recommender engines)

•Design, train, and deploy ML models suitable for mobile environments

•Connecting mobile UI with AI-powered features

•Attention to performance, privacy, and user experience

Part C: Project Development & Presentation

•Students work in teams/individually on project ideation, agile planning, prototyping, testing, and deploying their app

•Present project with design documents, architecture diagrams, implementation details, encountered challenges, adopted solutions, and demonstration on devices or emulators

Guidelines for evaluation:	***Marks(%)***
1. Regularity and progress of work(CA)	10%
2. Work knowledge and Involvement(CA)	10%
3. Semester End presentation and assesment(SEE)	40%
4. Level of completion and demonstration of Functionality/Specifications (CA: 10% + SEE: 10%)	20%
5. Project Report – Presentation style and content(CA)	20%

References:

1. Smith, J. (2022). Comparative Analysis of AI Technologies in Mobile Development (2nd ed.). Cambridge

University Press.
2. Hoffler, A. & Ramesh, M. (2019). Modern Mobile App Development: AI Techniques and Applications (3rd ed.). Pearson.
3. Date, J. C. (2016). An Introduction to Database and Intelligent Systems for Mobile Apps (12th ed.). O'Reilly Media.
4. Russell S. & Norvig P. (2022). Artificial Intelligence: A Modern Approach (4th ed.). Pearson.

SEMESTER VII

26- DATA SECURITY AND PRIVACY IN ARTIFICIAL INTELLIGENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Understand accounting fundamentals, bookkeeping, double-entry, journal/ledger, final accounts preparation.
2. Comprehend cost accounting, cost classification, costing methods, marginal costing, break-even analysis.
3. Analyse funds flow statements, working capital changes, funds from operations.
4. Explore e-banking, home banking, online banking approaches, security, management issues.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2		3	2			1	2	3	3
CO2	3	3	3	3	3	3		3	3	2		1	2	3	3
CO3	3	3	3	3	2	2		3	2			1	2	3	3
CO4	2	3	3	2	3	3	2	3	3	3	3	1	3	2	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Cybersecurity basics, CIA triad, cryptography (AES, DES, RSA, ECC), hash functions, PKI, digital signatures, AI lifecycle security, threat modeling, data poisoning attacks, model extraction, model inversion, membership inference, privacy leakage, insider threats, cloud security, blockchain, zero-trust architecture, access control, secure storage.

Module II

Differential privacy, ε-differential privacy, (ε,δ)-differential privacy, privacy budgets, Laplace mechanism, Gaussian mechanism, exponential mechanism, noisy gradient descent, PATE, local vs global differential privacy, federated learning, FedAvg, FedProx, secure aggregation, split learning, homomorphic encryption (FHE), secure multi-party computation (MPC), secret sharing, garbled circuits, synthetic data generation, k-anonymity, l-diversity, t-closeness, TEE (Intel SGX, ARM TrustZone).

Module III

Adversarial examples, white-box vs black-box attacks, evasion attacks (FGSM, PGD, C&W), adversarial patch attacks, backdoor attacks, trojan models, poisoning attacks, Byzantine attacks, adversarial training, defensive distillation, input transformation, certified defenses, randomized smoothing, detection methods, gradient masking, robustness metrics, model watermarking, fingerprinting, explainability (LIME, SHAP), red teaming, robust optimization.

Module IV

Data protection regulations (GDPR, CCPA, HIPAA), right to explanation, data subject rights, consent, DPIA, privacy by design, AI governance frameworks, ISO/IEC standards, NIST AI Risk Management Framework, secure software development, DevSecOps, MLSecOps, model versioning, security testing, vulnerability assessment, incident response, security monitoring, ethical considerations, bias and fairness, edge AI security, IoT security, API security, container security (Docker, Kubernetes), model serving security, audit trails, case studies.

Textbooks:

1. Acar, A., Aksu, H., Uluagac, A. S., & Conti, M. (2018). A survey on homomorphic encryption schemes: Theory and implementation. ACM Computing Surveys (CSUR), 51(4), 1-35.
2. Goodfellow, I., McDaniel, P., & Papernot, N. (2018). Making machine learning robust against adversarial inputs. Communications of the ACM, 61(7), 56-66.
3. Dwork, C., & Roth, A. (2014). The algorithmic foundations of differential privacy. Foundations and Trends in Theoretical Computer Science, 9(3-4), 211-407.

References:

1. McMahan, B., et al. (2017). Communication-efficient learning from decentralized data. PMLR.
2. Papernot, N., et al. (2018). SoK: Security and privacy in machine learning. IEEE EuroS&P, 399-414.
3. Carlini, N., & Wagner, D. (2017). Towards evaluating the robustness of neural networks. IEEE S&P, 39-57.
4. Tramèr, F., et al. (2016). Stealing machine learning models via prediction APIs. USENIX Security.

5. Shokri, R., et al. (2017). Membership inference attacks against ML models. IEEE S&P, 3-18.
6. Biggio, B., & Roli, F. (2018). Wild patterns: Ten years after adversarial ML. Pattern Recognition, 84, 317-331.

26- COMPUTER VISION AND IMAGE PROCESSING

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze image formation principles, color models, and apply fundamental image processing techniques for enhancement and restoration.
2. Design and implement feature extraction algorithms including edge detection, corner detection, and scale-invariant feature descriptors.
3. Develop deep learning models using CNNs for image classification, object detection, and semantic segmentation tasks.
4. Apply computer vision techniques to real-world applications including object recognition, tracking, 3D reconstruction, and video analysis.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**	**2**	**2**	**3**							**2**	3	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**3**				**2**			**2**	3	2	**3**
CO3	**3**	**3**	**3**	**2**	**3**				**2**			**2**	3	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**2**			**3**	**2**	**2**	**3**	**2**	3	**3**

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Computer vision introduction, human visual system, image formation, digital image representation, color models (RGB, HSV, YCbCr, Lab), histogram processing, point operations, spatial filtering, linear and non-linear filters, noise reduction, frequency domain processing, image sharpening, morphological operations.

Module II

Edge detection (Sobel, Canny), corner detection (Harris, FAST), blob detection, scale-space theory, feature descriptors (SIFT, SURF, ORB, HOG), feature matching, RANSAC, image segmentation (Otsu, watershed), superpixels, texture analysis, Hough transform.

Module III

Neural networks review, CNNs architecture, CNN models (LeNet, AlexNet, VGGNet, ResNet), batch normalization, dropout, training techniques, pre-trained models, image classification, object detection (R-CNN, YOLO, SSD), semantic segmentation (FCN, U-Net, DeepLab), instance segmentation (Mask R-CNN), attention mechanisms, Vision Transformers, model evaluation metrics.

Module IV

Object tracking (optical flow, Kalman filters, DeepSORT), stereo vision, depth estimation, 3D reconstruction, camera calibration, pose estimation, face detection and recognition, action recognition, video understanding, OCR, medical image analysis, autonomous driving applications, generative models (VAEs, GANs), real-time processing.

Textbook:

1. Szeliski, R. (2022). Computer Vision: Algorithms and Applications (2nd ed.). Springer.
2. Gonzalez, R. C., & Woods, R. E. (2018). Digital Image Processing (4th ed.). Pearson

References:

.Forsyth, D. A., & Ponce, J. (2012). Computer Vision: A Modern Approach (2nd ed.). Pearson.

1. Hartley, R., & Zisserman, A. (2004). Multiple View Geometry in Computer Vision (2nd ed.). Cambridge University Press.
2. Prince, S. J. (2012). Computer Vision: Models, Learning, and Inference. Cambridge University Press.

3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
4. He, K., Zhang, X., Ren, S., & Sun, J. (2016). Deep residual learning for image recognition. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 770-778).
5. Redmon, J., Divvala, S., Girshick, R., & Farhadi, A. (2016). You only look once: Unified, real-time object detection. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 779-788).

26---PROFESSIONAL ELECTIVE – II/MOOC
26---INDUSTRY ELECTIVE – II
26-MULTI-AGENT SYSTEMS AND APPLICATIONS

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze multi-agent system architectures, agent communication protocols, and coordination mechanisms for distributed problem solving.
2. Design negotiation strategies and apply game-theoretic approaches for competitive and cooperative multi-agent scenarios.
3. Implement multi-agent reinforcement learning algorithms and develop emergent behaviors in agent populations.
4. Develop multi-agent applications for robotics, distributed systems, simulation, and collaborative problem-solving domains.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2				3	2		2	3	3	3	3
CO2	3	3	3	3	2		2	3	2	2	2	3	3	2	2
CO3	3	3	3	3				3			3	3	3	2	3
CO4	3	3	3	3	3	2	2	3	2	3	3	2	2	3	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Multi-agent systems introduction, agent properties (autonomy, reactivity, proactivity, social ability), agent architectures (reactive, deliberative, hybrid, BDI), agent communication (speech acts, KQML, FIPA-ACL), coordination mechanisms, distributed problem solving, task allocation, Contract Net Protocol, organizational structures, agent platforms (JADE, Jason, NetLogo), design methodologies (Gaia, Prometheus, TROPOS).

Module II

Game theory fundamentals, normal and extensive form games, Nash equilibrium, Pareto optimality, repeated games, stochastic and Markov games, cooperative game theory (coalition formation, Shapley value), bargaining and negotiation, mechanism design, auction theory, voting and social choice, evolutionary game theory, replicator dynamics, learning in games, applications in resource allocation and network security.

