RV College of Engineering®

# Undergraduate Programs


Bachelor of Engineering (B.E) in

## Artificial Intelligence and Machine Learning

Scheme And Syllabus Of V & VI Semester
(2022 Scheme)

B.E. Programs : AS, BT, CH, CS, CS - AI, CS - CD, CS - CY, CV, EC, EE, EI, ET, IM, IS, ME.
M. Tech (13) MCA, M.Sc. (Engg.)
Ph.D. Programs : All Departments are recognized as Research Centres by VTU Except AI & AS

2024

**99TH**
NIRF RANKING IN ENGINEERING (2024)

TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023
**1501+**
TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS-2023 (ASIA)
**501-600**

EDUFUTURE EXCELLENCE AWARD
BEST PRIVATE ENGINEERING UNIVERSITY (SOUTH)
BY ZEE DIGITAL

**1001+**
SUBJECT RANKING (ENGINEERING)

**801+**
SUBJECT RANKING (COMPUTER SCIENCE)

**IIRF 2023**
ENGINEERING RANKING INDIA
NATIONAL RANK-10
STATE RANK - 2
ZONE RANK - 5

QS-IGUAGE DIAMOND UNIVERSITY RATING (2021-2024)

## CURRICULUM STRUCTURE

**61** CREDITS PROFESSIONAL CORES (PC)

**23** CREDITS BASIC SCIENCE

**22** CREDITS ENGINEERING SCIENCE

**18** CREDITS PROJECT WORK / INTERNSHIP

**12** CREDITS* OTHER ELECTIVES & AEC

**12** CREDITS PROFESSIONAL ELECTIVES

**12** CREDITS HUMANITIES & SOCIAL SCIENCE

**160** CREDITS TOTAL

*ABILITY ENHANCEMENT COURSES (AEC), UNIVERSAL HUMAN VALUES (UHV), INDIAN KNOWLEDGE SYSTEM (IKS), YOGA.

**17**
Centers of Excellence

**11**
Centers of Competence

**212**
Publications On Web Of Science

**669**
Publications Scopus (2023 - 24)

**1093**
Citations

**70**
Patents Filed

**39**
Patents Granted

**61**
Published Patents

**11**
Skill Based Laboratories Across Four Semesters

MOUS: 90+WITH INSDUSTRIES / ACADEMIC INSTITUTIONS IN INDIA & ABROAD

EXECUTED MORE THAN RS.40 CRORES WORTH SPONSORED RESEARCH PROJECTS & CONSULTANCY WORKS SINCE 3 YEARS

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2024

# DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

## DEPARTMENT VISION

To develop sustainable solutions for the greater good of society, through quality engineering education in Artificial Intelligence and Machine Learning, with innovation, research, and consultancy activities.

## DEPARTMENT MISSION

- To impart cutting-edge knowledge and skills in Artificial Intelligence and Machine Learning with a foundation in Computer Science and Engineering.
- To promote innovative research and development in Artificial Intelligence and Machine Learning and its allied fields in collaboration with industries.
- To prepare the students for solving real-world problems by imparting engineering skills through experiential learning mode.
- To provide a pleasant environment in pursuit of excellence by keeping high personal and professional values and ethics.

## PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

**PEO1:** Develop graduates capable of applying the principles of Mathematics, Science, core Computer Science Engineering with Artificial Intelligence, and Machine learning knowledge to solve real-world interdisciplinary problems.

**PEO2:** To develop the ability among graduates to analyse and understand the state-of-the-art technologies and industrial practices in the Artificial Intelligence and Machine-learning domain through experiential learning.

**PEO3:** Develop graduates who will exhibit cultural awareness, teamwork with professional ethics, and practical communication skills with an inspiration to understand the social and economic impact of Artificial Intelligence and Machine learning in the foreseeable future.

**PEO4:** Prepare employable graduates for the right roles in industries / to become entrepreneurs to achieve higher career goals or take up higher education to pursue lifelong learning.

## PROGRAM SPECIFIC OUTCOMES (PSOs)

**PSO1: Problem Solving and Analysis**
The student will be able to:
1. Appreciate the importance of Mathematics, Electronics and Sensors, Data organization and Algorithms, Design thinking, and Software Engineering principles in building Intelligent Computational Systems.
2. Learn the applicability of Artificial Intelligence and Machine learning algorithms to solve real-world problems.
3. Identify the need for Deep learning, Computer vision, and Natural language processing to develop intelligent software products focusing on application performance.
4. Display team participation, good communication, project management, and documentation skills.

**PSO2: Experiential Learning**
The student will be able to:
1. Demonstrate the application of knowledge to develop intelligent software programs for various use case scenarios in industrial sectors like healthcare, agriculture, education and skilling, governance, energy, automotive, infrastructure, banking and finance, and manufacturing.
2. Participate in planning and developing enterprise-level solutions with cutting-edge technologies, displaying group dynamics and professional ethics.
3. Employ experiential learning throughout the program to enrich the practical aspects to reach state-of-the-art in the domain

# ABBREVIATIONS

| Sl. No. | Abbreviation | Meaning |
|---|---|---|
| 1. | VTU | Visvesvaraya Technological University |
| 2. | BS | Basic Sciences |
| 3. | CIE | Continuous Internal Evaluation |
| 4. | SEE | Semester End Examination |
| 5. | PE | Professional Core Elective |
| 6. | IE | Institutional Elective |
| 7. | HS | Humanities and Social Sciences |
| 8. | PHY | Physics |
| 9. | CHY | Chemistry |
| 10. | MAT | Mathematics |
| 11. | AS | Aerospace Engineering |
| 12. | AI | Artificial Intelligence & Machine Learning |
| 13. | BT | Biotechnology |
| 14. | CH | Chemical Engineering |
| 15. | CS | Computer Science & Engineering |
| 16. | CV | Civil Engineering |
| 17. | EC | Electronics & Communication Engineering |
| 18. | EE | Electrical & Electronics Engineering |
| 19. | EI | Electronics & Instrumentation Engineering |
| 20. | ET | Electronics & Telecommunication Engineering |
| 21. | IM | Industrial Engineering & Management |
| 22. | IS | Information Science & Engineering |
| 23. | ME | Mechanical Engineering |
| 24. | CD | Computer Science & Engineering(Data Science) |
| 25. | CY | Computer Science & Engineering(Cyber Security) |

# INDEX

# Bachelor of Engineering in
# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
# V Semester

| Sl. No. | Course Code | Course Title | Credit Allocation | | | | BoS | Category | Max Marks CIE | | SEE Duration (H) | Max Marks SEE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | | Theory | Lab | | Theory | Lab |
| 1 | HS251TA | Principles of Management and Economics | 3 | 0 | 0 | **3** | HS | Theory | **100** | *** | **3** | **100** | *** |
| 2 | CD252IA | Data Base Management Systems (Common to CS,IS,AI,CD,CY) | 3 | 0 | 1 | **4** | CD | Theory + Lab | **100** | **50** | **3** | **100** | **50** |
| 3 | AI253IA | Artificial Neural Networks and Deep Learning | 3 | 0 | 1 | **4** | AI | Theory + Lab | **100** | **50** | **3** | **100** | **50** |
| 4 | AI254TA | Machine Learning Operations | 3 | 1 | 0 | **4** | AI | Theory | **100** | *** | **3** | **100** | *** |
| 5 | XXX55TBX | Professional Core Elective-I **(Group-B)** | 3 | 0 | 0 | **3** | AI | Theory | **100** | *** | **3** | **100** | *** |
| 6 | AI256TCX | Professional Core Elective-II **(Group C)** | 2 | 0 | 0 | **2** | AI | NPTEL | **50** | *** | **2** | *** | **50** |
| | | **Total** | | | | **20** | | | | | | | |

| PROFESSIONAL CORE ELECTIVE- I<br>GROUP B | | | |
|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Credits** |
| 1 | AI255TBA | Artificial Intelligence Integrated Software Engineering | **03** |
| 2 | CS355TBB | Advanced Algorithms<br>(Common to AI,CS,IS) | **03** |
| 3 | AI255TBC | Mathematical Algorithms for Artificial Intelligence | **03** |
| 4 | AI255TBD | Edge AI | **03** |

| PROFESSIONAL CORE ELECTIVE- II<br>GROUP C | | | |
|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Credits** |
| 1 | AI256TCA | Information Security-5-Secure Systems Engineering<br>(Common to AI,CS, CY, CD, IS) | **02** |
| 2 | AI256TCB | Design Technology And Innovation | **02** |
| 3 | AI256TCC | Emotional Intelligence | **02** |
| 4 | CS256TCD | Edge Computing<br>(Common to CS,AI) | **02** |

# Bachelor of Engineering in
# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
# VI Semester

| Sl. No. | Course Code | Course Title | Credit Allocation | | | | BoS | Category | Max Marks CIE | | SEE Duration (H) | Max Marks SEE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | | Theory | Lab | | Theory | Lab |
| 1 | HS361TA | Entrepreneurship and Intellectual Property Rights | 3 | 0 | 0 | **3** | HS | Theory | **100** | *** | **3** | **100** | *** |
| 2 | AI362IA | Big Data Technologies | 3 | 0 | 1 | **4** | AI | Theory+ Lab | **100** | **50** | **3** | **100** | **50** |
| 3 | AI363IA | Natural Language Processing and Transformers | 3 | 0 | 1 | **4** | AI | Theory + Lab | **100** | **50** | **3** | **100** | **50** |
| 4 | AI364TA | Cloud Computing Technology & Architectures | 3 | 1 | 0 | **4** | AI | Theory | **100** | *** | **3** | **100** | *** |
| 5 | AI365TDX | Professional Core Elective-III (Group- D) | 3 | 0 | 0 | **3** | AI | Theory | **100** | *** | **3** | **100** | *** |
| 6 | XX366TEX | Institutional Electives – I (Group E) | 3 | 0 | 0 | **3** | Resp BoS | Theory | **50** | *** | *** | **50** | *** |
| 7 | AI367P | Interdisciplinary Project | 0 | 0 | 2 | **3** | AI | Project | *** | **100** | **2** | *** | **100** |
| | | **Total** | | | | **24** | | | | | | | |

| PROFESSIONAL CORE ELECTIVE-III<br>Group-D | | | |
|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Credits** |
| 1 | AI365TDA | Information Retrieval Systems | **03** |
| 2 | AI365TDB | Hybrid Intelligence and Large Language Models | **03** |
| 3 | AI365TDC | Nature Inspired Computing | **03** |
| 4 | AI365TDD | Generative Artificial Intelligence<br>(Common to AI,CS,IS,CD) | **03** |

| INSTITUTIONAL ELECTIVE - 1<br>GROUP - E | | | |
|---|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** | **Credits** |
| 1 | AS266TEA | Fundamentals of Aerospace Engineering | **02** |
| 2 | BT266TEB | Bioinformatics | **02** |
| 3 | CH266TEC | Industrial Safety Engineering | **02** |
| 4 | CS266TED | Robotics Process Automation | **02** |
| 5 | CV266TEE | Intelligent Transport Systems | **02** |
| 6 | CV266TEF | Integrated Health Monitoring of Structures | **02** |
| 7 | CM266TEG | Advanced Energy Storage for E-Mobility | **02** |
| 8 | EC266TEH | Human Machine Interface (HMI) | **02** |
| 9 | EE266TEJ | Energy Auditing and Standards | **02** |
| 10 | EI266TEK | Biomedical Instrumentation | **02** |
| 11 | ET266TEM | Telecommunication Systems | **02** |
| 12 | ET266TEN | Mobile Communication Networks and Standards | **02** |
| 13 | IS266TEO | Mobile Application Development | **02** |
| 14 | IM266TEQ | Elements of Financial Management | **02** |
| 15 | IM266TER | Optimization Techniques | **02** |
| 16 | ME266TES | Automotive Mechatronics | **02** |
| 17 | MA266TEU | Mathematical Modelling | **02** |
| 18 | MA266TEV | Mathematics of Quantum Computing | **02** |
| 19 | HS266TEW | Applied Psychology for Engineers | **02** |
| 20 | HS266TEY | Universal Human Values | **02** |

| **Semester :V** | | | | | | |
|---|---|---|---|---|---|---|
| **PRINCIPLES OF MANAGEMENT & ECONOMICS**<br>**Category: Professional Core Course**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **HS251TA** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45Hrs** | | **SEE Duration** | **:** | **3.00 Hours** |
| **Unit-I** | | | | | | **06 Hrs** |
| **Introduction to Management:** Management Functions – POSDCORB – an overview, Management levels & Skills, Management History - **Classical Approach:** Scientific Management, Administrative Theory, **Quantitative Approach:** Operations Research, **Behavioral Approach:** Hawthorne Studies, **Contemporary Approach:** Systems Theory, Contingency Theory. **Caselets / Case studies** | | | | | | |
| **Unit – II** | | | | | | **10 Hrs** |
| **Foundations of Planning:** Types of Goals & Plans, Approaches to Setting Goals & Plans, Strategic Management Process, Corporate strategies – types of corporate strategies, BCG matrix, Competitive Strategies – Porters Five force Model, types of Competitive Strategies. **Caselets / Case studies**<br>**Organizational Structure & Design:** Overview of Designing Organizational Structure - Work Specialization, Departmentalization, Chain of Command, Span of Control, Centralization & Decentralization, Formalization, Mechanistic & Organic Structures. **Caselets / Case studies** | | | | | | |
| **Unit –III** | | | | | | **10 Hrs** |
| **Motivation:** Early Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Theory Y, Herzberg's Two Factor Theory. Contemporary Theories of Motivation: Adam's Equitytheory, Vroom's Expectancy Theory. **Caselets / Case studies**<br>**Leadership:** Behavioral Theories: Blake & Mouton's Managerial Grid, Contingency Theories of Leadership: Hersey & Blanchard's Situational Leadership, Contemporary Views of Leadership: Transactional & Transformational Leadership. **Caselets / Case studies** | | | | | | |
| **Unit –IV** | | | | | | **10 Hrs** |
| **Introduction to Economics:** Microeconomics and Macroeconomics, Circular flow model of economics, An Overview of Economic Systems.<br>**Essentials of Microeconomics:** Demand, Supply, and Equilibrium in Markets for Goods and Services, Price Elasticity of Demand and Price Elasticity of Supply, Elasticity and Pricing, Numericals on determining price elasticity of demand and supply. Changes in Income and Prices Affecting Consumption Choices, Monopolistic Competition, Oligopoly. | | | | | | |
| **Unit –V** | | | | | | **09 Hrs** |
| **Macroeconomic Indicators:** Prices and inflation, Consumer Price Index, Exchange rate, Labor Market, Money and banks, Interest rate. Gross Domestic product (GDP) - components of GDP, Measures of GDP: Outcome Method, Income method and Expenditure method, Numericals on GDP Calculations, ESG an overview.<br>**Macroeconomic models**- The classical growth theory, Keynesian cross model, IS-LM-model, The AS-AD model, The complete Keynesian model, The neo-classical synthesis. National Budgeting process in India | | | | | | |
| **Course Outcomes: After completing the course, the students will be able to:-** | | | | | | |
| **CO1** | Elucidate the principles of management theory & recognize the characteristics of an organization. | | | | | |
| **CO2** | Demonstrate the importance of key performance areas in strategic management and design appropriate organizational structures and possess an ability to conceive various organizational dynamics. | | | | | |
| **CO3** | Compare and contrast early and contemporary theories of motivation and select and implement the right leadership practices in organizations that would enable systems orientation. | | | | | |
| **CO4** | Demonstrate an understanding on the usage and application of basic economic principles. | | | | | |
| **CO5** | Appreciate the various measures of macro-economic performance and interpret the prevailing economic health of the nation. | | | | | |

| **Reference Books:** | |
|---|---|
| 1. | Management, Stephen Robbins, Mary Coulter &NeharikaVohra, 15th Edition, 2021, Pearson Education Publications, ISBN: 13: 978-0-13-558185-8 |
| 2. | Management, James Stoner, Edward Freeman & Daniel Gilbert Jr, 6th Edition, 2009, PHI, ISBN: 81-203-0981-2. |
| 3. | Principles of Microeconomics, Steven A. Greenlaw, David Shapiro, 2nd Edition, 2017, ISBN:978-1-947172-34-0 |
| 4. | Macroeconomics: Theory and Policy, Dwivedi D.N, 5th Edition, 2021, McGraw Hill Education; ISBN : 9789353163334 |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Some of the Experiential learning topics may include Reading Leadership books and summarizing, Analysis and interpretation of various economic reports, Visit to various organizations to understand organizational mechanics. Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **DATABASE MANAGEMENT SYSTEMS**<br>**Category: Professional Core Course**<br>**(Common to CS,IS, AI, CD,CY)**<br>**(Theory and Practice)** | | | | | | |
| **Course Code** | **:** | **CD252IA** | | **CIE** | **:** | **100 + 50 Marks** |
| **Credits: L:T:P** | **:** | **3:0:1** | | **SEE** | **:** | **100 + 50 Marks** |
| **Total Hours** | **:** | **45L+30P** | | **SEE Duration** | **:** | **3.00 + 3.00 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction to Database Systems** -Databases and Database users: Introduction, An example, Characteristics of Database Approach, Data Models, Schemas and Instances, Three-schema Architecture and Data Independence, The Database System Environment.<br>**Data Modeling Using the Entity-Relationship Model-** High-Level Conceptual Data Models for Database Design; A Sample Database Application; Entity Types, Entity Sets, Attributes and Keys; Relationship types, Relationship Sets, Roles and Structural Constraints; Weak Entity Types. | |
| **Unit – II** | **09 Hrs** |
| **Refining the ER Design for the COMPANY Database;** ER Diagrams, Naming Conventions and Design Issues, ER- to-Relational Mapping.<br>**Relational Model and Relational Algebra-**Relational Model Concepts; Relational Model Constraints and Relational Database Schemas; Update Operations and Dealing with Constraint Violations; Unary Relational Operations: SELECT and PROJECT; Relational Algebra Operations from Set Theory; Binary Relational Operations: JOIN and DIVISION ; Examples of Queries in Relational Algebra. | |
| **Unit –III** | **09 Hrs** |
| **Introduction to SQL- S**QL Data Definition, Specifying Constraints in SQL, Basic Queries in SQL; Insert, Delete and Update Statements in SQL More Complex SQL Retrieval Queries.<br>**Relational Database Design -** Functional Dependencies – Definition, Inference Rules, Equivalence of sets of FD's, Minimal Set of FD's ; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form; Properties of Relational Decompositions. | |
| **Unit –IV** | **09 Hrs** |
| **Transaction Processing Concepts-** Introduction to transaction processing, Transaction states and additional operations, Desirable properties of transaction, Schedules of transactions. Characterizing schedules based on Serializability: Serial, Non serial and Conflict- Serializable schedules, Testing for Conflict serializability of schedule<br>**Concurrency Control Techniques:** Two phase locking techniques for concurrency control, types of locks and system lock tables | |
| **Unit –V** | **09 Hrs** |
| **Introduction to NoSQL**: Aggregate data models: aggregates, key-value and document data models. Distribution models: sharding, master-slave replication, peer-peer replication – combining sharding and replication.<br>**Big Data** : Types of data: Structured, semi structured, unstructured. Distributed Architectures : Hadoop, Map Reduce Programming Model | |

| **Course Outcomes: After completing the course, the students will be able to: -** | |
|---|---|
| **CO 1** | Understand and explore the needs and concepts of relational, NoSQL database and Distributed Architecture |
| **CO 2** | Apply the knowledge of logical database design principles to real time issues. |
| **CO 3** | Analyze and design data base systems using relational, NoSQL and Big Data concepts |
| **CO 4** | Develop applications using relational and NoSQL database |
| **CO 5** | Demonstrate database applications using various technologies. |

| **Reference Books** | |
|---|---|
| **1.** | Elmasri and Navathe: Fundamentals of Database Systems, 6th Edition, Pearson Education, 2011, ISBN-13: 978-0136086208. |
| **2.** | Pramod J Sdalage, Martin Fowler: NoSQL A brief guide to the emerging world of Polyglot Persistence, Addison-Wesley, 2012, ISBN 978-0-321-82662-6, |
| **3.** | Raghu Ramakrishnan and Johannes Gehrke : Database Management Systems, 3rd Edition, McGraw-Hill, 2003 ISBN : 978-0072465631. |
| **4.** | Seema Acharya and Subhashini Chellappan. Big Data and Analytics. Wiley India Pvt. Ltd. 2nd Edition |

**LABORATORY COMPONENT**

**PART – A**

Open Ended Mini Project should be implemented and shall be carried out in a batch of two students. The students will finalize a topic in consultation with the faculty. The mini project must be carried out in the college only.

