AMRITA VISHWA VIDYAPEETHAM
DEEMED TO BE UNIVERSITY UNDER SECTION 3 OF UGC ACT, 1956

School of Computing

(AMARAVATI, AMRITAPURI, BENGALURU, CHENNAI, COIMBATORE (HQ), FARIDABAD, KOCHI, MYSURU, NAGERCOIL)

B.TECH COMPUTER SCIENCE AND ENGINEERING (ARTIFICIAL INTELLIGENCE) (BTC-AIE)

CURRICULUM 2026

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
HUM	-	Humanities (including Languages and others)
SCI	-	Basic Sciences (including Mathematics)
PRJ	-	Project Work (including Seminars)

AES	-	Aerospace Engineering
AIE	-	Computer Science and Engineering - Artificial Intelligence
BIO	-	Biology
CCE	-	Computer and Communication Engineering
CHE	-	Chemical Engineering
CHY	-	Chemistry
CSE	-	Computer Science and Engineering
CVL	-	Civil Engineering
CUL	-	Cultural Education
EAC	-	Electronics and Computer Engineering
ECE	-	Electronics and Communication Engineering
EEE	-	Electrical and Electronics Engineering
ELC	-	Electrical and Computer Engineering
HUM	-	Humanities
MAT	-	Mathematics
MEE	-	Mechanical Engineering
PHY	-	Physics

Course Outcome (CO) – Statements that describe what students are expected to know and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

Program Outcomes (POs) – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

PROGRAM OUTCOMES FOR ENGINEERING

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 specified needs with appropriate consideration for public health and safety, and 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 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 the World
Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, cultural, and environmental issues and the consequent responsibilities relevant to professional engineering practice.

PO7 – Ethics
Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering practice.

PO8 – Individual and Team Work
Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO9 – 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.

PO10 – Project Management and Finance
Demonstrate knowledge and understanding of 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.

PO11 – 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.

PROGRAM SPECIFIC OUTCOMES FOR CSE-AI

After completing the B.Tech CSE-AI program, the students will,

PSO1: Apply mathematical modelling, statistical reasoning, and algorithmic techniques to analyze and solve complex computational problems.

PSO2: Design and implement intelligent systems using machine learning, deep learning, reinforcement learning, data analytics, and modern AI frameworks and tools such as GenAI and Agentic AI Frameworks.

PSO3: Develop AI-driven solutions for real-world problems in domains such as healthcare, robotics, cybersecurity, smart systems, and data analytics.

PSO4: Develop and deploy AI systems responsibly by considering ethical, societal, and technological aspects using scalable computing platforms and emerging technologies in alignment with the national mission.

SEMESTER I

Cat.	Code	Title	L T P	Credit
SCI	26MAT110	Mathematics for Computing 1	2 1 3	4
SCI	26PHY106	Computational Physics	2 0 3	3
ENGG	26AIE101	Problem Solving & C Programming	2 1 3	4
ENGG	26AIE102	Elements of Computing Systems 1	2 0 3	3
ENGG	26MAT121	Discrete Mathematics	2 0 3	3
HUM	22ADM101	Foundations of Indian Heritage	2 0 1	2
HUM	23ENG101	Technical Communication	2 0 3	3
		TOTAL	35	22

SEMESTER II

Cat.	Code	Title	L T P	Credit
SCI	26MAT122	Mathematics for Computing 2	2 1 3	4
ENGG	26AIE111	Object Oriented Programming in Java	2 1 3	4
ENGG	26AIE112	Data Structures & Algorithms 1	2 1 3	4
ENGG	26AIE113	Elements of Computing Systems - 2	2 0 3	3
ENGG	26AIE114	Introduction to Electrical and Electronics Engineering	2 0 3	3
ENGG	26AIE115	User Interface Design	2 0 3	3
HUM	22ADM111	Glimpses of Glorious India	2 0 1	2
		TOTAL	36	23

SEMESTER III

Cat	Code	Title	L T P	Cr
SCI	26MAT220	Mathematics for Computing 3	2 1 3	4
ENGG	26AIE201	Fundamentals of AI	2 0 3	3
ENGG	26AIE202	Operating Systems	2 0 3	3
ENGG	26AIE203	Data Structures & Algorithms 2	2 0 3	3
ENGG	26AIE204	Introduction to Computer Networks	2 0 3	3
ENGG	26AIE205	Introduction to Python	1 0 3	2
ENGG	26BIO201	Intelligence of Biological Systems - 1	2 0 0	2
ENGG		Free Elective 1**	2 0 0	2
HUM		Amrita Value Program-I	1 0 0	1
HUM	26CCS201	Career Competency Skills I	1 0 2	P/F
		Total	38	23

SEMESTER IV

Cat	Code	Title	L T P	Cr
SCI	26MAT230	Mathematics for Computing 4	2 1 3	4
ENGG	26AIE211	Introduction to Communication & IoT	2 0 3	3
ENGG	26AIE212	Design and Analysis of Algorithms	2 0 3	3
2ENGG	26AIE213	Machine Learning	2 0 3	3
ENGG	26AIE214	Introduction to AI Robotics	2 0 3	3
ENGG	26BIO211	Intelligence of Biological Systems 2	2 0 3	3
HUM		Amrita Value Program-II	1 0 0	1
HUM	23ENV300	Environmental Science		P/F
HUM	26CCS211	Career Competency Skills II	1 0 2	2
HUM	26CUL200	Integrated Amrita Meditation Technique	0 0 2	1
		Total	37	23

SEMESTER V

Cat	Code	Title	L T P	Cr
ENGG	26AIE301	Probabilistic Reasoning	2 0 3	3
ENGG	26AIE302	Formal language and Automata	2 1 0	3
ENGG	26AIE303	Database Management Systems	2 1 3	4
ENGG	26AIE304	Deep Learning	2 0 3	3
ENGG	26AIE305	Introduction to Cloud Computing	2 0 3	3
ENGG		Professional Elective 1*	2 0 3	3
HUM	26CCS301	Career Competency Skills III	1 0 2	2
HUM	23LIV390	Live-in-Labs		[3]
		Total	32	21 + [3]

SEMESTER VI

Cat	Code	Title	L T P	Cr
ENGG	26AIE311	Software Engineering (Project-Based)	2 0 3	3
ENGG	26AIE312	Big Data Analytics	2 0 3	3
ENGG	26AIE313	Computer Vision & Image Processing	2 1 3	4
ENGG	26AIE314	Computer Security	2 0 3	3
ENGG	26AIE315	Natural Language Processing	2 0 3	3
ENGG		Professional Elective 2*	2 0 3	3
HUM	26CCS311	Career Competency Skills IV	1 0 2	2
PRJ	26AIE399	Project Phase 1	0 0 8	4
ENGG	23LIV490	Live-in-Labs		[3]
		Total	34	25 + [3]

SEMESTER VII

Cat	Code	Title	L T P	Cr
ENGG	26AIE401	Reinforcement Learning	2 0 3	3
ENGG		Professional Elective 3*	2 0 3	3
ENGG		Professional Elective 4*	2 0 3	3
HUM	23LAW300	Indian Constitution		P/F
ENGG		Free Elective 2**	3 0 0	3
PRJ	26AIE498	Project Phase 2	0 0 12	6
		Total	19	18

SEMESTER VIII

Cat	Code	Title	L T P	Cr
PRJ	26AIE499	Project Phase 3	0 0 12	6
		Total		6

		Total Credits		161

@'Hands-on' Project-based Lab.
***Professional Elective - Electives categorised under Engineering, Science, Mathematics, Live-in-Labs, and NPTEL Courses. Student can opt for such electives across departments/campuses. Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8.**
**** Free Electives - This will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam - (International Centre for Spiritual Studies).**
***** Live-in-Labs - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester.**

PROFESSIONAL ELECTIVES

Cat	Code	Title	L T P	Cr
ENGG	26AIE430	Agentic AI Systems	2 0 3	3
ENGG	26AIE431	Applied Cryptography	2 0 3	3
ENGG	26AIE432	Network and Wireless Security	2 0 3	3
ENGG	26AIE433	Intrusion Detection and Prevention Systems	2 0 3	3
ENGG	26AIE434	Software Vulnerability Analysis	2 0 3	3
ENGG	26AIE435	Cybercrime Forensics and Digital Forensics	2 0 3	3
ENGG	26AIE436	Distributed System Security	2 0 3	3
ENGG	26AIE437	Medical Image Processing	2 0 3	3
ENGG	26AIE438	Biomedical Signal Processing	2 0 3	3
ENGG	26AIE439	Clinical Information Systems	2 0 3	3
ENGG	26AIE440	Kinematics and Kinetics for Robotics	2 0 3	3
ENGG	26AIE441	Dynamics and Control of Robotics	2 0 3	3
ENGG	26AIE442	Robotic Operating Systems & Robot Simulation	2 0 3	3
ENGG	26AIE443	Underactuated Robotics	2 0 3	3
ENGG	26AIE444	Probabilistic Robotics	2 0 3	3
ENGG	26AIE445	Sensors and Actuators for Robotics	2 0 3	3
ENGG	26AIE446	NLP for Robotics	2 0 3	3

ENGG	**26AIE447**	**Data Driven Control in Robotics**	**2 0 3**	**3**
ENGG	**26AIE448**	**Introduction to Drones**	**2 0 3**	**3**
ENGG	**26AIE449**	**Introduction to Digital Manufacturing**	**2 0 3**	**3**
ENGG	**26AIE450**	**Speech Processing**	**2 0 3**	**3**
ENGG	**26AIE451**	**Modern & Smart Materials**	**2 0 3**	**3**
ENGG	**26AIE452**	**Data Driven Material Modelling & Simulation**	**2 0 3**	**3**
ENGG	**26AIE453**	**Computational Drug Design**	**2 0 3**	**3**
ENGG	**26AIE454**	**Deep learning in Genomics and Biomedicine**	**2 0 3**	**3**
ENGG	**26AIE455**	**DNA Sequencing Technologies**	**2 0 3**	**3**
ENGG	**26AIE456**	**CRISPR Technology**	**2 0 3**	**3**
ENGG	**26AIE457**	**Full Stack Development**	**2 0 3**	**3**
ENGG	**26AIE458**	**Mobile Application Development**	**2 0 3**	**3**
ENGG	**26AIE459**	**User Experience Design**	**2 0 3**	**3**
ENGG	**26AIE460**	**Software Design Patterns**	**2 0 3**	**3**
ENGG	**26AIE461**	**Concurrent Programming**	**2 0 3**	**3**
ENGG	**26AIE462**	**Deep Reinforcement Learning**	**2 0 3**	**3**
ENGG	**26AIE463**	**Time Series Analysis**	**2 0 3**	**3**

INDUSTRY ELECTIVES

ENGG	**26AIE470**	**Cloud Application Development**	**2 0 3**	**3**

List of courses in Amrita Value Programme I & II

Cat	Course Code	Title	L-T-P	Credits
HUM	22ADM201	Strategic Lessons from Mahabharatha	1-0-0	1
HUM	22ADM211	Leadership from Ramayana	1-0-0	1
HUM	22AVP210	Kerala Mural Art and Painting	1-0-0	1
HUM	22AVP218	Yoga Therapy and Lessons	1-0-0	1
HUM	22AVP212	Introduction to Traditional Indian Systems of Medicine	1-0-0	1
HUM	22AVP201	Amma's Life and Message to the modern world	1-0-0	1
HUM	22AVP204	Lessons from the Upanishads	1-0-0	1
HUM	22AVP205	Message of the Bhagavad Gita	1-0-0	1
HUM	22AVP206	Life and Message of Swami Vivekananda	1-0-0	1
HUM	22AVP207	Life and Teachings of Spiritual Masters of India	1-0-0	1
HUM	22AVP208	Insights into Indian Arts and Literature	1-0-0	1
HUM	22AVP213	Traditional Fine Arts of India	1-0-0	1
HUM	22AVP214	Principles of Worship in India	1-0-0	1
HUM	22AVP215	Temple Mural Arts in Kerala	1-0-0	1
HUM	22AVP218	Insights into Indian Classical Music	1-0-0	1
HUM	22AVP219	Insights into Traditional Indian Painting	1-0-0	1
HUM	22AVP220	Insights into Indian Classical Dance	1-0-0	1
HUM	22AVP221	Indian Martial Arts and Self Defense	1-0-0	1
HUM	22AVP209	Yoga and Meditation	1-0-0	1

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

CHEMISTRY				
Cat.	**Code**	**Title**	**L T P**	**Credit**
SCI	23CHY240	Computational Chemistry and Molecular Modelling	3 0 0	3
SCI	23CHY241	Electrochemical Energy Systems and Processes	3 0 0	3
SCI	23CHY242	Fuels and Combustion	3 0 0	3
SCI	23CHY243	Green Chemistry and Technology	3 0 0	3
SCI	23CHY244	Instrumental Methods of Analysis	3 0 0	3
SCI	23CHY245	Batteries and Fuel Cells	3 0 0	3
SCI	23CHY246	Corrosion Science	3 0 0	3
PHYSICS				
SCI	23PHY240	Advanced Classical Dynamics	3 0 0	3

SCI	**23PHY241**	**Electrical Engineering Materials**	**3 0 0**	**3**
SCI	**23PHY242**	**Physics of Lasers and Applications**	**3 0 0**	**3**
SCI	**23PHY243**	**Concepts of Nanophysics and Nanotechnology**	**3 0 0**	**3**
SCI	**23PHY244**	**Physics of Semiconductor Devices**	**3 0 0**	**3**
SCI	**23PHY245**	**Astrophysics**	**3 0 0**	**3**
Mathematics				
SCI	**23MAT240**	**Statistical Inference**	**3 0 0**	**3**
SCI	**23MAT241**	**Introduction to Game Theory**	**3 0 0**	**3**
SCI	**23MAT242**	**Numerical Methods and Optimization**	**3 0 0**	**3**

FREE ELECTIVES

FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM				
Cat.	**Code**	**Title**	**L T P**	**Credit**
HUM	**23MNG331**	**Financial Management**	**3 0 0**	**3**
HUM	**23MNG332**	**Supply Chain Management**	**3 0 0**	**3**
HUM	**23MNG333**	**Marketing Management**	**3 0 0**	**3**
HUM	**23MNG334**	**Project Management**	**3 0 0**	**3**
HUM	**23MNG335**	**Enterprise Management**	**3 0 0**	**3**
HUM	**23MNG336**	**Operations Research**	**3 0 0**	**3**
HUM	**23MEE321**	**Industrial Engineering**	**3 0 0**	**3**
HUM	**23MEE322**	**Managerial Statistics**	**3 0 0**	**3**
HUM	**23MEE323**	**Total Quality Management**	**3 0 0**	**3**
HUM	**23MEE324**	**Lean Manufacturing**	**3 0 0**	**3**
HUM	**23CSE321**	**Software Project Management**	**3 0 0**	**3**
HUM	**23CSE322**	**Financial Engineering**	**3 0 0**	**3**
HUM	**23CSE323**	**Engineering Economic Analysis**	**3 0 0**	**3**
HUM	**23CSE324**	**Information Systems**	**3 0 0**	**3**

FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS				
Cat.	**Code**	**Title**	**L T P**	**Credit**
HUM	**23CUL230**	**Achieving Excellence in Life - An Indian Perspective**	**2 0 0**	**2**
HUM	**23CUL231**	**Excellence in Daily Life**	**2 0 0**	**2**
HUM	**23CUL232**	**Exploring Science and Technology in Ancient India**	**2 0 0**	**2**
HUM	**23CUL233**	**Yoga Psychology**	**2 0 0**	**2**
HUM	**23ENG230**	**Business Communication**	**1 0 3**	**2**

HUM	**23ENG231**	**Indian Thought through English**	**2 0 0**	**2**
HUM	**23ENG232**	**Insights into Life through English Literature**	**2 0 0**	**2**
HUM	**23ENG233**	**Technical Communication**	**2 0 0**	**2**
HUM	**23ENG234**	**Indian Short Stories in English**	**2 0 0**	**2**
HUM	**23FRE230**	**Proficiency in French Language (Lower)**	**2 0 0**	**2**
HUM	**23FRE231**	**Proficiency in French Language (Higher)**	**2 0 0**	**2**
HUM	**23GER230**	**German for Beginners I**	**2 0 0**	**2**
HUM	**23GER231**	**German for Beginners II**	**2 0 0**	**2**
HUM	**23GER232**	**Proficiency in German Language (Lower)**	**2 0 0**	**2**
HUM	**23GER233**	**Proficiency in German Language (Higher)**	**2 0 0**	**2**
HUM	**23HIN101**	**Hindi I**	**2 0 0**	**2**
HUM	**23HIN111**	**Hindi II**	**2 0 0**	**2**
HUM	**23HUM230**	**Emotional Intelligence**	**2 0 0**	**2**
HUM	**23HUM231**	**Glimpses into the Indian Mind - the Growth of Modern India**	**2 0 0**	**2**
HUM	**23HUM232**	**Glimpses of Eternal India**	**2 0 0**	**2**
HUM	**23HUM233**	**Glimpses of Indian Economy and Polity**	**2 0 0**	**2**
HUM	**23HUM234**	**Health and Lifestyle**	**2 0 0**	**2**
HUM	**23HUM235**	**Indian Classics for the Twenty-first Century**	**2 0 0**	**2**
HUM	**23HUM236**	**Introduction to India Studies**	**2 0 0**	**2**
HUM	**23HUM237**	**Introduction to Sanskrit Language and Literature**	**2 0 0**	**2**
HUM	**23HUM238**	**National Service Scheme**	**2 0 0**	**2**
HUM	**23HUM239**	**Psychology for Effective Living**	**2 0 0**	**2**
HUM	**23HUM240**	**Psychology for Engineers**	**2 0 0**	**2**
HUM	**23HUM241**	**Science and Society - An Indian Perspective**	**2 0 0**	**2**
HUM	**23HUM242**	**The Message of Bhagavad Gita**	**2 0 0**	**2**
HUM	**23HUM243**	**The Message of the Upanishads**	**2 0 0**	**2**
HUM	**23HUM244**	**Understanding Science of Food and Nutrition**	**2 0 0**	**2**
HUM	**23JAP230**	**Proficiency in Japanese Language (Lower)**	**2 0 0**	**2**
HUM	**23JAP2313**	**Proficiency in Japanese Language (Higher)**	**2 0 0**	**2**
HUM	**23KAN101**	**Kannada I**	**2 0 0**	**2**
HUM	**23KAN111**	**Kannada II**	**2 0 0**	**2**
HUM	**23MAL101**	**Malayalam I**	**2 0 0**	**2**
HUM	**23MAL111**	**Malayalam II**	**2 0 0**	**2**
HUM	**23SAN101**	**Sanskrit I**	**2 0 0**	**2**
HUM	**23SAN111**	**Sanskrit II**	**2 0 0**	**2**
HUM	**23SWK230**	**Corporate Social Responsibility**	**2 0 0**	**2**
HUM	**23SWK231**	**Workplace Mental Health**	**2 0 0**	**2**
HUM	**23TAM101**	**Tamil I**	**2 0 0**	**2**
HUM	**23TAM111**	**Tamil II**	**2 0 0**	**2**

SYLLABUS

SEMESTER 1

26MAT110	MATHEMATICS FOR COMPUTING 1	L-T-P-C: 2-1- 3- 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus, and basic probability theory needed for subsequent study
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind them.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field
- Another goal of the course is to provide the connection between the concepts of linear algebra, differential equations, and probability theory.

Course Outcomes

After completing this course, students will be able to

CO1: Apply the concepts of linear algebra to solve canonical problems.

CO2: Model simple physical systems using ordinary differential equations.

CO3: Solve elementary problems using the concepts of probabilistic theory.

CO4: Analyze elementary problems in linear algebra, ODE, and probabilistic theory with computational techniques.

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-	2	-	-	-	-	-	1	3	-	-	-
CO2	3	3	1	1	2	-	-	-	-	-	1	3	-	-	-
CO3	3	3	-	2	2	-	-	-	-	-	1	3	-	1	-
CO4	3	2	2	2	3	-	-	-	-	-	1	3	1	1	-

Syllabus

Unit 1

Basics of Linear Algebra - Linear Dependence and independence of vectors - Gaussian Elimination - Rank of set of vectors forming a matrix - Vector space and Basis set for a Vector space - Dot product and Orthogonality - Rotation matrices - Eigenvalues and Eigenvectors and its interpretation.

Unit 2

Ordinary Linear differential equations, formulation, analytical and Numerical solutions, Impulse Response Computations, Converting higher order into first order equations. Examples of ODE modelling in falling objects, satellite and planetary motion, Electrical and mechanical systems. Multivariate calculus, Taylor series.

Unit 3

Introduction to random variables (continuous and discrete), mean, standard deviation, variance, probability distributions and Monte Carlo Simulations.

Textbooks:

- *Gilbert Strang, Introduction to Linear Algebra, Fifth Edition, Wellesley-Cambridge Press, 2016.*
- *Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*
- *William Flannery, Mathematical Modelling and Computational Calculus, Vol-1, Berkeley Science Books, 2013.*
- *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc*.

References:

- *Stephen Boyd and Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, 2018.*
- *Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.*
- *D. Bertsekas and J. Tsitsiklis, Introduction to Probability, 2nd Edition, Athena Scientific, 2008.*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Problem-solving assignments, quizzes (conceptual & numerical), short tests (open/closed book), analytical exercises.	20%
Continuous Assessment – Lab (CAL)	Internal	Computational exercises using Python/MATLAB (linear algebra simulations, ODE solving, Monte Carlo methods), mini computational tasks.	30%
Mid-Term Examination	Internal	Written examination focusing on analytical problem solving and modelling.	20%
End Semester Assessment	External	Written Examination on mathematical concepts and computing applications. OR Hybrid Mode Examination comprising written and computational/problem-solving components. OR Project-Based Examination involving mathematical modeling, computational analysis, project demonstration, and viva voce	30%

26PHY106	**COMPUTATIONAL PHYSICS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- The course will lay down the basic concepts and techniques needed for verticals such as robotics.

- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind them.
- It will help the students to perceive the engineering problems using the fundamental concepts in physics. S
- Another goal of the course is to provide the connection between the concepts of physics, mathematics, and computational thinking.

Course Outcomes

After completing this course, students will be able to

CO1: Apply the principles of statics to solve elementary problems in physics.

CO2: Apply computational techniques to solve elementary problems in statics.

CO3: Apply computational techniques to solve elementary problems in dynamics.

CO4: Analyze the motion of rigid bodies by applying fundamental principles of dynamics.

CO-PO Mapping

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

Syllabus

Unit 1

Newton's Laws of Motion, Force as 3D Vector, Resolution of Forces, Resultant of Forces.

Unit 2

Equilibrium about a Point, Moment, Couple, Equivalent System, Equilibrium of Rigid Bodies, Degree-of-freedom and Constraints at Supports, Free Body Diagram.

Unit 3

Kinematics of particles, assumptions, Cartesian, Cylindrical and Spherical frames, and motion of particles in them. Translation and rotation of rigid bodies in 2D – Translation and rotation of rigid bodies in 3D.

Unit 4

Kinematics of interconnected rigid bodies– Definition of a linkage – Definition of a mechanism –Four-bar mechanism.

Textbooks

- *Merlam J.L and Kraige L.G., Engineering Mechanics, Volume I - statics, Volume 11- dynamics, John Wiley & Sons, New York, 2018.*
- *Hibbeler R. C., Engineering Mechanics: Statics and Dynamics, 11th edition, Pearson Education India, 2017.*
- *Elementary Mechanics Using Matlab – Malthe & Sorenssen – Undergraduate Lecture Notes in Physics, Springer International Publishing, 2015.*
- *Elementary Mechanics Using Python – Malthe & Sorenssen – Undergraduate Lecture Notes in Physics, Springer International Publishing, 2015.*

References Books

- *Beer F.P. and Johnston E.R., Vector Mechanics for Engineers - Volume I - Statics, Volume II - Dynamics, McGraw Hill, New York, 2004.*
- *Shames I. H., Engineering Mechanics, Prentice HaII, New Delhi, 1996.*
- *Statics with Matlab – Marghitu, Dupac& Madsen, Springer – Verlag London 2013.*
- *Advanced Dynamics - Marghitu, Dupac& Madsen, Springer – Verlag London 2013.*
- *Dukkipati R. V., MATLAB: An Introduction with Applications, New Age International; 2010.*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, numerical problem-solving exercises, computational modeling tasks, simulation-based case studies, and short tests on computational physics concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Scientific programming exercises, numerical method implementation, simulation of physical systems, data visualization, computational experiments, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on numerical methods, computational modeling, simulation techniques, and physics-based problem solving	20%
End Semester Assessment	External	Written Examination on computational physics concepts, numerical methods, and simulations. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Project-Based Examination involving computational modeling, simulation of physical systems, data analysis, project demonstration, and viva voce	30%
Total			100%

26AIE101	PROBLEM SOLVING & C PROGRAMMING	L-T-P-C: 2- 1- 3- 4

Course Objectives

- To understand the various steps in Program development.
- To understand the basic concepts in C Programming Language.
- To learn how to write modular and readable C Programs.
- To imbibe the problem-solving strategy skill through C programming.

Course Outcomes

After completing this course, students will be able to
CO1: Translate pseudocode and algorithms for arithmetic and logical problems into C programs.
CO2: Debug C programs to identify and correct syntax and logical errors.
CO3: Construct modular C programs using functions, arrays, pointers, and structures to solve problems.
CO4: Apply programming to implement matrix operations, searching, sorting, and file handling tasks.

CO-PO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	3	1	–	–	–	–	–	–	–	1	2	2	–	–
CO 2	3	2	2	–	3	–	–	–	–	–	1	2	3	–	–
CO 3	2	3	–	1	2	–	–	–	–	–	1	2	3	–	–
CO 4	3	3	2	1	3	–	–	–	–	–	1	2	3	1	–

Syllabus

Unit 1
Introduction to problem-solving- Computation– expressions, logic; pseudocode vs programs, Problem Understanding and Analysis – problem definition, input-output, variables, name binding, the idea of algorithms, problem-solving strategy, Introduction to Programming language concepts, machine language, flowcharts/Pseudo codes, types of compilers and software, pseudocode to programs.

Unit 2
Introduction to C programming, Structure of a C program, Data type, Constants, Variables, Identifiers, Keywords, Declarations, Expressions, Statements, and Symbolic constants.
Input and Output: getchar, putchar, scanf, printf, gets, puts, functions, pre-processor commands, Preparing and running a complete C program.
Operators and expressions: Arithmetic, unary, logical, bitwise, assignment and conditional operators, Library functions.
Control statements: if-else, switch, break, continue, while, do-while, for statements, nested loops, goto statements, comma operator.

Unit 3
Functions: Defining and accessing function, passing arguments, function prototypes, recursion, use of library functions, and storage classes.
Arrays: Defining and processing an array, Passing array to a function, multi-dimensional arrays, Sequential search, Sorting arrays, String handling, Operations on strings,

Pointers: Declarations, Passing pointer to a function, Operations on pointers, Pointers and arrays, Arrays of pointers.
Structures and unions: Defining and processing a structure, passing structure to a function, Pointers; and Unions.

Unit 4
File handling: Open, Close, Create, File operations, Unformatted data files, Command line arguments. The Standard C Pre-processor: Defining and calling macros, utilizing conditional compilation, passing values to the compiler, The Standard C Library: Input/Output: fopen, fread, etc, string handling functions, Math functions: log, sin, alike Other Standard C functions.

Textbooks

- *Forouzan BA, Gilberg RF. Computer Science: A structured programming approach using C. Third Edition, Cengage Learning; 2006.*

Reference Books

- *Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018.*
- *Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.*
- *Byron Gottfried. Programming With C. Fourth Edition, McGrawHill; 2018.*
- *Kanetkar, Yashavant, Let us C, BPB publications, 2018.*
- *Brian W. Kernighan and Dennis M. Ritche, The C Programming Language, Pearson Publication, 2015*
- *Problem Solving and Program Design in C, J. R. Hanly and E. B. Koffman, 5th Edition, Pearson Education.*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, algorithm design exercises, flowchart and pseudocode development, problem-solving tests, and short assessments on C programming concepts	20%
Continuous Assessment – Lab (CAL)	Internal	C programming assignments, debugging exercises, implementation of control structures, functions, arrays, pointers, file handling, problem-solving tasks, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on problem-solving techniques, algorithms, C programming fundamentals, functions, arrays, pointers, and program analysis	20%
End Semester Assessment	External	Written Examination on problem solving and C programming concepts. OR Hybrid Mode Examination comprising written and coding/problem-solving components. OR Project-Based Examination involving development of C-based applications, implementation of problem-solving techniques, project demonstration, and viva voce	30%
Total			100%

26AIE102	**ELEMENTS OF COMPUTING SYSTEMS 1**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

• The course will expose the students to the basics of Boolean algebra, and it will further help them to understand the workings of a modern computer.

• Students will be trained to build a computing system using elementary logic gates such as NAND, AND, OR etc. through simulation software.

Course Outcomes

After completing this course, the students will be able to

CO1: Realize the concept of Boolean Algebra and Digital Logic.
CO2: Implement different combinational and sequential digital logic systems.
CO3: Design the hardware hierarchy of general-purpose computing systems.
CO4: Build a general-purpose computer capable of running stored programs written in the machine language.

CO – PO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	1	–	2	–	–	–	–	–	1	2	1	–	–
CO 2	3	2	3	1	3	–	–	–	–	–	1	2	3	–	–
CO 3	3	3	1	2	2	–	–	–	–	–	1	3	2	–	–
CO 4	3	3	2	2	3	–	–	–	–	–	1	3	3	1	1

Syllabus

Unit 1
Number System-Decimal to Binary Conversion- Negative Numbers- Signed Magnitude Number System- Boolean algebra and Karnaugh Maps-Boolean Logic, -Logic Gates-Introduction to Hardware simulator platforms; Nand ToTetris, -Hardware description language-Realization of basic gates using NAND gate.

Unit 2
Boolean function synthesis-Combinational Logic- Half Adder-Full Adder-Multiplexer (MUX) and demultiplexer (DeMUX) design-ALU and its implementation.

Unit 3
Sequential Logic Design- Memory Elements Computer Architecture: Von-Neumann Architecture-Registers-Flip-Flops-RAM, ROM, Program Counter -Hack CPU -Machine Language vs High-level- Basic experiments using machine language.

Textbooks:

1. *Noam Nisan and Shimon Schocken, "Elements of Computing Systems", MIT Press, 2012.*
2. *M. Morris Mano, "Digital Design", 5th Edition, Pearson Education (Singapore) Pvt. Ltd., New Delhi,2014.*
3. *John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.*

Reference Books:

4. *Anil K. Maini, "Digital Electronics", Wiley, 2014.*
5. *Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011.*
6. *Donald D.Givone, "Digital Principles and Design", TMH, 2003.*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, Boolean algebra problems, Karnaugh map simplification, digital logic design exercises, architecture analysis tasks, and short tests on computer organization concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Digital circuit implementation using simulators, HDL programming exercises, combinational and sequential circuit design, assembly language programming tasks, hardware construction exercises, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on Boolean algebra, digital logic design, computer architecture, machine language concepts, and hardware analysis problems	20%
End Semester Assessment	External	Written Examination comprising analytical, design-oriented, and application-based questions on digital logic, computer architecture, memory systems, CPU design, machine language programming, and hardware-software integration concepts OR Term Project involving the design and implementation of a simple computing system, digital subsystem development, hardware-software integration, project demonstration, report submission, and viva voce	30%
Total			**100%**

26MAT121	**DISCRETE MATHEMATICS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- Familiar various concepts in logic and proof techniques.
- Understand the concepts of various types of relations, partial ordering and equivalence relations.
- Understand the concepts of generating functions and apply to solve the recurrence relations.
- Familiar basic results in number theory and understand it applications in information security.