Module III

Reinforcement learning review (MDPs, Q-learning), MARL formulation, stochastic games, independent vs joint action learners, centralized training with decentralized execution (CTDE), value decomposition (VDN, QMIX, QTRAN), policy gradient methods (MADDPG, MAPPO), communication in MARL (CommNet, TarMAC), cooperative and competitive MARL, opponent modeling, mean field RL, graph neural networks, benchmarks (SMAC, PettingZoo).

Module IV

Multi-robot systems, swarm robotics, formation control, distributed sensor networks, consensus algorithms, blockchain as MAS, smart grid, autonomous vehicle coordination, social simulation, agent-based modeling, adversarial systems, robustness and safety, scalability, emergence and self-organization, human-agent teams, explainability and ethics in MAS.

Textbook:

1. Wooldridge, M. (2009). An Introduction to MultiAgent Systems (2nd ed.). John Wiley & Sons.
2. Shoham, Y., & Leyton-Brown, K. (2008). Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations. Cambridge University Press

References:

1. Weiss, G. (Ed.). (2013). Multiagent Systems (2nd ed.). MIT Press.
2. Busoniu, L., Babuska, R., & De Schutter, B. (2010). Multi-agent reinforcement learning: An overview. In Innovations in multi-agent systems and applications-1 (pp. 183-221). Springer.
3. Stone, P., & Veloso, M. (2000). Multiagent systems: A survey from a machine learning perspective. Autonomous Robots, 8(3), 345-383.
4. Zhang, K., Yang, Z., & Başar, T. (2021). Multi-agent reinforcement learning: A selective overview of theories and algorithms. In Handbook of Reinforcement Learning and Control (pp. 321-384). Springer.
5. Dorigo, M., & Birattari, M. (2010). Ant colony optimization. In Encyclopedia of machine learning (pp. 36-39). Springer.
6. Brambilla, M., Ferrante, E., Birattari, M., & Dorigo, M. (2013). Swarm robotics: a review from the swarm engineering perspective. Swarm Intelligence, 7(1), 1-41..

26- SMART SATELLITE SYSTEMS AND DATA ANALYTICS

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze satellite system architectures, orbital mechanics, and communication subsystems for space-based applications.
2. Design and implement remote sensing data processing pipelines for earth observation and environmental monitoring.
3. Apply machine learning and deep learning techniques for satellite image analysis, classification, and feature extraction.
4. Develop analytics solutions for satellite data applications in agriculture, disaster management, urban planning, and climate monitoring.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	2				3			2	2	2
CO2	3	3	3	3	3	3		2		2			3	3	3
CO3	3	3	3	3	3	3				2			3	2	3
CO4	2	3	3	3	3	3	3	3	2	2	2	2	2	3	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Satellite systems introduction, satellite classifications (LEO, MEO, GEO), orbital mechanics (Kepler's laws, orbital elements), satellite subsystems (power, thermal, ADCS, propulsion), communication subsystems (transponders, antennas), link budget analysis, multiple access techniques (FDMA, TDMA, CDMA), satellite constellations (GPS, Starlink), CubeSats, ground segment (tracking, TT&C).

Module II

Remote sensing principles, electromagnetic spectrum, passive vs active sensing, optical and hyperspectral imaging, resolution types (spatial, spectral, temporal, radiometric), SAR (polarimetry, interferometry), LiDAR, earth observation satellites (Landsat, Sentinel, MODIS), radiometric and geometric corrections, atmospheric correction, image preprocessing (denoising, mosaicking), image registration, data formats (GeoTIFF, HDF), platforms (NASA EarthData, Google Earth Engine).

Module III

Digital image processing, image enhancement, feature extraction (texture, spectral indices like NDVI, NDWI), PCA, image classification (supervised, unsupervised), traditional classifiers (SVM, random forests, k-means), deep learning (CNNs), semantic segmentation (U-Net, DeepLab), object detection (YOLO, Faster R-CNN), transfer learning, change detection, time series analysis, multi-sensor fusion, hyperspectral analysis, cloud detection.

Module IV

Agricultural monitoring (crop classification, yield prediction), disaster management (flood mapping, wildfire detection), urban planning (land use mapping, infrastructure monitoring), climate monitoring (deforestation, glacier monitoring), water resource management, environmental monitoring, maritime surveillance, big data analytics (cloud platforms), Google Earth Engine, GIS integration, real-time processing, IoT integration, future trends (AI-powered satellites, quantum communication)

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Textbooks:

1. Liang, S., Li, X., & Wang, J. (2012). Advanced Remote Sensing: Terrestrial Information Extraction and Applications. Academic Press.
2. Elachi, C., & Van Zyl, J. J. (2021). Introduction to the Physics and Techniques of Remote Sensing (3rd ed.). John Wiley & Sons.

References:

1. Richards, J. A. (2022). Remote Sensing Digital Image Analysis: An Introduction (6th ed.). Springer.

2. Jensen, J. R. (2015). Introductory Digital Image Processing: A Remote Sensing Perspective (4th ed.). Pearson.
3. Wertz, J. R., & Larson, W. J. (Eds.). (2011). Space Mission Analysis and Design (3rd ed.). Microcosm Press.
4. Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D., & Moore, R. (2017). Google Earth Engine: Planetary-scale geospatial analysis for everyone. Remote Sensing of Environment, 202, 18-27.
5. Zhang, L., Zhang, L., & Du, B. (2016). Deep learning for remote sensing data: A technical tutorial on the state of the art. IEEE Geoscience and Remote Sensing Magazine, 4(2), 22-40.
6. Zhu, X. X., Tuia, D., Mou, L., Xia, G. S., Zhang, L., Xu, F., & Fraundorfer, F. (2017). Deep learning in remote sensing: A comprehensive review and list of resources. IEEE Geoscience and Remote Sensing Magazine, 5(4), 8-36.

26- GENERATIVE ARTIFICIAL INTELLIGENCE AND APPLICATIONS

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze the fundamental architectures and training mechanisms of generative AI models including VAEs, GANs, and diffusion models.
2. Design and implement transformer-based large language models and apply prompt engineering techniques for various NLP tasks.
3. Develop applications using generative AI for image synthesis, text generation, code generation, and multimodal content creation.
4. Evaluate ethical implications, safety concerns, and deployment strategies for generative AI systems in real-world applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3				2	2		2	3	3	
CO2	3	3	3	2	3				2	2		2	3		
CO3	3	3	3	3	2	2			3	3	2	3	2	2	2
CO4	2	3	3	3	3	3	2	3	3		2	3	2	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Generative modeling introduction, discriminative vs generative models, autoencoders, Variational Autoencoders (VAEs, ELBO, reparameterization trick), Generative Adversarial Networks (GANs, minimax formulation, training dynamics), GAN variants (DCGAN, StyleGAN, CycleGAN), diffusion models (DDPM, score-based models, latent diffusion), energy-based models, flow-based models (normalizing flows).

Module II

Transformer architecture (self-attention, multi-head attention, positional encoding), pre-training strategies (masked/causal language modeling), BERT, GPT family (GPT-2/3/4), model scaling laws, LLM architecture and training, tokenization (BPE, WordPiece), fine-tuning methods (full fine-tuning, LoRA, QLoRA), instruction tuning, RLHF, model architectures (T5, BART, LLaMA, Mistral)

Module III

Prompt engineering (zero-shot, few-shot, chain-of-thought), in-context learning, Retrieval-Augmented Generation (RAG), text generation (summarization, translation, QA), code generation (Copilot, CodeLlama), image generation (DALL-E, Stable Diffusion), multimodal models (CLIP, GPT-4V, LLaVA), video and audio generation, AI agents (function calling, ReAct), LangChain and LlamaIndex, model distillation.

Module IV

Ethical considerations, bias and fairness, misinformation and deepfakes, content authenticity, AI-generated content detection, data privacy, AI alignment, red teaming, prompt injection, safety measures (content filtering, guardrails), model evaluation (perplexity, BLEU, ROUGE, benchmarks), deployment strategies, model optimization (quantization, pruning), serving infrastructure (vLLM, TensorRT), use cases (chatbots, education, healthcare, creative industries).

Textbooks:

1. Foster, D. (2023). Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play (2nd ed.). O'Reilly Media.

References:

1. Goodfellow, I., Pouget-Abadie, J., Mirza, M., Xu, B., Warde-Farley, D., Ozair, S., & Bengio, Y. (2014). Generative adversarial nets. Advances in neural information processing systems, 27.
2. Kingma, D. P., & Welling, M. (2013). Auto-encoding variational bayes. arXiv preprint arXiv:1312.6114.
3. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. Advances in neural information processing systems, 30.
4. Brown, T., Mann, B., Ryder, N., Subbiah, M., Kaplan, J. D., Dhariwal, P., ... & Amodei, D. (2020). Language models are few-shot learners. Advances in neural information processing systems, 33, 1877-1901.
5. Ramesh, A., Dhariwal, P., Nichol, A., Chu, C., & Chen, M. (2022). Hierarchical text-conditional image generation with clip latents. arXiv preprint arXiv:2204.06125.
6. Ho, J., Jain, A., & Abbeel, P. (2020). Denoising diffusion probabilistic models. Advances in neural information

processing systems, 33, 6840-6851.