The Mini Project tasks would involve:

- Understand the complete domain knowledge of application and derive the complete data requirement specification of the Mini Project
- Design of the project with Integrated database solution (SQL and NOSQL)
- Normalization of the Relational design up to 3NF.
- Appreciate the importance of security for database systems.
- Documentation and submission of report.
- Recent Trends used (Block chain, NLP, AI, ML, AR, VR etc) and Societal Concern issues addressed

**General Guidelines :**

- Database management for the project- MySQL, DB2, Oracle, SQL Server, MongoDB (Any NoSQL DB) server or any database management tool.
- Front End for the project – Java , VC++, C#, Python , Web Interface (HTML, Java Script)
- Use database Programming such as Embedded SQL,/Dynamic SQL/SQLJ.

| RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 4. | **LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks),lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50MARKS | **50** |
| | **MAXIMUM MARKS FOR THE CIE** | **150** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type of questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of THREE Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (LAB) | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| 1 | Write Up | 10 |
| 2 | Conduction of the Experiments | 20 |
| 3 | Viva | 20 |
| | **TOTAL** | **50** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING**<br>**Category: Professional Core Course**<br>**(Theory and Practice)** | | | | | | |
| **Course Code** | **:** | **AI253IA** | | **CIE** | **:** | **100+50 Marks** |
| **Credits: L: T: P** | **:** | **3:0:1** | | **SEE** | **:** | **100 + 50 Marks** |
| **Total Hours** | **:** | **45L+30P** | | **SEE Duration** | **:** | **3.00 + 3.00 Hours** |

**Unit-I** — **9Hrs.**

**Neural Networks:** Introduction to NN, models of neuron and network architectures. **Learning Processes**: Different types of learning processes, Learning with and without teacher, Memory, statistical learning theory.
**Single layer perceptron:** Adaptive filter problem, least mean square algorithm, learning rate, Learning rate annealing techniques, perceptron and perceptron convergence theorem.
**Multilayer Perceptron:** Back propagation algorithm, Sequential and batch modes of training, stopping criteria, XOR problem, and some numerical problems

**Unit – II** — **9Hrs.**

**Convolutional Neural Networks:** Introduction, Historical Perspective and Biological Inspiration. **Basic Structure of a Convolutional Network:** Padding, Strides, Typical Settings, The ReLU Layer, Pooling, Fully Connected Layers, The Interleaving Between Layers, Local Response Normalization, Hierarchical Feature Engineering.
**Training a Convolutional Network:** Back propagating Through Convolutions, Back propagation as Convolution with Inverted/Transposed Filter, Convolution/Back propagation as Matrix Multiplications, Data Augmentation.
**Applications of CNN:** Content based image retrieval, Object Localization, Object Detection, Natural Language and sequence learning, and Video classification

**Unit –III** — **9Hrs.**

**Recurrent Neural Networks:** Introduction and expressiveness of RNN. **Basic Structure of a RNN:** Language Modeling Example of RNN, Generating a Language Sample, Back propagation Through Time, Bidirectional Recurrent Networks, Multilayer Recurrent Networks. **Echo-State Networks, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRUs)**
**Applications of Recurrent Neural Networks:** Automatic Image Captioning, Sequence-to-Sequence Learning and Machine Translation, Sentence-Level Classification, Token-Level Classification with Linguistic Features, Time-Series Forecasting and Prediction, Temporal Recommender Systems, Secondary Protein Structure Prediction, End-to-End Speech Recognition, Handwriting Recognition

**Unit –IV** — **9Hrs.**

**Deep Reinforcement Learning:** Introduction, **Stateless Algorithms:** Multi-Armed Bandits, Na¨ıve Algorithm, Greedy algorithm, Upper Bounding Methods
**The Basic Framework of Reinforcement Learning:** Challenges of Reinforcement Learning, Simple Reinforcement Learning for Tic-Tac-Toe, ole of Deep Learning and a Straw-Man Algorithm. **Bootstrapping for Value Function Learning:** Deep Learning Models as Function Approximators, Example: Neural Network for Atari Setting, On-Policy Versus Off-Policy Methods: SARSA, Modeling States Versus State-Action Pairs, **Monte Carlo Tree Search**
**Case Studies:** Alpha Go: Championship Level Play at Go, Alpha Zero: Enhancements to Zero Human Knowledge, Self-Learning Robots: Deep Learning of Locomotion Skills, Deep Learning of Visuomotor Skills, Building Conversational Systems: Deep Learning for Chat-Bots, Self-Driving Cars

**Unit –V** — **9Hrs**

**Advanced Topics in Deep Learning:** Attention Mechanisms, Attention Mechanisms for Machine Translation, Neural Turing Machines, Competitive learning, Limitations of neural networks. Cars
**Generative Adversarial Networks (GANs):** Training a GAN, Comparison with variational auto encoder, Using GANs for generating Image data, conditional GANs.

| **Laboratory Component** |
|---|
| **Group of two students belong to the same batch are required to implement an engineering application using any one of the deep learning techniques, CNN, RNN and Reinforcement learning.**<br>**Examples:**<br>**CNN:** Biometric authentication using CNN, Object identification and recognition, Emotion recognition, Auto translation, Document classification etc.<br>**RNN:** Language translation, Generating image descriptions, Speech recognition etc.<br>**Reinforcement Learning:** Real-time bidding, Recommendation systems, Traffic control systems etc. |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Describe basic concepts of neural networks, its applications and various learning models |
| **CO2** | Analyze different network architectures, learning tasks, CNN, and deep learning models |
| **CO3** | Investigate and apply neural networks model and learning techniques to solve problems related to society and industry. |
| **CO4** | Demonstrate a prototype application developed using any NN tools and APIs. |
| **CO5** | Appraise the knowledge of neural networks and deep learning as an individual/as an team member. |

| **Reference Books** | |
|---|---|
| 1 | Neural Networks – A Comprehensive Foundation**,** Simon Haykin, 2nd Edition, PHI, 2005. |
| 2 | Neural Networks and Deep learning: A Textbook ,Charu C Aggarwal, Springer International Publishing AG, ISBN 978-3-319-94462-3 ISBN 978-3-319-94463-0 (eBook), https://doi.org/10.1007/978-3-319-94463-0, 2018 |
| 3 | Deep Learning (Adaptive Computation and Machine Learning Series),,Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press ,2017, ISBN-13: 978-0262035613. |
| 4 | Fundamentals of Artificial Neural Networks ,M H Hassoun, MIT Press, 2010, ISBN-13: 978-0262514675. |

| **RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 4. | **LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS | **50** |
| | **MAXIMUM MARKS FOR THE CIE (THEORY+LAB)** | **150** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type of questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of THREE Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (LAB) | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| 1 | Write Up | 10 |
| 2 | Conduction of the Experiments | 20 |
| 3 | Viva | 20 |
| | **TOTAL** | **50** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **MACHINE LEARNING OPERATIONS**<br>**Category: Professional Core**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **AI254TA** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T: P** | **:** | **3:1:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L+30T** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **9Hrs.** |
|---|---|
| **What and Why :** Why Now and Challenges: Defining MLOps and Its Challenges - MLOps to Mitigate Risk - MLOps for Scale. People of MLOps: Subject Matter Experts - Data Scientists - Data Engineers - Software Engineers – DevOps - Model Risk Manager/Auditor - Machine Learning Architect | |
| **Unit – II** | **9Hrs.** |
| **Features of MLOps and Developing a Model:**<br>Key MLOps Features: A Primer on Machine Learning - Model Development - Productionalization and Deployment – Monitoring - Iteration and Life Cycle - Governance. Developing Models: What Is a Machine Learning Model? - Data Exploration - Feature Engineering and Selection – Experimentation - Evaluating and Comparing Models - Version Management and Reproducibility. | |
| **Unit –III** | **9Hrs.** |
| **Preparation and Deployment of Production**<br>Preparing for Production: Runtime Environments - Model Risk Evaluation - Quality Assurance for Machine Learning - Quality Assurance for Machine Learning - Key Testing Considerations - Reproducibility and Auditability - Machine Learning Security - Model Risk Mitigation. | |
| **Unit –IV** | **9 Hrs** |
| **Deploying to Production:** CI/CD Pipelines - Building ML Artifacts - Deployment Strategies – Containerization - Scaling Deployments - Requirements and Challenges.<br>**Feedback Loop:** How Often Should Models Be Retrained? - Understanding Model Degradation - Drift Detection in Practice - The Feedback Loop. | |
| **Unit –V** | **9 Hrs** |
| **Model Governance** – Who decides what governance organization needs – Matching governance with Risk Level – Current regulations driving MLOps governance – Key elements of responsible AI – Template of MLOps Governance<br>**Monitoring and Logging –** Observability for Cloud MLOps - Introduction to Logging – Logging in Python – Monitoring and Observability | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Identify and apply various ML-Ops techniques to deploy machine learning models for real-world problems. |
| **CO2** | Design, deploy and evaluate Machine Learning models, follow the operational practices to benefit society, science, and industry. |
| **CO3** | Use modern tools and techniques to organize ML model from development to production for real world problems |
| **CO4** | Demonstrate effective communication through team presentations and reports to analyse the impact of the standard MLOPs practices on industry and society. |
| **CO5** | Conduct performance evaluation, design, deploy models in accordance with the appropriate Governance for the benefit of the industry and society. |

| **Reference Books** | |
|---|---|
| 1 | Mark Treveil and the Dataiku Team- Introducing MLOps How to Scale Machine Learning in the Enterprise, O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472 , 1st Edition ,2020,ISBN : 9781492083290 |
| 2 | Noah Gift and Alfredo Deza, Practical MLOps, O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472 , 1st Edition, 2021, ISBN: 9781098103019 |
| 3 | David Sweenor, Steven Hillion, Dan Rope, Dev Kannabiran, Thomas Hill, Michael O'Connell, "MLOps: Operationalizing Data Science", O'Reilly Media, Inc., 1st Edition , 2020, ISBN : 9781492074656 |
| 4 | Emmanuel Raj, Engineering MLOps, Packt Publishing, 1st Edition, 2021, ISBN : 9781800566323 |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **ARTIFICIAL INTELLIGENCE INTEGRATED SOFTWARE ENGINEERING**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **AI255TBA** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T: P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **9 Hrs.** |
|---|---|
| **Introduction:** Professional Software Development, Software Engineering Ethics, Case studies. Software Processes: Models, Process activities, Coping with Change, Process improvement. The Rational Unified Process. Computer Aided Software Engineering. Agile Software Development: Introduction to agile methods, Agile development techniques, Agile project management and scaling agile methods. | |
| **Unit – II** | **9 Hrs.** |
| **Requirements Engineering and System Modeling:** Software Requirements: Functional and Non-functional requirements. Requirements Elicitation, Specification, Validation and Change. System Modeling: Context models, Interaction models, Structural models, Behavioral models, Model driven architecture. Architectural Design: Design decisions, Architectural views, Architectural patterns and architectures. | |
| **Unit –III** | **9 Hrs.** |
| **Development and Testing:** Design and implementation: Object oriented design using UML, Design patterns, Implementation issues, Open-source development. Software Testing: Development testing, Test-driven development, Release testing, User testing. Software Evolution: Evolution processes. Legacy system evolution, Software maintenance | |
| **Unit –IV** | **9 Hrs.** |
| **Machine Learning to Support Code Reviews in Continuous Integration**<br>Introduction, Code review in CI, Code analysis tool chain, Code extraction, Feature extraction, Model development, Making a recommendation, Visualization of the results, Full example<br>**Using Artificial Intelligence for Auto-Generating Software for Cyber-Physical Applications**<br>Introduction, Model-Based Methods, Learning-Based Methods, Fault Trees, Model-Based Software Engineering, Running Example, AI-Based Framework for MBSE Task, AI-based MBSE Model Construction Methods, MBSE Trade-Off Framework, Empirical Modelling Cost Comparison | |
| **Unit –V** | **9 Hrs.** |
| **Application of Machine Learning in Software Testing**<br>Introduction, Applications of Machine Learning in software testing-Machine Learning for software fault prediction, Machine Learning for test oracles automation, Machine learning for test cases generation, Machine learning for test suite reduction, prioritization and evaluation, other tasks<br>**Creating Test Oracles Using Machine Learning Techniques**<br>Introduction, Background on Test Oracles, Test Oracles Based on Machine Learning Techniques | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Summarize the activities in Software Engineering and the use of artificial Intelligence in Software Engineering |
| **CO2** | Competence in software requirements analysis and software design |
| **CO3** | Demonstrate the use of modern tools for software design by exhibiting teamwork through oral presentations and reports |
| **CO4** | Apply AI techniques to automate software engineering tasks such as testing, debugging, and code analysis |
| **CO5** | Conduct case studies to appraise the benefits of integrating AI in software engineering |

| **Reference Books** | |
|---|---|
| 1 | Software Engineering ,Ian Sommerville, 10th Edition, Pearson Education, 2013, ISBN: 9788131762165. |
| 2 | Artificial Intelligence Methods for Software Engineering ,Meir Kalech, Rui Abreu, Mark Last, World Scientific Publishing Co. Pte. Ltd, 1st Edition, 2021, ISBN 978-981-123-992-2, ISBN 978-981-123-993-9. |
| 3 | Software Engineering-A Practitioners Approach ,Roger.S.Pressman,7th Edition, Tata McGraw Hill, 2007, ISBN: 9780071267823 |
| 4 | Fundamentals of Software Engineering ,Rajib Mall, 3rd Edition, Prentice-hall Of India Pvt Ltd., 2012, ISBN: 9788120348981. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **ADVANCED ALGORITHMS**<br>**Category: Professional Core Course Elective**<br>**(Common to AI, IS & CS)**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **CS355TBB** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Analysis techniques:** Growth of functions: Asymptotic notation, Standard notations and common functions, Substitution method for solving recurrences, Recursion tree method for solving recurrences, Master theorem. **Amortized Analysis:** Aggregate analysis, The accounting method, The potential method. | |
| **Unit – II** | **09 Hrs** |
| **Sorting in Linear Time:** Lower bounds for sorting, Counting sort, Radix sort, Bucket sort. **Dynamic Programming:** Matrix-chain multiplication. **Greedy Algorithms:** An activity-selection problem, Elements of the greedy strategy. | |
| **Unit –III** | **09 Hrs** |
| **Graph Algorithms:** Bellman-Ford Algorithm, Shortest paths in a DAG, Johnson's Algorithm for sparse graphs. **Maximum Flow:** Flow networks, Ford Fulkerson method and Maximum Bipartite Matching. | |
| **Unit –IV** | **09 Hrs** |
| **Number Theoretic Algorithms:** Elementary notions, GCD, Modular arithmetic, Solving modular linear equations, The Chinese remainder theorem, Powers of an element, RSA cryptosystem. **String Matching Algorithms:** Naïve algorithm, Rabin-Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm. | |
| **Unit –V** | **09 Hrs** |
| **Advanced Data structures:** Structure of Fibonacci heaps, Merge able-heap operations, Decreasing a key and deleting a node, Binomial Queues. **Polynomials and the FFT :** Representing polynomials, The DFT and FFT, FFT circuits. | |

| **Course Outcomes: After completing the course, the students will be able to: -** | |
|---|---|
| **CO1** | Analyze various algorithms for their time and space complexity. |
| **CO2** | Demonstrate a familiarity with major algorithms and data structures |
| **CO3** | Apply appropriate design techniques for solving real world problems. |
| **CO4** | Design and implement solutions using appropriate mathematical techniques. |

| **Reference Books** | |
|---|---|
| 1. | Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein; Introduction to Algorithms; Columbia University, 4th Edition; 2022, ISBN 9780262046305. |
| 2. | Mark Allen Weiss; Data Structures and Algorithm Analysis in C++, Addison-Wesley; 4th Revised edition; 2014, ISBN-13: 978-0-13-284737-7. |
| 3. | Kozen DC, The design and analysis of algorithms , Springer Science & Business Media, 2012, ISBN: 978-0387976877 |
| 4. | Kenneth A. Berman, Jerome L. Paul, Algorithms, Cengage Learning, 2002. ISBN: 978- 8131505212 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| # | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.** | **20** |
| 2. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **MATHEMATICAL ALGORITHMS FOR ARTIFICIAL INTELLIGENCE**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **AI255TBC** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T: P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **40L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **8Hrs** |
|---|---|
| **Matrix Computations:** Recap of Vector Spaces and subspaces, basis and dimension, Subspaces associated with a linear transformation, Projections, LU Decomposition, Cholesky Decomposition, Eigen Decomposition, Real Symmetric Matrices, Singular value decomposition, Pseudo inverse | |
| **Unit – II** | **8Hrs** |
| **Dimensionality Reduction Techniques:** Subspaces with inner product, Orthonormal basis, Gram-Schmidt Orthonormalization, QR Factorization and least squares, Dimensionality reduction, Principal Component Analysis, Independent Component Analysis | |
| **Unit –III** | **8Hrs** |
| **Statistical Techniques:** Least Mean Square Algorithm, Weighted least squares, Recursive least squares, Kalman Filter, Statistical version of Kalman Filter , Gaussian Mixture Models, Expectation Maximization Algorithm, Monte Carlo methods | |
| **Unit -IV** | **8Hrs** |
| **Vector Calculus and Matrix Differentiation -** Partial derivatives and Gradients, Directional derivatives, Jacobian, Hessian, Gradients of vector valued functions, Matrix Derivatives - Ax, AT Ax, Trace, Norm | |
| **Unit -V** | **8Hrs** |
| **Optimization** - Maxima, Minima, Notion of objective/cost functions, Least Squares solutions and pseudo inverse, Curve fitting through least squares, Gradient Descent algorithm, Constrained Optimization and Lagrangian Multipliers | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Analyse the working of AI solutions at their core |
| **CO2** | Optimize AI solutions and also justify mathematically the choice of algorithm chosen |
| **CO3** | Identify the areas for innovation and research, and contribute to the development of new AI techniques |
| **CO4** | Develop more reliable AI solutions by incorporating various Mathematical concepts |

