SCHEME OF INSTRUCTION AND SYLLABI (R26)

OF

M.Tech- IT(Artificial Intelligence and Robotics)

TWO YEAR POST GRADUATE COURSE

IN

INFORMATION TECHNOLOGY

(Inline with AICTE Model Curriculum with effect from **AY: 2026-27**)

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

Affiliated to OU, Approved by AICTE, Accredited by NBA, NAAC (A++)

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27

M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)
DEPARTMENT OF INFORMATION TECHNOLOGY

Institute Vision:
To be a center of excellence in technical education and research

Institute Mission:
To address the emerging needs through quality technical education and advanced research

Department Vision
To be a center of excellence in the field of Information Technology that yields pioneers and research experts who can contribute for the socio-economic development of the nation.

Department Mission:
- To impart state-of-the-art value-based education in the field of Information Technology.
- To collaborate with industries and research organizations and excel in the emerging areas of research.
- To imbibe social responsibility in students.
- To motivate students to be trend setters and technopreneurs.

Program Educational Objectives (PEOs)
Post graduates of IT(AI & Robotics) will be able to
1. Pursue careers in industries that incorporate Artificial Intelligence and Robotics technologies to foster innovation and resolve challenges.
2. Adopt a research-oriented perspective and commit to lifelong learning, adhering to the highest level of professional code of ethics.

Program Outcomes:
At the end of the program, students will be able to:
PO1: An ability to independently carry out research /investigation and development work to solve practical problems.
PO2: An ability to write and present a substantial technical report/document.
PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO4: Develop innovative approaches to solve real-world challenges in the emerging fields of Manufacturing, Agriculture, Health-care, Education and Cyber Security.
PO5: Conduct systematic research to provide advanced AI and Robotics solutions across multidisciplinary domains.

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M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

SEMESTER– I

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
	THEORY								
1	26ITC101	Essentials of Robotics	3	-	-	3	40	60	3
2	26ITC102	Artificial Intelligence and Machine Learning	3	-	-	3	40	60	3
3	26MTC105	Mathematical Foundations for AI and Quantum Computing	2	-	-	3	40	60	2
4		Program Elective-1	3	-	-	3	40	60	3
5	26MEM103	Research Methodology and IPR	2	-	-	3	40	60	2
6		Audit Course-1	2	-	-	2	-	50	Non-Credit
PRACTICALS									
7	26ITC103	Robotics Lab	-	-	3	-	50	-	1.5
8	26ITC104	Artificial Intelligence and Machine Learning Lab	-	-	3	-	50	-	1.5
9		Program Elective-1 Lab	-	-	2	-	50	-	1
TOTAL			**15**		**08**	**17**	**350**	**350**	**17**
Clock Hours Per Week: 23									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**
T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

Program Elective-1	
26ITE101	Cloud Computing
26ITE102	Cyber Security
26ITE103	Advanced Computer Networks
26ITE104	High-Performance Computing
26ITE105	Embedded Systems and Internet of Things

Program Elective-1 Lab	
26ITE106	Cloud Computing Lab
26ITE107	Cyber Security Lab
26ITE108	Advanced Computer Networks Lab
26ITE109	High-Performance Computing Lab
26ITE110	Embedded Systems and Internet of Things Lab

Audit Course-1 & 2	
26EGA101	English for Research Paper Writing
26CEA101	Disaster Mitigation and Management
26EEA101	Sanskrit for Computational Thinking & Engineering Applications
26ECA101	Value Education
26EGA102	Constitution of India
26EGA103	Stress Management by Yoga
26EGA104	Personality Development Through Life's Enlightenment Skills

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M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

SEMESTER-II

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
	THEORY								
1	26ITC105	Advanced Robotics	3		-	3	40	60	3
2	26ITC106	Deep Learning	3		-	3	40	60	3
3		Program Elective-2	3		-	3	40	60	3
4		Program Elective-3	3		-	3	40	60	3
5		Program Elective-4	3		-	3	40	60	3
PRACTICALS									
6	26ITC107	Deep Learning Lab	-		3	-	50	-	1.5
7		Program Elective-4 Lab	-		2	-	50	-	1
8	26ITC108	Mini Project	-		3	-	50	-	1.5
TOTAL			**15**		**8**	**15**	**350**	**300**	**19**
Clock Hours Per Week: 23									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**
T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

Program Elective-2	
26ITE111	Reinforcement Learning
26ITE112	Computer Vision
26ITE113	Natural Language Processing
26ITE114	Knowledge Engineering and Expert Systems
26ITE115	Prompt Engineering

Program Elective-3	
26ITE116	Cognitive Robotics
26ITE117	Cloud Robotics
26ITE118	Robotics Programming using Python
26ITE119	Augmented & Virtual Reality
26ITE120	Cyber Physical Systems

Program Elective-4	
26ITE121	Block chain Technology
26ITE122	Generative AI
26ITE123	Quantum Computing
26ITE124	Advanced Big Data Analytics
26ITE125	Unmanned Aerial Vehicles

Program Elective-4 Lab	
26ITE126	Block chain Technology Lab
26ITE127	Generative AI Lab
26ITE128	Quantum Computing Lab
26ITE129	Advanced Big Data Analytics Lab
26ITE130	Unmanned Aerial Vehicles Lab

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M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

SEMESTER– III

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1		Program Elective-5	3	-	-	3	40	60	3
2		Open Elective	3	-	-	3	40	60	3
3		Audit Course-2	2	-	-	2	-	50	Non-Credit
PRACTICALS									
4	26ITC109	Dissertation Phase-I	-	-	20	-	100	-	10
TOTAL			8	-	20	8	180	170	**16**
Clock Hours Per Week: 28									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**
T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

Program Elective-5	
26ITE131	Metaverse in Robotics
26ITE132	Robotic Simulation and Localization Mapping
26ITE133	Robotic Process Automation
26ITE134	Human Robot Interaction
26ITE135	Webots

Open Elective	
26CSO101	Business Analytics
26MEO102	Introduction to Optimization Techniques
26CEO101	Cost Management of Engineering Projects
26MEO101	Industrial Safety
26MEO103	Composite Materials
26EEO104	Waste to Energy

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M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

SEMESTER– IV

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
PRACTICALS									
1	26ITC110	Dissertation Phase-II	-		32	Viva-Voce	100	100	16
TOTAL			-		32	-	100	100	**16**
Clock Hours Per Week: 32									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**
T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

DEPARTMENT OF INFORMATION TECHNOLOGY

SCHEME OF INSTRUCTION FOR
R26 - M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

Program Elective Courses

Program Elective	COURSE GROUPS	COURSES NAMESS
PE-1(With Lab)	**Computing Systems & Network Technologies**	1. Cloud Computing 2. Cyber Security 3. Advanced Computer Networks 4. High Performance Computing 5. Embedded Systems Internet of Things
PE-II	**Artificial Intelligence & Intelligent Systems**	1. Reinforcement Learning 2. Computer Vision 3. Natural Language Processing 4. Knowledge Engineering and Expert Systems 5. Prompt Engineering
PE-III	**Smart Robotics & Control Systems**	1. Cognitive Robotics 2. Cloud Robotics 3. Robotics Programming using Python 4. Augmented & Virtual Reality 5. Cyber Physical Systems
PE-IV (With Lab)	**Emerging Digital & Intelligent Technologies**	1. Blockchain Technology 2. Generative AI 3. Quantum Computing 4. Advanced Big Data Analytics 5. Unmanned Aerial Vehicles
PE-V	**AI- Driven Robotics and Autonomous Systems**	1. Metaverse in Robotics 2. Robotic Simulation and Localization Mapping 3. Robotic Process Automation 4. Human Robot Interaction 5. Webots

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R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27

M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

SEMESTER– I

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
	THEORY								
1	26ITC101	Essentials of Robotics	3	-	-	3	40	60	3
2	26ITC102	Artificial Intelligence and Machine Learning	3	-	-	3	40	60	3
3	26MTC105	Mathematical Foundations for AI & Quantum Computing	2	-	-	3	40	60	**2**
4		Program Elective-1	3	-	-	3	40	60	3
5	26MEM103	Research Methodology and IPR	2	-	-	3	40	60	2
6		Audit Course-1	2	-	-	2	-	50	Non- Credit
PRACTICALS									
7	26ITC103	Robotics Lab	-	-	3	-	50	-	1.5
8	26ITC104	Artificial Intelligence and Machine Learning Lab	-	-	3	-	50	-	1.5
9		Program Elective-1 Lab	-	-	2	-	50	-	1
TOTAL			**15**		**08**	**17**	**350**	**350**	**17**
Clock Hours Per Week: 23									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**
T:Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

Program Elective-1	
26ITE101	Cloud Computing
26ITE102	Cyber Security
26ITE103	Advanced Computer Networks
26ITE104	High Performance Computing
26ITE105	Embedded Systems and Internet of Things

Program Elective-1 Lab	
26ITE106	Cloud Computing Lab
26ITE107	Cyber Security Lab
26ITE108	Advanced Computer Networks Lab
26ITE109	High Performance Computing Lab
26ITE110	Embedded Systems and Internet of Things Lab

26ITC101

ESSENTALS OF ROBOTICS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aim is to:

1. Deliver the fundamentals of robotics.
2. Explore the various sensors and actuators of robotics.
3. Impart the end effectors of robotics.
4. Understand the image analysis in robotics.
5. Explore the various types of and its programming languages to drive the robots.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Develop a basic skeleton of the robot by incorporating the sensors, actuators and end effectors.
2. Demonstrate the various sensors used in robots to sense the environment to act and react accordingly.
3. Apply the end effectors in the robots to pick and place the objects effectively.
4. Develop the effectors and grippers for robots to handle the objects.
5. Apply robotic languages to perceive, react and act accordingly in the environment to work effectively.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	3	2
CO2	2	1	2	2	2
CO3	2	1	2	3	2
CO4	3	1	3	3	3
CO5	3	2	3	3	3

UNIT-I

Introduction to Robotics: Classification of Robots, History of Robotics, Advantages and Disadvantages of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, Robot Applications.

UNIT-II

Sensors: Sensor Characteristics, Sensor Utilization, Position Sensors, Velocity Sensors, Acceleration Sensors, Force and Pressure Sensors, Torque Sensors, Microswitches, Visible Light and Infrared Sensors, Touch and Tactile Sensors, Proximity Sensors, Range Finders, Sniff Sensors, Taste Sensors, Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Actuators, Pneumatic Devices.

UNIT-III

Robot End Effectors: Types, Mechanical Grippers and Other types, Tools as End Effectors, The Robot/End Effector Interface, Considerations in Gripper Selection and Design. Basic Control Systems Concepts and Models, Controllers, Control System Analysis, Robot Activation and Feedback Components.

UNIT-IV

Image Processing and Analysis with Vision Systems: Basic Concepts, Fourier Transform and Frequency Content of a Signal, Frequency Content of an Image; Noise, Edges, Resolution and Quantization, Sampling Theorem, Image-Processing Techniques. Segmentation, Region Splitting, Binary Morphology Operations, Gray Morphology Operations.

UNIT-V

Robot Programming and Languages: Programming methods, Robot program as path in space, Motion Interpolation, WAIT, SIGNAL DELAY Commands, Branching. The Textual Robot languages, Generations of Robot programming languages, Robot language Structures, Constants, Variables, and other data Objects, Motion Commands, program Control and Subroutines.

Text Books:

1. Saeed B. Niku, Introduction to Robotics: Analysis, Control, and Applications, John Wiley and Sons, 2024.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 4th Edition, 2018.
3. Bruno Siciliano et al., Robotics: Modelling, Planning and Control, Springer, 2009.
4. Dilip Kumar Pratihar, Fundamentals of Robotics: Analysis and Control, Narosa Publishing House, 2017.

Suggested Reading:

1. R.K. Mittal and I.J. Nagrath, Robotics and Control, TMH, 2017.
2. David Poole, Alan Mackworth, Randy Goebel, Computational Intelligence: A Logical Approach, Oxford University Press, 1998.
3. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, John Wiley and Sons, 2006.
4. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 3rd Edition, 2010.

Web Resources:

1. NPTEL, https://nptel.ac.in, 2026.
2. MIT OpenCourseWare, https://ocw.mit.edu, 2026.
3. Coursera, https://www.coursera.org, 2026.
4. edX, https://www.edx.org, 2026.

26ITC102

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Instruction	3L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to

1. Understand the importance, fundamental principles, and search methods of Artificial Intelligence.
2. Provide knowledge of predicate logic and programming using Prolog.
3. Introduce the fundamentals of Machine Learning techniques.
4. Study supervised learning algorithms and their applications.
5. Study unsupervised learning algorithms and their applications.

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Explain the basic concepts, importance, and search techniques used in Artificial Intelligence.
2. Apply predicate logic and develop simple programs using Prolog.
3. Describe the fundamental concepts and workflow of Machine Learning.
4. Implement and analyze supervised learning algorithms for classification and regression tasks.
5. Apply unsupervised learning algorithms for clustering and pattern discovery.

CO-PO Articulation Matrix

PO / CO	PO1	PO 2	PO 3	PO4	PO5
CO 1	3	3	3	-	2
CO 2	3	3	3	-	2
CO 3	3	3	3	1	2
CO 4	3	3	3	1	1
CO 5	3	3	3	-	1

UNIT-I

Intelligent Agent and Uninformed Search: Introduction: Foundations of AI, History of AI, The state of the art, Risks and Benefits of AI. **Intelligent Agents**: Nature of Environment, Structure of Agent, Problem Solving Agents, Formulating Problems, **And Uninformed Search**: Breadth First Search, Dijkstra's algorithm or uniform cost search, Depth First Search, Depth Limited Search

UNIT-II

Problem Solving with Search Techniques: Informed Search, Greedy Best First, A* algorithm, Adversarial Game and Search. **Game theory**: Optimal decisions in game, Min Max Search algorithm, Alpha-beta pruning. **Constraint Satisfaction Problems (CSP):** Examples, Map Coloring, Job Scheduling, Backtracking Search for CSP.

UNIT-III

Machine Learning: Definitions, Classification, Regression, approaches of machine learning Models, Types of learning, Probability, Basics, Linear Algebra, Hypothesis space and inductive Bias,

Evaluation. Training and test sets, cross-validation, Concept of over fitting, under fitting, Bias and Variance, Regression: Linear Regression - Logistic Regression.

UNIT-IV

Supervised Learning: Decision Tree: Entropy – Information gain - Gini Impurity - classification algorithm - Rule-based Classification - Naïve Bayesian classification - Support Vector Machines (SVM). Neural Network: Introduction, Perceptron Networks, Back propagation networks

UNIT-V

Unsupervised Learning – Principal Component Analysis - Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – Clustering: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm.

TEXT BOOKS:

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, Fourth Edition, 2021.
2. S.N. Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.

SUGGESTED READING:

1. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.
2. Bratko, “Prolog: Programming for Artificial Intelligence‖, Fourth edition, AddisonWesley Educational Publishers Inc., 2011.

Web Resources:

1. NPTEL https://nptel.ac.in/domains/discipline/106?course=106_0.
2. https://onlinecourses.nptel.ac.in/noc26_cs74/preview.

26MTC105

Mathematical Foundations for AI & Quantum Computing

Instruction	2 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Course Objectives:
Upon completing this course, students will be able to:
1. Explain the concepts of basis, dimension of vector space.
2. Discuss matrix representation of a linear transformation.
3. Understand the Matrix Decomposition.
4. Explain different estimates.
5. Fit the curve to the data using the least squares approximation.

Course Outcomes:
Upon completing this course, students will be able to:
1. Determine the basis and dimension of a vector space.
2. Compute linear transformation.
3. Compute the decomposition of Matrix.
4. Infer the estimation of the statistical parameters.
5. Analysing appropriate model for Regression diagnostic of the raw data.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	1	-
CO2	2	-	1	1	1
CO3	3	-	1	-	-
CO4	3	-	2	1	1
CO5	3	-	1	1	1

UNIT-I
Vector Spaces: Definition of Vector Space - Vector Subspaces – Linear Dependence and Independence of vectors - Span of a set of vectors - Basis of Vector Space – Dimension of a Vector Space.

UNIT-II
Linear Transformations: Introduction to Linear Transformations- The null space and range of a linear map – Dimension of Null space and Range space - Rank - Nullity theorem (without proof)-Matrix of a Linear Transformation.

UNIT-III
Dimensionality Reduction
Eigen Decomposition, Singular Value Decomposition and Matrix Approximation. Principal component analysis and its application to dimensionality reduction.

UNIT-IV
Estimation Maximum Likelihood Estimation, Likelihood Ratio Tests; Estimate Parameters Using MLE for probability distributions (Exponential and Gaussian Distributions)

UNIT- V: Linear Predictors:
Statistical inference with the simple linear regression model, prediction and confidence intervals, Linear Regression for multiple Regression Tasks.

Text Books:

1. Kishor S. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science
2. Applications, John Wiley & Sons, 2016.
3. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014.
4. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press,2020.

Reference Books:

1. William M. Mendenhall Terry L. Sincich, Statistics for Engineering and the Sciences, Sixth Edition, CRC Press Taylor & Francis Group,2016.
2. David.Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/ Cole, 2005.

Online Resources

1. https://nptel.ac.in/courses/111105112 (Unit-1: Module-5 to Module-8)
2. https://nptel.ac.in/courses/108104174 (Unit-2: Week-6 and Week-7)
3. https://nptel.ac.in/courses/111102111(Unit 3, Unit4)
4. https://nptel.ac.in/courses/111104120(Unit 5)

26ITE101

CLOUD COMPUTING
(Program Elective - 1)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Knowledge on Data Bases and computing mechanisms.

Course Objectives:

This course aim is to:

1. To gain a comprehensive understanding of fundamental concepts in cloud computing, including its goals, benefits, risks, challenges, service models, and deployment models.
2. To explore cloud-enabling technologies such as cloud data centre technology, virtualization, multitenant technology, and containerization, along with their roles and implications in cloud computing environments.
3. To analyze specialized cloud mechanisms and management mechanisms to understand their significance in optimizing cloud performance and resource utilization.
4. To examine various access-oriented and data-oriented security mechanisms implemented in cloud computing environments
5. To evaluate different cloud computing architectures to design scalable, resilient, and efficient cloud solutions aligned with organizational requirements and objectives.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Understand the fundamental cloud computing concepts, including service models and deployment models.
2. Analyze cloud-enabled technologies and evaluate various cloud infrastructure components, storage technologies, and networking principles.
3. Apply the advanced cloud computing mechanisms and cloud management mechanisms
4. Analyze the security challenges, identify potential risks, and evaluate strategies for securing cloud deployments.
5. Critique different cloud computing architectures, evaluating their scalability, resilience, and suitability for diverse application scenarios leverage emerging trends such as edge computing and fog computing

CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	1	1	2	1	1
CO 2	2	1	2	2	2
CO 3	3	1	3	3	3
CO 4	2	2	2	2	3
CO 5	3	2	3	3	2

UNIT - I

Fundamental Concepts of Cloud Computing: Goals and Benefits, Risks and challenges, Cloud Computing Service and Deployment Models: Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud, Multi-Cloud.

UNIT - II

Cloud-Enabling Technology: Cloud Data Centre Technology, Modern Virtualization, Multitenant Technology, Service Technology and Service APIs, Fundamental of Containerization, Containers,

Container Images, Multi- Container Types. **Cloud Infrastructure Mechanisms:** Logical Network Perimeter, Virtual Server, Hypervisor, Cloud Storage Device, Cloud Usage Monitor, Resource Replication, Ready-Made Environment.

UNIT - III

Specialized Cloud Mechanisms: Automated Scaling Listener, Load Balancer, SLA Monitor, Pay-Per-Use Monitor, Audit Monitor, Failover System, Resource Cluster, Multi-Device Broker, State Management Database

Cloud Management Mechanisms: Remote Administration System, Resource Management System, SLA Management System, Billing Management System**.**

UNIT - IV

Cloud Computing Architectures: Workload Distribution Architecture, Elastic Resource Capacity Architecture, Multi Cloud Architecture, Hypervisor Clustering Architecture, Cloud Balancing Architecture

Specialized Cloud Architectures: Edge Computing Architecture, Fog Computing Architecture, Meta cloud Architecture, Federated Cloud Application Architecture**.**

UNIT - V

Cloud Computing Security: Threat Agents, Common Threats, **Cloud Security and Cybersecurity Access- Oriented Mechanisms:** Cloud-Based Security Groups, Hardened Virtual Server Image, Identity and Access Management (IAM) System,

Cloud Security and Cybersecurity Data-Oriented Mechanisms: Data Loss Prevention (DLP) System, Trusted Platform Module (TPM). **Cloud Delivery Model Considerations:** Case Study on Cloud Provider and Consumer Perspective.

Text Book:

1. Thomas Erl, Eric Barceló Monroy, “Cloud Computing: Concepts, Technology, Security, and Architecture”, 2nd Edition, 2023, Pearson, ISBN: 9780138052287.

Suggested Reading:

1. Rajkumar Buyya, Christian Vecchiola, and S. Thamarai Selvi, “Cloud Computing: Principles and Practice",
2. 2020.
3. Comer, D, “The Cloud Computing Book: The Future of Computing Explained”, 1st edition,. Chapman and
4. Hall/CRC, 2021. https://doi.org/10.1201/9781003147503.
5. Sean Howard, “Edge Computing with Amazon Web Services: A practical guide to architecting secure edge
6. cloud infrastructure with AWS”, 1st Edition, ISBN: 9781835081082, Packt Publishers, 2024.

26ITE102

CYBER SECURITY
(Program Elective -1)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aims to
1. To identify and present indicators that a cybercrime has occurred and understand methods and tools used in cybercrimes.
2. To collect, Process, Analyze and Present Computer Forensics Evidence.
3. To understand the legal perspectives and Organizational implications of Cyber Security

Course Outcomes:
Upon completion of this course, students will be able to
1. List the different types of cybercrimes and analyze legal frameworks to handle cybercrimes.
2. Identify the Tools and Methods used in cybercrimes.
3. Analyze and resolve cyber security issues and laws governing Cyberspace.
4. Describe the need of Digital Forensics and the importance of digital evidence in prosecution.
5. Interpret the commercial activities in the event of significant information security incidents in the Organization.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	3	3	-	2
CO 2	3	2	3	-	2
CO 3	3	3	3	1	2
CO 4	3	2	3	1	1
CO 5	2	3	3	2	1

UNIT-I
Ethical aspects of Robotic Design: Introduction, Blame the Robot, Blaming Homo sapiens, Negligence and Product Liability Laws, Security aspects and laws involved in Robotic Design. Introduction to Cyber Crime: Cyber Crime: Definition and Origins of the Word, Cybercrime and Information Security, Classification of Cyber Crimes, Cyber Crime: The Legal Perspective, Cyber Crime: An Indian Perspective, A Global Perspective of Cyber Crime.

UNIT-II
Cyber Offenses: Introduction, How Criminals plan the Attacks, phases of ethical hacking, Social Engineering, Cyber stalking, Cyber café and Cybercrimes, Botnets: The Fuel for Cybercrime, Attack Vector. Tools and Methods Used in Cybercrime: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.
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UNIT-III

Cyber Security: The Legal Perspectives: Cyber Crime and the Legal Landscape around the World, Need of Cyber laws: the Indian Context, The Indian IT Act, Challenges to Indian Law and Cyber Crime Scenario in India, Digital Signatures and the Indian IT Act, Cyber Crime and Punishment, Cyber Law, Technology and Students:The Indian Scenario.

UNIT-IV

Understanding Cyber Forensics: Introduction, Digital Forensics Science, Need for Computer Forensics, Cyber Forensics and Digital Evidence, Forensics Analysis of Email, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Cyber Forensics Investigation, Challenges in Computer Forensics.

UNIT-V

Cyber security: Organizational Implications: Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications, Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations. Real time case studies.

Text Books:

1. "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", by Nina Godbole, Wiley India, Alan L Foust, Sunit Bola Pure, Published 2011.
2. Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGraw Hill, 2016.
3. Angelo Cangelosi, Minoru Asada "Cognitive Robotics" MIT press 2022 2. Hooman Somani,"Cognitive Robotics", CRC Press, 2016.

Suggested Reading:

1. Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar, "Cyber Security and Cyber Laws", Paperback – 2018.
2. Mark F Grady, Fransesco Parisi, "The Law and Economics of Cyber Security", Cambridge university press, 2006.