Course Outcomes

After completing this course, the students will be able to

CO1: Apply the tools and techniques of mathematical reasoning required for computing.
CO2: Apply the concepts of generating functions to solve the recurrence relations.
CO3: Apply the concepts of divide and conquer method and principle of inclusion and exclusion to solve some simple algorithms in discrete mathematics.
CO4: Apply the formalism of number theory required for computing.

CO-PO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	**3**	**3**	**–**	**1**	**–**	**–**	**–**	**–**	**–**	**–**	**1**	**3**	**–**	**–**	**–**

CO 2	**3**	**3**	**1**	**1**	**–**	**–**	**–**	**–**	**–**	**–**	**1**	**3**	**–**	**–**	**–**
CO 3	**3**	**3**	**1**	**2**	**–**	**–**	**–**	**–**	**–**	**–**	**1**	**3**	**1**	**–**	**–**
CO 4	**3**	**2**	**1**	**1**	**–**	**–**	**–**	**–**	**–**	**–**	**1**	**3**	**1**	**2**	**–**

Syllabus

Unit 1

Logic, Mathematical Reasoning and Counting: Logic, Prepositional Equivalence, Predicate and Quantifiers, Theorem Proving, Functions, Mathematical Induction. Recursive Definitions, Recursive Algorithms, Basics of Counting, Pigeonhole Principle, Permutation and Combinations.

Unit 2

Relations and Their Properties: Representing Relations, Closure of Relations, Partial Ordering, Equivalence Relations, and partitions. Advanced Counting Techniques and Relations: Recurrence Relations, Solving Recurrence Relations, Generating Functions, Solutions of Homogeneous Recurrence Relations, Divide and Conquer Relations, Inclusion-Exclusion.

Unit 3

Number Theory: Divisibility and Factorization. Simultaneous linear congruences, Chinese Remainder Theorem. Wilson's Theorem, Fermat's Theorem, pseudoprimes and Carmichael numbers, Euler's Theorem. Arithmetic functions and Quadratic residues.

Textbooks:

7. *Kenneth H. Rosen, "Discrete Mathematics and its Applications", Tata McGraw- Hill Publishing Company Limited, New Delhi, Sixth Edition, 2007.*
8. *James Strayer, Elementary Number Theory, Waveland Press, 2002.*

Reference(s)

9. *R.P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition,2007.*
10. *Thomas Koshy, "Discrete Mathematics with Applications", Academic Press, 2005.*
11. *Liu, "Elements of Discrete Mathematics", Tata McGraw- Hill Publishing Company Limited, 2004*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, problem-solving exercises on logic, sets, relations, functions, counting principles, recurrence relations, graph theory, and mathematical proofs	20%
Continuous Assessment – Lab (CAL)	Internal	Computational exercises using discrete mathematics concepts, algorithmic problem-solving tasks, implementation of graph algorithms, combinatorial analysis exercises, proof-based assignments, and mini-projects involving discrete structures and applications	30%
Mid-Term Examination	Internal	Written examination focusing on propositional and predicate logic, set theory, relations,	20%

		functions, combinatorics, recurrence relations, and graph theory	
End Semester Assessment	External	Written Examination comprising analytical and application-oriented questions on discrete mathematics concepts. OR Hybrid Mode Examination comprising written assessment and Computational/problem-solving components. OR Term Project involving modelling and implementation of discrete mathematics concepts, project demonstration and viva voce.	30%
Total			**100%**

23ENG101	**TECHNICAL COMMUNICATION**	**L-T-P-C: 2-0-3-3**

Course Objectives:

- To introduce the students to the fundamentals of mechanics of writing
- To facilitate them with the style of documentation and specific formal written communication
- To initiate in them the art of critical thinking and analysis
- To help them develop techniques of scanning for specific information, comprehension and organization of ideas
- To enhance their technical presentation skills

Course Outcomes: The course will enable the student:

CO1: To gain knowledge about the mechanics of writing and the elements of formal correspondence

CO2: To understand and summarise technical documents

CO3: To apply the basic elements of language in formal correspondence

CO4: To interpret and analyze information and to organize ideas in a logical and coherent manner

CO5: To compose project reports/ documents, revise them for language accuracy and make technical presentations

CO-PO Mapping

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1										3					
CO2				1						2					
CO3										3					
CO4				1						2					
CO5									2	1					

Syllabus

Unit 1

Mechanics of Writing: Grammar rules -articles, tenses, auxiliary verbs (primary & modal) prepositions, subject-verb agreement, pronoun-antecedent agreement, discourse markers and sentence linkers

General Reading and Listening comprehension - rearrangement & organization of sentences

Unit 2

Different kinds of written documents: Definitions- descriptions- instructions-recommendations- user manuals - reports – proposals

Formal Correspondence: Writing formal Letters

Mechanics of Writing: impersonal passive & punctuation

Scientific Reading & Listening Comprehension

Unit 3

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting

Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation

Reading and listening comprehension of technical documents

Mini Technical project (10 -12 pages)

Technical presentations

Textbooks & References

1. *Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002*
2. *Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003*
3. *Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan& Bacon, 1999.*
4. *Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.*
5. *Michael Swan. '' Practical English Usage'', Oxford University Press, 2000*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Periodical 1	Internal	10
Periodical 2	Internal	10
*Continuous Assessment (Theory) (CAT)	Internal	10
*Continuous Assessment (Lab) (CAL)	Internal	40
End Semester	External	30

*CA can be Quizzes, Assignments, Projects and Report

SEMESTER II

26MAT122	MATHEMATICS FOR COMPUTING 2	L-T-P-C: 2- 1- 3- 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus and basic probability theory needed for subsequent study.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field.
- Another goal of the course is to provide connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

After completing this course student will be able to,

CO1: Apply matrix decomposition techniques to solve elementary problems.

CO2: Apply the concepts of linear algebra and differential calculus to solve elementary optimization problems.

CO3: Analyze data using fundamental techniques of probability.

CO4: Implement the concepts and techniques of linear algebra, optimization and probability for signal and image processing.

CO-PO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	1	1	2	–	–	–	–	–	1	3	1	–	–
CO 2	3	3	1	2	2	–	–	–	–	–	1	3	2	–	–
CO 3	3	3	–	2	2	–	–	–	–	–	1	3	1	1	–
CO 4	3	3	2	2	3	–	–	–	–	–	1	3	3	2	1

Syllabus

Unit 1

Gaussian elimination, LU decomposition, Infinite dimensional vector spaces, Fourier Series and Fourier Transform and its properties, Convolution, Vector spaces associated with Matrices, Projection matrix and Regression, Convolution sum, Convolution Integral, Cayley Hamilton theorem, Diagonalizability of matrices,

Eigenvalues and Eigenvectors of Symmetric matrices, Eigenvalues and Eigen vectors of A^TA, AA^T, Relationship between vector spaces associated with A, A^TA, AA^T, Singular Value Decomposition.

Unit 2

Taylor series expansion of multivariate functions, conditions for maxima, minima and saddle points, Concept of gradient and hessian matrices, Multivariate regression and regularized regression. Theory of convex and non-convex optimization, Newton method for unconstrained optimization. Signal processing with regularized regression.

Unit 3

Random variables and distributions, Expectation, Variance, Moments, Cumulants, Sampling from univariate distribution- various methods, Bayes theorem, Concept of Jacobian, and its use in finding pdf of functions of Random variables (RVs), box-muller formula for sampling normal distribution, Concept of correlation and Covariance of two linearly related RVs.

Textbooks:

- *Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*
- *William Flannery, "Mathematical Modelling and Computational Calculus", Vol-1, Berkeley Science Books, 2013.*
- *Stephen Boyd and Lieven Vandenberghe, "Convex Optimization ", Cambridge University Press, 2018.*
- *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.*

Reference Books:

- *Stephen Boyd and Lieven Vandenberghe, "Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares", Cambridge University Press, 2018.*
- *Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.*
- *Introduction to Probability, D. Bertsekas and J. Tsitsiklis, 2nd Edition, Athena Scientific, 2008.*

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, problem-solving exercises on linear algebra, vector spaces, matrices, eigenvalues and eigenvectors, probability, statistics, and mathematical modelling for computing applications	20%
Continuous Assessment – Lab (CAL)	Internal	Computational exercises using mathematical software/tools, matrix computations, statistical analysis, numerical problem-solving, implementation of mathematical models, and mini-projects involving computing applications	30%
Mid-Term Examination	Internal	Written examination focusing on linear algebra, probability, statistics, vector spaces, matrices, eigenvalues and eigenvectors, and mathematical foundations for computing	20%
End Semester Assessment	External	Written Examination comprising analytical and application-oriented questions on linear algebra, probability, statistics, and mathematical modelling. OR Hybrid Mode Examination comprising written assessment and computational/problem-solving components. OR Term Project involving mathematical modelling, data analysis, implementation using computational tools, project demonstration, and viva voce.	30%

Component	Internal / External	Suggested Assessment Methods	Weightage
Total			100%

26AIE111 OBJECT ORIENTED PROGRAMMING IN JAVA L-T-P-C: 2- 1- 3- 4

Course Objectives

- The course will provide an introduction to object-oriented programming.
- It will expose the students to the paradigm of object-oriented programming.
- Students will also be motivated to solve the problems in engineering using the concepts of object-oriented programming.

Course Outcomes

After completing this course, students will be able to

CO1: Represent the problems using objects and classes.
CO2: Implement object-oriented concepts using the Java language.
CO3: Apply the object-oriented concepts to design and visualize programs using UML.
CO4: Develop Java applications by applying core and advanced Java features.

CO-PO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	2	1	–	2	–	–	–	–	–	1	1	3	–	–
CO 2	3	2	2	–	3	–	–	–	–	–	1	2	3	–	–
CO 3	2	2	3	1	2	–	–	–	–	–	1	2	3	1	–
CO 4	3	2	2	1	3	–	–	–	–	–	1	2	3	1	–

Syllabus

Unit 1:

Introduction: Introduction to the Java Programming Language, Java Development Kit (JDK), Java Runtime Environment (JRE), Java Virtual Machine (JVM), Bytecode, Java program execution process, Object-Oriented Concepts—Abstraction, Encapsulation, Inheritance and Polymorphism, Basic program syntax, Hello World program, Data types, Variables, Operators, Control statements, Functions/Methods, Value types and Reference types, Concept of references**.**

Unit 2:

Classes, Objects, and Constructors: Objects in Java, Class file, Constructor functions, Class members and method, Class Instance variables, The Object class, Garbage collector, Method overloading, Constructors, Constructor overloading.

Inheritance and Packages: Basics of Inheritance, Types of Inheritance, Super keyword, Final keyword, overriding of methods, Applying and implementing interfaces, Packages-create, access and importing packages

Object-Oriented Design using UML: Introduction to UML, Class Diagrams, Object Diagrams, Use Case Diagrams, Sequence Diagrams, UML-based design of simple object-oriented systems.

Unit 3:

Exception handling and Threading: Introduction to exception handling, Hierarchy of exception, Usage of try, catch, throw, throws and finally, Built-in and user defined exceptions, Threads, Creating Threads, Thread life cycle, Concept of multithreading

Unit 4:

GUI programming with JavaFX: Introduction to JavaFX Architecture, Stage, Scene and Layouts, Event Handling, Controls (Label, TextField, Button, ListView, ComboBox), Mouse and Keyboard Events, Basic Styling using CSS, Introduction to FXML, Developing simple desktop GUI applications using JavaFX.

Introduction to Java Collections Framework and Generics: Generic classes and methods, bounded types and wildcards, Collection Framework architecture.

Textbooks

- *Herbert Schildt, Java: A Beginner's Guide, Tata McGraw-Hill Education, Ninth Edition*

Reference Books

- *Herbert Schildt, Java The Complete Reference, Tata McGraw-Hill Education, Ninth Edition.*
- *Cay S. Horstmann, Core Java: Fundamentals, Volume I, **12th Edition (Java 17/21)**, Pearson, 2023.*
- *Sierra, Kathy, and Bert Bates. Head first java. " O'Reilly Media, Inc.", 2003.*
- *John R. Hubbard, Schaum's Outline of Programming with Java, McGraw-Hill Education, 2004*

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, UML modelling exercises, object-oriented design problems, Java programming concepts, Java Collections and Generics, and short tests on object-oriented principles	20%
Continuous Assessment – Lab (CAL)	Internal	Java programming assignments, implementation of classes and objects, inheritance, polymorphism, exception handling, multithreading, JavaFX GUI development, Java Collections, Generics, debugging exercises, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on object-oriented concepts, Java programming constructs, UML-based design, exception handling, multithreading, and problem-solving	20%
End Semester Assessment	External	Written Examination on object-oriented programming concepts, UML modelling, Java language features, Java Collections Framework, Generics, and Java application development. OR Hybrid Mode Examination comprising written and coding/problem-solving components. OR Project-Based Examination involving Java application development using object-oriented design principles, JavaFX, and Collections Framework, followed by project demonstration and viva voce	30%
Total			100%

26AIE112	DATA STRUCTURES & ALGORITHMS 1	L-T-P-C: 2- 1- 3-4

Course Objectives

- This course aims at introducing the concept of data structure hierarchy.
- It will also expose the students to the basic and higher order data structures.
- Further the students will be motivated to apply the concept of data structures to various engineering problems.

Course Outcomes

After completing this course, the students will be able to

CO1: Apply an appropriate data structure for a specified problem.
CO2: Analyze the complexity of algorithms.
CO3: Implement linear data structures to solve different problems.
CO4: Implement non-linear data structures like trees to solve different problems.

CO-PO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	–	1	–	–	–	–	–	–	1	3	2	–	–
CO 2	3	3	2	–	2	–	–	–	–	–	1	3	3	–	–
CO 3	3	2	2	–	3	–	–	–	–	–	1	2	3	–	–
CO 4	3	3	3	1	3	–	–	–	–	–	1	2	3	1	–

CO-PO
Syllabus

Unit 1

Data Structure Hierarchy – primitive and non-primitive, Array data structure, properties and functions, single and multi-dimensional arrays, simple problems, Basics of Algorithm Analysis, big-O notation, notion of time and space complexity, dynamic arrays

Unit 2

Linked List, properties and functions, array implementations, singly linked list, doubly linked list, circular linked list, properties and functions, simple problems

Unit 3

Stack data structure, properties and functions, recursion, expression evaluation, simple problems, Queue data structure, Circular queue, Double ended queue, priority queues, properties and functions, simple problems (Implementation using arrays, LL)

Unit 4

Tree – Binary Tree, Binary Search Tree-– Array and Linked list representation, AVL Tree - union and intersections of tree structures, Complete binary tree, Binary Heap Data Structure-Heap order and Heapsort. **B-Trees:** Introduction, properties, insertion, deletion, searching, and applications in database and file-system indexing.

Textbooks

- *Alfred V Aho, John E Hopcroft, Jeffrey D Ullman. Data Structures & Algorithms, Pearson Publishers, 2002.*

- *Maria Rukadikar S. Data Structures & Algorithms, SPD Publishers, 2011.*

Reference Books

- *Michael T. Goodrich & Roberto Tamassia, Data Structures and Algorithms in Java,Wiley India Edition, Third Edition.*
- *Narasimha Karumanchi, Data Structures and Algorithms Made Easy in Java, CarrerMonk, 2011*
- *Y. Langsam, M. Augenstin and A. Tannenbaum, Data Structures using C and C++, Pearson Education, 2002.*
- *Lipschutz Seymour, Data Structures with C (Schaum's Outline Series), McGraw Hill Education India, 2004*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, algorithm analysis exercises, complexity evaluation problems, data structure design questions, and short tests on fundamental concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Programming assignments involving arrays, linked lists, stacks, queues, trees, and searching/sorting algorithms; debugging exercises, coding challenges, and implementation-based mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on data structures, algorithm design, complexity analysis, and problem-solving techniques	20%
End Semester Assessment	External	Written Examination on data structures, algorithms, and complexity analysis. OR Hybrid Mode Examination comprising written and coding/problem-solving components. OR Term Project involving implementation and application of data structures and algorithms, project demonstration, and viva voce	30%
Total			100%

26AIE113	ELEMENTS OF COMPUTING SYSTEMS – 2	L-T-P-C: 2- 0- 3- 3

Course Objectives

• This course is an integrative, project-oriented systems building course.
• The course exposes students to a significant body of computer science knowledge, gained through a series of hardware and software construction tasks.
• These tasks demonstrate how theoretical and applied techniques in AI are used in practice.

Course Outcomes
After completing this course, students will be able to

CO1: Analyze the important components of a MIPS computer system and the basic organization
CO2: Implement low-level programming on the hardware platform
CO3: Develop programs in object-based language 'Jack'
CO4: Execute experiments related to basic concepts and functions of operating systems and compilers.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4

CO															
CO1	3	3	2	2	3	-	-	3	2	3	3	-	-	-	-
CO2	3	3	3	3	3	-	-	3	2	3	3	-	2	-	-
CO3	3	2	3	3	3	-	-	3	2	3	3	-	2	-	-
CO4	3	2	3	2	3	-	-	3	2	3	3	-	2	-	-

Syllabus

Unit 1
Basic Computer Architecture-Instruction set and Machine language-MIPS instructions- add, subtract, bitwise operators, branches- CPI metric- Data path design for single clock. -Assembler

Unit 2
Virtual Machine I: Stack Arithmetic, Background VM Specification Part-1, Implementation and Perspective. Virtual Machine II: Program Control Background, VM Specification Part-2, Implementation, Perspective. High-Level Language: Background, The Jack Language Specification. Writing Jack Applications. Perspective.

Unit 3
Compiler I - Syntax Analysis: Background, Specification, Implementation, Perspective. Compiler II - Code Generation: Background, Specification, Implementation, Perspective. Operating System: Background, the Jack OS Specification, Implementation, Perspective

Textbooks:

- *Nisan, Noam, and Shimon Schocken. The elements of computing systems: building a modern computer from first principles. MIT Press, 2005.*
- *M. Morris Mano Computer System Architecture, Prentice Hall, Third Edition.*

Reference Books:

- *Hennessy, John L., and David A. Patterson. Computer architecture: a quantitative approach. Elsevier, 5th Edition, 2011.*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment Theory (CAT)	Internal	Quizzes, assignments, architecture analysis exercises, assembly language problems, operating system and compiler concepts, and short tests on system-level computing principles	20%
Continuous Assessment Lab (CAL)	Internal	Assembly language programming, CPU and memory system implementation, operating system simulations, compiler-related exercises, system-level programming tasks, hardware-software integration activities, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on computer architecture, assembly language, memory organization, operating system fundamentals, and system design concepts	20%

Component	Internal / External	Suggested Assessment Methods	Weightage
End Semester Assessment	External	Written Examination on computer architecture, assembly language, memory systems, operating systems, and system-level computing concepts. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving system design, hardware-software integration, project demonstration, and viva voce	30%
Total			**100%**

26AIE114 INTRODUCTION TO ELECTRICAL AND ELECTRONICS ENGINEERING L-T-P-C: 2- 0- 3-

Course Objectives

- The course will lay down the basic concepts and techniques of electrical, and electronics engineering needed for advanced topics in AI.
- It will help the students to perceive the engineering problems using the fundamental concepts in electrical and electronics engineering.
- Another goal of the course is to provide connection between the concepts of electrical and electronics engineering, mathematics, and computational thinking.

Course Outcomes

After completing this course, students will be able to

CO1: Familiarise the fundamental concepts in electrical and electronics engineering.
CO2: Implement the state-of-the-art computational techniques that can be employed to analyse the structured problems in electrical engineering.
CO3: Realize basic electronic components and circuits using various semiconductor devices
CO4: Implement various circuits applications in the perspective of electronics

CO-PO Mapping

PO/ PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	3	3	3	-	-	3	3	2	2	-	2	-	-
CO2	3	3	3	3	3	-	-	3	3	2	2	2	2	-	-
CO3	3	3	3	3	3	-	-	3	3	2	2	1	2	-	-
CO4	3	3	3	3	3	-	-	3	3	1	1	2	2	-	1

Syllabus

Unit 1

Fundamental electrical laws-Fundamental circuit elements: charge, voltage, current – Resistance – Ohms law – Kirchhoff's voltage and current law – Energy and power – Series parallel combination of R, L, C components –

Voltage divider and current divider rules – Super position theorem – Inductors and capacitors – Impedance and AC sinusoidal signals.

Unit 2

Semiconductor materials – PN junction diode – Diode characteristics – Diode applications: Clippers and Clampers – Rectifiers: Half wave, Full wave, Bridge – Zener diode –Introduction to BJT–BJT characteristics and configurations – CE amplifier – Transistor as a switch – Filed effect transistors: MOSFET.

Unit 3

Operational amplifiers – Inverting and non-inverting amplifier – Oscillators –Instrumentation amplifier

Textbooks:

1. *Hughes, Edward, John Hiley, Ian McKenzie Smith, and Keith Brown. Hughes electrical and electronic technology. Pearson education, 2005.*
2. *David A. Bell. Electronic Devices and Circuits, 5th Edition, Oxford University Press, 2008.*
3. *Bhattacharya, S. K. Basic Electrical Engineering. Pearson Education India, 2011.*

Reference Books:

- *A. Malvino And D. J. Bates. Electronic Principles, 7th Edition, Tata McGraw - Hill, 2007.*
- *Vincent Del Toro. Electrical Engineering Fundamentals, Prentice Hall of India Private Limited, 2nd Edition, 2003.*
- *Michael Tooley B. A. Electronic circuits: Fundamentals and Applications, 3rd Edition, Elsevier Limited, 2006*

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, numerical problem-solving exercises, circuit analysis tasks, conceptual tests on electrical and electronic components, and short assessments	20%
Continuous Assessment – Lab (CAL)	Internal	Circuit design and simulation, measurement and testing of electrical and electronic circuits, breadboard implementation, use of electronic instruments, troubleshooting exercises, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on circuit analysis, electrical networks, electronic devices, and fundamental electrical and electronics engineering concepts	20%
End Semester Assessment	External	Written Examination on electrical circuits, electronic devices, and engineering applications. OR Hybrid Mode Examination comprising written and practical/problem-solving components. OR Term Project involving circuit design, simulation, implementation, project demonstration, and viva voce	30%
Total			100%

26AIE115	USER INTERFACE DESIGN	L-T-P-C: 2- 0- 3- 3

Course Objectives

- Focus in this course is on the basic understanding of user interface design by applying HTML, CSS and Java Script.
- On the completion of the course, students will be able to develop basic web applications
- This course will serve as the foundation for students to do several projects and other advanced courses in computer science

Course Outcomes

After completing this course, students will be able to

CO1: Apply the basics of World Wide Web concepts during web development.
CO2: Develop webpage GUI using HTML5 technology.
CO3: Develop GUI using CSS and Java Script.
CO4: Develop a simple web application using html, CSS and JavaScript.

CO-PO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	2	2	–	1	–	–	–	2	–	1	–	1	2	–
CO 2	2	2	3	–	3	–	–	–	2	–	1	1	3	2	–
CO 3	2	2	3	1	2	–	–	–	3	–	1	–	2	2	1
CO 4	2	2	3	1	3	–	–	–	3	–	1	1	3	2	–

Syllabus

Unit 1

Introduction to Web – Client/Server - Web Server - Application Server- HTML Basics- Tags - Adding Web Links and Images- Creating Tables-Forms - Create a Simple Web Page - HTML 5 Elements - Media – Graphics.

Unit 2

CSS Basics –Features of CSS – Implementation of Borders - Backgrounds- CSS3 - Text Effects -Fonts -Page Layouts with CSS

Unit 3

Introduction to Java Script –Form Validations – Event Handling – Document Object Model - Deploying an application

Textbooks

- *Kogent Learning Solutions Inc. Html5 Black Book: Covers Css3, Javascript, Xml, Xhtml, Ajax, PhpAndJquery. Second Edition, Dreamtech Press; 2013.*

Reference Books

- *Tittel E, Minnick C. Beginning HTML5 and CSS3 For Dummies. Third edition, John Wiley & Sons; 2013.*
- *Powell TA, Schneider F. JavaScript: the complete reference. Paperback edition, Tata McGraw-Hill; 2012.*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, design critiques, usability analysis exercises, interface evaluation tasks, and short tests on UI/UX principles and design methodologies	20%
Continuous Assessment – Lab (CAL)	Internal	Wireframing, prototyping, interface design exercises, usability testing, design tool usage, user research activities, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on user-cantered design, usability principles, interaction design, accessibility, and interface evaluation techniques	20%
End Semester Assessment	External	Written Examination on UI/UX principles, design methodologies, and usability concepts. OR Hybrid Mode Examination comprising written and design/prototyping components. OR Term Project involving user interface design, prototyping, usability evaluation, project demonstration, and viva voce	30%
Total			100%

SEMESTER III

26MAT220	MATHEMATICS FOR COMPUTING 3	L-T-P-C: 2- 1- 3- 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus and basic probability theory needed for subsequent study.

- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field.
- Another goal of the course is to provide connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

After completing this course, students will be able to

CO1: Demonstrate the techniques of optimization needed for AI.

CO2: Analyze physical systems using the formalism of partial differential equation.

CO3: Use the tools and techniques of probability theory needed for data analysis.

CO4: Apply modern computational tools and techniques for solving advanced problems in optimization, differential calculus, and probability theory needed for AI.

CO-PO Mapping

PO/PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2	3	3	-	-	3	2		2	3	2	2	1
CO2	3	3	2	3	3	-	-	3	2		2	3	1	-	-
CO3	3	3	2	3	3	-	-	3	2		2	3	1	-	-
CO4	3	3	2	3	3	-	-	3	2		2	3	2	2	1

Syllabus

Unit 1

Direct methods for convex functions, sparsity inducing penalty functions. Constrained Convex Optimization problems, Krylov subspace, Conjugate gradient method, formulating problems as LP and QP, support vector machines, solving by packages (CVXOPT), Lagrangian multiplier method, KKT conditions. Introduction to alternating direction method of multipliers (ADMM) - the algorithm. Applications in signal processing, pattern recognition and classification.

Unit 2

Introduction to PDEs. Formulation and numerical solution methods (Finite difference and Fourier) for PDEs in Physics and Engineering.

Unit 3

Inequalities of statistics, Multivariate Gaussian and weighted least squares, Markov chains, Markov decision process.

Textbooks / References

Gilbert Strang, "Differential Equations and Linear Algebra Wellesley", Cambridge press, 2018.

Gilbert Strang, Wellesley, "Linear Algebra and learning from data", Cambridge press, 2019.

Stephen Boyd and Lieven Vandenberghe, "Convex Optimization", Cambridge University Press, 2018.

Stephen Boyd and, Lieven Vandenberghe, "Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares", Cambridge University Press, 2018.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, analytical problem-solving exercises, mathematical modelling tasks, and short tests on advanced computing mathematics concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Computational exercises using mathematical software/tools, implementation of mathematical models, numerical computations, data analysis tasks, simulations, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on mathematical foundations, analytical techniques, and computational problem solving	20%
End Semester Assessment	External	Written Examination on mathematical concepts and computing applications. OR Hybrid Mode Examination comprising written and computational/problem-solving components. OR Term Project involving mathematical modelling, computational analysis, project demonstration, and viva voce	30%
Total			**100%**

26AIE201	**FUNDAMENTALS OF AI**
L-T-P-C: 2- 0- 3- 3	

Course Objectives

- To introduce classical AI and rational intelligent agents.
- To introduce techniques for problem solving by search and adversarial games.
- To introduce constraints, logic, and inference techniques
- To introduce planning, acting, and multi-agent systems.
- To introduce knowledge-representation and reasoning.

Course Outcomes

After completing this course, students will be able to

CO1: Analyse different elements of an AI system.

CO2: Apply elementary principles of AI for problem solving and search

CO3: Apply constraints and logic for intelligent systems

CO4: Apply knowledge representation and reasoning for defining intelligent systems,

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	3	2	2	2	2	-	2	1	2	1	-
CO2	2	2	2	2	3	-	-	2	2	-	2	2	2	2	1
CO3	2	2	2	2	3	-	-	2	2	-	2	2	1	1	-

CO4	3	2	2	2	3	-	-	2	2	2	2	2	2	2	1

Syllabus:

Unit 1

History and Foundations of AI, Rational Intelligent Agents, Agents and Environments, Nature of Environments, Structure of Agents.

Unit 2

Problem Solving by Search: Uninformed and Informed Search Strategies, Heuristic Functions; Adversarial Search: Games, Optimal Decisions in Games, Alpha-Beta Pruning

Unit 3

Constraint Satisfaction Problems, Inference in CSPs, Backtracking Search; Knowledge-Based Agents, Propositional and First-Order Logic, Resolution Theorem Proving, Unification Forward and Backward Chaining

Unit 4

Classical Planning: Algorithms for Planning, Planning Graphs, Hierarchical Planning, Planning and Acting in Nondeterministic Domain, Multi-Agent Planning; Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Reasoning with Default Information.

Textbooks/ References:

Russell, Stuart Jonathan, Norvig, Peter, Davis, Ernest. Artificial Intelligence: A Modern Approach. United Kingdom: Pearson, 2010.

Deepak Khemani. A First Course in Artificial Intelligence. McGraw Hill Education (India), 2013.

Denis Rothman. Artificial Intelligence by Example, Packt, 2018.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, problem-solving exercises, case studies, concept-based tests on intelligent agents, search techniques, knowledge representation, reasoning, and AI applications	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of search algorithms, knowledge-based systems, reasoning techniques, AI programming exercises, problem-solving tasks, and mini-projects using AI tools and frameworks	30%
Mid-Term Examination	Internal	Written examination focusing on AI fundamentals, intelligent agents, search strategies, knowledge representation, reasoning, and problem-solving techniques	20%
End Semester Assessment	External	Written Examination on AI concepts, algorithms, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving development of an AI-based solution, project demonstration, and viva voce	30%
Total			**100%**

26AIE202	OPERATING SYSTEMS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course gives an insight to the important problems in operating system design and implementation.
- This course helps the students to understand the operating system responsibilities like sharing resources, files, memory and process scheduling.
- This course covers the major components of most operating systems and the trade-offs between performance and functionality in the design and implementation of an operating system.
- In this course, emphasis will be given to three major OS subsystems: process management, memory management, and file systems; and on operating system support for distributed systems.

Course Outcomes
After completing this course, the students will be able to

CO1: Apply system calls to implement basic OS functionalities.
CO2: Apply the algorithms for resource management and scheduling.
CO3: Apply semaphores and monitors for synchronization problems.
CO4: Implement memory management schemes.

CO-PO Mapping

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

Syllabus

Unit 1
Operating systems, structure, operating systems services, system calls. Process and Processor management: Process concepts, process scheduling and algorithms, threads, multithreading. CPU scheduling and scheduling algorithms

Unit 2
Process synchronization, critical sections, Deadlock: Shared resources, resource allocation and scheduling, resource graph models, deadlock detection, deadlock avoidance, deadlock prevention algorithms, mutual exclusion, semaphores, monitors, wait and signal procedures. Memory management: contiguous memory allocation, virtual memory, paging, page table structure, demand paging, page replacement policies, thrashing, segmentation, case study.