26- LEARNING ANALYTICS

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze educational data sources and apply foundational concepts of learning analytics to measure and improve learning outcomes.
2. Design and implement predictive models for student performance, retention, and engagement using machine learning techniques.
3. Develop dashboards and visualization tools for actionable insights to support educational decision-making.
4. Evaluate ethical considerations, privacy concerns, and apply learning analytics solutions in real-world educational contexts

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2	3	2	2	2		2	3		2
CO2	3	3	3	3	3			2	2			2	3		3
CO3	2	3	3	2	3	2		2	2	3	2	2	3	2	3
CO4	2	3	3	3	2	3	2	3	3	3	2	3	3		2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Learning analytics introduction, learning analytics vs educational data mining vs academic analytics, stakeholders, learning analytics lifecycle (capture, report, predict, act, refine), data sources (LMS, SIS, clickstream, sensor data), educational data types (demographic, behavioral, performance, affective, social), data collection methods, data quality and preprocessing, privacy and ethical considerations, FERPA regulations, learning theories (behaviorism, cognitivism, constructivism, connectivism).

Module II

Predictive modeling introduction, student performance prediction, dropout and retention prediction, early warning systems, classification algorithms (decision trees, random forests, SVM, neural networks), regression techniques, feature engineering, temporal features, student modeling (knowledge tracing, BKT, Deep Knowledge Tracing), Performance Factors Analysis, Item Response Theory, engagement prediction, at-risk identification, model evaluation metrics, cross-validation, interpretability.

Module III

Data visualization principles, visual encoding, dashboard design (student, instructor, administrator dashboards), real-time analytics, visualization tools (Tableau, Power BI, D3.js, Python libraries), learning analytics platforms (Moodle, Canvas, Blackboard), social network analysis, discourse analysis, collaborative learning analytics, temporal analysis, heatmaps, clickstream visualization, learning curves, actionable intelligence, A/B testing, recommendation systems.

Module IV

Ethical frameworks, privacy preservation (anonymization, differential privacy), informed consent, algorithmic bias and fairness, interpretability and explainability, student agency, applications (adaptive learning, intelligent tutoring, MOOC analytics, curriculum design), multimodal learning analytics (video, audio, sensors), affective computing, learning analytics standards (Caliper, xAPI), mobile and game-based analytics, academic integrity, institutional implementation, future trends (AI in education, personalized learning).

Textbook:

1. Lang, C., Siemens, G., Wise, A., & Gasevic, D. (Eds.). (2017). Handbook of Learning Analytics. Society for Learning Analytics Research (SoLAR).

References:

1. Baker, R. S., & Inventado, P. S. (2014). Educational data mining and learning analytics. In Learning analytics (pp. 61-75). Springer.
2. Romero, C., & Ventura, S. (2020). Educational data mining and learning analytics: An updated survey. Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 10(3), e1355.

3. Siemens, G., & Long, P. (2011). Penetrating the fog: Analytics in learning and education. EDUCAUSE Review, 46(5), 30-40.
4. Ferguson, R. (2012). Learning analytics: drivers, developments and challenges. International Journal of Technology Enhanced Learning, 4(5-6), 304-317.
5. Papamitsiou, Z., & Economides, A. A. (2014). Learning analytics and educational data mining in practice: A systematic literature review of empirical evidence. Journal of Educational Technology & Society, 17(4), 49-64.
6. Khalil, M., & Ebner, M. (2016). What is learning analytics about? A survey of different methods used in 2013-2015. arXiv preprint arXiv:1606.02878.

26----OPEN ELECTIVE – I

26- ETHICS AND POLICY IN ARTIFICAL INTELLIGENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze ethical frameworks and principles applicable to AI systems, identifying moral challenges in AI development and deployment.
2. Evaluate bias, fairness, and discrimination in AI algorithms and design mitigation strategies for equitable AI systems.
3. Compare and assess AI governance frameworks, regulatory approaches, and policy mechanisms across different jurisdictions.
4. Develop comprehensive ethical guidelines and policy recommendations for emerging AI technologies and applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3		2		3		2				2	2	2	
CO2	3	3	3	2		3		2	3			3	3	2	
CO3	2	2		3	2	2	3	2	2			3	2	3	
CO4	2	3	3	3	2	3	3	2	3		3	3	3	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Ethics and moral philosophy introduction, classical ethical frameworks (utilitarianism, deontology, virtue ethics, care ethics), technology ethics and digital ethics, core principles of AI ethics (fairness, transparency, accountability, privacy, safety, human autonomy), historical context of AI ethics, stakeholders in AI development (developers, organizations, users, policymakers, civil society), case studies of AI ethics failures, professional responsibility and codes of conduct.

Module II

Sources and types of bias in AI (historical, representation, measurement, aggregation bias), fairness definitions (individual fairness, group fairness, demographic parity, equalized odds, predictive parity), impossibility theorems and fairness trade-offs, high-stakes applications (criminal justice, hiring, credit scoring, healthcare, education), algorithmic discrimination and intersectionality, bias mitigation strategies (pre-processing, in-processing, post-processing), participatory design and inclusive development, algorithmic auditing and testing methodologies.

Module III

Global AI policy landscape (EU AI Act, GDPR, US sectoral approach, China's governance framework), risk-based regulation and classification systems, impact assessments (AIIAs, DPIAs), certification, standards, and compliance mechanisms, algorithmic auditing and accountability frameworks, liability and legal responsibility, self-regulation and industry standards, corporate AI ethics boards and guidelines, multi-stakeholder governance initiatives, intellectual property and data rights, AI-generated content ownership, international coordination and policy harmonization, public sector AI procurement and deployment.

Module IV

Generative AI ethics (large language models, deepfakes, misinformation), environmental sustainability and carbon footprint of AI, labor displacement and economic impacts, autonomous systems (self-driving vehicles, lethal autonomous weapons, care robots), AI and human rights (surveillance, freedom of expression, due process, digital divide), content moderation and platform governance, explainability and interpretability challenges, AI safety and alignment research, value alignment problem and specification gaming, long-term considerations and existential risks, ethics by design and value-sensitive design, participatory AI development, building ethical organizational culture, future of work and human-AI collaboration.

Textbook:

1. Coeckelbergh, M. (2020). AI Ethics. MIT Press.
2. O'Neil, C. (2016). Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy. Crown.
3. Noble, S. U. (2018). Algorithms of Oppression: How Search Engines Reinforce Racism. NYU Press.

References:

1.
2. Russell, S. (2019). Human Compatible: Artificial Intelligence and the Problem of Control. Viking.
3. Floridi, L., & Cowls, J. (2019). A unified framework of five principles for AI in society. Harvard Data Science Review, 1(1).
4. Barocas, S., Hardt, M., & Narayanan, A. (2019). Fairness and Machine Learning: Limitations and Opportunities. MIT Press.
5. Jobin, A., Ienca, M., & Vayena, E. (2019). The global landscape of AI ethics guidelines. Nature Machine Intelligence, 1(9), 389-399.
6. European Commission. (2021). Proposal for a Regulation laying down harmonised rules on artificial intelligence (Artificial Intelligence Act). EUR-Lex.

26-COGNITIVE COMPUTING SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals of human cognition and machine cognition.
2. Analyze the different design principles of cognitive system
3. Understanding how advanced technologies integrated with cognitive systems
4. Implement basics of cognitive analytics methods.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3										2	3	1	
CO2	3	3	1	1								1	3	2	
CO3	2	3	2	1	1				1			1	3	2	1
CO4	3	2	1									1	3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction: Artificial Intelligence and Cognitive Computing. Understanding cognition, Two systems of Judgement and choice Automatic thinking: Intuition and Biases, Controlled Rule– Centric and concentrated effort. Understanding complex relationship between systems, Elements of Cognitive Systems. Cognitive Applications.

Module II

Design Principles: Components of Cognitive Systems. Bringing Data into Cognitive Systems, Leveraging Internal and External Data Sources, Data access and Feature extraction services. Machine Learning: Finding Patterns in the Data, Hypothesis Generation and Scoring.

Module III

Cognitive Systems: Natural Language Processing and Cognitive Systems, Role of NLP in Cognitive Systems, Semantic Web. Relationship between Big Data and Cognitive Computing. Role of Cloud and Distributed Computing in Cognitive Computing

Module IV

Cognitive Analytics: Applying advanced analytics to cognitive computing, Key capabilities in advanced analytics, Relationship between Statistics, Data Mining and Machine Learning. Machine Learning in Analytics process. Predictive analytics, Text analytics, Image analytics, Speech analytics. Using Advanced analytics to create Value, Building Value within memory capabilities. Impact of Open-Source Tools on Advanced Analytics.

Textbook:

1. Hurwitz, J. S., Kaufman, M., & Bowles, A. (2015). Cognitive computing and big data analytics. John Wiley & Sons.

References:

1. Dhar, V. (2018). Cognitive Computing: A Brief Guide for Game Changers. Wiley.
2. Jain, V., Tayal, A., Singh, J., & Solanki, A. (2021). Cognitive Computing Systems: Applications and Technological Advancements (1st ed.). New York: Apple Academic Press. https://doi.org/10.1201/9781003082033
3. Vernon, D. (2014). Artificial cognitive systems: A primer. MIT Press. https://doi.org/10.7551/mitpress/9780262027678.001.0001
4. Watson, M. (2017). Introduction to cognitive computing: A guide for individuals and small organizations. Independently published.
5. Raghavan, V. V., & Gudivada, V. N. (2015). Cognitive computing: Theory and applications. Elsevier. https://doi.org/10.1016/C2014-0-03492-7.