Web Resources:

1. https://www.edx.org/learn/cybersecurity
2. https://www.coursera.org/courses?query=cyber%20security
3. https://swayam.gov.in/course/4002-cyber-law
4. https://onlinecourses.nptel.ac.in/noc25_cs116/preview

26ITE103

ADVANCED COMPUTER NETWORKS
(Program Elective -1)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to

1. Know the basic understanding of Computer networks starting with OSI Reference Model, Protocols at different layers with special emphasis on IP, TCP & UDP and Routing algorithms.
2. Understand the networking architecture and some of the major topics which are included in this course are CSMA/CD, TCP/IP implementation, LANs/WANs, internetworking technologies, Routing and Addressing.
3. Develop some familiarity with current research problems and research methods in advanced computer networks.
4. Explore the advanced background on relevant computer networking topics.
5. Give a comprehensive and deep knowledge in computer networks

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Explain reference models with layers, protocols and interfaces.
2. Combine and distinguish functionalities of different Layers.
3. Describe and Analysis of basic protocols of computer networks, and how they can be used to assist in network design and implementation.
4. Identify and resolve problems of a LAN and WAN in Enterprise.
5. Recognize the need for service integration and discuss how it can be accomplished.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	2	2	1	2	1
CO 2	2	2	1	2	1
CO 3	2	2	1	2	1
CO 4	2	2	1	2	1
CO 5	2	2	1	2	1

UNIT I

Introduction, Protocols and Standards: Definition and Uses of Computer Network, Classification of Computer network, Network Architecture, Internet Standards, Overview of reference models: The OSI model, The OSI Reference Model, TCP/IP Protocol Suite, The TCP/IP Reference Model, Comparison of the OSI & the TCP/IP Reference Models, Addressing, IP versions. Connectors, Transceivers and Media converters, Network interface cards, Repeaters, Hubs, Bridges, Switches, Routers and Gateways etc. Telephone networks, networking principles.

UNIT II

The WAN Protocol: Faces of ATM, ATM Protocol operations, ATM Networking basics, Theory of Operations, B - ISDN reference model, PHY layer, ATM Layer (Protocol model), ATM layer and cell, Traffic Descriptor and parameters, Traffic Congestion control defined, AAL Protocol model, Traffic contract and QoS, User Plane overview, Control Plane AAL, Management Plane, ATM public services.

UNIT III

Packet Switching Protocol: X.25, theory of Operation and Network Layer functions, X.75, Internetworking protocols, Switched Multimegabit Data Service (SMDS), Subscriber Interface and Access Protocol, Addressing and Traffic Control Common Protocols and interfaces in upper Layer: TCP/IP suite, Network Layer, Transport Layer, Applications Layer, Addressing and routing design, Socket programming.

UNIT IV

Routing in the Internet: Intra and interdomain routing; Unicast. Routing Protocols: RIP, OSPF, BGP; Multicast Routing Protocols: MOSPF, DVMRP, Drawbacks of traditional routing methods, Idea of Traffic Engineering (TE), TE and Different Traffic classes. IP over ATM, Multi-Protocol Label switching (MPLS), Storage Area Networks.

UNIT V

Network Management and Enterprise Network Security: De Militarized Zone (DMZ), Network Address Translation (NAT), Source Network Address Translation (SNAT), Destination Network Address Translation (DNAT), Port Forwarding, Proxy, Transparent Proxy, Packet Filtering. Backbone Network Design: Backbone Requirements, Network Capacities and Topologies, Topologies Strategies, Tuning Network. Concept, Management Components, Structure of Management Information(SMI), Management Information Base (MIB) , Simple Network Management Protocol (SNMP) format and Messages.

TEXTBOOKS:

1. Advance Computer Network, Dayanand Ambawade, Dr. Deven shah, Prof. Mahendra Mehra, Wiley India
2. High-Speed Networks and Internets, Performance and Quality of Service, William Stallings, Pearson

SUGGESTED READING:

1. Data Communications and Networking (5th edition), Behrouz Forouzan, McGraw Hill.

Web Resources:

1. NPTEL : nptel.ac.in/courses/106106243
2. COURSERA : https://www.coursera.org/learn/packt-advanced-networking-technologies-and-operations-6cthe
3. ONLINE : https://www.hh.se/english/education/courses/advanced-computer-networks-and-security.html

26ITE104

HIGH PERFORMANCE COMPUTING
(Program Elective - 1)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: C / C++ Programming and Data Structures, Python, Computer Architecture, Operating Systems, Mathematical Foundations for IT/CS, Computer Networks.

Course Objectives:
This course aims to:
1. Introduce the fundamental concepts of high performance and parallel computing systems.
2. Impart practical knowledge of shared and distributed memory programming using OpenMP and MPI.
3. Develop skills in designing and analyzing parallel algorithms for multicore architectures.
4. Familiarize students with GPU architectures and accelerator-based programming using CUDA and OpenACC.
5. Understand performance optimization techniques, HPC tools, and real-world applications.

Course Outcomes:
At the end of the course, the student will be able to:
1. Analyze different HPC architectures and parallel computing models.
2. Develop parallel programs using OpenMP and MPI for performance improvement.
3. Design and implement efficient parallel algorithms for scientific and engineering problems.
4. Apply GPU programming techniques using CUDA/OpenACC for accelerated computing.
5. Evaluate and optimize performance of HPC applications using appropriate tools and techniques.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	2	1	2	2	1
CO2	3	2	2	3	2
CO3	3	2	3	3	2
CO4	3	2	3	3	3
CO5	3	3	3	2	3

UNIT- I
Linux Basics: Introduction to Linux OS, Basic Commands, File System, Process Management, Memory Management Commands. **Shell Scripting**: Basics, Variables, Conditional Statements, Loops, User Input, Parent-Child Processes. **Fundamentals of HPC**: Definition, Need, Applications. **HPC System Components**: Compute Nodes, Interconnects, Storage. **Parallel Architecture Families**: Flynn's Taxonomy. Shared Memory vs Distributed Memory Systems. Introduction to Multicore and Manycore Architectures.

UNIT -II
Parallel Programming using OpenMP: Introduction to Parallel Computing Concepts, Shared Memory Programming Model, OpenMP Overview and Execution Model, Parallel Regions, Work Sharing

Constructs, Synchronization: Critical Sections, Barriers, Locks, Reduction Operations, Scheduling Techniques, Memory Model and Data Scoping, Performance Issues in OpenMP.

UNIT-III

Message Passing Interface (MPI**)** and Distributed Computing: Introduction to Distributed Memory Programming, MPI Basics: Processes, Communication, Point-to-Point Communication (Send/Receive), Collective Communication: Broadcast, Scatter, Gather, Reduce, MPI Communicators and Data Types, Domain Decomposition Techniques, Parallel Program Development using MPI, Performance Analysis of MPI Programs.

UNIT-IV

GPU Computing and Accelerator Programming: Introduction to GPU Computing , GPU Architecture and Execution Model , CUDA Programming Model ,CUDA Program Structure , Thread Hierarchy: Grid, Block, Warp , **Memory Types**: Global, Shared, Constant, Registers , **Basic CUDA Kernels**: Vector Addition, Matrix Multiplication ,Thread Divergence and Optimization Techniques , Introduction to OpenACC and Directive-based Programming , Loop Parallelization and Data Management in OpenACC.

UNIT-V

Advanced HPC Topics and Applications: **Parallel Algorithms**: Divide and Conquer ,Fork-Join Model ,MapReduce Concept , Embarrassingly Parallel Problems , Performance Metrics: Speedup, Efficiency, Scalability (Amdahl's & Gustafson's Laws) ,HPC Job Scheduling: Introduction to SLURM and PBS , Parallel File Systems and I/O Concepts Scientific Visualization Basics , Emerging Trends: Exascale Computing, AI with HPC, Heterogeneous Computing.

Text Book:

1. High Performance Computing: Modern Systems and Practices – Thomas Sterling, Matthew Anderson, Maciej Brodowicz, Morgan Kaufmann, 2018.

Suggested Reading:

1. Programming Massively Parallel Processors: A Hands-on Approach – David B. Kirk, Wen-mei W. Hwu, Elsevier.
2. An Introduction to Parallel Programming – Peter Pacheco, Morgan Kaufmann.
3. Using OpenMP: Portable Shared Memory Parallel Programming – Barbara Chapman et al.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc26_ma16/
2. https://onlinecourses.nptel.ac.in/noc26_cs43/
3. https://onlinecourses.nptel.ac.in/noc26_cs32/

26ITE105

Embedded Systems and Internet of Things
(Program Elective - 1)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aims to:

1. Introduce the basic concepts of embedded system and 8051 Microcontroller fundamentals.
2. Provide an overview of Programming with 8051and Basics of Internet of Things
3. Explore various IoT enabling technologies and the design methodology for IoT.
4. Deal with the Raspberry Pi device, its interfaces and Django Framework.
5. Introduce systems and the utilities for case studies.

Course Outcomes:

Upon completing this course, students will be able to:

1. Understand Embedded System design process and 8051 Architecture.
2. Apply instruction set of 8051 and Applications.
3. Interpret IoT Protocols, Communication models, APIs and enabling Technologies.
4. Explore Design Methodology and physical devices like Raspberry Pi3.
5. Get acquainted with Application Domains and Industrial IoT with real time Scenarios

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	2	2
CO2	2	2	2	2	2
CO3	2	2	2	2	2
CO4	2	2	2	2	2
CO5	2	2	2	2	2

UNIT-I

Embedded Computing: Introduction, Embedded System Design Process, Challenges and Characteristics of Embedded Systems, Applications of Embedded Systems. **The 8051 Architecture:** Introduction, 8051 Microcontroller Hardware.

UNIT-II

Programming using 8051: Data Transfer and Logical Instructions, Arithmetic Operations, Decimal Arithmetic, Jump and Call Instructions. Applications of 8051: Keyboards, Display devices and ADC &DAC.

UNIT-III

Introduction: Introduction to Internet of Things- Definitions & Characteristics of IoT, **Physical Design of IoT-** Things in IoT, IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs.

IOT Enabling Technologies-Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication. Embedded Systems. IOT Levels & Deployment Templates.

UNIT-IV

IoT Platforms Design Methodology: Introduction, **Steps-**Purpose and Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specifications, IoT Level Specification, Functional View Specification, Operational View Specification, Device and Component Integration, Application Development, Case Study on IoT System for Weather Monitoring.

IoT Physical Devices and End Points: Raspberry Pi About the board, Raspberry Pi Interfaces-Serial, SPI, I2C. **Python Web Application Framework**: Django Framework-Roles of Model, Template and View.

UNIT-V

Domain Specific IOTs: Various types of IoT Applications in Home Automation- smart lighting, Smart appliance, smoke and gas detectors, Cities, Environment, Energy, Retail, Logistics Agriculture, Industry, Health & Life Style-Wearable Electronics.

IoT and M2M – Introduction to M2M, Differences between IoT and M2M, Software Defined Networking, Network Function Virtualization.

Industrial IoT: Introduction to Industrial IoT, IIRA, Industry 4.0 Globalization and Emerging Issues, Cyber Security and Fog Computing. **Case studies:** Manufacturing Industry, Automotive Industry, Mining Industry.

Text Books:

1. Wayne Wolf, “Computers as Components”, 1 st Edition, Academic press, 2001.
2. Kenneth J.Ayala, “The 8051 Microcontroller”, 3 rd Edition, Thomson, 2014.
3. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-on Approach”, Universities Press,1st Edition.2014.
4. Misra, C. Roy, and A. Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”. 1st Edition,CRC Press.2020

Suggested Reading:

1. Raj Kamal, “Embedded Systems”, 2 nd Edition, McGraw Hill, 2015.
2. Samuel Greengard, “The Internet of Things”, 1st Edition, MIT Press, 2015.
3. Peter Waher, Pradeeka Seneviratne, Brian Russell, Drew Van Duren, “IoT: Building Arduino-Based Projects”, 1st Edition, Packt Publishing Ltd, 2016.
4. Jeeva Jose, “Internet of Things”, Khanna Book Publishing Company, 2018.

26MEM101

RESEARCH METHODOLOGY AND IPR

Instruction	2 Hours per week
Duration of SEE	3Hours
SEE	60 Marks
CIE	40 Marks
Credits	2

Course Objectives:

This course aims to:

1. Motivate to choose research as career
2. Formulate the research problem, prepare the research design
3. Identify various sources for literature review and data collection report writing
4. Equip with good methods to analyze the collected data
5. Know about IPR copyrights

Course Outcomes:

Upon completion of this course, students will be able to:

1. Define research problem, review and asses the quality of literature from various sources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various research designs.
3. Collect the data by various methods: observation, interview, questionnaires.
4. Analyze problem by statistical techniques: ANOVA, F-test, and Chi-square.
5. Understand apply for patent and copyrights.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	3	2	1	2	2
CO2	3	3	3	2	2
CO3	3	2	2	1	2
CO4	3	1	2	2	3
CO5	3	3	3	3	3

UNIT - I

Research Methodology: Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem

UNIT - II

Literature Survey Report writing: Literature Survey: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanics of writing a report. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal. Introduction to latex ,Basic rules, LaTeX templates — Reports

UNIT- III

Research Design:: Meaning of Research Design, Need of Research Design, Feature of a Good Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research

Plan, Steps in sample design, types of sample designs.

UNIT - IV

Data Collection and Analysis: Data Collection: Methods of data collection, importance of Parametric, non-parametric test, testing of variance of two normal population, use of Chi-square, ANOVA, Ftest, z-test.

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UNIT - V

Patents and Copyright: Patent: Macro economic impact of the patent system, Patent document, Patent Filling Procedures,. Granting of patent, Rights of a patent, patent protection. Copyright: Meaning.Copyrights protection, steps involved for applying copyrights registrations process ,Enforcement of Intellectual Property Rights: Infringement of intellectual property rights, Case studies of patents and IP Protection. IP as a Global Indicator of Innovation, Major Amendments In IP laws And Acts in India.

Text Books:

1. C.R Kothari, "Research Methodology, Methods & Technique"; New Age International Publishers, 2004
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, 2011
3. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publs., Pvt., Ltd., New Delhi, 2004.

Suggested Reading:

1. Ajit Parulekar and Sarita D' Souza, "Indian Patents Law – Legal & Business Implications"; Macmillan India ltd, 2006.
2. B. L. Wadehra; "Law Relating to Patents, Trademarks, Copyright, Designs & Geographical
3. Indications"; Universal law Publishing Pvt. Ltd., India2000.
4. P. Narayanan; "Law of Copyright and Industrial Designs"; Eastern law House, Delhi 2010.

26EGA101

ENGLISH FOR RESEARCH PAPER WRITING
(M. Tech Audit Course - I/II Sem - Common to all Branches)

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	No Credit

Prerequisite:
Writing to express science and technological concepts with good taste for research and development.

Course Objectives:
This course aims to:
1. Motivate learners for academic writing and thus encourage them for continuous professional updating and up-gradation.
2. Facilitate a practical understanding of the multiple purposes of Writing Research Papers and help them infer the benefits and limitations of research in science and technology.
3. Brainstorm and develop the content, formulating a structure and illustrating the format of writing a research paper.
4. Survey and select a theme/topic for a thorough reading and to write a research paper.
5. Understand how to implement the intricacies of writing and publishing a research paper.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Improve work performance and efficiency, illustrate the nuances of research paper writing and draw conclusions on professional usefulness.
2. Classify different types of research papers and organize the format and citation of sources.
3. Explore various formats of APA, MLA and IEEE and set up for writing a research paper.
4. Draft paragraphs and write theme-based thesis statements in a scientific manner.
5. Develop an original research paper while acquiring the knowledge of how and where to publish their papers.

CO-PO Articulation Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5
CO 1	2	2	1	2	1
CO 2	2	2	1	1	-
CO 3	2	2	1	1	-
CO 4	2	2	1	1	-
CO 5	2	3	2	1	1

UNIT - I
Academic Writing: Meaning & Definition of a research paper; Purpose of a research paper - Scope, Benefits, Limitations and outcomes for professional development, An introduction to methods and Approaches of Research.

UNIT - II
Research Paper Format: Title - Abstract - Introduction - Discussion - Findings - Conclusion - Style of Indentation - Font size/Font types - Indexing - Citation of sources.

UNIT - III
Process of writing a research paper, writing to Draft a Format, Develop content, Adapting, Reviewing, Paraphrasing& Plagiarism Checks.

UNIT - IV

Choosing a topic - Thesis Statement - Outline - Organizing notes - Language of Research - Word order, Paragraphs - Writing first draft-Revising/Editing - The final draft and proof reading. Understanding APA, MLA, and IEEE formats.

UNIT - V

Research Paper Publication Reputed Journals –Paid, Free and peer reviewed journals, National/International - ISSN No, No. of volumes, Scopus Index/UGC Journals. Getting Papers Published.

Text Books:

1. Kothari, C. R. and Gaurav, Garg, Research Methodology Methods and Techniques", 4thEdition, New Age International Publishers, New Delhi, 2019.
2. Ellison, Carroll. "Writing Research Papers", McGraw Hill's Concise Guide, 2010.
3. Lipson, Charles. "Cite Right: A Quick Guide to Citation Styles-- MLA, APA, Chicago, the Sciences, Professions, and More", 2nd Edition,. University of Chicago Press. Chicago, 2018.

Suggested Reading:

1. Day, Robert A. "How to Write and Publish a Scientific Paper", Cambridge University Press, 2006.
2. Girden, E. R. "MLA Hand book for writers of Research Papers", 7th Edition, East West Press Pvt. Ltd, New Delhi, 2009.
3. Bailey, Stephen. "Academic Writing: A Handbook for International Students", Routledge, 2018.

Online Resources:

1. https://onlin://onlinecourses.nptel.ac.in/noc 18_mg13/preview.
2. https://nptel.ac.in/courses/121/106/121106007/.
3. https://www.classcentral.com/course/swayam-introduction-to-research-5221.

Writing Tools:

1. https://owl.purdue.edu/owl_exercises/index.html - The Owl writing lab.
2. https://www.turnitin.com/login_page.asp?lang=en_us – Turn tin software.

26CEA101

DISASTER MITIGATION AND MANAGEMENT
(M. Tech Audit Course - I/II Sem - Common to all Branches)

Instruction	2L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	Non Credit

Course Objectives:
This course aims to
1. Equip the students with the basic knowledge of hazards, disasters, risks and vulnerabilities including natural, climatic and human induced factors and associated impacts.
2. Impart knowledge to students about the nature, causes, consequences and mitigation measures of the various natural disasters.
3. Enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters.
4. Enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.
5. Equip the students with the knowledge of the chronological phases in a disaster management cycle and to create awareness about the disaster management framework and legislations in the context of national and global conventions.

Course Outcomes:
After the completion of this course, the student will be able to
1. Analyze and critically examine existing programs in disaster management regarding vulnerability, risk and capacity at different levels.
2. Understand and choose the appropriate activities and tools and set up priorities to build a coherent and adapted disaster management plan.
3. Understand various mechanisms and consequences of human induced disasters for the participatory role of engineers in disaster management.
4. Understand the impact on various elements affected by the disaster and to suggest and apply appropriate measures for the same.
5. Develop an awareness of the chronological phases of disaster preparedness, response and relief operations for formulating effective disaster management plans and ability to understand various participatory approaches/strategies and their application in disaster management.

CO-PO Articulation Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5
CO 1	2	3	2		
CO 2	3	3	2		
CO 3	2	3	3		
CO 4	3	3	2		
CO 5	3	2	2		

UNIT-I:
Introduction: Basic definitions- Hazard, Disaster, Vulnerability, Risk, Resilience, Mitigation, Management; classification of types of disaster-Natural and manmade; International Decade for natural disaster reduction (IDNDR); International strategy for disaster reduction (ISDR), National disaster management authority (NDMA).

UNIT-II:

Natural Disasters: Hydro meteorological disasters: Causes, Early warning systems- monitoring and management, structural and non-structural measures for floods, drought and Tropical cyclones; Geographical based disasters: Tsunami generation, causes, zoning, Early warning systems- monitoring and management, structural and non- structural mitigation measures for earthquakes, tsunami, landslides, avalanches and forest fires. Case studies related to various hydro meteorological and geographical based disasters.

UNIT-III:

Human induced hazards: Chemical disaster- Causes, impacts and mitigation measures for chemical accidents, Risks and control measures in a chemical industry, chemical disaster management; Case studies related to various chemical industrial hazards eg: Bhopal gas tragedy; Management of chemical terrorism disasters and biological disasters; Radiological Emergencies and case studies; Case studies related major power break downs, Fire accidents, traffic accidents, oil spills and stampedes disasters due to double cellular construction in multistoried buildings.

UNIT-IV:

Disaster Impacts: Disaster impacts- environmental, physical, social, ecological, economic, political, etc.; health, psycho-social issues; demographic aspects- gender, age, special needs; hazard locations; global and national disaster trends; climate change and urban disasters.

UNIT-V:

Concept of Disaster Policies and legislation for disaster risk reduction.

Management: Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; risk analysis, vulnerability and capacity assessment; post-disaster environmental response water, sanitation, food safety, waste management, disease control; Roles and responsibilities of government, community, local in situations, NGOs and other stakeholders; DRR programmers in India and the activities of National Disaster Management Authority.

Textbooks:

1. Pradeep Sahni," Disaster Risk Reduction in South Asia", Prentice Hall, 2003.
2. B. K. Singh," Handbook of Disaster Management: Techniques &Guidelines", Rajat Publication, 2008.
3. Ministry of Home Affairs". Government of India, "National disaster management plan, Part I and II".
4. K. K. Ghosh," Disaster Management", APH Publishing Corporation, 2006.

Suggested Reading:

1. http://www.indiaenvironmentportal.org.in/files/file/disaster_management_india1.pdf
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs).
3. Hazards, Disasters and your community: A booklet for students and the community, Ministry of home affairs.

26EEA101

Sanskrit for Computational Thinking & Engineering Applications
(M. Tech Audit Course - I/II Sem - Common to all Branches)

Instruction	2L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	Non Credit

COURSE OBJECTIVES:
This course aims to
1. To introduce Sanskrit as a structured language useful for logical thinking and algorithm design.
2. To connect Sanskrit concepts with modern engineering domains (AI, circuits, structures, systems).
3. To develop computational and analytical skills using Sanskrit-based principles.
4. To enable students to explore interdisciplinary applications for research and innovation.

COURSE OUTCOMES :
After completion, students will be able to:
1. Apply structured Sanskrit rules to improve logical and algorithmic thinking
2. Relate concepts from Sanskrit texts to modern Engineering principles
3. Develop simple computational models inspired by Sanskrit grammar/logics
4. Use Sanskrit-based frameworks in AI, coding logic, or system design
5. Identify interdisciplinary research opportunities combining Sanskrit & Engineering

CO–PO ARTICULATION MATRIX

PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	1	1	1	1
CO 2	2	2	2	1	2
CO 3	2	2	2	1	1
CO 4	1	2	1	2	1
CO 5	2	1	2	1	2

UNIT–I:
Sanskrit as a Structured Language
Sanskrit as rule-based system -Basics: alphabets, word formation (only essentials) -Sandhi as **data compression analogy** -Samasa as **modular design / block abstraction**-Simple sentence formation (very minimal grammar).

UNIT–II:
Sanskrit & Computational Thinking
Paninian grammar → rule engine / compiler design -Shiva Sutras → encoding system-Binary concepts in Pingala (Chandas → digital logic) -Recursion & patterns in Sanskrit structures.

UNIT–III:

Sanskrit in Core Engineering Domains Civil / Mechanical:

Sulba Sutras → geometry, measurements -Ancient construction logic → modular design
Electrical / ECE: - Concept of energy (Agni, Surya) → symbolic + physical mapping , Wave & sound (Nada → signal analogy) **Systems Thinking:** Interconnectedness → system design philosophy.

UNIT–IV:
Sanskrit & Modern Technology
Sanskrit & Artificial Intelligence (knowledge representation) -Natural Language Processing (NLP) -Formal languages & syntax -Command-based structures → programming analogy.

UNIT–V:
Mini Applications & Case Studies
Case study: Sanskrit → Algorithm (simple flowchart) -Chandas → binary pattern generation-Design a simple rule-based system using Sanskrit logic -Mini presentation / activity.