Unit 3
Disk scheduling algorithms and policies, File management: file concept, types and structures, directory structure, Case study on Unix (about process management, Thread management and Kernel) and Mobile OS – iOS and Android – Architecture and SDK Framework, Media Layer, Services Layer, Core OS Layer, File System)

Textbooks/References

Silberschatz and Galvin, "Operating System Concepts", 9th Edition, Wiley India, 2009.
Tannenbaum A S, "Modern Operating Systems", Prentice Hall India, 2003.
W. Stallings, "Operating Systems: Internals and design Principles", Pearson Ed., LPE, 6th Ed., 2009
M.J. Bach, "Design of Unix Operating system", Prentice Hall, 1986

Evaluation Plan

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, problem-solving exercises, case studies, and short tests on process management, CPU scheduling, memory management, file systems, and synchronization concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Shell scripting, process scheduling simulations, synchronization and deadlock exercises, memory management experiments, file system operations, system programming tasks, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on process management, CPU scheduling, synchronization, memory management, and operating system fundamentals	20%
End Semester Assessment	External	Written Examination on operating system concepts and system-level problem solving. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving operating system simulations, system programming applications, project demonstration, and viva voce	30%
Total			**100%**

26AIE203	**DATA STRUCTURES & ALGORITHMS 2**	**L-T-P-C: 2-0- 3- 3**

Course Objectives

- This course helps students to implement and understand space and time optimizing structures and learn their behaviours
- This course helps students to comprehend multidimensionality in memory structures
- This course helps students to understand the geometric organization of data
- This course provides an overview of space-building and immutability in functional data structure
- This course gives an introduction to graphical structures and use them in solving problems

Course Outcomes
After completing this course, the students will be able to

CO1: Design suitable data structures for problem-solving.
CO2: Use appropriate data structures for problem-solving scenarios.

CO3: Apply the interoperability of data structures to solve problems.
CO4: Visualize multidimensional geometry of data structure and concurrency.

CO-PO Mapping

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

Syllabus

Unit 1
Graphs- Representations of graphs, Adjacency and Incidence matrices, Adjacency List, Dynamic Graphs and persistence - Sparse Matrices- Key Value and Structural implementations, Scalability and data driven parallelism, Block and band matrices. Generalized Matrix and Vector interface. Standard implementations in Numpy (Python) and NDArray (Java) - Temporal manipulation and persistence

Unit 2
Functional data structures, ConsList, immutable Set, Immutable Maps, Sorting immutable linear structures (functional sort). Map and Reduce Operations on Sequences

Unit 3
Retroactive structures and operations – Geometric structures- Point location and sweeping, Orthogonal Range searches and fractional cascading in 2D and 3D. -Higher data structures - Tries and inverted Tries- Radix Sort, Higher Hash functions, SHA256, Chaining of Hash Lists (Blockchain) and change detection, Merkel trees- Distributed bitwise representations and Fusion trees - large string structures (Google and DNA problems)

Textbooks/References

Mehlhorn, Kurt, Peter Sanders, and Peter Sanders. Algorithms and data structures: The basic toolbox. Vol. 55. Berlin: Springer, 2008.

Bhim P Upadhyaya, Data Structures and Algorithms with Scala. Springer International Publishing, 2019.

Aho, Alfred V. "Data Structures and Algorithms, Addison-Wesley." Reading, Mass. (1983).

Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. 2009. Introduction to Algorithms, Third Edition (3rd ed.). The MIT Press

Evaluation Plan

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, algorithm design exercises, complexity analysis problems, case studies, and short tests on advanced data structures and algorithmic techniques	20%
Continuous Assessment – Lab (CAL)	Internal	Programming assignments involving trees, graphs, hashing, heaps, advanced searching and sorting algorithms, algorithm implementation, coding challenges, implementation and performance comparison of selected numerical and algorithmic problems using NumPy and JAX, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on advanced data structures, algorithm design paradigms, complexity analysis, and problem-solving techniques	20%

Component	Internal / External	Suggested Assessment Methods	Weightage
End Semester Assessment	External	Written Examination on advanced data structures, algorithms, and complexity analysis. OR Hybrid Mode Examination comprising written and coding/problem-solving components. OR Term Project involving implementation and application of advanced data structures and algorithms, project demonstration, and viva voce	30%
Total			**100%**

26AIE204	INTRODUCTION TO COMPUTER NETWORKS L-T-P-C: 2-0-3- 3

Course Objectives

- This course helps students to understand the fundamental networking concepts and standards.
- This course helps students to understand the function of TCP/IP layers and the protocols involved.
- This course helps students to understand the configuration of different networks and routing using simulator/emulator.
- This course provides an overview of internet of things, its various applications, and their implementation using simulator/emulator/Raspberry-PI.
- This course gives an introduction to the concepts of software defined networks and its applications.

Course Outcomes
After completing this course, the students will be able to

CO1: Analyse the requirements for a given organizational structure to select the most appropriate networking architecture and technologies.
CO2: Analyse the working of protocols in the internet protocol stack for network applications.
CO3: Configure a router using simulator/emulator.
CO4: Implement IoT applications using simulator/emulator/Raspberry Pi.

CO-PO Mapping

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

Syllabus

Unit 1
Basic concepts of computer networks, Internet-The Network Edge, the Network Core, Network Topology, Types of Networks. Circuit switched networks vs packet switched network, Delay, Loss, and Throughput in Packet Switched Networks. OSI layer stack, Introduction to applications in networking, protocols in the context of the Internet protocol stack. Internet standards and organization.

Unit 2
Application Layer – Protocols in Web and Email applications, Peer-to-Peer Applications. Transport Layer – connection-oriented and connectionless service, protocols, and socket programming. Network Layer – Internet Protocol, Host Addressing for subnets, Routing and Forwarding principles, Router configuration. Configuration

and implementation of local area networks and intranets in simulator or emulator. Data link and Physical layer concepts for wired and wireless network

Unit 3

Internet of Things – Components like controllers, services, Fog and cloud computing, Applications. Configuration and implementation of IoT applications in simulator or emulator or real time hardware devices like Raspberry Pi. Introduction to Software Define Networks, Mininet and OpenFlow.

Textbooks/References

Kurose, James F. Computer networking: A top-down approach featuring the internet, 3/E. Pearson Education India, 2005.
Behrouz A Forouzan, and G. Hill. Data Communications and Networking, by Behrouz, 2006.
Rick Golden, Raspberry Pi Networking Cookbook – Second Edition, 2017

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, protocol analysis exercises, network design problems, case studies, and short tests on networking concepts, architectures, and communication protocols	20%
Continuous Assessment – Lab (CAL)	Internal	Network configuration exercises, packet analysis, socket programming, protocol implementation, network simulation experiments, troubleshooting tasks, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on network architectures, protocols, routing, switching, transport layer services, and network performance analysis	20%
End Semester Assessment	External	Written Examination on computer networking concepts, protocols, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving network design, protocol analysis, simulation or implementation of networking solutions, project demonstration, and viva voce	30%
Total			**100%**

26AIE205	**INTRODUCTION TO PYTHON**
L-T-P-C: 1- 0- 3- 2	

Course Objectives

- To acquire programming skills in core Python.
- To understand how to write functions and pass arguments in Python.
- To develop fundamental understanding of how to build and package Python modules for reusability.
- To develop program in python to read and write files.

Course Outcomes

After completing this course, students will be able to

CO1: Solve problems using Python conditionals and loops.

CO2: Apply Python functions and function calls to solve problems.

CO3: Apply Python data structures to represent complex data.

CO4: Develop Python Packages for reusability.

CO-PO Mapping

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

Syllabus

Unit 1 : Python Fundamentals -Introduction to Python, Python Programming Environment, Variables and Data Types, Input and Output, Operators, Built-in Functions, Control Statements, Lists, Tuples, Ranges, Dictionaries, Sets.

Unit 2: Functions, Object-Oriented Programming and Advanced Python - Functions and Function Arguments, Modules and Packages, Object-Oriented Programming in Python, Exception Handling, Regular Expressions, File Handling, Multithreaded Programming, Thread Essentials.

Unit 3: Database Programming and Web Development - Using Databases in Python, Interface of Python with SQL Databases, Connecting Python with SQL, Performing INSERT, UPDATE, DELETE operations using Cursor, **Introduction to Web Development using Django**, Web Scraping using Python.

Unit 4: Python for Data Science - Introduction to Data Science using Python, NumPy, Pandas, DataFrame Operations on **datasets**, Data Visualization using Matplotlib and Seaborn, Overview of Python Libraries for Data Science.

Textbooks

Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.

References

Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.

Eric Matthes, "Python Crash Course, A Hands – on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.

https://www.python.org/,numpy.org

Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

David Beazley, Brian Jones., "Python Cookbook", Third Edition, Orelly Publication, 2013, ISBN 978-1449340377

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, Python programming exercises, problem-solving tasks, database programming concepts, web development case studies, and short tests on Python fundamentals	20%
Continuous Assessment – Lab (CAL)	Internal	Python programming assignments, implementation of functions and modules, object-oriented programming exercises, file handling, SQL database connectivity, Django web application development, data analysis using NumPy and Pandas, visualization using Matplotlib and Seaborn, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on Python programming fundamentals, functions, object-oriented programming, exception handling, file handling, database programming, and problem-solving	20%
End Semester Assessment	External	Written Examination on Python programming concepts, object-oriented programming, database programming, web development, and data science fundamentals. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Project-Based Examination involving the development of Python applications for database, web, or data science applications, followed by project demonstration and viva voce	30%
Total			**100%**

26BIO201	**INTELLIGENCE OF BIOLOGICAL SYSTEMS 1**	**L-T-P-C: 2- 0- 0- 2**

Course Objectives

- Understanding the basic concepts about biomolecules, cell division, central dogma of the cell, mutations and evolutionary patterns

- Knowledge about biological databases, bacterial genomes and its hidden message
- Understanding the mechanism of DNA methylation in circadian rhythm
- Application of statistical methods in sequence analysis and motif finding

Course Outcomes

After completing this course, students will be able to:

CO1: Apply the cellular structure and biophysical process for creating engineered models

CO2: Incorporate the application of molecular mechanisms to build advanced computational pipelines

CO3: Apply statistical estimation and test of significance techniques for Motifs and to learn python for using biological databases**.**

CO4: Apply chaos model to represent DNA Sequences

CO-PO Mapping

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

Syllabus:

Unit 1

Classification of Biomolecules Cell division: Mitosis and Meiosis; Central Dogma of the cell: Replication, Transcription, Translation, Protein Synthesis; Genetic Variants of Evolutionary Patterns: Mutations and Polymorphisms.

Unit 2

Introduction to biological databases-Hidden messages in the genome – Finding Replication Origins – Frequent words in Vibrio cholera – Encodings in DNA to maintain circadian rhythm Basics of Probability-Probability Distributions.

Unit 3

Statistics-Statistical Estimation and Inference of Sequence Analysis in Matlab -and Python – Simple values, names, expression, module, collection, sequences, mapping and expression feature. Hunting for Regulatory Motifs - Scoring Motifs - Motif Search – Greedy & Randomized Motif Search – Gibbs Sampling- Chaos representation - DNA sequences comparison of related viruses

Textbooks/References

Gabi Nindl Waite, Lee R Waite, Applied Cell and Molecular Biology for Engineers, McGraw Hill Publishers, 2007.

Phillip Compeau & Pavel Pevzner, Bioinformatics algorithm, An active learning Approach Vol.1. and Vol. 2 ,2015.

George M. Malascinski, Freifelder's Essentials of Molecular Biology, 4th Edition, Jones and Bartlett Student Edition, 2015.

DM.Vasudevan, Sreekumari S, Kannan Vaidyanathan, Textbook of Biochemistry for Medical Students (As Per Revised MCI Curriculum),9th Edition, Jaypee Publishers, 2019.

David Nelson, Michael M Cox, LeningerPrinciples of Biochemistry, 8th Edition, Macmillan, 2021.

Evaluation pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, concept-based exercises, case studies on biomolecules, molecular biology, biological databases, sequence analysis, and bioinformatics applications	20%
Mid-Term Examination	Internal	Written examination focusing on biomolecules, cell biology, central dogma, biological databases, probability, statistical methods, and sequence analysis	30%
Continuous Assessment – Case Study	Internal	Analysis of biological datasets, genome sequence interpretation, motif discovery, DNA sequence comparison, or bioinformatics-based problem-solving through presentations and discussions	20%
End Semester Assessment	External	Written Examination on molecular biology, bioinformatics, biological databases, sequence analysis, and computational biology concepts. OR Hybrid Mode Examination comprising written and case-analysis/problem-solving components. OR Project-Based Examination involving biological data analysis, motif discovery, sequence analysis, computational modelling, project demonstration, and viva voce	30%
Total			100%

Sem: 3 26CCS201 Career Competency Skills I L-T-P-C: 1-0-2- P/F

CIR Course – BTech – Paper I

Pre-requisite:
SOFT SKILLS - Foundational understanding of professional values, ethical behavior & personal effectiveness and a receptive mind to gain exposure to cultured behavior.
VERBAL - Basic English language skills
APTITUDE – Basic knowledge in arithmetic and algebra.

Course Objectives
SOFT SKILLS

- Develop professional attitudes and behaviors required for academic and career success.

- Strengthen emotional intelligence and perception management for effective interpersonal relations.
- Enable students to set goals and manage time effectively for continuous personal and professional growth.

APTITUDE - Assist them in improving their problem solving and reasoning skills
VERBAL - Facilitate the enhancement of their communication skills

Course Outcomes

CO1 - Soft Skills: To develop greater morale and positive attitude to face, analyze and manage emotions in personal and professional life situations.
CO2 - Soft Skills: To be able to manage time effectively and set personal goals and achieve them.
CO3 - Aptitude: To manage time while applying suitable methods to solve questions on arithmetic and algebra.
CO4 - Aptitude: To investigate, understand and use appropriate techniques to solve questions in data analysis.
CO5 - Verbal: To infer the meaning of words and use them in the right context. To have a better understanding of the basics of English grammar and apply them effectively.
CO6 - Verbal: To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1								3	3		3
CO2							2	3	3		3
CO3		3		2							
CO4		3		2							
CO5									3		3
CO6								3	3		3

Syllabus

Soft Skills

Introduction to Life Skills: Importance of Soft Skills, Soft Skills vs Hard Skills, Role of Soft Skills in Life, School to College Transition.
Communication Skills: Listening skills, Barriers of communication, Communication styles, Role of non-verbal communication, Effective cross-cultural communication.
Perceptions: Self Perception – Self Concept & Identity formation, Social Perception – Stereotypes & Assumptions, Personal branding, Effective Study habits and Academic Integrity, Aligning intent vs impact in Professional life
Emotional Intelligence for Career Success: Emotional triggers, Process of Emotional Intelligence, Team Situational judgement & emotional choices, Emotional Intelligence in decision making, Change Management, Leadership foundation in Emotional Intelligence

Personal Productivity: Importance of Goal Setting, SMART Goals, SWOT analysis, Healthy habits, Time Management strategies

Aptitude

Numbers: Types, Power Cycles, Divisibility, Prime, Factors, Multiples, HCF, LCM, Surds, Indices, Square roots, Cube Roots and Simplification.
Percentage: Basics, Profit, Loss & Discount, and Simple & Compound Interest.
Ratio, Proportion & Variation: Basics, Alligations, Mixtures, and Partnership.
Averages: Basics, and Weighted Average.
Data Interpretation: Tables, Bar Diagrams, Venn Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, Network Diagrams and other forms of data representation.
Puzzles: Optimization Puzzles, Fermi Problems, Game-Based Puzzles, Sudoku, Anagrams, Futoshiki, and Rebus Puzzles.
Miscellaneous: Speed Mathematics and Shortcuts.

Verbal

Vocabulary: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions.
Grammar (**Basic**): Help students learn the usage of structural words and facilitate students to identify errors and correct them.
Reasoning: Stress the importance of understanding the relationship between words through analogy questions.
English for Competitive Exams – Strategy Orientation:
Develop exam-focused language strategies through guided practice in listening, speaking, reading, and writing skills to improve performance in competitive examinations.
Speaking Skills: Make students conscious of the relevance of effective communication in today's world through various individual speaking activities.

References:

SOFT SKILLS:

1. **Guides and Workbooks:**

- Student's Guide for Career Planning, CIR (UG)
- Soft Skills Handbook for UG

2. **Communication and listening skills:**

- Andrew J DuRbin, Applied Psychology: Individual and organizational effectiveness. Pearson-Merril Prentice Hall, 2004
- Michael G Aamodt, An Applied Approach, 6th edition, 2010, Wadsworth Cengage Learning

3. **Assertiveness skills:**

- People Style at Work. And Beyond: Making Bad Relationships Good and Good ...By Robert Bolton, Dorothy Grover Bolton, 2009, Ridge Associates Inc
- Interpersonal skills at work, John Hayes, Routledge, 2003

- Nord, W. R., Brief, A. P., Atieh, J. M., & Doherty, E. M. (1990). Studying meanings of work: The case of work values. In A. Brief & W. Nord (Eds.), Meanings of occupational work: A collection of essays (pp. 21- 64). Lexington, MA: Lexington Books.

4. **Self-perception and self-confidence**:

- Mark J Martinko, Attribution theory: an organizational perspective, St. Lucie, 1995
- Attribution Theory: Social and Functional Extensions [Paperback] Miles Hewstone, Blackwell Publishers *An attributional theory of motivation and emotion, Bernard Weiner, Springer-Verlag, 1987*

5. **Soft Skills:**

- Barun K. Mitra – Personality Development and Soft Skills (Oxford Press)
- HBR's 10 Must Reads on Managing Yourself (with bonus article "How Will You Measure Your Life?" by Clayton M. Christensen) Kindle Edition
- Emotional Intelligence: Why It Can Matter More Than IQ by Daniel Goleman
- Mindset: The New Psychology of Success by Carol S. Dweck (Author)
- Stephen Covey, "The habits of highly effective people", Free press Revised edition, 2004
- The 25 Best Time Management Tools & Techniques: How to Get More Done Without Driving Yourself Crazy, Kenneth H Blanchard, 2005, Peak Performance Press, 1st edition
- The One Minute Manager Kenneth H. Blanchard and Spencer Johnson, Publishers: William Morrow, 1984

6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
9. Cracking the New GRE 2012
10. Kaplan's – GRE Comprehensive Programme
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50
Pass / Fail		

*CA - Can be **presentations, speaking activities and tests.**

SEMESTER IV

26MAT230	MATHEMATICS FOR COMPUTING 4	L-T-P-C: 2- 1- 3- 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus and basic probability theory needed for subsequent study.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field.
- Another goal of the course is to provide connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

After completing this course student will be able to,

CO1: Demonstrate the techniques of linear algebra needed for AI.

CO2: Apply the tools and techniques of optimization to analyze physical systems.

CO3: Apply the principles of statistics to perform data analysis.

CO4: Apply modern computational tools and techniques for solving advanced problems in linear algebra, optimization, and statistics needed for AI.

CO-PO Mapping

PO/ PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PS O 1	PS O 2	PS O 3	PSO 4
CO 1	3	3	2	3	3	---	---	3	2	---	3	3	2	2	1
CO 2	3	3	2	3	3	---	---	3	2	---	3	3	1	-	-
CO 3	3	3	2	3	3	---	---	3	2	---	3	3	1	-	-
CO 4	3	3	2	3	3	---	---	3	2	---	3	3	1	2	1

Syllabus

Unit 1

Linear Algebra-4

Special Matrices: Fourier Transform, discrete and Continuous, Shift matrices and Circulant matrices, The Kronecker product, Toeplitz matrices and shift invariant filters, Graphs and Laplacians and Kirchhoff's laws, Clustering by spectral methods and K-means, Completing rank one matrices, The Orthogonal Procrustes Problem, Distance matrices.

Unit 2

Calculus-4

Optimization methods for sparsity: Split algorithm for L2+ L1, Split algorithm for L1 optimization, Augmented Lagrangian, ADMM, ADMM for LP and QP, Matrix splitting and Proximal algorithms, Compressed sensing, and Matrix Completion.

Optimization methods for Neural Networks: Gradient Descent, Stochastic gradient descent, and ADAM (adaptive methods), Loss function and learning function.

Unit 3

Probability and statistics - 4

Basics of statistical estimation theory and testing of hypothesis.

Textbooks / References

Gilbert Strang, Linear Algebra and learning from data, Wellesley, Cambridge press, 2019.

Bradley Efron, Trevor Hastie, Computer Age Statistical Inference, Algorithms, Evidence and Data Science.

Stephen Boyd, Lieven Vandenberghe, Convex Optimization, Cambridge University Press, 2018.

Stephen Boyd, Lieven Vandenberghe, Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares, Cambridge University Press, 2018.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, analytical problem-solving exercises, mathematical modelling tasks, and short tests on advanced mathematical concepts for computing	20%
Continuous Assessment – Lab (CAL)	Internal	Computational exercises using mathematical software/tools, numerical computations, optimization tasks, simulations, data analysis exercises, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on mathematical foundations, analytical techniques, and computational problem solving	20%
End Semester Assessment	External	Written Examination on mathematical concepts and computing applications. OR Hybrid Mode Examination comprising written and computational/problem-solving components. OR Term Project involving mathematical modelling, computational analysis, project demonstration, and viva voce	30%
Total			100%

26AIE211	**INTRODUCTION TO COMMUNICATION & IoT**	**L-T-P-C: 2- 0- 3- 3**

Course Objective

1. The course will expose the students to basics of communication systems
2. This course will realize communication experiments using various software defined radio systems.
3. The course provides an understanding on the basics of Internet of Things, architecture and its protocols.

Course Outcomes

After completing this course student will be able to,

CO1: Familiarise the basic concepts of communication systems
CO2: Realise various communication systems using software defined radio systems.
CO3: Familiarise basics of Internet of Things and its architecture
CO4: Interface I/O devices and communication modules.

CO-PO Mapping

PO/ PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	2	2	2	3	-	-	3	2	2	3	2	-	1	-
CO2	3	2	3	3	3	-	-	3	2	2	3	2	1	2	1
CO3	3	2	2	2	3	-	-	3	2	2	3	2	1	-	-
CO4	3	2	3	3	3	-	-	3	2	3	3	1	1	-	-

Syllabus

Unit 1

Introduction to signals - types and characteristics; Introduction to communication systems: Wired and Wireless communication systems – Modulations: AM, FM, PM - Digital modulation and de-modulation techniques: ASK, FSK, BPSK and QAM – OFDM - MATLAB and GNURADIO for Communication system experiments.

Unit 2

Introduction to IoT - Architectural overview- Design principles- IoT Applications- M2M and IoT Technology Fundamentals.

Unit 3

Elements of IoT: Hardware components, Communication Technologies, Sensing, Actuation, I/O interfaces Software Components- Programming APIs for communication protocols-MQTT, Zigbee, Bluetooth, CoAP, UDP, TCP.

Textbooks/ Reference Books:

Boylestad, Robert L., and Louis Nashelsky. Electronic devices and circuit theory. Prentice Hall, 2012.
Qasim Chaudhari, Wireless Communications from the Ground Up: Fundamentals of Digital Communication Systems, Createspace Independent Publishers, 2016
Vijay Madisetti, Arshdeep Bahga, Internet of Things, "A hands on Approach", University Press
Herrero, Rolando. Fundamentals of IoT Communication Technologies. Springer International Publishing, 2022.
Dr SRN Reddy, Rachit Thukral and Manasi Mishra," Introduction to Internet of Things": A practical Approach" ETI Labs
The Internet of Things: Applications and Protocols, Wiley publications. Author(s): Oliver Hersent, David Boswarthick, Omar Elloumi

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, communication system analysis exercises, IoT case studies, protocol-related problem-solving tasks, and short tests on communication and IoT concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Sensor interfacing, microcontroller programming, communication protocol experiments, IoT application development, cloud connectivity exercises, and mini projects	30%

Component	Internal / External	Suggested Assessment Methods	Weightage
Mid-Term Examination	Internal	Written examination focusing on communication fundamentals, signal transmission, networking concepts, IoT architectures, sensors, and communication protocols	20%
End Semester Assessment	External	Written Examination on communication systems and IoT concepts. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving IoT application development, communication system design, project demonstration, and viva voce	30%
Total			**100%**

26AIE212	DESIGN AND ANALYSIS OF ALGORITHMS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course helps students to impart various design techniques for formulation of algorithm.
- This course helps students to understand basic categories of algorithms.
- This course helps students to understand and apply analysis of space and time complexity of algorithms and understand concept of growth rate.
- This course helps students to deliver standard notations and representations of algorithmic complexity and known complexities.
- This course helps students to comprehend basic complexity classes.
- This course helps students to acquaint with will know tractable and intractable problems and map solutions to it.

Course Outcomes

After completing this course, the students will be able to

CO1:Analyze algorithms and their computational complexity for solving computational problems.

CO2: Apply appropriate algorithmic design techniques to solve computational problems.

CO3: Implement and evaluate algorithmic solutions for arrays, strings, trees and graphs based problems

CO4: Analyze the nature of tractable and intractable problems

CO-PO Mapping

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

Syllabus

Unit 1

Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving – Important Problem Types – Fundamentals of the Analysis of Algorithmic Efficiency –Asymptotic Notations and growth rate- Empirical analysis – Recursive and non-Recursive Templates. Brute Force: Exhaustive Search and String Matching, Divide and Conquer Methodology: Binary Search – Merge sort – Quick sort – Heap Sort – Multiplication of Large Integers.

Unit 2
Dynamic programming: Principle of optimality – Coin changing problem, Computing a Binomial Coefficient – Floyd 's algorithm – Multistage graph – Optimal Binary Search Trees – Knapsack Problem and Memory functions. Greedy Technique: Container loading problem – Huffman Trees. Iterative methods: The Simplex Method – The Maximum-Flow Problem – Maximum Matching in Bipartite Graphs, Stable marriage Problem, Measuring Limitations: Lower – Bound Arguments – P, NP, NP- Complete and NP Hard Problems.

Unit 3
Backtracking – n-Queen problem – Hamiltonian Circuit Problem – Subset Sum Problem, Branch and Bound – LIFO Search and FIFO search – Assignment problem – Knapsack Problem – Travelling Salesman Problem, Approximation Algorithms for NP-Hard Problems – Travelling Salesman problem – Knapsack problem revisited.

Textbooks/References
Jeffrey McConnell, Analysis of algorithms. Jones & Bartlett Publishers, 2nd Revised edition, 2007.
Anany Levitin, Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012.
Harsh Bhasin, Algorithms Design and Analysis, Oxford university press, 2016

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, algorithm design exercises, complexity analysis problems, recurrence relation solving, case studies, and short tests on algorithmic paradigms	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of searching, sorting, divide-and-conquer, greedy, dynamic programming, and graph algorithms; coding challenges, performance analysis exercises, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on algorithm design techniques, asymptotic analysis, recurrence relations, and problem-solving strategies	20%
End Semester Assessment	External	Written Examination on algorithm design, analysis, and optimization techniques. OR Hybrid Mode Examination comprising written and coding/problem-solving components. OR Term Project involving algorithm development, performance evaluation, project demonstration, and viva voce	30%
Total			**100%**

26AIE213	**MACHINE LEARNING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course dives into the basics of Machine learning.
- This course will enable the students to work with various types of data and its pre-processing techniques.
- The students will learn about Supervised and Unsupervised Learning.

- The students will enrich themselves with hands-on experience to implement various machine learning algorithms.

Course Outcomes

After completing this course, students will be able to

CO1: Apply pre-processing techniques to prepare the data for machine learning applications
CO2: Implement supervised machine learning algorithms for different datasets
CO3: Implement unsupervised machine learning algorithms for different datasets
CO4: Analyze the error to improve the performance of the machine learning models

CO-PO Mapping

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

Syllabus

Unit 1
Introduction to Machine Learning – Data and Features – Machine Learning Pipeline: Data Preprocessing: Standardization, Normalization, Missing data problem, Data imbalance problem – Data visualization - Setting up training, development and test sets – Cross validation – Problem of Overfitting, Bias vs Variance - Evaluation measures – Different types of machine learning: Supervised learning, Unsupervised learning, Generative Learning and adversarial learning.

Unit 2
Supervised learning - Regression: Linear regression, logistic regression – Classification: K-Nearest Neighbour, Naïve Bayes, Decision Tree, Random Forest, Support Vector Machine, Perceptron, Error analysis.

Unit 3
Unsupervised learning – Clustering: K-means, Hierarchical, Spectral, subspace clustering, Gaussian Mixture Model, Parameter Estimation: MLE and Bayesian Estimate, Expectation Maximization, Dimensionality Reduction Techniques, Principal component analysis, Linear Discriminant Analysis.

Unit 4
Introduction to Neural Networks, Reinforcement learning and generative learning.

Textbooks
Andrew Ng, Machine learning yearning, URL: http://www. mlyearning. org/(96) 139 (2017).
Kevin P. Murphey. Machine Learning, a probabilistic perspective. The MIT Press Cambridge, Massachusetts, 2012.
Christopher M Bishop. Pattern Recognition and Machine Learning. Springer 2010

References
Richard O. Duda, Peter E. Hart, David G. Stork. Pattern Classification. Wiley, Second Edition;2007
Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, machine learning problem-solving exercises, case studies, model evaluation tasks, analytical exercises on supervised and unsupervised learning, and short tests on machine learning concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Data preprocessing, feature engineering, implementation of regression, classification and clustering algorithms, model training and evaluation, neural network implementation, reinforcement learning experiments, and mini-projects using machine learning frameworks	30%
Mid-Term Examination	Internal	Written examination focusing on machine learning fundamentals, data preprocessing, supervised and unsupervised learning algorithms, model evaluation, neural networks, and problem-solving	20%
End Semester Assessment	External	Written Examination on machine learning concepts, algorithms, model evaluation, neural networks, and reinforcement learning. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Project-Based Examination involving the design, implementation, and evaluation of machine learning models for real-world datasets, followed by project demonstration and viva voce	30%
Total			100%

26AIE214	INTRODUCTION TO AI ROBOTICS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- To provide an introductory understanding of robots and its components.
- To introduce different paradigms used in AI robotics.
- To introduce the mathematical concepts needed for understanding basic robotic system operation.
- To introduce kinematics and its application in robotic manipulators.

Course Outcomes

After completing this course student will be able to,

CO1: Analyse a robotic system using different paradigms of AI robotics.
CO2: Apply mathematical concepts to represent the position and orientation of robotic systems.
CO3: Perform the forward and inverse kinematics of canonical robotic systems.
CO4: Simulate robotic systems using state-of-the-art computational platforms.

CO-PO Mapping

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	1	3	2	1	2	2	3	3	3	3	3	1	1	-
CO 2	3	3	2	2	3	-	-	3	3	-	3	3	2	1	-
CO 3	3	3	2	2	3	-	-	3	3	-	3	2	2	2	1

CO 4	3	3	3	3	3	-	-	3	3	3	3	-	2	2	2

Syllabus

Unit 1

Introduction to robots – Brief History – Types of robots – Teleoperation.

Unit 2

Attributes of the hierarchal paradigm - Attributes of the reactive paradigm – Biological foundations of the reactive paradigm – Common sensing techniques for reactive robots – Attributes of hybrid paradigm.

Unit 3

Mathematical representation of robots – Position and orientation of rigid bodies – Rotation and Orientation – Quaternions and other rotation representations - Transformation Matrix

Unit 4

D-H parameters – Forward and inverse kinematics of robot manipulators.

Textbook /Reference Books

'Robotics, Vision & Control', P. Corke, 2nd edition, Springer, 2011
'Robot Modelling and Control', M.W. Spong, S. Hutchinson and M. Vidyasagar, Wiley, 2006
'Robotics: Fundamental Concepts & Analysis', A. Ghosal, Oxford University Press, Ninth Edition, 2006
'Introduction to Robotics', T. Bajd, M. Mihelj and M. Munih, Springer Briefs in Applied Sciences and Technology, 2013
'Introduction to AI Robotics', Robin Murphy, MIT Press, 2000

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, problem-solving exercises, case studies on robotic systems, AI-enabled robotics applications, and short tests on robotics fundamentals	20%
Continuous Assessment – Lab (CAL)	Internal	Robot programming exercises, sensor interfacing, actuator control, simulation-based experiments, autonomous navigation tasks, AI-based robotics applications, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on robotics fundamentals, kinematics, sensors, actuators, perception, decision making, and AI techniques in robotics	20%
End Semester Assessment	External	Written Examination on AI robotics concepts and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving robotic system design, simulation or implementation of AI-enabled robotic applications, project demonstration, and viva voce	30%
Total			100%

26BIO211	INTELLIGENCE OF BIOLOGICAL SYSTEMS 2	L-T-P-C: 2-0-3-3

Course Objectives

- Application of statistics to interpret biological sequence analysis
- Application of programming to compare biological sequences
- Evaluation of algorithms in antibiotic sequencing.
- Evaluation of statistical models in Bioinformatics

Course Outcomes

After completing this course, students will be able to:

CO1: Apply Dynamic Programming in Sequence Alignment.