| **Reference Books** | |
|---|---|
| 1 | Mathematical Methods and Algorithms for Signal Processing, Todd Moon and Striling, Prentice Hall, 2000. ISBN, 0201361868 ... |
| 2 | Mathematics for Machine Learning, Deisenroth,Cambridge university Press, 2019, ISBN: 9781108470049 |
| 3 | Matrix Computations ,Golub, 4th Edition,TRIM Series, Hindustan Book Agencies,ISBN: 9789380250755, 9380250754 |
| 4 | Essential Math ,AIby Hala Nelson, O'Reilly Media, Inc.ISBN: 9781098107635 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| **Semester: V** | | | | | | |
|---|---|---|---|---|---|---|
| **EDGE AI**<br>**Category: Professional Core Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **AI255TBD** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **9 Hrs** |
|---|---|
| **Edge AI-** Introduction to Edge AI, Defining Key terms, Why Edge AI? Differences between Edge AI and Cloud AI, Applications of Edge AI, Edge AI Hardware and Software Components, Edge AI Architecture: Components and Design Patterns, Data Pipeline in Edge AI: Ingestion, Processing, and Storage, Embedded Machine Learning and Tiny Machine Learning, Digital Signal Processing, Challenges and Opportunities in Edge AI | |
| **Unit – II** | **9 Hrs** |
| **Edge AI Hardware and Platforms:** Sensors, Signals, and Sources of Data, Types of Sensors and Signals, Acoustic and Vibration Visual and Scene Motion and Position Force and Tactile Optical, Electromagnetic, and Radiation Environmental, Biological, and Chemical.<br>**Processors for Edge AI Edge AI:** Hardware Architecture, Microcontrollers and Digital Signal Processors, System-on-Chip, Deep Learning Accelerators, FPGAs and ASICs, Edge Servers Multi-Device Architectures, Devices and Workloads | |
| **Unit –III** | **9 Hrs** |
| **Machine Learning Models for Edge AI:** Feature Engineering, Working with Data Streams, Digital Signal Processing Algorithms, Combining Features and Sensors, Artificial Intelligence Algorithms, Algorithm Types by Functionality, Algorithm Types by Implementation, Optimization for Edge Devices On-Device Training.<br>**Edge AI Tools, Workflow:** Tools for Edge AI, Responsible AI in the Edge AI Workflow, Need of Edge AI, Determining Feasibility, Moral Feasibility, Business Feasibility, Dataset Feasibility, Technological Feasibility. | |
| **Unit –IV** | **9 Hrs** |
| **Edge AI Design, Development** - Designing Edge AI Applications - Product and Experience Design, Architecture Design, Iterative workflow for Edge AI Development, Evaluating and Deploying Edge AI.<br>**Artificial Intelligence Inference in Edge:** Optimization of AI Models in Edge, General Methods for Model Optimization, Model Optimization for Edge Devices, Segmentation of AI Models, Sharing of AI Computation | |
| **Unit –V** | **9 Hrs** |
| **Designing Edge AI Applications** Product and Experience Design, Design Principles Scoping a Solution Setting Design Goals Architectural Design Hardware, Software, and Services Basic Application Architectures Complex Application Architectures and Design Patterns Working with Design Patterns.<br>**Developing Edge AI Applications:** An Iterative Workflow for Edge AI Development, Exploration Evaluating, Deploying, and Supporting Edge AI Applications<br>**Evaluating Edge AI Systems**: Ways to Evaluate a System, Useful Metrics Techniques for Evaluation, Evaluation and Responsible AI | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Understand and apply the fundamentals and key concepts of Edge AI for developing engineering applications. |
| **CO2** | Analyze and select appropriate hardware architectures and platforms to build Edge AI-based engineering applications. |
| **CO3** | Design machine learning models and AI algorithms for Edge AI devices based on basic principles. |
| **CO4** | Develop Edge AI applications using modern tools to benefit various engineering domains and society. |
| **CO5** | Demonstrate teamwork while developing the Edge AI systems using appropriate metrics and techniques, ensuring ethical and responsible AI practices. |

| **Reference Books** | |
|---|---|
| 2. | Daniel Situnayake, "AI at the Edge", O'Reilly, 2023, Publisher(s): O'Reilly Media, Inc. ISBN: 9781098120207 |
| 2. | Edge AI Convergence of Edge Computing and Artificial Intelligence Xiaofei Wang · Yiwen Han Victor C. M. Leung · Dusit Niyato Xueqiang Yan · Xu Chen, Springer Nature, ISBN 978-981-15-6185-6 |
| 3. | TinyML: Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers by Pete Warden, Daniel Situnayake December 2019 Publisher(s): O'Reilly Media, Inc. ISBN: 9781492051992 |
| 4. | AI at the Edge: Solving Real-World Problems with Embedded Machine Learning" is authored by Daniel Situnayake and Jenny Plunkett. The publisher is O'Reilly Media, ISBN: 9781098120207. |
| 5. | Daniel Situnayake, "AI at the Edge", O'Reilly, 2023, Publisher(s): O'Reilly Media, Inc. ISBN: 9781098120207 |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **ENTREPRENEURSHIP & INTELLECTUAL PROPERTY RIGHTS**<br>**Category: Professional Core Course**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **HS361TA** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **42 L** | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **08Hrs** |
|---|---|

**Introduction to Entrepreneurship**: Definition and Scope of Entrepreneurship, Importance of Entrepreneurship in Engineering Innovation and Economic Growth, Techniques for Identifying Entrepreneurial Opportunities, Types of Entrepreneurs: Innovative, Imitative, Fabian, Characteristics and Traits of Successful Entrepreneurs.

**Role in economic development**- Emerging Trends in Entrepreneurship, Entrepreneur and Entrepreneurship, characteristics of Entrepreneur, Myths about Entrepreneurship, Entrepreneur vs Intrapreneur, Role of Entrepreneurial Teams

**Activities**: Case study on Entrepreneurship in Indian Scenario, Ideation Workshops and Hackathons,

| **Unit – II** | **08 Hrs** |
|---|---|

**Entrepreneurial Opportunity Evaluation**: Identifying Market Opportunities and Trends, Integration of Engineering Principles in Ideation Process, Cross-Disciplinary Collaboration for Technological Innovation, Assessing Market Feasibility and Demand Analysis, Evaluating Technical Feasibility: Prototype Development, Proof of Concept, Financial Feasibility Analysis: Cost Estimation, Revenue Projection, Break-Even Analysis**.**

**Business Planning and Strategy Development**: Elements of a Business Plan, Executive Summary, Company Description, Market Analysis, writing a Business Plan: Structure and Components, Strategic Planning: Vision, Mission, Goals, Objectives, SWOC Analysis, Competitive Strategy: Porter's Generic Strategies, Differentiation, Cost Leadership, Focus Strategy, Growth Strategies: Organic Growth, Mergers and Acquisitions, Strategic Alliances

**Activities**: Writing a Business Plan on given templates, Developing Business Models and Prototypes Based on Generated Ideas

| **Unit –III** | **08Hrs** |
|---|---|

**Entrepreneurial Marketing and Sales:** Basics of Marketing: Product, Price, Place, Promotion (4Ps), Market Segmentation, Targeting, and Positioning (STP), Branding and Product Development Strategies, Creating a Unique Value Proposition (UVP) Digital Marketing: Social Media Marketing, Content Marketing, SEO, SEM, Sales Techniques and Customer Relationship Management (CRM).

**Entrepreneurial Finance and Resource Management:** Sources of Financing: Equity Financing, Debt Financing, Venture Capital, Angel Investors, Crowdfunding, Financial Management: Budgeting, Cash Flow Management, Financial Statements Analysis, Risk Management and Insurance, Human Resource Management: Recruitment, Training, Performance Evaluation, Legal and Ethical Issues in Entrepreneurship: Intellectual Property Rights, Contracts, Corporate Governance

**Activities**: Case Studies and Practical Applications

| **Unit –IV** | **09Hrs** |
|---|---|

**Introduction to IP :** Types of Intellectual Property

**Patents:** Introduction, Scope and salient features of patent; patentable and non-patentable inventions, Patent Procedure - Overview, Transfer of Patent Rights; protection of traditional knowledge, Infringement of patents and remedy, Case studies, Patent Search and Patent Drafting, Commercialization and Valuation of IP.

**Trade Marks:** Concept, function and different kinds and forms of Trade marks, Registrable and non- registrable marks. Registration of Trade Mark; Deceptive similarity; Transfer of Trade Mark, ECO Label, Passing off, Infringement of Trade Mark with Case studies and Remedies.

| **Unit –V** | **09 Hrs** |
|---|---|
| **Trade Secrets:** Definition, Significance, Tools to protect Trade secrets in India.<br>**Industrial Design:** Introduction of Industrial Designs Features of Industrial, Design. Procedure for obtaining Design Protection, Revocation, Infringement and Remedies, Case studies.<br>**Copy Right:** Introduction, Nature and scope, Rights conferred by copy right, Copy right protection, transfer of copy rights, right of broad casting organizations and performer's rights, Exceptions of Copy Right, Infringement of Copy Right with case studies. | |

| **Course Outcomes:** After going through this course, the student will be able to | |
|---|---|
| **CO1** | Understand the concepts of entrepreneurship and cultivate essential attributes to become an entrepreneur or Intrapreneur and demonstrate skills such as problem solving, team building, creativity and leadership. |
| **CO2** | Comprehend the process of opportunity identification of market potential and customers while developing a compelling value proposition solutions. |
| **CO3** | Analyse and refine business models to ensure sustainability and profitability and build a validated MVP of their practice venture idea and prepare business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture. |
| **CO4** | Apply insights into the strategies and methods employed to attain a range of benefits from these IPs and deliver an investible pitch deck of their practice venture to attract stakeholders |
| **CO5** | Knowledge and competence related exposure to the various Legal issues pertaining to Intellectual Property Rights with the utility in engineering perspectives. |

| **Reference Books** | |
|---|---|
| **1.** | Donald F. Kuratko ,"Entrepreneurship: Theory, Process, and Practice", South-Western Pub publishers, 10th edition, 2016,978-ISBN-13: 1305576247 |
| **2.** | Eric Ries, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses", Crown Currency Publishers,1st Edition, 2011, ISBN-13: 978-0307887894. |
| **3** | Dr B L Wadehra, Law Relating to Intellectual Property, universa Law publishers 05th edition, ISBN : 9789350350300 . |
| **4** | Intellectual Property Rights: Unleashing Knowledge Economy, Prabuddha Ganguly, 1st Edition, 2001, Tata McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 0074638602 |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar / presentation / demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Fill in the blanks or descriptive for one or two marks type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only Small case lets and case example in one subdivision) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **BIG DATA TECHNOLOGIES**<br>**Category: Professional Core Course**<br>**(Theory & Practice)** | | | | | | |
| **Course Code** | **:** | **AI362IA** | | **CIE** | **:** | **100 +50Marks** |
| **Credits: L:T:P** | **:** | **3:0:1** | | **SEE** | **:** | **100 + 50Marks** |
| **Total Hours** | **:** | **45L+30P** | | **SEE Duration** | **:** | **3.00+ 3.00 Hours** |

**The Hadoop Distributed File system**
**The Design of HDFS** - HDFS Concepts – Blocks, Name nodes and Data nodes, HDFS Federation, HDFS High Availability
**Data Flow** – Anatomy of a File Read, Anatomy of a File Write

**Unit – II** — **09 Hrs**

**Map Reduce – Distributed Processing Framework-** A Weather Dataset – Data format, Analysing the data with Unix Tools, Analyzing the Data with Hadoop – Java MapReduce, Scaling Out
**Working of Map Reduce -** Anatomy of a Map Reduce Job Run, Failures, Shuffle and Sort, Task Execution

**Unit –III** — **09 Hrs**

**Hive** - Configuring Hive, Hive Services ,The Metastore
**Comparison with Traditional Databases** -Schema on Read Versus Schema on Write, Updates, Transactions, and Indexes ,SQL-on-Hadoop Alternatives
**HiveQL** - Data Types, Operators and Functions
**Tables** -Managed Tables and External Tables, Partitions and Buckets, Storage Formats, Importing Data, Altering Tables, Dropping Tables,
**Querying Data** -Sorting and Aggregating, Map Reduce Scripts, Joins, Subqueries,Views

**Unit –IV** — **09 Hrs**

**Flume** - Installing Flume, **Transactions and Reliability** -Batching ,**The HDFS Sink** -Partitioning and Interceptors File Formats
**Fan Out**-Delivery Guarantees, Replicating and Multiplexing Selectors
**Distribution: Agent Tiers**-,Delivery Guarantees,
**Sink Groups** - Integrating Flume with Applications, Component Catalog

**Unit –V** — **09 Hrs**

**Spark Applications**- Jobs, Stages, and Tasks, A Scala Standalone Application,
**Resilient Distributed Datasets** - Creation, Transformations and Actions, Persistence, Serialization
**Shared Variables** -Broadcast Variables, Accumulators
**Anatomy of a Spark Job Run** - Job Submission, DAG Construction, Task Scheduling, Task Execution

| Lab Component | |
|---|---|
| **Expt. No** | **Programs** |
| **1.** | **Map Reduce Program on Counting**<br>a) Write a Java Program using Mapper and Reducer function to find the number of records in the give dataset<br>b) Submit the job to cluster<br>c) Track the job information |
| **2.** | **Map Reduce Program using Temperature Dataset**<br>1. Write a Java program for finding Maximum recorded temperature by the year from Weather Dataset<br>2. Submit the job to cluster<br>3. Find the status of the Job and terminate it |
| **3.** | **Programs on Pig Script Using movie lens data**<br>a) List all the movies and the number of ratings<br>b) List all the users who have rated the same movie and find the number of ratings |

| | |
|---|---|
| | c) List all the Users who have rated the movies (Users who have rated at least one movie)<br>d) Find the count of the Movie which has the ratings more than 3<br>e) Find the max, min, average ratings for all the movie |
| **4.** | **Program on Advanced Concepts in Pig**<br>a) Group by Year and dump the result in a bag<br>b) Write a pig script to find the maximum temperature<br>c) Write a pig Script to find the average temperature of a state for 3 years and store the result in HDFS |
| **5.** | **Extract facts using Hive on movie lens data**<br>a) Write a query to select only those records which correspond to starting, browsing, completing, or purchasing movies. Use a CASE statement to transform the RECOMMENDED column into integers where 'Y' is 1 and 'N' is 0. Also, ensure GENREID is not null. Only include the first 25 rows.<br>b) Write a query to select the customer ID, movie ID, recommended state and most recent rating for each movie. |

**PART - B**

**Group of two students belongs to same batch are required to implement a problem statement which makes use of streaming data using Apache Spark.**

Examples: Identifying Credit Card Fraud, Identifying prospective customers on a commerce website, real-time stock trades, up-to-the minute inventory management, fake-news detection, etc.

**Course Outcomes: After completing the course, the students will be able to:-**

| | |
|---|---|
| **CO1** | Understand and apply the different building blocks of Big Data Technologies to a given problem |
| **CO2** | Articulate the programming aspect of Big Data Technologies to obtain solution to the problem through lifelong learning |
| **CO3** | Exhibit effective communication to represent the analytical aspects of Big Data Technologies for obtaining solution to the problems |
| **CO4** | Demonstrate solutions for societal and environmental concern problems using modern engineering tools through writing effective reports |
| **CO5** | Appraise the knowledge of Big Data Technologies as an Individual /as a team member to manage multidisciplinary projects |

**Reference Books**


| | |
|---|---|
| **1.** | Hadoop – The Definitive Guide; Storage and Analysis at Internet scale,Tom White ,4th Edition, 2015, O'Reilly, Shroff Publishers & Distributers Pvt. Ltd., ISBN – 978-93-5213-067-2 |
| **2.** | DT Editorial Services,Big Data – Black Book,Dreamtech Press, 1st Edition – 2015, ISBN - 978-93-511-9-757-7 |
| **3.** | Hadoop for Dummies, Dirk deRoos, Paul C. Zikopoulos, Roman B. Melnyk, Bruce Brown, Rafael Coss, 2014, John Wiley & Sons, Inc., ISBN: 978-1-118-60755-8 (pbk); ISBN 978-1-118-65220-6 (ebk); ISBN 978-1-118-70503-2 (ebk) |
| **4.** | Big Data Principles and best practices of scalable real-time data systems ,Nathan Marz and James Warren, 1st Edition, 2015, ISBN 9781617290343 |

| RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 4. | **LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. **THE FINAL MARKS WILL BE 50 MARKS** | **50** |
| | **MAXIMUM MARKS FOR THE CIE(THEORY+LAB)** | **150** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type of questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of THREE Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (LAB) | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| 1 | Write Up | 10 |
| 2 | Conduction of the Experiments | 20 |
| 3 | Viva | 20 |
| | **TOTAL** | **50** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **NATURAL LANGUAGE PROCESSING AND TRANSFORMERS**<br>**Category: Professional Core Course**<br>**(Theory and Practice)** | | | | | | |
| **Course Code** | **:** | **AI363IA** | | **CIE** | **:** | **100 + 50 Marks** |
| **Credits: L:T:P** | **:** | **3:0:1** | | **SEE** | **:** | **100 + 50 Marks** |
| **Total Hours** | **:** | **45T + 30L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **9 Hrs** |
|---|---|

**Introduction to NLP:** NLP in the Real-world, NLP Tasks, what is Language: Building Blocks of Language, Why NLP is Challenging, Machine Learning, Deep Learning, and NLP: An Overview, Approaches to NLP: Heuristic-based NLP, Machine Learning for NLP, Deep Learning for NLP, Why Deep Learning is not Yet the Silver Bullet for NLP, An NLP Walkthrough: Conversational Agents

**NLP Pipeline:** Data Acquisition, Text Extraction and Cleanup: HTML Parsing and Cleanup, Unicode Normalization, Spelling Correction, System-Specific Error Correction, Pre-Processing: Preliminaries, Frequent Steps, Other Pre-Processing Steps, Advanced Processing

| Unit II | **9 Hrs** |
|---|---|

**Tokenizing Text and WordNet Basics:** Introduction, Tokenizing text into sentences, Tokenizing sentences into words, Tokenizing sentences using regular expressions, training a sentence tokenizer, Filtering stop words in a tokenized sentence Looking up Synsets for a word in WordNet, looking up lemmas and synonyms in WordNet, Calculating WordNet Synset similarity, Discovering word collocations. Word similarity, Minimum Edit Distance algorithm.

**Replacing and Correcting Words:** Introduction, stemming words, Lemmatizing words with WordNet, replacing words matching regular expressions, removing repeating characters, Spelling correction with Enchant, replacing synonyms, Replacing negations with antonyms, word sense disambiguation, Feature-Based WSD, The Lesk Algorithm as WSD Baseline

| **Unit –III** | **9 Hrs** |
|---|---|

**Part-of-speech Tagging**: Pos Tagging approaches, The General Framework Rule-Based approaches, Transformation-Based learning, Modifications to TBL and Other Rule-Based Approaches, Markov Model Approaches, HMM-Based Taggers, Maximum Entropy Approaches, Taggers Based on ME Models, Default tagging, training a unigram part-of-speech tagger, combining taggers with backoff tagging, Training and combining n-gram taggers, creating a model of likely word tags, tagging with regular expressions, Affix tagging, training a Brill tagger, Training the TnT tagger, Using WordNet for tagging, tagging proper names, Classifier-based tagging, Training a tagger with NLTK-Trainer

| **Unit IV** | **9 Hrs** |
|---|---|

**Transformers Basics**

The Encoder-Decoder Framework, Attention Mechanisms, Transfer Learning in NLP, Hugging Face Transformers: Bridging the Gap, A Tour of Transformer Applications: Text Classification, Named Entity Recognition, Question Answering, Summarization, Translation, Text Generation, The Hugging Face Ecosystem: The Hugging Face Hub, Hugging Face Tokenizers, Hugging Face Datasets, Hugging Face Accelerate, Main Challenges with Transformers.