Text books:

1. **Kapil Kapoor** – Language, Linguistics and Literature- Indian Perspective ; Academic Foundation, New Delhi; 1994 (1st Edition); **ISBN:** 978-8171880577
2. **Frits Staal**: *A Reader on the Sanskrit Grammarians; MIT* Press / Motilal Banarsidass ; 1972 (Original); **ISBN:** 978-0262191340
3. **George Gheverghese Joseph:** The Crest of the Peacock"; Princeton University Press; 2000 (2nd Edition; widely used); **ISBN:** 978-0691135267
4. B.V. Subbarayappa: "Indian Scientific Heritage" – National Institute of Advanced Studies (NIAS), Bangalore; 2006 **ISBN:** 978-8185015026
5. – M. Krishnamachariar: "History of Sanskrit Literature"; Motilal Banarsidass Publishers; Reprint 1993 (Original: 1937, TTD Press); **ISBN:** 978-8120802841

Suggested reading:

1. Pingala. Chandah Shastra (various editions, Nirnaya Sagar Press / Chowkhamba)
2. Bharati, A., et al. Natural Language Processing: A Paninian Perspective, PHI, 1995
3. Selected IEEE / Springer Papers on Sanskrit & AI

26ECA101

VALUE EDUCATION

(M. Tech Audit Course - I/II Sem - Common to all Branches)

Instruction	2L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	Non Credit

Prerequisite:
Knowledge about Universal Human values.
Course Objectives:
This course aims to
1. Understand Value Education, Self-development and National development.
2. Imbibe good human values and Morals in students.
3. Cultivate individual and National character.

Course Outcomes:
After completion of the Course, Students will be able to:
1. Summarize classification of values and values for self-development.
2. Identify the importance of values in personal and professional life.
3. Apply the importance of social values for better career and relationships.
4. Analyze ethical issues in modern technology
5. Discuss concept of soul and reincarnation and promote responsible citizenship

CO-PO Articulation Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5
CO 1	2	2	2	1	1
CO 2	2	2	2	2	1
CO 3	2	2	2	3	2
CO 4	2	2	3	3	3
CO 5	2	2	3	2	2

UNIT - I
Human Values, Ethics and Morals: Concept of Values, Human Values, Indian concept of humanism, Values for self-development, Social values, Individual attitudes, Work ethics, Moral and non- moral behavior, Standards and Principles based on religion, Culture and Tradition.

UNIT - II
Value Cultivation, and Self-Management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT - III
Spiritual Outlook and Social Values: Personality and Behaviour Development, Scientific attitude and Spiritual (soul) outlook, Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, Avoiding fault finding in others, Reduction of anger, Forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance., Happiness Vs Suffering, Love for truth, Aware of self-destructive habits, Appreciation and co-operation.

UNIT - IV
Technology, Society, and Sustainability: Ethics in emerging technologies (AI, Data, 5G, IoT); Privacy

and cybersecurity, Environmental ethics and sustainable development; Social responsibility of engineers, Policy and governance.

UNIT - V

Universal Values and Global Perspectives: Mind your mind, Self-control, Concept of soul, Science of Reincarnation, Concepts of Dharma and Karma, The qualities of Devine and Devilish, Satwic, Rajasic and Tamasicgunas. Global citizenship, Happiness and meaningful life.

TEXT BOOKS:

1. Chakroborty, S.K. "Values & Ethics for organizations Theory and practice", Oxford University Press, New Delhi, 1998.
2. Jaya Dayal Goyandaka, "Srimad Bhagavad Gita", with Sanskrit Text, Word meaning and Prose meaning, Gita Press, Gorakhpur, 2017.

REFERENCE BOOKS:

1. George Reynolds, Ethics in Information Technology, 6th Edition, Cengage Learning, 2018.
2. Melanie Mitchell, Artificial Intelligence: A Guide for Thinking Humans, 1st Edition, Farrar, Straus and Giroux, 2019.

26EGA102

CONSTITUTION OF INDIA

(M. Tech Audit Course - I/II Sem - Common to all Branches)

Instruction	2L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	Non Credit

Prerequisite:
Knowledge on basics of the Constitution and the Government.

Course Objectives:
This course aims to:
1. The history of the Indian Constitution and its role in Indian democracy.
2. Get awareness on Fundamental Rights, Duties and Directive Principles of State Policy.
3. Understand the structure and organization of Union Executive, Legislature and Judiciary.
4. Examine the powers and functions of Election Commission and State Election Commission.
5. Explore th
6. e decentralization of administration in India through Local bodies.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand the making of the Indian Constitution and its features.
2. Establish relations among Directive Principles of State Policy, Fundamental Rights and Fundamental Duties.
3. Have an insight into various Organs of Governance at Union level.
4. Understand powers and functions of Urban local bodies and Panchayats.
5. Grasp the role of Election Commission and other organizations in safeguarding Constitution and protecting the rights of Citizens.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	1	1	-	1	-
CO 2	1	1	-	1	-
CO 3	1	1	-	1	-
CO 4	1	1	-	1	-
CO 5	1	1	-	1	-

UNIT-I

History of making of the Indian constitutions – History and Drafting Committee (Composition & Working). Philosophy of the Indian Constitution: Preamble and Salient Features.

UNIT-II

Contours of Constitutional Rights and Duties - Fundamental Rights: Significance of Rights. Directive Principles of State Policy: Relevance and Importance. Fundamental Duties: Importance of Duties.

UNIT-III

Organs of Governance – Union Legislature: Parliament-Composition, Qualifications, Powers and Functions. Union executive: President, Prime Minister and Council of Ministers. Judiciary: appointment and transfer of judges, qualifications, powers and functions.

UNIT-IV

Local Administration - District's Administration head: Role and Importance. Municipalities: Structure and Functions, Municipal Corporation: Mayor and Role of Commissioner. Panchayati Raj: Zilla Panchayat, Elected Officials and their roles, CEO: Position and Role. Block level: Organizational Hierarchy. Village level: Role of elected and appointed officials. Importance of grass roots democracy.

UNIT-V

Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners. State Election Commission: Role and functioning. Institutes and Bodies for the welfare of SC/ST/OBC and Women**.**

Text Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Busi, S. N., Dr. B. R. Ambedkar, Framing of Indian Constitution'', 1st Edition, Ava Publishers, New Delhi, 2015.
3. Jain, M. P., "Indian Constitution Law", 7th Edition, Lexis Nexis, New Delhi, 2014.
4. Basu, D.D. "Introduction to the Constitution of India", Lexis Nexis, New Delhi., 2015.

Suggested Reading:

1. Bhargava, Rajeev. (ed), "Politics and Ethics of the Indian Constitution", OUP, 2008.
2. NCERT, Indian Constitution at Work, 1st Edition, Government of India, New Delhi 2006, reprinted in 2025.
3. Ravindra Sastry, V. (ed.), Indian Government & Politics, 2nd edition, Telugu Akademi, 2018.

Online Resources:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg151

26EGA103

STRESS MANAGEMENT BY YOGA
(M. Tech Audit Course - I/II Sem - Common to all Branches)

Instruction	2 L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	Non Credit

Prerequisite:
Knowledge on Yoga Practices.

Course Objectives
This course aims to
1. Create awareness about different types of stress and the role of yoga in the management of stress.
2. Promote positive health and overall well-being (Physical, mental, emotional, social and spiritual).
3. Prevent stress related health problems by yoga practice.

Course Outcomes:
Upon completion of this course, students will be able to
1. Understand yoga and its benefits.
2. Enhance Physical strength and flexibility.
3. Learn to relax and focus.
4. Relieve physical and mental tension through asanas
5. Improve work performance and efficiency.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	-	-	-	-	-
CO 2	-	-	-	-	-
CO 3	1	1	1	1	-
CO 4	-	-	-	-	-
CO 5	1	1	1	1	-

UNIT - I
Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali).

UNIT - II
Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT - III
Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT - IV
Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas – Prone Asanas - Supine asanas - Surya Namaskar.

UNIT – V
Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama -

Bhramari Pranayama - Nadanusandhana Pranayama.
Meditation techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Text Books:

1. Janardhan, Swami, "Yogic Asanas for Group Training - Part-I": Yogabhyasi Mandal, Nagpur.
2. Vivikananda, Swami**.** "Rajayoga or Conquering the Internal Nature", Advaita Ashrama(Publication Department),Kolkata.
3. Nagendra H.R and R. Nagaratna, “Yoga Perspective in Stress Management”, Swami Vivekananda YogaPrakashan, Bangalore.

Online Resources:

1. https://nptel.ac.in/courses/110101165.

26EGA104

PERSONALITY DEVELOPMENT THROUGH LIFE'S ENLIGHTENMENT SKILLS
(M. Tech Audit Course - I/II Sem - Common to all Branches)

Instruction	2L Hours per Week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	--
Credits	Non Credit

Prerequisite:
Awareness on Personality Development.

Course Objectives:
This course aims to:
1. Learn to achieve the highest goal happily.
2. Become a person with stable mind, pleasing personality and determination.
3. Awake wisdom among themselves.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Develop their personality and achieve their highest goal of life.
2. Lead the nation and mankind to peace and prosperity.
3. Practice emotional self-regulation.
4. Develop a positive approach to work and duties.
5. Develop a versatile personality.

CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	1	1	1	1	1
CO 2	-	-	-	1	-
CO 3	-	-	-	-	-
CO 4	1	1	1	1	1
CO 5	-	-	-	-	-

UNIT - I
Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue).

UNIT - II
Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75& 78 (do's) - Approach to day to day works and duties.

UNIT - III
Introduction to Bhagavad Geetha for Personality Development – Shrimad Bhagavad Geeta: Chapter 2– Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48.

UNIT - IV
Statements of basic knowledge – Shrimad Bhagawad Geeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawad Geeta.

UNIT - V
Role of Bhagawad Geeta in the present scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Text Books:

1. Gopinath, P., “Bhartrihari’s Three Satakam (Niti-sringar-vairagya)”, Rashtriya Sanskrit Sansthanam, New Delhi, 2018.
2. Swarupananda, Swami, “Srimad Bhagavad Geeta”, Advaita Ashram (Publication Dept), Kolkata, 2017.

Web Resources:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_hs174

26ITC103

ROBOTICS LAB

Instruction	3L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1.5

Course Objectives:
This course aim is to:
1. Understand the basics of robotics includes sensors, actuators and grippers.
2. Know the various battery devices and sensors of robotics.
3. Explore the linux commands to control the robot through OpenCV
4. Understand the OpenCV mechanism to handle the images.
5. Explore the various ways for image region extractions.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Apply the various devices to build a basic skeleton of the robot with movement, identifying, picking and placing the object.
2. Illustrates the electrical connections with battery for robot to identify the environment.
3. Demonstrate the controlling mechanism and show the influence of robotic motion.
4. Develop the Open CV programs to identify the images and apply the various sensors to visualize the images.
5. Demonstrate the Open CV programs to identify the region extractions of the images.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO 4	PO 5
CO1	3	1	2	3	2
CO2	2	1	2	2	2
CO3	2	2	2	2	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

List of Experiments
1. Introduction to various robot mechanical components, mounting of motors, sensors, electronic circuits to the chassis.
2. Explain the procedure to connect the electronic circuitry: motor drivers, incremental encoders proximity sensors, micro controller.
3. Different types of batteries, selection of suitable battery for application, safety precaution.
4. Introduction to Linux Command Line Interface: basic file and directory management and other useful commands.
5. Controlling robot using Python: i) Move robot using Python code, ii) Make robot move in patterns using Webots.
6. Robot programming with Sensor inputs to Read sensor data using Python,
7. Robot programming with Sensor inputs to Visualize sensor data using Python.
8. Open CV to Create an Image and display an image , Read and change pixel values.
9. Open CV to Create colored shapes and save image.
10. Open CV to Extraction of Regions of Interest.

Text Books:

1. Saeed B. Niku, Introduction to Robotics: Analysis, Control, and Applications, John Wiley and Sons, 2024.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 4th Edition, 2018.
3. Francis X.Govers , Artificial Intelligence for Robotics, Packt Publishing , 2018
4. Dilip Kumar Pratihar, Fundamentals of Robotics: Analysis and Control, Narosa Publishing House, 2017.

Suggested Reading:

1. R.K. Mittal and I.J. Nagrath, Robotics and Control, TMH, 2017.
2. David Poole, Alan Mackworth, Randy Goebel, Computational Intelligence: A Logical Approach, Oxford University Press, 1998.
3. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, John Wiley and Sons, 2006.
4. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 3rd Edition, 2010.

Web Resources:

1. NPTEL, https://nptel.ac.in, 2026.
2. MIT OpenCourseWare, https://ocw.mit.edu, 2026.
3. Coursera, https://www.coursera.org, 2026.
4. edX, https://www.edx.org, 2026.

26ITC104

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB

Instruction	3L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1.5

COURSE OBJECTIVES:

This course aims to

1. Understand and implement search algorithms for problem solving.
2. Develop programming skills to apply supervised and unsupervised machine learning techniques.
3. Analyze and compare different search and learning algorithms in terms of performance and efficiency.
4. Apply machine learning algorithms to real-world datasets for prediction and clustering.
5. Gain practical knowledge in implementing AI and machine learning algorithms using programming tools.

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Implement search algorithms such as BFS, DFS, Greedy, and A* for solving problems.
2. Analyze the performance of search algorithms in terms of time and space complexity.
3. Develop supervised learning models such as Decision Tree, Naïve Bayes, and Neural Networks.
4. Apply regression and neural network algorithms for prediction and classification tasks.
5. Implement unsupervised learning techniques such as K-Means, SOM, and

CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	3	3	-	2
CO 2	3	3	3	-	2
CO 3	3	3	3	1	2
CO 4	3	3	3	1	1
CO 5	3	3	3	-	1

LABORATORY / PRACTICAL EXPERIMENTS:

1. Implement breadth first search and depth first search and analyse their complexity.
2. Implement and compare Greedy and A* algorithms.
3. Implement the non-parametric locally weighted regression algorithm in order to fit data points.
4. Select appropriate data set for your experiment and draw graphs
5. Write a program to demonstrate the working of the decision tree based algorithm.
6. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
7. Write a program to implement the naïve Bayesian classifier.
8. Implementing neural network using self-organizing maps
9. Implementing k-Means algorithm to cluster a set of data.
10. Implementing hierarchical clustering algorithm.

TEXT BOOKS:

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, Fourth Edition, 201.
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.

SUGGESTED SOFTWARE:

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall,
2. Fourth Edition, 2021.
3. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

ONLINE RESOURCES:

1. NPTEL : https://nptel.ac.in/domains/discipline/106?course=106_0.
2. https://onlinecourses.nptel.ac.in/noc26_cs74/preview.

26ITE106

CLOUD COMPUTING LAB

(Based on Program Elective -1)

Instruction	2 L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

Prerequisite:
Knowledge on Data Bases and computing mechanisms.

Course Objectives:
This course aims to familiarize with:
1. Key concepts of virtualization.
2. Various deployment models such as private, public, hybrid and community.
3. Different service models, such as IaaS and PaaS.
4. Security and Privacy issues in the cloud.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Adapt different types of virtualization and increase resource utilization.
2. Build a private cloud using Iaas technologies.
3. Analyze Containerization, orchestration issues on the cloud.
4. Develop real-world web applications and deploy them on the commercial cloud using Paas.
5. Demonstrate various Database migration in AWS.

CO-PO Articulation Matrix

PO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	2	1	2	2	1
CO 2	3	1	3	3	2
CO 3	3	2	3	3	2
CO 4	3	2	3	3	2
CO 5	3	2	2	3	1

List of Experiments
1. Study of NIST model of cloud computing: Understand deployment models, service models, and advantages of cloud computing.
2. Understand different types of virtualizations, Host and bare metal hypervisors and implement horizontal scalability using technology like XEN, VMware's ESXi ,Oracle Virtual box
3. Explore Infrastructure as a Service using customized resources on a cloud platforms such as AWS,Openstalk,
4. Simulate identity management in your private Cloud using OpenStack technology.
5. Implement Storage as a Service for remote file access using web interface S3 Using AWS.
6. Illustrate containerization using Docker
7. Explore orchestrating the cloud with kubernetes.
8. Implement Platform as a Service by deploying web applications on commercial cloud using technology like AWS lambda.
9. To perform database migration like simpleDB and DynamoDB.
10. Explore Top 10 Vulnerabilities from WSAP on deploying cloud applications in cloud platforms.

Text Books:
1. Enterprise Cloud Computing by Gautam Shroff, Cambridge,2010.
2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010.
3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013.

26ITE107

CYBER SECURITY LAB
(Based on Program Elective -1)

Instruction	2 L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:
This course aims to
1. To provide hands-on experience in setting up virtualization and using a security-focused operating system.
2. To understand and apply network scanning and reconnaissance techniques.
3. To demonstrate and analyze common cyber-attacks such as social engineering, SQL injection, and cross-site scripting.
4. To apply steganography techniques for secure data hiding and retrieval.
5. To develop practical skills in digital forensic analysis including email, browser, disk, and network investigations.

COURSE OUTCOMES: **Upon completion of this course, students will be able to**
1. Install and configure virtualization tools and use a security-focused operating system effectively.
2. Perform network scanning and reconnaissance to identify live hosts and open ports.
3. Analyze and demonstrate cyber attacks including social engineering, SQL injection, cross-site scripting, and steganography.
4. Perform forensic analysis of email and browser data to extract useful information.
5. Conduct disk imaging, cloning, and network traffic analysis using appropriate forensic tools.

CO-PO Articulation Matrix

PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	2	2	1	1
CO 2	3	3	2	1	1
CO 3	3	3	3	2	2
CO 4	2	3	2	2	1
CO 5	3	3	3	2	2

LABORATORY / PRACTICAL EXPERIMENTS:
1. Installation of Virtual box and Kali Linux and basic commands of kali Linux.
2. Perform the following network scanning techniques using NMAP: a) Live Host discovery b) Port scanning.
3. Demonstrate Social Engineering Attack.
4. Perform steganography by hiding a secret text file inside an image using a password, then extract the hidden message and verify its correctness.
5. Demonstrate SQL Injection Authentication Bypass and SQL injection error-based attack.
6. Implement reflected and stored Cross site Scripting techniques.
7. Perform email analysis using the tools like Exchange EDB viewer and View user mailboxes and public folders, Filter the mailbox data based on various criteria, Search for particular items in user mailboxes and public folders.
8. Perform browser history analysis and get the downloaded content, history, saved logins, searches, websites visited etc. using Dumpzilla.
9. Perform disk imaging and cloning using the X-way Forensics tools.

10. Perform network analysis using the Network Miner Wireshark tool.

Text Books:

1. Sunit Belpre and Nina Godbole, “Cyber Security: Understanding Cyber Crimes, Computer
2. Forensics and Legal Perspectives”, Wiley India Pvt, Ltd, 2018.
3. “Ethical Hacking”, Alana Maurushat, University of Ottawa Press.

Suggested Reading:

1. Alfred Basta, Nadine Basta, Mary Brown, Ravinder Kumar, “Cyber Security and Cyber Laws”, Paperback – 2018.
2. Mark F Grady, Fransesco Parisi, “The Law and Economics of Cyber Security”, Cambridge university press, 2006.

Web Resources:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/cec20_lb06.
2. https://www.coursera.org/courses?query=cyber%20security.
3. https://swayam.gov.in/course/4002-cyber-law.

26ITE108

ADVANCED COMPUTER NETWORKS LAB
(Based on Program Elective -1)

Instruction	2 L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:

This course aims to

1. Provide advanced background on relevant computer networking topics.
2. Have a comprehensive and deep knowledge in computer networks.
3. Gain knowledge on networking components.
4. Know the concepts of Application layer protocols.
5. Understand the Internet Protocols

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Gain practical experience with wireless hardware and software, link throughput measurements and analysis.
2. Develop a sound knowledge and understanding of Gigabit Ethernet deployment in large organizations, analysis and communication skills.
3. Explore Cisco packet tracer tool.
4. Configure different protocols in Cisco packet tracer tool.
5. Design different topologies and networks in Cisco packet tracer tool.

CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	2	2	1	2	1
CO 2	2	2	1	2	1
CO 3	2	2	1	2	1
CO 4	2	2	1	2	1
CO 5	2	2	2	1	1

LABORATORY /PRACTICAL EXPERIMENTS:

1. To Familiarize with Networking components and devices: LAN, Adapters, Hubs, Switches.
2. To Familiarize with Networking components and devices: Routers, Co-Axial Cables, UTP Cables, Crimping Tools, Connectors, etc.
3. Subnet planning and its implementation .
4. Installation of FTP server and client.
5. Configure Hyper Text Transfer Protocol (HTTP) and Domain Name System (DNS) in Packet Tracer.
6. Configure DHCP in Packet Tracer.
7. To Configure Routing Information Protocol (RIP) in Packet Tracer.
8. Configure Open Shortest Path First (OSPF) in Packet Tracer.
9. Configure Voice Over IP (VOIP) in Packet Tracer.
10. Configure a network Topology using packet tracer tool.

TEXT BOOKS:

1. A Practical Guide to Advanced Networking, Jeffrey S. Beasley and Piyasat Nilkaew, Pearson, 3rd Edition, 2012.

SUGGESTED READINGS:

1. Data Communications and Networking (5th edition), Behrouz Forouzan, McGraw Hill.

WEB RESOURCES:

1. https://ptgmedia.pearsoncmg.com/images/9780789749048/samplepages/0789749041.pdf.
2. https://www.researchgate.net/publication/352396688_Practical__In_Advance_Computer_Network_using_Cisco_Packet_Tracer.
3. Cisco Packet Tracer 9.0.0 : Download free labs and tutorials for CCNA v7 certification exam preparation - Packet Tracer Network.

26ITE109

HIGH PERFORMANCE COMPUTING LAB
(Based on Program Elective -1)

Instruction	2 L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

Prerequisites:
C / C++ Programming and Data Structures, Python, Computer Architecture, Linux Operating Systems, Mathematical Foundations for IT / CS, Computer Networks, Parallel Programming Basics.

COURSE OBJECTIVES:
This course aims to
1. Provide hands-on experience with the Linux environment and shell scripting.
2. Enable implementation of parallel programs using OpenMP (shared memory).
3. Develop distributed computing skills using MPI.
4. Introduce GPU programming using CUDA/OpenACC.
5. Analyze and optimize performance of parallel applications.

COURSE OUTCOMES:
Upon completion of this course, students will be able to
1. Use Linux commands and shell scripting for HPC environments.
2. Develop and execute shared memory parallel programs using OpenMP.
3. Implement distributed programs using MPI primitives.
4. Design and execute GPU-based programs using CUDA/OpenACC.
5. Evaluate performance metrics such as speedup and efficiency.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	2	1
CO2	3	2	2	3	2
CO3	3	2	3	3	2
CO4	3	2	3	3	3
CO5	3	3	3	2	3

LABORATORY / PRACTICAL EXPERIMENTS:
1. File handling, directory management, permissions, and process monitoring.
2. Shell scripting using variables, loops, and conditionals (Factorial, Fibonacci, file operations).
3. System monitoring using free, vmstat, uptime, lscpu.
4. OpenMP: Parallel “Hello World” program and parallel loop implementation.
5. OpenMP: Reduction operations and synchronization (critical, barrier, locks).
6. OpenMP: Scheduling techniques (static vs dynamic).
7. OpenMP: Performance analysis using omp_get_wtime().
8. MPI: Basics, point-to-point communication (Send/Receive), and collective communication.
9. MPI: Parallel matrix multiplication.
10. GPU Computing: CUDA programs (vector addition, matrix multiplication) and OpenACC directives.
11. SLURM job scheduling and execution of parallel applications.

TEXT BOOKS:

1. Thomas Sterling, Matthew Anderson, Maciej Brodowicz, High Performance Computing: Modern Systems and Practices, Morgan Kaufmann (Elsevier), 2nd Edition, 2024.
2. Peter Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann, 1st Edition, 2011.
3. Barbara Chapman, Gabriele Jost, Ruud van der Pas, Using OpenMP: Portable Shared Memory Parallel Programming, MIT Press, 1st Edition, 2007.
4. David B. Kirk, Wen-mei W. Hwu, Programming Massively Parallel Processors: A Hands-on Approach, Morgan Kaufmann, 3rd Edition, 2016.
5. Parallel Programming in MPI and OpenMP (The Art of HPC, Vol. 2), CC-BY License, 2nd Edition, 2022.
6. Jason Sanders, Edward Kandrot, CUDA by Example: An Introduction to General-Purpose GPU Programming, Addison-Wesley, 1st Edition, 2010.
7. Michael J. Quinn, Parallel Programming in C with MPI and OpenMP, McGraw-Hill,1st Edition, 2003.

SUGGESTED SOFTWARE:

1. HPC Clusters / Cloud License.
2. Linux (Ubuntu/CentOS).
3. GCC with OpenMP support.
4. MPI Library (MPICH / OpenMPI).
5. CUDA Toolkit (if GPU available).
6. SLURM (optional).
7. Linux (Ubuntu/CentOS).
8. GCC with OpenMP support.
9. MPI Library (MPICH / OpenMPI).
10. CUDA Toolkit (if GPU available).
11. SLURM (optional).

WEB RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc26_cs32/
2. https://onlinecourses.nptel.ac.in/noc20_me61
3. https://onlinecourses-archive.nptel.ac.in/noc18_cs55
4. https://onlinecourses.nptel.ac.in/noc22_cs2
5. https://www.coursera.org/specializations/high-performance-parallel-computing

26ITE110

Embedded and Internet of Things Lab
(Based on Program Elective -1)

Instruction	2 L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

Course Objectives:

1. To familiarize students with Embedded Programming.
2. To Experiment with On-Boarding Raspberry Pi / Arduino.
3. To Programming with Raspberry Pi Pins / Arduino Pins using sensors.
4. To introduce the concept of cloud data in IoT environment.
5. To Understand IoT Applications in real time scenario.

Course Outcomes:

Upon completing this course, students will be able to:

1. Design Embedded System using 8051 in Embedded 'c'
2. Write python programs that run on Raspberry Pi/Arduino.
3. Implement Applications using sensors for Raspberry Pi / Arduino.
4. Demonstrate Read and write cloud data using Things peak.
5. Develop simple IoT systems for different Case studies.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	0	2	2
CO2	2	1	1	2	2
CO3	2	1	0	2	2
CO4	2	1	0	2	2
CO5	2	1	1	2	0

LIST OF PROGRAMS

1. Interface Input-Output and other units such as: Relays, LEDs, Switches, Stepper Motors using 8051 Micro controllers.
2. Study and Configure Raspberry Pi.
3. Write programs using Raspberry Pi to blink LED.
   a)using loops b) using conditional & control statements
4. Write program using Raspberry Pi to interface LEDs, Switch and Buzzer.
5. Interface different Sensors using Raspberry Pi.
   a)IR b) PIR c) GAS d) LDR d) Rain e) Soil moisture.
6. Write a program to monitor temperature and humidity using DHT (Digital Humidity and Temperature) sensor using Raspberry Pi / Arduino
7. Uploading and reading the Cloud data using ThingSpeak platform.
   Study the Use Cases:
   a. Home Automation (e.g., Smart Lighting),
   b. City Applications (e.g., Smart Parking , Traffic Lighting)
   c. Environment (e.g., Pollution Monitoring, Weather Monitoring)
   d. Agriculture (e.g., Smart Irrigation) etc.

Text Books:

1. Kenneth J.Ayala, “The 8051 Microcontroller”, 3 rd Edition, Thomson, 2014.
2. Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-on Approach”, Universities Press, 2014.
3. Misra, C. Roy, and A. Mukherjee, 2020 “Introduction to Industrial Internet of Things and Industry 4.0”. CRC Press.

Suggested Reading:

1. Raj Kamal, “Embedded Systems”, 2 nd Edition, McGraw Hill, 2015.
2. Samuel Greengard, “The Internet of Things”, 1st Edition, MIT Press, 2015.
3. Peter Waher, Pradeeka Seneviratne, Brian Russell, Drew Van Duren, “IoT: Building Arduino-Based Projects”, 1st Edition, Packt Publishing Ltd, 2016.
4. Jeeva Jose, “Internet of Things”, Khanna Book Publishing Company, 2018.

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27

M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

SEMESTER-II

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	26ITC105	Advanced Robotics	3		-	3	40	60	3
2	26ITC106	Deep Learning	3		-	3	40	60	3
3		Program Elective-2	3		-	3	40	60	3
4		Program Elective-3	3		-	3	40	60	3
5		Program Elective-4	3		-	3	40	60	3
PRACTICALS									
6	26ITC107	Deep Learning Lab	-		3	-	50	-	1.5
8		Program Elective-4 Lab	-		2	-	50	-	1
9	26ITC108	Mini Project	-		3	-	50	-	1.5
TOTAL			**15**		**8**	**15**	**350**	**300**	**19**
Clock Hours Per Week: 23									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**
T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

Program Elective-2	
26ITE111	Reinforcement Learning
26ITE112	Computer Vision
26ITE113	Natural Language Processing
26ITE114	Knowledge Engineering and Expert Systems
26ITE115	Prompt Engineering

Program Elective-3	
26ITE116	Cognitive Robotics
26ITE117	Cloud Robotics
26ITE118	Robotics Programming using Python
26ITE119	Augmented & Virtual Reality
26ITE120	Cyber Physical Systems

Program Elective-4	
26ITE121	Block chain Technology
26ITE122	Generative AI
26ITE123	Quantum Computing
26ITE124	Advanced Big Data Analytics
26ITE125	Unmanned Aerial Vehicles

Program Elective-4 Lab	
26ITE126	Block chain Technology Lab
26ITE127	Generative AI Lab
26ITE128	Quantum Computing Lab
26ITE129	Advanced Big Data Analytics Lab
26ITE130	Unmanned Aerial Vehicles Lab

26ITC105

ADVANCED ROBOTICS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim is to:
1. Understand the basic kinematics mechanism of robots.
2. Explore the various types of trajectory planning in robots.
3. 3 Present the essential knowledge about object recognition and vision.
4. Study the advances in AI for robots.
5. Explore the various techniques to develop a robot.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Develop a robot to navigate from one place to another based on the kinematics to act and react.
2. Describe the trajectory planning of the robot to make the end-effector move continuously and smoothly from an initial state to the desired state.
3. Apply computer vision and image processing mechanism to spot people, objects, scenes for robots.
4. Develop various types of robots using various technologies including AI, ML and Computer vision and sensor integrations to operate autonomously and react according to the situation.
5. Design the techniques and algorithms to design the robots according to the environment.

CO-PO Articulation Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	3	2
CO2	2	1	2	2	2
CO3	3	2	2	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3

UNIT-I
Kinematics of Robotics**,** Position Analysis, Robots as Mechanisms, Conventions, Matrix Representation, Homogeneous Transformation Matrices, Representation of Transformations, Inverse of Transformation Matrices, Forward and Inverse Kinematics of Robots: Position, Orientation and Position and Orientation, Inverse Kinematic Programming of Robots, Degeneracy and Dexterity.

UNIT-II
Trajectory Planning, Introduction, Path versus Trajectory, Joint-Space versus Cartesian-Space Descriptions, Basics of Trajectory Planning, Joint-Space Trajectory Planning, Cartesian-Space Trajectories, Continuous Trajectory Recording.

UNIT-III
Object Recognition: Features, Moments, Template Matching, DF Descriptions, Depth Measurement with Vision Systems, Specialized Lighting, Image Data Compression, Color Images, Heuristics, Applications of Vision Systems.

UNIT-IV
AI and Advanced Robotics, Introducing the robot and development environment, Software components ROS,Python, Linux. Robot Control Systems and decision-making framework, The robot control system- a control loop with soft real-time control.

UNIT-V

A Concept for a Practical Robot Design Process, A System engineering-based approach, Use Cases, Storyboards, Giving the robot an Artificial Personality, Careers in Robotics, Issues in AI- real and not real, Understanding risk in AI.

TEXT BOOKS:

1. Saeed B. Niku, Introduction to Robotics: Analysis, Control, and Applications, John Wiley and Sons, 2024.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 4th Edition, 2018.
3. Francis X.Govers , Artificial Intelligence for Robotics, Packt Publishing , 2018
4. Dilip Kumar Pratihar, Fundamentals of Robotics: Analysis and Control, Narosa Publishing House, 2017.

SUGGESTED READING:

1. R.K. Mittal and I.J. Nagrath, Robotics and Control, TMH, 2017.
2. David Poole, Alan Mackworth, Randy Goebel, Computational Intelligence: A Logical Approach, Oxford University Press, 1998.
3. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, Robot Modeling and Control, John Wiley and Sons, 2006.
4. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson, 3rd Edition, 2010.

WEB RESOURCES:

1. NPTEL, https://nptel.ac.in, 2026.
2. MIT OpenCourseWare, https://ocw.mit.edu, 2026.
3. Coursera, https://www.coursera.org, 2026.
4. edX, https://www.edx.org, 2026.

26ITC106

DEEP LEARNING

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to

1. Explain the fundamentals of neural network architectures and significance of hyper-parameter tuning in training a multi-layer perceptron.
2. Explore various optimizers and regularization techniques.
3. Familiarize with convolutional neural network architectures.
4. Discuss recurrent neural networks (RNNs), LSTMs, and GRUs for sequential data processing and time-series analysis.
5. Introduce advanced architectures like Autoencoders, transformers and generative models.

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Build and evaluate basic neural network architectures to various applications.
2. Apply optimization algorithms to train deep learning models.
3. Design and evaluate convolutional neural networks for image classification, object detection, and segmentation tasks.
4. Implement Recurrent Neural Networks on sequence-to-sequence problems and time series analysis.
5. Apply Autoencoders, Transformers and GANs to real world applications.

CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	3	2	3	2	2
CO 2	3	2	3	2	2
CO 3	3	2	3	2	2
CO 4	3	2	3	2	2
CO 5	3	2	3	2	2

UNIT-I

Introduction to Deep Learning: Biological neuron vs artificial neuron, Perceptron, Multilayer Perceptron (MLP), Activation functions: Sigmoid, ReLU, Tanh, Softmax, Loss functions: Mean Squared Error, Cross-Entropy loss, Backpropagation algorithm and chain rule, Gradient Descent and its variants (Batch, Stochastic, Mini-batch), Fine-Tuning Neural Network Hyper parameters.

UNIT-II

Optimization and Regularization: Vanishing and Exploding Gradient problems, Weight initialization techniques, Optimization algorithms: Momentum based Gradient Descent, Neserov Accelerated Gradient Descent, AdaGrad, RMSProp, Adam, Regularization techniques: L1, L2, Dropout, Early stopping, Batch normalization.

UNIT-III

Convolutional Neural Networks (CNNs): From Fully-Connected Layers to Convolutions, Convolutions for Images, Padding and Stride, Multiple Input and Multiple Output Channels, Pooling, Transfer learning and fine-tuning , Pre-trained Convolutional Neural Networks Architectures: LeNet, Alex Net, VGGNet, Google Net, ResNet.

UNIT-IV

Recurrent Neural Networks: Introduction, types of recurrent neural networks, vector representation of words, Implementation of Recurrent Neural Networks, Backpropagation Through time, problems in recurrent neural networks. Modern Recurrent Neural Networks**:** Gated Recurrent UNITs (GRU), Long Short-Term Memory (LSTM), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset, Encoder-Decoder Architecture, Sequence to Sequence Learning.

UNIT-V

Advanced Deep Learning Architectures: Introduction to Autoencoders, Denoising autoencoders, Sparse autoencoders, Introduction to Attention Mechanism, transformers: BERT and ViT models , Generative Adversarial Networks (GANs): Purpose of GAN, Build blocks of GAN, Implementation of GAN, Challenges of GAN models.

TEXT BOOKS:

1. Aurelien Geron, “Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow”, O’Reilly Media, 3rd Edition, 2022.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, “Dive into Deep Learning”, d2l.ai, 2021.
3. Ganguly Kuntal, “Learning generative adversarial networks: next-generation deep learning simplified”, Packt Publishing, 2017.
4. Ian Goodfellow, Yoshua Bengio, Aaron , Courville, “Deep Learning”, MIT Press, 2016.

SUGGESTED READING:

1. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.
2. Indra den Bakker, “Python Deep Learning Cookbook”, PACKT publisher, 2017.
3. Wei Di, Anurag Bhardwaj, Jianing Wei, “Deep Learning Essentials”, Packt publishers, 2018.
4. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
5. Huang, Shih-Chia, and Trung-Hieu Le. Principles and labs for deep learning. Academic Press, 2021.

Web Resources:

1. COURSERA : https://www.coursera.org/specializations/machine-learning.
2. NPTEL : http://nptel.ac.in/courses.
3. ONLINE :https://drive.google.com/file/d/1lxhe8p-asfBVP3114uXjJJq-ljxF6tO5/view (Vector Representation of words)

26ITE111

REINFORCEMENT LEARNING
(Program Elective-2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aim is to:

1. To learn the concepts of reinforcement learning, Multi Armed bandits problem, Finite Markov Decision Process.
2. To introduce Dynamic programming, Monte Carlo methods and Temporal-Difference Learning.
3. To excel with Tabular Methods and Prediction with Approximation.
4. To provide approximate solutions methods for Reinforcement learning.
5. To familiarize with applications and case studies of reinforcement learning.

Course Outcomes:

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

1. Understand the concepts of Reinforcement Learning, Multi Armed Bandits and Finite Markov Decision process.
2. Apply Monte Carlo, Temporal Difference methods for policy evaluation and prediction.
3. Analyze the Tabular Methods and On-policy Prediction with Approximation.
4. Understand On-policy Control and Off-policy Methods with Approximation.
5. Apply Eligibility Traces, Policy Gradient Methods to improve the performance of reinforcement learning.

CO-PO Articulation Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	1	-	3	1	2
CO2	3	1	3	2	3
CO3	2	-	3	2	3
CO4	2	-	3	1	2
CO5	3	1	3	3	3

UNIT-I

Introduction: Reinforcement Learning, Elements of Reinforcement Learning, Limitations and Scope. **Multi Armed Bandits:** A n-Armed Bandit Problem**,** Action-Value Methods, Incremental implementation, Tracking a Non-stationary problem, Optimistic initial values, Upper-confidence-Bound Action Selection, Gradient Bandits, Associative search.

Finite Markov Decision Process: The Agent-Environment Interface, Goals and Rewards, Unified Notation for Episodic and Continuing Tasks, Policies and Value Functions.

UNIT-II

Dynamic Programming: Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration, Asynchronous dynamic programming, Generalized Policy Iteration, Efficiency of dynamic programming.

Monte Carlo Methods: Monte Carlo Prediction, Monte Carlo Estimation of Action values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy prediction via Importance Sampling.

Temporal-Difference Learning: TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), Sarsa: On-policy TD control, Q-learning: Off-policy TD control.

UNIT-III

Planning and Learning with Tabular Methods: Models and Planning, Integrated Planning, acting and learning, Prioritized Sweeping, Full vs Sample Backups, Trajectory sampling, Heuristic search, Monte carlo tree search.

On-policy Prediction with Approximation: Value-function approximation, stochastic-gradient and semi-gradient methods, Linear methods, Feature construction for linear methods, Selecting step-size parameters manually.

UNIT-IV

On-policy Control with Approximation: Episodic Semi-gradient Control, Semi-gradient n-step Sarsa, Average Reward: A New Problem Setting for Continuing Tasks, Deprecating the Discounted Setting, Differential Semi- gradient n-step Sarsa,

Off-policy Methods with Approximation: Semi-gradient Methods, Examples of Off-policy Divergence, The Deadly Triad, Linear Value-function Geometry, Gradient Descent in the Bellman Error.

UNIT- V

Policy Gradient Methods: Policy Approximation and its advantages, The Policy Gradient theorem, Reinforce: Monte Carlo Policy Gradient, Reinforce with Baseline, Actor-Critic methods, Policy gradient for continuing problems, Policy parameterization for continuous actions.

Text Book:

1. Sutton & Barto, Reinforcement Learning: An Introduction‖, MIT Press 2018, 2nd Edition.

Suggested Reading:

1. Vincent François-Lavel, Peter Henderson, Riashat Islam, Marc G. Bellemare, Joelle Pineau, An Introduction to Deep Reinforcement Learning‖, Now Publishers, 2018.
2. Csaba Szepesvari, Algorithms for Reinforcement Learning‖, Morgan & Claypool Publishers, 2010.
3. Maxim Lapan , Deep Reinforcement Learning Hands-On‖ Packt publisher, 2nd edition, 2020.

Web Resources:

1. Swayam Course: Reinforcement Learning: https://swayam.gov.in/nd1_noc19_cs55/preview.
2. NPTEL Course : https://nptel.ac.in/courses/106106143.

26ITE112

COMPUTER VISION
(Program Elective-2)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aim is to:

1. To understand the fundamental concepts related to computer vision and Image formation.
2. To Learn feature detection, matching and detection.
3. To become familiar with feature-based alignment.
4. To develop skills on 3D reconstruction.
5. To Understand Object Detection Techniques.

COURSE OUTCOMES:

Upon completing this Course, Students will be able to:

1. Understand Fundamentals of computer vision and physics of color.
2. Employ Image processing techniques.
3. Illustrate 2D Feature Based Image Alignment, Feature Detection and Segmentation.
4. Apply 3D Image Reconstruction Techniques.
5. Develop Innovative Computer Vision Applications.

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CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	3	3	-	2
CO 2	3	3	3	-	2
CO 3	3	3	3	1	2
CO 4	3	3	3	1	1
CO 5	3	3	3	-	1

UNIT-I

Introduction to Computer Vision: Computer vision, Applications of computer vision, Computer vision pipeline, Image input, Image preprocessing, Feature extraction, Classifier learning algorithm. **[T3]**

Color: The Physics of Colour, Human Colour Perception, Representing Colour. Application: Finding Specularities, Surface Colour from Image Colour. **[T2] .**

UNIT-II

Image Formation and Processing: Geometric primitives and transformations, Photometric image formation,The digital camera, Point operators, Linear filtering, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization. **[T1] .**

UNIT-III

Feature Detection, Matching and Segmentation: Points and patches, Edges, Lines, Segmentation, Active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts and energy-based methods. **[T1]**

Feature-based Alignment: 2D and 3D Feature Based Alignment, Pose estimation, Geometric intrinsic calibration. **[T1]**

UNIT-IV

3D Reconstruction: Shape from X, Active range finding, Surface representations, Point-based representations, volumetric representations, Model-based reconstruction, Recovering texture maps and albedosos. **[T1]**

UNIT- V

Object detection: General object detection framework, Region-based convolutional neural networks (R-CNNs) ,Single-shot detector (SSD) and You only look once (YOLO). **[T3]**
Generative adversarial networks (GANs): GAN architecture, Evaluating GAN models, Popular GAN applications.**[T3]**

Text Books:
1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer- Second Edition, 2022.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015.
3. Deep Learning for Vision Systems, Mohamed Elgendy, Manning Publications, Second Edition 2020.

Suggested Reading:
1. R. Hartley and A. Zisserman, "Multiple View geometry", Cambridge University Press, 2002.
2. Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", Second Edition, Cambridge University Press, March 2004.
3. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.

Web Resources:
1. CV online: http://homepages.inf.ed.ac.uk/rbf/CVonline.
2. NPTEL Course: https://nptel.ac.in/courses/108103174.
3. Computer Vision Basics: https://opencv.org/opencv-free-course/.
4. Computer Vision Tutorial: https://docs.opencv.org/4.x/d9/df8/tutorial_root.html.

26ITE113

NATURAL LANGUAGE PROCESSING
(Program Elective-2)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to

1. Familiarize various Natural Language Processing (NLP) Fundamentals.
2. Understand various text representations and labeling techniques.
3. Understand various NLP models and named entities.
4. Learn RNN for NLP.
5. Understand usage of GRU and LSTM models for machine translation and other NLP applications

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Understand the fundamentals of Natural Language Processing (NLP) to analyze and manipulate text data.
2. Apply NLP mechanisms for analyzing the significance of words.
3. Analyze the word embedding techniques and classification algorithms for text data.
4. Make use of the Deep learning algorithms and Transformer model for NLP.
5. Develop NLP applications using appropriate NLP tools and techniques.

CO-PO Articulation Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	2	-	1	1	1
CO2	3	-	2	2	2
CO3	3	-	2	2	3
CO4	3	-	3	3	3
CO5	3	1	3	3	3

UNIT-I

Introduction to NLP: Logical view of a document in Information Retrieval systems, Definition, History, NLP in the real world, Approaches to NLP, NLP Pipeline.

Language Processing and Python: Computing with Language: Texts and Words, Regular Expressions. A Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics. Accessing Text Corpora and Lexical Resources: Accessing Text Corpora, Conditional Frequency.

UNIT-II

Basic Vectorization approaches of Text Representation: One-Hot Encoding, Bag of Words, Bag of N-Gram, TFIDF; Distributed universal text and handcrafted feature Representations, Neural language models, N-gram language model.

Processing Raw Text: Accessing Text from the Web and from Disk, Text Processing with Unicode. Categorizing and Tagging Words: Using a Tagger, Tagged Corpora, Mapping Words to Properties using Python Dictionaries, Automatic Tagging.

UNIT-III

Word Embeddings: Count Vector, Frequency based Embedding, Prediction based Embedding, Word2Vec and Glove. **Learning to Classify Text:** Supervised Classification and Text classification with Machine learning algorithms.

UNIT-IV

Deep learning for NLP: RNN for language model, Sequence Labelling and Sequence Classification, EncoderDecoder with RNNs, GRUs and LSTMs for machine translation, Convolutional neural networks for sentence classification and Evolution metrics for NLP.

Transformers for NLP: Attention, Transformers and BERT.

UNIT-V

Case Study on NLP: Sentiment analysis, Machine translation, Automated speech recognition systems, Question answering based systems, Topic modelling, Text Generation and Summarization.

Text Books:

1. Steven Bird, Ewan Klein, and Edward Lope, Natural Language Processing with Python. O"Reily, 2009.
2. Deep Learning for Natural Language Processing Develop Deep Learning Models for Natural Language in Python (Jason Brownlee), Machine Learning Mastery, 2017.
3. Lewis Tunstall, Leandro von Werra, Thomas Wolf - Natural Language Processing with Transformers_ Building Language Applications with Hugging Face-O'Reilly Media (2022).

Suggested Reading:

1. Ricardo, Baeza-yates, BerthierRibeiro-Neto, "Modern Information Retrieval", Pearson Education, 2008.
2. Akshay Kulkarni, Adarsha Shivananda, Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning using Python. Apress, 2019.
3. Sudharsan Ravichandiran, Getting Started with Google BERT Build and train state-of-the-art natural language processing models using BERT.

Web Resources:

1. https://models.quantumstat.com/
2. https://www.coursera.org/learn/attention-models-in-nlp
3. https://github.com/keon/awesome-nlp

26ITE114

KNOWLEDGE ENGINEERING AND EXPERT SYSTEMS
(Program Elective - 2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aim is to:

1. To gain a thorough understanding of the fundamental concepts involved in creating knowledge bases and expert systems.
2. To become proficient in the tools and processes essential for developing expert systems.
3. To learn various methods to assess and evaluate the performance of expert systems.
4. To design and develop knowledge bases for expert systems, representing real-world concepts as knowledge units.
5. To apply Knowledge Engineering principles effectively in various contexts, including conducting comprehensive case studies on existing systems and comparing different methodologies and approaches.

Course Outcomes:

Upon completing this course, students will be able to:

1. To understand, define and describe various expert system applications, their relation to AI, key features, benefits, and selection criteria.
2. To identify principles of expert systems. Explain abduction, deduction, induction in expert systems and Apply reasoning techniques to develop simple expert systems.
3. To recognize and illustrate rule-based, logic-based, and network-based representations.
4. To analyze how expert systems handle uncertainties and evaluate architectures.
5. To apply diverse methodologies and tools to develop and enhance expert systems.

CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	3	2	1	2	2
CO 2	3	3	2	3	2
CO 3	3	3	2	3	3
CO 4	2	3	2	2	3
CO 5	2	2	3	3	3

UNIT – I

Expert Systems: The Nature of expertise,The characteristics of an expert system, Fundamental in expert systems, Classical period game playing and theorem proving, Romantic period (natural language understanding such as SHRDLU); modern period techniques and applications.

UNIT- II

Knowledge Representation: The representation of knowledge principles and techniques, The STRPS Planner operator tables, Assessment of STRIPS, Sub goals in MYCIN-Treating blood infection, MYCIN Knowledge base, control system, evaluator comparing expert system, evaluator of MYCIN, Comparison with STRIPS**.**

UNIT-III

Rule based system canonical system, production system for problem solving-syntax of rules, working memory, controlling the behavior of the interpreter conflict resolution, forward and backward chaning, Rules and rules.

UNIT-IV

Representing Uncertainty: Sources of Uncertainty, expert system and probability theory, conditional probabilities, certainty factors, Certain factor versus condition probabilities, vagueness and possibility-fuzzy sets, Fuzzy logic, possibility theory, the uncertain state of uncertainty.

UNIT-V

Expert System Development and Applications: Knowledge acquisition process and challenges, Knowledge elicitation techniques, Role of knowledge engineer, Explanation facilities in expert systems, User interface design in expert systems, Validation and verification of expert systems, Maintenance and refinement of knowledge bases, Case studies of expert systems.

Text Book:

1. P Jackson, Introduction to Expert Systems, Addison Wesley, 1997 (3nd Edition).

Suggested Reading:

1. P Jackson, Introduction to Expert Systems, Addison Wesley, 1990 (2nd Edition)
2. Elaine Rich, Kevin Knight, Artificial Intelligence, McGraw-Hill, Inc, 1991 (2nd Edition).
3. Jackson. Jean-Louis Lauriere, Problem Solving and Artificial Intelligence, Prentice Hall, 1990.

Web Resources:

1. NPTEL: https://archive.nptel.ac.in/courses/106/106/106106140/
2. COURSERA: https://www.coursera.org/in/articles/expert-system-in-ai
3. ONLINE: https://www.geeksforgeeks.org/expert-systems/

26ITE115

PROMPT ENGINEERING
(Program Elective - 2)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim to:
1. Understand the basics of Generative AI and how prompts are used to interact with AI systems.
2. Learn how to create effective prompts that produce useful responses from AI tools.
3. Explore real-world applications of prompt engineering across various fields.

Course Outcomes:
Upon completing this course, students will be able to:
1. Describe the core concepts of AI and Generative AI,
2. Explain the influence of prompts on the behaviour and responses of generative AI systems.
3. Create clear and effective prompts tailored for various AI tools and applications.
4. Apply prompt engineering techniques across various domains.
5. Identify bias, and privacy considerations in prompt engineering.

CO-PO Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	1
CO2	2	3	2	1	1
CO3	1	2	3	2	1
CO4	1	1	2	3	2
CO5	1	1	1	2	3

Unit I:
Basics of Generative Artificial Intelligence: Understanding AI, Machine Learning, and Deep Learning, The Future of Generative AI, Transformer Models, BERT (Bidirectional Encoder Representations from Transformers) GPT (Generative Pretrained Transformer), Applications of AI in Business.

Unit II:
Role of Prompts in Generative AI: genesis of prompts, Tokenization and Vectorization, Generative Capability, Adaptive Learning, Bias and Ethical Considerations, How Do Generative AI Systems Understand Input and Provide Output, The Need to Create Prompts to Receive the Best Output.

Unit III:
A Step-by-Step Guide to Creating Effective Prompts: Various Platforms and Their Prompt Formats, understanding a Prompt Dictionary, Key Factors to Consider: Context, Clarity, and Conciseness.

Prompt Design, Development, and Optimization: Designing effective prompts, Prompt optimization techniques (few-shot, zero-shot learning), Iterative Refinement, Chain-of-Thought (CoT) Prompting, Role-Based Prompting, Instruction-Based Prompting.

Unit IV:

Prompt Engineering across Industry: Mastering Creative Writing Use Cases for Content Creators, Transforming Operations Business Applications of Prompt Engineering, Revolutionizing Education Classroom Applications of Prompt Engineering, Streamlining Research Applications for Academics and Market Analysts, Prompt Engineering in Health Care: Reinventing Patient Communication and Data Analysis.

Unit V:

Advanced Topics and Applications in Prompt Engineering: Understanding Bias in AI and Prompts, Strategies for Reducing Bias in Your Prompts, Ethical Guidelines for Prompt Design, Prompts and Privacy Considerations, Advanced Techniques: Automated Bias Detection, Applications in Prompt Engineering, What Is GPT-4?, Exploring Prompts with ChatGPT, Use Cases and Examples.

Textbook:

1. Ian Khan, “The Quick Guide to Prompt Engineering: Generative AI Tips and Tricks for ChatGPT”, 1st edition, Wiley, 2024.

Reference Books:

1. James Phoenix, Mike Taylor, Prompt Engineering for Generative AI, 1st edition, O’Reilly Media, 2024.
2. Jay Alammar, Maarten Grootendorst, Hands-On Large Language Models, 1st edition, O’Reilly Media, 2024.

Web Resources:

1. “Prompt Engineering Guide”, https://www.promptingguide.ai/
2. “Prompt Engineering”, OpenAI,
3. https://platform.openai.com/docs/guides/promptengineering/strateg y-test-changessystematically
4. https://developers.google.com/machine-learning/resources/prompt-eng

26ITE116

COGNITIVE ROBOTICS
(Program Elective - 3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim is to:
1. To characterize the Ethical and Philosophical aspects of Cognitive Robotics
2. To understand the Chemical and Physical aspects of Cognitive Robotics
3. To know the Cultural and Social Aspects of Cognitive Robotics
4. To demonstrate the Social Cognition of Robots during Interacting with Humans
5. To describe the Psychological and AI aspects of Cognitive Robotics and do case studies.

COURSE OUTCOMES:
Upon completing this course, students will be able to:
1. Explain the Ethical and Philosophical aspects of Cognitive Robotics.
2. Illustrate the Chemical and Physical aspects of Cognitive Robotics
3. Analyze the methods and software/hardware technologies for robotics research and applications.
4. Explain the state of the art in cognitive and intelligent robotics models, and how this informs the design of future robot applications.
5. Analyze the AI aspects of Cognitive Robotics and Case studies of Multiagent Robotic Systems.

CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	1	1	1	2	2
CO 2	2	2	1	2	2
CO 3	2	2	2	2	2
CO 4	2	2	2	2	1
CO 5	2	2	2	1	1

UNIT I
Introduction- Cognitive robotics fundamentals, Context and Definition, Embodied Cognition Theories, AI and Knowledge-Based Systems, Behavior- Based Robotics, History of Cognitive Robotics. **Ethical aspects of Cognitive Robotics:** Introduction, Blame the Robot, Blaming Homo Sapiens, Negligence and Product Liability Laws, Robot Cars, Insurance.
Philosophical aspects of Cognitive Robotics, Designing Modular AI Robots Inspired by Amerindian Material Culture, Introduction, Evolution of Technology and Ideas, The Amerindian World and the Techno–Animistic Paradigm Shift, Animism: Material and Metamorphosis, Formation of a Robotic Community.

UNIT II
Chemical Aspects of Cognitive Robotics
A Learning Planet, Introduction, Perspective, the Second Law, Control of Fire, Emergence of Learning,
Physical Aspects of Cognitive Robotics, Embodiment In Cognitive Robotics: An Update, Introduction, Talking Chinese, Meaning And Recent Theoretical Deba, Recent Practical Implementations of the Embodiment of Emotions, Motivations and Intentional States, Imagined Physics: Exploring Examples of Shape-Changing Interfaces, Introduction, Shape-Changing Interfaces, Imagined Physics, Movement and Incidental Effects of Actuators.

UNIT III
Cultural & Social Aspects of Cognitive Robotics

Effects of Cultural Context and Social Role On Human–Robot Interaction, Introduction, Effects of Cultural Context, Factors Influencing Human–Robot Interaction, Effects of Cultural Context on Decision Making, Effects of Robots' Social Role: Autonomy Level and Group Orientation, Social Robots, Autonomy Level Of Robots, Group Orientation, Effects of Robots' Social Role On Decision Making, A Cognitive Model for Human Willingness to Collaborate With Robots, Introduction, A Cognitive Model For Determining Human Willingness to Engage With Collaborative Robots, Cultural Robotics.

UNIT IV

Social Cognition of Robots during Interacting with Humans

Introduction, Speech Acts and Dialogue Context, Model Speech Acts as Dialogue Context Change, Multiple Dialogue Contexts, Speech Act Model With Multiple Contexts, Context Awareness in Dialogue, Computational Model of Context Awareness Reasoning Using DBN, Experiment, A Speech Act Model with Multiple Contexts, Infer Social Context from Dialogue, Noise in Dialogue Context Awareness, Pragmatic Prediction with Dialogue Contexts, The Most Likely Pragmatic Speech Acts Sequence.

UNIT V

Psychological Aspects of Cognitive Robotics

On The Crossroads of Cognitive Psychology and Cognitive Robotics, Early History of the fields, Action Control, Acquisition of Action Control

Artificial Intelligence Aspects of Cognitive Robotics, Introduction, A Cognitive Robotics Approach, Perceiving the Environment, Interacting with the environment, Integration, Avoiding a Moving Obstacle, Reaching and Grasping Objects.

Case Studies: Human-motion-inspired leg robot, Coordinated robot group for foraging,Dual-agent system for cooperative manipulation, Agile robotic kitting in a dynamic factory, Agile planning with Gwendolen-R OS-Gazebo setup.

TEXT BOOKS:

1. Angelo Cangelosi, Minoru Asada "Cognitive Robotics" MIT press 2022
2. Hooman Somani,"Cognitive Robotics", CRC Press, 2016
3. Jiming Liu, Jianbing Wu, " Multiagent Robotic Systems" , 2001.

SUGGESTED READING:

1. Jared Kroff,"Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016
2. Patnaik, Srikanta, "Robot Cognition and Navigation - An Experiment with Mobile
3. Robots",SpringerVerlag Berlin and Heidelberg, 2007
4. Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.
5. David Vernon,"Artificial Cognitive Systems: A Primer" The MIT Press, 1st Edition, 2014.

ONLINE RESOURCES:

1. NPTEL: https://nptel.ac.in/courses/112104293
2. COURSERA : https://www.coursera.org/specializations/modernrobotics?msockid=1eb212c0be9468ea1be005fdbf216942
3. ONLINE: https://www.ieee-ras.org/cognitive-robotics/

26ITE117 **CLOUD ROBOTICS**
(Program Elective - 3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim is to:
1. To introduce the concepts, architecture, and evolution of cloud robotics .
2. To learn cloud-enabled cyber-physical systems, processing offloading techniques, and their role in healthcare and assistive robotics.
3. To explore technologies of HRI and enabling connectivity for mobile robots.
4. To know the concepts of cloud-robot communication frameworks, simulation tools, and applications.
5. To study the concept of Industry 4.0 and IoRT, methodology for cloud robotics experimentation.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Describe the architecture, components, and benefits of cloud robotics systems.
2. Analyze the role of cloud computing in enhancing robot capabilities and assess system limitations and challenges.
3. Demonstrate understanding of human-robot interaction, collaborative robotics, mobile robots.
4. Implement simulation, emulation platforms for cloud robotics communication. .
5. Develop and evaluate applications in Industry 4.0 and IoRT, autonomous navigation use cases.

CO-PO Articulation Matrix

PO	PO 1	PO 2	PO3	PO4	PO5
CO 1	3	1	2	3	3
CO 2	2	1	2	3	3
CO 3	3	1	2	3	3
CO 4	3	2	3	3	3
CO 5	3	2	3	3	3

UNIT-I
Introduction to cloud robotics: Definition and concept of Cloud Robotics, Evolution of robotics and cloud computing, Advantages of cloud-enabled robots, Components of cloud robotics, Cloud robotics system architecture, Empowering robots using the cloud, challenges in developing cloud robotics: Enabling requirements, Implementation aspects and reproducibility.

UNIT-II
Offloading Robots processing to the cloud: Cloud-Enabled Cyber Physical Systems, Human-Robot Interaction and Cloud Robotics in Healthcare, Requirements, Current Limitations, and challenges, Mobility assistance service enabled by the cloud (case study), Virtual Trails for Mobility Assistance, Impact of cloud-based HRI.

UNIT-III
Human Robot Interaction (HRI): Definition, History, Need of HRI, Ethical Issues for HRI, Multi-Modal Perception, Social, Service, and Assistive Robotics, HRI Architecture, Collaborative Robots, Definition, Types of Collaboration, Applications of collaborative robots, collaborative Robot Technology

Connectivity for Mobile Robots: Enabling Technologies for Cloud Robotics: Wireless Indoor Connectivity, A General Architecture for Cloud Robotics in Clinical Healthcare.

UNIT-IV

Cloud-Robot Communication: common practices and software: The Robot operating system, the pound cloud communication framework, Experimentation platform: A virtualized testbed for cloud robotics, Robot Simulation, Network Emulation ,Cloud Emulation, Case Study: Cloud-Enabled Autonomous Navigation.

UNIT-V

Industry 4.0 and Internet of Robotic things (IORT): Introduction, Internet of Things and Robotics, Applications and developments of the Internet of Robotic Things.

A common methodology for cloud robotics experimentation: Towards an open cloud robotics methodology, robotic platform and cloud platform for experimentation, cloud based services for robotics tasks, human- robot interaction (case study) and autonomous navigation service (case study)

Text Book:

1. Implementing Cloud Robotics for Practical Applications From Human-Robot Interaction to Autonomous Navigation By Ricardo C. Mello, Moises R. N. Ribeiro, Anselmo Frizera-Neto · 2023.

Suggested Reading:

1. Learning Robotics using Python, Lentin Joseph, Packt Publishing, 1st Edition, 2015.
2. Programming Robots with ROS: A Practical Introduction to the Robot Operating System, Morgan Quigley, Brian Gerkey and William Smart. O'Reilly Media, 1st Edition, 2015.
3. Mobile Robots: Mathematics, Models and Methods, Alonzo Kelly, Cambridge University Press, 1st Edition, 2013.
4. Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, The MIT Press; 2nd Edition, 2011.
5. A Gentle Introduction to ROS, Jason M. O'Kane, CreateSpace Independent Publisher; 1st Edition, 2013.
6. Robot Operating System (ROS), Open Source Robotics Foundations, www.ros.org.
7. A Survey of Research on Cloud Robotics and Automation. Ben Kehoe, Sachin Patil, Pieter Abbeel, Ken Goldberg. IEEE Transactions on Automation Science and Engineering (T-ASE): Special Issue on Cloud Robotics and Automation. Vol. 12, no. 2.

Web Resources:

1. https://www.uipath.com/product/automation-cloud-robots.
2. https://www.nokia.com/networks/5g/use-cases/cloud-robotics/.
3. https://github.com/Airbotics/awesome-cloud-robotics.
4. https://www.blueprism.com/guides/cloud-rpa/.

26ITE118

ROBOTICS PROGRAMMING USING PYTHON
(Program Elective - 3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim is to:
1. Understand the python basic concepts.
2. Impart knowledge on fundamentals of ROS and Gazebo.
3. Acquire the skills to simulate the robotic arm.
4. Do programming vision sensors using Python and ROS.
5. Gain skills to create GUI for robot using Qt and Python.

Course Outcomes:
At the end of the course, the student will be able to
1. Familiarize with the fundamentals of Python basic concepts.
2. Understand the fundamentals of ROS and Gazebo.
3. Simulate the Gazebo and integrate with ROS.
4. Analyze the vision sensors through Python and ROS programming.
5. Create GUI for robot using Qt and Python

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	2
CO2	3	2	3	2	1
CO3	3	2	3	3	2
CO4	3	3	3	2	3
CO5	3	2	2	3	2

UNIT- I
Python Basics: Python Introduction and applications, strings, Lists, and Tuples, Mapping and Set Types, Dictionaries, Functions, concepts of files and basic file operations, writing and reading data to and from a .csv file.

UNIT-II
Introduction to Robotic Operating System (ROS): ROS Introduction, ROS Concepts- ROS File System, ROS Computation Graph, ROS Community, Introduction to Catkin, Creating ROS Package, Introduction to Gazebo.

UNIT-III
Simulating Robots using ROS and Gazebo: Simulating the robotic arm using ROS and Gazebo, Creating the robotic arm simulation model for Gazebo, adding the gazebo_ros_control, simulating the robotic arm with Xtion Pro, moving the robot joints using ROS controllers in Gazebo.

UNIT-IV

Programming Vision Sensors Using Python and ROS: List of robotic vision sensors and image processing libraries, Introduction to OpenCV, OpenNI, and PCL, Programming Kinect with Python using ROS, OpenCV, and OpenNI.

UNIT-V

GUI for Robot using Qt and Python: Introduction to Qt, Introduction to PyQt and PySide, Qt designer, Qt Signals and slots, converting a Qt UI file into Python file, Adding a slot definition to PyQt code.

Textbooks

1. "Think Python: How to Think Like a Computer Scientist", Allen B. Downey, Second Edition, O'Reilly, 2016
2. "Learning Robotics using Python" - Lentin Joseph, Second Edition, 2018, Packt Publishing.
3. "Mastering ROS for Robotics Programming" - Lentin Joseph, Third Edition, 2021, Packt Publishing.

Suggested Reading:

1. Robotics: Control, Sensing, Vision, Intelligence" Fu K. S., Gonzelez R. C., Lee C. , McGraw Hill Book Co., 2008.
2. "Robotics and Control" R. K. Mittal, I. J. Nagrath,Tata-McGraw-Hill Publications,2017

Web Resources:

1. https://www.coursera.org/specializations/robotics.
2. Udemy course on "ROS for Beginners: Basics, Motion, and OpenCV"

26ITE119

AUGMENTED AND VIRTUAL REALITY
(Program Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aim is to:

1. Familiarize the students with the fundamentals of Virtual Reality.
2. Impart the knowledge of 3D orientation for understanding the behaviour of VR system with the environment.
3. Deal with the Development Tools and Frameworks in Virtual Reality.
4. Introduce the applications of Virtual Reality Systems.
5. Introduce technology and features of augmented reality.

Course Outcomes:

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

1. Describe the basic concepts of Virtual Reality and 3D Computer Graphics.
2. Apply 3D manipulation techniques in Virtual Reality.
3. Analyze Development Tools and Frameworks in Virtual Reality.
4. Develop a Virtual Reality application.
5. Evaluate Augmented Reality Systems

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	2	1	2	2	2
CO 2	2	1	1	2	2
CO 3	1	2	1	2	2
CO 4	2	1	1	2	2
CO 5	1	2	2	2	2

UNIT-I

Introduction to VR and AR: History of VR and AR, Technology and Features of Augmented Reality, Comparison of AR and VR, Challenges with AR, AR Systems and Functionality, Human factors, Human visual system, Perception of depth, color, contrast, resolution, Stereo Rendering, VR Hardware: Head-coupled displays etc. VR Software, Geometric Modelling: From 2D to 3D, 3D space curves, 3D boundary representation. The Graphics Pipeline and OpenGL, Overview and Transformations, Rotation, translation, scaling, mode view matrix, projection matrix, Lighting and Shading, OpenGL Shading Language (GLSL), GLSL vertex and fragment shaders.

UNIT-II

Visual computation in virtual reality: 3D Interaction Techniques: 3D Manipulation Techniques and Input Devices, 3D Travel Tasks, Travel Techniques, Theoretical Foundations of Wayfinding, Types of Centred-Wayfinding Support, Evaluating Wayfinding Aids, System Control, Classification, Graphical Menus, Voice Commands, Gestrual Commands, Tools, Muti-modal System Control Techniques,Case Study: Mixing System Control Methods, Symbolic Input Tasks.

UNIT-III

Framing using 3D virtual reality: Development Tools and Frameworks in Virtual Reality: VR. X3D Standard; Vega, MultiGen, Virtools etc., World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment - VR Database, Tessellated Data, LODs, Graphical User Interface, Control Panel, 2D Controls.

UNIT-IV

VR applications: Pose Tracking I, Tracking with light house, Pose Tracking II, Advanced positional tracking, Panoramic Imaging and Cinematic, VR Spatial Sound and the Vestibular System, VR Engines and Other Aspects of VR, Latency, eye tracking, post-rendering warp. The Future: Virtual environment, modes of interaction Application of VR in Digital Entertainment: VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games, Demonstration of Digital, Entertainment by VR.

UNIT- V

Augmented and Mixed Reality: Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

Text Books:

1. LaValle "Virtual Reality", Cambridge University Press, 2016.
2. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007.

Suggested Reading:

1. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann, 2009.
2. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
3. Ange Anderson, Virtual Reality, Augmented Reality and Artificial Intelligence in Special Education, 2019.

Web Resource:

1. https://nptel.ac.in/courses/106/106/106106138/
2. https://nptel.ac.in/noc/courses/noc18/SEM1/noc18-ge08/
3. https://www.coursera.org/learn/ar?
4. https://www.coursera.org/specializations/virtual-reality

26ITE120

CYBER PHYSICAL SYSTEMS
(Program Elective-3)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim is to
1. Introduce fundamental concepts of Cyber Physical Systems (CPS).
2. Explore various design approaches of CPS.
3. Discover the available sensors useful for CPS.
4. Walk through the design of controllers beyond Embedded Systems.
5. Aassess various real time scheduling methods available for CPS.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Understand the significance of Cyber Physical Systems in safety critical domains.
2. Choose the appropriate CPS design for a given real time scenario.
3. Perform hybrid automaton-based design of CPS.
4. Devise real time sensing and communication of CPS.
5. Analyze and verify the CPS models.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	-	2
CO2	3	2	3	1	2
CO3	3	3	3	1	1
CO4	3	2	3	1	1
CO5	3	3	2	-	1

UNIT-I
Introduction - Definition of Cyber-Physical System, Key Features of Cyber-Physical Systems, Applications, **The Design Process**- Model, Design, Analysis. Properties of Systems- Causal Systems, Memoryless Systems, Linearity and Time Invariance.

UNIT-II
Synchronous Model: Reactive Components - Variables, Valuations, and Expressions, Inputs, Outputs, and States. Initialization, Update, Executions, Extended-State Machines; Composing Components Block Diagram, Input/output Variable Renaming, Parallel Composition, Output Hiding.

UNIT-III
Design of Embedded Systems: Models of Sensors and Actuators: Linear and Affine Models, Dynamic Range, Quantization, Noise, Sampling, Sidebar, Decibels, Harmonic Distortion, Signal Conditioning, Common Sensors, Measuring Tilt and Acceleration.

UNIT-IV
Embedded Processors: Types of Processors, Microcontrollers, DSP Processors , Graphics Processors, Parallelism, Parallelism vs. Concurrency, Pipelining: Instruction-Level Parallelism .Multicore Architectures. Analysis and Verification: Invariants, Linear Temporal Logic, Propositional Logic Formulas.

UNIT-V

Timed Model: Timed Processes- Timing-Based Light Switch, Buffer with a Bounded Delay, Multiple Clocks, Formal Model, Timed Process Composition, Modelling Imperfect Clocks.

Text Books:

1. Alur, R. (2015). Principles of cyber-physical systems. MIT press.
2. Lee, Edward Ashford, and Sanjit Arunkumar Seshia. Introduction to embedded systems: A cyber-physical systems approach. MIT press, 2016.

Suggested Reading:

1. Lee, Edward Ashford, and Sanjit Arunkumar Seshia. Introduction to embedded systems: A cyber-physical systems approach. MIT press, 2016.
2. "Cyber-physical systems". Program Announcements & Information. The National Science Foundation, 4201 Wilson Boulevard, Arlington, Virginia 22230, USA. 2008-09-30. Retrieved 2009-07-21.

Web Resources:

1. https://web.archive.org/web/20100624002916/http://varma.ece.cmu.edu/CPS/Position-Papers/Rajesh-Gupta.pdf
2. https://www.sciencedirect.com/topics/computer-science/cyber-physical-systems
3. https://dst.gov.in/interdisciplinary-cyber-physical-systems-icps-division

26ITE121

BLOCKCHAIN TECHNOLOGY
(Program Elective-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aims to
1. Familiarize the basic concepts of blockchain.
2. Provide the significance of the bitcoin ecosystem.
3. Explore the consensus mechanisms and technologies that support ethereum.
4. Introduce Hyperledger Fabric and its architecture.
5. Familiarize BlockChain use cases in various domains.

Course Outcomes:
Upon completion of this course, students will be able to
1. Describe the concepts of distributed systems and blockchain properties.
2. Discuss the concepts of bitcoin and consensus mechanisms in bitcoin mining.
3. Explore the consensus mechanisms and technologies that support Ethereum.
4. Outline the Hyperledger Fabric architecture and Hyperledger Projects.
5. Analyse blockchain use cases in various domains.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	3	3
CO2	3	3	2	3	3
CO3	3	3	2	3	3
CO4	3	3	2	3	3
CO5	3	3	2	3	3

UNIT-I
Introduction: Overview of distributed systems, Introduction to Blockchain, Generic elements of a blockchain, Features of Blockchain, Applications of Blockchain.
Cryptocurrency And Blockchain : Hash Functions and Merkle Trees, Components of Blockchain Ecosystem, Cryptography and Consensus Algorithms; Types of Blockchain, Blockchain Platforms.