CO2: Apply Brute Force Method in Sequence Analysis

CO3: Apply Graph Theory in Genome Assembly

CO4: Apply Deep Learning in Bioinformatics

CO-PO Mapping

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

Syllabus:

Unit 1

Antibiotics Sequencing – Shattering into pieces – Brute force algorithm for cyclopeptide sequencing – Comparison of biological sequences – Cracking the Non-Ribosomal Code – Introduction to Sequence Alignment– Introduction to Dynamic Programming, building a Manhattan-like graph – Mass spectrometry – From 20 to more than 100 Amino Acids

Unit 2

Introduction – Assembling Genomes using Graph Algorithms – String reconstruction problem – String reconstruction as a walk in the overlap graph – Glueing Nodes – de Bruijn graphs – the seven bridges of Konigsberg Euler's theorem – Eulerian Cycle – Assembling genomes from read-pairs – Introduction to deep learning in bioinformatics.

Textbooks/References

Jin Xiong, Essential Bioinformatics, Cambridge University Press, 2006.

Gerald Karp, Chapter 15 – *Cell* Signalling *and Signal Transduction: Communication Between Cells, In Cell and Molecular Biology: Concepts and Experiments, 7e, Wiley, 2013.*

Phillip Compeau & Pavel Pevzner, Bioinformatics Algorithm: *An* Active Learning Approach, Vol. 1 *and Vol. 2, 2015.*

Karthik Raman, An *Introduction to Computational Systems Biology (Systems Level* Modelling *of Cellular Networks), CRC Press, 2021.*

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, analytical exercises on sequence alignment, genome assembly, graph algorithms, bioinformatics techniques, and deep learning applications in biology	20%
Continuous Assessment – Lab (CAL)	Internal	Sequence alignment experiments, genome assembly using graph algorithms, biological data analysis, implementation of bioinformatics algorithms, deep learning applications, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on sequence analysis, dynamic programming, graph algorithms, genome assembly, and computational bioinformatics concepts	20%
End Semester Assessment	External	Written Examination on bioinformatics, sequence analysis, genome assembly, graph algorithms, and deep learning applications in biology. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Project-Based Examination involving biological sequence analysis, genome assembly, bioinformatics pipeline development, deep learning-based biological data analysis, project demonstration, and viva voce	30%
Total			100%

23ENV300	ENVIRONMENTAL SCIENCE	P/F

Course Objectives

- To study the nature and facts about environment
- To appreciate the importance of environment by assessing its impact on the human world
- To study the integrated themes and biodiversity, pollution control and waste management

Course Outcomes

CO1: Ability to understand aspects of nature and environment
CO2: Ability to analyse impact of environment on human world
CO3: Ability to comprehend pollution control and waste management

CO – PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	3	2	3	-	-	-	-	-	-	

CO2	-	-	-	-	-	3	2	3	-	-	-	-	-	-	
CO3	-	-	-	-	-	3	2	3	-	-	-	-	-	-	

Syllabus
Unit 1

Overview of the global environment crisis – Biogeochemical cycles – Climate change and related international conventions and treaties and regulations – Ozone hole and related international conventions and treaties and regulations – Overpopulation – energy crisis – Water crisis – ground water hydrogeology – surface water resource development.

Unit 2
Ecology, biodiversity loss and related international conventions – treaties and regulations – Deforestation and land degradation – food crisis – water pollution and related International and local conventions – treaties and regulations – Sewage domestic and industrial and effluent treatment – air pollution and related international and local conventions – treaties and regulations – Other pollution (land, thermal, noise).

Unit 3
Solid waste management (municipal, medical, e-waste, nuclear, household hazardous wastes) – environmental management – environmental accounting – green business – eco-labelling – environmental impact assessment – Constitutional – legal and regulatory provisions – sustainable development.

Textbook(s)
R. Rajagopalan,"Environmental Studies – From Crisis to Cure", Oxford University Press, 2005, ISBN 0-19-567393-X.

Reference(s)
G.T.Miller Jr., "Environmental Science", 11th Edition, Cenage Learning Pvt. Ltd., 2008.
Benny Joseph, "Environmental Studies", Tata McGraw-Hill Publishing company Limited, 2008.

Evaluation Pattern

Assessment	Internal	External
Online Test	-	100
		P/F

Sem: 4	**26CCS211**	**Career Competency Skills II**	**L-T-P-C: 1-0-2-2**

CIR Course – BTech – Paper II

Pre-requisite:
SOFT SKILLS - Basic competence in professionalism, emotional intelligence, self-awareness and goal setting with the passion for betterment in their professional life.
VERBAL - Basic English language skills
APTITUDE – Basic knowledge in arithmetic and algebra.

Course Objectives
SOFT SKILLS
- To develop effective interpersonal skills for professional and collaborative environments.
- To enhance presentation skills for clear, confident, and structured communication.

- To equip students with conflict management strategies for constructive resolution in teams and workplaces.

APTITUDE - To assist students to improve their problem-solving skills

VERBAL - Facilitate them in improving the effectiveness of their communication

Course Outcomes

CO1 - Soft Skills: To improve interpersonal skills, resolve conflicts and work effectively in teams.

CO2 – Soft Skills: To develop self-confidence in making effective presentations in front of an audience.

CO3 - Aptitude: To analyze, understand and solve questions in arithmetic and algebra by employing the most suitable methods.

CO4 - Aptitude: To investigate and apply suitable techniques to solve questions in logical reasoning.

CO5 - Verbal: To learn to use more appropriate words in the given context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.

CO6 - Verbal: To be able to read texts critically and arrive at/ predict logical conclusions. To learn to organize speech and incorporate feedback in order to convey ideas with better clarity.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							2	3	3		3
CO2								3	3		3
CO3		3		2							
CO4		3		2							
CO5									3		3
CO6								3	3		3

Syllabus

Soft Skills

Interpersonal Skills: Transactional Analysis, Assertiveness & confidence building, Networking, Influencing & persuasion, Professional presence & personal impact

Presentation Skills: Effective technical presentations, Preparation & delivery Techniques, Slide Preparation, Ethical use of AI tools in preparing slides, Time Management, Do's & Don'ts, Handling Feedback & Questions, Presentation by student. Resume Building – Level 1.

Problems Solving Skills: Foundation of Problem Solving, Critical thinking in Engineering problems, Problem Solving Process, Industry case-studies & real-world problems

Conflict Management: Intrapersonal vs Interpersonal Conflict, Conflict Management Styles, Steps in Conflict Resolution, Handling Workplace Conflicts, Learning from Conflict & Personal Growth

Teamwork: Group Behavior, Stages of team development, Building Trust & Rapport, Collaboration in diverse teams, Leadership Dynamics

Aptitude

Equations: Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages.
Logarithms, Inequalities and Modulus: Basics
Heights & Distance: Basics
Time and Work: Basics, Pipes & Cistern, and Work Equivalence.
Time, Speed and Distance: Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular Tracks.
Logical Reasoning: Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives.
Puzzles: Optimization Puzzles, Fermi Problems, Game-Based Puzzles, Sudoku, Anagrams, Futoshiki and Rebus Puzzles.
Miscellaneous: Speed Mathematics and Shortcuts.

Verbal

Vocabulary: Create an awareness about the frequently misused words, commonly confused words and wrong form of words in English. Usage of more appropriate words in different contexts is emphasized.
Grammar (**Basic-intermediate**): Help students master usage of grammatical forms and enable students to identify errors and correct them.
Reasoning: Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication. Aid students learn to use their vocabulary and reasoning to complete the given sentences with the right words.
Speaking Skills: Make students aware of the importance of impactful communication through individual speaking activities in class.
Writing Skills: Practise past placement-test questions on professional email writing

References:

Soft Skills:

1. Student's Guide for Career Planning, CIR (UG)
2. Soft Skills Handbook for UG
3. Interpersonal skills at work, John Hayes, Routledge, 2003
4. Conflict Communication: A New Paradigm in Conscious Communication – by Rory Miller
5. Teamwork 101: What Every Leader Needs to Know – by John C. Maxwell
6. Teamwork is an Individual Skill: Getting Your Work Done While Sharing Responsibility – by Christopher M. Avery, Meri Aaron Walker and Erin O'Toole
7. Fixed: How to Perfect the Fine Art of Problem Solving by Amy E Herman
8. Cracked it! How to solve big problems and sell solutions like top strategy consultants by Bernard Garrette, Corey Phelps and Olivier Sibony
9. Upstream: The Quest to Solve Problems Before They Happen by Dan Heath
10. Problem Solving 101: A Simple Book for Smart People by Ken Watanabe

11. 101 Creative Problem-Solving Techniques: The Handbook of New Ideas for Business /James M. Higgins.
12. What's Your Problem? To Solve Your Toughest Problems, Change the Problems You Solve by Thomas Wedell-Wedellsborg
13. Bulletproof Problem Solving: The One Skill That Changes Everything by Charles Conn and Robert McLean
14. Getting to Yes: Negotiating Agreement Without Giving in by Roger Fisher, William L. Ury and Bruce Patton
15. Conflict Resolution Playbook: Practical Communication Skills for Preventing, Managing and Resolving Conflict by Jeremy Pollack
16. HBR Guide to Dealing with Conflict by Amy Gallo
17. Barun K. Mitra – Personality Development and Soft Skills (Oxford Press)
18. "The Power of Habit: Why We Do What Do in Life and Business" by Charles Duhigg
19. Simply Said: Communicating Better at Work and Beyond by Jay Sullivan
20. Words That Work: It's Not What You Say, It's What People Hear by Dr. Frank Luntz
21. The Fine Art of Small Talk: How to Start a Conversation, Keep It Going, Build Networking Skills — and Leave a Positive Impression! By Debra Fine
22. Communication Skills Training: A Practical Guide to Improving Your Social Intelligence, Presentation, Persuasion and Public Speaking by Ian Tuhovsky
23. Just Listen: Discover the Secret to Getting Through to Absolutely Anyone by Mark Goulston by Ian Tuhovsky
24. The Art of Communicating by Thich Nhat Hanh
25. The Keys to Being Brilliantly Confident and More Assertive – Richard Banks
26. The Art of Everyday Assertiveness: Speak Up. Say No. Set Boundaries. Take Back Control. – Patrick King
27. Assertiveness: How to Stand Up for Yourself and Still Win the Respect of Others – Judy Murphy
28. Managing Oneself by Peter Drucker
29. Mastering Behaviour: Managing Self and Others (SAGE IIM-Kozhikode Series for New Managers) by Payal Anand (Author)

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), *"Effective Team Building: How to make * winning team"*, London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & **Co.**
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
9. Cracking the New GRE 2012
10. Kaplan's – GRE Comprehensive Programme
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.

12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

26CUL200	**INTEGRATED AMRITA MEDITATION TECHNIQUE**	**L-T-P-C 0-0-2-1**

Nature of Course: Lab/Practical

Course Description:

The course introduces students to the Integrated Amrita Meditation Technique (IAM 20), a structured practice that combines yogic stretches, regulated breathing (pranayama), and guided meditation. The course integrates both theoretical understanding and experiential practice to enhance emotional balance, stress resilience, concentration, and overall holistic development.

Aligned with United Nations Sustainable Development Goal 3 (SDG 3): Good Health and Well-Being, the course promotes preventive mental health care, emotional well-being, and sustainable lifestyle practices among students. By fostering inner stability, self-awareness, and self-regulation, the programme supports academic excellence and contributes to the development of healthy individuals and communities.

The course is expected to improve student well-being, enhance academic focus and cognitive clarity, reduce stress-related indicators, and promote compassionate and emotionally supportive culture.

Course Objectives:

- To promote overall health and well-being of students.
- To train students in the structured practice of IAM 20.
- To develop emotional regulation and stress management skills.
- To encourage reflective awareness and compassionate living.

Course Outcomes:

After successful completion of the course, students will be able to:

CO	Course Outcomes	Knowledge Level (Bloom's Taxonomy)
CO1	Explain principles and components of IAM 20	Understand (L2)
CO2	Demonstrate and correct meditation practice independently	Apply (L3)
CO3	Analyze personal stress patterns using meditation insights	Analyse (L4)
CO4	Evaluate personal growth through daily practice	Evaluate (L5)

CO-PO Mapping: [affinity: 3 – high; 2- moderate; 1- slightly]

CO's	Program Outcomes (PO's)	Program Specific Outcomes

												(PSF's)			
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	-	-	-	-	-	**1**	-	**2**	-	-	**1**	-	-	-	-
CO2	-	-	-	-	-	**2**	**2**	**1**	**1**	-	**1**	-	-	-	-
CO3	-	-	-	-	-	**1**	**1**	**2**	-	-	**1**	-	-	-	-
CO4	-	-	-	-	-	**1**	**1**	**1**	**1**	-	**1**	-	-	-	-

Syllabus

Unit 1: Foundations of Meditation (CO1)

- Meaning and purpose of meditation
- Demonstration and supervised training
- Overview of structure of IAM
- Guidance for safe and effective practice
- Importance of mental health

Unit 2: Theoretical Foundations (CO2)

- Structure and components of IAM: yogic stretches, regulated breathing, and guided meditation
- Breath–mind connection
- Integration of IAM practice into daily routine and academic life
- Application of IAM for stress management, concentration, and holistic student development

Unit 3: IAM Practical Training (CO3)

- Preparatory stretches
- Pranayama components
- Guided meditation sequence
- Corrections and common challenges

Unit 4: Integration and Transformation (CO4)

- Building daily discipline
- Research evidence in higher education
- Compassion and mindful communication

Evaluation Pattern:

Assessment	**Internal (60)**	**External (40)**
Attendance	20 Marks	
Class Participation	20 Marks	
Activity	20 Marks	
Practical Demonstration		30 Marks
Viva		10 Marks

SEMESTER V

26AIE301	PROBABILISTIC REASONING	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course will lay down the basic concepts and techniques of probabilistic reasoning.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of probabilistic reasoning required for AI.

Course Outcomes

After completing this course student will be able to,

CO1: Create probabilistic models pertinent to represent uncertain knowledge.

CO2: Apply the formalism of Bayesian and Markov Networks to solve real world problems.

CO3: Apply tools and techniques of probabilistic reasoning for complex decision making.

CO4: Apply modern computational tools to build probabilistic models.

CO-PO Mapping

PO/ PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PSO1	PSO2	PSO3	PSO1
CO1	3	3	3	3	3	-	-	3	2	2	3	3	2	-	-
CO2	3	3	3	3	3	-	-	3	2	2	3	3	2	1	-
CO3	3	3	3	3	3	-	-	3	2	2	3	2	2	2	1
CO4	3	3	3	3	3	-	-	3	2	2	3	1	2	1	-

Syllabus

Uncertain Knowledge Representation, Introduction to Bayesian Networks (BNs), Representation Learning in Bayesian Networks, Inference in Bayesian Networks, Exact and Approximate Inference, Markov Networks, Message Passing, Learning in Markov Networks, Hidden Markov Models, Markov Random Fields (MRF), Markov Chain-Monte Carlo Method, Decision Networks.

Textbooks / Reference Books

'Artificial Intelligence: A modern Approach', S J Russell and P Norvig, Pearson (3rd edition), 2010.

'Machine Learning: A Probabilistic Perspective', Kevin Murphy and Francis Bach, Penguin Publishers, 2012

Probabilistic graphical models: principles and techniques. Koller, Daphne, and Nir Friedman. MIT press, 2009.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, probability-based problem-solving exercises, Bayesian reasoning tasks, uncertainty modelling exercises, and short tests on probabilistic inference concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of probabilistic models, Bayesian networks, inference algorithms, uncertainty analysis, simulation exercises, and mini-projects using probabilistic reasoning techniques	30%
Mid-Term Examination	Internal	Written examination focusing on probability theory, Bayesian inference, probabilistic models, reasoning under uncertainty, and decision-making concepts	20%
End Semester Assessment	External	Written Examination on probabilistic reasoning concepts and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving probabilistic modelling, inference, uncertainty analysis, project demonstration, and viva voce	30%
Total			100%

26AIE302	FORMAL LANGUAGE AND AUTOMATA	L-T-P-C: 2- 1- 0- 3

Course Objectives

- This course helps the students to understand discrete mathematical structures and formalism.
- This course helps the students to formalize and to formulate discrete concepts and algorithms.
- This course helps the students to understand the standard hierarchy of formal grammars and their corresponding automata.
- This course helps the students to visualize symbolic computation with automata.
- This course helps the students to understand decidable and undecidable problems in computer science and appreciate the Turing thesis.

Course Outcomes

After completing this course, the students will be able to

CO1: Analyze formalisms and write formal proofs for properties

CO2: Use grammatical notations to represent sequence manipulation problems

CO3: Apply various formal grammars to the problem-solving avenues

CO4: Identify limitations of some computational models and possible methods of proving them

CO-PO Mapping

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

Syllabus

Unit 1
Introduction to Automata and formal language - Finite State machines – Deterministic finite state machine – non-deterministic finite state machine- Equivalence of NFA and DFA –Minimization of Finite State Machine – Regular Expression -Regular Language – Properties of Regular Languages.

Unit 2
Context Free Grammar -Pushdown Automata – Variants of Pushdown automata – Derivations Using a Grammar, Leftmost and Rightmost Derivations, the Language of a Grammar, Sentential Forms, Parse Tress Equivalence between PDA and CFG- Context Free Languages – Properties of CFL – Normal Forms.

Unit 3
Context Sensitive Language- Linear Bound Automata- Turing Machine – Variants of Turing Machine – Decidability- Post correspondence problem – Introduction to undecidable problems.

Textbooks/References
Peter Linz, Introduction to Formal Languages and Automata, 6Th Edn by, Jones & Bartlett, 2016.
J.E.Hopcroft, R.Motwaniand andJ.D.Ullman, , Introduction to Automata Theory, Languages and Computation', Pearson, 2001
H.R.Lewis and C.H.Papadimitriou , Elements of the Theory of Computation', , Prentice Hall, 1997/Pearson 1998

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, problem-solving exercises on regular languages, finite automata, regular expressions, grammars, pushdown automata, and Turing machines	20%
Continuous Assessment – Lab (CAL)	Internal	Design and simulation of finite automata, regular expression implementation, grammar construction, parser design exercises, automata simulation tools, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on finite automata, regular languages, context-free grammars, pushdown automata, and computability concepts	20%
End Semester Assessment	External	Written Examination on formal languages, automata theory, and computability concepts. OR Hybrid Mode Examination comprising written and design/problem-solving components. OR Term Project involving automata design, language processing applications, project demonstration, and viva voce	30%
Total			**100%**

26AIE303	DATABASE MANAGEMENT SYSTEMS	L-T-P-C: 2- 1- 3- 4

Course Objectives

- This course aims to understand the concepts of database design, database languages, database-system implementation and maintenance.
- The course will provide knowledge of the design and development of databases for AI applications using SQL and python
- The course will provide an understanding of various databases system including modern databases systems apt for AI and ML applications

Course Outcomes

After completing this course, the students will be able to

CO1: Formulate relational algebraic expressions, SQL and PL/SQL statements to query relational databases.
CO2: Build ER models for real world databases.
CO3: Design a normalized database management system for real world databases.
CO4: Apply the principles of transaction processing and concurrency control.
CO5: Use high-level right database for AI and ML applications.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	3	3	-	-	-	-	-	-	2	1	-	-
CO2	1	3	3	3	3	-	-	-	-	-	-	1	3	2	-
CO3	2	3	2	3	-	-	2	2	2	2	-	1	2	2	1
CO4	1	1	1	2	-	-	-	-	-	-	-	2	2	2	2
CO5	1	1	-	-	-	-	-	-	-	-	-	1	3	2	1

Syllabus

Unit 1

Introduction: Overview of DBMS fundamentals – Overview of Relational Databases and Keys. Relational Data Model: Structure of relational databases – Database schema – Formal Relational Query Languages – Overview of Relational Algebra and Relational Operations. Database Design: Overview of the design process - The E-R Models – Constraints - Removing Redundant Attributes in Entity Sets - E-R Diagrams - Reduction to Relational Schemas - Entity Relationship Design Issues - Extended E-R Features – Alternative E-R Notations – Overview of Unified Modelling Language (UML).

Unit 2

Relational Database Design: Features of Good Relational Designs - Atomic Domains and 1NF - Decomposition using Functional Dependencies: 2NF, 3NF, BCNF and Higher Normal Forms. Functional Dependency Theory - Algorithm for Decomposition – Decomposition using multi-valued dependency: 4NF and 4NF decomposition. Database design process and its issues. SQL: review of SQL – Intermediate SQL – Advanced SQL.

Unit 3

Transactions: Transaction concept – A simple transaction model - Storage structure - Transaction atomicity and durability - Transaction isolation – Serializability – Recoverable schedules, Casecadeless schedules. Concurrency control: Lock-based protocols – Locks, granting of locks, the two-phase locking protocol, implementation of locking, Graph-based protocols. Deadlock handling: Deadlock prevention, Deadlock detection and recovery.
Case Study: Different types of high-level databases – MongoDB, Hadoop/Hbase, Redis, IBM Cloudant, Dynamo DB, Cassandra and Couch DB etc. Tips for choosing the right database for the given problem.

Textbooks/References

Silberschatz A, Korth HF, Sudharshan S. Database System Concepts. Sixth Edition, TMH publishing company limited; 2011.
Garcia-Molina H, Ullman JD, Widom J. Database System; The complete book. Second Edition, Pearson Education India, 2011
Elmasri R, Navathe SB. Fundamentals of Database Systems. Fifth Edition, Addison Wesley

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, problem-solving exercises on ER modelling, relational algebra, relational calculus, schema design, normalization, and database concepts	20%
Continuous Assessment – Lab (CAL)	Internal	SQL programming, database schema creation, normalization exercises, stored procedures, triggers, transaction processing, database application development, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on database design, relational models, normalization, SQL, transaction management, and indexing concepts	20%
End Semester Assessment	External	Written Examination on database design, SQL, transaction management, and database systems concepts. OR Hybrid Mode Examination comprising written and database design/query implementation components. OR Term Project involving database requirement analysis, schema design, implementation, query development, project demonstration, and viva voce	30%
Total			**100%**

26AIE304	**DEEP LEARNING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course provides the basic concepts of deep learning and implementation using Matlab/Python.
- This course provides the application of deep learning algorithms in signal and image data analysis.
- This course covers the concept of deep learning algorithms such as transfer learning and attention models for signal and image analysis.

Course Outcomes (CO)

After completing this course students will be able to,

CO1: Apply the fundamentals of deep learning.

CO2: Apply deep learning algorithms using Matlab/Python.

CO3: Apply deep learning models for signal analysis.

CO4: Implement deep learning models for image analysis.

CO-PO Mapping

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

Syllabus

Unit 1

Pre-processing: Noise Removal using deep learning algorithms - Feature Extraction - Signal Analysis: Time Series Analysis, CNNs, Auto encoders.

Unit 2

Convolutional Neural Networks (CNNs), Convolution and Pooling Operations, Feature Maps, Pre-processing Techniques, Noise Removal using Deep Learning, Feature Extraction, Autoencoders, Signal Analysis and Time-Series Applications using CNNs.

Unit 3

Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Transfer Learning, Attention Mechanisms, Ensemble Methods for Signal and Image Analysis.

Unit 4

Overview of Transformer Networks, Vision Transformers (ViT), **Introduction to Graph Neural Networks (GNNs)**, Emerging Trends and Applications of Deep Learning in Vision, Signal Processing, Healthcare, and Scientific Computing..

Textbooks

Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.

Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

K. P. Soman and R. Ramanathan, Digital Signal and Image Processing – The Sparse Way, Elsevier, 2012.

Reference Books

François Chollet, Deep Learning with Python, Second Edition, Manning Publications, 2021.

Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow, 3rd Edition, O'Reilly Media, 2023.

Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, 2018.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, analytical exercises on neural network architectures, case studies, hyperparameter tuning, model evaluation, and short tests on deep learning concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of neural networks, CNNs, RNNs/LSTMs, transfer learning, transformer-based models, model training and evaluation using TensorFlow/PyTorch, experimentation with real-world datasets, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on neural network fundamentals, backpropagation, activation functions, CNNs, RNNs/LSTMs, optimization techniques, and deep learning problem-solving	20%
End Semester Assessment	External	Written Examination on deep learning concepts, neural network architectures, optimization techniques, transformers, and emerging deep learning models. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Project-Based Examination involving the design, implementation, training, and evaluation of deep learning models for real-world applications, followed by project demonstration and viva voce	30%
Total			**100%**

26AIE305	**INTRODUCTION TO CLOUD COMPUTING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course introduces the basic principles of cloud computing, cloud native application development and deployment, containerization principles, micro-services and application scaling.
- This course will also equip the students to understand major industry players in the public cloud domain for application development and deployment.

Course Outcomes

After completing this course, the students will be able to

CO1: Demonstrate the functionalities of cloud computing.

CO2: Apply cloud native application development for containerization and container orchestration.

CO3: Analyze different types of cloud services – Delivery models, Deployment models.

CO4: Implement different solution approaches in Cloud – containers in public cloud, setting up private cloud and convert monolithic applications to containers.

CO-PO Mapping

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

Syllabus

Unit 1

Distributed Computing Taxonomy – Cluster, Grid, P2P, Utility, Cloud, Edge, Fog computing paradigms; Introduction to Cloud Computing – Cloud delivery models (XaaS), Cloud deployment models (Private, Public, Hybrid); Characteristics of Cloud, Major use cases of Cloud; disadvantages and best practices; Major public cloud players in the market; Security Issues and Challenges; Cloud Native application development – Introduction to JavaScript Cloud native application development

Unit 2

Public Cloud – Using public cloud for infrastructure management (compute and storage services), Web application deployment using public cloud services, and Deploying container images in public cloud, Overview of cognitive services, Case study on architecting cloud-based solutions for a chosen scenario.

Unit 3

Virtualization – Basics, Cloud vs Virtualization, Types of virtualizations, Hypervisor types; Containers – Introduction to dockers and containers, containerization vs virtualization, docker architecture, Use cases, Learn how to build container images, Operations on container images; Kubernetes – Need for orchestration, container orchestration methods, Introduction to Kubernetes, Kubernetes architecture, using YAML file, Running Kubernetes via minikube.

Textbooks/References

Rajkumar Buyya et.al. Mastering cloud computing, McGraw Hill Education;2013.
Matthias K, Kane SP. Docker: Up & Running: Shipping Reliable Containers in Production. " O'Reilly Media, Inc."; 2018.
Gift, Noah. Pragmatic AI: An Introduction to Cloud-based Machine Learning. Addison-Wesley Professional, 2018
Kocher PS. Microservices and Containers. Addison-Wesley Professional; 2018.
Sarkar A, Shah A. Learning AWS: Design, build, and deploy responsive applications using AWS Cloud components. Packt Publishing Ltd; 2018.
Menga J. Docker on Amazon Web Services: Build, deploy, and manage your container applications at scale. Packt Publishing Ltd; 2018.
Bentley W. OpenStack Administration with Ansible 2. Packt Publishing Ltd; 2016

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies, cloud service analysis exercises, virtualization concepts, cloud architecture problems, and short tests on cloud computing fundamentals	20%
Continuous Assessment – Lab (CAL)	Internal	Cloud platform exercises, virtual machine deployment, containerization tasks, cloud storage and networking experiments, deployment of cloud-based applications, and mini-projects	30%

Component	Internal / External	Suggested Assessment Methods	Weightage
Mid-Term Examination	Internal	Written examination focusing on cloud computing fundamentals, virtualization, cloud service models, deployment models, cloud architecture, and resource management	20%
End Semester Assessment	External	Written Examination on cloud computing concepts, architectures, and services. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving cloud-based application deployment, cloud solution design, project demonstration, and viva voce	30%
Total			**100%**

23LIV390	LIVE-IN-LAB II	L-T-P-C: 0-0-0-3

Course Objectives

- Identify and analyse the various challenge indicators present in the village by applying concepts of Human Cantered Design and Participatory Rural Appraisal.
- User Need Assessment through Quantitative and Qualitative Measurements
- Designing a solution by integrating Human Cantered Design concepts
- Devising proposed intervention strategies for Sustainable Social Change Management

Course Outcome

CO1: Learn ethnographic research and utilise the methodologies to enhance participatory engagement.
CO2: Prioritize challenges and derive constraints using Participatory Rural Appraisal.
CO3: Identify and formulate the research challenges in rural communities.
CO4: Design solutions using human cantered approach.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1		3		3		1		3	3		3	-	-	1	3
CO2		3					3	3	3			1	-	2	3
CO3		3						3	3		3	2	1	3	3
CO4	3		3				3	3	3		3	1	2	3	3

Syllabus

This initiative is to provide opportunities for students to get involved in coming up with technology solutions for societal problems. The students shall visit villages or rural sites during the vacations (after 4th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management

- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

The objectives and the projected outcome of the project will be reviewed and approved by the department chairperson and a faculty assigned as the project guide.

Evaluation Pattern

Assessment	**Marks**
Internal (Continuous Evaluation) [75 marks]	
Workshop (Group Participation)	15
Village Visit Assignments & Reports	15
Problem Identification and Assessment	15
Ideation: Defining the Needs, Proposed Designs & Review	20
Poster Presentation	10
External [25 marks]	
Research Paper Submission	25
Total	**100**
Attendance (To be added separately)	5
Grand Total	**105**

Sem: 5	**26CCS301 Career Competency Skills III**	**L-T-P-C: 1-0-2-2**

CIR Course – BTech – Paper III

Pre-requisite:

SOFT SKILLS - Practicing effective interpersonal skills, exploring nuances of presentation, exhibiting collaboration and working to execute successful professional discussions in future.

VERBAL - Basic English language skills

APTITUDE – Basic knowledge in arithmetic and algebra.

Course Objectives

SOFT SKILLS

- To instill core corporate values and ethical conduct in organizational settings.
- To develop critical thinking skills for analysis, evaluation, and informed decision-making.
- To enhance group discussion skills for effective participation, leadership, and consensus-building.

APTITUDE - To help students to enhance problem-solving skills

VERBAL - Empower students to communicate effectively

Course Outcomes

CO1 - Soft Skills: To improve interpersonal communication and leadership skills, vital for arriving at win-win situations in Group Discussions and other team activities.

CO2 - Soft Skills: To develop the ability to create better impact in Group Discussions through examination, participation, perspective-sharing, ideation, listening, brainstorming and consensus.

CO3 - Aptitude: To interpret, critically analyze and solve questions in geometry, probability, permutations & combinations, and statistics by employing the most suitable methods.

CO4 - Aptitude: To analyze, understand and apply suitable methods to solve questions in logical reasoning.

CO5 - Verbal: To be able to use diction that is more refined and appropriate and to be competent in spotting grammatical errors and correcting them.

CO6 - Verbal: To be able to logically connect words, phrases, sentences and thereby communicate their perspectives/ideas convincingly.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							2	3	3		3
CO2								3	3		3
CO3		3		2							
CO4		3		2							
CO5									3		3
CO6								3	3		3

Syllabus

Soft Skills

Corporate Culture and Managing Diversity: Campus to Corporate transition, Corporate Etiquette, Workplace Rules, Policies & Discipline, Sensitivity & Professional Conduct, Allyship, Inclusive Behavior & Collaboration, Resume Building – Level 2.