**Text Classification**

The Dataset: A First Look at Hugging Face Datasets, From Datasets to Data Frames, looking at the Class Distribution, How Long Are Our Tweets? From Text to Tokens: Character Tokenization, Word Tokenization, Sub-word Tokenization, Tokenizing the Whole Dataset, Training a Text Classifier: Transformers as Feature Extractors, Fine-Tuning Transformers

| Unit V | 9 Hrs |
|---|---|

**Transformer Anatomy**

The Transformer Architecture, The Encoder: Self-Attention, The Feed-Forward Layer, Adding Layer, Normalization, Positional Embeddings, adding a Classification Head, The Decoder, Meet the Transformers: The Transformer Tree of Life, The Encoder Branch, The Decoder Branch, The Encoder-Decoder Branch

**Text Generation**

The Challenge with Generating Coherent Text, Greedy Search Decoding, Beam Search Decoding, Sampling Methods, Top-k and Nucleus Sampling

**Summarization**

Text Summarization Pipelines, Summarization Baseline: GPT-2, T5, BART, PEGASUS

| **PART-A** | |
|---|---|
| • Implement the following application of Natural Language Processing<br>• Demonstrate the working of the programs by considering appropriate datasets | |
| 1 | **Text Summarization**: Text summarization refers to the technique of shortening long pieces of text. The intention is to create a coherent and fluent summary having only the main points outlined in the document. |
| 2 | **World Cloud**: A word cloud is a collection, or cluster, of words depicted in different sizes. The bigger and bolder the word appears, the more often it's mentioned within a given text and the more important it is. |
| 3 | **Sentiment Analysis**: Design a program(without using library functions) to perform Sentiment analysis that analyzes digital text to determine if the emotional tone of the message is positive, negative, or neutral using the following vectorization techniques:<br>• TF-IDF<br>• N-GRAMS<br>• Bag of words<br>• One-hot encoding |
| 4 | **Topic Modelling**: Topic modeling is an unsupervised machine learning approach that can scan a series of documents, find word and phrase patterns within them, and automatically cluster word groupings and related expressions that best represent the set. |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Apply various concepts, architectures, and frameworks of NLP to engineering problems |
| **CO2** | Demonstrate proficiency in utilizing the core and popular NLP libraries to provide solutions to real-world applications in Healthcare, Smart Cities, Agriculture, etc. |
| **CO3** | Design and Develop agents that use Transformers for natural language understanding and generation |
| **CO4** | Demonstrate the use of modern tools in solving day-to-day problems by exhibiting teamwork through oral presentations and reports |
| **CO5** | Collaborate in a group to build NLP solutions for the benefit of society |

| **Reference Books** | |
|---|---|
| **1** | Practical Natural Language Processing: A Comprehensive Guide to Building Real-World NLP Systems, Sowmya Vajjala, Bodhisattwa Majumder, Anuj Gupta & Harshit Surana ,1st Edition, 2020, O'Reilly, ISBN: 978-1-492-05405-4 |
| **2** | Python 3 Text Processing with NLTK 3 Cookbook, Jacob Perkins 2014, 1st Edition, Packt Publishing, ISBN 978-1-78216-785-3 |
| **3** | Natural Language Processing with Transformers: Building Language Applications with Hugging Fac,Lewis Tunstall, Leandro von Werra, and Thomas Wolf, 2022, 1st Edition, O'Reilly Media, ISBN: 978-1-098-10324-8 |
| **4** | Jurafsky, Dan., Martin, James H.Speech and Language Processing, 2nd Edition. United Kingdom: Pearson Prentice Hall, 2008. |

| | |
|---|---|
| **5** | Natural language processing, Eisenstein, Jacob, Online verfügbar unter https://princeton-nlp. github. io/cos484/readings/eisenstein-nlp-notes. pdf, zuletzt geprüft am 14 (2018): 2022. |

| **RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| 4. | **LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS | **50** |
| | **MAXIMUM MARKS FOR THE CIE(THEORY+LAB)** | **150** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type of questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of THREE Sub-divisions only) | |
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| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (LAB)** | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| 1 | Write Up | 10 |
| 2 | Conduction of the Experiments | 20 |
| 3 | Viva | 20 |
| | **TOTAL** | **50** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **CLOUD COMPUTING TECHNOLOGY & ARCHITECTURES**<br>**Category: Professional Core Course**<br>**(Theory))** | | | | | | |
| **Course Code** | **:** | **AI364TA** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T: P** | **:** | **03:01:00** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L+30T** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **8 Hrs.** |
|---|---|
| **Vision of Cloud Computing**: Defining a Cloud, Cloud Computing Reference Model, Characteristics and Benefits, Building Cloud Computing Environments<br>**Principles of Parallel and Distributed Computing** Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel Computing, Elements of Distributed Computing | |
| **Unit – II** | **8 Hrs.** |
| **Virtualization:** Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples, Xen, VMware, Microsoft Hyper-V<br>**Cloud Computing Architecture:** The cloud reference model, Types of clouds | |
| **Unit –III** | **8 Hrs.** |
| **Data-Intensive Computing:** What is data-intensive computing? Characterizing data-intensive computations, Challenges ahead, Historical perspective, Technologies for data-intensive computing – Storage systems, Programming platforms - Map Reduce.<br>**Public Cloud Infrastructures:** Amazon Web Services - Compute, Storage, and Communication Services; Google AppEngine – Architecture, Microsoft Azure-Architecture and Roles. | |
| **Unit –IV** | **10 Hrs.** |
| **Introduction to Multi-Cloud:** Introduction to Multi-Cloud, setting out a real strategy for multi-cloud, Analysing the enterprise strategy for the cloud, Introducing the scaffold for multi-cloud environments, Understanding identities and roles in the cloud.<br>**Enterprise Cloud Architecture:** Defining architecture principles for multi-cloud, using quality attributes in architecture, Defining principles from use cases-Business principles, Business principles, Principles for security and compliance, Data principles, Application principles, Infrastructure and technology principles, Principles for processes | |
| **Unit –V** | **9 Hrs.** |
| **Developing for Multi-Cloud with DevOps and DevSecOps,:** Introducing DevOps and CI/CD Getting started with CI/CD , Working under version control Using push and pull principles in CI Pushing the code directly to the main branch, Pushing code to forks of the main, Best practices for working with CI/CD. Using the DevSecOps Maturity Model, Manage traceability and auditability , Automating security best practices using frameworks<br>**Introducing AIOps and GreenOps in Multi-Cloud:** Understanding the concept of AIOps, Optimizing cloud environments using AIOps, Exploring AIOps tools for multi-cloud, Introducing GreenOps | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Explain the concepts of cloud computing, models, infrastructure, services, distributed computing, and other related concepts. |
| **CO2** | Apply the fundamental concepts in virtualization, virtualization cluster datacentres to understand the efficiency in PAAS, SAAS, IAAS |
| **CO3** | Illustrate the fundamental concepts of Multi-cloud storage and demonstrate their use in different use cases |
| **CO4** | Analyse various cloud programming models and apply them to solve problems on the cloud. |
| **CO5** | Demonstrate the use of modern tools by exhibiting teamwork and effective communication skills |

| **Reference Books** | |
|---|---|
| 1 | Mastering Cloud Computing Foundations and Applications Programming-Morgan Kaufmann (2013) Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi ISBN: 978-0-12-411454-8 |
| 2 | Jeroen Mulder ,Multi-Cloud Strategy for Cloud Architects_ Learn how to adopt and manage public clouds by leveraging BaseOps, FinOps, and DevSecOps,2nd Edition,2023,Packt Publishing (2023), ISBN 978-1-80461-673-4 |
| 3 | Distributed Computing and Cloud Computing, from parallel processing to internet of things ,Kai Hwang, GeofferyC.Fox, Jack J Dongarra ,1st Edition, 2012, Elsevier, ISBN: 978-0-12-385880-1. |
| 4 | Cloud Computing Implementation, Management and Security .John W Rittinghouse, James F Ransome,, 1st Edition, 2013, CRC Press, ISBN: 978-1-4398-0680-7. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| SEMESTER: VI | | | | | |
|---|---|---|---|---|---|
| **INFORMATION RETRIEVAL SYSTEMS**<br>**Category : Professional Core Elective-III**<br>**(Theory)** | | | | | |
| **Course Code** | **:** | **AI365TDA** | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | **SEE Duration** | **:** | **3.00 Hrs** |

| **Unit – I** | **09 Hrs** |
|---|---|
| **Introduction to information retrieval and architecture of a search engine-Search Engines and Information Retrieval-** What Is Information Retrieval? The Big Issues, Search Engines, Search Engineers<br>**Architecture of a Search Engine-** What is architecture? Basic Building Blocks, Breaking It Down | |
| **Unit – II** | **09 Hrs** |
| **Crawls and Feeds-** Deciding what to search, Crawling the Web, Crawling Documents and Email, Document Feeds, The Conversion Problem, Storing the Documents, Detecting Duplicates, Removing Noise<br>**Processing Text –** From words to text, Text Statistics, Document Parsing, Document Structure and Markup, Link Analysis, Information Extraction | |
| **Unit – III** | **09 Hrs** |
| **Ranking with Indexes -** Overview, Abstract Model of Ranking, Inverted indexes, Compression, Auxiliary Structures, Index Construction, Query Processing | |
| **Unit – IV** | **09 Hrs** |
| **Queries and Interfaces-** Information Needs and Queries, Query Transformation and Refinement, Showing the Results, Cross-Language Search | |
| **Unit – V** | **09 Hrs** |
| **Retrieval Models -** Overview of Retrieval Models , Probabilistic Models, Ranking Based on Language Models<br>**Evaluating Search Engines-** Why Evaluate? The Evaluation Corpus, Effectiveness Metrics, Efficiency Metrics | |

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

| | |
|---|---|
| **CO1** | Understand and apply Information Retrieval principles to extract relevant information from the given problem |
| **CO2** | Analyze the different Information Retrieval techniques, retrieval models and search engines appropriate for a given problem by engaging in lifelong learning for emerging technology |
| **CO3** | Exhibit effective communication to solve open problems using Information Retrieval principles to extract the information from different models |
| **CO4** | Demonstrate solutions using concepts of Information Retrieval by exhibiting team work and effective communication |
| **CO5** | Examine the applications of Information Retrieval principles using modern engineering tools for technological change |

**Reference Books**


| | |
|---|---|
| 1. | Search Engines: Information Retrieval in Practice Kindle ,Trevor Strohman, Bruce Croft Donald Metzler ,2015, Pearson Education Inc., ISBN-13: 978-0136072249 |
| 2. | Introduction to Information Retrieval,Christopher D. Manning, Prabhakar, Raghavan and Hinrich Schutze,", 2008, Cambridge University Press, ISBN 978-0-521-86571-5 |
| 3. | Information Retrieval Data Structures and Algorithms ,William B Frakes, Ricardo Baeza-Yates ,3rd Edition, 2009, Pearson Education, ISBN13: 9780134638379 |
| 4. | Information Storage & Retrieval ,Robert. R. Korfhage ,4th Edition, 1997, John Wiley & Sons, Inc. New York, NY, USA, ISBN:0-471-14338-3 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **HYBRID INTELLIGENCE AND LARGE LANGUAGE MODELS**<br>**Category: Professional Core Elective-III**<br>**(Theory)** | | | | | | |
| **Course Code** | : | **AI365TDB** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T: P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **8 Hrs.** |
|---|---|
| **Fundamentals of Hybrid Intelligent Systems and Agents**<br>Hybrid Intelligent Systems Are Essential for Solving Complex Problems, Hybrids Are Complex, Agent Perspectives Are Suitable for Hybrids, Motivation and Targets<br>**Basics of Hybrid Intelligent Systems**<br>Typical Intelligent Techniques, Advantages and Disadvantages of Typical Intelligent Techniques, Classification of Hybrid Intelligent Systems, Current Practice in Typical Hybrid Intelligent System Development | |
| **Unit – II** | **8 Hrs.** |
| **Basics of Agents and Multi-agent Systems**<br>Concepts of Agents and Multi-agent Systems, Agents as a Paradigm for Software Engineering, Agents and Object, Agents and Expert Systems, Approaches to Agentification, Approaches to Incorporating Intelligent Techniques into Agents, Agent-Based Hybrid Systems: State of the Art<br>**Methodology and Framework**<br>Traditional Methodologies, Gaia Methodology, Coordination-Oriented Methodology, Prometheus Methodology, Methodology for Analysis and Design of Agent-Based Hybrids | |
| **Unit –III** | **10 Hrs.** |
| **Agent-Based Hybrid Intelligent System for Financial Investment Planning**<br>Introduction to Some Models Integrated in the System, Analysis of the System, Design of the System, Architecture of the System, Implementation of the System, Case Study<br>**Agent-Based Hybrid Intelligent System for Data Mining**<br>Data Mining Requires Hybrid Solutions, Requirements of the Agent-Based Hybrid Systems for Data Mining, Analysis and Design of the System, Implementation of the System, Case Study. | |
| **Unit –IV** | **9 Hrs.** |
| **What Is Generative AI?**<br>Introducing generative AI, Understanding LLMs, text-to-image models, AI in other domains.<br>**Lang Chain for LLM Apps**<br>What is an LLM app? What is Lang Chain? Exploring key components of Lang Chain, How does Lang Chain work? Comparing Lang Chain with other frameworks | |
| **Unit –V** | **10 Hrs.** |
| **Building Capable Assistants**<br>Mitigating hallucinations through fact-checking, summarizing information, extracting information from documents, answering questions with tools, Exploring reasoning strategies.<br>**Building a Chabot like ChatGPT**<br>What is a chatbot? Understanding retrieval and vectors, Loading and retrieving in Lang Chain, Implementing a chatbot, Moderating responses. | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Understand, Recognize and Apply Agent and Multi-agent Concepts to solve engineering problems |
| **CO2** | Analyze Current Practices in Hybrid Intelligent System Development |
| **CO3** | Design sustainable solutions using Hybrid intelligence |
| **CO4** | Exhibit effective communication and engage in continuing professional development through experiential learning |

| | |
|---|---|
| **CO5** | Demonstrate skills like investigation, effective communication, working in team/Individual practices by implementing Database Design concepts and applications |

| **Reference Books** | |
|---|---|
| 1 | Agent-based Hybrid Intelligent Systems: An Agent-Based Framework for Complex Problem Solving, Zili Zhang, Chengqi Zhang, Springer, 2004, ISBN: 3-540-24623-1. |
| 2 | Generative AI with LangChain,: Build large language model (LLM) apps with Python, ChatGPT, and other LLMs, Ben Auffarth, Packt Publishing, 2023, ISBN 978-1-83508-346-8 |
| 3 | Exploring GPT-3: An unofficial first look at the general-purpose language processing API from OpenAI, Steve Tingiris, 1st Edition, Packt Publishing, 2021, ISBN: 978-1-80056-319-3 |
| 4 | Multi-Agent Programming: Languages, Tools and Applications, Rafael H. Bordini, Mehdi Dastani, Jurgen Dix, Amal El Fallah Seghrouchni, 1st Edition, Springer, 2009, ISBN 978-0-387-89299-3. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
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| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
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| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **NATURE INSPIRED COMPUTING**<br>**Category: Professional Core Elective-III**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **AI365TDC** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction:** From Nature to Nature Computing , Philosophy , Three Branches: A Brief Overview, Individuals, Entities and agents - Parallelism and Distributivity Interactivity ,Adaptation- Feedback-Self-Organization-Complexity, Emergence and ,Bottom-up Vs Top-Down- Determination, Chaos and Fractals. Artificial Life Background and history of Artificial Life research, Self-organizing systems, Artificial Chemistry | |
| **Unit – II** | **09 Hrs** |
| **Computing Inspired by Nature:** Evolutionary Computing, Hill Climbing and Simulated Annealing, Darwin's Dangerous Idea, Genetics Principles, Standard Evolutionary Algorithm -Genetic Algorithms , Reproduction-Crossover, Mutation, Evolutionary Programming, Genetic Programming | |
| **Unit –III** | **09 Hrs** |
| **Swarm Intelligence:** Introduction - Ant Colonies, Ant Foraging Behavior, Ant Colony Optimization, SACO and scope of ACO algorithms, Ant Colony Algorithm (ACA), Swarm Robotics, Foraging for food, Social Adaptation of Knowledge , Particle Swarm Optimization (PSO) | |
| **Unit –IV** | **09 Hrs** |
| **Immuno computing:** Introduction- Immune System, Physiology and main components, Pattern Recognition and Binding , Immune Network Theory- Danger Theory, Evaluation Interaction- Immune Algorithms , Introduction – Bone Marrow Models , Forest's Algorithm, Artificial Immune Networks | |
| **Unit –V** | **09 Hrs** |
| **Computing With New Natural Materials:** DNA Computing: Motivation, DNA Molecule , Adleman's experiment , Test tube programming language, Universal DNA Computers , PAM Model , Splicing Systems , Lipton's Solution to SAT Problem , Scope of DNA Computing , From Classical to DNA Computing | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Understand the strengths, weaknesses, and appropriateness of nature-inspired algorithms. |
| **CO2** | Apply nature-inspired algorithms to design and solve problems in various areas of computing, such as optimization and machine learning. |
| **CO3** | Identify the role of swarm intelligence, immuno-computing techniques and DNA Computing in solving industrial problems. |
| **CO4** | Exhibit teamwork and professional communication by developing nature-inspired computing solutions. |
| **CO5** | Use modern tools for implementing nature-inspired computing solutions. |

| **Reference Books** | |
|---|---|
| 1. | Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications,Leandro Nunes de Castro, , Chapman & Hall/ CRC, Taylor and Francis Group |
| 2. | Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies ,Floreano D. and Mattiussi C., , MIT Press, Cambridge, MA, 2008. |
| 3. | Handbook of Nature-Inspired and Innovative Computing,Albert Y.Zomaya, Springer, 2006. |
| 4. | Ant Colony Optimization ,Marco Dorrigo, Thomas Stutzle, PHI,2005 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
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| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **GENERATIVE ARTIFICIAL INTELLIGENCE**<br>**Category: Professional Core Elective-III**<br>**(Common to AI,CS,IS,CD)**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **AI365TDD** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T: P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **9Hrs** |
|---|---|
| **Introduction to Generative** Deep Learning, Generative Modeling What Is Generative Modeling? Historical perspective on Generative AI, Generative Versus Discriminative Modeling, Introduction to Large Language Models (LLMs), Applications of Large Language Models, Limitations and Risks of Large Language Models | |
| **Unit – II** | **9Hrs** |
| **Variational Autoencoders** Introduction, Autoencoders, The Autoencoder Architecture The Encoder, The Decoder, Joining the Encoder to the Decoder, Analysis of the Autoencoder<br>**Building a Variational Autoencoder** The Encoder The Loss Function Analysis of the Variational Autoencoder Using VAEs to Generate Faces, Training the VAE, Analysis of the VAE, Generating New Faces, Latent Space Arithmetic, Morphing Between Faces | |
| **Unit –III** | **9Hrs** |
| **Generative Adversarial Networks** Introduction to GAN (GAN), The Discriminator, TheGenerator<br>**Cycle GAN** Overview, The Generators (U-Net) The Discriminators Compiling the Cycle GAN Training the Cycle GAN Analysis of the Cycle GAN Creating a Cycle GAN to Paint Like Monet the Generators (ResNet) Analysis of the Cycle GAN.<br>**Neural Style Transfer** Content Loss Style Loss Total Variance Loss Running the Neural Style Transfer Analysis of the Neural Style Transfer Model | |
| **Unit -IV** | **9Hrs** |
| **Diffusion Models** Introduction Denoising Diffusion Models (DDM), The Flowers Dataset, The Forward Diffusion Process, The Reparameterization Trick, Diffusion Schedules, the Reverse Diffusion Process.<br>**Energy-Based Models** Introduction Energy-Based Models, The MNIST Dataset, The Energy Function Sampling, Using Langevin Dynamics | |
| **Unit -V** | **9Hrs** |
| **Bias and Fairness in Generative AI**: Understanding Bias in AI Types of biases (algorithmic, data, societal) Fairness Metrics Statistical parity, equal opportunity, disparate impact Mitigation Strategies Pre-processing, in-processing, and post-processing techniques<br>**Ethical Design and Deployment of Generative** AI Ethical AI Design Principles Human-centered design, ethical by design Deployment Challenges Real-world implementation, monitoring, and feedback loops Responsible AI Frameworks Guidelines and best practices for ethical deployment | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1** | Apply the concepts and principles of Generative Artificial Intelligence to engineering requirements. |
| **CO2** | Design and demonstrate proficiency in implementing and training various generative AI models using modern tools. |
| **CO3** | Investigate the need for Generative AI techniques to solve real-world problems in diverse domains. |
| **CO4** | Explore advanced topics and research directions in Generative AI and critically evaluate their potential applications. |
| **CO5** | Equip students with the knowledge to identify and address ethical issues in Generative AI, focusing on fairness, accountability, transparency, and human rights. |