UNIT-II
Bitcoin Platform: Bitcoin definition, Keys and addresses, public keys and Private keys in bitcoin, The transaction life cycle, the transaction structure, Bitcoin payments, Bitcoin investment and buying and selling bitcoins. Consensus mechanism in bitcoin.
Wallets: Wallet types, non-deterministic wallets, Deterministic wallets, Alternative Coins- Namecoin, Litecoin, Zcash.

UNIT-III
Smart contracts and Ethereum: Introducing Smart Contracts, Ethereum blockchain , The Ethereum stack, Ethereum virtual machine (EVM), Consensus mechanism in Ethereum, The Ethereum network, Ethereum Development, setting up a development environment, Development tools and clients, Applications developed on Ethereum.

UNIT-IV

Hyperledger Fabric: Introduction to Hyperledger Fabric, Hyperledger Fabric architecture, Membership services Blockchain services, Hyperledger Projects- Fabric, Sawtooth lake, Iroha , Components of the Fabric, Peers or nodes, Applications on Blockchain, Alternate Blockchains- Ripple, Corda.

UNIT-V

Applications of Blockchain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Blockchain, Blockchain enabled Trade, We Trade — Trade Finance Network, Supply Chain Financing, Identity on Blockchain.

Textbooks:

1. Imran Bashir, “Mastering Blockchain”, 3rd Edition, Packt Publishers, 2020.
2. Melanie Swan, "BlockChain: Blueprint for a New Economy", 1st Edition, O'Reilly, 2018.

Suggested Reading:

1. Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, 1st Edition, Apress, 2017.
2. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to BuildSmart Contracts for Ethereum and BlockChain”, Packt Publishing, 2019.

Web Resources:

1. NPTEL : https://nptel.ac.in/courses/106105235.
2. COURSERA : https://l1nq.com/o5zd2kf.
3. ONLINE : https://www.geeksforgeeks.org/software-engineering/blockchain/.

26ITE122

GENERATIVE AI
(Program Elective-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aims to
1. Understand the fundamentals of Generative AI.
2. Learn to build AI applications with LangChain.
3. Use generative AI for software development and data science.
4. Customize and fine-tune generative AI models.
5. Explore practical applications of Generative AI.

Course Outcomes: After completing the course, students will be able to:
1. Demonstrate key concepts of Generative AI and LangChain.
2. Develop practical generative AI applications.
3. Apply generative AI in software development and data science.
4. Customize and evaluate generative AI models.
5. Create innovative generative AI solutions.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	3
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	2	3
CO5	3	3	3	3	3

Unit – I
Generative AI: Introduction, Understanding LLMs, text to image models, AI in other domains; LangChain: LLM Limitations, LangChain, Key Components of LangChain, Working of LangChain, Comparison.

Unit – II
Getting Started with LangChain: Set up the dependencies, Exploring API model Integrations, Local models, Building an application for customer service; Building capable applications: fact checking, summarising, Extracting information from documents, Answering questions with tools, Exploring reasoning strategies; Building a Chatbot like ChatGPT: Chatbot, Understanding retrieval and vectors, Loading and retrieving in LangChain, Implementing a chatbot.

Unit – III
Developing Software with Generative AI: Software development and AI, Writing code with LLMs, Automating software development; LLMs for Data Science: impact of generative models on data science, Automated data science, Using agents to answer data science questions, Data exploration with LLMs.

Unit – IV
Customizing LLMs and Their Output: Conditioning LLMs, Fine Tuning, Prompt Engineering; Generative AI in Production: get LLM Apps ready for production, Evaluate LLM apps, Deploy LLM apps, Observe LLM apps; Future of Generative Models: current state of generative AI, Economic consequences, Societal implications.
Unit – V

Composing Music with Generative Models: Music generation, using LSTMs, using GANs, MuseGAN; Play Video Games with Generative AI: Reinforcement learning: Actions, agents, spaces, policies, and rewards; Finding new drugs with generative models.

Text Books:

1. Ben Auffarth - Generative AI with LangChain_ Build large language model (LLM) apps with Python, ChatGPT and other LLMs-Packt (2023)
2. Joseph Babcock, Raghav Bali - Generative AI with Python and TensorFlow 2_ Create images, text, and music with VAEs, GANs, LSTMs, Transformer models-Packt Publishing (2021)

Suggested Reading:

1. Ahmed J. Obaid, Bharat Bhushan, Muthmainnah S., S. Suman Rajest - Advanced Applications of Generative Ai and Natural Language Processing Models-IGI Global (2023)
2. Akshay Kulkarni, Adarsha Shivananda, Anoosh Kulkarni, Dilip Gudivada - Applied Generative AI for Beginners_ Practical Knowledge on Diffusion Models, ChatGPT, and Other LLMs-Apress (2023)
3. Daniel Jurafsky, James H Martin, “Speech and Language processing: An introduction to NLP, Computational Linguistics, and Speech Recognition” 3rd Edition

Web Resources:

1. https://learn.microsoft.com/en-us/training/modules/fundamentals-generative-ai/
2. https://learn.microsoft.com/en-us/training/modules/responsible-generative-ai/
3. https://learn.microsoft.com/en-us/training/modules/create-images-with-generative-ai/
4. https://learn.microsoft.com/en-us/training/modules/intro-generative-ai-explore-basics/
5. https://learn.microsoft.com/en-us/training/modules/create-prompts-for-generative-ai-training-tools/
6. https://learn.microsoft.com/en-us/training/modules/challenge-project-ideate-business-with-ai/
7. https://platform.openai.com/docs/guides/prompt-engineering/strategy-write-clear-instructions
8. https://www.cloudskillsboost.google/paths/118
9. https://jalammar.github.io/illustrated-transformer/

26ITE123

QUANTUM COMPUTING
(Program Elective-4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Pre-requisites:
Theory of computation and algorithms, linear algebra and probability.

Course Objectives:
This course aims to
1. Explain the fundamentals of linear algebra and quantum computing concepts such as qubits, superposition, and Bloch sphere representation.
2. Interpret the postulates of quantum mechanics and apply them in the design and analysis of quantum circuits.
3. Apply fundamental quantum algorithms and analyze their working principles using oracle models and quantum parallelism.
4. Analyze advanced quantum algorithms and interpret computational complexity concepts such as P and NP.
5. Explain quantum noise and analyze quantum error correction techniques for reliable quantum information processing.

Course Outcomes:
Upon completion of this course, students will be able to
1. Explain linear algebra concepts and quantum computing fundamentals, including qubits and superposition.
2. Apply quantum mechanical principles to construct and analyze quantum circuits using single and multi-qubit gates.
3. Apply and analyze quantum algorithms such as Deutsch, Deutsch–Jozsa, Grover, and Simon's algorithm.
4. Analyze the role of Quantum Fourier Transform and Shor's algorithm and interpret complexity classes in quantum computing.
5. Explain and analyze quantum noise models and apply basic quantum error correction techniques.

CO-PO ARTICULATION MATRIX

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1	2
CO2	3	1	3	2	3
CO3	3	2	3	2	3
CO4	3	2	3	2	2
CO5	2	2	3	2	3

Unit–I:
Linear Algebra: Complex Numbers Versus Real Numbers, Vectors, Scalar Multiplication, Vector Addition, and Bases.
Introduction to Quantum Computing: Introduction, Classical vs. quantum information, Superposition, Quantum Bits, Bloch Sphere Representation of a Qubit, Multiple Qubits.

Unit–II:

Introduction to Quantum Mechanics: The Postulates of Quantum Mechanics, EPR Paradox, Quantum Physics Essentials, Atoms, Elementary Particles, And Molecules, Hilbert Spaces, and Uncertainty. **Quantum Circuits:** Single Qubit Gates and Operations, Multiple Qubit Gates and Operations, Design and Simulation of Quantum Circuits.

Unit–III:
Quantum Algorithms I: Introduction to Quantum Algorithms, Deutsch's Algorithm, Deutsch's-Jozsa Algorithm, Grover's Algorithm, Quantum search: a two-bit example, Simons Algorithm and Generalizations, Quantum parallelism, Power of quantum computation.

Unit–IV:
Quantum Algorithms II: Oracle model and phase kickback, Quantum Fourier Transform, Shor's Algorithm, Computational complexity, Decision problems and the Complexity classes P and NP.

Unit–V:
Quantum Information Processing and Error Correction: Quantum Noise and Quantum Operations, Classical Noise and Markov Processes, Quantum Operations, Distance Measures for Quantum Information; Quantum.

Text Books:
1. Michael A. Nielsen, **"Quantum Computation and Quantum Information",** Cambridge University Press, 2000.

Reference Books:
1. Error-Correction- Classical Error Correction, Classical Three-Bit Code, Fault Tolerance and Error Recovery. Quantum Computing, Bernhardt, Chris, MIT Press, 1 st edn., 2019.
2. David McMahon, "**Quantum Computing Explained**", Wiley, 2008
3. Mermin N.D. (2007). **Quantum Computer Science: An Introduction**. Cambridge University Press.
4. Linear Algebra and Its Applications, David C. Lay, Steven R. Lay, Pearson, 5th Edition, 2015.

Web Resources:
1. https://nptel.ac.in/courses/106106232
2. https://www.coursera.org/specializations/packt-the-complete-quantum-computing-course-for-beginners
3. https://www.cse.iitm.ac.in/~shwetaag/CS6846-24.html

26ITE124

ADVANCED BIG DATA ANALYTICS
(Program Elective - 4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim is to:
1. Familiarize students with the Big Data technologies and its applications in distributed data processing.
2. Introduce MapReduce and Hive for large-scale data processing.
3. Explore SQL queries and DataFrame operations using Spark Framework.
4. Discuss the concept and writing applications using Spark Machine Learning.
5. Introduce Apache Kafka as a distributed streaming platform.

Course Outcomes:
After completion of the course students are expected to be able to:
1. Gain familiarity with Big Data technologies and its application
2. Analyze real-world scenarios where MapReduce and Hive are suitable for Big Data processing tasks.
3. Expertise in using Resilient Distributed Datasets (RDD) for creating applications in Spark and query using Spark SQL.
4. Apply Spark Machine Learning Applications for supervised and unsupervised learning.
5. Develop real-time processing applications using Kafka.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO4	PO5
CO1	3	3	3	1	2
CO2	3	3	3	-	2
CO3	3	3	3	1	2
CO4	3	3	3	1	3
CO5	3	3	3	2	2

UNIT-I
Introduction to Big Data: Introduction, Big Data characteristics, Big Data Applications, Hadoop eco-system.
Hadoop Distributed Files system: Overview, The Design of HDFS, HDFS Concepts, The Command-Line Interface, Hadoop File systems.

UNIT-II
MapReduce: Overview, MapReduce Architecture, How MapReduce works, developing a MapReduce Application, MapReduce Types and Formats, MapReduce Features, Word count using Map Reduce.
Hive: Comparison with Traditional Databases, HiveQL, Tables, Querying Data, User-Defined Functions, writing a User Defined Functions, writing a User Defined Aggregate Function.

UNIT-III
Big Data with Spark: Introduction to Apache Spark, Spark Architecture, RDDs (Resilient Distributed Datasets),DataFrame API, Data Frame Operations.
Spark SQL: Introduction to Spark SQL, Spark SQL Architecture and Components, DataFrames in Spark SQL, SQL Queries and DataFrame Operations.

UNIT-IV
Machine Learning with Spark: Introduction to Spark with ML, Linear Regression, Logistic Regression, Random Forest Classifier, KNN Classifier, SVM Classifier, K-means Clustering using Spark with ML- one case study, Spark structured Streaming, Example.

UNIT-V

Apache Kafka Stream Processing: Introduction to Apache Kafka, Kafka Architecture, Kafka Topics and Partitions, offsets, Producers and Consumers in Kafka, Kafka Real-World Use Cases and Applications. Kafka Connect for Data Integration, Kafka Streams for Stream Processing, Fault Tolerance and Replication in Kafka, Kafka APIs and Client Libraries.

Text Books:

1. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media Inc, 2015.
2. Bill Chambers, Matei Zaharia, “Spark: The Definitive Guide”, 4th Edition, O'Reilly Media Inc, 2018.
3. Neha Narkhede, Gwen Shapira, Todd Palino, "Kafka: The Definitive Guide", 2nd Edition, O'Reilly Media, 2017.

Suggested Reading:

1. Bill Chambers, Matei Zaharia, “Spark: The Definitive Guide”, 4th Edition, O'Reilly Media Inc, 2018.
2. Neha Narkhede, Gwen Shapira, Todd Palino, "Kafka: The Definitive Guide", 2nd Edition, O'Reilly Media, 2017.

26ITE125

UNMANNED AERIAL VEHICLES
(Program Elective - 4)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aim to :

1. Familiarize basics of Autonomous vehicles and its various applications.
2. Learn the Basics of navigation and explain the components used to build the drone devices.
3. Acquaint with the concepts of UAV aircraft and basics of Robot Programming.
4. Provide the payload and Navigation of Autonomous Vehicles.
5. Introduce the benefits of combining AI and Drones.

Course Outcomes:

Upon completing this course, students will be able to:

1. Understand the types, characteristics, Applications of Autonomous systems.
2. Analyze the concepts of Aerodynamics, Propulsion & Structures of Model aircraft.
3. Know the UAV / UGV Elements and Robot Arm Kinematics & Dynamics.
4. Infer about Navigation and guidance of Autonomous vehicles.
5. Explore applications of Drones in Artificial Intelligence .

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	1	3
CO2	2	2	1	1	3
CO3	2	2	1	1	3
CO4	2	2	1	1	3
CO5	2	2	1	1	3

UNIT-I

Introduction to Autonomous systems: Definition, Characteristics, differences between non autonomous Vs autonomous, Types of vehicles, Introduction to navigation and communication.

UNIT-II

Basics of navigation (Aerial and Ground): Different types of flight vehicles; Components and functions of an airplane; Forces acting on Airplane; Physical properties and structure of the atmosphere; Aerodynamics – aerofoil nomenclature, aerofoil characteristics, Angle of attack, Mach number, Lift and Drag, Propulsion and airplane structures.

UNIT-III

UAV / UGV Elements: Introduction to UAV and UGV**,** DGCA Classification of UAVs; Types and Characteristics of Drones: Fixed, Multi-rotor, Flight controller Software, MAVLINK protocol, Robot Arm Kinematics and Dynamics, Manipulator Trajectory planning and Motion Control, Robot Sensing, Robotic Operating System, Robotic Programming Languages.

UNIT-IV

Navigation and guidance: Data Link; Sensors and Payloads: GPS, IMU, Light Detection and Ranging (LiDAR), Imaging cameras, Classification of payload based on applications; Hyper-spectral sensors; Laser Detection and Range (LiDAR); cameras; ultra-sonic detectors; Introduction to navigation systems and types of guidance; Mission Planning and Control, Case studies: Autonomous Obstacle avoidance - Vision, Sonar and LiDAR.

UNIT-V

AI Drones: Benefits of Combining AI and Drones, Applications of AI-Powered Drones, Challenges and ethical considerations, Drone Swarm Technologies and Algorithms, Case Studies Drone Swarms, IoT Drones.

Text books :

1. K Valavanis; George J Vachtsevanos,"Handbook of Unmanned Aerial Vehicles", Springer, Boston, Massachusetts : Credo Reference, 2014. 2016.
2. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics : Control, Sensing, Vision and Intelligence
3. John J. Craig, Introduction to Robotics: Mechanics and Control, Addison Wesley publication, 3rd Edition.
4. Reg Austin"Unmanned Aircraft Systems: UAVS Design, Development and Deployment" John Wiley & Sons, Ltd.2011.
5. Fahlstrom P, Gleason T (2012) "Introduction to UAV systems", 4th edn. Wiley, UK
6. Yang, L. J., & Esakki, B. (2021). Flapping Wing Vehicles: Numerical and Experimental Approach. CRC Press.
7. Sebbane, Y. B. (2022). A first course in aerial robots and drones. CRC Press.

Suggested Reading:

1. Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs, John Baichtal DGCA RPAS Guidance Manual, Revision 3 – 2020
2. Aaron Martinez, Enrique Fernandez, Learning ROS for Robotics Programming: A practical, instructive, and comprehensive guide to introduce yourself to ROS, the top-notch, leading robotics framework, PACKT publishing, Open Source.
3. Andy Lennon, "Basics of R/C Model Aircraft Design" Model Airplane News Publication
4. John Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs.
5. DGCA RPAS Guidance Manual, Revision 3 – 2020.

Web Resources:

1. https://onlinecourses.swayam2.ac.in/ntr24_ed12/preview
2. https://archive.nptel.ac.in/courses/101/104/101104073/
3. https://onlinecourses.nptel.ac.in/noc21_ae14/preview

26ITC107

DEEP LEARNING LAB

Instruction	2 P Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

Course Objectives:

This course aims to

1. Explore the concepts of perceptron and multilayer perceptrons.
2. Extract knowledge on hyper-parameter tuning.
3. Understand the performance of various optimizers.
4. Appraise various convolutional neural network architectures(CNNs) and Recurrent Neural Networks(RNNs)
5. Acquire knowledge on Autoencoders, Transformers and GANs.

Course Outcomes:

Upon completion of this course, students will be able to

1. Design and Implement single layer perceptrons and Multilayer Neural Networks to solve various problems.
2. Improve the performance of the models using hyper-parameter tuning.
3. Analyse the performance of various optimizers.
4. Build convolutional neural networks and Recurrent Neural Networks to real time problem solving.
5. Apply Autoencoders, Transformers and GANs to various real time applications.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	3	2	3	2	2
CO 2	3	2	3	2	2
CO 3	3	2	3	2	2
CO 4	3	2	3	2	2
CO 5	3	2	3	2	2

LABORATORY / PRACTICAL EXPERIMENTS:

1. Implement a perceptron learning algorithm (single layer perceptron) for solving following Boolean functions. i) AND ii) OR iii) XOR
2. Implement Multi-layer perceptron (MLP) algorithm for handwritten digit classification using MNIST dataset and house price prediction using appropriate dataset.
3. Improve the performance of Deep Learning models with hyper-parameter tuning.
4. Compare the performance of various optimizers on any classification problem.
5. Create a model with Overfitting and remove Overfitting in the model using various regularization techniques.
6. Implement a customized convolutional neural network for image classification on the Fashion-MNIST dataset.
7. Implement a pre-trained VGG16 model for image classification with transfer learning.
8. Build Recurrent Neural Networks for text generation.
9. Design and implement Encoder-Decoder architecture for language translation.
10. Demonstrate Denoising Autoencoder and Implement GANs for generating synthetic datasets.
11. Fine-tuning of the BERT Model for sentiment analysis.

TEXT BOOKS:

1. Aurelien Geron, “Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow”, O’Reilly Media, 3rd Edition, 2022.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, “Dive into Deep Learning”, d2l.ai, 2021
3. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
4. Ian Goodfellow, Yoshua Bengio, Aaron , Courville, “Deep Learning”, MIT Press, 2016

SUGGESTED READING:

1. Indra den Bakker, “Python Deep Learning Cookbook”, PACKT publisher, 2017
2. Wei Di, Anurag Bhardwaj, Jianing Wei, “Deep Learning Essentials”, Packt publishers, 2018
3. Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
4. Huang, Shih-Chia, and Trung-Hieu Le. Principles and labs for deep learning. Academic Press, 2021.

ONLINE RESOURCES:

1. COURSERA : https://www.coursera.org/specializations/machine-learning
2. NPTEL : http://nptel.ac.in/courses
3. DATASETS : https://www.kaggle.com/datasets
4. DATASETS : https://www.csie.ntu.edu.tw/~cjlin/libsvmtools/datasets/multilabel.html#siam-competition2007

26ITE126

BLOCKCHAIN TECHNOLOGY LAB
(Based on Program Elective-4)

Instruction	2 P Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

COURSE OBJECTIVES: This course aims to
1. To familiarize the basic concepts of blockchain.
2. To provide the significance of the Ethereum blockchain.
3. To introduce solidity programming for developing blockchain applications.
4. To explore Remix Tool for developing smart contracts.
5. To explore the features of Hyper ledger Fabric.

COURSE OUTCOMES: Upon completion of this course, students will be able to
1. Explore the working of blockchain fundamentals such as cryptography and distributed computing.
2. Implement smart contract on the Ethereum blockchain.
3. Build smart contracts using Solidity programming language.
4. Write smart contracts using the Remix tool.
5. Acquire thorough knowledge of Hyperledger fabric.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	3	3	2	3	3
CO 2	3	3	2	3	3
CO 3	3	2	2	3	3
CO 4	2	2	2	3	3
CO 5	3	2	2	3	3

LABORATORY / PRACTICAL EXPERIMENTS:
1. Explore the basics of Blockchain Technology.
2. Familiarize with the working of Remix Ethereum tool, Truffle and Ganache.
3. Setup a Simple Ethereum wallet and use it to send and receive Ethers.
4. Creating and deploying the simple smart contract to store and get “Hello World”, on the Blockchain network.
5. Write a Solidity program for incrementing/decrementing a counter variable in a smart contract.
6. Develop a smart contract to create a function setter and getter to set and get a value.
7. Design a smart contract on Remix Ethereum to print the array of integers and its length.
8. Develop Solidity contracts to illustrate inheritance.
9. Develop Solidity contracts to illustrate polymorphism.
10. Write a Solidity program to send ether from a Meta-mask account to another Meta-mask account through a smart contract.
11. Hyperledger Fabric Demo.

Text Books:
1. Imran Bashir “Mastering Blockchain” 3rd Edition Packt Publishers, 2020.
2. Melanie Swan, "BlockChain: Blueprint for a New Economy", 1st Edition O'Reilly, 2018.

Suggested Reading:

1. Andreas Antonopoulos, “Mastering Bitcoin: Unlocking Digital Cryptocurrencies”, 1st Edition, Apress, 2017.
2. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to BuildSmart Contracts for Ethereum and BlockChain”, Packt Publishing, 2019.

Online Resources:

1. https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html.
2. https://www.hyperledger.org/projects/fabric.
3. https://www.packtpub.com/big-data-and-business-intelligence/hands-blockchain-hyperledger.
4. https://www.amazon.com/Hands-Blockchain-Hyperledger-decentralized-applications/dp/1788994523.
5. https://github.com/HyperledgerHandsOn/trade-finance-logistics.

26ITE127

GENERATIVE AI LAB
(Based on Program Elective-4)

Instruction	2 P Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

COURSE OBJECTIVES:
This course aims to
1. Understand generative AI and its models.
2. Apply frameworks to build LLM-based applications.
3. Analyze model performance and limitations.
4. Develop intelligent systems like chatbots and document processing tools.
5. Create and evaluate generative AI applications for real-world domains.

COURSE OUTCOMES:
Upon completion of this course, students will be able to
1. Demonstrate generative AI concepts and basic LLM tasks.
2. Implement applications using LangChain and LLM pipelines.
3. Compare API and local models for performance and limitations.
4. Build intelligent applications such as chatbots and document QA systems.
5. Create generative AI solutions in music, gaming, data science, and drug discovery.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	3	2	2	2	1
CO 2	3	2	3	2	2
CO 3	3	2	3	3	2
CO 4	3	3	3	2	3
CO 5	3	3	3	3	1

LABORATORY / PRACTICAL EXPERIMENTS:
1. Study and implementation of basic tasks using Large Language Models (LLMs).
2. Text-to-image generation using models like Stable Diffusion or DALL·E .
3. Introduction and basic pipeline creation using LangChain .
4. API integration and comparison with local LLM models .
5. Development of a customer support application using LangChain .
6. Document summarization and question answering using retrieval-based methods .
7. Implementation of a ChatGPT-like chatbot with retrieval and memory .
8. Code generation and data science tasks using LLMs .
9. Prompt engineering and basic fine-tuning of LLMs .
10. Mini project: Application of generative AI (music generation / reinforcement learning for games / drug discovery).

Suggested Reading
1. Brown et al., *Language Models are Few-Shot Learners*, 2020 – foundational LLM concepts .
2. Rombach et al., *High-Resolution Image Synthesis with Latent Diffusion Models*, 2022 – text-to-image .
3. Vaswani et al., *Attention is All You Need*, 2017 – transformer architecture & memory .

Textbooks

1. Natural Language Processing with Transformers – Lewis Tunstall, Leandro von Werra, Thomas Wolf
2. Speech and Language Processing (3rd Edition Draft) – Jurafsky & Martin .
3. Reinforcement Learning: An Introduction – Sutton & Barto .

Web Resources

1. Hugging Face Course – https://huggingface.co/course/chapter1 (LLMs, text, code generation)
2. LangChain Documentation & Tutorials – https://www.langchain.com/docs/ (retrieval, memory, chatbots)
3. NPTEL AI & Machine Learning Courses – https://nptel.ac.in/courses/106/105/106105191/

26ITE128

QUANTUM COMPUTING LAB
(Based on Program Elective-4)

Instruction	2 P Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

Pre-requisites: Theory of computation and algorithms, linear algebra and probability.

Course Objectives:

This course aims to

1. Explain Python fundamentals and basic quantum computing concepts including qubits, superposition, and quantum states.
2. Demonstrate and apply the usage of quantum tools such as Circuit Composer and Qiskit for designing quantum circuits.
3. Apply single and multi-qubit gates to construct and simulate quantum circuits.
4. Analyze fundamental quantum algorithms such as Deutsch–Jozsa, Grover's algorithm, and Quantum Fourier Transform.
5. Explain and analyze quantum noise models and evaluate their impact on quantum computations.

Course Outcomes:

Upon completion of this course, students will be able to

1. Explain Python basics and fundamental quantum computing concepts including qubits and superposition.
2. Apply quantum tools such as Circuit Composer and Qiskit to design and simulate basic quantum circuits.
3. Construct and simulate quantum circuits using single and multi-qubit gates and visualize their states using tools like statevector and Q-sphere.
4. Apply and analyze quantum algorithms such as quantum teleportation, Deutsch–Jozsa, Grover's algorithm, and QFT.
5. Analyze quantum noise using simple noise models (e.g., bit-flip channel) and interpret its effect on quantum systems.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	2	1	2	1	2
CO 2	3	1	3	2	3
CO 3	3	1	3	2	3
CO 4	3	2	3	2	3
CO 5	2	2	3	2	3

List of Experiments:

1. Write Python programs using Jupyter Notebook to perform complex number operations, matrix multiplication, tensor products, and vector normalization required for quantum computing applications.
2. Explore the Circuit Composer and implement basic quantum circuits using Qiskit, Cirq, and PennyLane in Quantum Lab.
3. Execute quantum circuits on simulators and available quantum hardware using the IBM Quantum Platform and compare the measurement outcomes.
4. Implement and analyze single-qubit and multi-qubit quantum gates including Pauli gates, Hadamard gate, CNOT gate, Controlled-Z gate, and SWAP gate.
5. Design and execute quantum circuits using combinations of quantum gates and analyze the output states for different input configurations.

6. Visualize quantum states using State Vector, Bloch Sphere, Q-Sphere, and histogram visualization tools available in Qiskit.
7. Implement the Quantum Teleportation protocol using Qiskit and verify the successful transfer of quantum states between qubits.
8. Implement Deutsch–Jozsa Algorithm for constant and balanced oracle functions and compare the results with classical computation methods.
9. Implement Grover's Search Algorithm for searching an element in an unsorted database and analyze the amplification of probability amplitudes.
10. Implement Quantum Fourier Transform (QFT) circuits and analyze phase transformations and output probabilities for different quantum states.
11. Simulate quantum noise models using Bit-Flip, Phase-Flip, and Depolarizing channels, and analyze their effects on quantum circuit outputs using Qiskit simulators.

Resources:

1. Quantum Computation and Quantum Information. M. A. Nielsen and I. L. Chuang, Cambridge University Press.
2. Quantum Computing ,Vishal Sahni, Tata McGraw-Hill Publishing Company Limited,2007.
3. Mikio Nakahara and Tetsuo Ohmi,"Quantum Computing", CRC Press, 2008.
4. N. David Mermin,"Quantum Computer Science", Cambridge, 2007.

Suggested Reading:

1. An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York
2. Quantum Computer Science. N. David Mermin:, Cambridge University Press
3. Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQ Experience. SAPV Tharrmashastha, D. Bera, A. Maitra and S. Maitra, Springer 2020.

Web Resources:

1. Quantum Cryptography. D. Unruh:, https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/
2. NIST Post Quantum Cryptography, Available online: https://csrc.nist.gov/projects/post-quantum-cryptography/round-2-submissions
3. https://qiskit.org/

26ITE129

ADVANCED BIG DATA ANALYTICS LAB
(Based on Program Elective-4)

Instruction	2L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

Course Objectives:
This course aims to:
1. Familiarize students with foundational Big Data technologies and frameworks.
2. Introduce data processing paradigms like MapReduce, Hive
3. Develop proficiency in using Apache Spark for large-scale data analytics.
4. Explore different applications using Spark Machine Learning.
5. Provide practical experience in real time processing of data using Kafka for diverse Big Data applications.

Course Outcomes:
After completion of the course students are expected to be able to:
1. Understand the principles and components of Big Data technologies such as Hadoop, HDFS.
2. Implement MapReduce applications for distributed data processing and analyze scenarios suitable for Hive.
3. Gain proficiency in Apache Spark, including RDDs, DataFrames and Spark SQL for batch and real-time data processing.
4. Apply practical skills in Machine Learning applications using Spark Framework
5. Develop skills in Apache Kafka for building real-time data pipelines, including topics, partitions, producers, consumers, and Kafka Streams.

CO-PO Articulation Matrix

PO/CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	3	3	3	-	2
CO 2	3	3	3	2	2
CO 3	3	3	3	1	2
CO 4	3	3	3	1	3
CO 5	3	3	3	2	2

List of Experiments:
1. Setup Hadoop and HDFS, perform basic file operations.
2. Implement MapReduce for word count.
3. Execute HiveQL queries on retail data set.
4. Install Apache Spark, develop RDD-based applications.
5. Convert RDDs to DataFrames, perform Spark SQL operations.
6. Develop structured streaming applications in Spark.
7. Build machine learning pipelines with Spark MLlib.
8. Set up Kafka, develop producers and consumers.
9. Implement stream processing with Kafka Streams.

Text Books:
1. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media Inc, 2015.
2. Bill Chambers, Matei Zaharia, “Spark: The Definitive Guide”, 4th Edition, O'Reilly Media Inc, 2018..
3. Neha Narkhede, Gwen Shapira, Todd Palino, "Kafka: The Definitive Guide", 2nd Edition, O'Reilly Media, 2017.

Suggested Reading:

1. Bill Chambers, Matei Zaharia, “Spark: The Definitive Guide”, 4th Edition, O'Reilly Media Inc, 2018
2. Neha Narkhede, Gwen Shapira, Todd Palino, "Kafka: The Definitive Guide", 2nd Edition, O'Reilly Media, 2017.

26ITE130

UNMANNED AERIAL VEHICLES LAB
(Based on Program Elective-4)

Instruction	2L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1

Course Objectives:

This course aims to

1. Understand the basic components of Unmanned aerial vehicles (Drones) and its various applications.
2. Provide hands-on experience on design, fabrication and flying of UAV-category aircraft.
3. Integration of drones with other hardware and software applications.

Course Outcomes:

Upon completing this course, students will be able to:

1. Know the parts and functions of Quad copter.
2. Demonstrate Calibration of UAV(Quadcopter) using Ardupilot Mission planner.
3. Write and test Various commands to communicate for successfully fly the drone.
4. Explore Object Avoidance using sensors and test them on UGV(Robot).
5. Design/Simulate to communicate UAV/UGV using BLE/WiFi/UHF/Cellular devices and IOT-UAV/UGV using text & voice commands.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	1	1	0	1	3
CO2	1	2	0	0	3
CO3	1	1	1	1	3
CO4	1	1	0	0	3
CO5	1	1	1	2	3

List of Experiments:

1. Assemble, integrate and demonstrate the Quad copter with all necessary parts.
2. Calibration of UAV(Quadcopter) using Ardupilot Mission planner and demonstrate the calibrated IMU parameters.
3. Write a program to read Telemetry parameters using Serial Port using TTC device.
4. Write a program to read GPS coordinates on Raspberry Pi and Arduino micro controller.
5. Write a program to send MAVLINK commands to Pixhawk version of Flight Controller.
6. Write a program to connect Dronekit for communication and testing various commands.
7. Use Mission planner for flight path panning and demonstrate the transfer of planning transects to flight controller.
8. Write object avoidance program using the following sensors and test them on UGV(Robot)
   a) Sonar b) LiDAR c) Camera
9. Write a Program to communicate UAV/UGV using BLE/WiFi/UHF/Cellular devices.
10. Write a program to communicate IOT-UAV/UGV using text & voice commanding for Swarm.

Text Books:

1. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics : Control, Sensing, Vision and Intelligence.
2. John J. Craig, Introduction to Robotics: Mechanics and Control, Addison Wesley publication, 3rd Edition.
3. Reg Austin"Unmanned Aircraft Systems: UAVS Design, Development and Deployment" John Wiley & Sons, Ltd.2011.
4. Fahlstrom P, Gleason T (2012) "Introduction to UAV systems", 4th edn. Wiley, UK.
5. Yang, L. J., & Esakki, B. (2021). Flapping Wing Vehicles: Numerical and Experimental Approach. CRC Press.
6. Sebbane, Y. B. (2022). A first course in aerial robots and drones. CRC Press.

Suggested Reading:

1. J.A.M. Mendoza, V.J.G. Villela, G.S. Cervantes, M.M. Martinez, H.S. Azuela, Advanced Robotic Vehicles Programming: An Ardupilot and Pixhawk Approach, First Edition, A Press, 2020.
2. Ty Audronis, Designing Purpose-Built Drones for Ardupilot Pixhawk 2.1: Build drones with Ardupilot, First Edition, CBS Publishers and Distributers, 2017.
3. J. Ranga, J. Saiteja, M. Seshu, Speed Control of BLDC Motor with RPM Display, First Edition, LAP Lambert Academic Publishing, 2020.
4. D. Hanselman, Brushless Motors: Magnetic Design, Performance, and Control of Brushless DC and Permanent Magnet Synchronous Motors, First Edition, E-Man Press LLC, 2012.
5. Frazier, K. Singh, Fundamentals of Capturing and Processing Drone Imagery and Data, First Edition, CRC Press, 2021.
6. J. Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs, First Edition, QUE Publishers, 2015.

Web Resources:

1. https://robu.in/understanding-various-components-used-for-quadcopter-2/
2. https://ardupilot.org/copter/docs/common-imutempcal.html
3. https://ardupilot.org/copter/docs/common-telemetry-port-setup.html
4. https://www.youtube.com/watch?v=OeTxaClOEWs
5. https://www.youtube.com/watch?v=zxjO9q34RLs
6. https://www.youtube.com/watch?v=t4rwKoLmgVI

26ITC108

MINI PROJECT

Instruction	2L Hours per week
Duration of SEE	-
SEE	-
CIE	50 Marks
Credits	1.5

Course Outcomes:

Upon completing this course, students will be able to:

1. Formulate a specific problem and give a solution.
2. Develop model/models either theoretical/practical/numerical form.
3. Solve, interpret/correlate the results and discussions.
4. Conclude the results obtained.
5. Write the documentation in standard format.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	3	1	2	2	2
CO 2	3	1	3	3	2
CO 3	3	2	3	3	3
CO 4	2	2	2	2	2
CO 5	2	3	2	1	2

Guidelines:

- As part of the curriculum in the II- semester of the program each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work for assessment.
- Each student will be allotted to a faculty supervisor for mentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something more original.
- Mini projects shall have inter disciplinary/ industry relevance.
- The students can select a mathematical modeling based/Experimental investigations or Numerical modeling.
- All the investigations are clearly stated and documented with the reasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of the work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions and references.

Department committee: Supervisor and two faculty coordinators

Guidelines for awarding marks (CIE): Max. Marks: 50		
Evaluation by	**Max. Marks**	**valuation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Department Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27

M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

SEMESTER–III

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1		Program Elective-5	3	-	-	3	40	60	3
2		Open Elective	3	-	-	3	40	60	3
3		Audit Course-2	2	-	-	2	-	50	Non Credit
PRACTICALS									
4	26ITC109	Dissertation Phase-1	-	-	20	-	100	-	10
TOTAL			8	-	20	8	180	170	16
Clock Hours Per Week: 28									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**
T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

Program Elective-5	
26ITE131	Metaverse in Robotics
26ITE132	Robotic Simulation and Localization Mapping
26ITE133	Robotic Process Automation
26ITE134	Human Robot Interaction
26ITE135	Webots

Open Elective	
26CSO101	Business Analytics
26MEO102	Introduction to Optimization Techniques
26CEO101	Cost Management of Engineering Projects
26MEO101	Industrial Safety
26MEO103	Composite Materials
26EEO104	Waste to Energy

26ITE131

Metaverse in Robotics

(Program Elective - 5)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aim is to:

1. To present and discuss Metaverse characteristics, concepts and layers.
2. To explain and analyze Metaverse technologies, tools, platforms, and applications.
3. To discuss design theories and practices relevant to the Metaverse.
4. To explore cybersecurity and cybercrime in the Metaverse.
5. To examine open challenges in the Metaverse.

Course Outcomes:

After completion of the course students are expected to be able to:

1. Understand the characteristics, and interdisciplinary nature of the Metaverse, the opportunities and risks it presents.
2. Analyze Metaverse layers, the technologies used in creating them, as well as design theories and practices for Metaverse.
3. Examine and discuss Metaverse platforms, applications and the latest technological developments in this area.
4. Identify cybersecurity issues, understand cybercrime, and discuss the open challenges.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	2	1	1	2	1
CO 2	2	2	1	2	1
CO 3	2	1	1	2	2
CO 4	2	2	1	2	2
CO 5	2	1	2	1	2

UNIT-I

Introduction to Metaverse: Metaverse evolution, Metaverse importance and characteristics, the interdisciplinary nature of the Metaverse, Metaverse opportunities, and risks, Computer-mediated communication (social presence theory, social information processing theory, media richness theory, cyborg theory), Avatar-mediated communication **The seven layers of Metaverse:** Experience, Discovery, Creator economy, Spatial computing, Decentralization, Human interface, Infrastructure.

UNIT-II

Metaverse Technologies: AR/VR/MR/XR, 3D reconstruction, Game engines, Smart glasses, wearables, haptic devices, headsets and headwear, Blockchain, smart contracts, tokens, NFTs, Cryptography, Artificial Intelligence (AI), Internet of Things (IoT), Edge computing and 5G, 6G.

UNIT-III

Design Theories, Practices, and Tools: Social presence and co-presence, Motion sickness and cyber sickness, Uncanny valley, Sense of self-location, sense of agency and sense of body ownership, Universal simulation principle, Prototyping, Evaluation techniques (qualitative and quantitative)

Tools and technologies for Metaverse UX and UI: Tools and services for avatar systems, spatial user interface design, and Cross-platform user experience design, Multimodal user interface, Technologies and devices for human- computer interaction in Metaverse.

UNIT-IV

Metaverse platforms: Decentral and, SANDBOX, Roblox, Axie Infinity, uHive, Hyper Nation, Nakamoto (NAKA), Metahero (HERO), Star Atlas (ATLAS), Bloktopia (BLOK), Stageverse, Spatial, PalkaCity, Viverse, Sorare, Illuvium, Upland, Second Life, Sansar, Sensorium Galaxy

Metaverse and cybersecurity: Cybersecurity concerns in Metaverse, Cybersecurity risks in Metaverse: process, people, technology, Best practices for preventing cyberattacks in Metaverse and Best practices for preventing cyberattacks in Metaverse.

UNIT-V

Metaverse and cybercrime: Scam and theft, Rug pull, Money manipulation and wash trading, Money laundering **Metaverse challenges and open issues:** Persistency, Interoperability and scalability, Maturity, Regulation, Usefulness and ease-of-use, Privacy and data security, Content creation, NFTs and creator economy.

Metaverse applications: Gaming and entertainment, Travel and tourism, Education and learning, Remote working, Commerce and business, Real estate, Banking and Finance, Healthcare, Social media, and Fashion.

Text Book:

1. Winters, T., 2021, "The Metaverse", independently published, ISBN: 979-8450959283.

Suggested Reading:

1. Ball, M., 2022, “The Metaverse and How It Will Revolutionize Everything“, Liveright, ISBN: 978-1324092032.
2. Christodoulou, K. Katelaris, L., Themistocleous, M, Christoudoulou P. and Iosif E, 2022, “NFTs and the Metaverse Revolution: Research Perspectives and Open Challenges", Blockchains and the Token Economy: Theory and Practice, Eds: Lacity M., Treiblmaier H., (2022), Palgrave Macmillan, Cham, pp. 139-178.
3. Damar, M. (2021). Metaverse shape of your life for future: A bibliometric snapshot. Journal of Metaverse, 1(1), 1–8.
4. Day, J. (2022) Metaverse will see cyberwarfare attacks unlike anything before: ’Massively elevated’, February 28, https://www.express.co.uk/news/science/1570844/metaverse-news-cyber- warfare-attacks-virtual-worlds- Russia-china-spt.

26ITE132

ROBOTIC SIMULATION AND LOCALIZATION MAPPING
(Program Elective - 5)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aim is to:

1. To understand the basic concepts of Robotic simulations
2. To describe principles functions of Robots, Standard Robot part and its usage
3. To know about Simulation packages, Loading Simulation, and analysis of robot elements
4. To demonstrate the concept of Robotic motion, types of simulation motion
5. To characterize the mobile robotic localization and mapping.

COURSE OUTCOMES:

Upon completing this course, students will be able to:

1. Explain the basic Robotic systems, movement and Robot Applications.
2. Illustrate the Robotic principles, Robotic functions, selecting robot views
3. Analyze the Simulation Package and Robot motion control
4. Explore the Robotic motion concepts such as harmonic motion, parabolic motion etc.
5. Illuminate the concepts of Mobile Robot Localization.

PO/CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	2	1	1	2	1
CO 2	2	2	1	2	1
CO 3	2	1	1	2	2
CO 4	2	2	1	2	2
CO 5	2	1	2	1	2

UNIT I

INTRODUCTION: Robotics systems, Robot movements, Quality of simulation, types of simulation, Robot applications, Robotics simulation displays. Simulation notation, Auto lisp functions. Features, Command syntax, Writing design functions.

UNIT II

ROBOTIC PRINCIPLES: Straight lines, Angles and optimal moves circular interpolation, Robotic functions Geometrical commands, Edit commands. Selecting robot views, Standard Robot part, using the parts in a simulation.

UNIT III

ROBOTICS SIMULATION: Simulation packages, Loading the simulation, Simulation editors, delay, Resume commands. Slide commands, Program flow control. Robot motion control, Analysis of robot elements, Robotic linkages.

UNIT IV

ROBOTIC MOTION: Solids construction, Solid animation. Types of motion, velocity and acceleration, Types of simulation motion Harmonic motion, Parabolic motion, Uniform motion velocity and acceleration analysis for robots.

UNIT V

MOBILE ROBOT LOCALIZATION: Introduction, The Challenge of Localization: Noise and Aliasing, To Localize or Not to Localize: Localization- Based Navigation versus Programmed Solutions, Belief Representation, Map Representation, Probabilistic Map- Based Localization, Other Examples of Localization Systems, Autonomous Map Building.

Text Books:

1. Daniel L. Ryan, Robotics Simulation, CRC Press Inc., 1994.
2. Roland Siegwart and Illah R. Nourbakhsh "Introduction to Autonomous Mobile Robots" MIT Press 2004.

Suggested Reading:

1. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Phi Learning., 2009.
2. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning. 2009.
3. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.
4. Francis N. Nagy, Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.
5. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning, 2009.
6. Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, the MIT Press, 2003.
7. John J. Craig, Introduction to Robotics Mechanics and Control, Third Edition, Pearson, 2008.
8. Bijay K. Ghosh, Ning XI, T.J. Tarn, Control in Robotics and Automation Sensor – Based integration, Academic Press, 1999.
9. Carl D. crane III and Joseph Duffy, Kinematic Analysis of Robot manipulation, Cambridge University press, 2008.

Online Resouces:

1. NPTEL: https://nptel.ac.in/courses/112106298
2. COURSERA : Robotic Mapping and Trajectory Generation | Coursera
3. ONLINE: https://cyberbotics.com/
4. https://www.boston-engineering.com/solutions/technical-innovation/robotics/robotics-
5. capabilities/localization-and-mapping-in-robotics/

26ITE133

ROBOTIC PROCESS AUTOMATION
(Program Elective - 5)

Instruction	3 L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aim is to
1. Introduce fundamental concepts of Robotic Process Automation (RPA).
2. Impart practical applications of different RPA platforms.
3. Explore various types of variables, Control Flow, and data manipulation techniques.
4. Acquire knowledge of Image, Text, and Data Tables Automation.
5. Learn different techniques for handling exceptions in automation processes.

Course Outcomes:
Upon successful completion of this course, students will be able to:
1. Explain the basic concepts of RPA technology.
2. Build real-world tasks by utilizing a range of RPA platforms effectively.
3. Use different types of variables, control flow, and data manipulation techniques within an RPA workflow.
4. Apply control techniques and Optical Character Recognition (OCR) to improve Automation.
5. Implement exception-handling mechanisms within an RPA workflow to manage potential errors.

CO-PO Articulation Matrix

PO / CO	PO 1	PO 2	PO 3	PO4	PO5
CO 1	3	3	3	-	2
CO 2	3	3	3	-	2
CO 3	3	3	3	1	2
CO 4	3	3	3	1	1
CO 5	3	3	3	-	1

UNIT-I
RPA Foundations- Flavors of RPA, history of RPA, The Benefits of RPA, The downsides of RPA, RPA Compared to BPO, BPM and BPA, Consumer Willingness for Automation, The Workforce of the Future. RPA Skills: On-Premise Vs. the Cloud, Web Technology, Programming Languages and Low Code- OCR, Databases, APl's, Al-Cognitive Automation, Agile, Scrum, Kanban and Waterfall Devops- Flowcharts.
(Textbook 1: Ch. 1, Ch. 2)

UNIT-II
RPA Platforms- Components of RPA, RPA Platforms, about UiPath, The future of automation, Record and Play, downloading and installing UiPath Studio, Learning Ui Path Studio, Task recorder, Step- by- step examples using the recorder.
(Textbook 2: Ch. 1, Ch. 2)

UNIT-III
Sequence, Flowchart, and Control Flow-sequencing the workflow, Activities, Control flow, various types of loops, and decision making-Step-by step example using Sequence and Flowchart-Step-by-step example using Sequence and Control Flow, Data Manipulation, Data table usage with examples, Clipboard Management-File operation with step-by-step example-CSV/Excel to data table and vice versa.

(Textbook 2: Ch. 3, Ch. 4)

UNIT-IV

Taking Control of the Controls- Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls, mouse and keyboard activities, Working with Ui Explorer: Handling events, Revisit recorder, Screen and web Scraping.

(Textbook 2: Ch. 5)

UNIT-V

Exception Handling, Debugging, and Logging- Exception handling, Common exceptions and ways to handle them, Logging and taking screenshots, Debugging techniques, Collecting crash dumps, Error reporting, Future of RPA, Process Mining.

(Text book 2: Ch. 8, Text book 1; Ch. 13)

Text Books:

1. Tom Taulli, "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", 2020, lSBN-13 (electronic):978-7-4842-5729-6, Publisher: A press.
2. Alok Mani Tripathi, "Learning Robotic Process Automation", Publisher: Packet Publishing Release Date: March 2018 ISBN: 9787788470940.

Suggested Reading:

1. Gerardus Blokdyk,"Robotic Process Automation RPA a Complete Guide-2020 Edition",1st Edition,5STARCooks,2019.
2. Frank Casale, Rebecca Dilla, Iieidi Jaynes, Lauren Livingston, "Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation.
3. Richard Murdoch, "Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant"
4. Srikanth Merianda, "Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation".

Web Resources:

1. Learning Robotic Process Automation, https://www.packtpub.com/in/business/learning-robotic-process-automation.
2. Automation Anywhere University, https://university.automationanywhere.com/.
3. https://www.urbanpro.com/ghaziabad/rpa-robotics-process-automation-automation-anywhere/11461411.
4. www.uipath.com/rpa/robotic-process-automation.
5. https://www.coursera.org/specializations/roboticprocessautomation.

26ITE134

HUMAN ROBOT INTERACTION

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES: This course aim is to:
1. To learn about Human Robot Interaction
2. To learn about design morphology of HRI
3. To learn the spatial interaction of HRI
4. To know the verbal and nonverbal interaction with robots
5. To understand the emotions, research methods and applications

COURSE OUTCOMES: Upon successful completion of this course, students will be able to:
1. Know the basic about HRI
2. Able to explain the design morphology
3. Apply the spatial Interaction of HRI
4. Examine the verbal and nonverbal interaction with robots
5. Know the emotions and basic applications of HRI

CO-PO Articulation Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5
CO 1	3	3	3	-	2
CO 2	3	3	3	-	2
CO 3	3	3	3	1	2
CO 4	3	3	3	1	1
CO 5	3	3	3	-	1

UNIT-I

Introduction: Definition: HRI as an interdisciplinary endeavour, The evolution of HRI. How a Robot works: The making of a Robot, Robot Hardware, Sensors, Actuators, Software, and Limitations of Robotics on HRI.