26-AUTONOMOUS SYSTEMS AND VEHICLES

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze sensor technologies and perception systems for environmental understanding in autonomous vehicles.
2. Design and implement localization and mapping algorithms for autonomous navigation in complex environments.
3. Develop path planning and decision-making algorithms for safe and efficient autonomous vehicle operation.
4. Evaluate control systems, vehicle dynamics, and safety frameworks for autonomous vehicle deployment

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2						2				1	2	2	3
CO2	3	2						2				1	3	2	3
CO3	3	2						2	1			1	2	1	3
CO4	3	2	3					2					3	2	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to autonomous systems and levels of autonomy (SAE J3016). Architecture of autonomous vehicles. Sensor technologies: cameras, LiDAR, radar, ultrasonic, IMU, GPS. Sensor characteristics and fusion techniques. Computer vision for autonomous systems: object detection, tracking, segmentation. Deep learning for perception: CNNs, YOLO, R-CNN. Environmental perception and 3D point cloud processing.

Module II

State estimation and coordinate systems. Localization techniques: dead reckoning, GPS-based, and map-based methods. Kalman filters and particle filters. Mapping approaches: occupancy grid, feature-based, and topological maps. Simultaneous Localization and Mapping (SLAM). Visual SLAM and visual odometry. Multi-sensor fusion for localization.

Module III

Motion planning fundamentals and configuration space. Graph-based planning: Dijkstra, A*, D*. Sampling-based planning: RRT, RRT*, PRM. Trajectory generation and optimization. Behavioral planning using finite state machines. Reinforcement learning for decision making. Dynamic obstacle avoidance and interaction-aware planning.

Module IV

Vehicle dynamics and kinematics models. Longitudinal and lateral control systems. PID control and Model Predictive Control (MPC). Pure pursuit and Stanley controllers. Adaptive cruise control and lane keeping systems. Functional safety standards: ISO 26262. Verification and validation methodologies. Simulation environments: CARLA, SUMO, Gazebo. Vehicle-to-Everything (V2X) communication and cybersecurity considerations.

Textbooks:

1. Paden, B., Čáp, M., Yong, S. Z., Yershov, D., & Frazzoli, E. (2016). A survey of motion planning and control techniques for self-driving urban vehicles. IEEE Transactions on intelligent vehicles, 1(1), 33-55.
2. Thrun, S., Burgard, W., & Fox, D. (2005). Probabilistic Robotics. MIT Press.
3. LaValle, S. M. (2006). Planning Algorithms. Cambridge University Press.

References:

1. Rajamani, R. (2011). Vehicle Dynamics and Control (2nd ed.). Springer.
2. Siegwart, R., Nourbakhsh, I. R., & Scaramuzza, D. (2011). Introduction to Autonomous Mobile Robots (2nd ed.). MIT Press.
3. Durrant-Whyte, H., & Bailey, T. (2006). Simultaneous localization and mapping: part I. IEEE Robotics & Automation Magazine, 13(2), 99-110.
4. Pendleton, S. D., Andersen, H., Du, X., Shen, X., Meghjani, M., Eng, Y. H., ... & Ang, M. H. (2017). Perception, planning, control, and coordination for autonomous vehicles. Machines, 5(1), 6.

5. Badue, C., Guidolini, R., Carneiro, R. V., Azevedo, P., Cardoso, V. B., Forechi, A., ... & De Souza, A. F. (2021). Self-driving cars: A survey. Expert Systems with Applications, 165, 113816.
6. Gruyer, D., Belaroussi, R., & Revilloud, M. (2017). Accurate lateral positioning from map data and road marking detection. Expert Systems with Applications, 43, 1-8.

26- PROMPT ENGINEERING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand Prompt Engineering Principles including precision of prompts, ethical considerations, and impact on system performance etc.
2. Design Effective Prompts for NLP Tasks including text generation, question answering, sentiment analysis etc.
3. Evaluate and Refine Prompts for HCI through conversational agents and user interfaces.
4. Apply Advanced Techniques in Prompt Engineering including Transfer learning, multimodal prompts

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			1						1		3	2	1
CO2	3	3	3	3	3		2				1		3	2	1
CO3	3	3	3	3	3						1		3	3	1
CO4	3	1		2	1		2				1		2	3	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Prompt Engineering: Definition and significance of prompt engineering, Historical context and evolution. Foundations of Machine Learning and Language Models: Overview of machine learning techniques. Introduction to language models, Connection between prompts and model outputs. Benefits of ChatGPT and Large Language Models, Limitations of Large Language Models and ChatGPT

Module II

Prompt Design Principles. Crafting effective prompts for different tasks, Understanding context and specificity, Ethical considerations in prompt design, Ambiguity reduction in formulating prompts, Constraint-based prompting to specific tasks

Module III

Prompt Engineering in Natural Language Processing. Text generation with prompts, Information retrieval and question-answering, Sentiment analysis and language understanding, Prompt response evaluation techniques, Six specific dimensions of response quality: Relevance, Accuracy, Completeness, Clarity, Coherence and Appropriateness (the RACCCA framework)

Module IV

Human-Computer Interaction and Prompt Engineering. Designing prompts for user interfaces, Conversational agents and chatbot prompts, User feedback and iterative prompt refinement, Chain-of-Thought (CoT) Approach in Prompt Engineering, Transfer learning and pre-trained models, Multimodal prompt engineering
Case Study: Designing and evaluating a prompt for a specific task.

Textbook:

1. Lane, H. C., Howard, N., & Hapke, M. (2019). Natural language processing in action: Understanding, analyzing and generating text with python. Manning Publications.

References:

1. Martin, J. H., & Jurafsky, D. (2008). Speech and language processing (2nd ed.). Prentice Hall.
2. Zhang, A., Ramesh, R., Lee, Y., & Wang, X. (2021). Overview of machine learning and language model techniques. Proceedings of the 2021 4th International Conference on Artificial Intelligence and Big Data, 125-130. https://doi.org/10.1145/3487552.3494473
3. Harris, S. (2020). Crafting ethical prompts for safety-critical applications. Proceedings of the AAAI/ACM Conference on AI, Ethics, and Society, 55–61. https://doi.org/10.1145/3375627.3375835
4. Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2018). Bert: Pre-training of deep bidirectional transformers

26- MULTIMODAL VISION LABORATORY

Course Outcomes:

On completion of this course the student will be able to:

1. Develop programs to implement image preprocessing, feature extraction, and classical computer vision algorithms.
2. Implement deep learning models for image classification, object detection, and semantic segmentation tasks.
3. Create multimodal AI systems that integrate vision with text, audio, and other modalities.
4. Demonstrate vision transformer architectures and advanced multimodal applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	2	3				1	2		1	3	2	
CO2	2	2	3	2	3				1	2		1	3	2	
CO3	2	2	3	2	3				1	2		1	3	2	
CO4	2	2	3	2	3				1	2		1	3	3	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A: Classical Computer Vision and Image Processing

1. Image Preprocessing and Enhancement Image loading, color space conversions, histogram processing, image filtering, noise reduction, morphological operations.
2. Feature Detection and Extraction Edge detection (Sobel, Canny), corner detection (Harris, FAST), feature descriptors (SIFT, ORB), feature matching, Hough transform.
3. Image Segmentation Thresholding (Otsu, adaptive), region-based segmentation, contour detection, superpixel segmentation.

Part B: Deep Learning for Computer Vision

1. Image Classification with CNNs Building CNN from scratch, implementing architectures (VGG, ResNet), transfer learning, fine-tuning, data augmentation, model evaluation.
2. Object Detection YOLO implementation, custom object detector training, Faster R-CNN, non-maximum suppression, performance metrics (mAP, IoU).
3. Semantic and Instance Segmentation U-Net for semantic segmentation, Mask R-CNN for instance segmentation, mask visualization, evaluation metrics.

Part C: Multimodal AI and Vision Transformers

1. Vision Transformers (ViT) Implementing ViT from scratch, using pre-trained models, SWIN Transformer, CNN vs Transformer comparison, attention visualization.
2. Image Captioning and Visual Question Answering Encoder-decoder for captioning, attention mechanisms, CLIP for zero-shot classification, VQA with multimodal models, evaluation metrics.
3. Multimodal Integration Text-to-image with Stable Diffusion, image-text retrieval with CLIP, video understanding, audio-visual learning, multimodal chatbot.
4. Advanced Applications Face recognition, pose estimation (OpenPose/MediaPipe), real-time video analysis, OCR and document analysis, medical image analysis.

References:

1. Szeliski, R. (2022). Computer Vision: Algorithms and Applications (2nd ed.). Springer.
2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
3. Géron, A. (2022). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd ed.). O'Reilly Media.
4. Raschka, S., & Mirjalili, V. (2019). Python Machine Learning (3rd ed.). Packt Publishing.
5. Rosebrock, A. (2021). Deep Learning for Computer Vision with Python. PyImageSearch.
6. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. Advances in neural information processing systems, 30.

26- CAPSTONE PROJECT- GENERATIVE ARTIFICAL INTELLIGENCE AND APPLICATIONS

Course Outcomes:

On completion of this course the student will be able to:

1. Design and implement generative AI models for text, image, audio, or multimodal applications.
2. Apply advanced techniques like prompt engineering, fine-tuning, and retrieval-augmented generation (RAG).
3. Integrate generative AI APIs and frameworks into real-world applications.
4. Evaluate ethical considerations, bias mitigation, and responsible AI deployment practices.
5. Collaborate effectively in teams and prepare comprehensive technical documentation including design specifications, implementation details, and testing results.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	3	3					1		1	3	3	
CO2	2	3	3	3	3				1	1		1	3	2	
CO3	2	3	3	3	3				1	2		1	3	3	
CO4		1	1						3	2	1	1	2	1	
CO5	2	1	2	1	1				1	2		1	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Part A Generative AI Project Domains

Platforms & Tools: LLM platforms (OpenAI GPT, Anthropic Claude, Google Gemini, Meta LLaMA, Mistral), image generation (Stable Diffusion, DALL-E, Midjourney), frameworks (LangChain, LlamaIndex, Hugging Face, PyTorch, TensorFlow), vector databases (Pinecone, Weaviate, ChromaDB, FAISS), development tools (Python, Jupyter, Gradio, Streamlit, FastAPI).