| **Reference Books** | |
|---|---|
| 1 | "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play" by David Foster,2nd Edition, 2023. ISBN: 978-1492041948. Publisher: O'Reilly Media. |
| 2 | 'Deep Learning" by Ian Good fellow, Yoshua Bengio, and Aaron Courville.2nd Edition 2016, ISBN: 978-0262035613. Publisher: MIT Press. |
| 3 | "Fairness and Machine Learning: Limitations and Opportunities"; Author(s) Solon Barocas, Moritz Hardt, Arvind Narayanan, 2023, ISBN-10/ASIN: 0262048612, Publisher: MIT Press |
| 4 | "Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way" by Virginia Dignum , 1st Edition, 2021,ISBN 9783030303716, Publisher: MIT Press |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
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| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
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| **Q. NO.** | **CONTENTS** | **MARKS** |
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| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **FUNDAMENTALS OF AEROSPACE ENGINEERING**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **AS266TEA** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Basics of Flight Vehicles:** History of aviation, International Standard atmosphere (ISA), Temperature, pressure and altitude relationships, Simple Problems on Standard Atmospheric Properties, Classification of aircrafts, Anatomy of an aircraft & Helicopters, Basic components and their functions. | |
| **Unit – II** | **10 Hrs** |
| **Aircraft Aerodynamics:** Bernoulli's theorem, Centre of Pressure, Lift and Drag, Types of Drag, Aerodynamic Coefficients, Aerodynamic Centre, Wing Planform Geometry, Airfoil Nomenclature, Basic Aerodynamic characteristics of Airfoil, Simple Numericals on Lift and Drag. | |
| **Unit –III** | **12 Hrs** |
| **Aerospace Propulsion:** Introduction, Turbine Engines: Brayton Cycle, Operation of Turbojet, Turboprop, Turbofan, Turboshaft, RAMJET and SCRAMJET Engines, Rocket Engines: Principles of operation of Solid, Liquid, Hybrid, Nuclear and Electric Rockets.<br>**Introduction to Space Mechanics:** Basic Orbital Mechanics-Types of Trajectories, Escape and Orbital Velocities, Kepler's Laws of Planetary Motion, Simple Numericals. | |
| **Unit –IV** | **06 Hrs** |
| **Aerospace Structures and Materials:** General types of construction-Monocoque, Semi-Monocoque & Geodesic, Structure of Wing and Fuselage, Metallic and Composite Materials. | |
| **Unit –V** | **08 Hrs** |
| **Aircraft Systems & Instruments:** Instrument Displays, Basic Air data systems & Pitot Probes- Mach meter, Air speed indicator, Vertical speed indicator, Altimeter.<br>**Basics of Aircraft Systems:** Hydraulic and pneumatic systems, Electrical System, Aircraft Fuel System, Environmental Control System. | |

| **Course Outcomes:** At the end of this course the student will be able to | |
|---|---|
| **CO1** | Identify the fundamental nuances of Aerospace Engineering and appreciate their significance on the Flight Vehicles design and performance |
| **CO2** | Interpret the design parameters that influence the design of the Aerospace Vehicles systems and its sub-systems |
| **CO3** | Evaluate critically the design strategy involved in the development of Aerospace vehicles |
| **CO4** | Categorically appraise the operation of the Aerospace Vehicles for different operating conditions |

| **Reference Books** | |
|---|---|
| **1** | Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059. |
| **2** | Fundamentals of Aerodynamics, Anderson J .D, 5th Edition, 2011, McGraw-Hill International Edition, New York ISBN:9780073398105. |
| **3** | Rocket Propulsion Elements, Sutton G.P., 8th Edition, 2011, John Wiley, New York, ISBN: 1118174208, 9781118174203. |
| **4** | Aircraft structural Analysis, T.H.G Megson, 2010, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4 |
| **5** | Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks adding up to 20 Marks. **THE SUM OF TWO QUIZZES WILL BE CONSIDERED AS FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test consisting of descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO TESTS** will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. **Phase I (20) & Phase II (20) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |
| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
| **Q. NO** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | **20** |
| | **PART B**<br>(Maximum of THREE Sub-divisions only) | |
| 2 | Unit 1: (Compulsory) | **16** |
| 3 & 4 | Unit 2: Question 3 or 4 | **16** |
| 5 & 6 | Unit 3: Question 5 or 6 | **16** |
| 7 & 8 | Unit 4: Question 7 or 8 | **16** |
| 9 & 10 | Unit 5: Question 9 or 10 | **16** |
| | **TOTAL** | **100** |

| Semester: VI | | | | | |
|---|---|---|---|---|---|
| **BIOINFORMATICS**<br>**Category: Institutional Electives -I**<br>**(Theory)** | | | | | |
| **Course Code** | **:** | **BT266TEB** | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 Hrs** | **SEE Duration** | **:** | **3.00 Hours** |
| **Unit-I** | | | | | **09 Hrs** |
| **Introduction to tools and databases:** Introduction to Bioinformatics, Goals, Scope, Applications, Sequence databases, Structure databases, Special databases – genome and microarray, Applications of these databases, examples, Database similarity search: Unique requirements of database searching, Heuristic Database Searching, Basic Local Alignment Search Tool (BLAST), FASTA, Comparison of FASTA and BLAST, Database Searching with Smith-Waterman Method | | | | | |
| **Unit – II** | | | | | **09 Hrs** |
| **Sequence Analysis:** Types of Sequence alignment -Pairwise and Multiple sequence alignment, Alignment algorithms, Scoring matrices, Statistical significance of sequence alignment. Multiple Sequence Alignment: Scoring function, Exhaustive algorithms, Heuristic algorithms, Profiles and Hidden Markov Models: Position-Specific scoring matrices, Profiles, Markov Model and Hidden Markov Model, Scoring matrices – BLOSSUM and PAM<br>**Molecular Phylogenetics:** Introduction, Terminology, Forms of Tree Representation. Phylogenetic Tree Construction Methods - Distance-Based, Character-Based Methods and Phylogenetic Tree evaluation. | | | | | |
| **Unit –III** | | | | | **09 Hrs** |
| **Introduction to Next-Generation Sequencing (NGS) analysis**: Sanger sequencing principles - history and landmarks, of Sequencing Technology Platforms, A survey of next-generation sequencing technologies, A review of DNA enrichment technologies, Base calling algorithms, Base quality, phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads, automation in NGS analysis and advantages (shell scripting) | | | | | |
| **Unit –IV** | | | | | **09 Hrs** |
| **Structural analysis & Systems Biology:** Gene prediction programs – ab initio and homology-based approaches. ORFs for gene prediction. Detection of functional sites and codon bias in the DNA. Predicting RNA secondary structure, Protein structure basics, structure visualization, comparison and classification. Protein structure predictive methods using protein sequence, Protein identity based on composition. Structure prediction - Prediction of secondary structure, tertiary structure prediction methods, Scope, Applications. Concepts, implementation of systems biology, Mass spectrometry and Systems biology, Flux Balance analysis. | | | | | |
| **Unit –V** | | | | | **09 Hrs** |
| **Drug Screening:** Introduction to Computer-aided drug discovery, target selection, ligand preparation and enumeration, molecular docking, post-docking processing, molecular dynamics simulations, applications and test cases, AI/ML in Drug discovery | | | | | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Gain proficiency in utilizing a range of bioinformatics tools and databases for comprehensive sequence and structural analysis. |
| **CO2** | Investigate and apply innovative sequencing technologies and analytical methods to solve complex biological questions and advance research in genomics and molecular biology. |
| **CO3** | Demonstrate expertise in NGS technologies, including performing data quality assessments, read processing, and managing large-scale data. |
| **CO4** | Apply bioinformatics tools for modeling and simulating biological processes, with a focus on gene prediction using both ab initio and homology-based approaches. |

| **Reference Books** | |
|---|---|
| 1. | Xiong J. Essential bioinformatics. Cambridge University Press; 2006 Mar 13. |
| 2. | Buehler LK, Rashidi HH, editors. Bioinformatics basics: applications in biological science and medicine. CRC Press; 2005 Jun 23. |
| 3. | Ghosh Z, Mallick BM. Bioinformatics principles and Applications. Oxford University Press; 2018 Jun 13. |
| 4. | Low L, Tammi MT. Introduction to next generation sequencing technologies. Bioinformatics. WORLD SCIENTIFIC. 2017 Jul 26:1-21. |
| 5. | Bioinformatics: Sequence and Genome Analysis; D W Mount; 2014; CSHL Press; 2nd edn; ISBN: 9780879697129. |
| 6. | Computational Systems Biology; A Kriete and R Eils; 2006; Academic Press; Illustrated edn; ISBN: 978-01-208-87866. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| **Semester: VI** | | | | | |
|---|---|---|---|---|---|
| **INDUSTRIAL SAFETY ENGINEERING**<br>**Category: Institutional Elective**<br>**(Theory)** | | | | | |
| **Course Code** | **:** | **CH266TEC** | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **40L** | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **08 Hrs** |
|---|---|
| **Introduction Safety:**<br>Introduction to industrial safety engineering, major industrial accidents, safety and health issues, key concepts and terminologies, Hazard theory, Hazard triangle, Hazard actuation, Actuation transition, Causal factors, problems on OSHA | |
| **Unit – II** | **08 Hrs** |
| **Risk assessment and control:** Risk assessment, Risk perception, acceptable risk, problems on net present value, internal rate of return, payback period concepts including real life examples.<br>**Hazard Identification Methods:** Preliminary Hazard List (PHL), worksheets, case study. Preliminary Hazard Analysis (PHA), Fault tree and Event tree analysis. Design and development of fault tree and event tree for high pressure reactor system. | |
| **Unit –III** | **08 Hrs** |
| **Hazard analysis:** Hazard and Operability Study (HAZOP): Guide words, HAZOP matrix, Procedure, HAZOP studies on reactors, heat exchanger, design of HAZOP table, Failure Modes and Effects Analysis (FMEA) concept, methodology, problems of FMEA, examples. | |
| **Unit –IV** | **08 Hrs** |
| **Risk analysis on capital budgeting:** Risk adjusted discount rate (RADAR) method, certainty equivalent approach, scenario analysis, probability distribution, quantification of risk using statistical parameters and associated problems. | |
| **Unit –V** | **08 Hrs** |
| **Safety in process industries and case studies: Personnel Protection Equipment (PPE):** Safety glasses, face shields, welding helmets, absorptive lenses, hard hats, types of hand PPE, types of foot PPE, types of body PPE. Bhopal gas tragedy, Chernobyl nuclear disaster, Chemical plant explosion and fire. | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Understand the risk assessment techniques used in process industry |
| **CO2** | Interpret the various risk assessment tools. |
| **CO3** | Use hazard identification tools for safety management. |
| **CO4** | Analyze tools and safety procedures for protection in process industries. |

| **Reference Books** | |
|---|---|
| 1. | Functional Safety in the Process Industry: A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84, Kirkcaldy K.J.D Chauhan, 2012, North corolina,Lulu publication, ISBN:1291187235. |
| 2. | Safety Instrumented Systems Verification Practical probabilistic calculations, Goble and William M., 2005, Pensulvania ISA publication, ISBN:155617909X. |
| 3. | Industrial safety and risk Management, Laird Wilson and Doug Mc Cutche, 1st Edition, 2003,The University of alberta press,Canada, ISBN: 0888643942. |
| 4. | ndustrial Safety, Health and Environment Management Systems, R K Jain, Sunil S Rao, 4th Edition, 2005, Khanna Publishers, New Delhi, ISBN: 8174092102. |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **ROBOTOC PROCESS AUTOMATION**<br>**Category : Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **CS266TED** | | **CIE** | **:** | **100** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100** |
| **Total Duration** | **:** | **36L** | | **SEE Duration** | **:** | **3.00 Hrs** |

| **Unit – I** | **8 Hrs** |
|---|---|
| **RPA Concepts**: RPA Basics, History of Automation, what is RPA? RPA vs Automation, Processes & Flowcharts, Programming Constructs in RPA, What Processes can be Automated? Types of Bots, Workloads that can be automated.<br>**RPA Advanced Concepts**: Standardization of processes, Setting up the Centre of Excellence, RPA Development methodologies, Difference from SDLC, RPA journey, RPA business case, RPA Team, Process Design Document/Solution Design Document, Industries best suited for RPA, Risks & Challenges with RPA, RPA and emerging ecosystem. | |
| **Unit – II** | **7 Hrs** |
| **RPA Tool Introduction:** Introduction to UiPath - the User Interface, Types of Variables, Variables in UiPath, Managing Arguments, The Arguments Panel, Namespaces; Control flow statements in UiPath, Sequences and Flowcharts, Control Flow Activities<br>Data Manipulation Introduction, Data Manipulation Operations, Types of data storing variables, Text Manipulation, main string methods.<br>**UiPath Recording:** Basic, Desktop and Web Recording, Image and Native Citrix Recording, Input/output methods, Types of OCR, Data Scraping, Advanced Scraping techniques. | |
| **Unit – III** | **7 Hrs** |
| **Advanced Automation Concepts:** Selectors, Types of Selectors (Full, partial, dynamic), Defining and Assessing Selectors, Customization, Debugging.<br>Image, Text & Advanced Citrix Automation – Introduction, Keyboard based automation, Information Retrieval, Best Practices<br>Excel Data Tables & PDF, Data Tables in RPA, Excel and Data Table, Extracting Data from Data Table, Anchors, Using anchors in PDF | |
| **Unit – IV** | **7 Hrs** |
| **Email Automation, Exceptions and Deploying Bots:** Introduction to Email Automation, Key concepts of email, email protocols, email automation in UiPath, email as input and output.<br>Debugging and Exception Handling, Types of exception, Debugging Tools, Strategies for solving issues, Catching errors.<br>Overview of orchestration Server, orchestrator functionalities, Connecting Bot to orchestrator | |
| **Unit – V** | **7 Hrs** |
| **Hyperautomation**: Components and application of Hyperautomation, Automation versus hyperautomation, Benefits and challenges of hyperautomation, use cases, Phases (Integration, Discover, Orchestration and Governance), Trends in Hyperautomation (low-code/no-code platform, HaaS) | |

| | **Course Outcomes: After completing the course, the students will be able to** |
|---|---|
| **CO1** | Understand RPA principles, its features and applications |
| **CO2** | Demonstrate proficiency in handling variables and decision making inside a workflow and data manipulation techniques |
| **CO3** | Gain insights into recording, Email Automation and exception handling and orchestrator. |
| **CO4** | Analyze the trends in automation and chose business strategy to design a real-world automation workflow. |

| **Reference Books:** | |
|---|---|
| **1.** | Alok Mani Tripathi, "Learning Robotic Process Automation, Publisher: Packt Publishing, Release Date: March 2018 ISBN: 9781788470940 |
| **2.** | PASCAL BORNET, Intelligent automation: Welcome to the world of hyperautomation, World Scientific Publishing Company, ISBN-13: 978-9811235481<br>December 2020 |
| **3.** | UiPath pdf manuals |
| **4.** | https://www.uipath.com/rpa/robotic-process-automation |
| **5.** | https://www.ibm.com/topics/hyperautomation |
| **6.** | https://www.pega.com/hyperautomation |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **INTELLIGENT TRANSPORTATION SYSTEMS**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **CV266TEE** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **40L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **08 Hrs** |
|---|---|
| **Introduction to Intelligent Transportation Systems (ITS):** Historical background, Urbanisation, Motorisation, Transport system characteristics, Transport problems and issues, Challenges and opportunities in ITS: ITS-Today and tomorrow, ITS training and education needs, Role and importance of ITS in context of Indian Transport system and opportunity for sector growth of ITS. | |
| **Unit – II** | **08 Hrs** |
| **ITS Architecture**: introduction, Functionalities required for User service, Logical architecture, Physical architecture, Equipment and Market packages, Need of ITS Architecture to solve problems in Urban area.<br>Technology building blocks for ITS: Introduction, Data acquisition, Communication tools, Data analysis and Traveller information. Various detection, Identification and collection methods for ITS. | |
| **Unit –III** | **08 Hrs** |
| **Traffic management system components and ITS**: Introduction, objectives, traffic management measures, ITS for traffic management, Development of traffic management system, Traffic Management Centre, Advance Traffic Management System, Advanced Traveller Information System, Advance Vehicle Control Systems, Advance Public Transport System, Commercial Vehicle Operations, ITS For Intermodal Freight Transport. | |
| **Unit –IV** | **08 Hrs** |
| **ITS Evaluation** – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines. ITS for Law Enforcement: Introduction, Enhance and support the enforcement traffic rules and regulations, ITS Funding options. | |
| **Unit –V** | **08 Hrs** |
| ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing. ITS for smart cities and Case studies. | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Identify and apply ITS applications at different levels |
| **CO2** | Illustrate ITS architecture for planning process |
| **CO3** | Examine the significance of ITS for various levels |
| **CO4** | Compose the importance of ITS in implementations |

| **Reference Books** | |
|---|---|
| 1. | Pradip Kumar Sarkar and Amit Kumar Jain, "Intelligent Transport Systems", PHI Learning Private Limited, Delhi,2018, ISBN-9789387472068 |
| 2. | Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House publishers (31 March 2003); ISBN-10: 1580531601 |
| 3. | Bob Williams, "Intelligent transportation systems standards", Artech House, London, 2008. ISBN-13: 978-1-59693-291-3 |
| 4. | Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola "Intelligent Transport Systems: Technologies and Applications" Wiley Publishing ©2015, ISBN:1118894782 9781118894781, |
| 5 | R.P Roess, E.S. Prassas, W.R. McShane. Traffic Engineering, Pearson Educational International, Third Edition, 2004, ISBN-13: 978-0-13-459971-7. |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| **Semester: VI** | | | | | | |
|---|---|---|---|---|---|---|
| **INTEGRATED HEALTH MONITORING OF STRUCTURES**<br>**Category: Institutional Electives - I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **CV266TEF** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **42L** | | **SEE Duration** | **:** | **3Hours** |

| **Unit-I** | **08 Hrs** |
|---|---|
| **Structural Health**: Factors affecting Health of Structures, Causes of Distress, Regular Maintenance, Importance of maintenance<br>**Structural Health Monitoring**: Concepts, Various Measures, Analysis of behavior of structures using remote structural health monitoring, Structural Safety in Alteration. | |
| **Unit – II** | **08 Hrs** |
| **Materials:** Piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique, Sensor technologies used in SHM<br>**Structural Audit**: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures, SHM using Artificial Intelligence | |
| **Unit –III** | **08 Hrs** |
| **Static Field Testing:** Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement. | |
| **Unit –IV** | **08 Hrs** |
| **Dynamic Field Testing:** Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring. | |
| **Unit –V** | **08 Hrs** |
| **Remote Structural Health Monitoring**: Introduction, Hardware for Remote Data Acquisition Systems, Advantages, Case studies on conventional and Remote structural health monitoring<br>**Case studies:** Structural Health Monitoring of Bridges, Buildings, Dams, Applications of SHM in offshore Structures- Methods used for non-destructive evaluation (NDE) and health monitoring of structural components | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Diagnose the distress in the structure understanding the causes and factors. |
| **CO2** | Understand safety aspects, components and materials used in Structural Health Monitoring. |
| **CO3** | Assess the health of structure using static field methods and dynamic field tests. |
| **CO4** | Analyse behavior of structures using remote structural health monitoring |

| **Reference Books** | |
|---|---|
| 1 | Structural Health Monitoring, Daniel Balageas, Claus Peter Fritzen, Alfredo Güemes,2006, John Wiley and Sons, ISBN: 978-1905209019 |
| 2 | Health Monitoring of Structural Materials and Components Methods with Applications, Douglas E Adams, 2007,John Wiley and Sons, ISBN:9780470033135 |
| 3 | Structural Health Monitoring and Intelligent Infrastructure, J. P. Ou, H. Li and Z. D. Duan, Vol1,2006,Taylor and Francis Group, London, UK. ISBN: 978-0415396523 |
| 4 | Structural Health Monitoring with Wafer Active Sensors, Victor Giurglutiu, 2007,Academic Press Inc, ISBN: 9780128101612 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **ADVANCED ENERGY STORAGE FOR E-MOBILITY**<br>**Category: Institutional Electives - I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **CM266TEG** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **42L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **07 Hrs** |
|---|---|
| **Energy storage in electric vehicles**<br>Introduction to E-mobility, background of alternative energy sources and sustainability. Types of electric vehicles and their salient features along with their energy requirement. Fundamentals of advanced battery technology. Battery characteristics. Specification of advanced battery for e mobility. | |
| **Unit – II** | **08 Hrs** |
| **Advanced lithium-ion batteries**<br>Basic concepts of lithium batteries. Types of advanced cathode and anode materials employed in lithium batteries. Construction, working and future applications of lithium cobalt oxide, lithium iron phosphate, Lithium air, lithium sulfur and lithium polymer batteries with their advancement in vehicle electrification. | |
| **Unit –III** | **09 Hrs** |
| **Non lithium batteries for e mobility**<br>Limitations of lithium batteries. Overview of non-lithium battery technology. Construction and working of advanced non-Lithium batteries such as Lead acid, Nickel Metal Hydride, Redox flow, Zebra, Sodium and Magnesium batteries. Electrode materials and electrolyte considerations in non lithium batteries. Performance comparison with lithium-ion batteries. Battery requirement in charging infrastructure. | |
| **Unit –IV** | **09 Hrs** |
| **Chemistry of alternative storage devices**<br>Introduction to super capacitor. Construction, working and applications of supercapacitors along with the materials used in electrodes. Types of advanced supercapacitors. Application of supercapacitors in regenerative braking. Advancement in battery-supercapacitor hybrid, Battery-fuel cell hybrid, and Battery-solar cell hybrid electric vehicles with their advantages and limitations. | |
| **Unit –V** | **09 Hrs** |
| **Battery management and recycling:**<br>Battery management systems (BMS): Fundamentals of battery management systems and controls, State-of-charge (SoC), state-of-health (SoH) and Cell balancing techniques.<br>Battery Thermal Management: Passive and active cooling systems. Safety mechanisms, thermal runaway and thermal management.<br>Battery recycling: Economic aspects, environmental safety and process of recycling of advanced batteries. | |

