
**(AMARAVATI, AMRITAPURI, BANGALORE, COIMBATORE, CHENNAI)**

# B.Tech in Artificial intelligence and Data Science

# CURRICULUM and SYLLABUS 2023

# GENERAL INFORMATION

## ABBREVIATIONS USED IN THE CURRICULUM

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

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

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

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

## PROGRAM OUTCOMES FOR ENGINEERING

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and

design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**SEMESTER I**

| Cat. | Course Code | Title | L T P | Credit |
|---|---|---|---|---|
| SCI | 23MAT106 | Mathematics for Intelligent Systems 1 | 3 0 2 | 4 |
| SCI | 23PHY104 | Computational Mechanics 1 | 2 0 2 | 3 |
| ENGG | 23AID101 | Computational Thinking | 2 0 2 | 3 |
| ENGG | 23AID102 | Elements of Computing - 1 | 2 0 2 | 3 |
| ENGG | 23EEE103 | Introduction to Electrical Engineering | 2 0 2 | 3 |
| SCI | 23BIO112 | Introduction to Biological Data | 2 0 2 | 3 |
| ENGG | 22ADM101 | Foundations of Indian Heritage | 2 0 1 | 2 |
| ENGG | 22AVP103 | Mastery Over Mind | 1 0 2 | 2 |
| HUM | 19ENG111 | Technical Communication | 2 0 3 | 3 |
| | | **TOTAL** | | **26** |

SEMESTER II

| Cat. | Course Code | Title | L T P | Credit |
|---|---|---|---|---|
| SCI | 23MAT112 | Mathematics for Intelligent Systems 2 | 2 0 2 | 3 |
| SCI | 23PHY114 | Computational Mechanics 2 | 2 0 2 | 3 |
| ENGG | 23AID111 | Object Oriented Programming | 2 0 2 | 3 |
| ENGG | 23AID112 | Data Structures & Algorithms | 2 0 2 | 3 |
| ENGG | 23AID113 | Elements of Computing 2 | 2 0 2 | 3 |
| ENGG | 23ECE113 | Introduction to Electronics | 2 0 2 | 3 |
| SCI | 23CHY115 | Introduction to Materials Informatics | 2 0 2 | 3 |
| HUM | 22ADM111 | Glimpses of glorious India | 2 0 1 | 2 |
| | | **TOTAL** | | **23** |

SEMESTER III

| Cat | Course Code | Title | L T P | Cr |
|---|---|---|---|---|
| SCI | 23MAT204 | Mathematics for Intelligent Systems 3 | 2 0 2 | 3 |
| ENGG | 23AID201 | Modelling, Simulation & Analysis | 2 0 2 | 3 |
| ENGG | 23AID202 | Introduction to Robotics | 2 0 2 | 3 |
| ENGG | 23AID203 | Software-Defined Communication Systems | 2 0 2 | 3 |
| ENGG | 23AID204 | Advanced Data Structures & Algorithm Analysis | 2 0 2 | 3 |
| ENGG | 23AID205 | Introduction to AI and Machine Learning | 2 0 2 | 3 |
| ENGG | 23AID206 | Introduction to Computer Networks | 2 0 2 | 3 |
| HUM | | Amrita Value Programme I | 1 0 0 | 1 |
| HUM | 23LSE201 | Life Skills for Engineers I | 1 0 2 | 2 |
| | | **Total** | | **24** |

# - These 3 slots are equivalent to 2 regular slots.

SEMESTER IV

| Cat | Course Code | Title | L T P | Cr |
|---|---|---|---|---|
| SCI | 23MAT214 | Mathematics for Intelligent Systems 4 | 2 0 2 | 3 |
| ENGG | 23AID211 | Deep Learning | 2 0 2 | 3 |
| ENGG | | Elective - 1 | 2 0 2 | 3 |
| ENGG | 23AID212 | Introduction to IoT | 2 0 2 | 3 |
| ENGG | 23AID213 | Operating Systems | 3 0 2 | 4 |
| ENGG | 23AID214 | Database Management Systems | 2 0 2 | 3 |
| HUM | 23AID215 | User Interface Design | 1 0 2 | 2 |
| HUM | | Amrita Value Programme II | 1 0 0 | 1 |
| HUM | 23LSE211 | Life Skills for Engineers II | 1 0 2 | 2 |

| | | | | |
|---|---|---|---|---|
| | | **Total** | | **24** |

# - These 3 slots are equivalent to 2 regular slots.

SEMESTER V

| Cat | Course Code | Title | L T P | Cr |
|---|---|---|---|---|
| **SCI** | 23MAT303 | Mathematics for Intelligent Systems 5 | 2 0 2 | 3 |
| **ENGG** | 23AID301 | Computer Vision | 2 0 2 | 3 |
| **ENGG** | 23AID302 | Big Data Analytics | 2 0 2 | 3 |
| **ENGG** | 23AID303 | Quantum Computing & Algorithms | 2 0 2 | 3 |
| **ENGG** | 23AID304 | High Performance and Cloud Computing | 2 0 2 | 3 |
| **ENGG** | 23AID305 | Control System | 2 0 2 | 3 |
| **ENGG** | | Elective - 2 | 2 0 2 | 3 |
| **HUM** | 23LSE311 | Life Skills for Engineers III | 1 0 2 | 2 |
| | | **Total** | | **21** |

# - These 3 slots are equivalent to 2 regular slots.

SEMESTER VI

| Cat | Course Code | Title | L T P | Cr |
|---|---|---|---|---|
| **SCI** | 23MAT313 | Mathematics for Intelligent Systems 6 | 2 0 2 | 3 |
| **ENGG** | | Elective - 3 | 2 0 2 | 3 |
| **ENGG** | | Elective - 4 | 2 0 2 | 3 |
| **ENGG** | | Elective - 5 | 2 0 2 | 3 |
| **ENGG** | | Elective - 6 | 2 0 2 | 3 |
| **ENGG** | 23AID311 | Analog Computing | 2 0 2 | 3 |
| **ENGG** | 23AID312 | Reinforcement Learning | 2 0 2 | 3 |
| | | **Total** | | **23** |

# - These 3 slots are equivalent to 2 regular slots.

SEMESTER VII

| Cat | Course Code | Title | L T P | Cr |
|---|---|---|---|---|
| **ENGG** | | Free Elective - 1 | 2 0 2 | 3 |
| **ENGG** | | Free Elective - 2 | 2 0 2 | 3 |
| **ENGG** | 23AID498 | Project Phase - 1 | | 7 |
| **ENGG** | 19ENV300 | Environmental Science | | P/F |
| **ENGG** | 19LAW300 | Indian Constitution | | P/F |
| | | **Total** | | **13** |

# - These 3 slots are equivalent to 2 regular slots.

SEMESTER VIII

| Cat | Course Code | Title | L T P | Cr |
|---|---|---|---|---|
| **PRJ** | 23AID499 | Project & Internship | 10 | |
| | | **Total** | | **10** |

| | | | | |
|---|---|---|---|---|
| | | **Total Credits** | | **164** |

***@'Hands-on' Project-based Lab.***

***Professional Elective - Electives categorized under Engineering, Science, Mathematics, Live-in-Labs, and NPTEL Courses. Student can opt for such electives across departments/campuses. Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8.**

**** Free Electives - This will include courses offered by Faculty of Humanities and Social Sciences/ Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam -(International Centre for Spiritual Studies).**

***** Live-in-Labs - Students undertaking and registering for a Live-in-Labs project, can be exempted from registering for an Elective course in the higher semester.**

## Amrita Value Programmes I & II for UG programmes

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

PROFESSIONAL ELECTIVES

| Robotics | | Credits | Smart Grids | | Credits |
|---|---|---|---|---|---|
| 23AID431 | Robotics - Kinematics, Dynamics and Control | 3 | 23AID461 | Fundamentals and Analysis of Power Systems | 3 |
| 23AID432 | Introduction to ROS2 | 3 | 23AID462 | Sustainable Energy Technologies | 3 |
| 23AID433 | NLP for Robotics | 3 | 23AID463 | Power System Stability | 3 |
| 23AID434 | Robotics Vision | 3 | 23AID464 | Micro Grids | 3 |
| 23AID435 | Mobile Robotics | 3 | 23AID465 | Intelligent Energy Management Systems | 3 |
| 23AID436 | Artificial Intelligence for Robotics | 3 | 23AID466 | Power Quality Management | 3 |
| | **Computational Healthcare** | **Credits** | | **NLP** | |
| 23AID441 | Introduction to Biomedical Informatics | 3 | 23AID471 | Speech Processing | 3 |
| 23AID442 | CRISPR/Cas9 Technology | 3 | 23AID472 | Text Analytics | 3 |
| 23AID443 | Introduction to Molecular Modelling | 3 | 23AID473 | Information Retreival | 3 |
| 23AID444 | Transcriptomics, Proteomics and Metabolomics | 3 | 23AID474 | Introduction to Chat Bots | 3 |

| | | | | | |
|---|---|---|---|---|---|
| 23AID445 | Introduction to High Performance Computing | 3 | 23AID475 | Machine Translation and Sequence-to- Sequence Models | 3 |
| 23AID446 | Genomics Data Science | 3 | 23AID476 | Speech Recognition and Understanding | 3 |
| 23AID447 | AI in system biology | 3 | 23AID477 | Social Media Text Analysis | 3 |
| 23AID448 | AI in Drug Design | 3 | | | |
| | **Intelligent Security Systems** | **Credits** | | | |
| 23AID451 | Applied Cryptography | 3 | | | |
| 23AID452 | Network & Wireless Security | 3 | | | |
| 23AID453 | Intrusion Detection & Prevention Systems | 3 | | | |
| 23AID454 | Software Vulnerability Analysis | 3 | | | |
| 23AID455 | Cybercrime Investigations & Digital Forensics | 3 | | | |
| 23AID456 | Distributed Systems Security | 3 | | | |

PROFESSIONAL ELECTIVES UNDER SCIENCE STREAM

| | | | | |
|---|---|---|---|---|
| **CHEMISTRY** | | | | |
| **Cat.** | **Course Code** | **Title** | **L T P** | **Credit** |
| **SCI** | **19CHY243** | **Computational Chemistry and Molecular Modelling** | **3 0 0** | **3** |
| **SCI** | **19CHY236** | **Electrochemical Energy Systems and Processes** | **3 0 0** | **3** |
| **SCI** | **19CHY240** | **Fuels and Combustion** | **3 0 0** | **3** |
| **SCI** | **19CHY232** | **Green Chemistry and Technology** | **3 0 0** | **3** |
| **SCI** | **19CHY239** | **Instrumental Methods of Analysis** | **3 0 0** | **3** |
| **SCI** | **19CHY241** | **Batteries and Fuel Cells** | **3 0 0** | **3** |
| **SCI** | **19CHY242** | **Corrosion Science** | **3 0 0** | **3** |
| **PHYSICS** | | | | |
| **SCI** | **19PHY340** | **Advanced Classical Dynamics** | **3 0 0** | **3** |
| **SCI** | **19PHY342** | **Electrical Engineering Materials** | **3 0 0** | **3** |
| **SCI** | **19PHY331** | **Physics of Lasers and Applications** | **3 0 0** | **3** |
| **SCI** | **19PHY341** | **Concepts of Nanophysics and Nanotechnology** | **3 0 0** | **3** |
| **SCI** | **19PHY343** | **Physics of Semiconductor Devices** | **3 0 0** | **3** |
| **SCI** | **19PHY339** | **Astrophysics** | **3 0 0** | **3** |
| **Mathematics** | | | | |
| **SCI** | **19MAT341** | **Statistical Inference** | **3 0 0** | **3** |
| **SCI** | **19MAT342** | **Introduction to Game Theory** | **3 0 0** | **3** |
| **SCI** | **19MAT343** | **Numerical Methods and Optimization** | **3 0 0** | **3** |

# FREE ELECTIVES

| FREE ELECTIVES OFFERED UNDER MANAGEMENT STREAM | | | | |
|---|---|---|---|---|
| **Cat.** | **Course Code** | **Title** | **L T P** | **Credit** |
| **HUM** | **19MNG331** | **Financial Management** | **3 0 0** | **3** |
| **HUM** | **19MNG332** | **Supply Chain Management** | **3 0 0** | **3** |
| **HUM** | **19MNG333** | **Marketing Management** | **3 0 0** | **3** |
| **HUM** | **19MNG334** | **Project Management** | **3 0 0** | **3** |
| **HUM** | **19MNG335** | **Enterprise Management** | **3 0 0** | **3** |
| **HUM** | **19MNG338** | **Operations Research** | **3 0 0** | **3** |
| **HUM** | **19MEE401** | **Industrial Engineering** | **3 0 0** | **3** |
| **HUM** | **19MEE346** | **Managerial Statistics** | **3 0 0** | **3** |
| **HUM** | **19MEE347** | **Total Quality Management** | **3 0 0** | **3** |
| **HUM** | **19MEE342** | **Lean Manufacturing** | **3 0 0** | **3** |
| **HUM** | **19CSE358** | **Software Project Management** | **3 0 0** | **3** |
| **HUM** | **19CSE359** | **Financial Engineering** | **3 0 0** | **3** |
| **HUM** | **19CSE360** | **Engineering Economic Analysis** | **3 0 0** | **3** |
| **HUM** | **19CSE362** | **Information Systems** | **3 0 0** | **3** |

| FREE ELECTIVES OFFERED UNDER HUMANITIES / SOCIAL SCIENCE STREAMS | | | | |
|---|---|---|---|---|
| **Cat.** | **Course Code** | **Title** | **L T P** | **Credit** |
| **HUM** | **19CUL230** | **Achieving Excellence in Life - An Indian Perspective** | **2 0 0** | **2** |
| **HUM** | **19CUL231** | **Excellence in Daily Life** | **2 0 0** | **2** |
| **HUM** | **19CUL232** | **Exploring Science and Technology in Ancient India** | **2 0 0** | **2** |
| **HUM** | **19CUL233** | **Yoga Psychology** | **2 0 0** | **2** |
| **HUM** | **19ENG230** | **Business Communication** | **1 0 3** | **2** |
| **HUM** | **19ENG231** | **Indian Thought through English** | **2 0 0** | **2** |
| **HUM** | **19ENG232** | **Insights into Life through English Literature** | **2 0 0** | **2** |
| **HUM** | **19ENG233** | **Technical Communication** | **2 0 0** | **2** |
| **HUM** | **19ENG234** | **Indian Short Stories in English** | **2 0 0** | **2** |
| **HUM** | **19FRE230** | **Proficiency in French Language (Lower)** | **2 0 0** | **2** |
| **HUM** | **19FRE231** | **Proficiency in French Language (Higher)** | **2 0 0** | **2** |
| **HUM** | **19GER230** | **German for Beginners I** | **2 0 0** | **2** |
| **HUM** | **19GER231** | **German for Beginners II** | **2 0 0** | **2** |
| **HUM** | **19GER232** | **Proficiency in German Language (Lower)** | **2 0 0** | **2** |
| **HUM** | **19GER233** | **Proficiency in German Language (Higher)** | **2 0 0** | **2** |
| **HUM** | **19HIN101** | **Hindi I** | **2 0 0** | **2** |
| **HUM** | **19HIN111** | **Hindi II** | **2 0 0** | **2** |
| **HUM** | **19HUM230** | **Emotional Intelligence** | **2 0 0** | **2** |
| **HUM** | **19HUM231** | **Glimpses into the Indian Mind - the Growth of Modern India** | **2 0 0** | **2** |
| **HUM** | **19HUM232** | **Glimpses of Eternal India** | **2 0 0** | **2** |
| **HUM** | **19HUM233** | **Glimpses of Indian Economy and Polity** | **2 0 0** | **2** |
| **HUM** | **19HUM234** | **Health and Lifestyle** | **2 0 0** | **2** |
| **HUM** | **19HUM235** | **Indian Classics for the Twenty-first Century** | **2 0 0** | **2** |
| **HUM** | **19HUM236** | **Introduction to India Studies** | **2 0 0** | **2** |
| **HUM** | **19HUM237** | **Introduction to Sanskrit Language and Literature** | **2 0 0** | **2** |
| **HUM** | **19HUM238** | **National Service Scheme** | **2 0 0** | **2** |
| **HUM** | **19HUM239** | **Psychology for Effective Living** | **2 0 0** | **2** |

| | | | | |
|---|---|---|---|---|
| **HUM** | **19HUM240** | **Psychology for Engineers** | **2 0 0** | **2** |
| **HUM** | **19HUM241** | **Science and Society - An Indian Perspective** | **2 0 0** | **2** |
| **HUM** | **19HUM242** | **The Message of Bhagwat Gita** | **2 0 0** | **2** |
| **HUM** | **19HUM243** | **The Message of the Upanishads** | **2 0 0** | **2** |
| **HUM** | **19HUM244** | **Understanding Science of Food and Nutrition** | **2 0 0** | **2** |
| **HUM** | **19HUM245** | **Service Learning** | **2 0 0** | **2** |
| **HUM** | **19JAP230** | **Proficiency in Japanese Language (Lower)** | **2 0 0** | **2** |
| **HUM** | **19JAP2313** | **Proficiency in Japanese Language (Higher)** | **2 0 0** | **2** |
| **HUM** | **19KAN101** | **Kannada I** | **2 0 0** | **2** |
| **HUM** | **19KAN111** | **Kannada II** | **2 0 0** | **2** |
| **HUM** | **19MAL101** | **Malayalam I** | **2 0 0** | **2** |
| **HUM** | **19MAL111** | **Malayalam II** | **2 0 0** | **2** |
| **HUM** | **19SAN101** | **Sanskrit I** | **2 0 0** | **2** |
| **HUM** | **19SAN111** | **Sanskrit II** | **2 0 0** | **2** |
| **HUM** | **19SWK230** | **Corporate Social Responsibility** | **2 0 0** | **2** |
| **HUM** | **19SWK231** | **Workplace Mental Health** | **2 0 0** | **2** |
| **HUM** | **19TAM101** | **Tamil I** | **2 0 0** | **2** |

# PROGRAMME SPECIFIC OUTCOMES

**PSO1** Develop AI systems using a variety of algorithms and techniques, such as machine learning, natural language processing, computer vision, and robotics, to solve real-world problems and demonstrate proficiency in coding and implementing AI algorithms.

**PSO2** Analyze the performance of AI models and systems using appropriate evaluation metrics and techniques, and apply optimization methods to improve the efficiency and effectiveness of AI algorithms, while considering factors such as accuracy, speed, scalability, and resource utilization.

**PSO3** Develop ethical and responsible AI solutions by considering the ethical implications of AI technologies, including issues related to bias, fairness, transparency, privacy, and security, and propose strategies to mitigate potential ethical concerns in the development and deployment of AI systems.

## SEMESTER 1

| 23MAT106 | Mathematics for Intelligent Systems 1 | L-T-P-C: 3- 0- 2- 4 |
|---|---|---|

**Course Objectives**

- To introduce students to the fundamental concepts and techniques of linear algebra, ordinary differential equations, probability theory, complex numbers, and quantum computing that are necessary for further study in science and related fields.
- To enable students to apply the concepts they learn in practical situations by using analytical and numerical methods to model real-world problems.
- To expose students to the wide range of applications of linear algebra, ordinary differential equations, probability theory, complex numbers, and quantum computing within the scientific field and to inspire them to pursue further study or research in these areas.
- To introduce students to the fundamental concepts of quantum computing
- To develop students' ability to communicate mathematical concepts and solutions clearly and effectively.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply the fundamental concepts of linear algebra and calculus to solve canonical problems analytically and computationally |
| **CO2** | Model and simulate simple physical systems using ordinary differential equations |
| **CO3** | Apply the concept of probability and random variables to solve elementary problems |
| **CO4** | Explain the basic concepts of quantum computing and differentiate it from conventional computing |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | | - | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | 2 | - | 3 | 2 | 3 | 3 | 3 | 2 | - |
| CO4 | 3 | - | - | - | - | - | - | - | 3 | 2 | 3 | 3 | 2 | - | - |

**Syllabus**

**Unit 1**

Basics of Linear Algebra - Linear Dependence and independence of vectors - Gaussian Elimination - Rank of set of vectors forming a matrix - Vector space and Basis set for a Vector space – Dot product and Orthogonality -CR decomposition - Rotation matrices - Eigenvalues and Eigenvectors and its interpretation-Introduction to SVD-Computational experiments using Matlab/Excel/Simulink.

**Unit 2**

Ordinary Linear differential equations, formulation - concept of slope, velocity and acceleration - analytical and numerical solutions- Impulse Response computations- converting higher order into first order equations - examples of ODE modelling in falling objects, satellite and planetary motion, Electrical and mechanical systems– Introduction to solving simple differential equations with Simulink- Introduction to one variable optimization - Taylor series- Computational experiments using Matlab /Excel/Simulink.

**Unit 3**

Introduction to random variables (continuous and discrete), mean, standard deviation, variance, sum of independent random variable, convolution, sum of convolution integral, probability distributions.

**Unit 4**

Introduction to quantum computing, Quantum Computing Roadmap, Quantum Mission in India, A Brief Introduction to Applications of Quantum computers, Quantum Computing Basics, Bracket Notation, Inner product, outer product, concept of state.

**Text Books / References**


*Gilbert Strang, Introduction to Linear Algebra, Fifth Edition, Wellesley-Cambridge Press, 2016.*

*Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*

*William Flannery, Mathematical Modelling and Computational Calculus, Vol-1, Berkeley Science Books, 2013.*

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

*Bernhardt, Chris. Quantum computing for everyone. Mit Press, 2019. (From pages 1 to 36).*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 3) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23PHY104** | **Computational Mechanics 1** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- This course aims to introduce students to the fundamental concepts of computational mechanics, with a focus on developing computational models for mechanical systems using numerical methods.
- This course aims to provide students with a thorough understanding of kinematics,statics, and kinetics and their application to mechanical systems.
- This course aims to equip students with the skills and knowledge necessary to analyze the behavior of mechanical systems using computational mechanics tools and techniques.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply numerical methods to develop computational models for mechanical systems and analyze their behavior |
| **CO2** | Derive constitutive relations for mechanical systems in motion or at rest, including particles and rigid bodies, and use these equations to solve real world problems. |
| **CO3** | Evaluate the results of computational simulations and use this information to make informed decisions about mechanical systems design and optimization |
| **CO4** | Use software tools for computational mechanics, including code for solving equations of motion and simulating mechanical systems |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 3 | - | - | 1 | 1 | 2 | - | 2 | - | - | - |
| CO2 | 3 | 3 | 1 | 1 | 3 | - | - | 1 | 2 | 3 | - | 2 | - | - | - |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | - | 1 | 3 | 3 | - | 2 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 3 | - | - | 1 | 3 | 3 | - | 2 | 2 | 2 | 2 |

**Syllabus**

**Unit 1 Kinematics and Statics**

Position, velocity, and acceleration of particles, Newton's laws of motion, Work and energy, Rigid body kinematics, Translations and Rotations, Alternate representations of Rigid body Rotation - Rotation matrices, Euler angles, Axis-angle representations, Quaternions. Introduction to statics and equilibrium, Free body diagrams, Equilibrium of particles and rigid bodies, Computational aspects of solving kinematics and statics problems of real world systems.

**Unit 2 Introduction to Kinetics**

Cross product of two vectors, Inertial and Non-Inertial frame of reference, Linear momentum, Center of mass, Coriolis, Inertial and Centripetal forces, Acceleration in polar coordinates, Angular velocity, Angular momentum and Torque on particles, Computational aspects of solving kinetics problems of particles.

**Unit 3 Kinetics of Rigid Bodies**

Two particle system angular momentum, Inertia matrix, Moment and product of inertia, Principal axes theorem, Principal axes as eigenvector of Inertia matrix, Parallel axes theorem, Computational aspects of solving kinetics problems of particles, Introduction to Euler-Lagrange and Newton-Euler equations for solving rigid body dynamics. Euler-Lagrange equation derivation using one dimensional point mass example, Application of Euler-Lagrange equation for solving dynamics of simple mechanical systems.