Project Categories:

1. Large Language Model Applications: Intelligent chatbots, document analysis and summarization, code generation assistants, content creation platforms, question-answering systems with RAG, multi-agent systems.
2. Computer Vision and Image Generation: AI-powered image generation and editing, style transfer, image inpainting and restoration, text-to-image applications, medical image synthesis, fashion design and virtual try-on.
3. Audio and Speech Applications: Text-to-speech synthesis, voice cloning, music generation, podcast content generation, speech enhancement, audio transcription with speaker diarization.
4. Multimodal AI Systems: Visual question answering, image captioning, video understanding and generation, document intelligence (OCR + LLM), accessibility tools.
5. Domain-Specific Applications: Education (tutoring systems, automated grading), healthcare (medical report generation, clinical support), legal (contract analysis, document drafting), finance (report generation, market analysis), e-commerce (product descriptions, customer service).

Part B Technical Implementation Requirements

Core Generative AI Components: Prompt engineering (zero-shot, few-shot, chain-of-thought), model fine-tuning (transfer learning, LoRA, QLoRA), RAG (document ingestion, vector embeddings, similarity search), agent-based systems (tool-using agents, multi-agent orchestration).

Integration & Deployment: API integration (LLM APIs, custom API development), UI development (web/mobile applications, chat interfaces), database & storage (vector databases, PostgreSQL, MongoDB, cloud storage), authentication & security (user authentication, API key management, rate limiting).

Advanced Features: Evaluation & monitoring (output metrics, quality scoring, analytics), guardrails & safety (content moderation, bias detection, adversarial protection), deployment & scalability (containerization, cloud deployment, load balancing), cost optimization (token tracking, caching).

Guidelines for evaluation:	***Marks(%)***
1. Regularity and progress of work(CA)	10%
2. Work knowledge and Involvement(CA)	10%
3. Semester End presentation and assesment(SEE)	40%
4. Level of completion and demonstration of Functionality/Specifications (CA: 10% + SEE: 10%)	20%
5. Project Report – Presentation style and content(CA)	20%

References:

1. Tunstall, L., von Werra, L., & Wolf, T. (2023). Natural Language Processing with Transformers. O'Reilly Media.
2. Rothman, D. (2024). Transformers for Natural Language Processing and Computer Vision (3rd ed.). Packt Publishing.
3. Jurafsky, D., & Martin, J. H. (2023). Speech and Language Processing (3rd ed.). Pearson.
4. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
5. Géron, A. (2023). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow (3rd ed.). O'Reilly Media.
6. Vaswani, A., et al. (2017). Attention is All You Need. NeurIPS

26--- ENTREPRENEURSHIP DEVELOPMENT

Course Outcomes:

On completion of this course the student will be able to:

1. Develop awareness about the importance of entrepreneurship opportunities available in the society
2. Get acquainted with the challenges faced by the entrepreneur

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1			1		1		1	1		
CO2	3	3	3	3	1			1		1		1	1		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Exercises

1. To study the types of entrepreneurs and the factors affecting entrepreneurial growth.
2. To make an assessment of the major motives influencing an entrepreneur
3. To make an overview of the various stress management techniques
4. How to identify and select a good business opportunity?
5. Preparation of a techno economic feasibility report for a given project
6. Preparation of a preliminary project report for a given project
7. To identify the various sources of finance and management of working capital
8. Carry out the costing and break-even analysis of a proposed project
9. Preparation of a PERT / CPM chart for the various activities involved in a project
10. To make a study of the various causes and consequences of sickness in small business and identify corrective measures.
11. To analyze logistics and supply chain processes for a proposed business venture

Text Books:

1. Roy, R. (2011). Entrepreneurship (2nd ed.). Oxford University Press.
2. Gordon, E., & Natarajan, K. (2009). Entrepreneurship development. Himalaya Publishing House

References:

1. Baron, R. A. (2018). Entrepreneurship: A Process Perspective (3rd ed.). Cengage Learning
2. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017). Entrepreneurship (10th ed.). McGraw-Hill Education.
3. Coulter, M. K. (2001). Entrepreneurship in action (2nd ed.). Prentice Hall.
4. Jain, P. S. (1998). Handbook for new entrepreneurs. Oxford University Press.
5. Khanka, S. S. (2010). Entrepreneurial development. S. Chand Publishing.

Note: *There will only be continuous evaluation for this course. The evaluation will be based on the performance of the student in the exercises given above. A minimum of 50% marks is required for a pass.*

26- PROJECT PHASE I

Course Outcomes:

On completion of this course the student will be able to:

1. Conduct a comprehensive literature survey to identify and analyze a specific problem statement in Information Technology.
2. Formulate a well-structured project proposal by synthesizing literature insights and engaging with industry experts and academic mentors.
3. Develop a detailed execution plan for Phase II, including resource allocation, timeline, and risk management strategies.
4. Demonstrate technical communication skills through a properly formatted thesis document and professional PowerPoint presentations.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1			1		1		1	3		
CO2	3	3	3	3	1			1		1		1	3	2	
CO3	3	3	3	3	1			1		1		1	2	3	
CO4	3	3	3	3	1			1		1		1	3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

This course aims to equip undergraduate students in Information Technology. with the essential skills and knowledge required to successfully navigate through the initial phases of a project. Students will learn to conduct a comprehensive literature survey, identify and focus on a specific problem, formulate a project proposal, develop an execution plan for Phase II, and enhance their technical communication skills through thesis preparation and presentation techniques.

Topics to be Covered

Introduction to Literature Survey and Problem Identification: Understanding the significance of literature survey in research, Techniques for conducting a thorough literature review, identifying relevant areas of study within Information Technology., and Narrowing down to a specific problem statement.

Formulating a Project Proposal: Guidelines for structuring a project proposal, the importance of consultation with industry experts and academic mentors, incorporating insights from the literature survey into the proposal, Developing a clear and concise problem statement and objectives

Project Execution Planning: Principles of project management and planning, developing a detailed execution plan for Phase II of the project, identifying resources, timeline, and milestones.

Enhancing Presentation Skills: Understanding the elements of effective presentations, Techniques for engaging and communicating technical information, Hands-on practice sessions on preparing and delivering technical presentations, and Peer feedback and improvement strategies.

Technical Communication: Thesis Preparation- Structure and format of a thesis document, Guidelines for writing thesis chapters- introduction, literature review, methodology, results, discussion, conclusion, Typesetting using Word or LaTeX for professional thesis formatting. Prepare PPTs for technical presentation.

Assessment:

Guidelines for evaluation:	***Marks (%)***
1. Attendance and Regularity	20%
2. Literature Survey and Problem Identification	20%
3. Project Proposal	20%
4. Project Execution Plan	20%
5. Thesis and Presentation Skills Assessment	20%

Note: Points (1)-(3) are to be evaluated by the respective project guides and project coordinator based on continuous evaluation. (4)-(5) to be evaluated by the final evaluation team comprising of 3 internal Examiners.

References:

1. Jesson, J. K., Matheson, L., & Lacey, F. M. (2011). Doing your literature review: Traditional and systematic techniques. SAGE.

2. Machi, L. A., & McEvoy, B. T. (2016). The literature review: Six steps to success (3rd ed.). Corwin Press.
3. Friedland, A. J., & Folt, C. L. (2009). Writing successful science proposals (2nd ed.). Yale University Press. https://doi.org/10.12987/9780300153654
4. Duarte, N. (2008). Slide:ology: The art and science of creating great presentations. O'Reilly Media, Inc.
5. Joyner, R. L., Rouse, W. A., & Glatthorn, A. A. (2018). Writing the winning thesis or dissertation: A step-by-step guide (4th ed.). Corwin, a SAGE Company.

SEMESTER VIII REGULAR TRACK
26---PROFESSIONAL ELECTIVE – III/MOOC
26---PROFESSIONAL ELECTIVE –IV/ MOOC
26---INDUSTRY ELECTIVE -III
26- DIGITAL MARKETING

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamental principles and strategies of Digital Marketing and analyse the concepts of display advertising.
2. Apply Search Engine Optimisation principles and road map for successful techniques in advertising.
3. Analyze the importance of Social media Platforms in Digital Marketing.
4. Understand the importance of web Analytics and identify the latest trends in Digital Marketing.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	1	2	1			1	3		1	3		
CO2	2	1	3	2	2	1			1	3		1	3	2	
CO3	2	1	2	1	2	2			1	3		1	3		
CO4	2	1	2	1	2	1			1	3		1	3	2	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to Digital Marketing: Origin and development of Digital Marketing, Traditional Marketing and Digital Marketing, Digital Marketing Strategy, The P-O-E-M Framework, Integrated Marketing Communications, The digital landscape, Digital Marketing Plan. Concept of Display Advertising: Digital Metrics, What makes a good Ad, Targeting in Digital Marketing, Programmatic Digital Advertising.

Module II

Search Engine Optimization: Definition of SEM, Introduction to SEO, Search Engine Result Pages, Positioning, Search Behavior, SEO process and stages, On-page and Off-page SEO, paid Search Engine Marketing, pay-per-click (PPC) advertising, SWOT, Overview of Google Ads, Google AdWords.

Module III

Social Media Marketing: Social media strategy, Social media listening tools, Strategy, Implementation, Performance metrics, Social Media Marketing Tools, Facebook marketing, LinkedIn marketing, Instagram marketing. Case studies: The fall and rise of Maggi, Launch of CISCO ASR 1000 series routers.

Module IV

Web Analytics and Trends in Digital Marketing: Introduction to web analytics, web analytics approach, get to know your website, a model of analysis, log file analysis, page tagging, metrics and dimensions, interacting with data in google analytics. Email Marketing, Mobile Marketing, Video Marketing.

Textbooks:

1. Gupta, S. (2018). Digital marketing (2nd ed.). McGraw Hill Education (India) Private Limited.
2. Dodson, I. (2016). The art of digital marketing: The definitive guide to creating strategic, targeted, and measurable online campaigns. John Wiley & Sons.

References:

1. Ahuja, V. (2019). Digital marketing: A practical approach (2nd ed.). Oxford University Press.
2. Ryan, D., & Jones, C. (2019). Understanding digital marketing: Marketing strategies for engaging the digital generation (5th ed.). Kogan Page.

3. Kingsnorth, S. (2022). Digital Marketing Strategy: An Integrated Approach to Online Marketing (3rd ed.). Kogan Page Publishers.
4. Chaffey, D., & Smith, P. (2022). Digital Marketing excellence: Planning, Optimizing and Integrating Online Marketing. Taylor & Francis.

26- AUGMENTED AND VIRTUAL REALITY

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze the fundamental concepts, hardware components, and tracking technologies used in AR/VR systems.
2. Design and develop immersive 3D virtual environments and interactive VR applications using modern development platforms.
3. Implement augmented reality applications with computer vision techniques for marker-based and markerless tracking.
4. Evaluate user interaction paradigms, human factors, and apply AR/VR solutions to real-world application domains.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3							2	2	3	3
CO2	3	3	3	2	3				2	2		2	2	3	3
CO3	2	3	3	3	3				2			2	3	3	3
CO4	2	3	3	3	3	3	2	2	3	2	2	3	2	2	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Extended reality (XR) introduction (VR, AR, MR), AR/VR evolution and taxonomy, human perception (visual, auditory, haptic, vestibular), display technologies (HMDs, CAVE, projection-based), optical systems (FOV, resolution, latency, refresh rate), VR headsets (tethered, standalone, mobile), AR displays (optical/video see-through, spatial AR), tracking technologies (optical, inertial, magnetic, hybrid), inside-out vs outside-out tracking, degrees of freedom (3DOF vs 6DOF), coordinate systems and transformations, rendering pipeline.

Module II

3D graphics fundamentals (vertices, meshes, textures, materials, lighting), rendering techniques (rasterization, ray tracing, shading), real-time rendering optimization, game engines (Unity, Unreal Engine), VR development workflow, stereoscopic rendering, IPD adjustment, performance optimization (frame rate, LOD), 3D modeling and asset creation, animation and rigging, physics simulation, spatial audio and 3D sound (HRTF, binaural audio), interaction design (locomotion, object manipulation, selection), teleportation and smooth locomotion, VR input devices (controllers, hand tracking, eye tracking).

Module III

AR system architecture, computer vision for AR (feature detection, tracking, recognition), marker-based AR (fiducial markers, QR codes, ArUco), markerless AR (natural feature tracking, SLAM-based), SLAM for AR, visual-inertial odometry, object detection and recognition, image target tracking, plane detection, AR platforms (ARCore, ARKit, Vuforia, Wikitude), AR frameworks (AR.js, A-Frame, Three.js), cloud anchors, persistent AR, occlusion handling, depth sensing, light estimation, environmental understanding, mobile AR development, WebAR.

Module IV

UX design for AR/VR, presence and immersion metrics, cybersickness mitigation, comfort and ergonomics, UI design for 3D environments, gesture recognition, natural user interfaces, hand and finger tracking, gaze-based interaction, eye tracking, voice commands, multimodal interaction, haptic and force feedback, collaborative AR/VR, multi-user experiences, social VR and avatars, application domains (gaming, education, healthcare, architecture, retail, industrial design), virtual prototyping, digital twins, remote collaboration, telepresence, AR navigation, accessibility.

Textbooks:

1. LaValle, S. M. (2023). Virtual Reality. Cambridge University Press.
2. Schmalstieg, D., & Höllerer, T. (2016). Augmented Reality: Principles and Practice. Addison-Wesley Professional
3. Jerald, J. (2015). The VR Book: Human-Centered Design for Virtual Reality. Morgan & Claypool.

References:

1. Billinghurst, M., Clark, A., & Lee, G. (2015). A survey of augmented reality. Foundations and Trends in Human–Computer Interaction, 8(2-3), 73-272.
2. Sherman, W. R., & Craig, A. B. (2018). Understanding Virtual Reality: Interface, Application, and Design (2nd ed.). Morgan Kaufmann.
3. Linowes, J., & Babilinski, K. (2017). Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt Publishing.
4. Parisi, T. (2015). Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile. O'Reilly Media.
5. Mullen, T. (2011). Prototyping Augmented Reality. John Wiley & Sons.
6. Bowman, D. A., Kruijff, E., LaViola Jr, J. J., & Poupyrev, I. P. (2004). 3D User Interfaces: Theory and Practice. Addison-Wesley

26- AGENTIC ARTIFICIAL INTELLIGENCE

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze intelligent agent architectures and design goal-oriented agents for complex problem-solving tasks.
2. Implement multi-agent systems with coordination, communication, and emergent behavior capabilities.
3. Apply reinforcement learning and decision-making algorithms for autonomous agent behavior in dynamic environments.
4. Develop agentic AI systems with tool use, planning, and reasoning capabilities for real-world applications.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2					2			2	3	2	3
CO2	3	3	3	3				2	3	2		2	3	2	2
CO3	3	3	3	3		3			2			3	3	3	2
CO4	3	3	3	3	2			2	2	2	2	3	2	3	3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to intelligent agents and agency. Agent definition: perception, action, autonomy, goal-orientation. Agent types: simple reflex, model-based reflex, goal-based, utility-based, learning agents. Agent architectures: reactive, deliberative, hybrid. Rational agents and rationality. Performance measures and evaluation metrics. Environment types: observable, deterministic, episodic, static, discrete, single/multi-agent.

Module II

Multi-agent systems (MAS) fundamentals. Agent communication: speech acts, FIPA-ACL, message passing. Coordination mechanisms: cooperation, competition, negotiation. Distributed problem solving. Task allocation and resource distribution. Auction mechanisms and market-based approaches. Game theory for multi-agent systems. Nash equilibrium and dominant strategies. Cooperative vs. non-cooperative games. Emergent behavior and swarm intelligence. Consensus algorithms and distributed decision making. Organization and social structures in MAS. Trust and reputation systems. Coalition formation. Applications: distributed sensor networks, multi-robot systems, traffic management.

Module III

Markov Decision Processes (MDPs). Bellman equations and dynamic programming. Value iteration and policy iteration. Monte Carlo methods. Temporal Difference (TD) learning: TD(0), SARSA, Q-learning. Function approximation and deep reinforcement learning. Deep Q-Networks (DQN) and variants. Policy gradient methods: REINFORCE, Actor-Critic. Proximal Policy Optimization (PPO). Trust Region Policy Optimization (TRPO). Multi-agent reinforcement learning (MARL). Exploration vs. exploitation trade-offs. Reward shaping and sparse rewards. Transfer learning and meta-learning for agents. Sim-to-real transfer. Model-based reinforcement learning.

Module IV

Large Language Model (LLM) based agents. Agent architectures with LLMs: ReAct, AutoGPT, BabyAGI. Chain-of-thought reasoning and planning. Tool use and function calling. API integration and external tool invocation. Memory systems: short-term, long-term, episodic. Retrieval-Augmented Generation (RAG) for agents. Planning algorithms: classical planning (STRIPS, PDDL), hierarchical task networks. Temporal planning and scheduling. Continual learning and adaptation. Human-agent interaction and collaboration. Explainability in agentic systems. Safety and alignment in autonomous agents. Agent evaluation frameworks and benchmarks. Applications: coding agents, research assistants, workflow automation, robotic process automation.

Textbook:

1. Russell, S., & Norvig, P. (2021). Artificial Intelligence: A Modern Approach (4th ed.). Pearson.
2. Sutton, R. S., & Barto, A. G. (2018). Reinforcement Learning: An Introduction (2nd ed.). MIT Press.
3. Wooldridge, M. (2009). An Introduction to MultiAgent Systems (2nd ed.). John Wiley & Sons.

References:

1. Shoham, Y., & Leyton-Brown, K. (2008). Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations. Cambridge University Press.
2. Ghallab, M., Nau, D., & Traverso, P. (2016). Automated Planning and Acting. Cambridge University Press.

3. Stone, P., & Veloso, M. (2000). Multiagent systems: A survey from a machine learning perspective. Autonomous Robots, 8(3), 345-383.
4. Busoniu, L., Babuska, R., & De Schutter, B. (2008). A comprehensive survey of multiagent reinforcement learning. IEEE Transactions on Systems, Man, and Cybernetics, Part C, 38(2), 156-172.
5. Wang, L., Ma, C., Feng, X., Zhang, Z., Yang, H., Zhang, J., ... & Liu, T. Y. (2024). A survey on large language model based autonomous agents. Frontiers of Computer Science, 18(6), 186345.
6. Xi, Z., Chen, W., Guo, X., He, W., Ding, Y., Hong, B., ... & Gui, T. (2023). The rise and potential of large language model based agents: A survey. arXiv preprint arXiv:2309.07864.
7. Silver, D., Hubert, T., Schrittwieser, J., Antonoglou, I., Lai, M., Guez, A., ... & Hassabis, D. (2018). A general reinforcement learning algorithm that masters chess, shogi, and Go through self-play. Science, 362(6419), 1140-1144.
8. Yao, S., Zhao, J., Yu, D., Du, N., Shafran, I., Narasimhan, K., & Cao, Y. (2022). ReAct: Synergizing reasoning and acting in language models. arXiv preprint arXiv:2210.03629.

26- STARTUPS AND AI ENTREPRENEURSHIP

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze the AI startup ecosystem and evaluate business opportunities leveraging artificial intelligence technologies.
2. Develop comprehensive business models and value propositions for AI-driven products and services.
3. Design go-to-market strategies, funding approaches, and growth plans for AI startups.
4. Apply lean startup methodologies and evaluate legal, ethical, and operational aspects of AI entrepreneurship.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2		3		2	2	3	3	3		2	
CO2		3	2	2	2	3		2	3	3	2	2		3	1
CO3		2	2	2	2	3	2	2	3	3	2	2		2	1
CO4	2	3	3	2	2	3	2	3	2	3	3	3		3	2

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Entrepreneurship and innovation introduction, AI startup landscape overview, AI market trends and emerging opportunities, industry verticals (healthcare, finance, retail, manufacturing, transportation), technology trends (machine learning, computer vision, NLP, robotics), identifying problems for AI solutions, customer discovery and problem validation, market research and competitive analysis, technology readiness assessment, AI capabilities and limitations, build vs buy decisions, open source vs proprietary technologies, case studies of successful AI startups.

Module II

Business model canvas for AI startups, value proposition design, revenue models (SaaS, API-based, licensing, freemium), B2B vs B2C AI businesses, platform business models, data monetization strategies, pricing strategies, unit economics and profitability analysis, customer segments and personas, channels and customer relationships, key resources (data, compute, talent), key partnerships and ecosystems, Minimum Viable Product (MVP) for AI, prototyping and proof of concept, product-market fit validation, UX design for AI products.

Module III

Marketing strategies for AI startups, digital marketing and growth hacking, sales strategies (direct, channel, partnerships), customer acquisition cost and lifetime value, brand positioning and messaging, content marketing and thought leadership, funding landscape (bootstrapping, angel investors, venture capital, grants), pitch deck preparation and storytelling, financial projections and valuation, term sheets and negotiation, equity and dilution management, accelerators and incubators, corporate venture capital, growth strategies (scaling operations, hiring, internationalization), strategic partnerships and alliances.

Module IV

Lean startup methodology, agile development for AI products, building and managing AI teams, talent acquisition and retention, data acquisition and management strategies, MLOps and AI infrastructure, cloud platforms (AWS, Azure, Google Cloud), performance monitoring and model maintenance, intellectual property (patents, trade secrets, copyrights), data privacy regulations (GDPR, CCPA), AI ethics and responsible AI practices, bias and fairness, transparency and explainability, regulatory compliance and certifications, exit strategies (acquisition, IPO, merger), failure analysis and pivoting, sustainability and social impact, case studies.

Textbooks:

1. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
2. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.

References:

1. Blank, S., & Dorf, B. (2020). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. John Wiley & Sons.
2. Thiel, P., & Masters, B. (2014). Zero to One: Notes on Startups, or How to Build the Future. Crown Business.

3. Agrawal, A., Gans, J., & Goldfarb, A. (2018). Prediction Machines: The Simple Economics of Artificial Intelligence. Harvard Business Review Press.
4. Chen, J. J. (2018). Artificial Intelligence and Entrepreneurship. In Artificial Intelligence and Economic Theory: Skynet in the Market (pp. 125-142). Springer.
5. Kawasaki, G. (2015). The Art of the Start 2.0: The Time-Tested, Battle-Hardened Guide for Anyone Starting Anything. Portfolio.
6. Maurya, A. (2012). Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly Media.

26…OPEN ELECTIVE – II

26- AI IN HEALTHCARE

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the fundamentals of AI and its applications in healthcare.
2. Analyze machine learning and deep learning techniques for clinical data.
3. Understand the integration of AI with medical imaging, diagnostics, and wearable technologies.
4. Implement basic AI-driven analytics for healthcare decision-making.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3										2	3			
CO2	3	1	1	1							1	3			
CO3	3	2	1								1	3			
CO4	2	1									1				

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to AI in Healthcare

Basics of Artificial Intelligence, Machine Learning, and Deep Learning,Overview of healthcare systems and challenges in clinical decision-making, AI applications in healthcare: diagnosis, treatment planning, patient monitoring, and drug discovery., Ethical, legal, and social considerations in AI-driven healthcare.

Module II

Machine Learning and Predictive Analytics

Data types in healthcare: structured, unstructured, and streaming data, Data preprocessing, feature extraction, and handling missing data., Supervised, unsupervised, and reinforcement learning in healthcare scenarios.

Predictive analytics for disease diagnosis, patient risk assessment, and outcome prediction.

Module III

AI for Medical Imaging and Diagnostics: Role of AI in medical imaging (X-ray, MRI, CT, Ultrasound).

Deep learning approaches for image recognition and segmentation.

Natural Language Processing (NLP) for clinical notes, EHRs, and pathology reports.

Integration of wearable sensors and IoT for real-time patient monitoring

Module IV

Advanced AI in Healthcare Analytics

AI in genomics, personalized medicine, and drug discovery, Text analytics, speech analytics, and predictive modeling for healthcare applications, Deployment of AI models in cloud-based and edge computing environments, Open-source tools and frameworks for AI in healthcare (TensorFlow, PyTorch, scikit-learn)., Measuring impact: clinical effectiveness, cost-benefit, and patient outcomes.

Textbook:

1. Jiang, F., Jiang, Y., Zhi, H., Dong, Y., Li, H., Ma, S., Wang, Y., Dong, Q., Shen, H., & Wang, Y. (2017). Artificial intelligence in healthcare: Past, present and future. Elsevier.

References:

1. Rajkomar, A., Dean, J., & Kohane, I. (2019). Machine learning in medicine. New England Journal of Medicine, 380(14), 1347–1358.
2. Yu, K. H., Beam, A. L., & Kohane, I. S. (2018). Artificial intelligence in healthcare. Nature Biomedical Engineering, 2, 719–731.
3. Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. Future Healthcare Journal, 6(2), 94–98.
4. Topol, E. (2019). Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic

Books.
5. Shukla, S., & Patel, R. (2021). AI and Healthcare Analytics: Techniques and Applications. Springer.

26-###---- SOCIAL NETWORK ANALYSIS

Course Outcomes:

On completion of this course the student will be able to:

1. Analyze computational models underlying social computing.
2. Understand social learning aspects of knowledge management, agents and social interaction.
3. Analyse security and identity in cyberspace.
4. Evaluate the services provided by social networks

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1					1			1	3	2	
CO2	3	3	2	1					1			1	3	2	
CO3	3	2	2	1					1			1	2	2	3
CO4	3	2	2	2					1			1	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Social Influence and Human Interaction with Technology, Social and Human Elements of Information Security: A Case Study, Computer Mediated Communication, Learning Environments, Online Communities and Social Networking, IT and the Social Construction of Knowledge.

Module II

Social Learning Aspects of Knowledge Management, Agents and Social Interaction: Insights from Social Psychology Social Perception, Agent Based Modelling and Social Psychological Theory.

Module III

Cyber identities and Social Life in Cyberspace, Online Learning, Social Presence, Social Networking, Social Networking Analysis, Social Networking Services. Social Networks in information Systems: Tools and Services.

Module IV

Mobile Social Networks and Services, Social Software, Self Organization in Social Software for Learning, Mailing Lists and Social Semantic Web.

Textbook:

2. Dasgupta, S. (2020). Social computing: Concepts, methodologies, tools, and applications (2nd ed.). IGI Global. https://doi.org/10.4018/978-1-60566-984-7

References:

6. Liu, H., Salerno, J. J., & Young, M. J. (2020). Social computing, behavioral-cultural modeling and prediction (2nd ed.). Springer Science & Business Media. https://doi.org/10.1007/978-1-4419-6281-2
7. Kamal, R. (2022). Mobile computing (3rd ed.). Oxford University Press.
8. Talukder, A., & Yavagal, R. (2019). Mobile computing: Technology, applications, and service creation (3rd ed.). McGrawHill Professional.

26--- CONSTITUTIONAL LAW

Course Outcomes:

On completion of this course the student will be able to:

1. Configure the preamble and fundamental rights.
2. Actuate the governance and functioning of constitutional functionaries.
3. Describe the functions of legislative bodies.
4. Decipher the judiciary system and its role in governance

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						2	1	2	2			2			
CO2						2	1	2	2			2			
CO3						2	1	2	2			2			
CO4						2	1	2	2			2			

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction

Constitution Law – Constitutional Assembly Debates – Constitution of India – Basic Features of Indian Constitution – Preamble – Structure and Content of Indian Constitution

Module II

Fundamental Rights

Rights – Fundamental Rights – Definition of State – Fundamental Rights under Indian Constitution – Right to Equality – Untouchability – Title – Right to Life Cultural and Educational Rights of Minorities - Enforcement of Fundamental Rights

Module III

Directive Principles of State Policy & Fundamental Duties

DPSP's – Relationship between DPSP and Fundamental Rights – Conversion of DPSP into Fundamental Rights – Role of Judiciary – Judicial Activism – PIL - Fundamental Duties

Module IV

Constitutional Organs

Legislative Organs – Parliament – Lok Sabha, Rajya Sabha - State Legislatures - Executive Organs - President, Vice President, Council of Ministers - Judicial Organs – Supreme Court and High Courts – Other Constitutional Bodies – Election Commission - Comptroller and Auditor General of India, etc.

Textbook:

1. Basu, D. D. (2019). Introduction to the Constitution of India (24th ed.). LexisNexis.

References:

1. Gupta, D. C. (2018). Indian government and politics (8th ed.). Vikas Publishing House.
2. Sreevai, H. M. (2015). Constitutional law of India (4th ed., Vols. 1-3). Universal Law Publishing

26---- INTELLIGENT RECOMMENDATION SYSTEMS

Course Outcomes:

On completion of this course the student will be able to:

1. Understand the concept of recommender systems in online platforms.
2. Apply data mining and machine learning concepts for recommender system design.
3. Analyze and evaluate recommendation accuracy.
4. Evaluate various recommendation algorithms.
5. Identify the various security aspects of recommender systems

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3	1							3	1	
CO2	3	3	3		3								3	2	
CO3	2	3	2	3	3								3	2	
CO4	2	3	3	1	3								3	2	
CO5	2	3				3		3					2		3

1-Slightly**; 2**-Moderately**; 3**-Substantially

Module I

Introduction to basic concepts, Need for recommender systems, Prediction vs Recommendations. Collaborative Recommendations: user based nearest neighbor recommendation, item based nearest neighbor recommendation, model based and preprocessing based approach, types of ratings, data sparsity, cold start problem, advantages and disadvantages of collaborative filtering. Case Study: Amazon Recommender System.

Module II

Content Based Recommendation: content representation and content similarity, similarity-based retrieval, other text classification methods. Case Study: Movie Recommender System.

Knowledge based recommendation: Knowledge representation and reasoning, Interacting with constraint based recommenders, Interacting with case based recommenders Case Study: Entree Restaurant Recommendation System

Module III

Hybrid recommendation approaches: Opportunities for hybridization, Monolithic hybridization design, Parallelized hybridization design, Pipelined hybridization design.

Explanations in recommender systems: Explanations in constraint-based recommenders, Explanations in case based recommenders, Explanations in collaborative filtering recommenders.

Module IV

Evaluating recommender systems: General properties of evaluation research, Popular evaluation designs, Evaluation on historical datasets, Case study: Personalized game recommendations on the mobile Internet. Attacks on Collaborative Recommender Systems:

Types of attacks, evaluation of effectiveness and countermeasures. Recommendations in ubiquitous environments

Textbook:

1. Jannach, D., & Zanker, M. (2010). Recommender systems: An introduction. Cambridge University Press. https://doi.org/10.1017/CBO9780511763113

References:

1. Kumar, P. P., Vairachilai, S., Potluri, S., & Mohanty, S. N. (2021). Recommender Systems. CRC Press.
2. Falk, K. (2019). Practical Recommender systems. Manning Publications.
3. Aggarwal, C. C. (2016). Recommender Systems: The Textbook. Springer.
4. Bhasker, B., & Srikumar, K. (2010). Recommender systems in e-commerce. Tata McGraw Hill Education.
5. Santos, O. C., & Boticario, J. G. (Eds.). (2011). Educational recommender systems and technologies: Practices and challenges. IGI Global. https://doi.org/10.4018/978-1-60960-479-0
6. Robillard, M. P., Maalej, W., Walker, R. J., & Zimmermann, T. (Eds.). (2014). Recommendation systems in software engineering. Springer. https://doi.org/10.1007/978-3-642-45135-5
7. Aggarwal, C. C. (2016). Recommender systems: The textbook. Springer. https://doi.org/10.1007/978-3-319-29659-3

26--- SEMINAR

Course Outcomes:

On completion of this course the student will be able to:

1. Identify and familiarize with some of the good publications and journals in their field of study.
2. Acquaint oneself with preparation of independent reports, name them based on a central theme and write abstracts, main body, conclusions, and references identifying their intended meaning and style.
3. Understand effective use of tools of presentation, generate confidence in presenting a report before an audience and improve their skills in the same.
4. Develop skills like time management, leadership quality and rapport with an audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1			1		1		1	2		
CO2	3	3	3	3	1			1		1		1	3		
CO3	3	3	3	3	1			1		1		1	2		
CO4	3	3	3	3	1			1		1		1	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Instructions

- Students shall individually prepare and submit a seminar report on a topic of current relevance related to the field of Information Technology and trends.
- The references shall include standard journals, conference proceedings, reputed magazines, and textbooks, technical reports, and URLs.
- The references shall be incorporated in the report following IEEE standards reflecting the state of the art in the topic selected.
- Each student shall present a seminar for about 30 minutes duration on the selected topic.
- The report and presentation shall be evaluated by a team of internal experts composed of 3 teachers based on style of presentation, technical content, adequacy of references, depth of knowledge and overall quality of the seminar report.

26---- PROJECT PHASE II

Course Outcomes:

On completion of this course the student will be able to:

1. Realize various steps involved in conducting a project work, like literature survey, the methodology adopted – field study/survey/experiments / numerical work, analysis of the data to arrive at final results and conclusions, etc.
2. Initiate a habit of proper report writing with all of its major components, proper style of writing and preparation of distinct abstract and carved-out conclusions.
3. Conceive the pros and cons of working in a team and the wonderful results which could evolve through teamwork.
4. Present and defend a self-prepared and corrected report (with the help of a project guide) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1			1		1		1	3	2	1
CO2	3	3	3	3	1			1		1		1	2	1	1
CO3	3	3	3	3	1			1		1		1	2	1	1
CO4	3	3	3	3	1			1		1		1	2	1	1

1-Slightly**; 2**-Moderately**; 3**-Substantially

Instructions

Each batch of students shall develop the project designed during the VII semester. The implementation phase shall proceed as follows:

1. A detailed project report in the prescribed format shall be submitted at the end of the semester. All test results and relevant design and engineering documentation shall be included in the report.
2. The work shall be reviewed and evaluated periodically

A committee consisting of the Project Coordinator (appointed by the Head of the Department / Division), project guide and at least one senior faculty member will carry out the assessment based on at least one interim review and a final review just before the submission of the project report.

The final evaluation of the project shall include the following

1. Presentation of the work
2. Oral examination
3. Demonstration of the project against design specifications
4. Quality and content of the project report.

Guidelines for evaluation:	***Marks (%)***
1. Regularity and progress of work	10%
2. Work knowledge and Involvement	25%
3. Semester End presentation and oral examination	25%
4. Level of completion and demonstration of Functionality / Specifications	25%
5. Project Report – Presentation style and content	15%

Note:

Points (1) and (2) are to be evaluated by the respective project guide and the project coordinator based on continuous evaluation. (3)-(5) to be evaluated by the final evaluation team.

26---- COMPREHENSIVE VIVA VOCE

Course Outcomes:

On completion of this course the student will be able to:

1. Review all the subjects covered during the programme.
2. Gain good knowledge of theory and practice.
3. Develop oral communication skills and a positive attitude.
4. Attend technical interviews with confidence

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2										2	3	1	
CO2	3	2	1	1								1	3	2	1
CO3	2	3	2	1	1				1			1	2		
CO4	3	2	1									1	2		

1-Slightly**; 2**-Moderately**; 3**-Substantially

Instructions

Each student is required to appear for a viva voce examination at the end of the complete course work. The examination panel shall comprise of a minimum of one internal examiner and one external examiner, both appointed by the University. The examiners shall evaluate the students in terms of their conceptual grasp of the course of study and practical/analysis skills in the field.

26---- INTERNSHIP-IV

Course Outcomes:

On completion of this course the student will be able to:

5. Understand the real time technical/managerial skills required and relevant to the subject of area of internship
6. Initiate a habit of proper daily diary writing with adequacy and quality of information recorded, drawing and sketches and data, thought process and the proper organization of the information gained during the internship.
7. Conceive the pros and cons of working in a real time industrial environment and the wonderful results which could evolve through team-work.
8. Present and defend self-prepared and corrected internship report (with the help of internship guide/industry mentors) of a self-created work to a peer audience.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1			2	1		2	2	1	1
CO2	2	3	1	2	2	1			2	2	1	1	2	1	
CO3	2	2	3	2	2	1			2	2	1	1	2	1	
CO4	2	2	2	3	2	1			2	2	1	1	3	1	

1-Slightly**; 2**-Moderately**; 3**-Substantially

Internship Guidelines

- An internship plan has to be prepared by the interns incorporating the job description/internship duties, name of the project, if any and internship schedule and expected learning outcomes in consultation with industry supervisor/mentor and institute faculty.
- A detailed training report in the prescribed format shall be submitted at the end of the internship.
- Training Certificate from the industry for the prescribed period shall be submitted at the end of the internship.
- The work shall be reviewed and evaluated periodically.
- Orientation of interns, resource requirement of interns, monitoring of interns progress on a daily basis shall be carried out by the industry offering internship in addition to ensuring safety and welfare of the interns

A committee consisting of the Internship Coordinator (nominated by the Head of the Department/Division), faculty mentor, and at least one senior faculty member at the level of Associate Professor or above will carry out the final review.

Guidelines for evaluation:	**Marks (%)**
1. Regularity and progress of work	20%
2. Work knowledge and Involvement	20%
3. Semester End presentation and oral examination	20%
4. Level of completion of the internship	20%
5. Internship Report – Presentation style and content	20%