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

| | |
|---|---|
| **CO1** | Implement the fundamentals of chemistry in advanced energy storage and conversion devices. |
| **CO2** | Apply the chemistry knowledge used for hybridization of various energy storage and conversion devices. |
| **CO3** | Analyze the different battery system for achieving maximum energy storage for vehicle electrification |
| **CO4** | Evaluation of efficiency of a battery with respect to cost, environmental safety, material, energy consumption and recycling. |

| **Reference Books** | |
|---|---|
| 1 | Battery reference book, T. R. Crompton., 3rd edition, NEWNES Reed Educational and Professional Publishing Ltd 2000, ISBN: 07506 4625 X. |
| 2 | Batteries for Electric Vehicles, D. A. J. Rand, R. Woods, and R. M. Dell, Society of Automotive Engineers, Warrendale PA, 2003. ISBN 10: 0768001277. |
| 3 | Lithium Batteries, Science and Technology, GA. Nazri and G. Pistoa, Kluwer Academic Publisher, 2003, ISBN 978-0-387-92675-9. |
| 4 | Battery Technology Handbook, H. A. Kiehne, Marcel Dekker, NYC, 2003. ISBN: 0824742494 9780824742492. |
| 5 | Electric Vehicle Technology Explained, James Larminie and John Lowry. 2nd Edition, Wiley, ISBN-13: 978-1118505429. |
| 6 | Electric Vehicle Technology and Design, Antoni Gandia. CRC Press, ISBN-13: 978-1138551912. |
| 7 | Sustainable Transportation: Problems and Solutions. William R. Black, The Guilford Press, ISBN-13: 978-1462532072. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **HUMAN MACHINE INTERFACE**<br>**Category- Institutional Elective – I**<br>**Industry Assisted Elective-BOSCH** | | | | | | |
| **Course Code** | **:** | **EC266TEH** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **03 Hrs** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Foundations of HMI:** The Human: History of User Interface Designing, I/O channels, Hardware, Software and Operating environments, The Psychopathology of everyday Things, Psychology of everyday actions, Reasoning and problem solving. The computer: Devices, Memory, Processing and networks. Interaction: Models, frameworks, Ergonomics, styles, elements, interactivity, Paradigms.<br>**Introduction to HMI and Domains**: Automotive, Industrial, CE, Medical, ECUs within car and their functionalities. Interaction between ECUs. Communication protocols for ECUs(CAN, LIN, Most, FlexRay, Ethernet etc) | |
| **Unit – II** | **09 Hrs** |
| **Automotive Human-Machine Interfaces:** Automotive infotainment system - Evolution road map, Feature sets, System architecture, Trends, Human factors and ergonomics in automotive design, Automotive User Experience (UX) Design Principles, In-Vehicle Information Systems (IVIS), Driver-Assistance Systems (DAS) Interfaces, HMI design for adaptive cruise control, Voice and Gesture Recognition in Automotive HMIs, Touchscreen Interfaces and Controls, Usability Testing and Evaluation in Automotive HMIs, Safety Considerations and Regulations in Automotive HMIs, Emerging Technologies in Automotive HMIs, Human-Machine Interfaces for Autonomous Vehicles | |
| **Unit –III** | **09 Hrs** |
| **UX and Guidelines:** Introduction to UX design - stages, theory, Design thinking, UX Study, Interaction concepts, Graphic design tools - Adobe Photoshop, Adobe XD, Blender, GIMP, Asset Design - Overview, Guidelines and norms, 2D/3D rendering, OpenGL, OSG. | |
| **Unit –IV** | **09 Hrs** |
| **HMI User Interface**: User-centered HMI development process,Basics of Web-Server.Web-based HMI: Basics of TwinCAT and HTML, CSS, JavaScript.<br>**HMI on Mobile**: Four Principles of Mobile UI Design, Benefits of Mobile HMIs, Mobile HMI Development Suites. | |
| **Unit –V** | **09 Hrs** |
| **HMI Control Systems**: Introduction to Voice-Based HMI, Gesture-Based HMI, Sensor-Based UI controls.<br>**Haptics in Automotive HMI**: Kinesthetic Feedback Systems, Tactile Feedback Systems, Haptics in Multimodal HMI, Automotive Use-Cases<br>**HMI Testing**: Limitations of Traditional Test Solutions, Case - Study: Bosch's HMI validation tool - Graphics Test Systems (GTS).<br>**UI analytics**: Usage patterns, Debugging, Performance Profiling, Use Cases. | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Understanding the application of HMIs in various domain. |
| **CO2** | Comparison of various communication protocols used in HMI development. |
| **CO3** | Apply and analyse the car multimedia system free software and hardware evolution. |
| **CO4** | Design and evaluate the graphic tools and advanced techniques for creating car dashboard multimedia systems. |

| **Reference Books** | |
|---|---|
| 1. | Touch based HMI; Principles and Applications, Shuo gao, Shuo Yan, Hang Zhao, Arokia Nathan, Springer Nature Switzerland AG, 1st Edition. |
| 2. | Unity 2020 by Example: A Project based guide to building 2D, 3D augmented reality and Virtual reality games from sratch, Robert Wells, Packt Publishing ltd, 2020. |
| 3. | GUI Design and Android Apps, Ryan Cohen, Tao Wang, Apress, Berkley, CA,2014. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1: (Compulsory) | 16 |
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| 5 & 6 | Unit 3: Question 5 or 6 | 16 |
| 7 & 8 | Unit 4: Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **ENERGY AUDITING & STANDARDS**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **EE266TEJ** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 L** | | **SEE Duration** | **:** | **3Hours** |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Types of Energy Audit and Energy-Audit Methodology:** Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.<br>**Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data Acquisition System,<br>**Energy Audit of a Power Plant:** Indian Power Plant Scenario, Benefit of Audit, Types of Power Plants, Energy Audit of Power Plant. | |
| **Unit – II** | **10 Hrs** |
| **Electrical-Load Management:** Electrical Basics, Electrical Load Management, VariableFrequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses.<br>**Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling.<br>**Energy Audit of Pumps, Blowers and Cooling Towers:** Pumps, Fans and Blowers, Cooling Towers | |
| **Unit –III** | **09 Hrs** |
| **Communication & Standards:**<br>**Wireless technologies:** WPANs, LAN, Wireless metropolitan area network, cellular network, satellite communication, Zigbee, Bluetooth, LAN, NAN<br>**Wireline communication:** Phone line technology, powerline technology, coaxial cable technology; Optical communication, TCP/IP networks | |
| **Unit –IV** | **09 Hrs** |
| **Energy Audit of Boilers:** Classification of Boilers, Parts of Boiler, Efficiency of a Boiler, Role of excess Air in Boiler Efficiency, Energy Saving Methods.<br>**Energy Audit of Furnaces:** Parts of a Furnace, classification of Furnaces, Energy saving Measures in Furnaces, Furnace Efficiency<br>**Energy Audit of Steam-Distribution Systems :** S team as Heating Fluid, Steam Basics, Requirement of Steam, Pressure, Piping, Losses in Steam Distribution Systems, Energy Conservation Methods | |
| **Unit-V** | **09 Hrs** |
| **Energy Audit of Lighting Systems:** Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities.<br>**Energy Audit Applied to Buildings:** Energy – Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy – Savings Tips Applicable to New as well as Existing Buildings. | |

| **Course Outcomes: After completing the course, the students will be able to: -** | |
|---|---|
| **CO 1** | Explain the need for energy audit, prepare a flow for audit and identify the instruments needed. |
| **CO 2** | Design and perform the energy audit process for electrical systems. |
| **CO 3** | Design and perform the energy audit process for mechanical systems |
| **CO 4** | Propose energy management scheme for a building |

| **Reference Books** | |
|---|---|
| 1. | Handbook of energy audit, Sonal Desai, Kindle Edition, 2015, McGraw Hill Education, ISBN: 9339221346, 9789339221348. |
| 2. | Energy management handbook, Wayne C Turner and Steve Doty, 6th Edition, 2015, CRC Press, ISBN: 0-88173-542-6. |
| 3. | Energy management, Sanjeev Singh and Umesh Rathore, 1st Edition, 2016, Katson Books, ISBN 10: 9350141019, ISBN 13: 9789350141014. |
| 4. | Energy audit of building systems, Moncef Krarti, 2nd Edition, 2010, CRC Press ISBN: 9781439828717 |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **BIOMEDICAL INSTRUMENTATION**<br>**Category: Institutional Elective**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **EI266TEK** | | **CIE** | : | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | : | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | : | **03 Hrs** |
| **Unit-I** | | | | | | **09 Hrs** |
| **Fundamentals:** Sources of Biomedical signals, Basic medical instrumentation system, General constraints in design of medical instrumentation systems.<br>**Bioelectric Signals and Electrodes**: Origin of bioelectric signals, Types of bioelectric signals, Recording electrodes, Electrode-tissue interface, Polarization, Skin contact impedance, Silver-silver chloride electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes. | | | | | | |
| **Unit – II** | | | | | | **09 Hrs** |
| **Electrocardiograph:** Electrical activity of heart, Genesis and characteristics of Electrocardiograph (ECG), Block diagram description of an Electrocardiograph, ECG lead systems, Multi-channel ECG machine.<br>**Electroencephalograph:** Genesis of EEG, Block diagram description of an EEG, 10-20 Electrode system, Computerized analysis of EEG. | | | | | | |
| **Unit –III** | | | | | | **09 Hrs** |
| **Patient Monitoring System:** Bedside monitors, Central Monitors, Measurement of Heart Rate, Average Heart Rate meter, Instantaneous heart rate meter, Measurement of pulse rate, Blood Pressure measurement, Direct and indirect method, Automatic blood pressure measuring apparatus using Korotkoff's method.<br>**Oximeters:** Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter. | | | | | | |
| **Unit –IV** | | | | | | **09 Hrs** |
| **Blood Flow Meters:** Electromagnetic blood flow meter, Types of electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters, Laser Doppler blood flow meters.<br>**Cardiac Pacemakers and Defibrillators:** Need for Cardiac pacemaker, External Pacemaker, Implantable Pacemaker, Types of Implantable Pacemaker, Ventricular Synchronous Demand Pacemaker and Programmable Pacemaker. Need for a defibrillator, DC defibrillator, Defibrillator electrodes, DC defibrillator with synchronizer. | | | | | | |
| **Unit –V** | | | | | | **09 Hrs** |
| **Advances in Radiological Imaging:** X-rays-principles of generation, Conventional X-ray radiography, Fluoroscopy, Angiography, Digital radiography, Digital subtraction angiography (DSA). Basic principle of computed tomography, magnetic resonance imaging system and Ultrasonic imaging system. | | | | | | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Understand the sources of biomedical signals and basic biomedical instruments. |
| **CO2** | Apply concepts for the design of biomedical devices |
| **CO3** | Analyze the methods of acquisition and signal conditioning to be applied to the physiological parameters |
| **CO4** | Develop instrumentation for measuring and monitoring biomedical parameters. |

| **Reference Books** | |
|---|---|
| 1. | Handbook of Biomedical Instrumentation, R. S. Khandpur,3rd Edition, Reprint 2016, Tata McGraw-Hill, ISBN: 9780070473553. |
| 2. | Biomedical Instrumentation and Measurements, Leslie Cromwell & others, 2nd Edition, Reprint 2015, ISBN: 9780130771315. |
| 3. | Medical instrumentation: Application and Design, J. G. Webster, 3rd Edition, Reprint 2015, Wiley Publications, ISBN: 9788126511068. |
| 4. | Principles of Medical Imaging, K.Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 2016, ISBN: 978-0126409703. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
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| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20)**. Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
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| 7 & 8 | Unit 4: Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **TELECOMMUNICATION SYSTEMS**<br>**Category: Institutional Elective Course-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **ET266TEM** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 L** | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **8 Hrs** |
|---|---|
| **Introduction to Electronic Communication:** The Significance of Human Communication, Communication Systems, Types of Electronic Communication, Modulation and Multiplexing, Electromagnetic Spectrum, Bandwidth, A Survey of Communication Applications.<br>**The Fundamentals of Electronics:** Gain, Attenuation, and Decibels.<br>**Radio Receivers:** Super heterodyne receiver. | |
| **Unit – II** | **10 Hrs** |
| **Modulation Schemes: Analog Modulation:** AM, FM and PM- brief review.<br>**Digital Modulation:** PCM, Line Codes, ASK, FSK, PSK & QAM (Architecture).<br>**Wideband Modulation:** Spread spectrum, FHSS, DSSS.<br>**Multiple Access:** FDMA, TDMA, CDMA. | |
| **Unit –III** | **10 Hrs** |
| **Satellite Communication:** Satellite Orbits, Satellite Communication Systems, Satellite Subsystems, Ground Stations, Satellite Applications, Global Positioning System. | |
| **Unit –IV** | **9 Hrs** |
| **Optical Communication:** Optical Principles, Optical Communication Systems, Fiber-Optic Cables, Optical Transmitters and Receivers, Wavelength-Division Multiplexing, Passive Optical Networks. | |
| **Unit –V** | **8 Hrs** |
| **Cell Phone Technologies:** Cellular concepts, Frequency allocation, Frequency reuse, Internet Telephony.<br>**Wireless Technologies:** Wireless LAN, PANs and Bluetooth, Zig Bee, Mesh Wireless Networks, WiMax, and Wireless Metropolitan Area Networks. | |

| **Course Outcomes: After completing the course, the students will be able to :-** | |
|---|---|
| **CO1** | Describe the basics of communication systems. |
| **CO2** | Analyze the importance of modulation and multiple access schemes for communication systems. |
| **CO3** | Analyze the operational concept of cell phone and other wireless technologies. |
| **CO4** | Justify the use of different components and sub-system in advanced communication systems. |

**Reference Books**


| | |
|---|---|
| 1. | Principles of Electronic Communication Systems, Louis E. Frenzel, 4th Edition, 2016, Tata McGraw Hill, ISBN: 978-0-07-337385-0. |
| 2. | Electronic Communication Systems, George Kennedy,3rd Edition, 2008, Tata McGraw Hill, ISBN: 0-02-800592-9. |
| 3. | Introduction to Telecommunications, Anu A. Gokhale, 2nd Edition, 2008, Cengage Learning ISBN: 981-240-081-8 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
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| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

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| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **TELECOMMUNICATION SYSTEMS**<br>**Category: Institutional Elective Course-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **ET266TEN** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 L** | | **SEE Duration** | **:** | **3 Hours** |

| **Unit-I** | **9 Hrs** |
|---|---|
| **Principle of Cellular Communication:** Cellular Terminology, Cell Structure and Cluster, Frequency Reuse Concept, Cluster size and System Capacity, Method of Locating Co-channel cells, Frequency Reuse distance, Co-channel Interference and Signal Quality, Co-channel interference Reduction Methods. | |
| **Unit – II** | **9 Hrs** |
| **Basic Cellular system:** Consideration of components of a cellular system- A basic cellular system connected to PSTN, Main parts of a basic cellular system, Operation of a Cellular system, Performance criteria- Voice quality, Trunking and Grade of Service, Spectral Efficiency of FDMA and TDMA systems | |
| **Unit –III** | **9 Hrs** |
| **Second generation Cellular Technology: GSM:** GSM Network Architecture, Identifiers used in GSM System, GSM channels, Authentication and Security in GSM, GSM Call Procedure, GSM Hand-off Procedures. | |
| **Unit –IV** | **9 Hrs** |
| **3G Digital Cellular Technology: GPRS:** GPRS technology, GPRS NetworkArchitecture, GPRS signalling, Mobility Management in GPRS. **UMTS:** UMTS Network Architecture, UMTS Interfaces, UMTS Air Interface Specifications, UMTS Channels**.** | |
| **Unit –V** | **9 Hrs** |
| **Wireless Personal Area Networks:** Network architecture, components, Bluetooth, Zigbee, Applications. **Wireless Local Area networks:** Network Architecture, Standards, Applications. Wireless Metropolitan Area Networks: IEEE 802.16 standards, advantages, WMAN Network architecture, Protocol stack | |

| **Course Outcomes: After completing the course, the students will be able to :-** | |
|---|---|
| **CO1** | Describe the concepts and terminologies for Cellular Communication. |
| **CO2** | Analyze the Architecture, Hand-off and Security aspects in 2G and 3G Networks. |
| **CO3** | Compare the performance features of 2G and 3G Cellular Technologies. |
| **CO4** | Analyze and Compare the architectures of various Wireless technologies and standards. |

| **Reference Books** | |
|---|---|
| 1. | Wireless Communications, T.L. Singal, 2nd Reprint 2011,Tata McGraw Hill Education Private Limited, ISBN: 978-0-07-068178-1 |
| 2. | Wireless and Mobile Networks Concepts and Protocols, Dr.Sunil Kumar SManvi, 2010, Willey India Pvt. Ltd., ISBN: 978-81-265-2069-5. |
| 3. | Wireless Communication, Upena Dalal, 1st Edition, 2009, Oxford higher Education, ISBN-13:978-0-19-806066-6. |
| 4 | Wireless Communications Principles and practice, Theodore S Rappaport, 2nd Edition, Pearson, ISBN 97881-317-3186-4 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| # | COMPONENTS | MARKS |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **MOBILE APPLICATION DEVELOPMENT**<br>**Category: Institutional Elective Course-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **IS266TEO** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **03 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction:**<br>Smart phone operating systems and smart phones applications. Introduction to Android, Installing Android Studio, creating an Android app project, deploying the app to the emulator and a device. UI Design: Building a layout with UI elements, Layouts, Views and Resources, Text and Scrolling Views.<br>Activities and Intents, The Activity Lifecycle, Managing State, Activities and Implicit Intents, The Android Studio Debugger, Testing the Android app, The Android Support Library. | |
| **Unit–II** | **09 Hrs** |
| **User experience**:<br>User interaction, User Input Controls, Menus, Screen Navigation, Recycler View, Delightful user experience, Drawables, Styles, and Themes, Material Design, Testing app UI, Testing the User Interface | |
| **Unit–III** | **09 Hrs** |
| **Working in the background:**<br>Async Task and Async Task Loader, Connect to the Internet, Broadcast Receivers and Services. Scheduling and optimizing background tasks – Notifications, Scheduling Alarms, and Transferring Data Efficiently | |
| **Unit–IV** | **09 Hrs** |
| **All about data:**<br>Preferences and Settings, Storing Data, Shared Preferences. Storing data using SQLite, SQLite Database. Sharing data with content providers.<br>Advanced Android Programming: Internet, Entertainment and Services. Displaying web pages and maps, communicating with SMS and emails, Sensors. | |
| **Unit–V** | **09 Hrs** |
| **Hardware Support & devices:**<br>Permissions and Libraries, Performance and Security. Fire base and AdMob, Publish and Polish, Multiple Form Factors, Using Google Services. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Comprehend the basic features of android platform and the application development process. Acquire familiarity with basic building blocks of Android application and its architecture. |
| **CO2:** | Apply and explore the basic framework, usage of SDK to build Android applications incorporating Android features in developing mobile applications. |
| **CO3:** | Demonstrate proficiency in coding on a mobile programming platform using advanced Android technologies, handle security issues, rich graphics interfaces, using debugging and troubleshooting tools. |
| **CO4:** | Create innovative applications, understand the economics and features of the app marketplace by offering the applications for download. |