UNIT-II

Design: Design in HRI: Robot Morphology, Design Patterns, Design principles in HRI Anthropomorphization in HRI Design: Theorizing, Designing and Measuring Design Methods, Prototyping Tools, From Machine to People and the in between.

UNIT-III

Spatial Interaction: Use of Space in Human Interaction: Proxemics, Group spatial Interaction Dynamics Spatial Interaction for Robots: Localization and Navigation, socially appropriate positioning, spatial dynamics, Informing Users.

UNIT-IV

Nonverbal Interaction: Functions of Nonverbal cues in Interaction. Types of Nonverbal interaction: Gaze & Eye Movement, Gesture, Mimicry and Imitation, Touch, Posture & Movement, Interaction rhythm and timing Nonverbal Interaction in Robots: Robot perception of nonverbal cues, Generating nonverbal cues in robots.

Verbal Interaction: Human-Human Verbal Interaction, Speech Recognition, Dialogue Management, Speech Production.

UNIT-V

Emotions: Understanding Human Emotions, Emotions for Robots. **Research Methods**: Defining a research question and approach, choosing among qualitative, quantitative and mixed methods, Defining the context of interaction, choosing a robot for your study, Selecting appropriate HRI measures.
Applications: Service Robots, Robots for learning, Robots for entertainment, Robots in Healthcare and Therapy, Service robots, Collaborative robots, Self-driving cars.

Text Book:

1. Bartneck, C., Belpaeme, T., Eyssel, F., Kanda, T., Keijsers, M., & Šabanović, S. (2024). Human-robot interaction: An introduction. Cambridge University Press.

Suggested Reading:

1. Barattini, P., Vicentini, F., Virk, G. S., & Haidegger, T. (Eds.). (2019). Human-robot interaction: safety, standardization, and benchmarking. CRC Press.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc20_me92/preview
2. https://nptel.ac.in/courses/112104293
3. https://www.shiksha.com/online-courses/foundations-of-cognitive-robotics-course-nptel806

26ITE135

WEBOTS

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

COURSE OBJECTIVES:

This course aims to

1. Understand the Webots simulation environment and its features
2. Design and simulate robotic systems using Webots
3. Work with sensors and actuators within Webots
4. Develop control programs for robots inside Webots
5. Build and analyze autonomous robot simulations

COURSE OUTCOMES:

Upon completion of this course, students will be able to

1. Use Webots interface effectively for simulation
2. Create and model robots using Webots tools
3. Implement controllers using programming languages
4. Simulate and analyze sensors and actuators
5. Develop autonomous robotic systems in Webots

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	2	1
CO2	3	2	3	2	2
CO3	3	2	3	3	2
CO4	3	3	3	2	3
CO5	3	3	3	3	1

UNIT-I

Introduction to robotics and simulation concepts, overview of Webots and its applications, installation and setup of Webots, Webots interface (Scene Tree, 3D View, Console), world files (.wbt), simulation controls (Run, Pause, Reset), basic robot simulation.

UNIT-II

Nodes and fields, types of nodes (Robot, Solid, Shape, Transform), hierarchical robot structure, DEF and USE keywords, PROTO nodes, custom robot design, environment modeling (floors, walls, obstacles), textures and colors.

UNIT-III

Distance sensor, camera, GPS, compass, motor types, velocity and position control, servo mechanisms, sensor data reading, decision-making using sensor input, actuator control.

UNIT-IV

Robot controllers, programming using Python, C, C++, controller structure, accessing sensors and actuators, differential drive robots, line following algorithm, obstacle avoidance, debugging and testing.

UNIT-V

Autonomous navigation, path planning, localization, multi-robot systems, ROS integration, real-world applications.

Text Books:

1. Cyberbotics, Webots User Guide, Cyberbotics Ltd., 2024.
2. Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in Python, 3rd Edition, Springer, 2023.
3. Craig John J., Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson, 2021.
4. Roland Siegwart, Introduction to Autonomous Mobile Robots, 2nd Edition, MIT Press, 2011

Suggested Reading:

1. Peter Corke, Robotics and Control: Fundamental Algorithms, Springer, 2022.
2. Bruno Siciliano, Robotics: Modelling, Planning and Control, Springer, 2009.
3. Steven M. LaValle, Planning Algorithms, Cambridge University Press, 2006.
4. Mark W. Spong, Robot Modeling and Control, Wiley, 2006.

Web Resources:

1. Webots : https://cyberbotics.com/doc
2. NPTEL : https://nptel.ac.in
3. COURSERA : https://www.coursera.org
4. ROS : https://www.ros.org

26CSO101

BUSINESS ANALYTICS
(Open Elective)

Instruction	3 L Hours per Week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

PRE-REQUISITES: Basic of programming, basic mathematics**.**

COURSE OBJECTIVES:

This course aims to

1. Understanding the basic concepts of business analytics and applications.
2. Study various business analytics methods including predictive, prescriptive and descriptive analytics.
3. Prepare the students to model business data using various data mining, decision making methods.

COURSE OUTCOMES:

After completion of this course, students will be able to

1. Identify and describe complex business problems in terms of analytical models.
2. Apply appropriate analytical methods to solve business problems and interpret the resulting metrics and measures to achieve stated objectives.
3. Illustrate descriptive, predictive and prescriptive analytics methods and techniques.
4. Model business data using data mining, forecasting, decision tree, and clustering techniques.
5. Design and evaluate viable data-driven solutions to complex business decision-making problems.

CO-PO ARTICULATION MATRIX

PO / CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	2	3	3	3

UNIT - I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, Generative AI , LLMs and Explainable AI (XAI) in business analytics, framework for decision making, challenges in data driven decision making and future.

UNIT - II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization.

UNIT - III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting

method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT - IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble methods, Random Forest, XGBoost. Clustering: Distance and similarity measures used in clustering, Clustering algorithms, K-Means, Prescriptive Analytics- Linear Programming (LP) and LP model building.

UNIT-V

Six Sigma: Introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox.

TEXTBOOKS:

1. U Dinesh Kumar, "Business Analytics", Wiley Publications, 2nd Edition, 2022
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015

SUGGESTED READINGS:

1. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making",6th Edition, Cengage, 2020.

ONLINE RESOURCES:

1. Coursera – Business Analytics Specialization (University of Pennsylvania, Wharton): https://www.coursera.org/specializations/business-analytics
2. NPTEL – Business Analytics and Data Mining (IIT Roorkee): https://nptel.ac.in/courses/110107106
3. edX – Data Science and Analytics MicroMasters (MIT): https://www.edx.org/micromasters/mitx-statistics-and-data-science

26MEO102

INTRODUCTION TO OPTIMIZATION TECHNIQUES
(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to
1. Understand the LPP models.
2. Understand the Transportation and Assignment techniques.
3. Understand the procedure of Project Management along with CPM and PERT techniques.
4. Understand the concepts of queuing theory and inventory models.
5. Understand sequencing techniques.

Course Outcomes: Upon completion of this course, students will be able to:
1. Formulate a linear programming problems (LPP).
2. Build and solve Transportation Models and Assignment Models.
3. Apply project management techniques like CPM and PERT to plan and execute project successfully.
4. Apply queuing and inventory concepts in industrial applications.
5. Apply sequencing models in industries.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	3	1	3	1	2
CO 2	3	1	3	1	2
CO 3	1	1	3	2	3
CO 4	2	1	3	2	2
CO 5	2	1	3	2	2

UNIT - I
Operations Research: Definition, Scope, Models, Linear programming problems (LPP), Formulation, Graphical Method, and Simplex Method.

UNIT - II
Transportation Models: Finding an initial feasible solution, North West corner method, Least cost method, Vogel's approximation method, Finding the optimal solution, Special cases in transportation problems, Unbalanced transportation problem, Degeneracy in transportation, Profit maximization in transportation.

UNIT- III
Project Management: Definition, Procedure and objectives of project management, Differences between PERT and CPM, Rules for drawing network diagram, Scheduling the activities, Fulkerson's rule, Earliest and latest times, Determination of ES and EF times in forward path, LS & LF times in backward path, Determination of critical path, Duration of the project, Free float, Independent float and total float.

UNIT - IV
Queuing Theory and Inventory:: Kendols notation, Single server models, Inventory control, Deterministic inventory models, Probabilistic inventory control models.

UNIT - V

Sequencing Models: Introduction, Objectives, General assumptions, Processing 'n' jobs through two machines, Processing 'n' jobs through three machines**.**

Text Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008.
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.

Suggested Reading:

1. Hitler Libermann, Operations Research, McGraw Hill Pub, 2009.
2. Harvey M Wagner, Principles of Operations Research, Prentice Hall of India, 2010.

26CEO101

COST MANAGEMENT OF ENGINEERING PROJECTS

(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:

This course aims to

1. Enable the students to understand the concepts of Project management.
2. Provide knowledge on concepts of Project Planning and scheduling.
3. Create an awareness on Project Monitoring and Cost Analysis
4. Provide adequate knowledge to the students on Recourse Management Costing-Variance Analysis.
5. Train the students with the concepts of Budgetary Control for cost management and to provide basic platform on Quantitative techniques for cost management.

Course Outcomes:

After the completion of this course, the student will be able to

1. Acquire in-depth knowledge about the concepts of project management and understand the principles of project management.
2. Determine the critical path of a typical project using CPM and PERT techniques.
3. Prepare a work breakdown plan and perform linear scheduling using various methods.
4. Solve problems of resource scheduling and leveling using network diagrams.
5. Learn the concepts of budgetary control and apply quantitative techniques for optimizing project cost.

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CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	1	1	-		
CO 2	1	2	1		
CO 3	1	1	1		
CO 4	2	2	1		
CO 5	-	1	1		

UNIT-I:

Project Management: Introduction to project management, stakeholders, roles, responsibilities and functional relationships. Principles of project management, objectives and project management system. Project team, organization, roles, anSd responsibilities. Concepts of project planning, monitoring, staffing, scheduling and controlling.

UNIT-II:

Project Planning and Scheduling: Introduction for project planning, defining activities and their interdependence, time and resource estimation. Work breakdown structure. Linear scheduling methods-bar charts, Line of Balance (LOB), their limitations. Principles, definitions of network-based scheduling methods: CPM, PERT. Network representation, network analysis-forward and backward passes.

UNIT-III:

Project Monitoring and Cost Analysis: Introduction-Cost concepts in decision making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a costing system; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making, Time

cost trade-off- Crashing project schedules, its impact on time on time, cost. Project direct and indirect costs.

UNIT-IV:

Resources Management and Costing-Variance Analysis: Planning, Enterprise Resource Planning, Resource scheduling and leveling. Total quality Management and Theory of constraints. Activity-Based Cost Management, Benchmarking; Balanced Scorecard and Value-Chain Analysis.

Standard Costing and Variance Analysis: Pricing strategies: Pareto analysis. Target costing, Life cycle costing. Cost of service sector. Just-in-time approach, Material Requirement.

UNIT-V:

Budgetary Control: Flexible Budgets; Performance budgets; zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management: Linear programming, PERT/CPM, Transportation Assignment problems, simulation, learning curve theory.

Text Books:

1. Charles T Horngren "Cost Accounting A Managerial Emphasis", Pearson Education; 14 edition (2012).
2. Charles T. Horngren and George Foster, "Advanced Management Accounting" Prentice-Hall; 6th Revised edition (1 February 1987).
3. Robert S Kaplan Anthony A. Atkinson, "Management & Cost Accounting" , Pearson; 2 edition (18 October 1996).

Suggested Reading:

1. K. K Chitkara, "Construction Project Management: Planning, scheduling and controlling", Tata McGraw Hill Education. (2004).
2. Kumar Neeraj Jha "Construction Project Management Theory and Practice", Pearson Education India; 2 edition (2015)

26MEO101

INDUSTRIAL SAFETY

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: This course aims to cover:
1. Causes for industrial accidents, preventive steps to be taken, Factories act 1948 and 5S Techniques.
2. Fundamental concepts of Maintenance Engineering.
3. About Safety in advanced manufacturing systems.
4. The basic concepts and importance of fault tracing.
5. The steps involved in periodic and preventive maintenance of various industrial equipment.

Course Outcomes: Upon completion of this course, students will be able to:
1. Identify causes of industrial accidents and recommend preventive measures.
2. Select appropriate tools and practices for various maintenance procedures.
3. Apply different Safety measures in advanced manufacturing systems.
4. Diagnose faults in equipment such as machine tools, IC engines, and boilers.
5. Implement periodic and preventive maintenance for industrial equipment including motors, pumps, air compressors, and machine tools.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	3	3	2	2	1
CO 2	3	3	2	2	1
CO 3	3	3	2	2	1
CO 4	3	3	2	2	1
CO 5	3	3	3	2	1

UNIT - I

Safety Management Concepts And Industrial Safety Practices

Industrial Safety & Legal Aspects: Industrial accidents – causes, types, consequences, and preventive measures. Mechanical and electrical hazards and their control. Fire hazards, prevention and firefighting methods. Safety color codes and safety signage. Salient provisions of the Factories Act 1948 related to health, safety, and welfare.

Safety Audit: Types of safety audits – audit methodology, preparation of audit checklists, Non-Conformity Reporting (NCR). Analysis and interpretation of accident records and safety reports.

5S Techniques: Introduction, objectives, and elements of 5S (Sort, Set in order, Shine, Standardize, Sustain). Benefits of 5S in enhancing workplace safety, productivity, and efficiency.

UNIT - II

Fundamentals of Maintenance Engineering: Definition and objectives of maintenance engineering. Primary and secondary functions and responsibilities of the maintenance department. Types of maintenance (preventive, predictive, breakdown, corrective) and their applications. Tools and equipment used in maintenance activities. Maintenance cost and its relationship with replacement decisions and economy. Concept of service life and factors affecting the lifespan of equipment.

UNIT- III

Safety in advanced manufacturing systems: Machine safety in CNC, robotics, and Flexible Manufacturing Systems (FMS). Human–machine interaction safety. Safety in Industry 4.0 environments including cyber-physical systems, smart factories, and digital twins. Safety in additive manufacturing (powder handling and laser safety). Safety in material handling systems (conveyors, cranes, AGVs) and manufacturing processes (welding, casting, forging, machining). Electrical safety in automation and Lockout/Tagout (LOTO) procedures.

UNIT - IV

Fault Tracing: Concept and importance of fault tracing. Decision tree approach – need, structure, and applications. Sequence of fault-finding activities and systematic troubleshooting procedures. Development and representation of fault diagnosis using decision trees. Fault tracing in industrial equipment including machine tools, pumps, air compressors, internal combustion engines, boilers, and electrical motors. Types of faults in machine tools and their general causes.

UNIT - V

Maintenance and Condition Monitoring

Periodic and Preventive Maintenance: Periodic inspection, concept and need. Cleaning, servicing, and overhauling of mechanical components and electrical motors. Common motor faults and remedies. Preventive maintenance definition, steps, and advantages. Maintenance procedures for machine tools, pumps, air compressors, and DG sets.

Condition monitoring and basic concepts of Proactive maintenance for Industry 4.0.

Text Books:

1. L. M. Deshmukh, Industrial Safety Management, McGraw Hill Education, New Delhi, 1st Edition, 2010.
2. M.R. Sahoo, Industrial Safety Engineering, RK Publications, New Delhi, 1st Edition, 2015.
3. H. P. Garg, “Industrial Maintenance”, S. Chand and Company, may 1987.
4. Das Akhil Kumar, Principles of Industrial Safety Management Understanding the Ws of Safety at Work, Second edition, PHI Learning Pvt Ltd, Jan 2020.

Suggested Reading:

1. Parth B. Shah, Industrial Safety and Maintenance Engineering, Technical publications, 2021.
2. Higgins & Morrow, “Maintenance Engineering Handbook”, McGraw-Hill Education Eighth Edition, February 2014.
3. M.P. Poonia, S.C. Sharma, Khanna Publishing House - Technology & Engineering, year 2019.

23MEO103

COMPOSITE MATERIALS
(Open Elective)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives:
This course aims to
1. Provide concepts of Composite materials and their constituents.
2. Explain the Classification of the reinforcements and matrix materials.
3. Provide Fabrication methods of metal matrix composites.
4. Explain manufacturing of Polymer matrix composites.
5. Elucidate Failure mechanisms in composite materials.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand composite materials and their reinforcements.
2. Summarize micro-mechanics approach as applied to UD lamina.
3. Apply fabrication methods of metal, ceramic and carbon matrix composites.
4. Apply fabrication methods of polymer matrix composites.
5. Analyze the lamina and laminate from failure perspective.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	3	1	3	1	-
CO 2	3	1	3	1	-
CO 3	3	1	3	1	-
CO 4	3	1	3	1	-
CO 5	3	1	3	1	-

UNIT - I
Introduction: Definition Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT - II
Reinforcements: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements.
Mechanical Behaviour of composites: Rule of mixtures, Inverse rule of mixtures. Iso-strain and Iso-stress conditions.

UNIT- III
Processing of Metal Matrix Composites: Casting - Solid State diffusion technique, Cladding - Hot isostatic pressing. Properties and applications.
Processing of Ceramic Matrix Composites: Liquid Metal Infiltration - Liquid phase sintering.
Processing of Carbon - Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT - IV

Processing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs - hand layup method - Autoclave method - Filament winding method - Compression moulding - Reaction injection moulding. Properties and applications.

UNIT - V

Strength: Lamina Failure Criteria, strength ratio, maximum stress criteria, maximum strain criteria, interactive failure criteria and hygrothermal failure. Laminate first ply failure -insight strength**.**

Text Books:

1. K.K.Chawla, "Composite Materials- Science and Engineering", 4th edition, Springer Verlag, 2019.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007..
3. R.M. Jones. Mechanics of Composite Materials. 2 nd ed. CRC press. 2018.

Suggested Reading:

1. Deborah D.L. Chung, "Composite Materials Science and Applications" 2nd edition, Springer Verlag, 2010.
2. Sanjay K. Mazumdar, "Composites Manufacturing- materials, product and process engineering", 1st edition, CRC press, 2002.
3. Daniel Gay, "Composite Materials Design and Applications" 3rd edition, CRC press, 2015.

26EEO104

WASTE to ENERGY

(Common All Branches)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite:
Students should have prior knowledge of Energy Conversions.
Course Objectives: This course aims to:
1. understand the everyday waste and its impact on society.
2. Learn how waste can be converted into useful energy.
3. Explore simple technologies used globally and in India.

Course Outcomes:
After completion, students will be able to:
1. Identify different types of waste in daily life.
2. Explain simple methods of converting waste into energy.
3. Understand how waste-to-energy plants work (basic level).
4. Recognize environmental benefits and concerns.
5. Evaluate real-world waste-to-energy practices.

CO-PO Articulation Matrix

PO / CO	PO1	PO2	PO3	PO4	PO5
CO 1	1	1	1	1	1
CO 2	2	1	1	1	1
CO 3	2	1	1	2	1
CO 4	1	-	-	1	1
CO 5	2	2	1	1	1

UNIT -I
Introduction: The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source. Waste Sources & Characterization Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria, Smart waste management systems (IoT-based monitoring).

UNIT -II
Energy Extraction Options: Landfill gas, collection and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets. Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers. Conversion of wastes fuel resources for other useful energy applications Energy from Plastic Wastes: Non-recyclable plastic wastes for energy recovery. Energy Recovery from waste and optimization of its use, benchmarking and standardization. Energy Analysis

UNIT -III
Energy production Methodologies: Collection, segregation, transportation and storage requirements. Location and Siting of 'Waste Energy' plants. Industry Specific Applications: In-house use: sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry.

Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and its operations

UNIT -IV

Environmental Implications: Environmental standards for Waste Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms

UNIT -V

Case Studies: Success/failures of waste energy Global Best Practices in Waste energy production distribution and use. Indian Scenario on Waste Energy production distribution and use in India. Success and Failures of Indian Waste Energy plants. Role of the Government in promoting 'Waste Energy ", Government policies & PPP models, Future trends: AI in waste management, circular economy

TEXTBOOKS

1. "Industrial and Urban Waste Management in India", TERI Press.
2. Banwari Lal and Patwardhan, "Wealth from Waste: Trends and Technologies" TERI Press.
3. S.N Mukhopadhyay, "Fundamentals of waste and Environmental Engineering", TERIPress.
4. "Waste-to-Energy in Austria – White Book – Figures, Data Facts", 2nd edition, May 2010.

SUGGESTED READING

1. CPCB Guidelines for Co-processing in Cement/Power/Steel Industry.
2. Report of the task Force on Waste Energy, Niti Ayog (Formerly Planning Commission) 2014.
3. Municipal Solid Waste Management Manual, CPHEEO, 2016.
4. Gazette Notification on Waste Management Rules 2016.

26ITC109

DISSERTATION PHASE- I

Instruction	20L Hours per week
Duration of SEE	-
SEE	-
CIE	100 Marks
Credits	10

COURSE OBJECTIVES: This course aims to

1. The 'Industrial project/Dissertation Phase 1(Project work) will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the student contribution(s).
2. To expose and learn the required simulation software/experimental techniques.
3. To carry out the work in a research environment or in an industrial environment.

COURSE OUTCOMES: After completion of this course, students will be able to

1. Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
2. Learn the required software/ computational/analytical tools for implementations.
3. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
4. Ability to present the findings of their technical solution in a written report.
5. Presenting the work in International/ National conference or reputed journals.

CO-PO Articulation Matrix

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	2	2
CO2	3	1	3	2	3
CO3	3	1	3	2	3
CO4	2	3	2	1	2
CO5	2	3	2	2	2

Guidelines:

1. The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work.
3. The CIE shall include reviews and the preparation of a report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the committee consists of Head, Chairperson-BoS, Supervisor and Project coordinator.
6. The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

Guidelines for the award of Marks: Max. Marks: 50		
Evaluation by	**Max .Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Department Committee	10	Relevance of the Topic
	10	PPT Preparation(s)
	10	Presentation(s)
	10	Question and Answers
	10	Report Preparation

Note: **The Department committee has to assess the progress of the student every two weeks.**

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

R26 (In line with AICTE Model Curriculum) with effect from AY 2026-27

M.TECH - IT (ARTIFICIAL INTELLIGENCE AND ROBOTICS)

SEMESTER–IV

S.No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
PRACTICALS									
1	26ITC110	Dissertation Phase-II	-		32	Viva-Voc e	100	100	16
TOTAL			**-**		**32**	**-**	**100**	**100**	**16**
Clock Hours Per Week: 32									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**
T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

26ITC110

DISSERTATION PHASE- II

Instruction	32 Hours per week
Duration of SEE	Viva
SEE	100 Marks
CIE	100 Marks
Credits	16

COURSE OBJECTIVES: This course aims to

1. Industrial project/Dissertation Phase 2 is the continuation of Industrial project/Dissertation Phase 1
2. Implementation of Project objectives.
3. Presentation of periodic reviews of the objectives and preparing of Dissertation in a prescribed format.

COURSE OUTCOMES: After completion of this course, students will be able to

1. Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
2. Learn the required software/ computational/analytical tools for implementations.
3. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
4. Ability to present the findings of their technical solution in a written report.
5. Presenting the work in International/ National conference or reputed journals.

CO \ PO	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	2	3
CO2	3	1	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	2	3	2	2	2

Guidelines:

- It is a continuation of Project work started in semester III.
- The student has to submit the report in prescribed format and also present a seminar.
- The dissertation should be presented in standard format as provided by the department.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner (HoD and BoS Chairperson) guide/co-guide.
- The candidate has to be in regular contact with his/her guide/co-guide.

Guidelines for awarding marks in CIE: Max. Marks: 100 **CIE (Continuous Internal Evaluation) Max. Marks: 50**		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Department Review Committee	05	Review 1
	10	Review 2
	10	Review 3
	15	Final presentation with the draft copy of the report in standard format
	20	Submission of the report in a standard format
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	10	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format

Guidelines for awarding marks in SEE: Max. Marks: 100

Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
External and Internal Examiner(s)	20	PowerPoint Presentation
	40	Quality of thesis and evaluation
	20	Quality of the project • Innovations • Applications • Live Research Projects • Scope for future study • Application to society
	20	Viva-Voce