**Text Books / References**


*"Introduction to Computational Mechanics" by B. S. Choo and S. H. Han - 2005, 1st edition*
*"Engineering Mechanics: Dynamics" by J.L. Meriam and L.G. Kraige - 2016, 8th edition*
*"Engineering Mechanics: Statics" by J.L. Meriam and L.G. Kraige - 2016, 8th edition*
*"Vector Mechanics for Engineers: Statics and Dynamics" by Ferdinand P. Beer and E. Russell Johnston Jr. - 2015, 11th edition*
*"Mechanics of Materials" by James M. Gere and Barry J. Goodno - 2018, 9th edition*
*"Introduction to Classical Mechanics: With Problems and Solutions" by David Morin - 2008, 1st edition*
*Engineering Mechanics: Statics and Dynamics" by Irving H. Shames –2002, 4th edition.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 23AID101 | Computational Thinking | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- Provide an insight on the importance of computational thinking
- Help to develop skills to solve problems using spreadsheet and matlab
- Provide logical thinking capabilities to solve problems .

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Develop critical thinking |
| **CO2** | Apply logical thinking to solve problems |
| **CO3** | Develop skills to use spreadsheet for problem solving |
| **CO4** | Develop skills to use matlab for problem solving |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 | 1 |
| CO2 | 2 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 | 1 |
| CO3 | 2 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 | 1 |
| CO4 | 2 | 3 | - | 2 | 2 | - | - | - | - | - | - | - | 1 | 2 | 1 |

**Syllabus**

**Unit 1**

Computational Thinking, critical thinking, data representation, abstraction, decomposition- breaking problems into parts, basic data types, pseudocode, algorithms-methods to solve the problems, brute-force or exhaustive search problems, divide and conquer problems

**Unit 2**

Computational Thinking using spreadsheets, basic operations, cell references – relative and absolute, lookup operations, implement fractals – newton, Sierpinski triangle, L-system fractals, solve calculus based problems using spreadsheet, using spreadsheet for solving probability related problems

**Unit 3**

Computational thinking using matlab, basic operations, plotting of vectors, array and matrix operations, implement fractals – newton, Sierpinski triangle, L-system fractals, solve calculus based problems using matlab, using matlab for solving probability related problems

**Text Books / References**


*Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018*
*Beecher K. Computational Thinking: A beginner's guide to Problem-solving and Programming. BCS Learning & Development Limited; 2017.*
*Irfan Turk, Matlab programming, 2018*
*Noreen Brown, Beginning Excel 2019, 2019* .


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 23AID102 | Elements of Computing - 1 | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- The course will introduce the principles of number system conversions, Boolean logic, logic gates, and Boolean algebra.
- The course will aid the students in the design and analysis of combinational and sequential logic circuits.
- The course will also equip students to build a general-purpose computing system using elementary NAND gates through a simulation software

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Demonstrate proficiency in performing number system conversion, manipulating Boolean Algebra expressions and realization of basic gates . |
| **CO2** | Implement different combinational logic circuits. |
| **CO3** | Implement different sequential logic circuits |
| **CO4** | Build a general-purpose computer using elementary NAND gates through a simulation software |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 2 | 2 |

**Syllabus**

**Unit 1**

Number System, Conversions, Signed and Unsigned Binary Number Representation, Boolean algebra and Karnaugh Maps, Logic gates, Realization of basic gates using universal gates, Boolean function synthesis, Introduction to Hardware simulator platform Nand2teris, Hardware description language, Implementation of basic gates and its multi-bit and multiway versions in Nand2teris software suite.

**Unit 2**

Combinational Logic, Half Adder, Full Adder, Multiplexer and demultiplexer, Multi-bit and Multiway versions, Realization of Boolean functions using combinational logic, Arithmetic logic unit (ALU)- specification, design, Sequential logic, Flip Flops, Registers, RAM, ROM.

**Unit 3**

Von-Neumann architecture, Program Counter, Central Processing unit, Data Memory, Hack machine language specifications/ instructions for CPU design, Hack CPU Design, CPU Control logic, building a Hack Computer.

**Text Books / References**


*Noam Nisan and Shimon Schocken, "Elements of Computing Systems", MIT Press, 2012.*
*M. Morris Mano, "Digital Design", 5th Edition, Pearson Education (Singapore) Pvt. Ltd., New Delhi,2014.*
*John. M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.*
*Anil K. Maini, "Digital Electronics", Wiley, 2014.*
*Thomas L. Floyd, "Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011.*
*Donald D.Givone, "Digital Principles and Design", TMH, 2003.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23EEE103** | **Introduction to Electrical Engineering** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- To develop the understanding of both AC and DC circuits.
- To acquire the knowledge of circuit analysis techniques for solving both AC and DC circuits
- To learn state space modelling and solution of DC circuits.
- To establish connections between the concepts of electrical engineering, mathematics, and computational solution methods.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply and analyse circuit laws and the analysis techniques for solving electric circuits |
| **CO2** | Comprehend the transient behaviour of DC circuits and generate solutions computationally |
| **CO3** | Use the concepts of Thevenin and Norton equivalent networks to simplify complex circuits |
| **CO4** | Computationally solve the state space model of electric circuits |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | - | - | 3 | 2 | 3 | 3 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | - | - | 3 | 2 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 3 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | - | 3 | 2 | 3 | 3 | 3 | 3 | 2 |

**Syllabus**

**Unit 1 DC Circuit**

EMF, Charge, Voltage, Current - Linear circuit elements – Energy and power - Ohms law – Kirchhoff's voltage and current law – Series parallel combination of R, L, C components – Voltage divider and current divider rules – Super position theorem – Nodal and Mesh Analysis – Step response of RL and RC Circuits (Transient behaviour) – Equivalent network: Thevenin and Norton.

**Unit 2 AC Circuit**

Impedance - Instantaneous, Average, Active, Reactive and Apparent Power – Power Factor – Phasors

**Unit 3 Introduction to Control Systems**

State Space Representation: State, State variable, and State Model – Canonical state space model for Series RLC Circuit – Solution using eigen values and eigen vectors.

**Text Books / References**


*"Basic Electrical Engineering" by D. P. Kothari and J. Nagrath (4th edition), McGraw Hill, 2019.*

*"Electric Circuits" by James W. Nilsson and Susan Riedel (11th edition), Pearson, 2018.*

*"Modern Control Engineering" by Ogata (5th edition), Pearson, 2009.*

*"Linear Control Systems with MATLAB Applications" by B.S. Manke, Khanna, 12th edition, 2016 .*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23BIO112** | **Introduction to Biological Data** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- The course is aimed at educating students on fundamentals concept of biomolecules (sequence, structure, conformational state and functions) and the central dogma of biology.
- To teach them how to read /write molecular structure and sequence from specific file using scripting language (like awk, LINUX command vim) and introduced with LINUX system.
- It will explore different biological databases (Uniport, RSCB, GeneBank, PDBbind etc) and teach how to extract data from those databases.
- Ontology: Storing data in a structured manner through ontologies
- Teach fundamental concept to process the bio-signal and biomedical images.
- The fundamental concept of regression and classification will be introduced using example of biological data set.
- Introduced students with the biological visualization software (PyMol, VMD, ChemDraw, Arena3D etc.) and different webservers.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Develop ability to process (read, write, and analyse) biological data. |
| **CO2** | Analysis of different biological data |
| **CO3** | Design AI and ML research problem to address biological research problem |
| **CO4** | Develop knowledge to use different visualization tools and write script to handle software by command line |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | 3 | - | - | 2 | 3 | 3 | - | - | - |
| CO2 | 3 | 3 | 3 | 3 | 3 | 1 | - | - | 3 | 2 | 3 | 3 | 2 | - | - |
| CO3 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 1 | - | - | 3 | 2 | 3 | 3 | - | - | - |

**Syllabus**

**Unit 1**

Introduction to nucleic acid and protein sequence, structure, and function – introduction of drug molecules - Scripting language / Linux command to handle big biological data files (sequence and structure) – programming using python and R – Linux commands.

**Unit 2**

Explore different biological databases (RCSB, GenBank, DrugBank etc.) – introduction to protein family and onotology - protein functional database (Pfam, GO etc.) - extract data from database using scripting languages (awk, bash)

**Unit 3**

Biomolecular sequence descriptors – presents biomolecular structure using graph – quantify dynamics natures of biomolecules - scoring matrices to describe evolution relationship – fundamental of biomedical image analysis using python and MATLAB (CT scan, mammography, MRI etc.) – biomedical signal (ECG, EEG etc.) visualization and annotation using MATLAB -Virtualization software (PyMol, VMD etc) – TCL and Python programming to write code for PyMol and VMD.

**Unit 4**

Application of AI and machine learning to predict biological activity of biomolecules (regression) – AI-based biomolecular structure prediction models – Binary and multi classification problems related to biological data..

**Text Books / References**


*“Introduction to Protein Structure” by Carl Ivar Branden, John Tooze*

*Ramachandran, G.N., and Sasisekharan, V. Advances in Protein Chemistry, Vol. 23, Academic Press, P. 283 (1968).*

*Schulz and Schirmer, Principles of Protein Structure, Springer-Verlag (1979).*

*Wolfram Saenger. Principles of Nucleic Acid Structure (19840).*

*UNIX: Concepts and Applications Sumitabha Das*

*“Bioinformatics: Sequence and Genome Analysis” by David mount*

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

*"Bio-Inspired Computation and Applications in Image Processing" by João Paulo Papa and Xin-She Yang Professor*

*ECG Signal Processing, Classification and Interpretation: A Comprehensive Framework of Computational Intelligence" by Witold Pedrycz and Adam Gacek.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 25 |
| Quizzes (minimum 2) | Internal | 20 |
| Viva | Internal | 10 |
| Mid-Term Examination | Internal | 15 |
| Term Project/ End Semester Examination | External | 30 |

| **22ADM101** | **Foundations of Indian Heritage** | **L-T-P-C: 2- 0- 1- 2** |
|---|---|---|

**Course Objectives**

- The course is designed as an introductory guide to the variegated dimensions of Indian cultural and intellectual heritage, to enable students to obtain a synoptic view of the grandiose achievements of India in diverse fields.
- It will equip students with concrete knowledge of their country and the mind of its people and instil in them some of the great values of Indian culture.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma's life and vision of holistic education |
| **CO2** | Understand the foundational concepts of Indian civilization like puruśārtha-s, law of karma and varṇāśrama |
| **CO3** | Gain a positive appreciation of Indian culture, traditions, customs and practices |
| **CO4** | Imbibe spirit of living in harmony with nature, and principles and practices of Yoga |
| **CO5** | Get guidelines for healthy and happy living from the great spiritual masters |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | - | - | - | - | - | 3 | 2 | 3 | - | - | - | 2 | - | - | - |
| CO2 | - | - | - | - | - | 3 | 1 | 3 | - | - | - | 2 | - | - | - |
| CO3 | - | - | - | - | - | 3 | 1 | 3 | - | - | - | 2 | - | - | - |
| CO4 | - | - | - | - | - | 3 | 3 | 3 | - | - | - | 2 | - | - | - |
| CO5 | - | - | - | - | - | 3 | 1 | 3 | - | - | - | 2 | - | - | - |

**Syllabus**

**Unit 1**

Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; Amma's life

and vision of holistic education.

**Unit 2**

Goals of Life – Purusharthas; Introduction to Varnasrama Dharma; Law of Karma; Practices for Happiness.

**Unit 3**

Symbols of Indian Culture; Festivals of India; Living in Harmony with Nature; Relevance of Epics in Modern Era; Lessons from Ramayana; Life and Work of Great Seers of India.

**Text Books / References**

*Cultural Education Resource Material Semester-1*

*The Eternal Truth (A compilation of Amma's teachings on Indian Culture)*

*Eternal Values for a Changing Society. Swami Ranganathananda. BharatiyaVidyaBhavan.*

*Awaken Children (Dialogues with Mata Amritanandamayi) Volumes 1 to 9*

*My India, India Eternal. Swami Vivekananda. Ramakrishna Mission*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Periodical 1 (P1) | Internal | 15 |
| Periodical 2 (P2) | Internal | 15 |
| *Continuous Assessment (CA) | Internal | 20 |
| End Semester | External | 50 |

*CA – Can be Quizzes, Assignment, Projects, and Reports.

| **22AVP103** | **Mastery Over Mind (MAOM)** | **L-T-P-C:1-0-2-2** |
|---|---|---|

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | To be able to describe what meditation is and to understand its health benefits |
| **CO2** | To understand the causes of stress and how meditation improves well-being. |
| **CO3** | To understand the science of meditation. |
| **CO4** | To learn and practice MA OM meditation in daily life. |
| **CO5** | To understand the application of meditation to improve communication and relationships. |
| **CO6** | To be able to understand the power of meditation in compassion-driven action. |

**Syllabus**

**Unit 1: Describe Meditation and Understand its Benefits**

A:Importance of meditation. How does meditation help to overcome obstacles in life (Pre-recorded video with Swami Shubhamritananda Puri)

Reading 1: Why Meditate? (Swami Shubamritananda ji)

MA OM Mastery Over Mind, School of Spiritual and Cultural Studies| Amritapuri Campus Course Outline, September 2022

Reading 2: 'Stillness of the Mind' Chapter 17 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

Additional Reading: Abhyasa Yoga: The Yoga of Practice. (Br. Achyutamrita Chaitanya)

B:Understand how meditation works. Understand how meditation helps in improving physical and mental health. Understand how meditation helps in the development of personality (Pre-recorded video with Dr. Ram Manohar).

**Unit 2: Causes of Stress and How Meditation Improves Well-being**

A:Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in supporting meditation. (Pre-recorded video with Dr. Ram Manohar)

Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace. (Pre-recorded video with Prof Udhaykumar)

Reading 1: Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress. Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in-depth/meditation/art-20045858 (PDF provided)

Reading 2: 'Efficient Action.' Chapter 28 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

**Unit 3: The Science of Meditation**

A:Learn how to prepare for meditation. Understand the aids that can help in effectively practicing meditation. Understand the role of sleep, physical activity, and a balanced diet in supporting meditation. (Pre-recorded video with Dr. Ram Manohar)

B:Causes of Stress. The problem of not being relaxed. Effects of stress on health. How meditation helps to relieve stress. Basics of stress management at home and the workplace. (Pre-recorded video with Prof Udhaykumar)

Reading 1: Mayo Clinic Staff (2022, April 29). Meditation: A Simple, Fast Way to Reduce Stress. Mayo Clinic. https://www.mayoclinic.org/tests-procedures/meditation/in-depth/meditation/art-20045858 (PDF provided)

Reading 2: 'Efficient Action.' Chapter 28 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

**Unit 4: Practicing MA OM Meditation in Daily Life**

Guided Meditation Sessions following scripts provided (Level One to Level Five)

Reading 1: MA OM and White Flower Meditation: A Brief Note (Swami Atmananda Puri)

Reading 2: 'Live in the Present Moment.' Chapter 71 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

**Unit 5: Improving Communication and Relationships**

How meditation and mindfulness influence interpersonal communication. The role of meditation in improving relationship quality in the family, at the university and in the workplace. (Pre-recorded video with Dr Shobhana Madhavan)

Reading 1: Seppala E (2022, June 30th) 5 Unexpected Ways Meditation Improves

Relationships a Lot. Psychology Today.

https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-ways-

meditation-improves-relationships-lot

Reading 2: 'Attitude.' Chapter 53 in Amritam Gamaya (2022). Mata Amritanandamayi Mission Trust.

**Unit 6 Meditation and Compassion-driven Action**

Understand how meditation can help to motivate compassion-driven action. (Pre-recorded video with Dr Shobhana Madhavan)

Reading 1: Schindler, S., & Friese, M. (2022). The relation of mindfulness and prosocial

behavior: What do we (not) know?. Current Opinion in Psychology, 44, 151-156.

Reading 2: 'Sympathy and Compassion.' Chapter 100 in Amritam Gamaya (2022). Mata Amritanandamyi Mission Trust.

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Reflection | Internal | 20 |
| Group Activities | Internal | 20 |
| Class Participation | Internal | 40 |
| Written Examination | Internal | 20 |

| **19ENG111** | **Technical Communication** | **L-T-P-C: 2- 0- 3- 3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | To gain knowledge about the mechanics of writing and the elements of formal correspondence |
| **CO2** | To understand and summarise technical documents |
| **CO3** | To apply the basic elements of language in formal correspondence |
| **CO4** | To interpret and analyze information and to organize ideas in a logical and coherent manner |
| **CO5** | To compose project reports/ documents, revise them for language accuracy and make technical presentations |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO2 | - | - | - | 1 | - | - | - | - | - | 2 | - | - | - | - | - |
| CO3 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - |
| CO4 | - | - | - | 1 | - | - | - | - | - | 2 | - | - | - | - | - |
| CO5 | - | - | - | - | - | - | - | - | 2 | 1 | - | - | - | - | - |

**Syllabus**

**Unit 1**

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

General Reading and Listening comprehension - rearrangement & organization of sentences

**Unit 2**

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

Formal Correspondence: Writing formal Letters Mechanics of Writing: impersonal passive & punctuation Scientific Reading & Listening Comprehension

**Unit 3**

Technical paper writing: documentation style - document editing – proof reading - Organising and formatting Mechanics of Writing: Modifiers, phrasal verbs, tone and style, graphical representation

Reading and listening comprehension of technical documents Mini Technical project (10 -12 pages)

Technical presentations

**Text Books / References**


*Hirsh, Herbert. L "Essential Communication Strategies for Scientists, Engineers and Technology Professionals". II Edition. New York: IEEE press, 2002*

*Anderson, Paul. V. "Technical Communication: A Reader-Centred Approach". V Edition. Harcourt Brace College Publication, 2003*

*Strunk, William Jr. and White. EB. "The Elements of Style" New York. Alliyan& Bacon, 1999.*

*Riordan, G. Daniel and Pauley E. Steven. "Technical Report Writing Today" VIII Edition (Indian Adaptation). New Delhi: Biztantra, 2004.*

*Michael Swan. '' Practical English Usage'', Oxford University Press, 2000*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|

| | | |
|---|---|---|
| Periodical 1 | Internal | 10 |
| Periodical 2 | Internal | 10 |
| *Continuous Assessment (Theory) (CAT) | Internal | 10 |
| *Continuous Assessment (Lab) (CAL) | Internal | 40 |
| End Semester | External | 30 |

*CA – Can be Quizzes, Assignment, Projects, and Reports.

## SEMESTER 2

| 23MAT112 | Mathematics for Intelligent Systems 2 | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- To introduce students to the fundamental concepts of linear algebra, differential equations, optimization, and probabilistic modelling
- To enable students to apply the concepts they learn in practical situations by using analytical and numerical methods to model real-world problems.
- To expose students to the wide range of applications of linear algebra, ordinary differential equations, probability theory, and quantum computing within the scientific field and to inspire them to pursue further study or research in these areas.
- To equip students with advanced mathematical knowledge and problem-solving skills highly valued in various industries and research fields.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Implement matrix decomposition techniques to solve linear systems of equations. |
| **CO2** | Formulate optimization problems and solve them using gradient based and Newton's methods |
| **CO3** | Analyse data using fundamental techniques of probability. |
| **CO4** | Explain quantum entanglement, qubits and state vectors |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | | - | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | 2 | - | 3 | 2 | 3 | 3 | 3 | 2 | - |
| CO4 | 3 | - | - | - | - | - | - | - | 3 | 2 | 3 | 3 | 2 | - | - |

**Syllabus**

**Unit 1**

Gaussian elimination – LU decomposition – Vector spaces associated with Matrices- Special orthogonal matrices - Fourier Series and Fourier Transform and its properties – Convolution - Projection matrix and Regression - Convolution sum - Convolution Integral - Eigenvalues and Eigenvectors of Symmetric matrices - Eigenvalues and Eigen vectors of ATA, AAT - Relationship between vector spaces associated with A, ATA, AAT- Singular Value Decomposition – Concept of Pseudoinverse- Computational experiments using MATLAB/Excel/Simulink

**Unit 2**

Taylor series expansion of multivariate functions-conditions for maxima, minima and saddle points-Concept of gradient and Hessian matrices- Impulse Response computations- converting higher order into first order equations – concept of eAT- Multivariate regression and regularized regression -Theory of convex and non-convex optimization-Newton method for unconstrained optimization- Signal processing with regularized regression- Computational experiments using MATLAB/Excel/Simulink

**Unit 3**

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

**Unit 4**

Introduction to quantum computing–Introduction to spin – state vectors – Qubits – Entanglement. Measurement in Quantum Mechanics.

**Textbooks / References**


*Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*

*William Flannery, Mathematical Modelling and Computational Calculus, Vol-1, Berkeley Science Books, 2013.*

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

*Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc*

*Bernhardt, Chris. Quantum computing for everyone. Mit Press, 2019. (From pages 37 to 70).*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23PHY114** | **Computational Mechanics 2** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- This course introduces students to the concepts and techniques of computational applied Mechanics, providing them with a solid foundation in analyzing and solving mechanical engineering problems using computational methods.

- This course equips students with the necessary skills to apply the Finite Element Method (FEM) and Computational Fluid Mechanics (CFD) for the analysis of common robotic applications.
- This course familiarizes students with the basic robotic control and its implementation for simple robotic systems.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply the Finite Element Method (FEM) to solve linear and nonlinear equations, demonstrating proficiency in utilizing FEM for computational analysis of mechanical engineering problems. |
| **CO2** | Analyze stress and strain analysis results, utilizing computational techniques to evaluate the structural behavior of beams and frames. |
| **CO3** | Perform computational fluid dynamics (CFD) simulations to analyze fluid flow over simple 3-dimensional objects.Implement reactive control systems for simple robotic systems. |
| **CO4** | Implement reactive control systems for simple robotic systems. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 3 | - | 2 | - | - | - |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 | 3 | - | 2 | 1 | - | - |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 3 | 1 | 2 | 2 | 1 | - |
| CO4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 3 | - | 2 | 2 | 2 | 1 |

**Syllabus**

**Unit 1 Solid Mechanics**

Stress and strain analysis, Stiffness matrices and element equations, Introduction to Finite Element Method (FEM), Discretization techniques: Meshing and Grid Generation, Solving linear and nonlinear equations using FEM, Finite element analysis software overview and usage, Modeling and analysis of beams and frames.

**Unit 2 Fluid Mechanics**

Introduction to fluids, Conservation of mass, Conservation of momentum, Navier-Stokes equations, Introduction to Computational fluid dynamics (CFD) simulations, Flow in channels & Flow over simple 3-dimensional objects simulations.

**Unit 3 Introduction to Robotics Control**

Chronology of Robotic control systems, Control objectives for robotic control, Model free or Reactive control – Proportional, Proportional Derivative, Proportional Integral, Proportional Integral Derviative controls. Computational aspects of reactive control for simple robotic systems.

**Text Books / References**

*"A First Course in the Finite Element Method" by Daryl L. Logan – 2016, CL Engineering; 6th edition.*

*"MATLAB Guide to Finite Elements: An Interactive Approach" by Peter I. Kattan - 2007, Springer; 2nd edition.*

*"Fluid Mechanics" by Frank M. White & Henry Xue – 2022, McGraw Hill.*

*"Computational Fluid Dynamics: A Practical Approach" by Jiyuan Tu, Guan-Heng Yeoh & Chaoqun Liu – 2018, Butterworth-Heinemann; 3rd edition.*

*Robot Modeling and Control by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar -2005, 1st edition.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID111** | **Object Oriented Programming** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- To introduce Objective Oriented Programming concepts.
- To equip the students to solve engineering problems by applying Object Oriented Concepts.
- To introduce development of GUI based applications.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Represent the problems using objects and classes. |
| **CO2** | Implement object-oriented concepts using the Java language |
| **CO3** | Apply object-oriented concepts to design and visualize programs using UML. |
| **CO4** | Implement applications using object-oriented features. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | - | - | - | 2 | 2 | - | 3 | 1 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | - | 2 | 2 | - | 3 | 1 | 2 | 1 |
| CO3 | 3 | 2 | 3 | 3 | 3 | - | - | - | 2 | 2 | - | 3 | 1 | 2 | 1 |
| CO4 | 3 | 2 | 3 | 3 | 3 | - | - | - | 2 | 2 | - | 3 | 1 | 2 | 1 |

**Syllabus**

**Unit 1**

Introduction to Java Language and Runtime Environment, JVM, Bytecode, Basic program syntax, Datatypes, Variables, Operators, Control statements,Loops,Arrays,Functions.

**Unit 2**

Object-oriented concepts- Abstraction, Encapsulation, Inheritance and Polymorphism. Class and objects, Constructor functions, Class members and methods, Class Instance variables, Garbage collector, Method overloading.

Basics of Inheritance, Types of Inheritance, Super keyword, Final keyword, overriding of methods, Applying and implementing interfaces, Packages-create, access and importing packages. Introduction to UML diagrams.

**Unit 3**

Introduction to exception handling, Hierarchy of exception, Usage of try, catch, throw, throws and finally. Built-in and user defined exceptions, Threads, Creating Threads, Thread lifecycle, Concept of multithreading.

**Unit 4**

Applets-Applet class, Delegation event model-events, event sources, event listeners, event classes, mouse and keyboard events, JLabel, JText, JButton, JList, JCombo box.

**Text Books / References**


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

*Herbert Schildt, Java The Complete Reference, Tata McGraw-Hill Education, Ninth Edition.*

*Sierra, Kathy, and Bert Bates. Head first java. " O'Reilly Media, Inc.", 2003*

*John R. Hubbard, Schaum's Outline of Programming with Java, McGraw-Hill Education, 2004*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID112** | **Data Structures & Algorithms** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Choose an appropriate data structure as applied to a specified problem |
| **CO2** | Use various techniques for representation of the data in the real world |

| | |
|---|---|
| **CO3** | Develop applications using data structures. |
| **CO4** | Test the logical ability for solving problems |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 1 | - |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | 3 | 2 | - |
| CO3 | 3 | 2 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 2 | - |
| CO4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 3 | 2 |

**Syllabus**

**Unit 1**

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

**Unit 2**

Linked List - singly linked list, doubly linked list, circular linked list- properties and functions, implementations, Sorting algorithms – selection, bubble, insertion, quick sort, merge sort, comparison of sorting algorithms, implementation using arrays.

**Unit 3**

Stack data structure, properties and functions, recursion, expression evaluation, Queue data structure - circular queue, double ended queue, properties, and functions

**Unit 4**

Binary Tree– arrays and linked list representation, tree traversals-preorder, postorder, inorder, level order.Graphs-directed and undirected graphs, adjacency list and matrices, Incidence matrices, path, graph traversals – breadth-first and depth-first, Shortest path- Dijkstra's algorithm, Bellman-Ford algorithm, Floyd-Warshall algorithm -

**Text Books / References**


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

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

*Michael T. Goodrich & Roberto Tamassia, Data Structures and Algorithms in Java,Wiley India Edition, Third Edition*

*Narasimha Karumanchi, Data Structures and Algorithms Made Easy in Java, CarrerMonk, 2011*

*Y. Langsam, M. Augenstin and A. Tannenbaum, Data Structures using C and C++, Pearson Education, 2002.*

*Lipschutz Seymour, Data Structures with C (Schaum's Outline Series), McGraw Hill Education India, 2004*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID113** | **Elements of Computing -2** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- This course aims to provide an integrative, project-oriented approach to build software layers of a general-purpose computer system.
- The course will take the students through a series of software-layer construction tasks.
- This course will demonstrate how theoretical and applied techniques taught in other computer science courses are used in practice.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Develop and execute programs in low-level languages such as Hack machine language and assembly language |
| **CO2** | Create virtual machine specification or VM code for high-level and assembly languages |
| **CO3** | Develop programs in object-based language 'Jack' |
| **CO4** | Execute experiments related to basic concepts and functions of operating systems/compilers |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 3 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 2 | 2 |

**Syllabus**

**Unit 1**

Basic Computer architecture, Basic Elements of Machine Language, Hack Machine language, different sets of instructions, Hack programming, Assembly language vs Machine language, Assembler- assembly process, Hack assembly language, assembly language to binary conversions.

**Unit 2**

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

**Unit 3**

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

**Text Books / References**

*Nisan, Noam, and Shimon Schocken. The elements of computing systems: building a modern computer from first principles. MIT press, 2005*

*M. Morris Mano Computer System Architecture, Prentice Hall, Third Edition.*

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

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23ECE113** | **Introduction to Electronics** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- The course will lay down the basic concepts and techniques of electronics needed for advanced topics in AI.
- It will explore the concepts through computational/hardware experiments alongside introducing the concepts/theory behind it.
- It will help the students to perceive the engineering problems using the fundamental concepts in electronics.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Explain the basic concepts of analogy and digital electronics |
| **CO2** | Design and implement various electronic circuits using diodes and transistors and demonstrate an understanding of their applications in electronic devices and systems. |
| **CO3** | Design and implement operational amplifier circuits for a range of applications and demonstrate an understanding of their operation and behaviour in electronic systems |
| **CO4** | Model and analyse engineering problems and demonstrate the ability to propose and implement electronic solutions to these problems. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | 3 | 3 | 3 |

**Syllabus**

**Unit 1 Semiconductor Physics**

Conduction in semiconductors, Doping, PN Junction, Semiconductor diodes: PN diodes, Zener diode, Rectifiers and filters, Clipping and clamping circuits, Voltage regulators.

**Unit 2 Transistors**

Bipolar Junction Transistor (BJT), Field Effect Transistors (FET), MOSFET, BJT amplifiers and oscillators, Transistor as a switch - Amplifiers: common amplifier configurations, voltage gain and current gain, input and output impedance, small signal analysis, frequency response, power amplifiers.

**Unit 3 Operational Amplifiers (Op-Amps)**

Ideal characteristics, inverting and non-inverting amplifiers, summing and difference amplifiers, integrators and differentiators, comparators, oscillators, Schmitt trigger, Multivibrators - Feedback Amplifiers - Oscillators - DAC and ADC

**Text Books / References**

*"Microelectronics" by Jacob Millman and A. Grabel, Tata McGraw-Hill Publishers, Second Edition, New Delhi, 1999.*

*"Op-amps and Linear Integrated circuits" by Ramakant Gayakwad, , Prentice Hall, New Delhi, 1988.*

*'Operational Amplifiers and Linear Integrated Circuits' by Robert F. Coughlin and Frederick F. Driscoll, Pearson, 6th edition, 2000.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23CHY115** | **Introduction to Material Informatics** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- Provide a fundamental understanding of the field of material science and informatics, material properties.

- Explore the cutting-edge of modern material informatics tools, including machine learning, data analysis and visualization, and molecular/multiscale modelling.
- Learn how to work with small, spare, and low-quality dataset.
- Analysis material failure and sustainability
- Develop AI-based computational model to design new materials with specific properties.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply modern material informatics tools including machine learning, simulations. Modelling, visualizations to solve a specific challenge most significantly. |
| **CO2** | Analysis material failure and sustainability |
| **CO3** | Design new materials and solve inverse design problem using AI. |
| **CO4** | Developed efficient predictive model using small, spares and low-quality dataset. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 3 | 2 | - | - | 2 | 2 | 1 | 2 | - | 3 | 3 |
| CO2 | 3 | 3 | 1 | 3 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | - | 3 | - |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 3 | 3 | 2 | 2 | 3 | 2 | 3 |

**Syllabus**

**Unit 1**

Introduction to material science – structure, properties, and process spaces - process-structure-property linkages – foundation of material informatics – introduction to molecular mechanism and force field – quantification of dynamics properties of polymers (monte carlo simulation, molecular dynamics simulation, normal mode analysis) – electronics structure of atoms (Gaussian, Gauss view, density functional theory)

**Unit 2**

Quantification and screening of materials properties - property prediction and optimization using AI - materials design and discovery using AI – how to handle small, spared, and low-quality dataset using AI**.**

**Unit 3**

Materials failure and sustainability analysis – new material and inverse materials design concept – solve inverse design using AI – enhance speed, efficacy and cost-effectiveness of material using AI - basic concept of quantum computing in material informatics.

**Unit 4**

Case studies of materials informatics (use of AI) in different fields (e.g. energy, aerospace, biomedical, etc.) - ethical considerations and limitations of materials informatics - future directions and challenges in materials informatics.

**Text Books / References**

*"Material Informatics: Methods, Tools and Applications" by Olexandr Isayev, Alexander Tropsha and Stefano.*

*"Informatics for Materials Science and Engineering" by Krishna Rajan*

*"Machine Learning in Materials Informatics: Methods and Applications by Yuling An*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **22ADM111** | **Glimpses of Glorious India** | **L-T-P-C: 2- 0- 1- 2** |
|---|---|---|

**Course Objectives**

- To deepen students' understanding and further their knowledge about the different aspects of Indian culture and heritage.
- To in still into students a dynamic awareness and understanding of their country's achievements and civilizing influences in various fields and at various epochs.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Get an overview of Indian contribution to the world in the field of science and literature. |
| **CO2** | Understand the foundational concepts of ancient Indian education system. |
| **CO3** | Learn the important concepts of Vedas and Yogasutra-s and their relevance to daily life. |
| **CO4** | Familiarize themselves with the inspirational characters and anecdotes from the Mahābhārata and Bhagavad Gita and Indian history. |
| **CO5** | Gain an understanding of Amma's role in the empowerment of women |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | - | - | - | - | - | 3 | 3 | - | - | - | - | 2 | - | - | - |
| CO2 | - | - | - | - | - | 1 | - | 3 | - | - | - | 2 | - | - | - |
| CO3 | - | - | - | - | - | 3 | 3 | 3 | - | - | - | 2 | - | - | - |
| CO4 | - | - | - | - | - | 3 | 3 | 3 | - | - | - | 2 | - | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - |

**Syllabus**

**Unit 1**

To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India's Scientific System for Personality Refinement.

**Unit 2**

The Vedas: An Overview; One God, Many Forms; Bhagavad Gita – The Handbook for Human Life; Examples of Karma Yoga in Modern India.

**Unit 3**

Chanakya's Guidelines for Successful Life; Role of Women; Conservations with Amma.

**Textbooks / References**

*Cultural Education Resource Material Semester-2*

*Cultural Heritage of India. R.C.Majumdar. Ramakrishna Mission Institute of Culture.*

*The Vedas. Swami ChandrashekharaBharati. BharatiyaVidyaBhavan.*

*Indian Culture and India's Future. Michel Danino. DK Publications.*

*The Beautiful Tree. Dharmapal. DK Publications.*

*India's Rebirth. Sri Aurobindo. Auroville Publications*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Periodical 1 | Internal | 15 |
| Periodical 2 | Internal | 15 |
| *Continuous Assessment (CA) | Internal | 20 |
| End Semester | External | 50 |

*CA – Can be Quizzes, Assignment, Projects, and Reports.

## SEMESTER 3

| 23MAT204 | Mathematics for Intelligent Systems 3 | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- To provide students with advanced knowledge and skills in optimization, PDEs, probability and statistics, and quantum computing.
- To develop students proficiency in solving real-world problems in various domains, including physics, engineering, and computer science using the concepts of optimization, PDEs, and probability.
- To apply the concepts and techniques learned in the course to solve complex problems and communicate their solutions effectively to both technical and non-technical audiences.
- To equip students with advanced mathematical knowledge and problem-solving skills highly valued in various industries and research fields.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply the fundamental techniques of optimization theory to solve data science problems. |
| **CO2** | Analyse and solve computationally, physical systems using the formalism of partial differential equations. |
| **CO3** | Apply Markovian concepts in stochastic sequential systems. |
| **CO4** | Explain Bells Inequality and Quantum gates. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | 3 |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | - |
| CO4 | 3 | - | - | - | - | - | - | - | 3 | 2 | - | 3 | 2 | - | 3 |

**Syllabus**

**Unit 1**

Direct methods for convex functions - sparsity inducing penalty functions- Constrained Convex Optimization problems - Krylov subspace -Conjugate gradient method - formulating problems as LP and QP - Lagrangian multiplier method-KKT conditions - support vector machines- solving by packages (CVXOPT) - Introduction to RKS - Introduction to DMD-Tensor and HoSVD- Linear algebra for AI.

**Unit 2**

Introduction to PDEs - Formulation and numerical solution methods (Finite difference and Fourier) for PDEs in Physics and Engineering- Computational experiments using Matlab/Excel/Simulink.

**Unit 3**

Multivariate Gaussian and weighted least squares - Markov chains - Markov decision Process

**Unit 4**

Introduction to quantum computing-Bells inequality-Quantum gates

**Text Books / References**


*Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*

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

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

*Bernhardt, Chris. Quantum computing for everyone. Mit Press, 2019. (From pages 71 to 140).*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID201** | **Modelling, Simulation & Analysis** | **L-T-P-C: 2- 0- 2-3** |
|---|---|---|

**Course Objectives**

- This course intends to provide students with the ability to create and analyze mathematical models of physical systems using various techniques such as bond graph modeling and system transfer functions.
- This course aims to equip students with the skills to use simulation tools such as MATLAB to simulate and analyze the behavior of dynamic systems and validate and verify simulation models.
- The course aims to develop student's abilities to apply system analysis and optimization techniques such as block diagram algebra, signal flow graphs, state variable formulation, frequency response, and Bode plot, to engineering problems.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply various modeling techniques including physical, mathematical, and computer-based modeling for engineering applications. |
| **CO2** | Analyze different system models, including basic ones such as mechanical, electrical, hydraulic, pneumatic, and thermal systems, and advanced ones such as electro-mechanical, hydro-mechanical, and robotic systems. |
| **CO3** | Apply various methods for modeling and simulating the behavior dynamic systems, including bond graph modeling, simulation using MATLAB, and parameter estimation methods. |
| **CO4** | Design simulations and analysis for engineering problems using optimization, block diagram algebra, signal flow graphs, state variable formulation, frequency response, and Bode plot. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 1 | 1 | - | - | 1 | 2 | 2 | - | 1 | - | - | - |
| CO2 | 3 | 3 | 1 | 1 | 1 | - | 1 | 1 | 2 | 2 | 1 | 1 | - | 1 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 1 | 2 | 2 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 1 |

**Syllabus**

**Unit 1**

Introduction to modelling - Examples of models, Modelling of dynamic systems, Introduction to simulation - Matlab as a simulation tool, Bond graph modelling - Bond graph model and causality, Generation of system equation, Methods of drawing bond graph models - Mechanical systems, Electrical systems. Basic system models – Mechanical systems, Electrical systems, Hydraulic systems, Pneumatic systems, and Thermal systems

**Unit 2**

System models – Linearity and nonlinearity in systems, Combined rotary and translator systems, Electro-Mechanical systems, Hydro-mechanical systems, Robotic systems, Dynamic response of 1st and 2nd order systems, Performance measures for 2nd order system, System transfer functions – 1st and 2nd order systems

**Unit 3**

Block diagram algebra, Signal flow graphs, State variable formulation, Frequency response, Bode plot, Simulation using Matlab, Simulation of - simple and compound pendulums, planar mechanisms, and wheeled mobile robots, Validation and verification of simulation models, Parameter estimation methods, Parameter estimation examples, System identification, Introduction to optimization, Optimization with modeling engineering problems.

**Text Books / References**


*Borutzky, Wolfgang, "Bond Graph Modelling of Engineering Systems", Springer, 2011.*

*Esfandiari, Ramin S. and Bei Lu, "Modeling and Analysis of Dynamic Systems", CRC Press, 2010.*

*Gardner, John F., Bohdan T. Kulakowski, and J. Lowen Shearer. "Dynamic Modeling and Control of Engineering Systems." Publisher: Cambridge University Press; 3rd edition (2008).*

*Karnopp, Dean C., Donald L. Margolis, and Ronald C. Rosenberg. "System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems." Publisher: Wiley; 5th edition (2012).*

*Lennart, L. and Torkel, G., "Modeling of Dynamic Systems", Prentice Hall, 1994.*

*Woods, Robert L. and Kent L. Lawrence. "Modeling and Simulation of Dynamic Systems." Publisher: Prentice Hall; 1st edition (1997).*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 23AID202 | Introduction to Robotics | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- This course aims to provide students with an overview of concepts to applications of robotics.
- This course intends to equip students with the ability to design and analyze simple and elementary robotic systems (Upto 4 DOF systems like SCARA) using mathematical and computational tools.
- This course aims to give students elementary hands-on experience in programming robotic systems using Robotic Toolbox in python/Matlab.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Explain facts pertaining to robotics including history, sub-fields, and applications. |
| **CO2** | Explain the elementary concepts required for modelling robotic systems. |
| **CO3** | Develop mathematical and mechanistic models for simple robotic systems. |
| **CO4** | Use tools such as Robotics toolbox to program and visualize simple robotic systems |

**CO-PO Mapping**

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

**Syllabus**

**Unit 1 Overview of Robotics**

Definition and History of Robots, Applications of robots, Current trend in robotics, Basic mathematics for robotics – Vectors, Matrices and Linear Algebra concepts, Rigid body transformations – Translation and Rotation, Homogeneous Transformation matrix.

**Unit 2 Kinematics of Simple Robotic Systems**

Forward Kinematics of simple industrial robotic systems, Inverse kinematics of simple industrial robotic systems, Differential Kinematics of simple industrial robotic systems, Kinematics of simple wheeled mobile robots.

**Unit 3 Dynamics and Control of Simple Robotic Systems**

Introduction to rigid body kinetics, Euler-Lagrange equation of simple robotic systems, Forward and Inverse dynamics of simple robotic systems, Velocity based control of simple robotic systems, Torque based control of robotic systems.

**Textbooks**

*Corke P. Robotics, Vision and Control. Springer; 2017.*

*Craig J J. Introduction to Robotics: Mechanics and Control. Pearson Publishing, 2017.*

*Spong M.W., Hutchinson S. and Vidyasagar M, Robot Modeling and Control, Wiley, 2006*

*Saha S K, Introduction to Robotics, McGraw Hill publishing, 2014*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID203** | **Software-Defined Communication Systems** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- Understand the basic principles of communication systems, including signal analysis, system characteristics, and different types of modulation/demodulation techniques.
- Develop practical skills in using SDR platforms and tools such as MATLAB Simulink, GNU Radio Companion, RTL-SDR, and Adalm Pluto to implement analog and digital modulation/demodulation techniques and analyse signals/spectra.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyse different signal attributes related to communication system |
| **CO2** | Design and implement basic analog communication techniques using software defined radio platforms |
| **CO3** | Design and implement basic digital communication techniques using software defined radio platforms |
| **CO4** | Develop an appreciation of the role of AI in communication systems |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | 3 | - | - | 3 | 3 | 2 | 2 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 3 | - | - | 3 | 3 | 3 | 2 | 2 | 2 | 1 |

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

**Syllabus**

**Unit 1**

Introduction to communication systems, introduction to signals, different types of signals and their characteristics, concept of system, linear time-invariant (LTI) system, sinusoids- concept of frequency, in-phase and quadrature component, bandwidth, pass band and stop band, Introduction to SDR platforms and devices- MATLAB Simulink and GNU radio Companion (GRC), RTL-SDR and Adalm Pluto. Signal analysis/ spectrum analysis and visualization using SDR tools.

**Unit 2**

Need for modulation, analog modulation schemes, amplitude modulation (AM) and its types - AM-DSB-SC, AM-DSB-TC, SSB. AM Demodulation schemes, angle modulation- frequency modulation (FM) -Narrowband and wideband, phase modulation, FM demodulation, implementation of analog modulation/demodulation schemes using SDR tools.

**Unit 3**

Quadrature amplitude modulation and demodulation, pulse analog modulation schemes, digital carrier modulation/demodulation Schemes- amplitude shift keying (ASK), frequency shift keying (FSK), phase shift keying (PSK), M-ary signalling, BPSK, QPSK, implementation of digital modulation/demodulation schemes using SDR tools. Multicarrier modulation- OFDM, MIMO, Prospects of AI in communication system- radio signal or modulation classification.

**Text Books / References**


*Wyglinski, Alexander M., Robin Getz, Travis Collins, and Di Pu. Software-defined radio for engineers. Artech House, 2018.*

*QasimChaudhari, Wireless Communications from the Ground Up: An SDR Perspective, 2018*

*Andrew Barron, Software Defined Radio: for Amateur Radio Operators and Shortwave Listeners, 2019*

*C.R. Johnson and W.A. Sethares, Software Receiver Design: Build Your Own Digital Communication System in Five Easy Steps, Cambridge University Press, 2011*

*Proakis, John G., Masoud Salehi, and Gerhard Bauch. Contemporary communication systems using MATLAB. Cengage Learning, 2012.*

*Wyglinski, Alexander M., and Di Pu. Digital communication systems engineering with software-defined radio. Artech House, 2013.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (Minimum 3) | Internal | 30 |
| Quizzes (Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 20 |

| 23AID204 | Advanced Data Structures & Algorithm Analysis | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- To impart various design techniques for formulation of algorithm.
- To understand basic categories of algorithms.
- To comprehend basic complexity classes.
- To acquaint with will know tractable and intractable problems and map solutions to it.

**Course Outcomes**

After completing this course student will be able to,

| | |
|---|---|
| **CO1** | Develop skills for analyzing algorithmic strategies |
| **CO2** | Analyse and apply appropriate algorithmic technique for a given problem |
| **CO3** | Implementing standard algorithms on arrays, strings, trees and graphs |
| **CO4** | Visualize multidimensional geometry of data structure and concurrency. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | - | 3 | 3 | 2 | 3 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | - | - | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 1 | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 1 | - | - | 3 | 3 | 3 | 3 | 2 | 3 | 3 |

**Syllabus**

**Unit 1**

Full binary tree, complete binary tree, perfect binary tree, balanced binary tree, binary search tree, properties and functions

**Unit 2**

Binary Heap Data Structure-Heap property, properties and functions, Heapsort, AVL Tree – balance factor, rotating the subtrees in an AVL tree –right rotation, left rotations, left-right and right-left rotate, operations on AVL trees- insertion and deletion

**Unit 3**

Trie data structure- basic operations, simple problems, Hashing and Hash Tables – hash functions, collision, collision avoidance methods, Merkel trees

**Unit 4**

Fundamentals of the Analysis of Algorithmic Efficiency –Asymptotic Notations and growth rate- Empirical Analysis - Divide and Conquer Methodology - Dynamic programming - Knapsack Problem and Memory functions. Greedy Technique - Iterative methods – Backtracking - Branch and Bound

**Text Books / References**


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

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

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

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

*Jeffrey McConnell, Analysis of algorithms. Jones & Bartlett Publishers, 2nd Revised edition, 2007*

*Anany Levitin, Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education, 2012*

*Harsh Bhasin, Algorithms Design and Analysis, Oxford university press, 2016*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID205** | **Introduction to AI and Machine Learning** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- To introduce fundamentals of AI.
- To introduce fundamentals of Data Science.
- To introduce different tools and techniques used in AI and Data Science.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyse different elements of an AI system. |
| **CO2** | Analyse different types of data representation. |
| **CO3** | Apply concepts of AI and Data Science to solve canonical problems. |
| **CO4** | Implement basic computational tools pertinent to AI and Data Science to solve canonical problems. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | - | 2 | 3 | 2 | 3 |
| CO2 | 2 | 2 | 2 | 2 | 3 | - | - | - | 2 | 2 | - | 2 | 3 | 2 | 3 |
| CO3 | 2 | 2 | 2 | 2 | 3 | - | - | - | 2 | 2 | - | 2 | 3 | 2 | 3 |
| CO4 | 3 | 2 | 2 | 2 | 3 | - | - | - | 2 | 2 | 2 | 2 | 3 | 2 | 3 |

**Syllabus**

**Unit 1**

History and Foundations of AI and Data Science, Applications of AI and Data Science, Career paths pertinent to AI and Data Science

**Unit 2**

Rational Intelligent Agents, Agents and Environments, Nature of Environments, Structure of Agents. Introduction - Overview of Data Science – Introduction to Statistics: Sampling, Sample Means and Sample Sizes - Descriptive statistics: Central tendency, dispersion, variance, covariance, kurtosis, five-point summary

**Unit 3**

Basic tools for AI and Data Science, Introduction to Data Science process pipeline, Different representations of Data, Importance of pre-processing the data, Elementary Applications of AI and Data Science

**Text Books / References**

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

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

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

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 23AID206 | Introduction to Computer Networks | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objective**

- This course helps students to understand the fundamental networking concepts and standards.
- This course helps students to understand the function of TCP/IP layers and the protocols involved.
- This course helps students to understand the configuration of different networks and routing using simulator/emulator.
- This course helps students to understand the importance and application of artificial intelligence in computer networks
- This course gives an introduction to the concepts of software defined networks and its applications.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyze the requirements for a given organizational structure to select the most appropriate networking architecture and technologies. |
| **CO2** | Analyze the working of protocols in the internet protocol stack for network applications. |
| **CO3** | Configure a router using simulator/emulator. |
| **CO4** | Analyze the network data to detect potential security threats in a network |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | - | - | - | 1 | 2 | 1 | - | 1 | - | - | - | 1 | - | 2 | - |
| CO2 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | 2 | 1 |
| CO3 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | 2 | 1 |
| CO4 | 1 | 1 | 1 | 2 | 2 | 1 | - | 1 | - | - | - | 2 | 1 | - | 1 |

**Syllabus**

**Unit 1**

Basic concepts of computer networks, Internet- network edge, network core, delay, loss, and throughput in packet switched networks, network topology, types of networks, Internet standards and organization. OSI layer stack, protocols in the context of the Internet protocol stack. Introduction to AI powered networks that monitor the connected devices and their bandwidth requirements

**Unit 2**

Application Layer – Protocols in Web and Email applications, Peer-to-Peer Applications. Transport Layer – connection-oriented and connectionless service, protocols, and socket programming. Network Layer – Internet Protocol, Host Addressing for subnets, Routing and Forwarding principles. Data link and Physical layer concepts for wired and wireless network

**Unit 3**

Network security- analyze the network traffic. Introduction to Software Define Networks

**Text Books / References**

*Kurose, James F. Computer networking: A top-down approach featuring the internet, 3/E. Pearson Education India, 2005.*

*Andrew, S. "Tanenbaum–Computer Networks –Prentice Hall." New Jersey (2003).*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 22ADM211 | **Leadership from Ramayana** | **L-T-P-C: 1 0 0 1** |
|---|---|---|

**Syllabus**

**Chapter 1** - Introduction to the Great Itihasa

**Chapter 2** - Bala-Kāṇḍa: (Preparing for the renowned mission.)

And Ayodhya-Kāṇḍa: (Harbinger of an Entire Tradition of Nobleness.)

**Chapter 3** - Araṇya-Kāṇḍa: (Tale of the forest life)

And Kishkindha-Kāṇḍa: (The Empire of Holy Monkeys.)

**Chapter 4** - Sundara-Kāṇḍa: (Heart of the Ramayana)

And Yuddha-Kāṇḍa: (The most popular part of the Ramayana)

**Chapter 5** - Ramayana and Modern-day learning

**Chapter 6** - Ecological Awareness in the Ramayana

**Chapter 7** - Different Ramayana: (Epic that connects the world)

**Chapter 8** - Uttara-Kāṇḍa: (An attempt to explain the untold stories)

**Text Books / References**

*1. Valmiki Ramayana (English translation published by Gita Press)*

*2. Skanda Purana*

*3. Ramayana - C Rajagopalachari .*

| 23LSE201 | Life Skills for Engineers I | L-T-P-C: 1 0 2-2 |
|---|---|---|

**Course Objective**

- Assist students in inculcating Soft Skills and developing a strong personality
- Help them improve their presentation skills
- Support them in developing their problem solving and reasoning skills
- Facilitate the enhancement of their communication skills

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Soft Skills: To develop greater morale and positive attitude to face, analyse, and manage emotions in real life situations, like placement process. |
| **CO2** | Soft Skills: To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews. |
| **CO3** | Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra. |
| **CO4** | Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis. |
| **CO5** | Verbal: To infer the meaning of words and use them in the right context. To have a better understanding of the basics of English grammar and apply them effectively. |
| **CO6** | Verbal: To identify the relationship between words using reasoning skills. To develop the capacity to communicate ideas effectively. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | - | - | - | - | - | - | - | 2 | 3 | 3 | - | 3 | - | - | - |
| CO2 | - | - | - | - | - | - | - | - | 2 | 3 | - | 3 | - | - | - |
| CO3 | - | 3 | - | 2 | - | - | - | - | - | - | - | - | - | - | - |
| CO4 | - | 3 | - | 2 | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | - | - | - | - | - | - | - | - | - | 3 | - | 3 | - | - | - |
| CO6 | - | - | - | - | - | - | - | - | 3 | 3 | - | 3 | - | - | - |

**Syllabus**

**Soft skills and its importance:** Pleasure and pains of transition from an academic environment to work-environment. New-age challenges and distractions. Learning to benefit from constructive criticisms and feedback, Need for change in mindset and up-skilling to keep oneself competent in the professional world.

**Managing Self:** Knowing oneself, Self-perception, Importance of positive attitude, Building and displaying confidence, Avoiding being overconfident, Managing emotions, stress, fear. Developing Resilience and handling failures. Self-motivation, Self-learning, and continuous knowledge up-gradation / Life-long learning. Personal productivity - Goal setting and its importance in career planning, Self-discipline, Importance of values, ethics and integrity, Universal Human Values.

**Aptitude**

**Problem Solving I**

**Numbers:** Types, Power Cycles, Divisibility, Prime, Factors & Multiples, HCF & LCM, Surds, Indices, Square roots, Cube Roots and Simplification.

**Percentage**: Basics, Profit, Loss & Discount, and Simple & Compound Interest.

**Ratio, Proportion & Variation:** Basics, Alligations, Mixtures, and Partnership.

**Averages**: Basics, and Weighted Average.

**Data Interpretation:** Tables, Bar Diagrams, Venn Diagrams, Line Graphs, Pie Charts, Caselets, Mixed Varieties, Network Diagrams and other forms of data representation.

**Verbal**

**Vocabulary**: Familiarize students with the etymology of words, help them realize the relevance of word analysis and enable them to answer synonym and antonym questions. Create an awareness about the frequently misused words, commonly confused words and wrong form of words in English.

**Grammar (Basic)**: Help students learn the usage of structural words and facilitate students to identify errors and correct them.

**Reasoning**: Stress the importance of understanding the relationship between words through analogy questions.

**Speaking Skills:** Make students conscious of the relevance of effective communication in today's world through various individual speaking activities.

**Text Books / References**


*Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.*

*Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.*

*Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K*

*Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*

*The hard truth about Soft Skills, by Amazon Publication.*

*Verbal Skills Activity Book, CIR, AVVP*

*English Grammar & Composition, Wren & Martin*

*Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce*

*Cracking the New GRE 2012*

*Kaplan's – GRE Comprehensive Programme*

*Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.*

*Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.*

*How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.*

*How to Prepare for Data Interpretation for the CAT, Arun Sharma.*


**Evaluation Pattern**

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

## SEMESTER 4

| 23MAT214 | Mathematics for Intelligent Systems 4 | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- To provide students with advanced knowledge and skills in optimization, statistical estimation theory, and quantum computing.
- To understand and analyze special matrices used in various areas of signal processing and data analysis.
- To learn optimization techniques for convex and non-convex problems, and their application to machine learning problems.
- To introduce statistical estimation theory and hypothesis testing, and their relevance to data analysis.
- To provide an overview of quantum computing and its potential applications in various field

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply proximal algorithms, augmented Lagrangian, and ADMM to solve convex and non-convex optimization problems. |
| **CO2** | Develop optimization algorithms used in neural networks. |
| **CO3** | Apply statistical estimation theory and hypothesis testing to data analysis applications. |
| **CO4** | Apply quantum computing concepts to solve problems in various fields including cryptography and optimization. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 2 | 3 | 3 | - | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 2 | 3 | 3 | - | 3 |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 2 | 3 | 3 | - | 3 |
| CO4 | 3 | 3 | 3 | 1 | 3 | - | - | 2 | 3 | 2 | 2 | 3 | 2 | - | 3 |

**Syllabus**

**Unit 1**

Special Matrices: Fourier Transform, discrete and Continuous, Shift matrices and Circulant matrices, The Kronecker product, Toeplitz matrices and shift invariant filters, Hankel matrices, DMD and need of Hankelization - Importance of Hankelization – DMD and its variants - Linear algebra for AI

**Unit 2**

Matrix splitting and Proximal algorithms - Augmented Lagrangian- Introduction to ADMM, ADMM for LP and QP - Optimization methods for Neural Networks: Gradient Descent, Stochastic gradient descent- loss functions and learning functions

**Unit 3**

Basics of statistical estimation theory and testing of hypothesis.

**Unit 4**

Introduction to quantum computing- Bells's circuit, Superdense coding, Quantum teleportation. Programming using Qiskit, Matlab.

**Text Books / References**


*Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*

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

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

*Bernhardt, Chris. Quantum computing for everyone. Mit Press, 2019. (From pages 71 to 140).*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID211** | **Deep Learning** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply the fundamentals of deep learning. |
| **CO2** | Apply deep learning algorithms using Matlab/Python. |
| **CO3** | Apply deep learning models for signal analysis |
| **CO4** | Implement deep learning models for image analysis. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 2 | 2 | - | 3 | 2 | - | - | 3 | 3 | - | 3 | 2 | 3 | 2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 2 | 2 | 2 | 3 | 3 | - | - | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 2 | 2 | 2 | 3 | 3 | - | - | 3 | 3 | 2 | 3 | 3 | 3 | 2 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 3 | - | - | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

**Syllabus**

**Unit 1**

Introduction to neural networks – Gradient Descent Algorithm - Deep Neural Networks (DNN) –Convolutional Neural Network (CNN) – Recurrent Neural Network (RNN): Long-Short- Term-Memory (LSTM).

**Unit 2**

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

**Unit 3**

Image Analysis: Transfer Learning, Attention models- Ensemble Methods for Signal and Image Analysis.

**Textbooks & References:**


*Bishop C.M, "Pattern Recognition and Machine Learning", Springer, 1st Edition, 2006.*

*Goodfellow I, Bengio Y, Courville A, & Bengio Y, "Deep learning", Cambridge: MIT Press, 1st Edition, 2016.*

*Soman K.P, Ramanathan. R, "Digital Signal and Image Processing – The Sparse Way", Elsevier, 1st Edition, 2012.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (Minimum 2) | Internal | 30 |
| Quizzes (Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID212** | **Introduction to IoT** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- To provide hands-on experience in IoT concepts such as sensing, actuation, and communication.
- To develop program skills in Arduino and Raspberry-PI programming for IoT applications.
- To introduce the process of interfacing actuators and sensing devices to Arduino and Raspberry PI.
- To impart the knowledge of networking concepts that enable wired and wireless communication among devices for IoT applications.
- To introduce cloud platforms for storing and implementing IoT applications.

**Course outcomes**

Upon completion of the course, students will be able to,

| | |
|---|---|
| **CO1** | Familiarize with the fundamental concepts of Internet of Things. . |
| **CO2** | Develop skills in programming and hardware platform like Arduino and Raspberry-PI for IOT applications. |
| **CO3** | Familiarize with the design and implementation of IOT protocols and connecting devices for IOT application. |
| **CO4** | Analyse and integrate the IOT applications to cloud service. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 2 | 2 | | 1 | 1 | 1 | 1 | - | - | | | 1 | 1 | 1 | 1 |
| CO2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | - | - | - | 1 | 2 | 2 | 3 | 1 |
| CO3 | 2 | 3 | 1 | 3 | 2 | 1 | 1 | - | - | - | 1 | 2 | 1 | 2 | 1 |
| CO4 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | - | - | - | 1 | 2 | 1 | 2 | 2 |

**Syllabus**

**Unit 1**

Introduction to IOT Overview of machine-to-machine communication - Sensing – Actuations-Basics of Networking- Introduction to Micro-Controllers-Introduction to Embedded systems.

**Unit 2**

Basics of networking for device-to-device communication ,Communication Protocols – wired and wireless communication – Network Topology-Sensor Networks-Introduction to Arduino and Raspberry-PI-Introduction to IOT protocols-MQTT-COAP-Wi-Fi and Bluetooth connections in Arduino-Raspberry-PI Ethernet and Wi-Fi connectivity

**Unit 3**

Programming Arduino and Raspberry-PI Introduction to Arduino programming – Arduino GPIO's – Arduino Digital and Analog Input & Output - Interfacing Sensors to Arduino – Interfacing communication devices to Arduino – Configuring Raspberry-PI-Introduction to python-Programming Raspberry-PI using python-Raspberry-PI GPIO's- Interfacing sensors to Raspberry-PI- Communicating Arduino and Raspberry-PI using ethernet / Bluetooth/ Wi-Fi- Remote Actuation and control of motors, LED's and Relays using Arduino and Raspberry-PI.

**Unit 4**

Introduction to cloud and IOT cloud Services - Cloud services for IOT storage-Introduction to cloud services to visualize IOT data- Streaming IOT data to cloud-Plot and Visualize data using cloud tools- Adding IOT devices to cloud- Integrating Arduino and Raspberry-PI to ThingSpeak /IBM Watson.

**Textbooks/References:**


*The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).*

*Singh, R., Gehlot, A., Gupta, L. R., Singh, B., & Swain, M. (2019). Internet of things with Raspberry Pi and Arduino. CRC Press.*

*Strickland, James R. "Raspberry Pi for Arduino Users." Raspberry Pi for Arduino Users -Building IoT and Network Applications and Devices,(2018).*

*Singh, Rajesh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, and Mahendra Swain. Internet of things with Raspberry Pi and Arduino. CRC Press, 2019.*

*Wallace, Shawn, Matt Richardson, and Wolfram Donat. Getting started with raspberry pi. Maker Media, Inc., 2021.*

*Banzi, Massimo, and Michael Shiloh. Getting started with Arduino. Maker Media, Inc., 2022.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (Minimum 3) | Internal | 30 |
| Quizzes (Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 20 |

| **23AID213** | **Operating Systems** | **L-T-P-C: 3- 0- 2- 4** |
|---|---|---|

**Course Objectives**

- To give insight about design and development of Operating Systems
- To introduce the concepts of process creation and synchronization.
- To introduce the memory management techniques used by the Operating System.
- To understand the adaptation of the concepts by modern Operating Systems.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Illustrate the use of system calls to perform basic Operating System functionalities. |
| **CO2** | Apply the algorithms for resource management |
| **CO3** | Analyze the usage of Synchronization techniques. |
| **CO4** | Analyze memory management techniques. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 2 | 1 | - | - | - | 2 | 2 | - | 1 | 1 | 2 | 1 |
| CO2 | 2 | 3 | 3 | 2 | 1 | - | - | - | 2 | 2 | - | 2 | 1 | 2 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 1 | - | - | - | 2 | 2 | - | 2 | 1 | 2 | 1 |
| CO4 | 2 | 2 | 3 | 1 | 1 | - | - | - | 2 | 2 | - | 2 | 1 | 2 | 1 |

**Syllabus**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Textbook / References**


*Silberschatz and Galvin, "Operating System Concepts", 10th Edition, Wiley India, 2018.*

*Tannenbaum A S, "Modern Operating Systems", Prentice Hall India, 2003.*

*W. Stallings, "Operating Systems: Internals and design Principles", Pearson Ed., LPE, 6th Ed., 2009*

*X. M.J. Bach, "Design of Unix Operating system", Prentice Hall, 1986*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage(%) |
|---|---|---|
| Assignments (Minimum 3) | Internal | 30 |
| Quiz(Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term project/End semester examination | External | 30 |

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

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

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 |
| CO2 | 1 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 |
| CO3 | 2 | 3 | 2 | 3 | - | - | - | 2 | 2 | 2 | 2 | - | - | 1 | 2 |
| CO4 | 1 | 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 2 |

**Syllabus**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Text Books / References**


*Silberschatz A, Korth HF, Sudharshan S. Database System Concepts. Sixth Edition, TMH publishing company limited; 2017.*

*Garcia-Molina H, Ullman JD, Widom J. Database System; The complete book. Second Edition, Pearson Education India, 2011*

*Elmasri R, Navathe SB. Fundamentals of Database Systems. Fifth Edition, Addison Wesley*


**Evaluation Pattern**

| Assessment | Internal / External | Weightage (%) |
|---|---|---|
| Assignments(minimum 3) | Internal | 30 |
| Quiz(minimum 2) | Internal | 20 |
| Midterm Examination | Internal | 20 |
| Project / End Semester Examination | External | 30 |

| **23AID215** | **User Interface Design** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

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

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 2 | 2 | 2 | - | - | 2 | 2 | - | - | - | - | - | - | - | - |
| CO2 | 2 | 2 | 2 | - | - | - | - | - | 3 | - | - | - | - | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO3 | 2 | 2 | 2 | - | - | - | - | - | 3 | - | - | - | - | - | - |
| CO4 | - | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | - | - | - | - |
| CO5 | 2 | 2 | 3 | 2 | 3 | - | - | 3 | 2 | - | - | - | - | - | - |

**Syllabus**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Text Books / References**


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

*Tittel E, Minnick C. Beginning HTML5 and CSS3 For Dummies. Third edition, John Wiley & Sons; 2013.*

*Powell TA, Schneider F. JavaScript: the complete reference. Paperback edition, Tata McGraw-Hill; 2012.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **22ADM201** | **Strategic Lessons from Mahabharata** | **L-T-P-C: 1 0 0 1** |
|---|---|---|

**Syllabus**

**Unit 1 – Unit 4**

Mahābhārata - A Brief Summary

A Preamble to the Grand Itihāsa

The Unbroken Legacy

Dharmic insights of a butcher

**Unit 5 - 8**

The Vows we take: Pratijñā

Mahābhārata - The Encyclopaedia for Kingship and Polity Acumen

Karna: The Maestro that Went Wide of the Mark

Strategical Silhouette of An Extraordinary Peace Mission

**Unit 9 -11**

Yajñaseni, A Woman from Fire.

Popular Regional Tales

Death and Deathlessness

**Unit 12 -14**

Mahabharata- An All-Encompassing Text

Mahabharatha- Whats and What Nots

Mahābhārata in Adages

**Text Books / References**

*The Mahabharata by Bibek Debroy (Translator)*

*Some exemplary characters of Mahabharata by Geeta press.*

*Epic India: by C V Vaidya*

*The Mahabharata as a History and Drama: by Rai Promatha Nath Mullick*

*The Mahabharata- A Criticism: by C V Vaidya*

*The Mahabharata Abridged:by C V Vaidya*

| 23LSE211 | Life Skills for Engineers II | L-T-P-C: 1 0 2-2 |
|---|---|---|

**Course Objectives**

- Assist students in inculcating Soft Skills and developing a strong personality
- Help them improve their presentation skills
- Aid them in developing their problem solving and reasoning skills
- Facilitate them in improving the effectiveness of their communication.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Soft Skills: To develop greater morale and positive attitude to face, analyse, and manage emotions in real life situations, like placement process. |
| **CO2** | Soft Skills: To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews. |
| **CO3** | Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra. |
| **CO4** | Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis. |
| **CO5** | Verbal: To learn to use more appropriate words in the given context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively. |

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

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | 2 | 3 | 3 | | 3 | | | |
| CO2 | | | | | | | | | 2 | 3 | | 3 | | | |
| CO3 | | 3 | | 2 | | | | | | | | | | | |
| CO4 | | 3 | | 2 | | | | | | | | | | | |
| CO5 | | | | | | | | | | 3 | | 3 | | | |
| CO6 | | | | | | | | | 3 | 3 | | 3 | | | |

**Syllabus**

**Soft Skills**

Communication: Process, Language Fluency, Non-verbal, Active listening. Assertiveness vs. aggressiveness. Barriers in communication. Digital communication Presentations: Need, importance, preparations, research and content development, structuring and ensuring flow of the presentation. Ways and means of making an effective presentation: Understanding and connecting with the audience – using storytelling technique, managing time, appropriate language, gestures, posture, facial expressions, tones, intonations and grooming. Importance of practice to make an impactful presentation.

**Aptitude**

**Problem Solving II**

**Equations:** Basics, Linear, Quadratic, Equations of Higher Degree and Problems on ages. Logarithms, Inequalities and Modulus: Basics

**Time and Work:** Basics, Pipes & Cistern, and Work Equivalence.

**Time, Speed and Distance:** Basics, Average Speed, Relative Speed, Boats & Streams, Races and Circular tracks.

**Logical Reasoning:** Arrangements, Sequencing, Scheduling, Venn Diagram, Network Diagrams, Binary Logic, and Logical Connectives.

**Verbal**

**Vocabulary:** Aid students learn to use their vocabulary to complete the given sentences with the right words. Usage of more appropriate words in different contexts is emphasized.

**Grammar (Basic-intermediate):** Help students master usage of grammatical forms and enable students to identify errors and correct them.

**Reasoning:** Emphasize the importance of avoiding the gap (assumption) in arguments/ statements/ communication.

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

**Speaking Skills:** Make students be aware of the importance of impactful communication through individual speaking activities in class.

**Writing Skills:** Introduce formal written communication and keep the students informed about the etiquette of email writing.

**Evaluation Pattern**

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

**Text Books / References**


*Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.*
*Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.*
*Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K*
*Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*
*The hard truth about Soft Skills, by Amazon Publication.*
*Verbal Skills Activity Book, CIR, AVVP*
*English Grammar & Composition, Wren & Martin*
*Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce*
*Cracking the New GRE 2012*
*Kaplan's – GRE Comprehensive Programme*
*Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.*
*Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.*
*How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.*
*How to Prepare for Data Interpretation for the CAT, Arun Sharma.*


## SEMESTER 5

| 23MAT303 | Mathematics for Intelligent Systems 5 | L-T-P-C:2-0-2-3 |
|---|---|---|

**Course Objectives**

- To introduce students to the concepts of probabilistic graphical models and their applications in various fields.
- To teach students the methods of representation learning in Bayesian Networks.
- To enable students to perform inference in Markov Networks and Markov Random Fields.
- To provide an appreciation of probabilistic reasoning required for AI.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Model complex systems using the basics of probabilistic graphical models. |
| **CO2** | Develop a mathematical foundation of Bayesian Networks and their applications in real-world scenarios. |
| **CO3** | Develop directed and undirected graphical models. |
| **CO4** | Apply graphical models to real-world problems such as image recognition, natural language processing, and recommendation systems. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | 3 |
| CO2 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | 3 |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | 3 |
| CO4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 2 | - | 3 |

**Syllabus**

**Unit 1**

Introduction to probabilistic graphical models, Probabilistic AI, Introduction to Bayesian Networks, Representation Learning in Bayesian Networks, Inference in Bayesian Networks

**Unit 2**

Markov Networks, Independencies in Markov Networks, Hidden Markov Models

**Unit 3**

Markov Random Fields (MRF), Decision Networks, From Bayesian Networks to Markov Networks

**Text Books / References**

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

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

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

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (Minimum 3) | Internal | 30 |
| Quiz(Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term project/End semester examination | External | 30 |

| 23AID301 | Computer Vision | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- To introduce students to the state-of-the-art algorithms in image analysis and object recognition.
- Give an exposure to video analysis techniques for object tracking and motion estimation.
- To build good understanding on the computer vision concepts and techniques to be applied for robotic vision applications.
- Enable students to apply the vision algorithms and develop applications in the domain of image analysis and robotic navigation.

.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | To implement different image segmentation approaches |
| **CO2** | To use different deep learning based object detection algorithms for real time applications |
| **CO3** | To use various deep learning based object tracking algorithms on video data |
| **CO4** | To implement 3D reconstruction algorithms for real time applications |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 1 |
| CO3 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 1 |
| CO4 | 3 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 3 | 1 | 1 |

**Syllabus**

**Unit 1**

Image Segmentation Algorithms: contextual, non-contextual segmentation, texture segmentation. Feature Detectors and Descriptors, Feature Matching-Object Recognition, Face detection (Viola Jones), Face Recognition.

**Unit 2**

Modern computer vision architectures based on deep convolutional neural networks, The Use of Motion in Segmentation Optical Flow & Tracking Algorithms, YOLO, DeepSORT: Deep Learning to Track Custom Objects in a Video, Action classification with convolutional neural networks, RNN, LSTM

**Unit 3**

Markov Random Fields (MRF), Decision Networks, From Bayesian Networks to Markov NetworksImage registration, 2D and 3D feature-based alignment, Pose estimation, Geometric intrinsic calibration, - Camera Models and Calibration: Camera Projection Models - Projective Geometry, transformation of 2-d and 3-d, Internal Parameters, Lens Distortion Models, Calibration Methods Geometry of Multiple views - Stereopsis, Camera and Epipolar Geometry, Fundamental matrix; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration., Introduction to SLAM (Simultaneous Localization and Mapping).

**Text Books / References**


*Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach, "Deep Learning (Adaptive Computation and Machine Learning series)", January 2017, MIT Press.*

*Richard Szelinski, "Introduction to Computer Vision and its Application", 2010.*

*E. Trucco and A. Verri, "Introductory techniques for 3D Computer Vision", Prentice Hall, 1998.*

*Marco Treiber, "An Introduction to Object Recognition Selected Algorithms for a Wide Variety of Applications", Springer, 2010.*

*Forsyth and Ponce, "Computer Vision: A Modern Approach", Second Edition, Prentice Hall, 2011.*

*R. C. Gonzalez, R. E. Woods, 'Digital Image Processing', 4th edition Addison-Wesley, 2016.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (Minimum 2) | Internal | 30 |
| Quizzes (Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID302** | **Big Data Analytics** | **L-T-P-C:2-0-2-3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Implement functional and object-oriented programs in Scala, including using higher-order functions, pattern matching, and type classes |
| **CO2** | Create and maintain a Spark deployment, including cluster configuration, resource allocation, and job monitoring |
| **CO3** | Deploy of Spark for various use cases, such as ETL, data warehousing, and real-time analytics. |
| **CO4** | Analyze real-world data sets and extract meaningful insights using statistical and machine learning techniques |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | - | - | - |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | - | - | - |
| CO3 | 3 | 2 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | - | - | - |
| CO4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | - | - | - |

**Syllabus**

**Unit 1**

Introduction to Big Data Analytics: Definition, characteristics, and importance of big data, tools and technologies for big data analytics, State-of-the-art computing paradigms/platforms, Hadoop ecosystem in Brief, Mapper, Reducer.

**Unit 2**

Introduction to Functional Programming (FP), FP concepts in Scala Programming, Mutable and Immutable Data structures, Scala Collections, Type Hierarchy, Higher Order Functions, Closures, ConsList, Tail Recurrsion, Object Oriented Programming in Scala, Introduction to concurrency

**Unit 3**

Basic entity classes and objects in Scala, Spark Architecture, Spark Cluster, Resilient Distributed Datasets (RDDs), Spark Transformations and Actions APIs, DataFrames and Datasets in Spark, Basic Operations on RDDs and DataFrames, lazy evolutions and optimization, Directed Acyclic Graph (DAG)

**Unit 4**

Introduction to Machine Learning with Spark, MLlib and its algorithms, Building a Machine Learning Pipeline in Spark, Case Study in Healthcare, Finance, etc.

**Text Books / References**

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

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

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

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

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (Minimum 3) | Internal | 30 |
| Quiz(Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term project/End semester examination | External | 30 |

| **23AID303** | **Quantum Computing & Algorithms** | **L-T-P-C:2-0-2-3** |
|---|---|---|

**Course Objectives**

- Studying the structural units of quantum computers of the future, forming an understanding of the differences between quantum bits and classical bits.
- Study of basic quantum logical operations and algorithms for processing quantum information.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | The basic principles of quantum computing. |
| **CO2** | The fundamental differences between conventional computing and quantum computing. |
| **CO3** | Several basic quantum computing algorithms. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | - | 3 | 3 | 3 | - | - | - | - | - | - |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | | - | 3 | - | - | - | - | - | - |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | 2 | - | 3 | - | - | - | - | - | - |
| CO4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

**Syllabus**

**Unit 1**

Review of the principles of quantum computation, The Deutsch Jozsa Algorithm, Bernstein Vazirani Algorithm, Simmons Algorithm

**Unit 2**

Shor’s Algorithm, Grover's Search, Grover's algorithm Programming

**Unit 3**

NISQ-era quantum algorithms, Variational Quantum Algorithms

**Unit 4**

Variational Quantum Eigen solver, Quantum Generative Adversarial Networks (QGANs)

**Unit5**.

Applications

**Text Books / References**


*Bernhardt, Chris. Quantum computing for everyone. Mit Press, 2019.*

*Yuly Billing, Quantum Computing for High School Students.*

*Quantum Computation and Quantum Information, M. A. Nielsen & I.Chuang, Cambridge University Press (2000).*

*Gilbert Strang, Introduction to Linear Algebra, Fifth Edition, Wellesley-Cambridge Press, 2016.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|

| | | |
|---|---|---|
| Assignments (Minimum 3) | Internal | 30 |
| Quiz(Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term project/End semester examination | External | 30 |

| **23AID304** | **High-Performance and Cloud Computing** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- Familiarize student with architectural overview of modern HPC and GPU based heterogeneous architectures, focusing on its computing power versus data movement needs.
- Familiarize the students working with cloud platforms and services to configure and use computational resources and storage.
- To educate students how to write efficient parallel programming and GPU programming.
- To discuss various application of HPC computational techniques in computational science.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply high-performance computing in different research field. |
| **CO2** | Design OpenMPI programme and CUDA programme |
| **CO3** | Simulate on cloud computing system. |
| **CO4** | Evaluate how the convergence of HPC and AI is transforming the data science. |

**CO-PO Mapping**

| PO/PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | 2 | 2 | 3 | 2 | - | - | 2 | 1 | 3 | 1 | 1 | - |
| CO2 | 2 | 3 | 3 | 3 | 3 | - | 1 | - | 2 | 1 | 2 | 3 | 3 | 3 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | - | 2 | 1 | 2 | 3 | 2 | 2 | 1 |
| CO4 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 3 | 3 | 3 | 3 |

**Syllabus**

**Unit 1**

Introduction to basic architecture and OS concepts –architecture of parallel computing–shared and distribution memory in parallel computing – parallel algorithm – performance metrices of parallel algorithm.

**Unit 2**

Introduction to OpenMP – essentials of OpenMP – data sharing and synchronization – efficient OpenMP for matrix computing – Introduction to MPI and distributed memory parallel computing – communicating using MPI – Matrix representation of physical system and parallel matrix solvers – domain decomposition techniques

**Unit 3**

Overview of GPU architecture and its evolution –introduction to GPGPU and CUDA – CUDA programming – thread execution in CUDA programming – matrix computing in CUDA -introduction to cuBLAS and cuDNN libraries for linear algebra and deep learning - case studies of GPU: accelerated applications in scientific computing, data analytics, and machine learning

**Unit 4**

Introduction to cloud computing and its importance – benefits and challenges of cloud computing - types of cloud services (IaaS, PaaS, SaaS) and their characteristics - cloud computing architecture and its components - cloud storage and its types - cloud networking and its challenges - cloud security and its importance - cloud application - benefits and challenges of HPC and AI - synergy between HPC and AI - training and inference of AI models using HPC

**Text Books / References**

*"High Performance Computing: Modern Systems and Practices" by Thomas Sterling and Matthew Anderson*

*"CUDA by Example: An Introduction to General-Purpose GPU Programming" by Jason Sanders and Edward Kandrot*

*"Parallel Programming with MPI" by Peter S. Pacheco*

*Comer, D. (2021). The Cloud Computing Book: The Future of Computing Explained. CRC Press*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (Minimum 2) | Internal | 20 |
| Quiz(Minimum 2) | Internal | 20 |
| Mini Project | Internal | 20 |
| Mid-Term Examination | Internal | 10 |
| Term project/End semester examination | External | 30 |

| **23AID305** | **Control System** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- This course introduces the fundamentals of control systems through a hands-on approach involving programming tools such as MATLAB.
- This course familiarizes concepts of control systems, such as open-loop, closed-loop, and feedback systems.
- This course enables the students to judge the performance and stability of control systems

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Explain the fundamental principles that govern control systems. |
| **CO2** | Apply analytical techniques to evaluate and characterize basic control systems. |
| **CO3** | Evaluate the performance and stability of control systems |
| **CO4** | Apply control system theory to practical applications in engineering. |

**CO-PO Mapping**

| PO/PSO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 3 | - | - | - | 3 | 3 | - | 2 | 3 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 1 | - | - | 3 | 3 | - | 2 | 2 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 3 | - | 2 | 2 | 2 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 3 | 1 | - | - | 3 | 3 | - | 3 | 3 | 2 | 1 |

**Syllabus**

**Unit 1**

Introduction to Control Systems and Frequency Domain Methods, Definition and types of control systems, Mathematical modelling of systems, Block diagram and signal flow graph representation of systems, Feedback and control system characteristics, Stability analysis and root locus techniques, Frequency response analysis, Bode plot and Nyquist plot, PID controllers Lead-lag compensators, Design of classical controllers using root locus.

**Unit 2**

State Space Methods State space analysis and design, State-Space representation of control systems: state variables, state-space models, Multivariable control systems: MIMO systems, decoupling, Controllability and observability, Pole placement and observer design, Linear quadratic regulator (LQR) Optimal control, Introduction to nonlinear control

**Unit 3**

Applications of Control Systems, Control of mechanical systems, Control of electrical systems, Control of chemical and biological systems, Introduction to optimal control for aerospace system

**Text Books / References**


*S. L. Brunton and J. N. Kutz, "Data-driven science and engineering: Machine learning, dynamical systems, and control", Cambridge University Press, 2022. ISBN 9781108422093.*

*Ogata Katsuhiko, "Modern control engineering", Prentice Hall, 2010. ISBN 9780136156734.*

*M. F. Golnaraghi, B. C. Kuo, and M. F. Golnaraghi, "Automatic control systems" Wiley, 2010. ISBN9780470048962.*

*N. Nise, "Control systems engineering", 6th ed. John Wiley & Sons, 2017. ISBN 9780470917695.*

*G. F. Franklin, J. D. Powell, and M. L. Workman, "Digital control of dynamic systems", Vol. 3, Ellis Kagle Press, 1998. ISBN 9780979122606.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (Minimum 3) | Internal | 30 |
| Quiz(Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term project/End semester examination | External | 30 |

| 23LSE311 | Life Skills For Engineers III | L-T-P-C : 1 0 2-2 |
|---|---|---|

**Course Objectives**

- Help students understand corporate culture, develop leadership qualities and become good team players
- Assist them in improving group discussion skills
- Help students to sharpen their problem solving and reasoning skills
- Empower students to communicate effectively

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Soft Skills: To improve the inter-personal communication and leadership skills, vital for arriving at win-win situations in Group Discussions and other team activities. |
| **CO2** | Soft Skills: To develop the ability to create better impact in a Group Discussions through examination, participation, perspective-sharing, ideation, listening, brainstorming and consensus. |
| **CO3** | Aptitude: To identify, investigate and arrive at appropriate strategies to solve questions on geometry, statistics, probability and combinatorics. |
| **CO4** | Aptitude: To analyze, understand and apply suitable methods to solve questions on logical reasoning. |
| **CO5** | Verbal: To be able to use diction that is more refined and appropriate and to be competent in spotting grammatical errors and correcting them. |
| **CO6** | Verbal: To be able to logically connect words, phrases, sentences and thereby communicate their perspectives/ideas convincingly. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | | | | | | | | | 3 | 3 | 2 | 3 | | | |
| CO2 | | | | | | | | | | 3 | 2 | 2 | | | |
| CO3 | | 3 | | 2 | | | | | | | | | | | |
| CO4 | | 3 | | 2 | | | | | | | | | | | |
| CO5 | | | | | | | | | | 3 | | 3 | | | |
| CO6 | | | | | | | | | 3 | 3 | | 3 | | | |

**Soft Skills**

**Professional Grooming and Practices:** Basics of corporate culture, key pillars of business etiquette – online and offline: socially acceptable ways of behavior, body language, personal hygiene, professional attire and Cultural adaptability and managing diversity. Handling pressure, multi-tasking. Being enterprising. Adapting to corporate life: Emotional Management (EQ), Adversity Management, Health consciousness. People skills, Critical Thinking and Problem solving.

**Group Discussions:** Advantages of group discussions, Types of group discussion and Roles played in a group discussion. Personality traits evaluated in a group discussion. Initiation techniques and maintaining the flow of the discussion, how to perform well in a group discussion. Summarization/conclusion.

**Aptitude**

**Problem Solving III**

**Geometry:** 2D, 3D, Coordinate Geometry, and Heights & Distance.

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

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

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

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

**Verbal**

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

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

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

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

**Writing Skills:** Practice closet tests that assess basic knowledge and skills in usage and mechanics of writing such as punctuation, basic grammar and usage, sentence structure and rhetorical skills such as writing strategy, organization, and style.

**References:**


*Students" Career Planning Guide, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.*

*Soft Skill Handbook, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.*

*Adair. J., (1986), "Effective Team Building: How to make * winning team", London, U.K*

*Gulati. S., (1006) "Corporate Soft Skills", New Delhi, India: Rupa & Co.*

*The hard truth about Soft Skills, by Amazon Publication.*

*Verbal Skills Activity Book, CIR, AVVP*

*English Grammar & Composition, Wren & Martin*

*Public Sector – Engineer Management Trainee Recruitment Exam (General English)*

*Nova's GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce*

*Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations,*

*Amrita Vishwa Vidyapeetham.*

*Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.*

*How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.*

*How to Prepare for Data Interpretation for the CAT, Arun Sharma.*

*How to Prepare for Logical Reasoning for the CAT, Arun Sharma.*

*Quantitative Aptitude for Competitive Examinations, R S Aggarwal.*

*A Modern Approach to Logical Reasoning, R S Aggarwal.*

*A Modern Approach to Verbal & Non-Verbal Reasoning, R S Aggarwal.*

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

## SEMESTER 6

| **23MAT313** | **Mathematics for Intelligent Systems 6** | **L-T-P-C:2-0-2-3** |
|---|---|---|

**Course Objectives**

- To introduce students to the concept of Neuro-symbolic AI and its significance in artificial intelligence.
- To provide an overview of knowledge graphs and their applications in various domains

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Develop intelligent systems using the concept of Neuro-Symbolic AI. |
| **CO2** | Develop knowledge representation and reasoning techniques in Neuro-Symbolic AI. |
| **CO3** | Apply the concepts of logical neural networks and Markov random fields in Neuro-Symbolic AI |
| **CO4** | Develop hybrid models that combine different AI approaches, such as Neuro-Symbolic AI and deep learning |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | 3 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | 3 |
| CO3 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 3 | - | 3 |
| CO4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | - | 3 | 2 | - | 3 |

**Syllabus**

**Unit 1**

Introduction to Neuro-Symbolic AI: Definition and overview of Neuro-Symbolic AI- Advantages and disadvantages of Neuro-Symbolic AI- Applications of Neuro-Symbolic AI.

**Unit 2**

Knowledge Representation and Reasoning: Reasoning in neuro-symbolic AI - Types of reasoning. Logical Neural Networks-Markov Random Fields-Hybrid Models

**Unit 3**

Explainable AI, Multi-Modal Neuro-Symbolic AI, Future Directions in Neuro-Symbolic AI

**Text Books / References**

*Bouneffouf, Djallel, and Charu C. Aggarwal. "Survey on Applications of Neurosymbolic Artificial Intelligence." arXiv preprint arXiv:2209.12618 (2022).*

*Neuro-Symbolic Artificial Intelligence: The Next Big Step" by Daniele Magazzeni and Tomas Petricek.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID311** | **Analog Computing** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- Learn the principles of analog computing.
- Learn the concepts of Hybrid computing.
- Apply machine learning in Hybrid computing.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Understand the principles of analog computing |
| **CO2** | Understand the concepts of Hybrid computing (Analog and digital computing |
| **CO3** | Computation using Hybrid computing |
| **CO4** | Apply machine learning in Hybrid computing |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | - | - | 3 | 3 | - | - | - | - | 2 | - | - | - |
| CO2 | - | - | - | - | - | 1 | - | 3 | - | - | - | 2 | - | - | - |
| CO3 | - | - | - | - | - | 3 | 3 | 3 | - | - | - | 2 | - | - | - |
| CO4 | - | - | - | - | - | 3 | 3 | 3 | - | - | - | 2 | - | - | - |

**Syllabus**

**Unit 1**

Introduction to analog computer, direct versus indirect analogies, A short history of analog computing, Characteristics of analog computers, Computing elements – machine units, summer, integrators, free elements, potentiometers, function generators, multiplication, comparators and switches, Input/Output devices.

**Unit 2**

Analog computer operation, basic programming – radioactive decay, analytical solutions, using an analog computer, scaling, harmonic functions, sweep, Mathematical pendulum, Straight forward implementation, variants, Mass-spring-damper system, analytical solution, using an analog computer, RLC-circuit

**Unit 3**

Inverse functions, square root, division, power and polynomials, low pass filter, triangle/square wave generator, Ideal diode, absolute value, limiters, dead space, hysteresis, Bang-bang, Minimum/Maximum holding circuits, sample and hold, time derivative, time delay, historic approaches to delay, digitization, sample and hold circuits, analog delay network.

**Unit 4**

Inverse Chemical kinetics, damped pendulum with external force, MATHIEU'S equation, Introduction, Scaling and programming, VANDER POL's equation, Programming, Solving the one dimensional SCHRODINGER equation, Ballistic trajectory, Charged particle in a magnetic field, RUTHERFORD scattering, Celestial mechanics, Bouncing ball, Zombie apocalypse, ROSSLER attractor, LORENZ attractor, another Lorenz attractor, CHAU attractor, Nonliner chaos, AIZAWA attractor, NOSE-HOOVER oscillator, rotating spiral, flow around an airfoil, Heat transfer, Two dimensional heat transfer, systems of linear equations, Human-in-the-loop, Inverted pendulum, Double pendulum

**Unit 5**

Hybrid computing - Hybrid controllers, Basic operations, shell trajectory, data gathering, training an AI with analog computer.

**Textbooks / References**

*Analog and Hybrid computer programming, Bernd Ulmann, CPI books GmbH, Leck*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|

| | | |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID312** | **Reinforcement Learning** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Formulate an application problem as a reinforcement learning problem |
| **CO2** | Implement common reinforcement learning algorithms using Python/Matlab |
| **CO3** | Evaluate reinforcement learning algorithms on the metrics such as regret, sample complexity, computational complexity, empirical performance, and convergence |
| **CO4** | Evaluate different approaches for addressing exploration vs exploitation challenge in terms of performance, scalability, complexity of implementation, and theoretical guarantees |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | - | 1 |
| CO2 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | - | 1 |
| CO3 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | - | - | - | 1 | - | 3 | 1 |
| CO4 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | - | - | - | 1 | - | 3 | 1 |

**Syllabus**

**Unit 1**

Introduction to Reinforcement Learning – History of Reinforcement Learning - Elements of Reinforcement Learning – Limitations and scope

**Unit 2**

Multi-armed Bandits – Finite Markov Decision Processes – Dynamic Programming – Policy evaluation – Policy improvement – Policy Iteration – Value Iteration

**Unit 3**

Monte Carlo Methods – Monte Carlo prediction – Monte Carlo control – Incremental Implementation – Temporal-Difference Learning – TD prediction – Q-Learning - n-step Bootstrapping

**Unit 4**

Planning and Learning with Tabular Methods – Models and planning – Prioritized sweeping – Trajectory sampling – Heuristic search – Rollout algorithms

**Text Books / References**

*Richard.S.Sutton and Andrew G.Barto, Reinforcement Learning, MIT Press, Second Edition, 2018*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23xxxxxx** | **Foundations of Indian Heritage** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Syllabus**

**Unit 1 – Unit 4**

Educational Heritage of Ancient India

Life and Happiness

Impact of Colonialism and Decolonization

A timeline of Early Indian Subcontinent

**Unit- 5 - 8**

Pinnacle of Selflessness and ultimate freedom

Indian approach towards life

Circle of Life

Ocean of love; Indian Mahatmas.

**Unit 9 - 13**

Man's association with Nature

Celebrating life 24/7.

Metaphors and Tropes

Become A Strategic Thinker (Games / Indic activity)

India: In the Views of Other Scholars and Travellers

**Unit 14-16**

Personality Development Through Yoga.

Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness

Conversations on Compassion with Amma

**Text Books / References**

- *The beautiful tree by Dharampal*
- *Peasants and Monks in British India by William Pinch*
- *India, that is Bharat: Coloniality, Civilisation, Constitution by J Sai Deepak*
- *Awaken Children Dialogues with Mata Amritanandamayi*
- *Man and Nature by Mata Amritanandamayi Devi*
- *What Becomes of the Soul After Death, Divine Life Society*

## SEMESTER 7

| 19ENV300 | Environmental Science | P/F |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

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

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | - | - | - | - | - | 3 | 2 | 3 | - | - | - | - | - | - | - |

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

**Syllabus**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Text Books / References**

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

*G.T.Miller Jr., "Environmental Science", 11th Edition, Cenage Learning Pvt. Ltd., 2008.*

*Benny Joseph, "Environmental Studies", Tata McGraw-Hill Publishing company Limited, 2008.*

**Evaluation Pattern**

| Assessment | Internal | External |
|---|---|---|
| Online Test | - | 100 |
| | | P/F |

| **19LAW300** | **Indian Constitution** | **L-T-P-C: P/F** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Understand the functions of the Indian government |

| | |
|---|---|
| **CO2** | Understand and abide the rules of the Indian constitution. |
| **CO3** | Understand and appreciate different culture among the people |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | - | - | - | - | - | 3 | 2 | 3 | - | - | - | - | - | - | - |
| CO2 | - | - | - | - | - | 3 | 2 | 3 | - | - | - | - | - | - | - |
| CO3 | - | - | - | - | - | 3 | 2 | 3 | - | - | - | - | - | - | - |

**Syllabus**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Text Books**

*Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.*

*R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.*

**References**

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

**Evaluation Pattern**

| Assessment | Internal | External |
|---|---|---|
| Online Test | - | 100 |
| | | P/F |

| | | |
|---|---|---|
| **23AID498** | **Project Phase – 1** | **L-T-P-C: 0- 0- 14- 7** |

**Course Objectives**

- Project Phase – 1 aims at helping students to identify the research problems by conducting a thorough

- literature review
- The course introduces the students to real world problems associated with AI
- The course also aims at helping students to publish scientific articles in peer reviewed scientific
- publications.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Identify a valid research problem by conducting literature review in the appropriate area |
| **CO2** | Identify the appropriate methodology to solve the research problem.. |
| **CO3** | Apply the AI tools & techniques to solve the identified problem. |
| **CO4** | Communicate scientific discoveries through peer-reviewed publications. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | - |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | - |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | - |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | - | - | 3 |

**Evaluation Pattern**

| Assessment | Weightage (%) |
|---|---|
| Internal | 70 |
| External | 30 |

## SEMESTER 8

| 23AID499 | Project & Internship | L-T-P-C: 0- 0- 30- 10 |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Solve a valid research problem by employing appropriate tools & techniques. |
| **CO2** | Implement the appropriate methodology to solve the research problem. |
| **CO3** | Apply the AI tools & techniques to solve the identified problem. |
| **CO4** | Communicate scientific discoveries through peer-reviewed publications. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | - |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | - |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | - | - | 3 |

**Evaluation Pattern**

| Assessment | Weightage (%) |
|---|---|
| Internal | 70 |
| External | 30 |

## ELECTIVES

| **23AID431** | **Robotics –Kinematics, Dynamics and Control** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- This course aims to provide students with a solid foundation in the principles of robot kinematics, dynamics, control, navigation, and localization for both industrial and mobile robots.
- This course intends to equip students with the ability to design and analyze common robotic systems using mathematical and computational tools.
- This course aims to give students hands-on experience in programming robots for navigation and control, enabling them to apply their knowledge to practical applications in the field of robotics.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Develop mathematical models for robot kinematics, dynamics, and control systems to solve problems related to robotic systems. |
| **CO2** | Implement simple robotic control systems using different types of control algorithms, such as PD, PID, and adaptive control. |
| **CO3** | Develop machine learning/deep learning models for solving NLP applications Apply gained knowledge of robotic concepts to design and program robots for tasks such as path/trajectory planning, localization, and obstacle avoidance. |
| **CO4** | Use simulation tools to model and analyze the behavior of robotic systems. |

**CO-PO Mapping**

| PO/ | PO | PO | PO | PO | PO | PO | PO | PO | PO | PO | PO | PO | PSO | PSO | PSO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| PSO / CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | 2 | 1 | 1 | | 3 | 3 | | 2 | 2 | - | - |
| CO2 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | | 3 | 3 | | 2 | 2 | 1 | - |
| CO3 | 3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 3 | | 2 | 3 | 2 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 3 | 3 | | 3 | 1 | 1 | 1 |

**Syllabus**

**Unit 1: Industrial Robots – Kinematics**

Introduction to Industrial Robots and their Applications, Robot Coordinates and Transformations, Forward Kinematics, DH parameters and table, Twists, Inverse Kinematics, Differential kinematics, Trajectory Planning

**Unit 2: Industrial Robots - Dynamics and Control**

Robot Dynamics, Euler-Lagrange's Equations, Newton-Euler method, Inverse Dynamics and Trajectory Tracking, PD & PID Control, Adaptive Control, Force Control.

**Unit 3: Mobile Robots - Kinematics, Navigation, and Localization**

Introduction to Mobile Robots and their Applications, Mobile Robot Kinematics, Robot Navigation and Path Planning, Localization Techniques, Simultaneous Localization and Mapping (SLAM)

**Text Books / References**


*Corke P. Robotics, Vision and Control. Springer; 2017.*

*Craig J J. Introduction to Robotics: Mechanics and Control. Pearson Publishing, 2017.*

*Spong M.W., Hutchinson S. and Vidyasagar M, Robot Modeling and Control, Wiley, 2006*

*Saha S K, Introduction to Robotics, McGraw Hill publishing, 2014*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID432** | **Introduction to ROS2** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- This course aims to introduce students to the fundamentals of Robotic Operating System (ROS2) and Gazebo simulation, including key concepts such as nodes, topics, services, and actions, as well as the development of ROS2 packages.
- This course aims to equip students with the knowledge and skills required to apply ROS2 to mobile and industrial robots, including navigation, SLAM, robot arm control, perception, and communication.

- This course aims to provide students with hands-on experience working with ROS2 and Gazebo, allowing them to design, implement, and test robotic applications using these tools.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Program ROS2 packages and utilize ROS2 concepts such as nodes, topics, services, and actions to control, perceive, and communicate with mobile and industrial robots. |
| **CO2** | Apply ROS2 to mobile robots to navigate, use SLAM, and control them effectively. |
| **CO3** | Apply ROS2 to industrial robots to control robotic arms and perform real world tasks within a simulation environment. |
| **CO4** | Evaluate the performance of chatbots using various metrics and techniques. Use Gazebo to simulate robotic applications and test their code effectively, improving the overall proficiency with ROS2. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | | 2 | 1 | | |
| CO2 | 3 | 3 | 3 | 2 | 3 | 1 | | 1 | 3 | 3 | | 2 | 2 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 1 | | 1 | 3 | 3 | | 2 | 2 | 2 | 2 |
| CO4 | 1 | 2 | 2 | 2 | 3 | - | | | 3 | 3 | | 2 | 2 | 2 | 1 |

**Syllabus**

**Unit 1: Introduction to ROS2**

Overview of ROS2 architecture and communication protocols, Comparison with ROS1, setting up ROS2 environment and creating a ROS2 package, Introduction to ROS2 command-line tools, Basic ROS2 concepts such as nodes, topics, messages, and services, Introduction to Gazebo simulator.

**Unit 2: Advanced ROS2 Concepts**

ROS2 middleware and communication mechanisms, ROS2 launch files and parameter management, ROS2 package dependencies and ROS2 ecosystem, Advanced ROS2 concepts such as actions and transformations.

**Unit 3: ROS2 Applications in Mobile and Industrial Robotics**

Introduction to ROS2-based mobile robot navigation, Overview of ROS2-based industrial robot control, Integration of ROS2 with sensors and actuators for mobile and industrial robots, ROS2-based robot perception and manipulation.

**Text Books / References**

*Rico, F. M. A Concise Introduction to Robot Programming with ROS2. CRC Press; 2023.*

*Nehmzow U. Mobile robotics: a practical introduction. Springer Science & Business Media; 2012.*

*P. Corke, Robotics, Vision, and Control, Springer, 2011.*

*Ros2 Humble Tutorial: https://docs.ros.org/en/humble/Tutorials.html*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID433** | **NLP for Robotics** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- The course aims to introduce spoken language technology with an emphasis on dialog and conversational systems
- The course helps in establishing the understanding of Deep learning and other methods for automatic speech recognition, speech synthesis systems for robotics

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Demonstrate understanding of acoustic phonetics in the context of spoken language. |
| **CO2** | Analyze different types of dialog systems and their applications. |
| **CO3** | Apply AI techniques used in dialog systems. |
| **CO4** | Implement automatic speech recognition, text-to-speech synthesis, and evaluation. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 0 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 3 | 2 | 3 | 0 | 0 | 0 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 0 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 1 |

**Syllabus**

**Unit 1**

Introduction and Acoustic Phonetics, Overview of dialog: Human conversation. Task-oriented dialog. Dialog systems, Machine Learning in Dialog- Recurrent NNs, Attention, Transformers

**Unit 2**

Automatic Speech Recognition, Foundation models for spoken language-Using the Speech Brain ASR toolkit, Advanced ASR

**Unit 3**

Text to Speech (TTS): Overview. Text normalization, Spectrogram prediction, Vocoding, TTS, Evaluation.

**Text Books / References**

*Dan Jurafsky and James H. Martin. Speech and Language Processing, (3rd ed. draft), available at https://web.stanford.edu/~jurafsky/slp3/*

*Yoav Goldberg. A Primer on Neural Network Models for Natural Language Processing. Available at https://u.cs.biu.ac.il/~yogo/nnlp.pdf*

*Ian Goodfellow, Yoshua Bengio, and Aaron Courville. Deep Learning. MIT Press. Available at https://www.deeplearningbook.org/*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID434** | **Robotics Vision** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

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

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | - | 2 | 2 | 1 | 1 | 1 | - | - | - | - | - | - |
| CO2 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 1 | - | - | - | - | - |
| CO3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | - | - | - | - | - |
| CO4 | 3 | 3 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | - | - | - | - | - |

**Syllabus**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

Recognition – object detection, face recognition, instance recognition, category recognition, Stereo

Correspondence – Epipolar geometry, 3D reconstruction.

**Text Books / References**


*Szeliski R. Computer Vision: Algorithms and Applications Springer. New York. 2010..*

*Shapiro LG, Stockman GC. Computer Vision: Theory and Applications. 2001.*

*Forsyth DA, Ponce J. Computer Vision: a modern approach;2012.*

*Davies ER. Machine vision: theory, algorithms, practicalities. Elsevier; 2004 Dec 22.*

*Jain R, Kasturi R, Schunck BG. Machine vision. New York: McGraw-Hill; 1995 Mar 1*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID435** | **Mobile Robotics** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- This course aims to provide students with a comprehensive understanding of the underlying principles and technologies used in designing, implementing, and controlling autonomous mobile robots.
- This course seeks to equip students with practical skills in perception and control of mobile robots, including sensing and estimation, basic and advanced control techniques, and sensor fusion and localization.
- This course intends to introduce students to advanced topics in mobile robotics, such as path planning and navigation, motion planning and control, multi-robot systems, and human-robot interaction, providing them with the knowledge necessary to develop and implement cutting-edge mobile robotic applications.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Design autonomous mobile robot systems using the fundamental principles and technologies. |
| **CO2** | Apply perception and control techniques to mobile robotics, to solve real-world mobile robotic challenges. |
| **CO3** | Use advanced techniques in mobile robotics to design mobile robotic systems that can operate in complex and dynamic environments. |
| **CO4** | Analyze the capabilities and limitations of mobile robotic systems in the light of potential impact on society and various industries. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | - | 2 | 2 | 1 | - |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | - | 2 | 2 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | - | 2 | 2 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | - | 2 | 2 | 2 | 3 |

**Syllabus**

**Unit 1: Introduction to Mobile Robotics**

Introduction to Mobile Robotics, Brief history of Mobile Robotics, Overview of Mobile Robotics applications, Locomotion Systems in Mobile Robotics, Sensors in Mobile Robotics.

**Unit 2: Perception and Control**

Perception: Sensing and Estimation, Control: Basic and Advanced Techniques, Sensor Fusion and Localization, Mapping and SLAM (Simultaneous Localization and Mapping).

**Unit 3: Advanced Topics in Mobile Robotics**

Path Planning and Navigation, Motion Planning and Control, Multi-robot Systems, Human-Robot Interaction.

**Text Books / References**

*Siegwart R, Nourbakhsh IR, Scaramuzza D. Introduction to autonomous mobile robots. MIT press; 2011.*

*Nehmzow U. Mobile robotics: a practical introduction. Springer Science & Business Media; 2012.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 23AID436 | Artificial Intelligence for Robotics | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- This course aims to introduce students to the fundamentals of artificial intelligence and machine learning techniques and their applications to robotics, including perception, planning, and control.
- This course will help students understand the challenges involved in applying AI and machine learning techniques to robotics and develop the ability to design and implement intelligent robotics systems.
- This course will provide students with the knowledge and skills required to apply deep learning algorithms to robotics problems, including object recognition, motion planning, and robot control.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply machine learning and deep learning algorithms to solve robotics problems. |
| **CO2** | Design intelligent agents that can perceive and act in different environments. |
| **CO3** | Evaluate different robotics and AI applications and identify their strengths and weaknesses. |
| **CO4** | Implement deep learning models for robotics tasks. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 1 | 3 | - | - | 2 | 3 | 2 | - | 2 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 1 | 1 | 3 | 1 | - | - | 3 | 3 | - | 2 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | - | 2 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 3 | - | 2 | 3 | 3 | 2 |

**Syllabus**

**Unit 1: Introduction to AI for Robotics**

Overview of AI for robotics, Robotics components and their interactions, Sensing and perception in robotics, Planning and decision-making in robotics, Control systems and robotics.

**Unit 2: Machine Learning for Robotics**

Supervised learning and its applications in robotics, Unsupervised learning and its applications in robotics, Reinforcement learning and its applications in robotics, Transfer learning in robotics

**Unit 3: Deep Learning for Robotics**

Neural networks and deep learning, Convolutional Neural Networks for Perception in Robotics, Recurrent Neural Networks for Robotics Planning, Deep Reinforcement Learning for Robotics Control

**Text Books / References**

*Govers, F. X. Artificial Intelligence for Robotics. Packt Publishing; 2018*

*Nehmzow U. Mobile robotics: a practical introduction. Springer Science & Business Media; 2012.*

*P. Corke, Robotics, Vision, and Control, Springer, 2011.*

*P. Antsaklis and K. Passino, An Introduction to Intelligent and Autonomous Control, Kluwer, 1993.*

*D. Kortenkamp, R. Bonasso, and R. Murphy, ed., Artificial Intelligence and Mobile Robots, AAAI Press, 1998.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID441** | **Introduction to Biomedical Informatics** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- The course is aimed at educating students on the basic concepts and techniques of AI
- This would cover the methods of collecting, cleaning, and preparing biomedical data before processing.
- Introduced different methods for feature set optimization and handing imbalanced biomedical data.
- Describe the role of biomedical informatics in clinical decision-making and the design of clinical decision support systems.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Application of AI and ML to biomedical problems. |
| **CO2** | Application data acquisition, integration, retrieval, and manipulation. |
| **CO3** | Develop knowledge on different biomedical area, like public health informatics, clinical trials, agro informatics, nutri informatics etc. |
| **CO4** | Develop skill to initiate collaborative research with interdisciplinary teams to develop innovative solutions to real-world problems in biomedical informatics using AI techniques and tools. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | - | 3 | 2 | - | 3 | 3 | - | - |
| CO2 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | - | 3 | 2 | - | 3 | - | 3 | 2 |
| CO3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | - | 3 | 2 | - | 3 | - | 3 | 2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | - | 3 | 2 | - | 3 | - | 2 | 3 |

**Syllabus**

**Unit 1**

Introduction to Biomedical Informatics – different biomedical data and databases – methods of data integration of heterogenous data – data retrieval and acquisition - Querying biomedical databases using SQL – heterogeneous data standardization.

**Unit 2**

Application of data mining and AI techniques in biomedical information – Querying biomedical databases using SQL- Biomedical Imaging Informatics.

**Unit 3**

Clinical Informatics and Electronic Health Record Systems – AI and mathematical model in clinical trial – community and population health - tackles disease treatment and prevention.

**Unit 4**

Agro informatics - nutri informatics - ethics of AI in biomedical informatics

**Text Books / References**


*Biomedical Informatics: Computer Applications in Health Care and Biomedicine" by Edward H. Shortliffe and James J. Cimino*

*"Statistical Methods for Clinical Trials" by J. Rick Turner*

*"Agro-Informatics and Precision Agriculture" by Manoj Karkee, Qin Zhang, and Shrinivasa K. Upadhyaya*

*"Public Health Informatics and Information Systems" by J.A. Magnuson and P.G. Fu*

*Johnson, K. B., & Lorenzi, N. M. (2017). Health Informatics: An Interprofessional Approach. Mosby.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID442** | **CRISPR/Cas9 Technology** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- The goal of this course is to cover the overview of the relevant background in crispr technology and high-throughput biotechnology, focusing on the available data and their relevance.
- It will then cover the ongoing developments with the focus on the applications of these methods to biomedical data.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyze and learn the discovery of Crisper with emphasis to molecular mechanisms. |
| **CO2** | Apply the basic concepts on various application of gene therapy. |
| **CO3** | Design familiar with experimental design. |
| **CO4** | create automated pipelines for identifying the associations between multiple genome editions. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 | | 3 | 3 | | |
| CO2 | 3 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 | | 3 | | 3 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 | | 3 | | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 3 | 3 | | 3 | 3 | 3 | | 3 | | 2 | 3 |

**Syllabus**

Introduction to Genetic Engineering - History of Crispr – Crispr in bacteria – Classification of Crispr – General structure of cas9 protein – Mechanism of Crispr cas9 – Applications – Database of Crispr – Case studies.

**Textbooks / References**


*Maximilian Haeussler, Jean-Paul Concordet, CRISPOR Manual, MIT, 2016. Singh et al: A Mouse Geneticist's Practical Guide to CRISPR Applications; Genetics, Vol.199, No.1, 2015.*

*Ran et al, Genome engineering using the CRISPR-Cas9 system, Nature Protocols, 2013.*

*Fujihara&Ikawaw, CRISPR/Cas9-Based Genome Editing in Mice by Single Plasmid Injection, Methods Enzymol. 2014.*


**Evaluation Pattern**

| **Assessment** | **Internal/External** | **Weightage (%)** |
|---|---|---|
| Assignments (Minimum 2) | Internal | 30 |
| Quizzes (Minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID443** | **Introduction Molecular Modelling** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- The course will lay down the basic concepts of computational techniques to analyse the coordinate systems in molecular construction.
- It will explore the concepts initially through basic formats to represent synthetic and biomolecules.
- It will provide an appreciation for the broad application of AI in drug design.

- Goal of the course is to provide a connection between the concepts of organic chemistry and simulation studies.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | To develop an understanding of the basic concepts of Machine Learning Techniques in Computer Aided Drug Design. |
| **CO2** | To evaluate the suitability of molecular file formats in 2-D and 3-D analysis. |
| **CO3** | To connect the concepts of 2-D and 3-D Modeling of Synthetic and Biomolecules. |
| **CO4** | To evaluate the biologically active point of biomolecular confirmations. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | | | | 3 | 2 | 3 | 3 | 3 | 3 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | | | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| CO3 | 3 | 2 | 3 | 3 | 3 | | | | 3 | 2 | 3 | 3 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 2 | 3 | | | | 3 | 2 | 3 | 3 | 3 | 3 | 3 |

**Syllabus**

Introduction – Structure – Properties - Molecular Formats – SMILES - SMART – Mol – SDF - InChi – Molecular Representation – Chemsketch – Chemistry -42 – Automated De Novo Design – Scalable Engineering of Chemistry - Databases – Pubchem – Drug Bank – ZINC – ADME Constrains – Forcefields – Molecular Mechanics – Quantum Mechanics - Configurations – Boundaries - Confirmations – QSAR – Hansch Equation – Free Wilson Method – CoMFA – CoMSIA – Ligand – Based Drug Design –Molecular Annotation- Pharmacopore – Structure-Based Drug Design - Free-Energy Binding Analysis – 3-D Modeling – Proteins – Pharma AI – Panda Omics: Disease-Target Identification – Synthetic Biology – Prediction – In Clinico: Clinical Outcomes – Chemistry 42: Novel Lead Molecules -Virtual Screening – Docking – MD Simulation.

**Textbooks / References**


*K. Raman (2021) An Introduction to Computational Systems Biology: Systems-Level Modelling of Cellular Networks, Chapman and Hall/CRC, Boca Raton, FL.*

*Voit E (2012) A First Course in Systems Biology, Garland Science.*

*Klipp E (2009) Systems Biology, A Textbook, Wiley-VCH.*

*Newman MEG (2011), "Networks: An Introduction", Oxford University Press.*

*Weblink:https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/computer-aided-drug-design*

*Weblink: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5248982/*

*Weblink: https://jcheminf.biomedcentral.com/articles/10.1186/s13321-019-0351-x*

*Weblink: https://www.frontiersin.org/articles/10.3389/fchem.2018.00057/full*

*Weblink: https://insilico.com/chemistry42*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID444** | **Transcriptomics, Proteomics and Metabolomics** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- Introduce students to using artificial intelligence (AI) in transcriptomics, proteomics, and metabolomics research, including machine learning algorithms, data mining techniques, and other computational approaches.
- Teach students how to apply AI techniques to analyse and interpret omics data, including genomic, transcriptomic, proteomic, and metabolomic data, and integrate data from multiple omics platforms.
- Foster students' ability to critically evaluate the strengths and limitations of AI-based approaches in omics research and understand the importance of validation and reproducibility in scientific research.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Application of AI in omics research. |
| **CO2** | Develop the ability to integrate data from multiple omics platforms using AI-based approaches. |
| **CO3** | Identify limitations of existing AI-based software tools and overcome the computational limitations of models |
| **CO4** | Develop critical thinking and problem-solving skills (real-world problems in biomedical, agriculture etc.) to design and carry out experiments in transcriptomics, proteomics, and metabolomics and analyse and interpret the resulting data. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 1 | - | - | 2 | 2 | - | 1 | - | - | - | 3 | 2 | - | - |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 3 | 2 | 2 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 3 | 2 | 3 | 3 | - | 2 | 2 |

**Syllabus**

**Unit 1**

Overview of omics technologies (transcriptomics, proteomics, metabolomics) - history and evolution of omics technologies – the importance of application of AI omics research – the role of omics research in biological research.

**Unit 2**

Gene expression profiling using microarrays and RNA sequencing - transcriptomics data analysis using bioinformatics toll and AI-based methods - functional annotation of transcripts and pathways - alternative splicing analysis - single-cell transcriptomics and spatial transcriptomics.

**Unit 3**

Protein separation and identification using mass spectrometry - quantitative proteomics and label-free quantification - proteome analysis using bioinformatics tools and AI-based algorithm - proteins and pathways - protein-protein interactions and network analysis - structural proteomics and protein modifications.

**Unit 4**

Metabolite identification and quantification using mass spectrometry and NMR - metabolite profiling and metabolic pathway analysis - metabolomics data analysis using bioinformatics tools and AI-based algorithms - metabolic flux analysis and isotopic labelling - metabolomics in systems biology and synthetic biology - metabolomics in disease diagnosis and drug discovery.

**Unit 5**

Multi-omics data integration and analysis - correlation and causation analysis - AI-based predictive models - biomarker discovery and validation - A-based method to analyse biomarker data – the future direction of omics research with AI.

**Text Books / References**


*“Transcriptomics and Gene Regulation" by Simon Tavaré and Nancy R. Zhang*

*"Proteomics: Methods and Protocols" edited by Daniel J. Liebler*

*"Metabolomics: From Fundamentals to Clinical Applications", edited by Ute Roessner and J. Cameron Thrash*

*"Integrated Omics Analysis: Methods and Applications" edited by Andrew J. Percy and David S. Wishart*

*"Transcriptome Analysis: Methods and Applications" edited by Vinita Chauhan, Rakesh Sharma, and Debmalya Barh*

*"Proteomics in Systems Biology: Methods and Protocols" edited by Daniel J. Kliebenstein*

*"Metabolomics in Practice: Successful Strategies to Generate and Analyze Metabolic Data" by Michael Lammerhofer and Wolfram Weckwerth Recent literature*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 23AID445 | Introduction to High-Performance Computing | L-T-P-C: 2- 0 -2- 3 |
|---|---|---|

**Course Objectives**

- Familiarize student with architectural overview of modern HPC and GPU based heterogeneous architectures, focusing on its computing power versus data movement needs.
- Familiarise the students working with cloud platforms and services to configure and use computational resources and storage.
- To educate students how to write efficient parallel programming and GPU programming.
- To discuss various application of HPC computational techniques in computational science.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply high-performance computing in different research field. |
| **CO2** | Design OpenMPI programme and CUDA programme |
| **CO3** | Simulate on cloud computing system. |
| **CO4** | Evaluate how the convergence of HPC and AI is transforming the data science. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | - | 2 | 2 | 3 | 2 | - | - | 2 | 1 | 3 | 1 | 1 | - |
| CO2 | 2 | 3 | 3 | 3 | 3 | - | 1 | - | 2 | 1 | 2 | 3 | 3 | 3 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | - | 2 | 1 | 2 | 3 | 2 | 2 | 1 |
| CO4 | 2 | 2 | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 3 | 3 | 3 | 3 |

**Syllabus**

**Unit 1**

Introduction to basic architecture and OS concepts - multi-core CPUs - high-speed interconnects - overview of High-Performance Computing (HPC) and its importance - hardware and software requirements for HPC - parallel programming and their applications (MPI/OpenMP) – brief introduction to workload manager and job schedulers.

**Unit 2**

Overview of GPU architecture and its evolution - comparison of CPU and GPU architecture - introduction to CUDA programming and its basic concepts - optimizing CUDA kernels for maximum performance - advanced CUDA programming techniques, such as shared memory, constant memory, and texture memory - introduction to cuBLAS and cuDNN libraries for linear algebra and deep learning - case studies of GPU: accelerated applications in scientific computing, data analytics, and machine learning.

**Unit 3**

Definition of cloud computing and its importance - Benefits and challenges of cloud computing - types of cloud services (IaaS, PaaS, SaaS) and their characteristics - cloud computing architecture and its components - cloud storage and its types - cloud networking and its challenges - cloud security and its importance - cloud application

- benefits and challenges of HPC and AI - synergy between HPC and AI - training and inference of AI models using HPC.

**Text Books / References**


*"High Performance Computing: Modern Systems and Practices" by Thomas Sterling and Matthew Anderson*

*"CUDA by Example: An Introduction to General-Purpose GPU Programming" by Jason Sanders and Edward Kandrot*

*"Parallel Programming with MPI" by Peter S. Pacheco*

*Comer, D. (2021). The Cloud Computing Book: The Future of Computing Explained. CRC Press*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2 Assignments) | Internal | 20 |
| Quiz (minimum 2 Quizzes) | Internal | 20 |
| Min Project | Internal | 20 |
| Mid. Term Periodical | Internal | 10 |
| End Semester Exam (Theory and Practical) | External | 30 |

| **23AID446** | **Genomics Data Science** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- Provide a strong foundation in genomics.
- Teach computational and statistical tools for analysing large-scale genomics data, gene sequence and expression analysis.
- Familiarize students with the tools, algorithm, data structure and principles of contemporary genomics (DNA sequencing, cancer genomics, single-cell sequencing and next-generation sequencing etc.)
- Introduced Python and R for DNA sequencing.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Design sequence assembly in Genomics Data Science. |
| **CO2** | Develop the ability to apply advanced computational methods to analyse genomics data. |
| **CO3** | Develop the ability to identify the main results from a genomics research study and interpret figures from primary research papers. |
| **CO4** | Analyse genomics data and design simulation experiments and interpret results. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | - | 2 | - | 1 | 3 | 3 | - | - |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | - | 2 | - | 1 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | - | - | 2 | - | - | 3 | 2 | 3 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | - | 2 | - | - | 3 | - | 2 | 3 |

**Syllabus**

**Unit 1**

Introduction to genomics – functional genomics – gene – different genomics experimental technology (next-generation sequencing, CRISPR/Cas9 etc.) – programming in R

**Unit 2**

Data cleaning and processing – sequence alignment for gene analysis – gene expression analysis – differential gene expression – Pathway analysis and functional annotation – machine learning in genomics.

**Unit 3**

Comparative genomics – epigenomics – metagenomics – pharmacogenomics – gene regulatory network analysis.

**Unit 4**

Precision medicine and personalised genomics – Cancer genomics and analysis – Infectious disease genomics and analysis

**Text Books / References**

*"Bioinformatics: Sequence and Genome Analysis" by David Mount*

*"Genomics and Personalized Medicine: What Everyone Needs to Know" by Michael Snyder*

*"Practice Computing for Biologists" by Steven Haddock and Casey Dunn*

*"Bioinformatics and Functional Genomics" by Jonathan Pevsner*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID447** | **AI in system biology** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- The goal of this is to cover the basic concept and principles of artificial intelligence and their application in field system biology.
- Explore AI and other computational methods to analyse biological networks and complex biological systems.
- Explore enzyme kinetics, metabolic pathway, flux balance analysis and signal transduction.
- Cover mathematical, statistical and dynamics modelling of biological networks.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analysis biological networks |
| **CO2** | Develop the ability to apply ML/DL techniques to understand and analyse biological networks, signal transduction, metabolic network, and gene regulatory network in physiology and pathology. |
| **CO3** | Design and simulate network-based mathematical and statistical models. |
| **CO4** | Develop pipelines for biochemical pathway analysis based on recent Omics studies and AI developments. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | 3 | - | - |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | - | - | 3 | 2 | 3 | 3 | - | 3 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 3 | - | - | - | 3 | 2 | 3 | 3 | - | 3 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 3 | - | - | - | 3 | 2 | 3 | 3 | - | 2 | 3 |

**Syllabus**

**Unit 1**

Introduction to complex systems - cell signalling – metabolic network – experimental technologies - network building analysis - enzyme kinetics – metabolic analysis – flux balance analysis

**Unit 2**

Modelling, construction and simulation of the biological network using AI - dynamic modelling of biological systems – network structure analysis using AI– ML/DL algorithm to design gene circuit

**Unit 3**

Modelling the behaviour of single cells using AI – AI accelerated cell and gene therapy – AI to analyse cryo-electron tomogram.

**Unit 4**

Ethical and legal considerations of AI in System biology - Future directions and opportunities for AI in Biotechnology

**Text Books / References**

*Raman K (2021) An Introduction to Computational Systems Biology: Systems-Level Modelling of Cellular Networks. 1/e ISBN 9781138597327 (Chapman and Hall/CRC)*

*Voit E (2012) A First Course in Systems Biology. Garland Science, 1/e. ISBN 081534467 Recent literature*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|

| | | |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID448** | **AI in drug design** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- To educate students on fundamentals stages of drug discovery pipeline and how computational and informatics techniques can accelerate the pace of drug discovery.
- To teach them how to encode a molecule into numerical molecular descriptors and strings, allowing computational treatment of molecules.
- Discuss drug-likeness, informatics approaches to the prediction of chemical properties - QSAR, pharmacophores, pharmacokinetics, and pharmacodynamics.
- To teach them how to apply AI / ML techniques and construct validated classification and regression models for biological endpoints.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Explain the drug discovery pipeline and the role of computational drug discovery in the process. |
| **CO2** | Construct SMILES Representations of Molecular Structures |
| **CO3** | Extract chemical information from Molecular Structures in different chemical file formats. |
| **CO4** | Compute different kinds of Molecular Descriptors and Fingerprints, and construct similarity kernels from them. |
| **CO5** | Construct validated Classification and Regression models for pharmacological endpoints and evaluate model performance and Domain of Applicability. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | - | - | 2 | 2 | 3 | - | 1 | 1 | 1 | - | - | 2 |
| CO2 | 2 | 3 | 3 | - | 2 | - | - | - | - | 1 | - | 1 | 2 | - | - |
| CO3 | 2 | 3 | 3 | - | 2 | - | - | - | - | 1 | - | 1 | 2 | - | - |
| CO4 | 3 | 2 | 2 | 2 | 3 | - | - | 1 | 1 | - | - | 2 | 2 | 2 | - |
| CO5 | 2 | 1 | 3 | 3 | 3 | - | - | 1 | 1 | 1 | - | 2 | 3 | 3 | 2 |

**Syllabus**

**Unit 1**

Why Computational Drug Design? The Drug Discovery pipeline; Chemical Space; Cheminformatics and Virtual High Throughput Screening; Lipinski's Rules of 5 and ADMET Modelling; Pharmacodynamics and pharmacokinetics; Structure-Based and Ligand-Based Drug Design.

**Unit 2**

Chemical File Formats and Representations; Topological Indices; Substructural Descriptors and 2D fingerprints; Local Molecular Surface Property Descriptors; 3D Shape and Chiral descriptors; Molecular Similarity Measures and Kernels; Chemical and Biological Networks.

**Unit 3**

Linear Free Energy Relationships; Pharmacophores and Molecular Interaction Fields; Model Validation; Structure Based Methods - Docking & Scoring; Molecular Simulation (Monte-Carlo, Molecular dynamics) – Structure and dynamics properties (normal mode analysis) – Gaussian and Gauss view – Density functional theory.

**Unit 4**

Linear and Non-Linear Models; Classification, Regression and Ranking; Data preprocessing, Performance Measures and unbalanced datasets; Dimensionality reduction and Feature selection; Evolutionary computing; Kernel methods; Best Practices in Predictive Modeling; Applications of Deep Learning in Pharma.

**Text Books / References**


*Johann Gasteiger, Thomas Engel, Chemoinformatics: A Textbook (Wiley-VCH, 2003)*

*Jürgen Bajorath (Editor), Chemoinformatics and Computational Chemical Biology (Methods in Molecular Biology) (Humana Press, 2004)*

*Andrew R. & Leach, Valerie Gillet, An Introduction to Chemoinformatics (Springer International, New Delhi, 2009)*

*Merz Jr, K.M., Ringe, D. and Reynolds, C.H. (Editors) Drug design: structure-and ligand-based approaches (Cambridge University Press, 2010).*

*N. Sukumar, et al, Computational Drug Discovery: A Primer (Ion Cure Press, 2023).*

*John L. Lamattina, Drug Truths: Dispelling the Myths about Pharma R&D (John Wiley, Hoboken, NJ, 2008)*

*Barry Werth, The Billion Dollar Molecule: One Company's Quest for the Perfect Drug (Simon & Schuster, 1995)*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID451** | **Applied Cryptography** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- To understand the underlying fundamentals of classical and modern cryptography
- To understand about the cryptographic systems used over the Internet.
- To help the students to study cryptographic protocols, common attacks and their prevention.

**Course Outcomes**

After completing this course, students will be able to

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

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | - | - | - | - | 2 | 2 | - | 3 | 2 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | - | - | - | - | 2 | 2 | - | 3 | 1 | 2 | 1 |
| CO3 | 3 | 2 | 3 | 3 | 1 | - | - | - | 2 | 2 | - | 3 | 2 | 2 | 1 |
| CO4 | 3 | 2 | 3 | 3 | - | - | - | - | 2 | 2 | - | 3 | 1 | 2 | 1 |

**Syllabus**

**Unit 1**

Number theory concepts – Divisibility,GCD,modular exponential,congruence,Chinese remainder theorem.Groups,rings,fields.

**Unit 2**

Overview of Cryptography , Symmetric key cryptography, stream ciphers, block ciphers, DES and Enhancements, AES, Attacks on block ciphers, Message integrity- Message integrity: definition and applications. Hashing, collision resistance. Public key cryptography- Arithmetic modulo primes, Cryptography using arithmetic modulo primes, Public key encryption Arithmetic modulo composites,.RSA,Attacks on RSA, Rabin Cryptosystem, Discrete Logarithm Problem and related Algorithms, ElGamal Cryptosystem

**Unit 3**

Introduction to Elliptic Curve Cryptography, Digital signatures: definitions and applications, More signature schemes and applications, Identification protocols, Authenticated key exchange and SSL/TLS session setup, Zero knowledge protocols. Key agreement protocols, Diffie-Hellman protocol, variations.

**Text Books / References**


*James Strayer, Elementary Number Theory, Waveland Press, 2002.*

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

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

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

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID452** | **Network and Wireless security** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- To understand the various techniques for network protection.
- To gain knowledge on security and privacy issues on various networks.
- To study the use of modern tools and techniques used in analysing various security parameters of the network.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyse the network security protocols and standards. |
| **CO2** | Evaluate the various network security threats. |
| **CO3** | Apply modern tools to simulate network attacks. |
| **CO4** | Interpret the ethical aspects of network security. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | - | - | - | 2 | 2 | - | 3 | 1 | 2 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | - | - | - | 2 | 2 | - | 3 | 2 | 2 | 1 |
| CO3 | 3 | 2 | 3 | 3 | 3 | - | - | - | 2 | 2 | - | 3 | 2 | 2 | 1 |
| CO4 | 3 | 2 | 3 | 3 | 3 | - | - | - | 2 | 2 | - | 3 | 1 | 2 | 1 |

**Syllabus**

**Unit 1**

Overview of network security principles, concepts, and terminology. Threats to network security, including attacks on confidentiality, integrity, and availability. Network security goals and objectives. IP tables,NAT.Intrusion detection systems ,Types.Honeypots.

**Unit 2**

Network protocols and standards, SSL,TLS,IPsec,HTTPS. Wireless network architecture and protocols, Security risks and threats in wireless networks, Wireless security standards, including WPA and WPA2. Mobile security architecture, Mobile device security risks and threats, Mobile security standards, including iOS and Android.

**Unit 3**

Common network attacks. Wireshark ,packet sniffing.LAN attacks, ARP cache spoofing, ettercap.Analysing network vulnerability using NMAP.Use of metasploit and metasploitable to perform common attacks over the network.Usage of aircrack-ng suite. Legal issues in network security, cyber crime and cyber law. Ethical issues in network security, privacy and intellectual property rights.

**Text Books / References**


*William Stallings, Cryptography and Network Security: Principles and Practice,8thEdition, Pearson edition, 2020.*

*Behrouz A. Forouzan, Cryptography & Network Security, McGraw-Hill, 3rd Edition 2015.*

*Jeremy Faircloth, Penetration Tester's Open Source Toolkit,4th Edition,2016.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID453** | **Intrusion Detection & Prevention Systems** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- This course helps the students to understand the basics of intrusion detection and prevention systems, including concepts of intrusion detection, types of intrusions, vulnerabilities, and threats.
- This course helps the students to learn the different types of intrusions and their potential impacts.
- This course also provides methods to explore different techniques and methodologies for intrusion detection and prevention.
- This course will help students to gain practical experience with popular intrusion detection and prevention systems.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyze the characteristics of various network attacks and select appropriate intrusion detection and prevention techniques to mitigate the associated risks. |
| **CO2** | Configure open-source intrusion detection and prevention systems to detect and prevent network attacks |
| **CO3** | Implement machine learning and deep learning models for detecting intrusions |
| **CO4** | Analyze the effectiveness of intrusion detection and prevention systems |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 1 | 1 | - | - | 2 | 2 | - | 2 | - | - | - | 1 | 1 | 2 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 1 | 1 | 1 | 1 | 3 | 2 | - | 2 | - | - | - | 2 | 1 | - | 1 |
| CO3 | 3 | 2 | 2 | 2 | 3 | 2 | - | 2 | - | - | - | 2 | 3 | 2 | 1 |
| CO4 | 1 | 1 | - | - | 1 | 1 | - | 1 | - | - | - | 1 | - | 1 | 1 |

**Syllabus**

**Unit 1**

Introduction to Intrusion Detection and Prevention Systems - Overview of Intrusion Detection and Prevention Systems - Types of Intrusions - Goals and Requirements of Intrusion Detection and Prevention Systems - Differences between IDS and IPS

**Unit 2**

Network Security Fundamentals - Network Security Basics - OSI Reference Model - TCP/IP Protocol Suite - Network Security Threats - Network-Based IDS - NIDS Architecture - NIDS Detection Techniques - Snort: An Open Source NIDS - Snort Rules - Host-Based IDS - HIDS Architecture - HIDS Detection Techniques - OSSEC: An Open Source HIDS - OSSEC Rules - Anomaly Detection - Anomaly Detection and Classification - Machine Learning Techniques for Anomaly Detection

**Unit 3**

Intrusion Prevention Systems - IPS Architecture and Mechanisms - Signature-Based IPS - Behavior-Based IPS

**Text Books / References**


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

*Carl Enrolf, Eugene Schultz, Jim Mellander, "Intrusion detection and Prevention", McGraw Hill, 2004*

*Paul E. Proctor, "The Practical Intrusion Detection Handbook ", Prentice Hall, 2001.*

*Ankit Fadia and Mnu Zacharia, "Intrusiion Alert", Vikas Publishing house Pvt., Ltd, 2007.*

*Earl Carter, Jonathan Hogue, "Intrusion Prevention Fundamentals", Pearson Education, 2006.*

*Rafeeq Ur Rehman. Intrusion detection systems with Snort: advanced IDS techniques using Snort, Apache, MySQL, PHP, and ACID. Prentice Hall Professional, 2003.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID454** | **Software Vulnerability Analysis** | **L-T-P-C: 2- 0 -2- 3** |
|---|---|---|

**Course Objectives**

- This course teaches software engineering techniques for building security into software as it is developed.

- This course introduces students to the discipline of designing, developing, and testing secure and dependable software-based systems.
- This course provides hands on experience in software security analysis and development
- This course helps students to learn how to mitigate software vulnerabilities through secure software development practices

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyse the security risk of a system under development. |
| **CO2** | Apply secure coding practices to prevent common vulnerabilities from being injected into software. |
| **CO3** | Design security requirements (which include privacy requirements). |
| **CO4** | Validate security requirements. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | 1 | 2 | 2 | - | 2 | - | - | - | 2 | - | 2 | 1 |
| CO2 | 1 | 2 | 2 | 3 | 3 | 2 | - | 1 | - | - | - | 2 | 1 | 1 | - |
| CO3 | 1 | 2 | 3 | 2 | 3 | 2 | - | 1 | - | - | - | 2 | - | 1 | - |
| CO4 | - | 1 | - | - | 1 | 2 | - | 2 | - | - | - | 2 | - | 2 | - |

**Syllabus**

**Unit 1**

Introduction to Software Vulnerability Analysis - Overview of software vulnerabilities - Importance of vulnerability analysis in software development - Types of Software Vulnerabilities

**Unit 2**

Common types of software vulnerabilities - Code Injection vulnerabilities - Authentication and Authorization vulnerabilities - Input Validation vulnerabilities - Static Analysis - Source code analysis techniques - Dynamic Analysis - Types of dynamic analysis techniques - Binary Analysis - Overview of binary analysis - Reverse engineering techniques

**Unit 3**

Mitigation Strategies - Overview of software security mitigation strategies - Secure coding practices - Input validation and output encoding - Security testing and verification techniques - Security standards and best practices

**Text Books / References**

*Anley, Chris, John Heasman, Felix Lindner, and Gerardo Richarte. The shellcoder's handbook: discovering and exploiting security holes. John Wiley & Sons, 2011.*

*Takanen, Ari, Jared D. Demott, Charles Miller, and Atte Kettunen. Fuzzing for software security testing and quality assurance. Artech House, 2018.*

*Sikorski, Michael, and Andrew Honig. Practical malware analysis: the hands-on guide to dissecting malicious software. no starch press, 2012.*

*Dowd, Mark, John McDonald, and Justin Schuh. The art of software security assessment: Identifying and preventing software vulnerabilities. Pearson Education, 2006.*

*McGraw, Gary. "Software security." Building security in, Addison-Wesley Professional, 2006.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID455** | **Cybercrime Investigations & Digital Forensics** | **L-T-P-C: 2 0 2 3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Enable the student to define and describe the nature and scope of cybercrime. |
| **CO2** | Develop knowledge of major incidents of cybercrime and their resulting impact. |
| **CO3** | Facilitate the student to analyse and discuss national and global digital law enforcement efforts |
| **CO4** | Evaluate the specific AI and ML enabled technology that facilitates cybercrime and digital law enforcement |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | 2 | 3 | 3 | | 3 | | 1 | | 3 | | | 2 |
| CO2 | 2 | 2 | 3 | 2 | 3 | 3 | | 3 | | 2 | | 3 | | | 2 |
| CO3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | | 2 | 2 |
| CO4 | 3 | 1 | 3 | 2 | 3 | 2 | 1 | 3 | 2 | 1 | 1 | 1 | | 2 | 3 |

**Syllabus**

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

**Text Books / References**


*Thomas J. Holt, Adam M. Bossler, and Kathryn C. Seigfried-Spellar. 2022. Cybercrime and Digital Forensics: An Introduction. Third Edition New York: Routledge. ISBN: 978-0367360078.*

*Thomas J. Holt, Adam M. Bossler, and Kathryn C. Seigfried-Spellar. 2017. Cybercrime and Digital Forensics: An Introduction. Second Edition New York: Routledge. ISBN: 978-0367360078.*

*Nate Anderson. 2014. The Internet Police: How Crime Went Online, and the Cops Followed. New York: W.W. Norton & Company, Inc. ISBN: 978-0393349450.*

*Peter Grabosky. 2016. Cybercrime. Oxford/New York: Oxford University Press. ISBN: 978-0190211554. Kevin F. Steinmetz. 2016. Hacked: A Radical Approach to Hacker Culture and Crime.New York: New York University Press. ISBN: 978-1479869718.*

*Orin S. Kerr. 2013. Computer Crime Law (3ded.). St. Paul: Thomsen Reuters. ISBN: 978-0314281364. Susan W. Brenner. 2012. Cybercrime and the Law: Challenges, Issues, and Outcomes. Lebanon, NH: Northeastern University Press. ISBN: 978-1555537999.*

*Ralph D. Clifford. 2011. Cybercrime: The Investigation, Prosecution and Defense of a Computer-related Crime. Durham: Carolina Academic Press. ISBN: 978-1594608537.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID456** | **Distributed Systems Security** | **L-T-P-C: 2 0 2-3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Understand the distributed systems and threats against distributed systems and how to protect against them |

| | |
|---|---|
| **CO2** | To have a foundation for designing and developing secure distributed systems, and for evaluating the security of existing solutions. |
| **CO3** | To have knowledge of standards, security protocols, technologies, principles, methods and cryptographic mechanisms applicable for securing modern distributed systems. |
| **CO4** | Design and Development of AI enabled distributed security systems. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 2 | 1 | 3 | 2 | 3 | 2 | 2 | | 3 | 2 | 1 | 3 | | | |
| CO2 | 2 | 2 | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 3 | | | |
| CO3 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 1 | 3 | 2 | 1 | 3 | | | |
| CO4 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 2 | | | |

**Syllabus**

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

**Text Books / References**


*Anderson, Ross. Security engineering: a guide to building dependable distributed systems. John Wiley & Sons, 2020.*

*Andrew S. Tannenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Pearson, 2007.*

*Belapurkar, Abhijit, Anirban Chakrabarti, HarigopalPonnapalli, Niranjan Varadarajan, Srinivas Padmanabhuni, and Srikanth Sundarrajan. Distributed systems security: issues, processes and solutions. John Wiley & Sons, 2009.*

*George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair, "Distributed Systems: Concepts and Design", Fifth Edition,Addison Wesley, 2011.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 23AID461 | Fundamentals and Analysis of Power Systems | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- To familiarize with various components of power systems, including generators, transformers, transmission lines, distribution systems, and loads
- To perform load flow studies and how to simulate using software tools.
- To acquire knowledge about fault analysis and stability analysis
- Understand the fundamentals of power system protection and power quality

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Identify and describe the various components of power systems, including generators, transformers, transmission lines, distribution systems, and loads. |
| **CO2** | Perform load flow analysis to determine the steady-state operating conditions of power systems and understand the flow of active and reactive power in the network. |
| **CO3** | Analyse fault conditions in power systems, calculate fault currents and voltages, and design appropriate protection schemes to ensure system safety and reliability. |
| **CO4** | Identify power quality issues such as voltage sag, swell, flicker, harmonics, and propose solutions to maintain the desired quality of power supply. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | - | - | 3 | 2 | 3 | 3 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 3 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | - | 3 | 2 | 3 | 3 | 3 | 1 | 2 |

**Syllabus**

**Unit 1 Introduction to power systems and transmission lines**

Overview of power systems, types of power generation, power systems components, transmission lines, transmission line parameters, insulators, cables, grading, complex power calculations, power factor correction.

**Unit 2 Load flow analysis and power system control**

Load flow analysis, Gauss Siedel Method, Newton Raphson method, Fast decoupled method, load frequency control, automatic voltage regulator, MATLAB experiments on load flow and power system control.

**Unit 3 Power system Protection, stability and security**

Types of faults, symmetrical unsymmetrical faults, power system stability and dynamics, power quality, power system security, Assessment of stability, protection and quality using MATLAB and python

**Textbooks / References**

*"Power System Analysis and Design" by J. Duncan Glover, Mulukutla S. Sarma, and Thomas J. Overbye, Cengage Learning (6th Edition), 2022*

*"Electric Energy Systems Theory - An Introduction" by O.I.Elgerd,, McGraw-Hill, 1988.*

*"Power Systems Analysis" by A.R.Bergen and Vijay Vittal, Pearson Education Asia, 2001.*

*"Power System Stability and Control" by P.Kundur, Mc Graw Hill, 1994.*

**Evaluation Pattern**

| **Assessment** | **Internal/External** | **Weightage (%)** |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID462** | **Sustainable Energy Technologies** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- To understand global energy challenges and recognize the need for sustainable energy technologies as a solution
- To gain knowledge about renewable energy sources and understand their characteristics
- To familiarize energy storage technologies
- To analyse sustainable transportation solutions and energy management challenges

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Able to describe the basic principles of sustainable energy technologies and their significance in addressing global energy challenge |
| **CO2** | Able to evaluate and categorize renewable energy source. |
| **CO3** | Able to familiarize energy storage technologies and its basic operations |
| **CO4** | Competent to understand basic concepts of smart grid, energy management and sustainable transportation options. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 2 | 2 | 3 | 1 | - | - | 3 | 2 | 3 | 3 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | - | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 |
| CO3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | - | 3 | 2 | 3 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | - | 3 | 2 | 3 | 3 | 3 | 1 | 2 |

**Syllabus**

**Unit 1 Introduction to sustainable energy**

Overview of global energy challenges and the need for sustainable energy technologies, Environmental influences of conventional energy sources, United Nations Framework Convention on Climate Change (UNFCC) sustainable development. Definition and criteria for sustainable energy technologies.

**Unit 2 Renewable Energy Sources**

Solar Energy, Wind Energy, Biomass, Geothermal energy, Hydropower, Energy Storage Technologies like battery, pumped hydro storage and thermal energy storage.

.

**Unit 3 Sustainable transportation, smart grid and energy management**

Electric Vehicles: Battery Electric and Plug-in Hybrid Vehicles, Fuel Cell Vehicles and Hydrogen Infrastructure, Alternative Fuels: Biofuels, CNG, and Hydrogen, Introduction to Smart Grid Technologies, Demand Response and Energy Management Systems, Microgrids and Decentralized Energy Systems

**Textbooks / References**


*"Energy and the Challenge of Sustainability, World Energy assessment, UNDP, NewYork 2000.*

*Thamas B Johanssson et al, "Renewable Energy Sources for fuel and electricity", Earthscan Publishers, London, 1993.*

*J W Twidell and A D Weir, "Renewable Energy Resources", ELBS, 1998.*

*N K Bansal, M Kleemann and M Mellis, "Renewable Energy Resources and conversion Technology", Tata McGraw Hill, 1990.*

*G N Tiwari, M K Ghosal, "Fundamentals of Renewable Energy Sources", Narosa Publishing House.*

*Kastha D, Banerji S and Bhdra S N, " Wind Electrical Systems", Oxford University Press, New Delhi, 1998.*

*Tony Burton, David Sharpe, Nick Jemkins and Ervin Bossanyi., "Wind Energy Hand Book", John Wiley & Sons, 2004.*

*Chetan S. Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", Second Edition, PHI Publications, 2011.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| 23AID463 | Power System Stability | L-T-P-C: 2- 0- 2- 3 |
|---|---|---|

**Course Objectives**

- The course shall teach the students to analyse power system stability using both traditional and data-driven techniques.
- The course aims to enable students to understand and develop control strategies that can improve power system stability.
- By the end of the course, students should be able to simulate and analyse power system stability using synchronous machine models.
- The course intends to equip students with the critical thinking and problem-solving skills needed to tackle power system stability challenges.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Comprehend the fundamentals of power system stability |
| **CO2** | Apply mathematical modelling techniques to simulate power system stability |
| **CO3** | Familiarize and compare different techniques for improving power system stability |
| **CO4** | Apply data-driven techniques for power system stability analysis and improvement |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 2 | 2 | - | 1 | 1 | 1 | 2 | - | - | - | - | 2 | 1 | - | - |
| CO2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | - | - | - | 1 | 2 | 3 | - | 2 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | - | - | - | 1 | 2 | 2 | - | 2 |
| CO4 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | - | - | - | 1 | 2 | 3 | - | 3 |

**Syllabus**

**Unit 1**

Introduction to Power System Stability:Definition, types, and causes of power system instability - Overview of power system modelling - Synchronous generator models - Excitation system models - Governor models - Load models.

**Unit 2**

Power System Stability Analysis:Small-signal stability analysis - Transient stability analysis - Critical clearing time - Voltage stability - Basics of power system control

**Unit 3**

Improving Power System Stability:Power System Stabilizers - FACTS and HVDC systems for power system stability - Microgrids for power system stability - Data-driven Techniques for power system stability

**Text Books / References**

*Prabha Kundur ,Power System Stability and Control,1998*

*John Grainger and William D. Stevenson Jr. ,Power System Analysis1994*

*Harry G. Kwatny , Karen Miu-Miller ,Power System Dynamics and Control,2016*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID464** | **Micro Grids** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- To enable students to identify and analyse the benefits and hurdles of Microgrids in various industries and applications.
- To equip students with the ability perform comparative analysis of different control strategies and energy management systems.
- To develop the skillset towards applying optimization techniques for modelling and analysing Microgrids to achieve optimal performance.
- To develop the knowledge and proficiency for incorporating AI and ML-based to Microgrid optimization and control problems

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Gain a critical comprehension of Microgrid technology, comprising its structure, constituents, and usage. |
| **CO2** | Acquaint themselves with various control tactics and energy management systems for Microgrids. |
| **CO3** | Utilize optimization methods to design and evaluate Microgrids for attaining optimal performance |
| **CO4** | Assess and incorporate advanced areas in Microgrid optimization and control, involving artificial intelligence and machine learning, to enhance Microgrid effectiveness and dependability. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 2 | 2 | - | 1 | 1 | 1 | 2 | | - | - | | 2 | 1 | - | 1 |
| CO2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | | - | - | 1 | 2 | 2 | - | 1 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | | - | - | 1 | 2 | 3 | - | 3 |
| CO4 | 2 | 3 | 3 | 2 | 2 | 1 | 2 | | - | - | 1 | 2 | 3 | 1 | 3 |

**Syllabus**

**Unit 1**

Introduction to Microgrids:Introduction - Overview of Microgrid architecture and components - Advantages and challenges of Microgrids - Applications of Microgrids in different industries

**Unit 2**

Microgrid Control :Control strategies for Microgrids - Energy management systems for Microgrids - Microgrid stability analysis and control - Microgrid protection and islanding

**Unit 3**

Microgrid Optimization :Microgrid modeling for optimization - Linear and nonlinear programming for Microgrid optimization - Convex optimization for Microgrid optimization

**Unit 4**

Advanced Topics in Microgrid Optimization and Control :Distributed optimization for Microgrids - Stochastic optimization for Microgrids - Artificial intelligence and machine learning for Microgrid control and optimization - Integration of renewable energy sources in Microgrids

**Text Books / References**


*Nikos Hatziargyriou, Hassan Bevrani, and Jacob Ostergaard, "Microgrids: Control and Operation",2017*

*S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks",2009*

*Jizhong Zhu, "Optimization of Power System Operation",2015*

*Weerakorn Ongsakul and Vo Ngoc Dieu, "Artificial Intelligence in Power System Optimization",2013*

*Haitham Abu-Rub, Mariusz Malinowski, and Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation, and Industrial Applications",2014*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID465** | **Intelligent Energy Management Systems** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- The course aims to help the students to identify and describe the fundamental concepts and principles of intelligent energy management.
- Students will learn to differentiate and categorize the key components of intelligent energy management systems, including sensors, controllers, and algorithms.
- The course will enable students to apply data analysis techniques to extract insights and trends from energy usage data and propose opportunities for energy savings and efficiency improvements.
- Students will learn to evaluate and compare potential benefits and challenges associated with implementing intelligent energy management in different contexts.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Identify and explain the key components of intelligent energy management systems and their application in optimizing energy consumption, using data analytics tools and techniques |
| **CO2** | Analyse energy usage data using various data analytics techniques to identify opportunities for energy savings and efficiency improvements and develop recommendations for implementation. |
| **CO3** | Evaluate the benefits and challenges of implementing intelligent energy management systems in buildings and other applications, using quantifiable metrics and data-driven approaches |
| **CO4** | Formulate simple intelligent energy management systems, using data analytics tools and techniques to optimize energy consumption and efficiency. |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 2 | 1 | - | 1 | - | 1 | 2 | - | - | - | - | 1 | 1 | - | 1 |
| CO2 | 2 | 3 | 2 | 2 | 2 | 1 | 2 | - | - | - | 1 | 2 | 2 | - | 2 |
| CO3 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | - | - | - | 1 | 2 | 3 | - | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | - | - | - | 1 | 2 | 3 | - | 3 |

**Syllabus**

**Unit 1**

Introduction to Energy Management:Overview - Types of energy management systems - Key components of intelligent energy management systems – Types of controllers and algorithms used in energy management systems - Algorithms for energy management and optimization - Data analytics techniques for energy management.

**Unit 2**

Energy Efficiency:Concepts of energy efficiency - Techniques for improving energy efficiency - Measurement and verification of energy savings using data analytics.

**Unit 3**

Demand Response:Introduction - Techniques for implementing demand response programs - Data-driven approaches to demand response.

**Unit 4**

Renewable Energy Integration & Storage:Challenges and opportunities for renewable energy integration with data-driven approaches - Overview of energy storage technologies - Integration of energy storage into energy management systems - Benefits and challenges of energy storage with data-driven approaches.

**Text Books / References**

*Craig B. Smith and Kelly Parmenter, "Energy Management Principles, Second Edition",2015*

*James Momoh, "Smart Grid: Fundamentals of Design and Analysis".2012*

*Lawrence E. Jones, "Renewable Energy Integration: Practical Management of Variability, Uncertainty, and Flexibility in Power Grids",2017*

*Pengwei Du and Ning Lu, "Energy Storage for Smart Grids: Planning and Operation for Renewable and Variable Energy Resources (VERs)",2014*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID466** | **Power Quality Management** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- The course aims to enable students to understand the fundamental concepts of power quality management.
- The course shall empower the students to identify the various sources of power quality problems.
- The course aims to equip students with the ability to analyse power quality data and draw conclusions about the nature of the issues.
- Finally, the course shall enable students to develop data-driven solutions for power quality problems.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Identify and diagnose common power quality problems, their sources, effects, and significance. |
| **CO2** | Analyse the impact of various power quality problems on electrical systems and equipment. |
| **CO3** | Evaluate different power quality improvement techniques, towards the design optimal solutions |
| **CO4** | Interpret power quality data and formulate data-driven solutions for the quality improvement. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 1 | 3 | 2 | 1 | 2 | - | - | - | - | 2 | 2 | - | 2 |
| CO2 | 2 | 2 | 1 | 3 | 2 | 1 | 2 | - | - | - | 1 | 2 | 1 | - | 1 |
| CO3 | 2 | 3 | 2 | 3 | 2 | 1 | 1 | - | - | - | 2 | 2 | 3 | - | 2 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | - | - | - | 1 | 2 | 3 | - | 3 |

**Syllabus**

**Unit 1**

Introduction to Power Quality Management:Definition and importance of power quality - Power quality terminology and units of measurement - Common power quality problems and their sources - Effects of power quality problems on electrical systems and equipment - Power quality indices and their significance – Power quality standards - Overview of power quality measurements and monitoringText Books / References

**Unit 2**

Power Quality Problems:Harmonics and their causes - Harmonic distortion and its impact on electrical systems and equipment - Filtering techniques for mitigating harmonics – Voltage sags and swells: Overview, causes, effects and mitigation - Transient over- and under-voltages: Overview, causes, effects and mitigation

**Unit 3**

Power Quality Improvement Techniques:Overview and comparison of different techniques and their effectiveness - Reactive Power Compensation: overview and design - Active Power Filtering: overview and design – Energy storage for power quality improvement - Analysis and interpretation of power quality data.

**Text Books / References**


*Ewald F. Fuchs and Mohammad A.S Masoum, "Power Quality in Power Systems and Electrical Machines" .Pearson Education, 2008*

*Bhim Singh, Ambrish Chandra, and Kamal Al-Haddad , "Power Quality Problems and Mitigation Techniques" , 2014*

*Jos Arrillaga, Bruce C. Smith, Neville R. Watson, and Alan R. Wood, "Power System Harmonic Analysis",2013*

*J. Benesty, M. M. Sondhi and Y. Huang, "Handbook of speech processing", Springer, 2008.*

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


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID471** | **Speech Processing** | **L-T-P-C: 2- 0-2- 3** |
|---|---|---|

**Course Objective**

- To understand the principles of speech processing, human speech production and perception system.
- To estimate excitation and vocal tract features using time and frequency domain processing techniques.
- To explore the various conventional, machine learning and deep learning models for speech classification, recognition, synthesis, and detection tasks

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyse the acoustic/articulatory characteristics of different speech regions and speech sounds |
| **CO2** | Apply time and frequency domain processing techniques to speech signals |
| **CO3** | Analyse and extract relevant spectral parameters and temporal parameters of speech signal |
| **CO4** | Evaluate the performance of a model or algorithm (conventional/Machine learning/Deep learning) developed for a speech technology application |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 3 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 1 | 2 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 3 | 3 | 3 |

**Syllabus**

**Unit 1**

Introduction to Speech Processing, Overview of the human speech production system, acoustic and physiological mechanisms of speech production, glottal signal characteristics and source features, significance of glottal activity regions, speech signal characteristics, acoustic/articulatory characteristics of different speech sounds -vowels and consonants.

**Unit 2**

Short time processing of speech for estimation of excitation and vocal tract features - Time Domain processing- Energy, magnitude, zero crossing rate, STACF, Linear Prediction Analysis, Frequency domain processing and Spectro-temporal representation of speech signal- Narrowband, wideband spectrograms, Cepstral Analysis, Melspectrogram, MFCC feature extraction.

**Unit 3**

Speech data preparation and feature engineering, machine learning versus deep learning models in speech classification tasks (age, gender, dialect/accent), Automatic speech recognition (ASR) - statistical models- Hidden Markov Models (HMMs) for ASR, Deep learning speech recognition pipeline (end-to-end models), overview of other speech technology applications such as emotion recognition, speaker recognition, speech synthesis, and speech pathology detection.

**Text Books / References**

*'Fundamentals of Speech Recognition', L. Rabiner, Biing-Hwang Juang and B. Yegnanarayana, Pearson Education Inc.2009*

*'Speech Communication', Douglas O'Shaughnessy, University Press, 2001*

*'Discrete Time Speech Signal Processing', Thomas F Quatieri, Pearson Education Inc., 2004*

*Hannun, Awni, et al. "Deep speech: Scaling up end-to-end speech recognition." arXiv preprint arXiv:1412.5567 (2014).*

*Collobert, Ronan, Christian Puhrsch, and Gabriel Synnaeve. "Wav2letter: an end-to-end convnet-based speech recognition system." arXiv preprint arXiv:1609.03193 (2016).*

*Gulati, Anmol, et al. "Conformer: Convolution-augmented transformer for speech recognition." arXiv preprint arXiv:2005.08100 (2020).*

*Shen, Jonathan, et al. "Natural TTS synthesis by conditioning wavenet on mel spectrogram predictions." 2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP). IEEE, 2018*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID472** | **Text Analytics** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Apply modern tools for solving problems in computational linguistics |
| **CO2** | Implement word representation models to solve NLP problems |
| **CO3** | Develop machine learning/deep learning models for solving NLP applications |
| **CO4** | Evaluate the performance of NLP models |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 1 | 2 | 3 | - | - | 1 | - | - | - | 2 | 1 | - | 1 |
| CO2 | 2 | 2 | 2 | 2 | 3 | 1 | - | 1 | - | - | - | 2 | 3 | 2 | 1 |
| CO3 | 3 | 2 | 2 | 2 | 3 | 1 | - | 1 | - | - | - | 2 | 3 | 2 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | - | - | - | 1 | 2 | 1 | - | 1 | - | - | - | 1 | - | 2 | 1 |

**Syllabus**

**Unit 1**

Computational linguistics- Introduction, syntax, semantics, morphology, collocation and other NLP problems.

**Unit 2**

Word representation: One-hot encoding, Bag-of-Words (BoW) Dictionary: Term Frequency – Inverse Document Frequency (TF-IDF), Language Model-n-gram – Neural Network-based word embedding algorithms

**Unit 3**

Sequences and sequential data: Machine learning and deep learning for NLP, Sequence to sequence modelling - BERT, GPT, Graph NLP, Hidden Markov Model, Conditional Random Field, Topic modelling

**Unit 4**

Applications of NLP: Part-of-Speech tagging, Named Entity recognition, Dependency parsing, - Sentiment Analysis, Machine translation, Question answering, Text summarization, Evaluation metrics for NLP models and Visualization

**Text Books / References**


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

*Christopher Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT press, 1999.*

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

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


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID473** | **Information Retrieval** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- To Understand Document as Vector
- Performance evolution metric for IR
- Learn to write code for text indexing and retrieval.
- Learn to evaluate information retrieval systems
- Learn about text similarity measure
- Understanding about search engine

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Use various techniques to represent a document as a vector |
| **CO2** | Implement IR systems using various techniques |
| **CO3** | Apply methods to evaluate IR systems |
| **CO4** | Develop applications |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 3 | 3 | 1 | - | 3 | 3 | 2 | 3 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 3 | 2 | - | - | 3 | 3 | 2 | 3 | 3 | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 1 | - | - | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 1 | - | - | 3 | 3 | 3 | 3 | 2 | 3 | 3 |

**Syllabus**

**Unit 1**

Goals and history of IR, impact of web in IR, basic concepts- query, document, corpus, text representation and evaluation, Boolean model, TF-IDF, vector-space retrieval models, Probabilistic retrieval models

**Unit 2**

Text similarity metrics, Tokenizing, language models, KL-divergence, performance metrics, reference collections and evaluation of IR systems, query languages for IR, relevance feedback, query expansion-local and global

**Unit 3**

Web search, web crawling, link analysis – hits, page rank, matrix decompositions and latent semantic indexing, Deep learning for IR- word embeddings, neural language models

**Text Books / References**


*Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008. http://nlp.stanford.edu/IR-book/information-retrieval-book.html*

*ChengXiang Zhai, Statistical Language Models for Information Retrieval (Synthesis Lectures Series on Human Language Technologies), Morgan & Claypool Publishers, 2008.*

*Stefan Buettcher, Charles L. A. Clarke, Gordon V. Cormack, Information Retrieval: Implementing and Evaluating Search Engines, MIT Press. (2010)*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |

| | | |
|---|---|---|
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID474** | **Introduction to Chat bots** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- This course helps the students to develop a functional chatbot that can respond to user queries and complete simple tasks.
- Apply NLP techniques to improve the chatbot's ability to understand and respond to user input.
- Apply appropriate evaluation metrics to assess the performance of a chatbot.
- Evaluate the performance of a chatbot and make necessary adjustments to improve its functionality.
- Critically analyze and evaluate the ethical implications of using chatbots in various contexts, and propose ethical solutions to address these issues.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Implement chatbots with different frameworks |
| **CO2** | Develop machine learning/deep learning models for chatbots |
| **CO3** | Apply Natural Language Processing techniques to enhance chatbot capabilities |
| **CO4** | Evaluate the performance of chatbots using various metrics and techniques. |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 1 | 2 | 1 | 3 | 2 | - | 1 | - | - | - | 2 | 1 | - | 1 |
| CO2 | 2 | 2 | 2 | 3 | 3 | 2 | - | 2 | - | - | - | 2 | 3 | 1 | 1 |
| CO3 | 1 | 1 | 1 | 2 | 3 | 2 | - | 2 | - | - | - | 2 | 3 | 1 | 1 |
| CO4 | - | - | - | 1 | 2 | 1 | - | 1 | - | - | - | 1 | - | 2 | 1 |

**Syllabus**

**Unit 1**

Introduction to chatbots - definition and characteristics of chatbots - brief history of chatbots - types of chatbots - Use cases and applications

**Unit 2**

Natural Language Processing (NLP) for Chatbots - Understanding language processing - Syntax and Semantics - Pre-processing and Tokenization - Fundamental Methods of NLP for Building Chatbots

**Unit 3**

Machine Learning/Deep Learning for Chatbots - Machine Learning/Deep Learning Algorithms used in chatbots - Data collection and annotation - Training and evaluation of chatbots - Designing and Implementing Chatbots - Designing conversational interfaces - Implementing chatbots using frameworks like Dialogflow, Rasa, etc. - Integration with different messaging platforms

**Unit 4**

Ethics in Chatbot Development - Responsible AI and ethics - Bias and fairness considerations in chatbot development - Human-in-the-loop approaches for chatbot development

**Text Books / References**


*Sumit Raj, Building Chatbots with Python Using Natural Language Processing and Machine Learning, First Edition, Apress Berkeley, CA, 2019 (Softcover ISBN 978-1-4842-4095-3).*

*Srini Janarthanam. Hands-on chatbots and conversational UI development: build chatbots and voice user interfaces with Chatfuel, Dialogflow, Microsoft Bot Framework, Twilio, and Alexa Skills. Packt Publishing Ltd, 2017.*

*Shevat, Amir. Designing bots: Creating conversational experiences. " O'Reilly Media, Inc.", 2017.*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID475** | **Machine Translation and Sequence-to-Sequence Models** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- The main objective of the course is to obtain basic understanding and implementation skills for modern methods for machine translation
- This course introduces different approaches to build machine translation systems
- This course helps the students to understand various evaluation metrics used for assessing the performance of a machine translation model
- This courses introduces different deep learning architectures used for implementing the machine translation system.

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Implement a statistical machine translation system |
| **CO2** | Implement a neural machine translation system using RNN-based encoder-decoder architecture |
| **CO3** | Implement a neural machine translation system using transformer-based encoder-decoder architecture |
| **CO4** | Evaluate the performance of machine translation models |

**CO-PO Mapping**

| PO/ PSO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | | | | | | | | | | | | | | | |
| CO1 | 2 | 2 | 3 | 2 | 3 | - | - | - | 1 | - | 1 | 1 | 3 | 1 | 1 |
| CO2 | 2 | 2 | 3 | 2 | 3 | - | - | - | 1 | - | 1 | 1 | 3 | 1 | 1 |
| CO3 | 2 | 2 | 3 | 2 | 3 | - | - | - | 1 | - | 1 | 1 | 3 | 1 | 1 |
| CO4 | - | - | 1 | - | 1 | - | - | - | - | - | - | 1 | - | 3 | - |

**Syllabus**

Introduction - Machine Translation Overview – Language Models – Rule based Machine Translation – Statistical Machine Translation – Encoder-decoder models – Attention mechanism - Neural Machine Translation – Phrase based models – Tree based models – Subword level models – Transformer networks - Evaluation metrics

**Text Books / References**

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

*Philipp Koehn, Statistical machine translation. Cambridge University Press, 2009..*

*Philipp Koehn, Neural machine translation. Cambridge University Press, 2020.*

**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| **23AID476** | **Speech Recognition and Understanding** | **L-T-P-C: 2- 0- 2- 3** |
|---|---|---|

**Course Objectives**

- The main objective of the course is to give an introduction to recognition and understanding of the speech
- This course introduces different approaches to build a speech recognition system
- This course helps the students to understand language model and acoustic models required for building a speech recognition system
- This courses introduces different deep learning architectures used for implementing the end to end automatic speech recognition system

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Implement language and acoustic models required for a speech recognition system |
| **CO2** | Develop a feature extraction model for speech recognition |
| **CO3** | Implement a speech recognition model |

| | |
|---|---|
| **CO4** | Develop a deep learning based end to end speech recognition model |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | 1 | 1 |
| CO2 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | 1 | 1 |
| CO3 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | 1 | 1 |
| CO4 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | 1 | 1 |

**Syllabus**

Introduction of speech recognition - Overview of speech recognition systems - Speech recognition formulations - Feature extraction – Alignment – Hidden Markov Model - Advanced acoustic modelling - Language model - Deep learning for speech recognition - Advanced neural network architectures for acoustic model - End-to-end ASR

**Text Books / References**


*L. R. Rabiner, B. H. Jhuang and B. Yegnanarayana, "Fundamentals of speech recognition", Pearson Education, 2009.*

*J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis Discrete-Time Processing of Speech Signals, Wiley-IEEE Press, NY, USA, 1999.*

*D. O'Shaughnessy, Speech Communications: Human and Machine, Second Edition,University Press, 2005.*

*J. Benesty, M. M. Sondhi and Y. Huang, "Handbook of speech processing", Springer, 2008.*

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


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |

| | | |
|---|---|---|
| **23AID477** | **Social Media Text Analysis** | **L-T-P-C: 2- 0- 2- 3** |

**Course Objectives**

- The main objective of the course is to give an introduction to the key concepts about social media text data
- This course introduces machine/deep learning and topic modelling approaches to build a social media text classification model
- This course helps the students to monitor consumers and competitors and glean deeper consumer insights based on advanced social media data modelling

- This courses helps the students to make better business decisions by leveraging social media dat

**Course Outcomes**

After completing this course, students will be able to

| | |
|---|---|
| **CO1** | Analyze social media text data |
| **CO2** | Implement a sentiment analysis model using machine/deep learning algorithms |
| **CO3** | Implement a topic model for social media text categorization |
| **CO4** | Analyze a social network |

**CO-PO Mapping**

| PO/ PSO / CO | PO 1 | PO 2 | PO 3 | PO 4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | 1 | 2 | 1 | - | 1 | - | - | - | 1 | - | 2 | - |
| CO2 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | 2 | 1 |
| CO3 | 2 | 2 | 2 | 2 | 2 | - | - | 1 | - | - | - | 2 | 3 | 2 | 1 |
| CO4 | 1 | 1 | 1 | 2 | 2 | 1 | - | 1 | - | - | - | 2 | 1 | - | 1 |

**Syllabus**

Introduction to Social Media Analytics - Social media data collection - Processing unstructured and semi-structured data – Monitoring user engagement in social media - Identifying Opinions through Sentiment Analysis and Topic Modeling - Social Network Analysis and Metrics - Identifying Influencers in Social Network

**Text Books / References**


*Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus, Social Media Data Mining and Analytics, Wiley, ISBN 978-1-118-82485-6, 2019*

*Golbeck, Jennifer. Analyzing the social web. Newnes, 2013.*

*Finger, L. & Dutta, S,. Ask, Measure, Learn: Using Social Media Analytics to Understand and Influence Customer Behavior. Sebastopol, CA: O'Reilly, 2014*


**Evaluation Pattern**

| Assessment | Internal/External | Weightage (%) |
|---|---|---|
| Assignments (minimum 2) | Internal | 30 |
| Quizzes (minimum 2) | Internal | 20 |
| Mid-Term Examination | Internal | 20 |
| Term Project/ End Semester Examination | External | 30 |