| **Reference Books** | |
|---|---|
| **1** | Android Programming, Phillips, Stewart, Hardyand Marsicano, Big Nerd Ranch Guide, 2nd Edition, 2015, ISBN-13 978-0134171494 |
| **2** | AndroidStudioDevelopmentEssentials-Android6, NeilSmyth,2015, Create space Independent Publishing Platform, ISBN:9781519722089 |
| **3** | Android Programming–Pushing the limits, EricHellman,2013, Wiley, ISBN-13:978-1118717370 |
| **4** | Professional Android2ApplicationDevelopment,RetoMeier, Wiley India Pvt. Ltd, 1st Edition, 2012, ISBN-13:9788126525898 |
| **5** | BeginningAndroid3, Mark Murphy, A press Springer India Pvt Ltd,1st Edition,2011, ISBN-13:978-1-4302-3297-1 |
| **6** | AndroidDeveloperTraining-https://developers.google.com/training/android/ AndroidTestingSupportLibrary-https://google.github.io/android-testing-support-library/ |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B** (Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **ELEMENTS OF FINANCIAL MANAGEMENT**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **IM266TEQ** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **06 Hrs** |
|---|---|
| **Financial Management-An overview:** Financial Decisions in a firm, Goals of a firm, Fundamental principle of finance, Organization of finance function and its relation to other functions, Regulatory framework.<br>**The financial System:** Functions, Assets, Markets, Market returns, Intermediaries, regulatory framework, Growth and trends in Indian financial system. | |
| **Unit – II** | **10 Hrs** |
| **Financial statements, Taxes and cash flow:** Balance sheet, statement of profit and loss, items in annual report, manipulation of bottom line, Profits vs Cash flows, Taxes. **(Conceptual treatment only)**<br>**Time Value of Money:** Future value of a single amount, future value of an annuity, present value of a single amount, present value of an annuity.<br>**Valuation of securities:** Basic valuation model, bond valuation, equity valuation-dividend capitalization approach and other approaches. | |
| **Unit –III** | **10 Hrs** |
| **Risk and Return:** Risk and Return of single assets and portfolios, measurement of market risk, relationship between risk and return, implications.<br>**Techniques of Capital Budgeting:** Capital budgeting process, project classification, investment criteria, Net present value, Benefit-Cost ratio, Internal Rate of return, Payback period, Accounting rate of return.<br>**(Conceptual and Numerical treatment)** | |
| **Unit –IV** | **10 Hrs** |
| **Long term finance:** Sources- Equity capital, Internal accruals, preference capital, term loans, debentures. Raising long term finance- Venture capital, Initial Public Offer, Follow on Public Offer, Rights Issue, Private Placement, Term Loans, Investment Banking<br>**Securities Market:** Primary market vs Secondary market, Trading and Settlements, Stock market quotations and Indices, Govt. securities market, Corporate debt market. | |
| **Unit –V** | **09 Hrs** |
| **Working Capital – Policy and Financing:** Factors influencing working capital requirements, Current assets financing policy, operating cycle and cash cycle. Accruals, trade credit, banks, public deposits, inter-corporate deposits, short term loans, right debentures, commercial paper, Factoring<br>**(Conceptual treatment only)** | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Explain the features and elements of a financial system. |
| **CO2** | Recognize the relevance basic principles of financial management in decision making. |
| **CO3** | Describe the processes and techniques of capital budgeting and working capital financing by organizations. |
| **CO4** | Demonstrate an understanding of various sources of finance. |

| **Reference Books:** | |
|---|---|
| 1. | Fundamentals of Financial Management, Prasanna Chandra, 6th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 978-93-392-0313-9, 93-392-0313-5 |
| 2. | Financial Management ,I M Pandey, 12th edn, 2021, Pearson, ISBN-939057725X, 978-9390577255 |
| 3. | Financial Management-Text, Problems and Cases, Khan M Y & Jain P K, 8th Edition, 2018, McGraw Hill Education(India) Pvt. Ltd, ISBN: 9353162181 , 9789353162184 |

| | |
|---|---|
| 4. | Fundamentals of Financial Management, Eugene F Brigham, Joel F Houston, 8th Edition, 2014, Cengage Learning, ISBN : 9781285065137, 1285065131. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9z or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **OPTIMIZATION TECHNIQUES**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **IM266TER** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **42L** | | **SEE Duration** | **:** | **03 Hours** |

| **UNIT – I** | **08 Hrs** |
|---|---|
| **Introduction:** OR Methodology, Definition of OR, Application of OR to Engineering and Managerial problems, Features of OR models, Limitations of OR.<br>**Linear Programming:** Definition, Mathematical Formulation, Standard Form, Solution Space, Types of solution – Feasible, Basic Feasible, Degenerate, Solution through Graphical Method. Problems on Product Mix, Blending, Marketing, Finance, Agriculture and Personnel.<br>**Simplex methods:** Variants of Simplex Algorithm – Use of Artificial Variables. | |
| **UNIT – II** | **09 Hrs** |
| **Simplex Algorithm:** How to Convert an LP to Standard Form, Preview of the Simplex Algorithm, Direction of Unboundedness, Why Does an LP Have an Optimal basic feasible solution, The Simplex Algorithm, Using the Simplex Algorithm to Solve Minimization Problems, Alternative Optimal Solutions, Degeneracy and the Convergence of the Simplex Algorithm, The Big M Method, The Two-Phase Simplex Method. | |
| **UNIT – III** | **09 Hrs** |
| **Transportation Problem:** Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel's Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.<br>**Assignment Problem:** Formulation of the Assignment problem, solution method of assignment problem-Hungarian Method, Variants in assignment problem, Travelling Salesman Problem (TSP). | |
| **UNIT – IV** | **08 Hrs** |
| **Project Management Using Network Analysis:** Network construction, CPM & PERT, Determination of critical path and duration, floats. Crashing of Network. Usage of software tools to demonstrate N/W flow problems | |
| **UNIT – V** | **08 Hrs** |
| **Game Theory**: Introduction, Two person Zero Sum game, Pure strategies, Games without saddle point - Arithmetic method, Graphical Method, The rules of dominance | |

| **Course Outcomes: After going through this course the student will be able to** | |
|---|---|
| **CO1** | Understand the characteristics of different types of decision – making environments and the appropriate decision making approaches and tools to be used in each type. |
| **CO2** | Build and solve Transportation Models and Assignment Models. |
| **CO3** | Design new simple models, like: CPM, PERT to improve decision –making and develop critical thinking and objective analysis of decision problems. |
| **CO4** | Implement practical cases, by using TORA, WinQSB, Excel, GAMS. |

| **Reference Books:** | |
|---|---|
| 1. | Operation Research An Introduction, Taha H A, 10th Global Edition, 2017, Pearson Education Limited, ISBN 13: 978-1-292-16554-7 |
| 2. | Principles of Operations Research – Theory and Practice, Philips, Ravindran and Solberg, 2nd Edition, 2007, John Wiley & Sons (Asia) Pvt Ltd, ISBN 13: 978-8126512560 |
| 3. | Introduction to Operation Research, Hiller, Liberman, Nag, Basu, 10th Edition, 2017, McGraw Hill Education, ISBN 13: 978-9339221850 |
| 4. | Operations Research Theory and Application, J K Sharma, 6th Edition, 2009, Trinity Press, ISBN : 978-93-85935-14-5 |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50 Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q.NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9z or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: V | | | | | | |
|---|---|---|---|---|---|---|
| **AUTOMOTIVE MECHATRONICS**<br>**Category: Institutional Elective Course-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **ME266TES** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 L** | | **SEE Duration** | **:** | **03 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Automobile Engines**<br>Classifications of Internal Combustion Engines**.** Engine nomenclature and mechanics. Mixture formation – External, internal, quality and quantity control – homogeneous and stratified injection. Thermodynamic principles of Otto and Diesel cycle. Characteristics – pressure curve and energy yield, engine speed, torque, and power | |
| **Unit-II** | **10 Hrs** |
| **Engine Auxiliary Systems:**<br>Turbocharger, Intercooler, Exhaust manifold, 3-way catalytic convertor, Exhaust Gas Recirculation system.<br>**Common Rail Fuel Injection system**- Low pressure and high pressure fuel systems, Return line, Quantity control valve and Injectors. | |
| **Unit-III** | **10 Hrs** |
| **Vehicular Auxiliary Systems:**<br>Vehicle frame and body classification- Hatchback, Sedan, SUV, Coupe, Roadster. Adaptive Brakes - Disc and drum brakes, Antilock Braking Systems, ESP, TCS. Wheels and Tyres- Toe-In, Toe-Out, Caster and Camber angle. Classification of tyres, Radial, Tubeless.<br>**Supplemental Restraint System**: Active and passive safety, Vehicle structure, Gas generator and air bags, Belt Tensioner, Acceleration sensor, Rollover sensor, Seat occupancy recognition. | |
| **Unit-IV** | **09 Hrs** |
| **EV Technology**: Types of EV's, ICE vs EV torque output, Architecture and Working of EV's.<br>Battery Thermal Management System, Regenerative braking, Safety system and Impacts of EV on the environment. | |
| **Unit-V** | **07 Hrs** |
| **Telematics in vehicles** – Radio Transmission, Exchange of information, signal path & properties, Concept of radio waves.<br>**Sensors:** Oxygen sensors, Crankshaft/Cam shaft Sensor, Boost Pressure Sensor, Coolant Temperature Sensor, Hot Film Air Mass flow Sensor, Throttle Position Sensor, Rain/Light sensor | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Describe the functions of Mechatronic systems in a modern automobile |
| **CO2:** | Evaluate the performance of an engine by its parameters |
| **CO3:** | Analyse the automotive exhaust pollutants as per emission norms |
| **CO4:** | Demonstrate communication of control modules using a On-Board Diagnostic kit |

| **Reference Books** | |
|---|---|
| **1.** | Automotive Technology – A systems approach, Jack Erjavec, 5th Edition, Delamr Cengage Learning, ISBN-13: 978-1428311497 |

| | |
|---|---|
| **2.** | Automotive Engineering Fundamentals, Richard Stone and Jeffrey K. Ball, 2004, SAE International, ISBN: 0768009871 |
| **3.** | Bosch Automotive Handbook, Robert Bosch, 9th Edition, 2004, ISBN: 9780768081527 |
| **4.** | Understanding Automotive Electronics, William B Ribbens, 5th Edition, Butterworth–Heinemann, ISBN 0-7506-7008-8 |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding up to 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
| 2 | Unit 1: (Compulsory) | 16 |
| 3 & 4 | Unit 2: (Internal Choice) | 16 |
| 5 & 6 | Unit 3: (Internal Choice) | 16 |
| 7 & 8 | Unit 4: (Internal Choice) | 16 |
| 9 & 10 | Unit 5: (Internal Choice) | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **MATHEMATICAL MODELLING**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **MA266TEU** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction to Mathematical Modelling:**<br>Basic concepts, steps involved in modelling, classification of models, assorted simple mathematical models from diverse fields. | |
| **Unit – II** | **09 Hrs** |
| **Mathematically Modelling Discrete Processes:**<br>Difference equations - first and second order, Introduction to Difference equations, Introduction to discrete models-simple examples, Mathematical modelling through difference equations in economics, finance, population dynamics, genetics and other real world problems. | |
| **Unit –III** | **09 Hrs** |
| **Markov modelling:**<br>Mathematical foundations of Markov chains, application of Markov Modelling to problems. | |
| **Unit –IV** | **09 Hrs** |
| **Modelling through graphs:**<br>Graph theory concepts, Modelling situations through different types of graphs. | |
| **Unit –V** | **09 Hrs** |
| **Variational Problem and Dynamic Programming:**<br>Optimization principles and techniques, Mathematical models of variational problem and dynamic programming, Problems with applications. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Explore the fundamental concepts of mathematical models arising in various fields engineering. |
| **CO2:** | Apply the knowledge and skills of discrete and continuous models to understand various types of analysis. |
| **CO3:** | Analyze the appropriate mathematical model to solve the real world problem and to optimize the solution. |
| **CO4:** | Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations. |

| **Reference Books** | |
|---|---|
| **1** | Mathematical Modeling, J. N. Kapur, 1st Edition, 1998, New Age International, New Delhi, ISBN: 81-224-0006-X. |
| **2** | Mathematical Modeling: Models, Analysis and Applications, Sandip Banerjee, 2014, Chapman and Hall/CRC Textbook, ISBN 9781439854518. |
| **3** | Case studies in mathematical modeling, D. J. G. James and J. J. Mcdonald, 1981, Stanly Thames, Cheltonham, ISBN: 0470271779, 9780470271773. |
| **4** | Modeling with difference equations, D. N. Burghes, M. S. Borrie, Ellis Harwood, 1981, ISBN 13: 9780853122869. |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **MATHEMATICS OF QUANTUM COMPUTING**<br>**Category: Institutional Elective-I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **MA266TEV** | | **CIE** | **:** | **100 Marks** |
| **Credits: L: T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **09 Hrs** |
|---|---|
| **Introduction to Quantum Computing:**<br>Quantum superposition, Qubits, Linear algebra for quantum computing, Inner products and Tensor products of vector spaces, Quantum states in Hilbert space, The Bloch sphere, Generalized measurements, No-cloning theorem. | |
| **Unit – II** | **09 Hrs** |
| **Quantum Gates:**<br>Universal set of gates, quantum circuits, Dirac formalism, superposition of states, entanglement Bits and Qubits. Qubit operations, Hadamard Gate, CNOT Gate, Phase Gate, Z-Y decomposition, Quantum Circuit Composition, Basic Quantum circuits. | |
| **Unit –III** | **09 Hrs** |
| **Quantum Algorithm - I:**<br>Deutsch Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazarani Algorithm, Simon periodicity algorithm, Phase estimation algorithm, Quantum Fourier transform. | |
| **Unit –IV** | **09 Hrs** |
| **Quantum Algorithm - II:**<br>Grover search algorithm, Shor quantum factoring algorithm, Harrow-Hassidim-Lloyd (HHL) algorithm for solving linear system problems. | |
| **Unit –V** | **09 Hrs** |
| **Applications of Quantum Computing:**<br>Application to: order-finding, discrete logarithm, quantum counting, Boolean satisfiability problems(SAT), graph theory problems. | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO1:** | Explore the fundamental concepts of quantum computing. |
| **CO2:** | Apply the knowledge and skills of quantum computing to understand various types of problems arising in various fields engineering |
| **CO3:** | Analyze the appropriate quantum algorithm to solve the real-world problem and to optimize the solution. |
| **CO4:** | Distinguish the overall knowledge gained to demonstrate the problems arising in many practical situations. |

| **Reference Books** | |
|---|---|
| **1** | An introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme, 2007, Oxford University press. |
| **2** | Quantum Computing for Everyone, Chris Bernhardt, 2020, The MIT Press, Cambridge. |
| **3** | Quantum Computation and Quantum Information, M. A. Nielsen & I. Chuang, 2013, Cambridge University Press. |
| **4** | Quantum Computing for the quantum curious, Cirian Hughes et. al., 2021, Springer, ISBN 978-3-030-61600-7. |
| **5** | Concise guide to quantum computing, Sergei Kurgalin, Sergei Borzunov, 2021, Springer, ISBN 978-3-030-65051-3, ISBN 978-3-030-65052-0 (eBook). |

| RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY) | | |
|---|---|---|
| | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). TWO tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| RUBRIC FOR SEMESTER END EXAMINATION (THEORY) | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **APPLIED PSYCHOLOGY FOR ENGINEERS**<br>**Category: Institutional Electives – I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **HS266TEW** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **45 Hrs** | | **SEE Duration** | **:** | **3 Hours** |
| **Unit-I** | | | | | | **08 Hrs** |
| **Introduction to Psychology**: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology- Clinical, Industrial). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method. | | | | | | |
| **Unit – II** | | | | | | **08 Hrs** |
| **Intelligence and Aptitude:** Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence. | | | | | | |
| **Unit –III** | | | | | | **10 Hrs** |
| **Personality**: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio- Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment. | | | | | | |
| **Unit –IV** | | | | | | **10 Hrs** |
| **Learning:** Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning. | | | | | | |
| **Unit –V** | | | | | | **09 Hrs** |
| **Application of Psychology in Working Environment:** The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. **Psychological Stress**: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress.Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control. Type A and Type B.**Psychological Counseling** - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling. | | | | | | |

| **Course Outcomes: After completing the course, the students will be able to:-** | |
|---|---|
| **CO1** | Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors and mental processes. |
| **CO2** | Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process. |
| **CO3** | Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement. |
| **CO4** | Apply the theories into their own and others' lives in order to better understand their personalities and experiences. |
| **CO5** | Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment. |

| **Reference Books** | |
|---|---|
| 1. | Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India |
| 2. | Psychology Robert A. Baron, III edition (1995) Prentice Hall India. |
| 3. | Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3 |
| 4. | Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5 |
| 5 | Psychology-themes and variations , Wayne Weiten, IV edition, Brooks / Cole Publishing Co. |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
| 1. | **QUIZZES:** Quizzes will be conducted in online/offline mode. TWO QUIZZES will be conducted & Each Quiz will be evaluated for 10 Marks. **THE SUM OF TWO QUIZZES WILL BE THE FINAL QUIZ MARKS.** | **20** |
| 2. | **TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). THREE tests will be conducted. Each test will be evaluated for 50 Marks, adding upto 150 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.** | **40** |
| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only; wherein one sub division will be a caselet in the related topics) | |
| 2 | Unit 1 : (Compulsory) | 16 |
| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester: VI | | | | | | |
|---|---|---|---|---|---|---|
| **UNIVERSAL HUMAN VALUES**<br>**Category: Institutional Electives – I**<br>**(Theory)** | | | | | | |
| **Course Code** | **:** | **HS266TEY** | | **CIE** | **:** | **100 Marks** |
| **Credits: L:T:P** | **:** | **3:0:0** | | **SEE** | **:** | **100 Marks** |
| **Total Hours** | **:** | **42L** | | **SEE Duration** | **:** | **3.00 Hours** |

| **Unit-I** | **10 Hrs** |
|---|---|
| Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution. The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution are the activities of the Self, Self is central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution. | |
| **Unit – II** | **10 Hrs** |
| Right Understanding (Knowing)- Knower, Known & the Process. The domain of right understanding starts from understanding the human being (the knower, the experiencer and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct). | |
| **Unit –III** | **08 Hrs** |
| Understanding Existence (including Nature). A comprehensive understanding (knowledge) about the existence, which certainly includes the Nature. The need and the process of inner evolution (through self-exploration, self-awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence). | |
| **Unit –IV** | **08 Hrs** |
| Understanding Human Being. Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body, the activities and potentialities of the self, Reasons for harmony/contradiction in the self. | |
| **Unit –V** | **08 Hrs** |
| Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living. Understanding Human Conduct, Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence. | |

| **Course Outcomes: After completion of the course the students will be able to** | |
|---|---|
| **CO1** | Understand the basic human aspiration with program of its fulfilment and meaning of resolution in the complete expanse of human living. |
| **CO2** | Understand human being in depth and see how self is central to human being |
| **CO3** | Understand existence in depth and see how coexistence is central to existence |
| **CO4** | Understand human conduct and the holistic way of living leading to human tradition |

| **Reference Books** | |
|---|---|
| 1 | A foundation course in human values and professional ethics, R. R. Gaur, R Asthana, G P Bagaria, 2nd revised Edition, excel books, New Delhi – 2019, ISN 978-93-87034-47-1 |
| 2 | Avartansheel Arthshastra, A Nagraj, Divya Path Sansthan, Amarkantak, India, ISBN 978-8-174-46781-2 |
| 3 | Economy of Performance- a quest for social order based on non – violence, J C Kumarappa, 2010, Sarva-Seva-Sangh-Prakashan, Varanasi, India |

| | |
|---|---|
| 4 | Energy and Equity, Ivan Illich, 1974, The Trinity Press, Worcester & Harper Collins, USA, ISBN, 0060803274, 9780060803278 |

| **RUBRIC FOR THE CONTINUOUS INTERNAL EVALUATION (THEORY)** | | |
|---|---|---|
| **#** | **COMPONENTS** | **MARKS** |
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| 3. | **EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study-based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (20**) ADDING UPTO 40 MARKS**. | **40** |
| | **MAXIMUM MARKS FOR THE CIE THEORY** | **100** |

| **RUBRIC FOR SEMESTER END EXAMINATION (THEORY)** | | |
|---|---|---|
| **Q. NO.** | **CONTENTS** | **MARKS** |
| | **PART A** | |
| 1 | Objective type questions covering entire syllabus | 20 |
| | **PART B**<br>(Maximum of TWO Sub-divisions only) | |
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| 3 & 4 | Unit 2 : Question 3 or 4 | 16 |
| 5 & 6 | Unit 3 : Question 5 or 6 | 16 |
| 7 & 8 | Unit 4 : Question 7 or 8 | 16 |
| 9 & 10 | Unit 5: Question 9 or 10 | 16 |
| | **TOTAL** | **100** |

| Semester VI | | | | | | |
|---|---|---|---|---|---|---|
| **INTERDISCIPLINARY PROJECT** | | | | | | |
| **Course Code** | **:** | **AI367P** | | **CIE** | **:** | **50 Marks** |
| **Credits: L:T:P** | **:** | **0:0:3** | | **SEE** | **:** | **50 Marks** |
| **Total Hours** | **:** | **15 P** | | **SEE Duration** | **:** | **2 Hours** |

## Interdisciplinary Project Guidelines:

1. The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the VI semester.
2. The detailed Synopsis (approved by the department ***Project Review Committee***) has to be submitted during the 1st week after the commencement of VI semester.