Corporate Values: Change Management, Integrity, Reliability, Accountability, Organizational effectiveness

Critical Thinking: Meaning and importance of critical thinking, Barriers to critical thinking (bias, assumptions), Identifying facts vs opinions, Brainstorming techniques, Case studies from engineering practice

Group Discussion: Briefing & Classes, Critical Thinking & Perspective Building, Clarity, Fluency & Professional Language, Body Language & Eye Contact, Handling Interruptions & Disagreements, Self-reflection & Improvement, Group discussion by students

Aptitude

Geometry: 2D, 3D, and Coordinate Geometry.

Permutations & Combinations: Basics, Fundamental Counting Principle, Circular Arrangements, and Derangements.

Probability: Basics, Addition & Multiplication Theorems, Conditional Probability and Bayes' Theorem.

Statistics: Mean, Median, Mode, Range, Variance, Qartile Deviation and Standard Deviation.

Logical Reasoning: Blood Relations, Direction Test, Syllogisms, Series, Odd One Out, Coding & Decoding, Cryptarithmetic Problems and Input - Output Reasoning.

Puzzles: Lateral Thinking Problems, Riddles, Logical Puzzles, Deduction Puzzles, Calculation Puzzles, and Other Interview Puzzles.

Miscellaneous: Time Management Strategies.

Verbal

Vocabulary: Create an awareness of using refined language through idioms and phrasal verbs.

Grammar (**Upper Intermediate-Advanced**): Train Students to comprehend the nuances of Grammar and empower them to spot errors in sentences and correct them.

Reasoning: Enable students to connect words, phrases, and sentences logically.

Reading Comprehension (**Basics**): Introduce students to smart reading techniques and help them understand different tones in comprehension passages.

Storytelling for Professional Success and Personal Branding:

Practice narrative skills to convert experiences and achievements into concise mini-stories and transform factual reports into engaging professional narratives.

Oral Communication Skills: Aid students in using the gift of the gab to interpret images, do a video synthesis, try a song interpretation or elaborate on a literary quote.

References:

SOFT SKILLS:

1. Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), *"Effective Team Building: How to make * winning team"*, London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. The Ace of Soft Skills - Attitude, Communication & Etiquette for success - Gopalaswamy Ramesh and Mahadevan Ramesh
7. Business Etiquette – Shital Kakkar Mehra

8. Body language in the workplace – Allan, Barbara Pease
9. The definite Book of Body language – Barbara Pease
10. Group Discussion and Interview Skills - Priyadarshi Patnaik

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), *"Effective Team Building: How to make * winning team"*, London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & **Co.**
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Public Sector – Engineer Management Trainee Recruitment Exam (General English)
9. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
10. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
11. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
12. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
13. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
14. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
15. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
16. A Modern Approach to Logical Reasoning, R S Aggarwal.
17. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

SEMESTER VI

26AIE311 SOFTWARE ENGINEERING (PROJECT BASED) L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course presents a broad perspective on software systems engineering, concentrating on widely used techniques for developing large-scale software systems.
- This course covers a wide spectrum of software processes from initial requirements elicitation through design and development to system evolution.
- This course also covers a wide range of software development abilities and skills from analysing a problem to implementing a solution.

Course Outcomes

After completing this course, the students will be able to

CO1 :Explain the basic principles of Software Engineering.

CO2: Analyze and select the appropriate SDLC models depending on the user requirements.

CO3: Apply the concept of Requirements Engineering for software development.

CO4: Apply the concept of Software Design.

CO5: Design and develop software solutions, and perform software testing and maintenance.

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CO-PO Mapping

PSO/PO / **CO**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	2										2	-	-	-
CO2	3	3	2	2	2					3	3	2	1	-	-
CO3	3	3	2		1					2		1	2	1	-
CO4	3	2	3		2					2	2	2	2	1	1
CO5	3	2	2		2			2	2	2	2	2	2	2	1

Syllabus

Unit-1

Introduction to Software Engineering: Introduction, Software Failures, Software Crisis, Classification of Software, Software characteristics, Software Engineering-A Layered Technology, Basic of Life Cycle, Software Life Cycle Models: Waterfall Model, V-Model, Prototype Model, Incremental Model, Iterative Model, Evolutionary Process Model, Spiral Model, Agile Manifesto, Principles of the agile manifesto, Various Agile methodologies: Scrum, Extreme programming.

Unit-2

Requirement Engineering: Basic concepts of Requirements Analysis and Specification, Role of a system analyst, SRS document and its important parts, properties of a good SRS document, functional requirements, non-functional requirements, decision tree, and decision table.

Design Engineering: Basic Concepts of Software Design, Preliminary and detailed design, Characteristics of a good software design, cohesion and its types, coupling and its types, function-oriented design approach, and object-oriented design approach. Data Flow Diagrams, Structured Design.

Unified Modelling Language (UML): Basic concepts of UML, Different types of diagrams, and views supported in UML.

Unit-3

User interface design: Basic concepts of user interface design, Types of User Interfaces.

Coding and Testing: Coding- Coding Standards and Guidelines, Code Review- Code Walkthrough, Code Inspection, Clean Room Testing. Testing- Basic Concepts of Testing and Terminologies, Testing Activities, Why Design Test Cases?, Testing in the Large versus Testing in the Small, Unit Testing, Black-box Testing-Black-box Test Suite Design Approach: Equivalence Class Partitioning, Boundary Value Analysis, White-Box Testing-Basic concept, statement coverage, branch coverage, Multiple Condition Coverage, Path Coverage, McCabe's Cyclomatic Complexity Metric, Data Flow-based Testing, Mutation Testing, Grey-Box Testing, Integration Testing, System Testing, Smoke Testing- Performance Testing, Error Seeding, Some General Issues Associated with Testing. Debugging techniques. Software Documentation- Internal Documentation, External Documentation.

Textbooks

Pressman R S, Bruce R.Maxim, Software Engineering - A Practitioner's Approach. Eighth Edition, McGraw-Hill Education, 2019.

Rajib Mall, "Fundamentals of Software Engineering", Fifth Edition, PHI

Reference Books

Pankaj Jalote's, Software Engineering: A Precise Approach, Wileyindia, 2010

Crowder JA, Friess S. Agile project management: managing for success. Cham: Springer International Publishing; 2015.

Stellman A, Greene J. Learning agile: Understanding scrum, XP, lean, and kanban. " O'Reilly Media, Inc."; 2015.

Gregory J, Crispin L. More agile testing: learning journeys for the whole team. Addison-Wesley Professional; 2015.

Rubin KS. Essential Scrum: a practical guide to the most popular agile process. Addison-Wesley; 2012.

Cohn M. User stories applied: For agile software development. Addison-Wesley Professional; 2004

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies, requirements analysis exercises, software design activities, estimation and project management tasks, and short tests on software engineering principles. Case studies on AI-assisted software development, ML pipelines, MLOps workflows, model deployment, experiment tracking (MLflow), model versioning, and model monitoring.	20%

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Lab (CAL)	Internal	Requirements elicitation, software design documentation, sprint reviews, prototype development, project planning, implementation milestones, team collaboration. Hands-on use of AI coding assistants (e.g., Claude Code/GitHub Copilot) for code generation, debugging, testing, documentation and refactoring; implementation of simple ML pipelines, experiment tracking, Docker-based deployment, model registry, and basic model monitoring exercises.	30%
Mid-Term Examination	Internal	Written examination focusing on software development life cycle, requirements engineering, design methodologies, testing, project management, and software quality concepts	20%
End Semester Assessment	External	Written Examination on software engineering principles and practices. OR Hybrid Mode Examination comprising written and case-analysis/problem-solving components. OR Term Project involving software solution development, project demonstration, and viva voce	30%
Total			100%

26AIE312	BIG DATA ANALYTICS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- To understand how to use Big data frameworks and APIs.
- To conceptualize data analysis.
- To learn about various data processing and pipelining strategies.
- To understand and visualize map-reduce computing paradigm.
- To learn the intricate and distributed working of Big Data clusters
- To train and impart the skills required for managing and balancing large data clusters

Course Outcomes (CO)

After completing this course student will be able to,

CO1: Solve problems through map-reduce approach

CO2: Implement data analytics solutions using general data pipelining

CO3: Apply scaling up machine learning techniques and associated computing techniques and technologies.

CO4: Identify the characteristics of datasets and compare the trivial data and big data for various applications.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	1	-	2	2	3	2	3	2	1	-
CO2	3	3	3	3	3	2	-	3	3	3	3	2	2	1	-

CO3	3	3	3	3	3	1	-	2	3	3	2	1	3	2	1
CO4	2	2	3	2	3	1	-	2	2	2	2	1	1	-	-

Syllabus

UNIT 1

Classification of Digital Data, Structured and Unstructured Data – Introduction to Big Data: Characteristics – Evolution – Definition, - Data Warehouse, Hadoop ecosystem in Brief, Map Reduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression -Terminologies used in Big Data Environments - NoSQL, Comparison of SQL and NoSQL, Distributed Computing Challenges - Hadoop Distributed File System - Processing Data with Hadoop - Basically Available Soft State Eventual Consistency, programming paradigm - Functional Programming in Scala: Basic Syntax-type inference- Parameters-Recursive arbitrary collections – ConsList-Arrays-Tail recursion- Higher order functions

UNIT 2

MapReduce Template-Pattern Matching syntax, objects in Scala. Apache Spark: -Resilient Distributed Datasets - Creating RDDs, Lineage and Fault tolerance, DAGs, Immutability, task division and partitions, transformations and actions, lazy evolutions and optimization -Formatting and housing data from spark RDDs--Persistence.

UNIT 3

Data frames, datasets, Apache Spark SQL, Setting up a standalone Spark cluster-: spark-shell, basic API, Modules-Core, Key/Value pairs and other RDD features, MLlib-examples for bi-class SVM and logistic regression.

UNIT 4

MongoDB: Why Mongo DB - Terms used in RDBMS and Mongo DB - Data Types - MongoDB Query Language. Stream and Graph Processing on Spark.

Textbooks / Reference Books

Learning Spark: Lightning-Fast Big Data Analysis', Holden Karau , Andy Konwinski, Patrick Wendell and MateiZaharia, O'Reilly; 1st edition , 2015

'Programming in Scala: A Comprehensive Step-by-Step Guide', Martin Odersky,Lex Spoon andBill Venners, Artima Inc; Version ed. edition , 2008

'High Performance Spark: Best Practices for Scaling and Optimizing Apache Spark', Holden Karau, Rachel Warren, O'Reilly; 1st edition, 2017

'Scala for the Impatient', Cay S. Horstmann, Addison-Wesley; 2nd edition, 2017

"Mongo DB in Action", Kyle Banker, Manning Publications; 2nd edition, 2016

"MongoDB: The Definitive Guide", Shannon Bradshaw, Eoin Brazil, Kristina Chodorow, O'Reilly; 3rd edition, 2019

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies, data processing exercises, analytical problem-solving tasks, and short tests on big data concepts and architectures	20%

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Lab (CAL)	Internal	Hadoop and Spark programming, distributed data processing, data analytics exercises, NoSQL database experiments, visualization tasks, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on big data ecosystems, distributed computing, storage architectures, data processing frameworks, and analytics techniques	20%
End Semester Assessment	External	Written Examination on big data technologies, analytics techniques, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving large-scale data processing, analytics solution development, project demonstration, and viva voce	30%
Total			**100%**

26AIE313 COMPUTER VISION AND IMAGE PROCESSING L-T-P-C: 2- 1- 3- 4

Course Objectives

- This course introduces the geometry of image formation and its use for 3D reconstruction and calibration.
- This course introduces the analysis of patterns in visual images that are used to reconstruct and understand objects and scenes.

Course Outcomes

After completing this course, the students will be able to

CO1: Apply image formation and camera calibration for various applications.
CO2: Analyze and select image features and apply for image matching.
CO3: Develop image recognition algorithms.
CO4: Develop stereo vision applications for distance estimation.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction, Image Formation – geometric primitives and transformations, photometric image formation, digital camera, Camera calibration. Edge Detection, Segmentation.

Unit 2

Feature Detection and Matching – points and patches, edges, lines, Feature-Based Alignment - 2D, 3D feature-based alignment, pose estimation, Image Stitching, Dense motion estimation – Optical flow - layered motion, parametric motion, Structure from Motion.

Unit 3

Recognition – object detection, face recognition, instance recognition, category recognition, Stereo Correspondence – Epipolar geometry, 3D reconstruction.

Textbooks/References

Szeliski R. Computer Vision: Algorithms and Applications Springer. New York. 2010..
Shapiro LG, Stockman GC. Computer Vision: Theory and Applications. 2001.
Forsyth DA, Ponce J. Computer Vision: a modern approach;2012.
Davies ER. Machine vision: theory, algorithms, practicalities. Elsevier; 2004 Dec 22.
Jain R, Kasturi R, Schunck BG. Machine vision. New York: McGraw-Hill; 1995 Mar 1

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, image analysis exercises, problem-solving tasks on image processing techniques, feature extraction, and computer vision concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Image processing experiments, feature extraction, object detection tasks, image segmentation, computer vision model implementation, OpenCV-based applications, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on image processing fundamentals, feature representation, computer vision techniques, image analysis, and pattern recognition concepts	20%
End Semester Assessment	External	Written Examination on image processing and computer vision concepts and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving development of computer vision solutions, image analysis applications, project demonstration, and viva voce	30%
Total			100%

26AIE314	COMPUTER SECURITY	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course provides basic knowledge and skills in the fundamental theories and practices of cyber security.
- This course provides an overview of the field of security and assurance emphasizing the need to protect information being transmitted electronically.

Course Outcomes

After completing this course, students will be able to:
CO1: Implement cryptographic techniques in secure application development
CO2: Apply methods for authentication, access control, intrusion detection and prevention
CO3: Apply fundamental security principles to analyze threat situations
CO4: Design mechanisms to provide security in a network

CO-PO Mapping

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

Syllabus:

Unit 1

Basics of Computer Security: Overview – Definition of terms – Security goals – Shortcomings – Attack and defence – Malicious code – Worms – Intruders – Error detection and correction Encryption and Cryptography: Ciphers and codes – Public key algorithms – Key distribution – Digital signatures.

Unit 2

Security Services: Authentication and Key Exchange Protocols - Access control matrix – User authentication – Directory authentication service – Diffie-Hellman key exchange – Kerberos

Unit 3

System security and Security models: Disaster recovery - Protection policies. E-mail Security: Pretty good privacy- Database Security: Integrity constraints - multi-phase commit protocols - Networks Security: Threats in networks - DS authentication -Web and Electronic Commerce: Secure socket layer - Client-side certificates – Trusted Systems: Memory protection.

Textbooks/References

William Stallings, Lawrie Brown, "Computer Security: Principles and Practice", Prentice Hall, 4th edition
Stallings William, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson/Prentice-
Hall, 2018.
Forouzan B A, Cryptography and Network Security, Special Indian Edition, Tata McGraw Hill, 2007.
Padmanabhan TR, Shyamala C K, and Harini N, Cryptography and Security, First Edition, Wiley India Publications, 2011

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, cryptography exercises, security protocol analysis, case studies on cyber attacks and security mechanisms, and short tests on computer security concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Cryptographic algorithm implementation, authentication and access control exercises, network security experiments, vulnerability assessment, security tool usage, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on cryptography, authentication protocols, access control, system security, network security, and security models	20%
End Semester Assessment	External	Written Examination on computer security concepts, cryptographic techniques, authentication mechanisms, system and network security. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Project-Based Examination involving the design and implementation of secure systems, security analysis, vulnerability assessment, project demonstration, and viva voce	30%
Total			100%

26AIE315	**NATURAL LANGUAGE PROCESSING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- The main objective of the course is to understand the leading trends and systems in Natural Language
- This course will help the students to understand the basic representations used in syntax, the semantics of Natural Language Processing
- This course will help the students to understand and explore the models used for word/sentence representations for various NLP applications
- This course will help the students to implement deep learning algorithms in Python and learn how to train deep networks for NLP applications.

Course Outcomes

After completing this course, students will be able to:

CO1: Apply modern tools for solving problems in computational linguistics

CO2: Implement word representation models to solve NLP problems

CO3: Develop deep learning models for solving NLP applications

CO4: Evaluate the performance of NLP models

CO-PO Mapping

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

Syllabus:

Unit 1

Introduction to Natural Language Processing – Applications and challenges of NLP – Levels of linguistic analysis: phonology, morphology, syntax, semantics, and pragmatics – Corpus linguistics – Text corpora and linguistic resources – Tokenization and normalization – Ambiguity in natural language – Overview of rule-based, statistical, and neural approaches to NLP.

Unit 2

Text representation techniques – One-hot encoding – Bag-of-Words (BoW) – Term Frequency and Inverse Document Frequency (TF–IDF) – N-gram language models – Distributed word representations – Word2Vec (CBOW and Skip-gram) – GloVe – Subword embeddings (FastText) – Static vs contextual embeddings – Sentence and document embeddings

Unit 3

Sequential data in NLP – Probabilistic sequence models: Hidden Markov Models (HMM) and Conditional Random Fields (CRF) – Neural sequence models – Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), and Gated Recurrent Units (GRU) – Sequence-to-sequence modeling – Encoder–decoder architecture – Attention mechanism – Transformer architecture – Pre-trained language models: BERT and GPT – Introduction to large language models (LLMs) – Overview of Graph-based NLP.

Unit 4

NLP applications – Part-of-Speech tagging – Named Entity Recognition – Dependency parsing – Sentiment analysis – Machine translation – Question answering – Text summarization – Topic modeling – Evaluation metrics for NLP models: accuracy, precision, recall, F1-score, BLEU, ROUGE – Error analysis and visualization techniques

Textbooks/References

Daniel Jurafsky, James H Martin, Speech & language processing, preparation [cited 2020 June 1] Available from: https://web. stanford. edu/~ jurafsky/slp3 (2018).

Christopher Manning and Hinrich Schütze, F oundations of Statistical Natural Language Processing, MIT press, 1999.

Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly Media, Inc.,2009.

Jason Browlee, Deep Learning for Natural Language Processing: Develop Deep Learning Models for your Natural Language Problems (Ebook), Machine Learning Mastery, 2017.

Yoav Goldberg, Neural network methods for natural language processing, Computational Linguistics 44.1 (2018): 194-195.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, text processing exercises, linguistic analysis, word embedding tasks, case studies on NLP applications, and short tests on natural language processing concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Text preprocessing, tokenization, sentiment analysis, named entity recognition, word embedding implementation, transformer-based NLP experiments, chatbot or language model development, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on computational linguistics, text representation, language models, deep learning for NLP, and NLP applications	20%
End Semester Assessment	External	Written Examination on natural language processing concepts, deep learning models, and NLP applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Project-Based Examination involving development of NLP applications, language model implementation, text analytics, project demonstration, and viva voce	30%
Total			100%

Sem: 6 26CCS311 Career Competency Skills IV L-T-P-C: 1-0-2-2

CIR Course – BTech – Paper IV

Pre-requisite:

SOFT SKILLS - Basic competence in corporate awareness, communication, critical thinking, and open mind to get equipped with skills to face interview for their successful career
VERBAL - Basic English language skills
APTITUDE – Basic knowledge in arithmetic and algebra.

Course Objectives

SOFT SKILLS

- To introduce entrepreneurial skills and mindset for innovation, initiative, and self-employment.
- To develop interview etiquette and professional behavior for recruitment processes.
- To nurture leadership qualities for effective team guidance and decision-making.

APTITUDE - Assist them in improving their problem -solving and reasoning skills
VERBAL - Enable them to communicate confidently before an audience

Course Outcomes

CO1 - Soft Skills: At the end of the course, the students will have the ability to prepare a suitable resume (including a video resume). They would also have acquired the necessary

skills, abilities, and knowledge to present themselves confidently. They would be sure-footed in introducing themselves and facing interviews.

CO2 - Soft Skills: At the end of the course, the students will have the ability to analyze every question asked by the interviewer, compose correct responses and respond in the right manner to justify and convince the interviewer of one's right candidature through displaying etiquette, positive attitude and courteous communication.

CO3 - Aptitude: To manage time while arriving at appropriate strategies to solve questions in arithmetic and algebra.

CO4 – Aptitude: To analyze, understand and apply suitable methods to solve questions in data sufficiency and logical reasoning.

CO5 - Verbal: To use diction that is less verbose and more precise and to use prior knowledge of grammar to correct/improve sentences.

CO6 -Verbal: To understand arguments, analyze arguments, and use inductive/deductive reasoning to arrive at conclusions. To be able to generate ideas, structure them logically and express them in a style that is comprehensible to the audience/recipient.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1							2	3	3		3
CO2								3	3		3
CO3		3		2							
CO4		3		2							
CO5									3		3
CO6								3	3		3

Syllabus

Soft Skills

Enterprising / Entrepreneurship skills: Entrepreneurial Mindset & Attitude, Market Need Analysis & Customer Discovery, Design Thinking for Entrepreneurs, Communication & Pitching Skills, Networking & Mentorship

Leadership: Importance of Leadership in Engineering, Leadership Styles, Team Motivation & Influencing Skills, Ethical Leadership & Integrity, Leadership in Corporate & Startup Environments

Professional Networking: Importance of Professional Networking, Networking for Internships, Projects & Placements, LinkedIn Profile Building & Best Practices, Networking in Virtual & Hybrid Events

Resume Bulding – Level 3: Resume writing, Cover letter, Digital profile, Video resume

Interviewing Skills: Types of Interviews (Technical, HR, Managerial, Research), Understanding Job Descriptions & Role Expectations, Competency-based & Behavioral Interviews, STAR Technique for Behavioral Questions, Professional Grooming for interviews
Mock Interviews: Experiential session

Aptitude

Sequence and Series: Basics, AP, GP, HP, and Special Series.
Data Sufficiency: Basics, 5-Option and 4-Option Data Sufficiency Problems.
Logical Reasoning: Clocks, Calendars, Cubes, Non-Verbal Reasoning, and Symbol-Based Reasoning.
Campus Recruitment Papers: Discussion of previous year question papers of all major recruiters.
Competitive Examination Papers: Discussion of old question papers of relevant entrance examinations.
Puzzles: Lateral Thinking Problems, Riddles, Logical Puzzles, Deduction Puzzles, Calculation Puzzles, and Other Interview Puzzles.
Miscellaneous: Time Management Strategies.

Verbal

Vocabulary: Empower students to communicate effectively through one-word substitution.
Grammar: Enable students to improve sentences through a clear understanding of the rules of grammar.
Reasoning: Facilitate the student to tap his reasoning skills through critical reasoning arguments
Reading Comprehension (**Advanced**): Enlighten students on the different strategies involved in tackling reading comprehension questions.
Speaking Skills: Empower students to overcome glossophobia and speak effectively and confidently before an audience.
Writing Skills: Practice closet tests that assess basic knowledge and skills in writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.
References:
SOFT SKILLS:

1. Students' Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), *"Effective Team Building: How to make * winning team"*, London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Teamwork Isn't My Thing and I Don't Like to Share! – Julia Cook
7. The Sapp Brothers' Story: Tough Times, Teamwork, & Faith - Tom Osborne

8. Successful Interview Skills – Rebecca Corfield
9. Hindle, Tim, Interviewing Skills
10. Julie Ann Amos, Handling Tough Job Interviews

1. Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
2. Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
3. Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K
4. Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.
5. The hard truth about Soft Skills, by Amazon Publication.
6. Verbal Skills Activity Book, CIR, AVVP
7. English Grammar & Composition, Wren & Martin
8. Public Sector – Engineer Management Trainee Recruitment Exam (General English)
9. Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
10. A Modern Approach to Verbal Reasoning – R.S. Aggarwal
11. Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
12. Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
13. How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
14. How to Prepare for Data Interpretation for the CAT, Arun Sharma.
15. How to Prepare for Logical Reasoning for the CAT, Arun Sharma.
16. Quantitative Aptitude for Competitive Examinations, R S Aggarwal.
17. A Modern Approach to Logical Reasoning, R S Aggarwal.
18. A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal

Evaluation Pattern

Assessment	Internal	External
Continuous Assessment (CA)* – Soft Skills	30	-
Continuous Assessment (CA)* – Aptitude	10	25
Continuous Assessment (CA)* – Verbal	10	25
Total	50	50

*CA - Can be **presentations, speaking activities and tests.**

26AIE399	PROJECT – PHASE – 1	L-T-P-C: 0-0-8-4

Course Objectives

- The initial stage of the academic project involves identification of a problem domain and demonstrating a sound knowledge on the chosen domain.
- This phase offers students an opportunity to delve into the state-of-the-art within their chosen domain.
- During this phase, students are empowered to identify real-world applications within their chosen domain of study. This enables them to gain insight into their own strengths and innovate problem statements that align with practical scenarios.

Course Outcomes

At the end of this course the students will be able to:

CO1: Identify ongoing developments and research gaps in the chosen domain and demonstrate technical knowledge pertaining to the same.

CO2: Define a problem and design effective solution(s) for the identified problem.

CO3: Implement and verify the designed solution(s).

CO-PO Mapping

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

Evaluation Pattern: 70:30
Internal Marks: 70
External Marks: 30

23LIV490	**LIVE-IN-LAB II**	**L-T-P-C: 0-0-0-3**

Course Objectives

- Proposal writing in order to bring in a detailed project planning, enlist the materials required and propose budget requirement.
- Use the concept of CoDesign to ensure User Participation in the Design Process in order to rightly capture user needs/requirements.
- Building and testing a prototype to ensure that the final design implementation is satisfies the user needs, feasible, affordable, sustainable and efficient.
- Real time project implementation in the village followed by awareness generation and skill training of the users (villagers)

Course Outcome

CO1: Learn co-design methodologies and engage participatorily to finalise a solution
CO2: Understand sustainable social change models and identify change agents in a community.
CO3: Learn Project Management to effectively manage the resources
CO4: Lab scale implementation and validation
CO5. Prototype implementation of the solution

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	3	3			1	3	3	3		3
CO2									3	3		
CO3									3	3	3	
CO4	3		3			3	1	3	3	3		3

CO5			1						3	3		

Syllabus

The students shall visit villages or rural sites during the vacations (after 6th semester) and if they identify a worthwhile project, they shall register for a 3-credit Live-in-Lab project, in the fifth semester.
Thematic Areas

- Agriculture & Risk Management
- Education & Gender Equality
- Energy & Environment
- Livelihood & Skill Development
- Water & Sanitation
- Health & Hygiene
- Waste Management & Infrastructure

Evaluation Pattern

Assessment	Marks
Internal (Continuous Evaluation) [63 marks]	
1. Proposed Implementation	**2**
Presentation Round 1	
2. Proposal Submission + Review	**6**
3. Co-design	**6**
i. Village Visit I (Co-Design Field Work Assignments)	4
ii. Presentation of Co-design Assessment	2
4. Prototype Design	**14**
i. Prototype Design	4
ii. Prototype Submission	8
iii. Sustenance Plan	2
5. Implementation	**35**
i. Implementation Plan Review	3
ii. Implementation	24
iii. Testing & Evaluation	4
iv. Sustenance Model Implementation	4
External [37 marks]	
6. Research Paper	**18**
7. Final Report	**15**
8. Poster Presentation	**4**
Total	**100**
Attendance	5
Grand Total	**105**

SEMESTER VII

26AIE401	**REINFORCEMENT LEARNING**	**L-T-P-C:2- 0- 3- 3**

Course Objectives

- This course will provide a solid introduction to the field of reinforcement learning.
- It will also make the students learn about the core challenges and approaches, including exploration and exploitation.
- The course will make the students well versed in the key ideas and techniques for reinforcement learning

Course Outcomes

After completing this course, the students will be able to

CO1: Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning

CO2: Decide if an application problem should be formulated as a RL problem; if yes be able to define it formally (in terms of the state space, action space, dynamics and reward model), state what algorithm (from class) is best suited for addressing it

CO3: Implement in code common RL algorithms

CO4: Describe (list and define) multiple criteria for analysing RL algorithms and evaluate algorithms on these metrics: e.g., regret, sample complexity, computational complexity, empirical performance, convergence, etc.

CO5: Describe the exploration vs exploitation challenge and compare and contrast at least two approaches for addressing this challenge (in terms of performance, scalability, complexity of implementation, and theoretical guarantees)

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	3	-	-	3	2	3	3	3	1	-	-
CO 2	3	3	3	3	3	-	-	3	2	3	3	3	1	-	-
CO 3	3	3	3	3	3	-	-	3	2	3	3	2	2	1	-
CO 4	3	3	3	3	3	-	-	3	2	3	3	2	1	-	-
CO 5	3	3	3	3	3	-	-	3	2	3	3	1	2	1	1

Syllabus

Introduction to Reinforcement Learning – Elements of Reinforcement Learning – Multi-armed Bandits – Finite Markov Decision Processes – Dynamic Programming – Monte Carlo Methods – Temporal-Difference Learning – n-step Bootstrapping - Planning and Learning with Tabular Methods.

Textbooks / Reference Books

'Reinforcement Learning', Richard.S.Sutton and Andrew G.Barto, Second edition, MIT Press, 2018

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, problem-solving exercises, case studies, policy evaluation tasks, and short tests on reinforcement learning concepts and algorithms	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of reinforcement learning algorithms, environment modelling, policy optimization, value function estimation, simulation-based experiments, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on Markov Decision Processes, dynamic programming, Monte Carlo methods, temporal difference learning, and reinforcement learning fundamentals	20%
End Semester Assessment	External	Written Examination on reinforcement learning concepts, algorithms, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving development of reinforcement learning solutions, agent training and evaluation, project demonstration, and viva voce	30%
Total			100%

23LAW300	**INDIAN CONSTITUTION**	**L-T-P-C: P/F**

Course Objective

- To know about Indian constitution.
- To know about central and state government functionalities in India
- To know about Indian society

Course Outcomes

CO1: Understand the functions of the Indian government
CO2: Understand and abide the rules of the Indian constitution
CO3: Understand and appreciate different culture among the people

CO-PO Mapping

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

Syllabus

Unit 1
Historical Background – Constituent Assembly Of India – Philosophical Foundations Of The Indian Constitution – Preamble – Fundamental Rights – Directive Principles Of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies For Citizens.

Unit 2
Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review.

Unit 3
State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature – Judicial System in States – High Courts and other Subordinate Courts.

Textbook(s)

Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.
R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.

Reference(s)

Sharma, Brij Kishore, "Introduction to the Constitution of India", Prentice Hall of India, New Delhi.

Evaluation Pattern

Assessment	Internal	External
Online Test	-	100
		P/F

26AIE498	**PROJECT PHASE-2**	**L-T-P-C: 0-0-12-6**

Course Objectives

- In this phase, the emphasis is on fine-tuning the problem statement through the insights obtained from the identification of any existing research gaps.
- This phase involves providing a detailed representation of the solution strategy, including modules and workflow, as well as designing the solution in terms of algorithms, diagrams, or models.
- This phase exposes the students to design-develop-debug cycle.
- The implementation of the solution is carried out in this phase.

Course Outcomes

At the end of this course the students will be able to:
CO1: Apply the insights from the problem analysis and literature survey to formalize the problem statement.
CO2: Design effective solution(s) for the identified problem.
CO3: Implement and verify the designed solution(s).

CO-PO Mapping

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

Evaluation Pattern: 70:30
Internal Marks: 70
External Marks: 30

SEMESTER VIII

26AIE499	PROJECT PHASE - 2	L-T-P-C: 0- 0- 12- 6

Course Objectives

- Project Phase – 2 aims at helping students to solve the identified research problem
- The course introduces the students to real world problems associated with AI
- The course also aims at helping students to publish scientific articles in peer reviewed scientific publications.

Course Outcomes

After completing the course, the students will be able to

CO1: Solve a valid research problem by employing appropriate tools & techniques.

CO2: Implement the appropriate methodology to solve the research problem.

CO3: Apply the AI tools & techniques to solve the identified problem.

CO4: Communicate scientific discoveries through peer-reviewed publications.

CO-PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	3	2	2	3	3	3	3	2	1	-	-
CO 2	3	3	3	3	3	2	2	3	3	3	3	1	2	1	-
CO 3	3	3	3	3	3	2	2	3	3	3	3	1	3	2	1
CO 4	3	3	3	3	3	2	2	3	3	3	3	1	1	2	1

Evaluation Pattern

Assessment	Weightage (%)
Internal	70
External	30

PROFESSIONAL ELECTIVES

26AIE430	**Agentic AI Systems**	**L-T-P-C:** 2-0-3-3

Pre-requisite: Python Programming, Machine Learning Fundamentals, Generative AI Basics

Course Objective

To provide students with the knowledge and practical skills required to design, develop, evaluate, and deploy autonomous AI agents capable of reasoning, planning, tool usage, memory management, multi-agent collaboration, and real-world task execution using modern Agentic AI frameworks.

Course Outcomes (COs)

CO1: Explain the foundational concepts, reasoning paradigms, planning methods, memory models, and mathematical principles underlying Agentic AI systems.

CO2: Design and Develop AI agents using contemporary frameworks and orchestration platforms for real-world applications.

CO3: Implement multi-agent systems with collaboration, communication, and coordination strategies.

CO4: Evaluate and deploy Agentic AI applications considering performance, reliability, safety, and ethical concerns.

CO-PO Mapping

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

Module 1:

Introduction to Agentic AI, Evolution from Traditional AI to Generative AI, LLMs, and Agentic AI, Characteristics of Autonomous Agents, Agent Architectures, Reactive and Deliberative Agents, Goal-Oriented Agents, Reasoning Paradigms, Planning Fundamentals, Agent Lifecycle, Human-in-the-Loop Systems, Agentic AI Applications and Case Studies.

Module 2:

Agent Decision Making, Chain-of-Thought Reasoning, Tree-of-Thought Reasoning, ReAct Framework, Reflection and Self-Correction, Task Decomposition, Planning Algorithms, Long-Term and Short-Term Memory, Episodic and Semantic Memory, Retrieval-Augmented Generation (RAG), Context Management, Knowledge Integration.

Module 3:

Agent Development Lifecycle, Prompt Engineering for Agents, Tool Calling and Function Calling, Workflow Orchestration, Agent Frameworks and Platforms, LangChain, LangGraph, CrewAI, AutoGen, Semantic Kernel, OpenAI Agents SDK, MCP (Model Context Protocol), Agent Evaluation Tools, Observability and Monitoring.

Module 4:

Multi-Agent Architectures, Agent Communication Protocols, Cooperative and Competitive Agents, Role-Based Agents, Swarm Intelligence, Agent Collaboration Strategies, Task Allocation, Distributed Decision Making, Agentic Workflows, Autonomous Research Agents, Coding Agents, Business Process Automation Agents. Agent -evaluation metrics, observability, safety, security, deployment, and applications of Agentic AI in research, healthcare, education, finance, cybersecurity and software engineering

Textbook/References

Albada, Michael. *Building Applications with AI Agents: Designing and Implementing Multiagent Systems*. 1st ed., O'Reilly Media, 2025. ISBN: 978-1098176501.

Agentic AI for Engineers: Architecting Goal-Driven Systems, O'Reilly / Springer-linked edition.

Jay Alammar and Maarten Grootendorst, *Hands-On Large Language Models*, O'Reilly Media, 2024.

LangChain, LangGraph, LlamaIndex, CrewAI, AutoGen, Semantic Kernel, OpenAI Agents SDK and Model Context Protocol official documentation.

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies, agent design exercises, reasoning and planning tasks, prompt engineering activities, and short tests on agentic AI concepts and architectures	20%

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Lab (CAL)	Internal	Development of autonomous agents, workflow automation tasks, tool integration exercises, multi-agent simulations, LLM-based agent implementation, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on agent architectures, planning, reasoning, memory systems, tool usage, multi-agent collaboration, and agentic AI fundamentals	20%
End Semester Assessment	External	Written Examination on agentic AI concepts, architectures, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving development of autonomous AI agents, workflow automation solutions, project demonstration, and viva voce	30%
Total			100%

26AIE431	APPLIED CRYPTOGRAPHY	L-T-P-C: 2-0-3-3

Course Objectives

- This course will provide a strong grasp of the basic concepts underlying classical, modern cryptography and its fundamentals.
- This course will help students to understand how security is defined and proven at the cryptographic level.
- This course will help students to understand common attacks and how to prevent them.
- This course will help students to gain the ability to apply appropriate cryptographic techniques to a security engineering (and management) problem at hand.

Course Outcomes

After completing this course, students will be able to

CO1: Implement the concepts of classical and modern cryptography.
CO2: Analyze the common attacks and the preventive systems.
CO3: Apply appropriate cryptographic techniques to a security engineering problem.
CO4: Implement canonical security protocols.

CO-PO Mapping

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

Syllabus

Overview of cryptography - What is a cipher, Basic symmetric-key encryption- One time pad and stream ciphers, Block ciphers, Block cipher abstractions: PRPs and PRFs, DES and Enhancements, AES, Attacks on block ciphers, Message integrity- Message integrity: definition and applications, Collision resistant hashing, Authenticated encryption: security against active attacks, Public key cryptography- Arithmetic modulo primes, Cryptography using arithmetic modulo primes, Public key encryption, Arithmetic modulo composites, RSA, Attacks on RSA, Rabin Cryptosystem, Discrete Logarithm Problem and related Algorithms, ElGamal Cryptosystem, Introduction to Elliptic Curve Cryptography, Digital signatures: definitions and applications, More signature schemes and applications, Identification protocols, Authenticated key exchange and SSL/TLS session setup, Zero knowledge protocols.

Textbooks / References

D. Bonesh and V Shoup, A Graduate Course in Applied Cryptography, Stanford university Press, Volume-0.4.

Katz, Jonathan, and Yehuda Lindell. Introduction to modern cryptography. Chapman and Hall/CRC, 2014.

Katz, Jonathan, Alfred J. Menezes, Paul C. Van Oorschot, and Scott A. Vanstone. Handbook of applied cryptography. CRC press, 1996.

Stallings, William. Cryptography and network security: principles and practice. Upper Saddle River: Pearson, 2017.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, cryptographic problem-solving exercises, security analysis tasks, case studies, and short tests on cryptographic principles and protocols	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of classical and modern cryptographic algorithms, key management exercises, cryptographic protocol implementation, security tool usage, attack simulations, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on cryptographic foundations, symmetric and asymmetric encryption, hashing, digital signatures, key exchange protocols, and security applications	20%
End Semester Assessment	External	Written Examination on cryptographic techniques, protocols, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving development or analysis of cryptographic solutions, project demonstration, and viva voce	30%
Total			**100%**

26AIE432	**NETWORK & WIRELESS SECURITY**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course covers security and privacy issues in wireless networks and systems, such as cellular networks, wireless LANs, wireless PANs, mobile ad hoc networks, vehicular networks, satellite networks, wireless mesh networks, sensor networks and RFID systems.
- This course will lay down the Functions, protocols and configurations for realizing authentication, key distribution, integrity, confidentiality and anonymity in wireless access networks for mobile users.
- This course presents security techniques employed in existing systems, such as WPAN, WLAN, UMTS and IMS.
- This course will help students to propose solutions for new network technology, such as various types of ad-hoc networks. Digital forensics in wireless systems.

Course Outcomes

After completing this course, students will be able to

CO1: Analyze security technology and methods for communication systems that provide services for mobile users by wireless access networks.
CO2: Analyze security mechanisms and protocols in wireless communication systems, such as the topical technologies of WLAN IEEE 802.11, WAN 802.16, GSM/UMTS/LTE, Ad-hoc and sensor networks.
CO3: Apply design principles, mechanisms and solutions used in wireless network security to obtain authentication and key transport protocols
CO4: Implement the security mechanisms and protocols using canonical models.

CO-PO Mapping

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

Syllabus

Introduction to network security and wireless network, Wireless network technologies and application, Security and Cryptography, Network Security Protocols, Security and Layered Architecture, Voice-Oriented Wireless Networks, Data-Oriented Wireless Networks, Security in Traditional Wireless Networks, Security in Wireless LAN, Security in Wireless Ad Hoc Network.

Textbooks / References

Xiao, Yang, Hui Chen, Shuhui Yang, Yi-Bing Lin, and Ding-Zhu Du. "Wireless network security." (2009), Springer.

Vacca, J. R, Guide to wireless network security. Springer Science & Business Media ,2006.

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, security analysis exercises, case studies on wireless attacks, protocol evaluation tasks, and short tests on network and wireless security concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Network security experiments, wireless security configuration, vulnerability assessment, intrusion analysis, protocol implementation, security tool usage, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on network security principles, wireless security protocols, authentication mechanisms, cryptographic techniques, and threat analysis	20%
End Semester Assessment	External	Written Examination on network and wireless security concepts, protocols, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving network security analysis, wireless security solution development, project demonstration, and viva voce	30%
Total			100%

26AIE433 INTRUSION DETECTION & PREVENTION SYSTEMS L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course helps the students to understand when, where, how, and why to apply Intrusion Detection tools and techniques in order to improve the security posture of an enterprise.
- This course helps the students to apply knowledge of the fundamentals and history of Intrusion Detection in order to avoid common pitfalls in the creation and evaluation of new Intrusion Detection Systems.
- This course helps the students to analyse intrusion detection alerts and logs to distinguish attack types from false alarms.

Course Outcomes

After completing this course, students will be able to
CO1: Analyze basic issues, concepts, principles, and techniques in intrusion detection.
CO2: Analyse intrusion detection systems for particular security requirements.
CO3: Design preventive systems for various engineering applications
CO4: Implement preventive systems for various engineering applications.

CO-PO Mapping

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

Syllabus

Introduction-Understanding Intrusion Detection – Intrusion detection and prevention basics – IDS and IPS analysis schemes, Attacks, Detection approaches –Misuse detection – anomaly detection – specification based detection – hybrid detection , Theoretical foundations of detection-Taxonomy of anomaly detection system – fuzzy logic – Bayes theory – Artificial Neural networks – Support vector machine – Evolutionary computation – Association rules – Clustering, Architecture and implementation-Centralized – Distributed – Cooperative Intrusion Detection – Tiered architecture, Justifying intrusion detection-Intrusion detection in security – Threat Briefing –Quantifying risk – Return on Investment (ROI), Applications and tools -Tool Selection and Acquisition Process – Introduction to various commonly used IDS and IPS Systems - Bro Intrusion Detection – Prelude Intrusion Detection – Cisco Security IDS – Snorts Intrusion Detection – NFR security, Legal issues and Organizations standards-Law Enforcement / Criminal Prosecutions – Standard of Due Care – Evidentiary Issues, Organizations and Standardizations.

Textbooks / References

Ali A. Ghorbani, Wei Lu, "Network Intrusion Detection and Prevention: Concepts and Techniques", Springer, 2010.

Carl Enrolf, Eugene Schultz, Jim Mellander, "Intrusion detection and Prevention", McGraw Hill, 2004 Paul E. Proctor, "The Practical Intrusion Detection Handbook ", Prentice Hall, 2001.
Ankit Fadia and Mnu Zacharia, "Intrusiion Alert", Vikas Publishing house Pvt., Ltd, 2007.
Earl Carter, Jonathan Hogue, "Intrusion Prevention Fundamentals", Pearson Education, 2006.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, intrusion analysis exercises, case studies on cyber-attacks, IDS/IPS rule design tasks, and short tests on intrusion detection and prevention concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Configuration and deployment of IDS/IPS tools, traffic monitoring, log analysis, attack detection experiments, signature and anomaly-based detection exercises, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on intrusion detection techniques, prevention mechanisms, attack analysis, IDS/IPS architectures, and security monitoring concepts	20%
End Semester Assessment	External	Written Examination on intrusion detection and prevention concepts, techniques, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving threat detection, security monitoring, IDS/IPS deployment or analysis, project demonstration, and viva voce	30%
Total			**100%**

26AIE434	**SOFTWARE VULNERABILITY ANALYSIS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course teaches software engineering techniques for building security into software as it is developed.
- This course introduces students to the discipline of designing, developing, and testing secure and dependable software-based systems.
- This course provides hands on experience in software security analysis and development using Fortify, Threat Modelling, and Rational AppScan software.

Course Outcomes

After completing this course, students will be able to
CO1: Analyse the security risk of a system under development.
CO2: Apply secure coding practices to prevent common vulnerabilities from being injected into software.
CO3: Design security requirements (which include privacy requirements).
CO4: Validate security requirements.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	1	3	2	3	2	1		2		3	3	-	-	-
CO2	2	2	3	2	3	2	2		2		3	2	1	-	-
CO3	2	3	3	2	3	2	3	3	2	2	3	1	2	1	-

CO4	2	3	3	2	3	2	3	3	2	2	3	1	2	1	-

Syllabus

Introduction to software and system security principles-Confidentiality, Integrity, and Availability, Isolation, Least Privilege, Compartmentalization, Threat Model, Bug versus Vulnerability, Secure Software Life Cycle-Software Design, Software Implementation, Software Testing, Continuous Updates and Patches, Modern Software Engineering, Memory and Type Safety - Pointer Capabilities, Memory Safety, Spatial Memory Safety, Temporal Memory Safety, a Definition of Memory Safety, Practical Memory Safety, Type Safety, Défense Strategies – Software verification, Software testing, Language-based security, Mitigations – data execution prevention, Address space layout randomization, Stack integrity, Safe exception handling, Fortify source, Control flow integrity, Code pointer integrity, sandboxing and software-based fault isolation, Attack vectors – Denial of service, information Leakage, Privilege escalation, Web security- Browser security, Command injection, Sql injection , Cross site scripting, Mobile security- Android system security, application-specific security measures.

Textbooks / References

Mathias Payer, "Software Security: Principles, Policies, and Protection", HexHive Books, edition 0.35, 2019
Anderson, Ross. Security engineering. John Wiley & Sons, 2008.
Dowd, Mark, John McDonald, and Justin Schuh. The art of software security assessment: Identifying and preventing software vulnerabilities. Pearson Education, 2006.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, vulnerability assessment exercises, secure coding reviews, case studies on software exploits, and short tests on software security concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Static and dynamic code analysis, vulnerability scanning, penetration testing exercises, secure coding practices, exploit analysis, security tool usage, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on software vulnerabilities, secure software development, threat modelling, vulnerability assessment techniques, and mitigation strategies	20%
End Semester Assessment	External	Written Examination on software vulnerabilities, security analysis, and mitigation techniques. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving vulnerability assessment, secure software analysis, remediation strategies, project demonstration, and viva voce	30%
Total			**100%**

26AIE435	**Cybercrime Forensics and Digital Forensics**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course provides an overview of global reach of the Internet and various cybercrimes in various domains.
- This course provides an overview of cybercrime and the digital law enforcement practices put in place to respond to them.
- The course will focus on the types and extent of current cyber-crimes, how the justice system responds to these crimes, the various constitutional protections afforded to computer users, the law and policies that govern cybercrime detection and prosecution, and related technologies.

Course Outcomes

After completing this course, students will be able to
CO1: Analyse the nature and scope of cybercrime.

CO2: Develop knowledge of major incidents of cybercrime and their resulting impact.
CO3: Analyse national and global digital law enforcement efforts
CO4: Evaluate the specific technology that facilitates cybercrime and digital law enforcement
CO-PO Mapping

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

Syllabus

Introduction to cybercrime, criminal law, courts, and law-making, Types of computer-related crimes, Sources of cybercrime law (substantive and procedural), Technology, cybercrime, and police investigations, Technology and crime, Cyber deviance, cybercrime, and cyber terror, Computer misuse crimes, Malware and automated computer attacks, Malware, DDoS attacks, and Botnets, Digital piracy and Intellectual property theft, Digital piracy, Copyright, trademark, and trade secrets, Pornography, prostitution, and sex crime, The Fourth Amendment, computers, and computer networks, Digital/Computer Forensics -Introduction to digital and computer forensics, Legal issues related to digital investigations, National security.

Textbooks / References

Thomas J. Holt, Adam M. Bossler, and Kathryn C. Seigfried-Spellar. 2015. Cybercrime and Digital Forensics: An Introduction. New York: Routledge. ISBN: 978-1138021303.
Nate Anderson. 2014. The Internet Police: How Crime Went Online, and the Cops Followed. New York: W.W. Norton & Company, Inc. ISBN: 978-0393349450.
Peter Grabosky. 2016. Cybercrime. Oxford/New York: Oxford University Press. ISBN: 978-0190211554. Kevin F. Steinmetz. 2016. Hacked: A Radical Approach to Hacker Culture and Crime. New York: New York University Press. ISBN: 978-1479869718.
Orin S. Kerr. 2013. Computer Crime Law (3ded.). St. Paul: Thomsen Reuters. ISBN: 978-0314281364. Susan W. Brenner. 2012. Cybercrime and the Law: Challenges, Issues, and Outcomes. Lebanon, NH: Northeastern University Press. ISBN: 978-1555537999.
Ralph D. Clifford. 2011. Cybercrime: The Investigation, Prosecution and Defense of a Computer-related Crime. Durham: Carolina Academic Press. ISBN: 978-1594608537.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, forensic case studies, cybercrime analysis exercises, legal and ethical issue discussions, and short tests on digital forensics concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Digital evidence collection, log analysis, network forensics, disk and memory forensics, forensic tool usage, incident investigation exercises, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on cybercrime investigation procedures, digital evidence handling, forensic techniques, legal frameworks, and incident response concepts	20%
End Semester Assessment	External	Written Examination on cybercrime investigation and digital forensics concepts and applications. OR Hybrid Mode Examination comprising written and forensic analysis/problem-solving components. OR Term Project involving digital forensic investigation, cybercrime analysis, project demonstration, and viva voce	30%
Total			**100%**

26AIE436	DISTRIBUTED SYSTEMS SECURITY	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course emphasises on the techniques for creating functional, usable, and high-performance distributed systems.
- The course focuses on security in networks and distributed systems and gives a short introduction to cryptography.
- The course covers threats against distributed systems, as well as applicable methods, technologies and standards to protect against these threats.

Course Outcomes

After completing this course, students will be able to
CO1: Analyse threats against distributed systems and the protection measures against such threats
CO2: Design secure distributed systems to evaluate the security of existing solutions.
CO3: Analyse the principles and standards of security protocols.
CO4: Implement cryptographic mechanisms to secure modern distributed systems.

CO-PO Mapping

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

Syllabus

Understanding the Core Concepts of Distributed Systems -distributed systems designs, system constraints, trade-offs and techniques in distributed systems, distributed system for different data and applications, Distributed system security-Access and location transparency, Processes and Communication, naming, Parallelization of tasks - Concurrency and Synchronization, Consistency and Replication, Distributed system Security and network protocols – types of attacks, encryption algorithms, authentication, public key cryptosystems, data verification.

Textbooks / References

Andrew S. Tannenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Pearson, 2007.
Belapurkar, Abhijit, Anirban Chakrabarti, HarigopalPonnapalli, Niranjan Varadarajan, Srinivas Padmanabhuni, and Srikanth Sundarrajan. Distributed systems security: issues, processes and solutions. John Wiley & Sons, 2009.
George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair, "Distributed Systems: Concepts and Design", Fifth Edition, Addison Wesley, 2011.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, security analysis exercises, case studies on distributed systems attacks, protocol evaluation tasks, and short tests on distributed systems security concepts	20%

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Lab (CAL)	Internal	Secure distributed application development, authentication and access control implementation, cryptographic protocol experiments, security monitoring exercises, vulnerability assessment, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on distributed systems security principles, secure communication, authentication mechanisms, access control, fault tolerance, and threat analysis	20%
End Semester Assessment	External	Written Examination on distributed systems security concepts, protocols, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving secure distributed system design, security analysis, project demonstration, and viva voce	30%
Total			**100%**

26AIE437 MEDICAL IMAGE PROCESSING L-T-P-C: 2- 0- 3- 3

Course Objectives:

- To provide the basics of different medical image modalities.
- To introduce the basic concepts applied in medical image processing.
- To introduce different machine learning/deep learning-based algorithms for medical image analysis.
- To apply tools and methodologies for medical image processing and analysis.

Course Outcomes

After completing this course, students will be able to:

CO1: Apply basic image processing techniques in medical data.

CO2: Implement image enhancement algorithms in medical data.

CO3: Implement image segmentation algorithms in medical data.

CO4: Apply machine learning/deep learning algorithms for medical image analysis.

CO-PO Mapping

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

Syllabus:

Unit 1

Imaging Modalities: Survey of major modalities for medical imaging: Ultrasound, X-ray, CT, MRI, PET, and SPECT.

Unit 2

Image Processing and Analysis: Registration, Feature Extraction: Edge Detection, Hough transform, Filtering: Noise removal and Image Enhancement, Segmentation, Domain transformation.

Unit 3

Introduction to Machine Learning/Deep Learning Approaches for Biomedical Image Classification, Biomedical Image Segmentation, Case studies on some recent advances in analysis of retinal, CT, MRI, ultrasound and histology images.

Textbooks/ References:

Sinha G. R, Patel, B. C., "Medical Image Processing: Concepts and Applications", Prentice Hall, 2014.

Gonzalez R C, Woods R E, "Digital Image Processing", Third Edition, Prentice Hall, 2007.

Rangayyan R M, "Biomedical Image Analysis", Fifth Edition, CRC Press, 2005.

Evaluation Pattern:

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, image analysis exercises, case studies on medical imaging applications, problem-solving tasks, and short tests on medical image processing concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Image enhancement, segmentation, feature extraction, image registration, medical image analysis using software tools, AI-assisted imaging experiments, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on medical imaging modalities, image processing techniques, feature analysis, segmentation methods, and diagnostic applications	20%
End Semester Assessment	External	Written Examination on medical image processing concepts, techniques, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving medical image analysis, diagnostic support applications, project demonstration, and viva voce	30%
Total			**100%**

26AIE438	BIOMEDICAL SIGNAL PROCESSING	L-T-P-C: 2- 0- 3- 3

Course Objectives

The objectives of this course are:

- To provide the basics of different types of biomedical signals.
- To introduce the basic concepts of time domain and frequency domain analysis in biomedical signals.
- To introduce machine learning/deep learning-based algorithms for biomedical signal analysis.
- To impart skills to develop efficient deep learning models on biomedical data.

Course Outcomes

After completing this course, students will be able to:

CO1: Apply basic time domain processing techniques in biomedical signals.

CO2: Implement frequency domain transformation algorithms in biomedical signals.

CO3: Implement decomposition-based filtering techniques in biomedical signals.

CO4: Apply machine learning/deep learning algorithms for biomedical signal analysis.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	3	2	-	3	3	-	3	3	1	2	0
CO2	3	2	2	2	3	3	-	3	3	2	3	3	2	2	0
CO3	3	2	2	2	3	3	-	3	3	2	3	3	2	2	1
CO4	3	3	2	2	3	3	-	3	3	2	3	2	3	3	2

Syllabus:

Unit 1

Introduction to Biomedical Signals: Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

Unit 2

Biosignal Analysis: Time-domain analysis of Biosignals, Fourier Spectrum of Biosignals, Short Time Fourier Transform and Spectrogram, Discrete Cosine Transform and its Applications, Signal Decomposition based

filtering: Wavelet Transform, Hilbert Transform, Empirical Mode Decomposition and Empirical Wavelet Transform.

Unit 3

Introduction to Machine Learning/Deep Learning Approaches for Biomedical Signal Detection and Classification. Performance Measures for Detection and Classification System. Case studies on some recent advances in analysis of biomedical signals.

Textbooks/ References:

Rangayyan R M, "Biomedical Signal Analysis: A case-study approach", Wiley India, 2009.

Eugene N. Bruce, "Biomedical Signal Processing and Signal Modeling", Wiley Inter-Science, 1st edition, 2000.

John.L.Semmlow, "Biosignal and Biomedical Image Processing: Matlab-based applications", CRC, 1st edition, 2004.

Stephen Mallet, "A Wavelet Tour of Signal Processing: The Sparse Way", 3rd edition, Academic Press, 2008.

Evaluation Pattern:

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, signal analysis exercises, case studies on biomedical applications, problem-solving tasks, and short tests on biomedical signal processing concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Time-domain and frequency-domain signal analysis, filtering techniques, feature extraction, ECG/EEG signal processing, machine learning-based signal analysis, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on biomedical signal characteristics, signal processing techniques, filtering methods, feature analysis, and healthcare applications	20%
End Semester Assessment	External	Written Examination on biomedical signal processing concepts, techniques, and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving biomedical signal analysis, healthcare analytics applications, project demonstration, and viva voce	30%
Total			**100%**

26AIE439	CLINICAL INFORMATION SYSTEM	L-T-P-C: 2- 0- 3- 3

Course Objectives

- To gain insights and situational experience with clinical information systems.
- To examine the effective use of data and information technology to assist the students to easily migrate from paper-based systems to CIS, thereby improving organizational performance.
- To understand the impacts of CIS on patients and health care providers.

Course Outcomes

After completing this course, students will be able to:

CO1: Explore the basics of clinical information systems.

CO2: Apply information technology and related tools in workflow design.

CO3: Explore the "benefits and barriers" associated with electronic health records.

CO4: Apply strategies for minimizing the major barriers to the adoption of electronic health records.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	3	2	-	3	3	1	3	1	1	2	2
CO2	3	3	3	3	3	2	1	3	3	3	3	1	2	2	2
CO3	3	3	1	1	3	2	-	3	3	1	3	0	1	3	3
CO4	3	3	3	3	3	2	1	3	3	3	3	0	1	3	3

Syllabus:

Unit 1

Introduction to clinical information systems – contemporary issues in healthcare – workflow and related tools for workflow design – electronic health records databases – Healthcare IT & portable technology.

Unit 2

Data mining in health care, Artificial intelligence in health care: Use of AI, The healthcare industry, Electronic medical records, Clinical decision support systems.

Unit 3

Bioethics and challenges to deployment, Challenges in clinical decision support.

Textbooks/ References:

Sittig & Ash, Clinical Information Systems – Overcoming Adverse Consequences, Jones & Bartlett Learning Publishers, 2009.

Edward H. Shortliffe; Leslie E. Perreault, Medical Informatics – Computer Applications in Healthcare and Biomedicine, Springer-Verlag New York Inc. Publishers, 2014.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies on healthcare information systems, workflow analysis exercises, electronic health record (EHR) evaluation tasks, and short tests on clinical information system concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Clinical data management exercises, EHR system exploration, healthcare database design, workflow modelling, health informatics applications, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on clinical information systems, healthcare workflows, electronic health records, interoperability, and health informatics concepts	20%
End Semester Assessment	External	Written Examination on clinical information systems, health informatics, and EHR concepts. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving healthcare information system design, clinical data management applications, project demonstration, and viva voce	30%
Total			**100%**

26AIE440	**KINEMATICS & KINETICS FOR ROBOTICS**	**L-T-P-C: 2-0-3-3**

Course Objectives

- To introduce the basic concepts of Kinetics & Kinematics of robotic systems and investigate the connections between Kinetics and Kinematics of robotic systems.
- The course will introduce the state-of-the-art computational tools to solve the Kinetics and Kinematics problems

Course Outcome

After completing this course, the students will be able to

CO1: Understand the fundamentals of Kinematics & Kinetics for Robotics.

CO2: Apply the concepts of vector mechanics for solving Kinematics problems.

CO3: Apply computational techniques to solve Kinematics & Kinetics problems.

CO4: Implement computational models for Kinematics & Kinetics problems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	2	1		3	2	3	3	3	-	-	-
CO2	3	3	2	2	2	1		3	2	3	3	2	2	-	-
CO3	3	3	3	3	3	2		3	2	3	3	3	2	1	-
CO4	3	3	3	3	3	2		3	2	3	3	1	2	1	1

Syllabus

Components and Mechanisms of a Robotic System – Link – Joint – Manipulator – Actuator – Sensor – Controller – Kinetics and Kinematics of Robots – Rotation Kinematics – Rotation about Global and Local Axes – Euler angles – Transformation Matrices – Rotation Matrix – Quaternion – Composition and decomposition of Rotations - Homogeneous transformation – Inverse Homogeneous transformation – Compound homogeneous transformation – Forward Kinematics – D-H Notation – Inverse Kinematics – Angular Velocity – Velocity Kinematics – Numerical Methods in Kinematics.

Textbooks/References

Theory of Applied Robotics: Kinematics, Dynamics & Control – R. Jazar, Springer, 2010.

Statics and Kinematics with application to Robotics: J. Duffy, Cambridge University Press, 1996.

Kinematics and Dynamics of Machinery – Wilson & Sadler, Third Edition, Pearson Publication, 2003.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, kinematic analysis exercises, robot motion problems, workspace analysis tasks, and short tests on robotic kinematics and kinetics concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Forward and inverse kinematics implementation, robot motion simulation, trajectory planning exercises, dynamic modelling, robotic arm analysis, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on robot kinematics, transformations, velocity and acceleration analysis, dynamics, and motion planning concepts	20%
End Semester Assessment	External	Written Examination on robotic kinematics, kinetics, and motion analysis. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving robot modelling, motion simulation, trajectory planning, project demonstration, and viva voce	30%
Total			**100%**

26AIE441	DYNAMICS & CONTROL OF ROBOTICS	L-T-P-C: 2-0-3-3

Course Objectives

- To provide a mathematical foundation to dynamics and control of robotic systems and introduce a set of analytical and computational tools for the modelling and control of robots.
- This will enable the students to simulate and control robotic motion for various types of robotic systems.

Course Outcome

After completing this course, the students will be able to

CO1: Develop mathematical models for dynamics and control of robotic systems.

CO2: Apply analytical and computational tools for modelling and control of robots.

CO3: Simulate simple robotic motion.

CO4: Control simple robotic motion.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	3	2	1	-	3	3	3	3	3	-	-	-
CO2	3	3	3	3	3	1	-	3	3	3	3	3	1	-	-
CO3	3	2	3	3	3	2	-	3	3	3	3	-	3	2	-
CO4	3	2	3	3	3	2	-	3	3	3	3	2	2	1	1

Syllabus

Dynamics of Robotics – Acceleration Kinematics – Motion Dynamics – Review of Rigid body Kinetics – Translational Kinetics – Rotational Kinetics – Rigid link acceleration – Newton-Euler dynamics – Recursive Newton – Euler Dynamics – Lagrange Equations – Robot Statics – Introduction to control of robotics – Path Planning – Polynomial Path – Non-Polynomial Path – Cartesian Path – Rotational Path – Manipulator Motion – Time optimal control – Bang – Bang control – Open Loop and Closed Control – Classical Control Techniques – Modern Control Techniques – Sensing and Control.

Textbooks / References

Theory of Applied Robotics: Kinematics, Dynamics & Control – R. Jazar, Springer, 2010.

Advances in Robotics, automation and control: Aramburo& Trevino, In-Tech Publishers, 2008.

Robotics: Modelling, Planning & Control- B Siciliano, L Sciavicco, L Villani & G Oriolo. Springer Text books in Control and Signal Processing, 2009.

Aspects of Soft Computing, Intelligent Robotics and Control –Janos Fodor – Springer Publishers, 2009.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, control system analysis exercises, dynamic modelling problems, stability analysis tasks, and short tests on robotics dynamics and control concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Dynamic modelling of robotic systems, controller design and tuning, simulation of robotic motion, trajectory tracking experiments, stability analysis, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on robot dynamics, equations of motion, feedback control, stability analysis, and control system design concepts	20%
End Semester Assessment	External	Written Examination on robotics dynamics and control concepts. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving robotic control system design, simulation and performance evaluation, project demonstration, and viva voce	30%
Total			100%

26AIE442 ROBOTIC OPERATING SYSTEMS & ROBOT SIMULATION L-T-P-C: 2- 0- 3- 3

Course Objectives

- To provide an introductory understanding on robotic operating system and gazebo simulation environment.
- To introduce the students with module developments in ROS for mobile robot control, navigation and environment mapping.
- To introduce the students with module developments in ROS for industrial robot control, path planning and trajectory planning.

Course Outcomes

After completing this course student will be able to,

CO1: Apply the principles of ROS for module development of robotic systems.

CO2: Analyse various robotic systems using ROS integrated simulation platforms.

CO3: Apply the knowledge of robotic system and ROS for mobile robot control, navigation and environment mapping using ROS simulators.

CO4: Develop prototypical robotic systems using ROS for real-time problems.

CO-PO Mapping

PO/ PSO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PS O3	PS O4
CO															
CO1	1	2	1	1	3	2	-	3	3	-	2	3	-	-	-
CO2	3	2	1	2	3	2	-	3	3	-	-	2	1	-	-
CO3	3	2	3	2	3	-	3	3	3	3	2	2	1	-	-
CO4	3	2	3	2	3	-	3	3	3	3	2	1	3	1	1

Syllabus

ROS concepts - Preliminaries – Publishing a topic – Subscribing to a topic – Latched topics – Defining message types – Mixing Publishers and subscribers – Services – Defining a service – Implementing a service – Using a service – Actions – Definition of an Action – Implementing a basic action server – Robots model and Simulators – Sub systems – Actuation: Mobile platform – Actuation manipulator arm – Cameras and Scanners

Textbook /Reference Books

Joseph, Lentin, and Jonathan Cacace. Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System. Packt Publishing Ltd, 2018.

Programing Robots with ROS', M. Quigley, B. Gerkey, and W. D. Smart, Oreilly Publishers, 2015.

Koubâa, Anis, ed. Robot Operating System (ROS). Vol. 1. Cham: Springer, 2017.

'ROS Robotics by example', Fairchild & Harman, PACKT Publishing, 2016

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, ROS architecture exercises, simulation-based problem-solving tasks, middleware concepts, and short tests on robotic operating systems and simulation frameworks	20%
Continuous Assessment – Lab (CAL)	Internal	ROS programming, node and topic implementation, sensor integration, robot simulation using Gazebo or equivalent tools, navigation and control experiments, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on ROS fundamentals, communication mechanisms, robotic software architecture, simulation environments, and robot control concepts	20%
End Semester Assessment	External	Written Examination on robotic operating systems and simulation concepts. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving ROS-based robotic application development, simulation and performance evaluation, project demonstration, and viva voce	30%
Total			**100%**

26AIE443	Underactuated Robotics	L-T-P-C: 2- 0- 3- 3

Course Objectives

- This course covers nonlinear dynamical aspects and control of mechanical systems that are underactuated, with a focus on computational approaches.
- The course helps in establishing the understanding of nonlinear dynamics of robotic manipulators, applied optimal and robust control and motion planning
- The course aims to discuss examples from biology and applications to legged locomotion, compliant manipulation, underwater robots, and flying machines.

Course Outcomes

After completing this course, students will be able to:

CO1: Analyze nonlinear underactuated systems

CO2: Demonstrate simple robot models for walking and running

CO3: Simulate the dynamics and control of Highly articulated robots

CO4: Perform nonlinear planning and control of simple robot models.

CO-PO Mapping

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

Syllabus

Underactuated systems – Introduction, Nonlinear modelling – Simple pendulum, Nonlinear analysis of complicated systems – Acrobots - Cart-poles – Quadrotores – Pendubot - Inertia wheel pendulum - Furuta pendulum (horizontal rotation and vertical pendulum) – Hovercraft, Models for – Walking – Running – Walking and Running, Highly-articulated Legged Robots, Model Systems with Stochasticity, Nonlinear Planning and Control – Dynamic programming, Linear Quadratic Regulators, Lyapunov Analysis, Trajectory Optimization, Policy Search, Motion Planning as Search, Feedback Motion Planning, Robust and Stochastic Control, Output Feedback, Algorithms for Limit Cycles, Planning and Control through Contact, Estimation and Learning - System Identification, State Estimation, Model-Free Policy Search

Textbooks:

Anthony Bloch and P. Crouch and J. Baillieul and J. Marsden, "Nonholonomic Mechanics and Control", Springer, April 8, 2003.
Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Boulder, CO: Westview Press, 2001. ISBN: 9780738204536.

Fantoni, Isabelle, and Rogelio Lozano. Non-linear Control for Underactuated Mechanical Systems. New York, NY: Springer-Verlag, 2002. ISBN: 9781852334239.
Bertsekas, Dimitri P. Dynamic Programming and Optimal Control. 3rd ed. Vols. I and II. Nashua, NH: Athena Scientific, 2007. ISBN: 9781886529083 (set).
LaValle, Steven M. Planning Algorithms. New York, NY: Cambridge University Press, 2006. ISBN: 9780521862059.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, analysis of underactuated systems, control challenges, motion planning exercises, and short tests on underactuated robotics concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Modelling and simulation of underactuated robotic systems, controller implementation, trajectory generation, balancing and stabilization experiments, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on dynamics of underactuated systems, nonlinear control, motion planning, stability analysis, and control strategies	20%
End Semester Assessment	External	Written Examination on underactuated robotics concepts and control techniques. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving modelling, simulation, and control of underactuated robotic systems, project demonstration, and viva voce	30%
Total			**100%**

26AIE444	**PROBABILISTIC ROBOTICS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- The course aims at statistical techniques for representing information and making decisions in robotics.
- The course helps to overcome the uncertainty that arises in most contemporary robotics applications.

Course Outcomes

After completing this course, students will be able to:

CO1: Enumerate the fundamental aspects concerning mobile robotics.

CO2: Apply state estimation techniques and observability filters to mobile robots.

CO3: Apply simultaneous localization and mapping and its variations for mobile robot path planning.

CO4: Analyze the decision-making process for mobile robots.

CO-PO Mapping

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

Syllabus

Introduction & Robot Paradigms, State Estimation, Gaussian Filters - Kalman Filter - Extended Kalman Filters & Geometric Approach, Nonparametric Filters - Discrete and Particle Filters, Wheeled Locomotion & Robot Motion Models, Sensors & Robot Perception Models, Mapping with known poses, SLAM - The FastSLAM Algorithm - GraphSLAM - Self SLAM, Exploration and 3D Mapping, Uncertain knowledge and reasoning - Probabilistic Reasoning - Probabilistic Reasoning over Time - Making Simple Decisions - Making Complex Decisions -Multiagent Decision Making – Robotics.

Textbooks / Reference Books

Sebastian Thrun, Wolfram Burgard and Dieter Fox, Probabilistic Robotics, The MIT Press, 2005. ISBN: 9780262201629, 3rd edition.
Stuart Russell and Peter Norvig 'Artificial Intelligence - A Modern Approach' 3rd edition.
Machine Learning: A Probabilistic Perspective, Kevin Patrick Murphy. MIT Press, 2012.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, probabilistic modelling exercises, localization and mapping problems, uncertainty analysis tasks, and short tests on probabilistic robotics concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of Bayesian filters, Kalman filters, particle filters, localization and mapping algorithms, robot perception experiments, simulation exercises, and mini projects.	30%
Mid-Term Examination	Internal	Written examination focusing on probability theory, state estimation, localization, mapping, sensor fusion, and probabilistic decision-making in robotics	20%
End Semester Assessment	External	Written Examination on probabilistic robotics concepts and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving localization, mapping, state estimation, or probabilistic robotic system development, project demonstration, and viva voce.	30%
Total			**100%**

26AIE445	SENSORS AND ACTUATORS FOR ROBOTICS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course aims to give a reasonable understanding of the principles and operations of sensors and actuators for robotics
- The course helps with the selection of sensors and actuators for the robot based on the application.

Course Outcomes

After completing this course, students will be able to:

CO1: Distinguish the different classes of sensors and actuators suitable for robotics application

CO2: Analyze the principle of operation of different sensors and actuators used in robotics application

CO3: Design sensors and actuators for robotics applications with easy implementation and cost-effectiveness.

CO4: Identify the best sensor and actuator for accomplishing the work with accuracy, convenient operating features, and great functionality.

CO-PO Mapping

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

Syllabus

Sensors for robots: Sensor classification and characteristics, Touch and proximity sensors: IR, Photodiodes. Tactile sensors, collision sensors, interaction sensors – proximity/distance sensors, Position measurement: Optical encoder, Potentiometer, 2D and 3D cameras, Velocity measurement. Inertial sensors: Gyroscopes, Accelerometer. Force sensors, Torque sensors. Range sensors: IR, Ultrasonic sensors, laser ranger finder. Robot actuators: Hydraulic actuators, Pneumatic Actuator, Electrical actuator, Introduction to motors: DC motors, AC motors, Stepping motors, Servo motors. Motion transmission: Gear transmission, Belt transmission. Harmonic drive.

Textbooks / References

Sensors, Actuators, and Their Interfaces: A multidisciplinary introduction, 2nd edition. Nathan Ida, 2020.
Industrial Robotics: Technology Programming and Applications, 2nd Edn, Mikell P Groover, Tata McGraw Hill Education Private Limited, 2012.
John J Craig, Introduction to Robotics, Mechanics and control, second edition Addison – Wesley, 1999.
Robert J Schilling: Fundamentals of Robotics, Analysis and Control. Prentice Hall of India, 1996.
http://www.societyofrobots.com/robot_tutorial.sh tml#sensors
http://www.sensorcentral.com/photoelectric/ultra sonic01.php

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, sensor characterization exercises, actuator selection problems, signal conditioning tasks, and short tests on sensors and actuators used in robotics	20%
Continuous Assessment – Lab (CAL)	Internal	Sensor interfacing, actuator control experiments, calibration exercises, data acquisition tasks, embedded system integration, robotic sensing applications, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on sensor principles, actuator technologies, signal processing, interfacing techniques, and robotic sensing systems	20%
End Semester Assessment	External	Written Examination on sensors, actuators, and robotic sensing systems. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving sensor-actuator integration for robotic applications, project demonstration, and viva voce	30%
Total			**100%**

26AIE446	NLP FOR ROBOTICS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course aims to introduce spoken language technology with an emphasis on dialog and conversational systems
- The course helps in establishing the understanding of Deep learning and other methods for automatic speech recognition, speech synthesis systems for robotics

Course Outcomes

After completing this course, students will be able to:

CO1: Apply the basics of speech and language processing for robotics.

CO2: Build Dialog systems using the NLP pipeline for robotics.

CO3: Implement different end-to-end deep neural network approaches for speech recognition.

CO4: Build text to speech systems for dialogue systems

CO-PO Mapping

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

Syllabus

Introduction and Acoustic Phonetics, Overview of dialog: Human conversation. Task-oriented dialog. Dialog systems, Machine Learning in Dialog- Recurrent NNs, Attention, Transformers, Automatic Speech Recognition, Foundation models for spoken language-Using the Speech Brain ASR toolkit, Advanced ASR, Text to Speech (TTS): Overview. Text normalization, Spectrogram prediction, Vocoding, TTS Evaluation.

Textbooks / Reference Books

Dan Jurafsky and James H. Martin. Speech and Language Processing, (3rd ed. draft), available at https://web.stanford.edu/~jurafsky/slp3/
Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing. Available at https://u.cs.biu.ac.il/~yogo/nnlp.pdf
Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Deep Learning. MIT Press. Available at https://www.deeplearningbook.org/

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, language understanding exercises, dialogue analysis tasks, case studies on human-robot interaction, and short tests on NLP concepts for robotics	20%
Continuous Assessment – Lab (CAL)	Internal	Text preprocessing, intent recognition, command interpretation, conversational agent development, speech-to-text integration, NLP-enabled robotic applications, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on NLP fundamentals, language models, dialogue systems, semantic understanding, and NLP applications in robotics	20%
End Semester Assessment	External	Written Examination on NLP techniques and robotic communication systems. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving development of NLP-enabled robotic applications, human-robot interaction systems, project demonstration, and viva voce	30%
Total			**100%**

26AIE447	**DATA DRIVEN CONTROL IN ROBOTICS**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

1. The course aims to review the basic modelling and control aspects of robotic systems.
2. The course then directs to data-based methods for better control of robotic systems.
3. The course also covers the computer vision part essential for data-based control of robotics.
4. The course also imparts knowledge about learning based control systems.

Course Outcomes

After completing this course, students will be able to:

CO1: Apply principles of computer vision and machine learning for robotic control

CO2: Model dynamical robot systems using data driven techniques.

CO3: Apply machine learning techniques to build more robust robotic systems

CO4: Apply neural networks to do overall control of mobile robots.

CO-PO Mapping

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	1	-	3	-	-	3	3	-	3	3	2	1	1
CO 2	3	3	3	3	3	-	1	3	3	-	3	2	2	-	-
CO 3	3	3	3	3	3	2	1	3	3	-	3	3	3	2	1
CO 4	3	3	3	3	3	2	1	3	3	-	3	3	3	2	1

Syllabus

System Modelling - Control System Principles - Computing, Measurement, State, and Parameter Estimation - Decision-Making and Machine Learning - Numerical Methods for Evaluation and Search - Expert Systems - Neural Networks for Classification and Control - Vision for Robots: Mid-Level Visual State Estimation, Direct Perception, Active and Interactive Perception, Self-Supervised Image Representations: Unstructured Full-Scene Representations, Object and Key point - Structured Representations. Learning - Based Control: Predictive Models and Forward Dynamics Models, Model-Based Reinforcement Learning and Visual Servoing, Model-Free Reinforcement Learning and Sim-to-Real Transfer, Learning from Demonstrations.

Text Books / Reference Books

H. Asada and J.-J. Slotine, Robot Analysis and Control, J. Wiley & Sons, 1986.
M. Brady, J. Hollerbach, T. Johnson, T. Lozano-Perez, and M. Mason, Robot Motion: Planning and Control, MIT Press, 1984.
P. Corke, Robotics, Vision, and Control, Springer, 2011.
A. Staugaard, Jr., Robotics and AI: An Introduction to Applied Machine Intelligence, Prentice-Hall, 1987.
P. Antsaklis and K. Passino, An Introduction to Intelligent and Autonomous Control, Kluwer, 1993.
D. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989.
D. Kortenkamp, R. Bonasso, and R. Murphy, ed., Artificial Intelligence and Mobile Robots, AAAI Press, 1998.
K. P. Valavanis and G. N. Saridis, Intelligent Robotic Systems: Theory, Design, and Applications, Kluwer, 1992.
P. Winston and R. Brown, Artificial Intelligence: An MIT Perspective, MIT Press, 1979.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, control system analysis exercises, data-driven modelling tasks, case studies on intelligent robotic control, and short tests on data-driven control concepts	20%
Continuous Assessment – Lab (CAL)	Internal	System identification experiments, controller design using data-driven approaches, machine learning-based control implementation, simulation studies, robotic control applications, and mini-projects	30%

Component	Internal / External	Suggested Assessment Methods	Weightage
Mid-Term Examination	Internal	Written examination focusing on control theory, system identification, learning-based control, optimization techniques, and data-driven decision making in robotics	20%
End Semester Assessment	External	Written Examination on data-driven control concepts and robotic applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving development of data-driven control solutions for robotic systems, project demonstration, and viva voce	30%
Total			100%

26AIE448	INTRODUCTION TO DRONES	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The main aim of this course is to understand the basics of Unmanned Arial Vehicles (Drones) and its various applications in the age of artificial intelligence.
- The course will take the students to understand the basic dynamics of drone based flying system.
- The course will provide the knowledge of basic electronic components and their working principles in a drone/ Unmanned Aerial vehicle system
- The course will also impart the knowledge of how to fly a drone by considering the rules and regulations to the specific country.

After completing this course, the students will be able to

CO1: Distinguish the right drone / UAV flying regulations specific to India

CO2: Analyse the working principles of various electronic components to build the drone

CO3: Apply the concept of drone dynamics and different movements during flight

CO4: Illustrate UAV flying in the given environment

CO-PO Mapping

PO /PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	-	3	3	3	-	2	1	2	1	-	-	-
CO2	3	1	2	1	3	-	2	2	2	3	2	2	-	-	-
CO3	3	3	2	1	3	2	3	2	2	3	2	2	2	-	-
CO4	3	3	3	1	3	3	3	2	1	-	2	1	2	2	1

Syllabus

Introductions to drones and its applications in the age of AI, Drone regulations specific to India, Basics of drone dynamics for flying - frame types, propellers, types of drones, dynamics specific to quadcopter, Understanding

UAV movements (Quadcopter), How to fly a drone, Introduction to drone electronic components, working principle behind each electronic component, Drone and electronic assembly, flying experiments.

Textbook / References

Syed Omar Faruk Towaha, Building Smart Drones with ESP8266 and Arduino: Build exciting drones by leveraging the capabilities of Arduino and ESP8266, Packt Publishing, 2018.

Barnhart, R. Kurt, Douglas M. Marshall, and Eric Shappee, eds. Introduction to unmanned aircraft systems. Crc Press, 2021.

Garg, P. K. Unmanned Aerial Vehicles: An Introduction. Stylus Publishing, LLC, 2021

Kimon P. Valavanis, Handbook of Unmanned Aerial Vehicles, Volume4, Springer Netherlands, 2014.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, drone system analysis exercises, flight dynamics problems, case studies on UAV applications, and short tests on drone technologies and operations	20%
Continuous Assessment – Lab (CAL)	Internal	Drone simulation exercises, flight control experiments, mission planning tasks, sensor integration, UAV data acquisition activities, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on drone fundamentals, UAV architectures, flight dynamics, navigation systems, sensors, communication, and regulatory aspects	20%
End Semester Assessment	External	Written Examination on drone technologies and UAV applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving drone-based solution development, flight simulation and analysis, project demonstration, and viva voce	30%
Total			**100%**

26AIE449	**INTRODUCTION TO DIGITAL MANUFACTURING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course will at imparting the knowledge of basics of digital manufacturing and its importance in current era.
- It will also equip the students to understand about the basics of Additive manufacturing used in various industry applications.
- Further it will expose the students to additive manufacturing technology using 3-D printing.

Course Outcomes

After completing this course, the students will be able to

CO1: Assemble and use a 3D printer.

CO2: Design simple 3D design using CAD packages.

CO3: Illustrate Slicing and evaluate the model in a CAD packages.

CO4: Design small robots and DIY projects comprising of 3D printed parts.

CO-PO Mapping

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

Syllabus

History of Manufacturing: From classical to Additive manufacturing, 3D Printers and Printable Materials, 3D Printer Workflow and Software, selecting a printer: Comparing Technologies, working with a 3D Printer, 3D Models, Applications, Building Projects

Textbook/References:

Joan Horvath, Rich Cameron, Mastering 3D Printing in the Classroom, Library and Lab, Apress, 2018.

https://ultimaker.com/en/resources/education/3d-printing-in-the-classroom

Brian Evans, Practical 3d Printers the Science and Art of 3d Printing, Apress, 2018.

Chris Anderson, Makers-The New Industrial Revolution, Crown Publishing, 2018.

Kalani Kirk Hausman and Richard Horne 3D Printing for Dummies, Wiley Publications, 2018.

Ben Redwood, Filemon Schoffer, Brian Garret, 3D Printing Handbook, Technologies design and Applications, 3D Hubs, 2018.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies, manufacturing process analysis exercises, digital manufacturing workflow tasks, and short tests on Industry 4.0 concepts	20%
Continuous Assessment – Lab (CAL)	Internal	CAD/CAM exercises, digital manufacturing simulations, additive manufacturing tasks, process optimization experiments, smart manufacturing applications, and mini projects	30%

Component	Internal / External	Suggested Assessment Methods	Weightage
Mid-Term Examination	Internal	Written examination focusing on digital manufacturing fundamentals, smart factories, additive manufacturing, CAD/CAM technologies, and Industry 4.0 concepts	20%
End Semester Assessment	External	Written Examination on digital manufacturing concepts and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving digital manufacturing solution development, process simulation and analysis, project demonstration, and viva voce	30%
Total			**100%**

26AIE450	**SPEECH PROCESSING**	**L-T-P-C: 2- 0- 3- 3**

Course Objective

- The objective of the course is to understand acoustic theory behind the human speech production systems.
- As a part of this course students will be able to analyze time and frequency domain features from a speech signal.
- Further student will be able to implement ML/DL based models for speech technology applications.

Course Outcomes

After completing this course, students will be able to

CO1: Analyse the acoustics behind of the production of a speech signal

CO2: Differentiate the characteristics of different speech sounds

CO3: Analyse the time-domain and frequency domain features of the speech signal

CO4: Implement various ML/DL approaches for modelling speech towards applications such as classification, detection, and recognition.

CO-PO Mapping

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

Syllabus

Overview of Speech Processing Systems, Speech Production and Perception, Speech Signal Characteristics, Properties of speech sounds-Vowels and Consonants. Short time processing of speech- Time Domain parameters,

Frequency domain parameters, Spectrograms, Cepstral Analysis, Mel-frequency Cepstral Coefficients, Linear Prediction Analysis - Speech Recognition- GMM-HMM, Machine learning and Deep neural network models used for speech modelling and classification, Speech synthesis, End-to-End Models for speech technology applications.

Textbooks / References

'Fundamentals of Speech Recognition', L. Rabiner, Biing-Hwang Juang and B. Yegnanarayana, Pearson Education Inc.2009

'Speech Communication', Douglas O'Shaughnessy, University Press, 2001

'Discrete Time Speech Signal Processing', Thomas F Quatieri, Pearson Education Inc., 2004

Hannun, Awni, et al. "Deep speech: Scaling up end-to-end speech recognition." arXiv preprint arXiv:1412.5567 (2014).

Collobert, Ronan, Christian Puhrsch, and Gabriel Synnaeve. "Wav2letter: an end-to-end convnet-based speech recognition system." arXiv preprint arXiv:1609.03193 (2016).

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, speech analysis exercises, feature extraction problems, case studies on speech applications, and short tests on speech processing concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Speech signal acquisition, feature extraction, speech analysis, speech enhancement experiments, speech recognition tasks, ML/DL-based speech applications, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on speech production, speech signal analysis, feature extraction, speech modelling, and speech processing techniques	20%
End Semester Assessment	External	Written Examination on speech processing concepts and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving speech analysis, recognition, or speech-enabled application development, project demonstration, and viva voce	30%
Total			**100%**

26AIE451	MODERN AND SMART MATERIALS	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course aims introduce current trends in materials for innovative solutions.
- The course helps in establishing the properties of modern and smart materials involved in innovative technologies.
- The course will augment the knowledge of Computational material science by considering the modelling and simulation of modern and smart materials.

Course Outcomes

After completing this course, students will be able to:

CO1: Identify modern and smart materials for innovative solutions.

CO2: Distinguish important properties of modern and smart materials.

CO3: Simulate modern and smart materials using various approaches in computational material science.

CO4: Analyse the simulated modern and smart materials.

CO-PO Mapping

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

Syllabus

Introduction to Smart materials, Piezoelectric materials, Magenetostrictive materials, Electroactive Polymers, Chromogenic materials, Shape Memory Alloys, Heat Energy Storage materials, Electro and Magneto Rheological Fluids, Smart hydrogels and Smart Polymers. Smart materials for 4D printing. Modelling and Simulation of Smart Materials. Introduction to Nanomaterials, Nanomaterial structure, Energy at Nanoscale, Functional Nanomaterials: metal nanoparticles, quantum dots, nanoclusters, carbon-based nanomaterials, organic, inorganic, hybrid nanomaterials, biomimetic nanomaterials, Modelling and simulation of Nanomaterials – Atomistic and Quantum methods.

Textbooks / Reference Books

'Engineering Analysis of Smart Material Systems', D.J. Leo, Wiley 2007.

'Smart Structures Physical Behaviour, mathematical Modelling and Applications' Paolo Gaudenzi, Wilet, 2009.

'Nanoscale Materials in Chemistry', Kenneth J. Klabunde, Ryan M. Richards, Wiley, 2009.

'Nano: The Essentials", T. Pradeep, McGraw-Hill (India) Pvt Limited, 2008.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, material characterization exercises, case studies on smart materials, problem-solving tasks, and short tests on modern and smart material concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Material property analysis, computational simulations, characterization experiments, smart material applications, modelling exercises, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on modern materials, smart material properties, material behaviour, computational modelling, and engineering applications	20%
End Semester Assessment	External	Written Examination on modern and smart materials concepts and applications. OR Hybrid Mode Examination comprising written and simulation/problem-solving components. OR Term Project involving material modelling, simulation, analysis of smart material applications, project demonstration, and viva voce	30%
Total			**100%**

26AIE452 DATA DRIVEN MATERIAL MODELLING AND SIMULATION L-T-P-C: 2- 0- 3- 3

Course Objectives

- The course aims to review the artificial intelligence concepts relevant to computational material science.
- The course focuses on using data driven modelling in order to solve various problems in computational material science.
- The course aims to apply the combination of artificial intelligence and material modelling to solve real systems through data-based simulations.
- The course also helps student analyse the data driven simulations and arrive at appropriate conclusions.

Course Outcomes

After completing this course, students will be able to:

CO1: Distinguish the artificial intelligence concepts applied to material science.

CO2: Apply various algorithms pertaining to machine learning to solve real-world material science problems.

CO3: Apply various algorithms pertaining to neural networks to solve real-world material science problems.

CO4: Analyse the data driven models to arrive at solutions to real-world problems in material science.

CO-PO Mapping

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

Syllabus

Machine learning – Regression, Classification and Kernel Learning, Deep learning Fundamentals – Common Neural Networks architectures, Explaining Predictions, Application of Machine learning and Neural networks in materials science – Unsupervised learning of material spaces, Kernel Ridge Regression for materials property Prediction, Deep learning for sequences, Predicting DFT energies with GNN, Gaussian Approximation Potentials and machine learning of force field, cmlkit – Toolkit for machine learning for Material science and Quantum Chemistry.

Text Books / Reference

'Deep Learning for Molecules and Materials', Andre white, [online], https://dmol.pub/intro.html.

'Machine learning in materials science: Recent progress and emerging applications,' Kusne, A., Mueller, T. and Ramprasad, R., Reviews in Computational Chemistry (2016), [online], https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=915933.

'Machine learning for quantum mechanics in a nutshell', Rupp, M. International Journal in Quantum Chemistry, 2015, 115, 1058– 1073. DOI:10.1002/qua.24954.

Nomad Tutorials . https://nomad-lab.eu/prod/v1/gui/analyze/tutorials

Recent Publications for AI in Material Science. https://archive.materialscloud.org/

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies on material informatics, machine learning exercises, data analysis tasks, and short tests on data-driven material modelling concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Data preprocessing, machine learning model implementation, material property prediction, simulation studies, computational material analysis, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on material informatics, machine learning techniques, neural networks, data-driven modelling, and simulation concepts	20%
End Semester Assessment	External	Written Examination on data-driven material modelling and simulation concepts. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project	30%

Component	Internal / External	Suggested Assessment Methods	Weightage
		involving material property prediction, data-driven simulation, model development and analysis, project demonstration, and viva voce	
Total			**100%**

26AIE453	COMPUTATIONAL DRUG DESIGN	L-T-P-C: 2- 0- 3- 3

Course Objectives

- The main objective of this course is to explore computer assisted drug design
- To understand molecular structure and sequence representations for proteins and ligands used in drug discovery
- To apply artificial intelligence–driven models for predicting, designing, and optimizing drug candidates by analyzing molecular structures, biological sequences, drug–target interactions, and ADMET properties.

Course Outcomes

After completing this course, students will be able to:

CO1: Explain basic concepts of drug discovery and molecular interactions.

CO2: Apply computational techniques like docking and virtual screening.

CO3: Analyses results from QSAR, pharmacophore, and molecular simulations.

CO4: AI-driven drug design and optimized drug like molecules.

CO-PO Mapping

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

Syllabus:

Unit 1

Introduction to Drug discovery and development pipeline – Target identification and validation – Types of biological targets (enzymes, receptors, ion channels) – Protein structure (primary to quaternary) – Molecular representation: SMILES - Ligand–receptor interactions and binding forces – Binding affinity and specificity – Structure-Based and Ligand-Based Drug Design – Introduction to databases: PDB, PubChem, DrugBank, ChEMBL

Unit 2

Molecular docking: principles and theory of docking - scoring functions (force-field based, empirical, knowledge-based) - Virtual screening -Pharmacophore modelling (subtopics)- QSAR - Molecular dynamics simulations - result analysis and interpretation of MD simulation result.

Unit 3

Introduction to Artificial Intelligence and Machine Learning in drug discovery - ADMET prediction – Drug-likeness and Lipinski's Rule of Five - Lead identification and optimization strategies -Drug repurposing approaches - AI-based drug–target interaction prediction - de novo drug design and generative models - Case studies (cancer, CNS drug design).

Textbooks/References

Daniel Jurafsky, James H Martin, Speech & language processing, preparation [cited 2020 June 1] Available from: https://web. stanford. edu/~ jurafsky/slp3 (2018).

Christopher Manning and Hinrich Schütze, F oundations of Statistical Natural Language Processing, MIT press, 1999.

Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, O'Reilly Media, Inc.,2009.

Jason Browlee, Deep Learning for Natural Language Processing: Develop Deep Learning Models for your Natural Language Problems (Ebook), Machine Learning Mastery, 2017.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, molecular modeling exercises, drug discovery case studies, structure–activity relationship (SAR) analysis, and short tests on computational drug design concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Molecular docking, virtual screening, protein–ligand interaction analysis, molecular visualization, ADMET prediction, use of computational drug design tools, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on drug discovery pipeline, molecular modeling, molecular docking, pharmacophore modeling, virtual screening, and computational drug design principles	20%
End Semester Assessment	External	Written Examination on computational drug design concepts and applications. **OR** Hybrid Mode Examination comprising written and implementation/problem-solving components. **OR** Project-Based Examination involving molecular docking, virtual screening, drug candidate analysis, computational modeling, project demonstration, and viva voce	30%
Total			**100%**

26AIE454	DEEP LEARNING IN GENOMICS AND BIOMEDICINE	L-T-P-C: 2-0-3-3

Course Objectives

- The goal of this course is to cover the overview of the relevant background in genomics.
- The course focuses the ongoing developments in deep learning applications of biomedical data.
- The course visualises the landscape of the genome.

Course Outcome

After completing this course, the students will be able to

CO1: Analyse the computational formats for representing genome.
CO2: Evaluate the open-source tools available for genome assembly.
CO3: Application of deep learning models available for genome annotations.
CO4: Create automated health database.

CO-PO Mapping

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

Syllabus

Unit 1

Introduction to deep learning - Applications of deep learning, Application of Deep learning to regulatory genomics-metagenomics-variant scoring and population genetics - probability and statistics.

Unit 2

Applications of deep learning to predicting protein structure and pharmacogenomics - Applications of deep learning to electronic health records and medical imaging data.

Textbooks / References

Polina Mamoshina, Armando Vieira, Evgeny Putin, Alex Zhavoronkov, Applications of deep learning in Biomedicine, Mol.Pharmaceutics, 2016.

Riccardo Miotto, Fei Wang, Shuang Wang, Xiaoqian Jiang, Joel T Dudley, Deep learning for healthcare: review, opportunities and challenges, Briefings in Bioinformatics, Vol.19, Issue.6, 2018.

Tianwei Yue, Haohan Wang, Deep Learning for Genomics: A Concise Overview, Handbook of Deep Learning Applications, Springer, 2018.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, genomics data analysis exercises, case studies on biomedical applications, deep learning problem-solving tasks, and short tests on genomics and AI concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Genomic data preprocessing, implementation of deep learning models for sequence analysis, genome annotation tasks, biomedical data analytics, model evaluation, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on genomics fundamentals, biomedical data analysis, deep learning architectures, genome annotation, and healthcare AI applications	20%
End Semester Assessment	External	Written Examination on deep learning in genomics and biomedicine concepts and applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving genomic data analysis, biomedical AI model development, genome annotation, or healthcare analytics applications, project demonstration, and viva voce	30%
Total			**100%**

26AIE455	**DNA SEQUENCING TECHNOLOGIES**	**L-T-P-C: 2-0-3-3**

Course Objectives

- The goal of this course is to cover the overview of DNA Sequencing.
- The course focus on the advancements in nucleic acid sequencing.
- The course emphasizes the interpretable, biological insights obtained from DNA Sequencing.

Course Outcomes

After completing this course, the students will be able to

CO1: Analyse the computational formats for representing read type in the DNA Sequencing.
CO2: Evaluate the open-source tools available for read-interpretations in DNA Sequencing.
CO3: Analyse the recent algorithms for signal-sequence conversion.
CO4: Create automated pipelines for the data analysis of comparative genomics.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	3	3		3	3		3	3	1	2	1
CO2	3	3	3	2	3	3		3	3		3	2	2	2	1
CO3	3	3	3	2	3	3		3	3		3	3	2	3	1

CO4	3	3	3	2	3	3		3	3		3	2	3	3	2

Syllabus

Unit 1

Introduction to Genome Sequencing – Applying Euler's theorem to assemble genomes - sequencing antibiotics - Introduction to Structural Variation - Advantages of long-read sequencing for structural variation analysis - Application of long-reads to structural variation analysis.

Unit 2

Data Analysis Tools for DNA sequencing - Accurate analysis of targeted genomic regions - Quantifying gene expression and transcriptome analysis - Simultaneous analysis of epigenetic modifications and sequence data – Metagenomic analysis of environmental samples - Applications of nanopore sequencing technologies to whole genome sequencing of human viruses.

Textbooks/References

Sudmant, P.H. et al, An integrated map of structural variation in 2,504 human genomes. Nature. 2015.

Lu, H., Giordano, F. and Ning, Z, Oxford Nanopore MinION Sequencing and Genome Assembly. Genomics Proteomics Bioinformatics, Vol.15, Issue.5, 2016.

Stankiewicz, P. and Lupski, J.R, Structural variation in the human genome and its role in disease. Annu Rev Med. Vol. 61, 2010.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, sequence analysis exercises, genomics data interpretation tasks, case studies on sequencing technologies, and short tests on DNA sequencing concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Sequence data processing, genome assembly exercises, read alignment, variant analysis, use of bioinformatics tools, comparative genomics tasks, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on DNA sequencing principles, sequencing platforms, genome assembly, sequence analysis, and bioinformatics workflows	20%
End Semester Assessment	External	Written Examination on DNA sequencing technologies and genomic data analysis. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving sequence analysis, genome assembly, comparative genomics, or bioinformatics pipeline development, project demonstration, and viva voce	30%
Total			**100%**

26AIE456	**CRISPR TECHNOLOGY**	**L-T-P-C: 2-0-3-3**

Course Objectives

- The goal of this course is to cover the overview of the relevant background in crispr technology and high-throughput biotechnology, focusing on the available data and their relevance.

- It will then cover the ongoing developments with the focus on the applications of these methods to biomedical data.

Course Outcomes

After completing this course, the students will be able to

CO1: Analyse and learn the discovery of Crisper with emphasis to molecular mechanisms.
CO2: Understand a base knowledge on various application of gene therapy.
CO3: To become familiar with experimental design.
CO4: create automated pipelines for identifying the associations between multiple genome editions.

CO-PO Mapping

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

Syllabus

Introduction to Genetic Engineering - History of Crispr – Crispr in bacteria – Classification of Crispr – General structure of cas9 protein – Mechanism of Crispr cas9 – Applications – Database of Crispr – Case studies.

Textbooks/References

Maximilian Haeussler, Jean-Paul Concordet, CRISPOR Manual, MIT, 2016. Singh et al: A Mouse Geneticist's Practical Guide to CRISPR Applications; Genetics, Vol.199, No.1, 2015.

Ran et al, Genome engineering using the CRISPR-Cas9 system, Nature Protocols, 2013.

Fujihara&Ikawaw, CRISPR/Cas9-Based Genome Editing in Mice by Single Plasmid Injection, Methods Enzymol. 2014.

Evaluation Pattern:

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, genome editing analysis exercises, case studies on CRISPR applications, gene therapy discussions, and short tests on CRISPR technology concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Guide RNA design exercises, sequence analysis, CRISPR tool exploration, genome editing workflow simulations, genomic data interpretation, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on CRISPR mechanisms, genome editing techniques, gene therapy applications, experimental design, and ethical considerations	20%
End Semester Assessment	External	Written Examination on CRISPR technology, genome editing, and gene therapy applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving genome editing analysis, CRISPR-based solution development, comparative genomics studies, project demonstration, and viva voce	30%
Total			**100%**

26AIE457	FULL STACK DEVELOPMENT	L-T-P-C: 2- 0- 3- 3

Course Objectives

- Full Stack Development is an indispensable course for computer science students. The course is concerned with end-to-end development of a three-tier web application.
- It deals with the frameworks necessary to implement front-end, back-end and database covering design, development and deployment.
- The course is designed to progress on both front-end and back-end in a synchronized fashion and leverages GitHub and Heroku for version control and deployment.
- The course includes a term project to reinforce the technologies learnt.

Course Outcomes

After completing this course, students will be able to

CO1: Use markup and scripting languages to design and validate dynamic web pages.

CO2: Customize pages for users need based on responsive web design concepts.

CO3: Learn to design appropriate database services based on the requirements.

CO4: Design, develop and deploy an end-to-end web application as a term project.

CO-PO Mapping

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PSO 2	PSO 3	PSO 4
CO1	2	1	1	-	3	1	-	2	-	2	1	3	-	-	-
CO2	2	1	1	2	3	1	-	2	-	2	1	3	-	-	-
CO3	3	2	3	2	2	1	-	2	-	2	2	3	2	-	-
CO4	2	2	2	2	2	1	-	3	3	3	2	3	3	1	1

Syllabus

Introduction to web development, Git and GitHub, Taxonomy of frameworks. HTML basics – structuring, positioning, alignment, CSS and JS basics, Browser development tools, Bootstrap basics. Basic Backend App serving text/HTML and HTML from templates. Jinja template, Semantic tags, HTTP components – parameters, headers, cookies, sessions, Handling forms, Serve-Handle JSON/XML requests, Intro to jQuery, jQuery request handling and Ajax, more jinja templating, Lists and tables, DOM styling, Responsive design. Database creation and connection, Creation of DB Schema from model, Adding relation between models, Intro to REST APIs, Basic CRUD app, Form and tables for CRUD services. Authentication, designing error pages, setup default error pages. Simple hosting on a public web host.

Textbooks / References

Laura Lemay, Rafe Colburn, Jennifer Kyrnin, "Mastering HTML, CSS & JavaScript Web Publishing", Paperback, 2016.

Jon Duckett, "Web Design with HTML, CSS, JavaScript and jQuery", Paperback, 2014.

Miguel Grinberg, "The New and Improved Flask Mega-Tutorial", Paperback., 2017.

Kunal Relan, "Building REST APIs with Flask: Create Python Web Services with MySQL", Paperback, 2019.

Evaluation Pattern:

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies, web architecture analysis exercises, software design tasks, and short tests on full-stack development concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Front-end development, back-end programming, database integration, REST API development, authentication and authorization implementation, deployment exercises, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on web technologies, client-server architecture, databases, APIs, software design, and full-stack development principles	20%
End Semester Assessment	External	Written Examination on full-stack development concepts and technologies. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving end-to-end web application development, deployment, project demonstration, and viva voce	30%
Total			**100%**

26AIE458	**MOBILE APPLICATION DEVELOPMENT**	**L-T-P-C: 2-0-3-3**

Course Objectives

- This is a hands-on elective course which introduces the fundamentals of native android application development using Android Studio.
- The students will learn to customize activities and intents, create rich user interface and manage data on databases such as SQLite.
- The course provides exposure to use various components such as services, async tasks, broadcast receivers and content providers.
- The students also learn to use various APIs such as Maps, Sensors and GPS enabling them to develop ready to use android applications for real-world use cases.

Course Outcomes

After completing this course, students will be able to

CO1: Understand the fundamental concepts of android operating system and android application development.
CO2: Understand the various building blocks of native android applications.
CO3: Design android specific user interface (UI).
CO4: Design and develop applications using android services and sensors.
CO5: Understand and apply data storage and sharing techniques for applications.

CO-PO Mapping

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO 2	PSO 3	PSO 4
CO1	2				2							3	-	-	-
CO2	3	2	2	2	3						3	2	-	-	-

CO3	2	1	3		3		3	3	3		3	2	2	-	-
CO4	2	2	2	3	3		3	3	3		3	2	2	-	-
CO5	3	2	3	3	3		3	3	3		3	2	2	1	-

Syllabus

Unit 1: Introduction and User Interface
Basics of Android - Android OS architecture, Versions, SDK, API Levels. Set up of mobile app development environment - Understand the app idea and design user interface/wireframes of mobile application - Developing and debugging mobile app components - First application - understanding file structure - layout and resource files - deployment - emulators and devices.
Basic UI design - Button, EditText, TextView, basic event handlers. Activity - Lifecycle, Layouts - Selection components - Radio, checkbox, Date/Time Picker. ListView, Grid view, ScrollView, Image view, Image buttons, Spinner, Toggle, AutocompleteTextView.
Advanced UI design - Intents - Internal/External/Pending, Intent Filters, Android Manifest - Permissions - Fragment, Fragment Lifecycle, Fragment communication - Menu, Notifications, Material Design, Navigation Drawer, WebView.

Unit 2: Components
Data storage - SQLite, Shared Preferences, Internal/External Storage, Room Persistence Library. Background Processing - Services - Started, Bound, Foreground, Intent Service - AsyncTasks. Broadcast receivers, Content Providers, Content resolvers.

Unit 3: Sensors and Location API
Sensors - Motion sensors, Environmental, Position sensors. Touch sensors and Gesture detector. Location Based Services - GPS and Google Maps. Apps with Connectivity to External APIs.

Textbook(s)
Burd B. Android application development all-in-one for dummies. John Wiley & Sons; 2015.

Reference(s)
AndroidDeveloperFundamentalsVersion2, 2018.Accessibleonline: https://developer.android.com/courses/fundamentals-training/overview-v2
Darcey L, Conder S. Sams Teach Yourself Android Application Development in 24 Hours: Sams Teac Your Andr Appl D_2. Pearson Education; 2011.
Hardy B, Phillips B. Android Programming: The Big Nerd Ranch Guide. Addison-Wesley Professional; 2013.

Evaluation Pattern:

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, mobile application design exercises, UI/UX case studies, architecture analysis tasks, and short tests on mobile development concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Mobile application development, user interface implementation, API integration, database connectivity, device feature utilization, testing and debugging exercises, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on mobile application architecture, user interface design, application lifecycle, data management, and mobile development frameworks	20%
End Semester Assessment	External	Written Examination on mobile application development concepts and technologies. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving mobile application development, deployment, project demonstration, and viva voce	30%
Total			**100%**

26AIE459	USER EXPERIENCE DESIGN	L-T-P-C 2-0-3- 3

Course Objectives

- This course provides a comprehensive overview of the user experience design process, and is intended to familiarize students with the methods, concepts, and techniques necessary to make user experience design an integral part of developing information interfaces.
- The course provides students with an opportunity to acquire the resources, skills, and hands-on experience they need to design, develop, and evaluate information interfaces from a user-cantered design perspective.
- The students of this course will be able to apply the knowledge / learning's from this course to their own professional work as a user experience designer, UX Designers, Information Architects, Usability Engineers etc. in IT domain. They will be able to apply learning's in designing the Website design, Mobile applications, Enterprise and consumer software products and applications.

Course Outcomes

After completing this course, students will be able to

CO1: Define the critical issues and theoretical underpinnings of User Experience (UX) design.

CO2: Establish requirements for UX design concepts.

CO3: Develop alternatives for UX design concepts and demonstrate the construction of UX design artifacts.

CO4: Evaluate Ux Design artifacts.

CO5: Learn how Ux design concepts are applied for real life problems.

CO-PO Mapping

PO/ PSO / CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO 2	PSO 3	PSO 4
CO1	1						2					1	-	-	-
CO2	3	1					1					2	-	-	-
CO3	3	1			3							2	1	-	-
CO4	3	3	3	3	3			2	1			2	2	1	-
CO5	3	3	3		3	2	3	2	3		2	2	2	1	1

Syllabus

Unit 1

Ux Introduction: User Interaction with the products, applications and services – Cognitive Model/Mental Model, Principles of Ux Design, Elements of Ux design - Core elements of User Experience. How these elements work together; Ux Design Process - Defining the UX Design Process and Methodology, Research and Define – Importance of research, Research methods and tools, Understanding the User Needs and Goals, Understanding the Business Goals, Deliverables of the Research & Define phase, Insight on User Goals and Business Goals.

Unit 2

Ux Design Process Ideate and Design - Visual Design Principles, Information Design and Data Visualization, Interaction Design, Information Architecture, Wireframing & Storyboarding, UI Elements and Widgets, Screen Design and Layouts, Prototype and Test – Need for design testing, Definition of Usability Testing, Types of Usability Testing, Usability Testing Process, Prepare and plan for the Usability Tests, Prototype Design to Test, Introduction of prototyping tools, Conducting Usability Tests, Communicating Usability Test Results.

Unit 3

Ux Design Process Iterate and Improve - Understanding the Usability Test findings, Applying the Usability Test feedback in improving the design, Deliver - Communication with implementation team, UX Deliverables to be given to implementation team, Ux Metrics – Overview, Types of metrics – CSAT, NPS, SUS, TPI, Choosing the right metrics, Future of Ux Design, Case studies: Commuter Rail Mobile App, Medical Patient portal, Ux Tools – Wireframing Ux Design tools such as Pencil, MockPlus, UxPin Usability Testing Tools – Optimizely, ClickHeat, Chalkmark

Textbook(s)

1. Platt D. The Joy of UX: User Experience and interactive design for developers. Addison-Wesley Professional; 2016.

Reference(s)

1. Garrett JJ. The elements of user experience: user-cantered design for the Web and beyond (2. pianos). Berkeley: New Riders; 2011.
2. Goodman E, Kuniavsky M, Moed A. Observing the user experience: A practitioner's guide to user research. Elsevier; 2012.
3. Buxton B. Sketching User Experiences: Getting the Design Right and the Right Design. Morgan Kaufmann; 2010.
4. Shneiderman B, Plaisant C. Designing the User Interface: Strategies for Effective Human-Computer Interaction. Pearson Education India; 2010.
5. Tenner E. The Design of Everyday Things by Donald Norman. Technology and Culture; 2015.

Evaluation Pattern:

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, user research exercises, usability analysis tasks, design critique sessions, case studies, and short tests on UX design principles	20%
Continuous Assessment – Lab (CAL)	Internal	User persona development, wireframing, prototyping, usability testing, interaction design exercises, design tool usage, and mini projects	30%

Component	Internal / External	Suggested Assessment Methods	Weightage
Mid-Term Examination	Internal	Written examination focusing on user-cantered design, usability principles, interaction design, accessibility, design thinking, and UX evaluation techniques	20%
End Semester Assessment	External	Written Examination on user experience design principles and methodologies. OR Hybrid Mode Examination comprising written and design/problem-solving components. OR Term Project involving user research, prototyping, usability evaluation, UX solution development, project demonstration, and viva voce	30%
Total			100%

26AIE460	SOFTWARE DESIGN PATTERNS	S	L-T-P-C 2-0-3- 3

Course Description and Objectives: Design patterns are a general repeatable solution to a commonly occurring software design problem and represent the best practices of experienced object-oriented software designers and developers. Design patterns accelerate the development process by providing time tested solutions that enhance the readability and maintainability of code across a broad spectrum of software developers, designers and architects familiar with patterns. This course provides an overview of the important design patterns and focuses on their applicability to various design problems. This course helps a student with basic knowledge of object-oriented design and programming become a more efficient and effective software professional.

Course Outcomes

After completing this course, students will be able to

CO1: Understand the common software design problems seen in the development process

CO2: Demonstrate the use of various design patterns to tackle these common problems.

CO3: Identify the most suitable design pattern to address a given software design problem.

CO4: Analyze existing code for anti-patterns and refactor the code.

CO5: Apply best practices of design principles for software design and development.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	2	3	2	2	3	2	2	2	1	2	2	1	2	1	1
CO2	3	3	3	3	3	3	2	2	3	2	3	1	3	1	1
CO3	3	3	3	3	3	3	2	2	3	2	3	2	3	1	1
CO4	3	3	3	3	3	2	2	3	2	1	2	2	3	1	2
CO5	3	3	3	3	3	2	2	3	2	1	3	2	3	2	2

Syllabus

Unit 1

Introduction to Design Patterns: Significance – Software Design and patterns – Model – View - Controller.

Unit 2

Observer Pattern - Decorator Pattern - Factory Pattern - Singleton Pattern - Command Pattern - Adapter and Facade Patterns - Template

Method Pattern - Iterator and Composite Patterns – The State Pattern – The Proxy Pattern – Compound Patterns.

Unit 3

GRASP Patterns and Anti-patterns. Case Study: Use of patterns in the Design of a Modern Web Framework.

TEXTBOOK/ REFERENCES:

Erich Freeman, Elisabeth Robson, Bert Bates and Kathy Sierra "Head First Design Patterns", O'Reilly Media Inc., October 2004.

Erich Gamma, Richard Helm, Ralph Johnson and John M. Vlissides, "Design Patterns: Elements of Reusable Object-Oriented Software", Second Edition, Addison Wesley, 2000

James W. Cooper, "Java Design Patterns: A Tutorial", Second Edition, Pearson Education, 2003.

Mark Grand, "Patterns in Java – A Catalog of Reusable Patterns Illustrated with UML", Wiley – Dream tech India, 2002

Evaluation Pattern:

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, design pattern identification exercises, software design case studies, pattern selection tasks, and short tests on object-oriented design principles	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of creational, structural, and behavioural design patterns, code refactoring exercises, anti-pattern analysis, UML modelling, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on object-oriented design principles, design patterns, pattern applicability, software architecture, and refactoring techniques	20%
End Semester Assessment	External	Written Examination on software design principles and design patterns. OR Hybrid Mode Examination comprising written and design/problem-solving components. OR Term Project involving design pattern implementation, software refactoring, architecture design, project demonstration, and viva voce	30%
Total			**100%**

26AIE461	CONCURRENT PROGRAMMING	L-T-P-C: 2-0-3-3

Course overview:

The course aims to provide fundamentals of concurrency and expose students to the various concurrent frameworks that includes multi-threaded and parallel frameworks. Although, the content of the course is centred around Java, the underlying concepts are general and applicable irrespective of the languages. The course will provide hands-on exposure to various subtleties in concurrent programming which are key for software developers.

Course Outcome

After completing this course, the students will be able to

CO1: Understand and appreciate the associated with concurrent programming.

CO2: Get a hands-on exposure to a multi-threaded programming framework in Java.

CO3: Get a hands-on exposure to a parallel programming framework in Java.

CO4: Understand the use of concurrent data structures and synchronization utilities

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	1	1			2							2	-	-	-
CO2	1	1			3							3	2	-	-
CO3	1	2	2									3	2	-	-
CO4	1	2	2									2	1	-	-

Syllabus

Unit 1

Basic concurrency concepts, problems with concurrent applications – data races, deadlocks, live-locks, resource starvation, priority inversion, Designing concurrent applications – analysis-design-implementation-testing-tuning, Java concurrency API – Threads in Java.

Unit 2

Managing lots of threads – basic components of executor framework, serial vs. coarse grained vs. fine grained concurrency with examples, Concurrency in a client/server environment, Callable and Future interfaces, running tasks divided into phases using Phaser class.

Unit 3

Fork-Join parallel programming framework – Divide-and-conquer, Recursive Action Task, ForkJoinPool, and ExecutorService, Work stealing. Processing massive dataset with Parallel Streams – Concurrent Loader, Concurrent Statistics, Concurrent data structures and synchronization utilities.

Textbooks

Javier Fernández González, Mastering Concurrency with Java 9, Second Edition, Pakt Publishing, July 2017.

Brian Goetz, Java Concurrency in Practice. Addison Wesley, 2010.

Herbert Schidlt, Java Complete Reference, Eleventh Edition, Paperback, 2020.

Evaluation Pattern

Component	**Internal / External**	**Suggested Assessment Methods**	**Weightage**
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, synchronization exercises, concurrency problem-solving tasks, case studies, and short tests on concurrent programming concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Multithreaded programming, synchronization mechanism implementation, deadlock handling exercises, parallel programming tasks, performance analysis, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on concurrency models, threads, processes, synchronization, deadlocks, parallelism, and concurrent system design	20%
End Semester Assessment	External	Written Examination on concurrent programming concepts and synchronization techniques. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving development of concurrent or parallel applications, performance evaluation, project demonstration, and viva voce	30%
Total			**100%**

26AIE462	**DEEP REINFORCEMENT LEARNING**	**L-T-P-C: 2- 0- 3- 3**

Course Objectives

- This course aims to provide the cutting-edge concepts in deep reinforcement learning
- It also helps the students to train an agent which can perform a variety of complex tasks.
- It will also help students to learn about the core challenges and approaches, including generalization and exploration and also make the students well versed in the key ideas and techniques for deep reinforcement learning

Course Outcomes

After completing this course, the students will be able to

CO1: Decide whether a given application problem should be formulated as a Deep Reinforcement Learning (DRL) problem.

CO2: Correctly define the problem formulation, design the most suitable algorithm from the different possible classes of DRL algorithms, providing a justification

CO3: Implement and apply temporal-difference reinforcement learning algorithms

CO4: Apply the multiple criteria for analysing and evaluating the DRL algorithms on the relevant metrics: regret, sample complexity, computational complexity, empirical performance, convergence.

CO5: Implement in code the main DRL algorithms and apply it to solve several practical problems in different application domains, evaluating experimentally their performance.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	-	-	3	2	2	3	3	-	-	-
CO2	3	3	3	3	3	-	-	3	2	2	3	3	-	-	-
CO3	3	3	3	3	3	-	-	3	2	2	3	2	2	1	-
CO4	3	3	3	3	3	-	-	3	2	2	3	2	-	-	-
CO5	3	3	3	3	3	-	-	3	2	2	3	2	2	1	-

Syllabus

Unit 1: Foundations of Reinforcement Learning - Introduction to Reinforcement Learning and Deep Reinforcement Learning, Markov Decision Processes (MDP), Bellman Equations, Value Functions, Policy and Value Iteration, Temporal Difference Learning, Exploration vs. Exploitation, Function Approximation.

Unit 2: Value-Based Deep Reinforcement Learning -Deep Q-Networks (DQN), Experience Replay, Target Networks, Double DQN, Dueling DQN, Prioritized Experience Replay, Performance Evaluation and Comparison of Value-Based Methods.

Unit 3:Policy-Based and Actor-Critic Methods- Policy Gradient Methods, REINFORCE Algorithm, Actor-Critic Architecture, Advantage Actor-Critic (A2C/A3C), Proximal Policy Optimization (PPO), Off-policy Actor-Critic Methods (Overview).

Unit 4: Advanced Topics and Applications - Eligibility Traces, On-policy and Off-policy Learning with Function Approximation, Model-Based Reinforcement Learning (Overview), Multi-Agent Reinforcement Learning (Overview), Applications and Case Studies in Robotics, Autonomous Driving, Games, Finance, and Healthcare.

Textbooks / Reference Books

'Reinforcement Learning', Richard.S.Sutton and Andrew G.Barto, Second edition, MIT Press, 2018

Maxim Lapan, Deep Reinforcement Learning Hands-On, Third Edition, Packt Publishing, 2024.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, analytical exercises on Markov Decision Processes (MDPs), reinforcement learning algorithms, policy evaluation, value function approximation, case studies, and short tests on deep reinforcement learning concepts	20%
Continuous Assessment – Lab (CAL)	Internal	Implementation of Deep Q-Networks (DQN), Double DQN, Dueling DQN, Actor-Critic and PPO algorithms, training intelligent agents in simulation environments (e.g., OpenAI Gym), performance evaluation, hyperparameter tuning, and mini-projects	30%
Mid-Term Examination	Internal	Written examination focusing on reinforcement learning fundamentals, Bellman equations, temporal-difference learning, policy gradient methods, deep reinforcement learning architectures, and algorithm analysis	20%
End Semester Assessment	External	Written Examination on deep reinforcement learning concepts, value-based and policy-based algorithms, actor-critic methods, and real-world DRL applications. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Project-Based Examination involving the design, implementation, training, and evaluation of deep reinforcement learning agents for real-world or simulated environments, followed by project demonstration and viva voce	30%
Total			100%

26AIE463	**TIME SERIES ANALYSIS**	**L-T-P-C 2-0-3- 3**

Course Objectives

- This course will cover the tools and techniques required to analyse time series data
- The course will focus on the linear time series analysis, nonlinear time series analysis and ML/DL methods for predictive analytics.
- The course will also focus on generating models from non-stationary and stationary time series data.

Course Outcomes

After completing this course, students will be able to

CO1: Analyse linear time series data

CO2: Analyse nonlinear time series data

CO3: Analyse stationary and non-stationary time series data

CO4: Apply ML/DL models to perform predictive analytics on time series data

CO-PO Mapping

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

Syllabus

Unit 1

Introduction – Review of basic statistics – Stationarity – Ergodicity – Autocorrelation – Partial Autocorrelation – Linear Models – Autoregressive Models – Moving Average Models

Unit 2

ARMA – ARIMA – SARIMA – VAR – Conditional Heteroscedastic Models – ARCH Model – GARCH Model

Unit 3

Nonlinear Models – Tests for Stationarity – Tests for nonlinearity – State Space Models

Unit 4

Machine Learning Models – Deep Learning Models –Precursors for Catastrophic Transitions.

Textbooks / References

Jonathan D Cryer & Kung Silk Chan, Time Series Analysis with Applications in R, Second Edition, Springer, 2008

Robert H Shumway & David S Stoffer, Time Series Analysis and Its Applications with R examples, Third Edition, Springer,2011

G E P Box, G M Jenkins, G C Reinsel, G M Ljung, Time Series Analysis: Forecasting and Control, fifth edition, Wiley, 2016

Aileen Nielsen, Practical Time Series Analysis Prediction with Statistics and Machine Learning, O'Reilly, first edition, 2019

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, time series analysis exercises, forecasting problems, case studies, and short tests on temporal data analysis concepts	20%

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Lab (CAL)	Internal	Time series preprocessing, trend and seasonality analysis, forecasting model implementation, anomaly detection, visualization tasks, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on time series components, statistical forecasting methods, temporal data modelling, and performance evaluation techniques	20%
End Semester Assessment	External	Written Examination on time series analysis and forecasting concepts. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving temporal data analysis, forecasting model development, trend analysis, project demonstration, and viva voce	30%
Total			**100%**

INDUSTRIAL ELECTIVES

26AIE470 CLOUD APPLICATION DEVELOPMENT L-T-P-C : 2-0-3-3

Prerequisites

Object Oriented Programming, Database Management Systems, Software Engineering, and Web Technologies.

Course Objectives

- To understand the architecture and components of Guidewire InsuranceSuite.
- To learn Guidewire application configuration using Data Model, Typelists, and User Interface components.
- To develop business logic using the Gosu programming language.
- To understand source code management, testing, and deployment in Guidewire Cloud Platform (GWCP).
- To learn observability, monitoring, and lifecycle management in cloud-native insurance applications.
- To prepare students for Guidewire Associate Developer Certification.

Course Outcomes (CO)

CO1: Configure and customize Guidewire InsuranceSuite applications using data model extensions, typelists, and UI components.

CO2: Develop and debug business logic using Gosu programming language and Guidewire development tools.

CO3: Apply cloud-native development practices including source control, build management, testing, and deployment in Guidewire Cloud Platform.

CO4: Utilize monitoring, observability, lifecycle management, and quality assurance mechanisms for enterprise insurance applications deployed in the cloud.

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	2	3	-	-	2	2	2	2	3	2	-
CO 2	3	3	3	3	3	-	-	2	2	2	2	3	3	1
CO 3	3	3	3	3	3	1	-	2	2	3	3	2	3	2
CO 4	2	2	3	3	3	1	-	2	2	3	3	2	2	2

Syllabus

UNIT 1
Introduction to Guidewire and InsuranceSuite

Introduction to Property and Casualty Insurance Industry – Guidewire Overview – Guidewire Product Ecosystem – InsuranceSuite Architecture – ClaimCenter – PolicyCenter – BillingCenter – Development Environment Setup – Guidewire Studio – Development Instances – Application Structure and Navigation.

UNIT 2
Data Model and User Interface Configuration

Guidewire Data Model Architecture – Data Dictionary – Entity Structure – Extending Existing Entities – Creating New Entities – Typelists and Typecodes – User Interface Configuration using PCF Files – Containers – Atomic Widgets – Detail Views – List Views – Editable Views – Input Sets – Popups – Validation Expressions.

UNIT 3
Gosu Programming and Business Logic Development

Introduction to Gosu – Syntax and Data Types – Arrays and Collections – Classes and Objects – Rule Framework – Business Rules – Query APIs – Query Processing – Logging Standards – Debugging Techniques – Bundle Basics – Bundle Management Best Practices.

UNIT 4
Guidewire Cloud Platform and DevOps

Guidewire Cloud Platform Architecture – Source Code Management using Git and Bitbucket – Build Management using TeamCity – Deployment Pipelines – Deployment Practices – Datadog Monitoring – Log Analysis – Dashboards – Lifecycle Manager – Administrative Configuration – Quality Gates – Cloud Data Access.

Textbooks / Reference Books

1. Guidewire Education Services, InsuranceSuite Developer Fundamentals.
2. Guidewire Education Services, Guidewire Cloud Platform Fundamentals.
3. Guidewire Software Documentation, Guidewire Cloud Platform Documentation.
4. Scott Chacon and Ben Straub, Pro Git, Apress.
5. Gene Kim et al., The DevOps Handbook, IT Revolution Press.
6. Kelsey Hightower, Brendan Burns and Joe Beda, Kubernetes: Up and Running, O'Reilly.

Evaluation Pattern

Component	Internal / External	Suggested Assessment Methods	Weightage
Continuous Assessment – Theory (CAT)	Internal	Quizzes, assignments, case studies, Guidewire Cloud architecture analysis, configuration exercises, and short tests on insurance domain concepts and cloud application development	20%
Continuous Assessment – Lab (CAL)	Internal	Guidewire Cloud configuration, business rule implementation, workflow customization, API integration, cloud deployment exercises, testing activities, and mini projects	30%
Mid-Term Examination	Internal	Written examination focusing on Guidewire Cloud platform architecture, policy administration concepts, cloud services, integration mechanisms, and application development practices	20%
End Semester Assessment	External	Written Examination on Guidewire Cloud platform concepts and application development. OR Hybrid Mode Examination comprising written and implementation/problem-solving components. OR Term Project involving Guidewire Cloud application development, configuration, integration, project demonstration, and viva voce	30%
Total			**100%**