## Batch Formation:

- Students are free to choose their project partners from any other program.
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house only.
- ***The project work is to be carried out by a team of two to four students.***

## Project Topic Selection:

The topics of the project work must be in the ***field of Sustainable Development goals areas or in line with CoE's(Centre of Excellence) identified by the college*** or **List of project areas as given by Faculty. The projects as far as possible should have societal relevance with focus on sustainability.**

## Project Evaluation:

Continuous monitoring of project work will be carried out and cumulative evaluation will be done.

- The students are required to meet their guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Guide regularly.
- For CIE assessment the project groups must give a final presentation with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.

| **Course Outcomes:** | |
|---|---|
| **1** | Identifying critical thinking and problem-solving abilities by analyzing and addressing interdisciplinary challenges, utilizing creative approaches and innovative solutions. |
| **2** | Exhibit proficiency in conducting comprehensive research, including literature review, data collection, modelling, simulation, and analysis, to address significant technical challenges and propose innovative solutions. |

| | |
|---|---|
| **3** | Demonstrate the ability to do effective teamwork, leadership, project management, and communication skills, while adhering to ethical standards and professional responsibility in delivering the project outcomes within time and budget constraints. |
| **4** | Utilize appropriate engineering tools, technologies, and software to design, test, and implement project solutions, ensuring adherence to technical specifications, safety standards, and industry best practices. |

**CIE Assessment:**

The following are the weightings given for the various stages of the project.

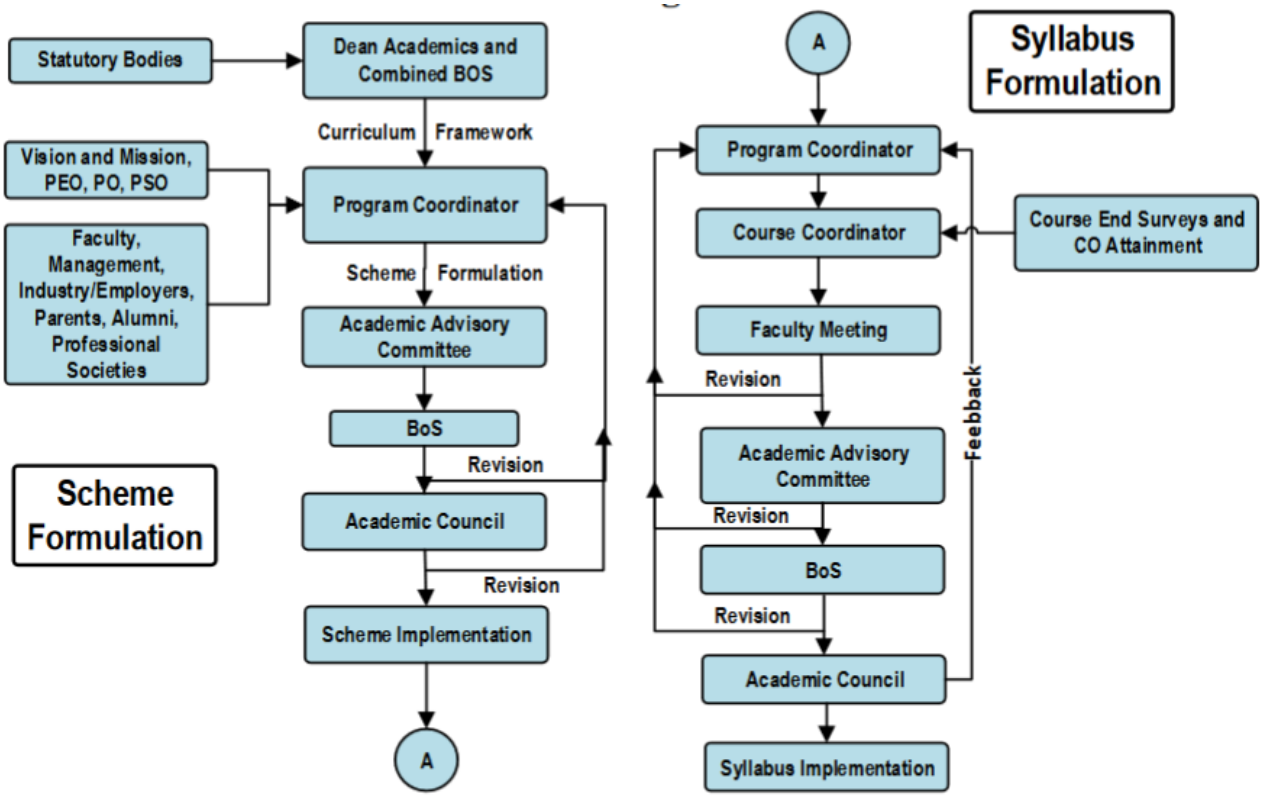
| | | |
|---|---|---|
| 1. | Selection of the topic and formulation of objectives | 10% |
| 2. | Design and Development of Project methodology | 25% |
| 3. | Execution of Project | 25% |
| 4. | Presentation, Demonstration and Results Discussion | 30% |
| 5. | Report Writing & Publication | 10% |

**SEE Assessment:**

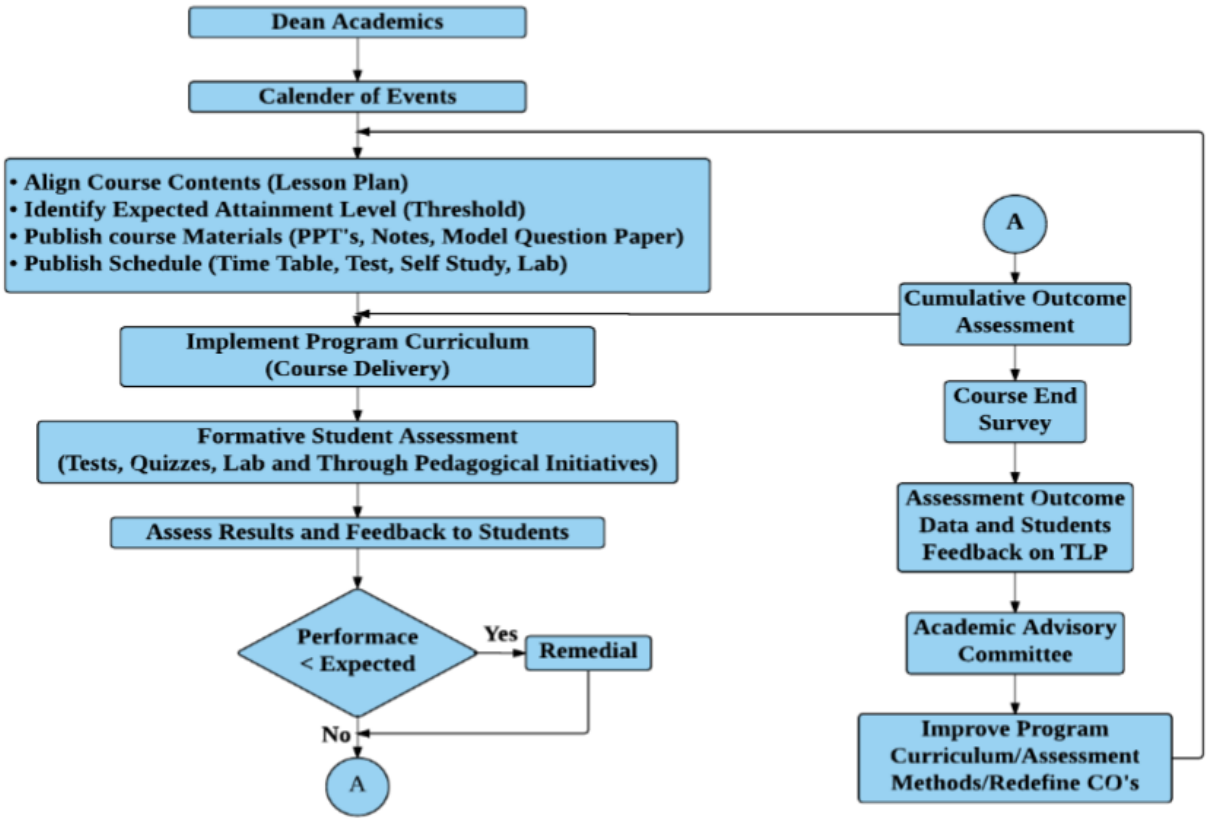
The following are the weightages given during Viva Examination.

| | | |
|---|---|---|
| 1. | Written presentation of synopsis | 10% |
| 2. | Presentation/Demonstration of the project | 30% |
| 3. | Methodology and Experimental Results & Discussion | 30% |
| 4. | Report | 10% |
| 5. | Viva Voce | 20% |

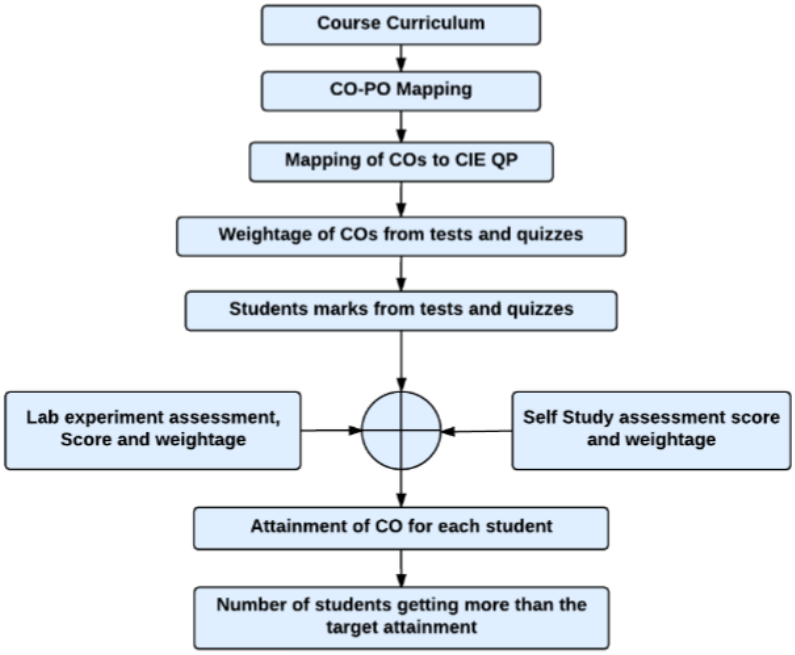
# Curriculum Design Process



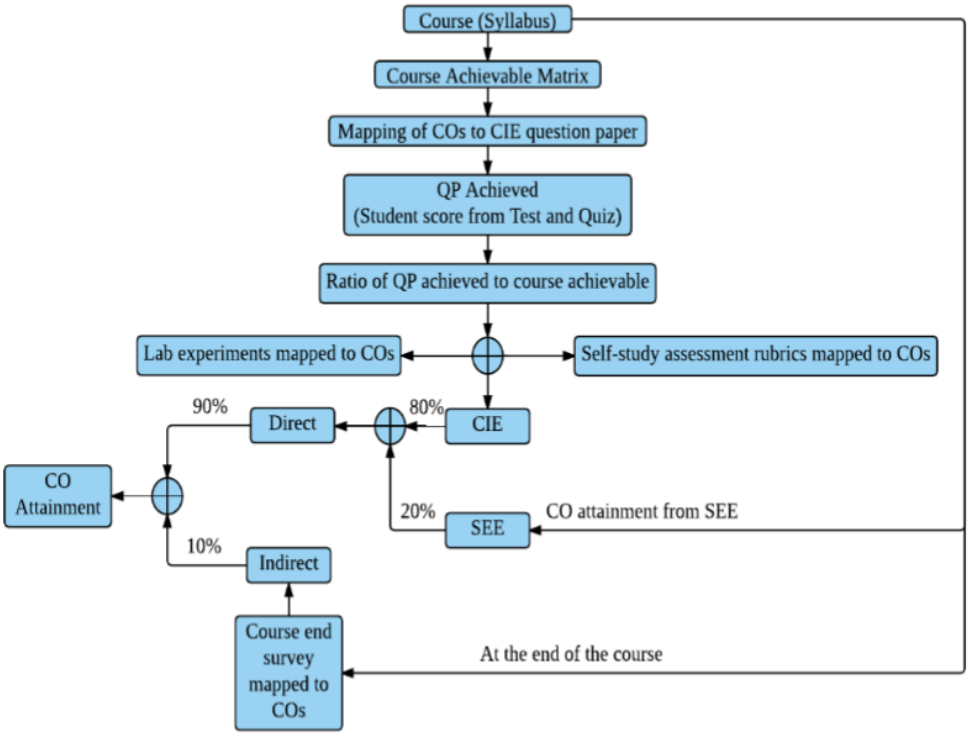
## Academic Planning and Implementation



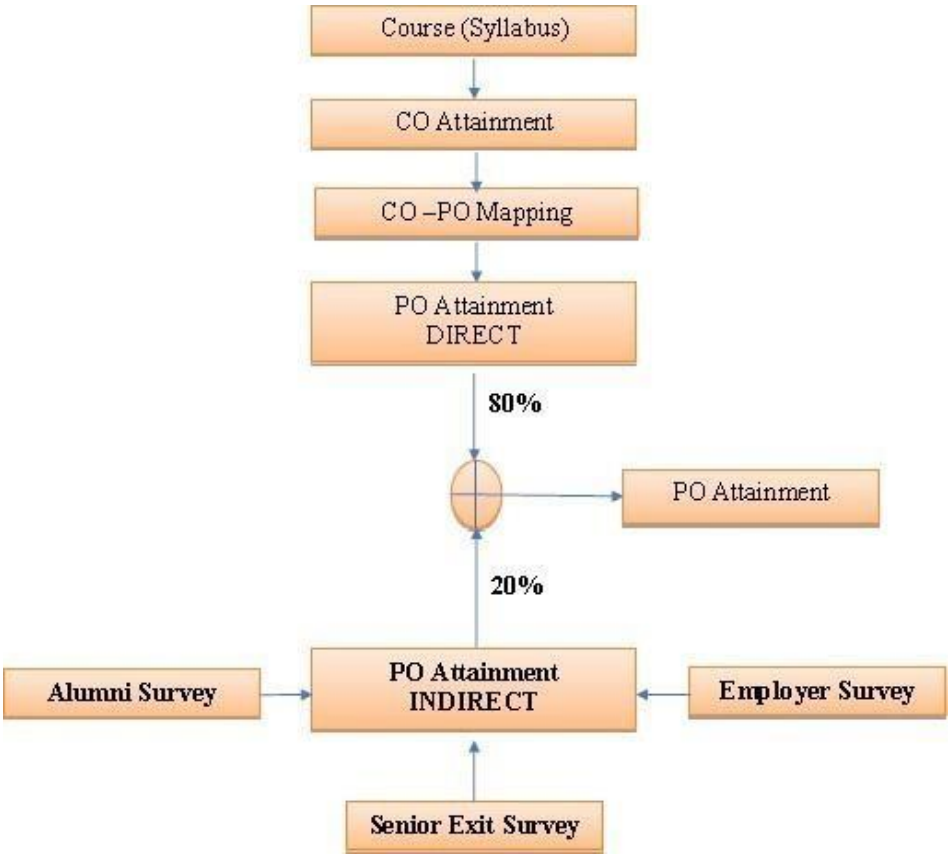
## Process For Course Outcome Attainment




## Final CO Attainment Process



## Program Outcomes (POs) Attainment Process



# Knowledge and Attitude Profile (WK)

- **WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
- **WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
- **WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
- **WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
- **WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
- **WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
- **WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
- **WK9:** Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

# New Program Outcomes(PO)

- **PO1:** Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
- **PO2:** Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
- **PO3:** Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
- **PO4:** Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
- **PO5:** Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
- **PO6**: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
- **PO7:** Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
- **PO8:** Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
- **PO9:** Communication: Communicate effectively and inclusively within the community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
- **PO10:** Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
- **PO11:** Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

# INNOVATIVE TEAMS OF RVCE

**Ashwa Mobility Foundation (AMF):** Designs and fabricates Formula-themed race cars and mobility solutions to address urban transportation issues.

**Astra Robotics Team:** Focuses on designing and building application-specific robots.

**Coding Club:** Helps students gain coding skills and succeed in competitions like GSoC and ACM-ICPC.

**Entrepreneurship Development Cell (E-Cell):** Promotes entrepreneurship through workshops, speaker sessions, and mentoring for startups.

**Frequency Club Team:** Works on software and hardware, emphasizing AI and Machine Learning.

**Team Garuda:** Develops a supermileage urban concept electric car and E-mobility products.

**Team Jatayu:** Builds low-cost UAVs with autonomous capabilities for various tasks.

**Solar Car Team:** Aims to create a solar electric vehicle for sustainable transportation.

**Team Antariksh:** Focuses on space technology and the development of operational rockets.

**Team Chimera:** Builds a Formula Electric Car through R&D in E-Mobility.

**Helios Racing Team:** Designs and tests All-Terrain Vehicles, participating in SAE's BAJA competitions.

**Team Hydra:** Develops autonomous underwater vehicles for tasks like water purification.

**Team Krushi:** Creates low-cost farming equipment to assist farmers in cultivation and harvesting.

**Team Vyoma:** Designs and tests radio-controlled aircraft and UAVs.

**Team Dhruva:** Engages in astronomy-related activities and collaborates on projects with organizations like ICTS and IIA.

**Ham Club:** Promotes Amateur Radio and explores technical innovations in communications, especially for disaster response.

## Cultural Activity Teams

1. AALAP (Music club)
2. DEBSOC (Debating society)
3. CARV (Dramatics club)
4. FOOTPRINTS (Dance club)
5. QUIZCORP (Quizzing society)
6. ROTARACT (Social welfare club)
7. RAAG (Youth club)
8. EVOKE (Fashion team)
9. f/6.3 (Photography club)
10. CARV ACCESS (Film-making

NSS of RVCE

NCC of RVCE

## VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

## MISSION

- To deliver outcome based Quality education, emphasizing on experientiallearning with the state of the art infrastructure.
- To create a conducive environment for interdisciplinary research and innovation.
- To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
- To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
- To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

## QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

## CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation