RCOEM

Shri Ramdeobaba College of
Engineering and Management, Nagpur

# SHRI RAMDEOBABA COLLEGE OF ENGINEERING AND MANAGEMENT, NAGPUR – 440013

An Autonomous College affiliated to
Rashtrasant Tukadoji Maharaj Nagpur University,
Nagpur, Maharashtra (INDIA)

## PROGRAMME SCHEME & SYLLABI
## 2023 – 2024

## B. Tech. COMPUTER SCIENCE & ENGINEERING (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING)

Published By

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ISO 9001 : 2015 CERTIFIED ORGANISATION

## About the Department

The Bachelor of Technology program in Computer Science & Engineering, with a focus on Artificial Intelligence & Machine Learning (AI & ML), started in the academic year 2020-21. The initial intake of students was 60, however it has increased to 180 from the academic session 2022-23. The undergraduate course spans four years and aims to equip students with the necessary knowledge and skills to develop intelligent machines, software, or applications using a state-of-the-art blend of Artificial Intelligence, Machine Learning, and Deep Learning technologies. It provides a solid foundation in Computer Science and Engineering.

The objective is to provide students with the ability to propose resolutions for scientific, technical, and intricate real-world challenges. The aim is to foster the capacity to develop intelligent systems using artificial intelligence (AI) and machine learning (ML) methodologies across diverse disciplines, in order to address societal requirements. The objective is to foster a multidisciplinary approach to design and development.

The major focus of the programme is to create skilled engineers to innovate, design, think and provide intelligent solutions to problems in a variety of domains such as Education, healthcare, security, information forensics, Data virtualization, Agriculture, efficient transportation, smart cities and business applications, in various government and public sectors etc.

## Salient Features of the Department

The programme covers fundamental courses of Computer science and engineering major including programming for problem solving, Data Structures, Computer Architecture, Operating Systems, Algorithms, Computer Networks, Database Management Systems, Compiler Design. The foundation of Computer Science and Engineering enriched by the specialized technical courses on Artificial Intelligence, Machine learning, Deep Learning, Natural Language processing, Data Analytics and Visualization, Image and video processing, Computer vision, Internet of thing. Courses on various application domain and advanced techniques are included such as : Information Retrieval, Biomedical Image Processing, Social network Analysis, Cyber Security Intelligence, Reinforcement learning, Cloud computing, Big data Analytics, Robotics, Game theory, Cognitive systems, Soft Computing.

The programme offers an opportunity to assimilate the students by studying both foundational and experimental components of AI and ML. Artificial Intelligence (AI) & Machine Learning (ML) are increasingly necessary to translate today's exponentially growing data into direct business value. It illustrates how AI and ML fit in the data science ecosystem, and presents several real-world use cases that show how companies are implementing ML to maximize their business results. The Curriculum also covers human and ethical aspects through the courses like Cyber laws and Ethics in IT, Constitution of India, Environment Sciences, Business Communication for Engineers, Indian Traditional Knowledge etc. The programme offers one full semester industry internship facility to final year students to nurture and build professional, ethical and responsible citizen.

## Department Vision

To Continually improve the education environment, in order to develop graduates with strong academic and technical background needed to achieve distinction in the discipline. The excellence is expected in various domains like workforce, higher studies or lifelong learning. To strengthen links between industry through partnership and collaborative development works.

## Department Mission

To develop strong foundation of theory and practices of computer science amongst the students to enable them to develop into knowledge, responsible professionals, lifelong learners and implement the latest computing technologies for the betterment of the society.

## Program Education Objectives (PEOs)

1. To be able to comprehend, understand and analyse Computer Science Engineering problems related to real life which can be better resolved by artificial intelligence and machine learning.
2. To impart exhaustive knowledge of Computer Science Engineering, AI and Machine Learning to cater the industrial needs and excel in innovation and management fields by prediction analysis.
3. To promote collaborative learning and spirit of team work through multidisciplinary AI based projects and diverse professional ethics.
4. To inculcate a conviction to believe in self, impart professional and ethical attitude and nurture to be an effective team member, infuse leadership qualities, and build proficiency in soft skills and the abilities to relate engineering with the social, political and technical issues as per the current scenario.

### Programme Outcomes (POs)

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.

## Programme Specific Outcomes (PSOs)

1. The ability to understand, analyse and demonstrate the knowledge of human cognition, Artificial Intelligence and Machine Learning in terms of real world problems to meet the challenges of the future.
2. The ability to develop computational knowledge and project development skills using innovative tools and techniques to solve problems in the areas related to Artificial Intelligence, Machine learning, Deep Learning.

# Teaching Scheme for Bachelor of Technology
# B. Tech. CSE (Artificial Intelligence and Machine Learning)
## (Semester - I)

| Sr. No. | Course Type | Course Code | Course Name | Hours/Week | | | Credits | Maximum marks | | | ESE Exam Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | Continuous Assessment | End Sem Exam | Total | |
| 1. | BSC | CHT1001 | Chemistry of Smart Materials | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 2. | BSC | CHP1001 | Chemistry of Smart Materials Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 3. | BSC | MAT1002 | Calculus | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 4. | ESC | CAT1001 | Digital Electronics | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 5. | ESC | CAP1001 | Digital Electronics Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 6. | ESC | CAT1002 | Programming for Problem Solving | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 7. | ESC | CAP1002 | Programming for Problem Solving Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 8. | VSEC | CAT1003 | Computer Workshop – I | 1 | 0 | 0 | 1 | 50 | - | 50 | - |
| 9. | VSEC | CAP1003 | Computer Workshop – I Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 10. | HSSM -IKS | HUT1001 | Foundational Literature of Indian Civilization | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. - |
| 11. | CCA | PET1001 | Sports-Yoga- Recreation | 1 | 0 | 0 | 1 | 50 | - | 50 | - |
| 12. | CCA | PEP1001 | Sports-Yoga- Recreation | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| | | | **TOTAL** | **15** | **0** | **10** | **20** | | | **850** | |

# Teaching Scheme for Bachelor of Technology
# B. Tech. CSE (Artificial Intelligence and Machine Learning)
# (Semester - II)

| Sr. No. | Course Type | Course Code | Course Name | Hours/Week | | | Credits | Maximum marks | | | ESE Exam Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | Continuous Assessment | End Sem Exam | Total | |
| 1. | BSC | PHT2001 | Introduction to Quantum Computing | 2 | 1 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 2. | BSC | PHP2001 | Quantum Computing Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 3. | BSC | MAT2002 | Discrete Mathematics | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 4. | BSC | MAP2001 | Computational Mathematics Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 5. | BSC | CHT2007 | Bioinformatics | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 6. | ESC | CAT2001 | Object Oriented Programming | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 7. | ESC | CAP2001 | Object Oriented Programming Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 8. | PCC | CAT2002 | Computer Architecture | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 9. | VSEC | CAT2003 | Computer Workshop- II | 1 | 0 | 0 | 1 | 50 | - | 50 | - |
| 10. | VSEC | CAP2003 | Computer Workshop – II Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 11. | AEC | HUT2002 | English for Professional Communication | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 12. | AEC | HUP2002 | English for Professional Communication Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 13 | CCA | HUP0001 | Liberal/Performing Art | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 14. | VEC | HUT2004 | Foundational Course in Universal Human Values | 1 | 0 | 0 | 1 | 50 | - | 50 | - |
| | | | **TOTAL** | **16** | **1** | **12** | **23** | | | **1000** | |

| Sr. No. | Course Code | Course Name | Hours/ week | Credits | Maximum marks |
|---|---|---|---|---|---|
| 1. | HUP0001-1 | Fundamentals of Indian Classical Dance: Bharatnatayam | 2 | 1 | 50 |
| 2. | HUP0001-2 | Fundamentals of Indian Classical Dance: Kathak | 2 | 1 | 50 |
| 3. | HUP0001-3 | Introduction to Digital Photography | 2 | 1 | 50 |
| 4. | HUP0001-4 | Introduction to Japanese Language and Culture | 2 | 1 | 50 |
| 5. | HUP0001-5 | Art of Theatre | 2 | 1 | 50 |
| 6. | HUP0001-6 | Introduction to French Language | 2 | 1 | 50 |
| 7. | HUP0001-7 | Introduction to Spanish Language | 2 | 1 | 50 |
| 8. | HUP0001-8 | Art of Painting | 2 | 1 | 50 |
| 9. | HUP0001-9 | Art of Drawing | 2 | 1 | 50 |
| 10. | HUP0001-10 | Nature Camp | 2 | 1 | 50 |
| 11. | PEP0001-21 | Disaster Management Through Adventure Sports | 2 | 1 | 50 |
| 12. | PEP0001-22 | Self-Défense Essentials and Basics Knowledge of Défense Forces | 2 | 1 | 50 |
| 13. | CHP0001-31 | Art of Indian Traditional Cuisine | 2 | 1 | 50 |
| 14. | CHP0001-32 | Introduction to Remedies by Ayurveda | 2 | 1 | 50 |

| **Exit option: Award of UG Certificate in Major with 43 credits and an additional 8 credits.** | | | |
|---|---|---|---|
| **Exit Courses** | | | |
| 1. | Web Designer | Online/offline certification Course | 8 |
| 2. | IT Support Engineer | | 8 |
| 3. | Certified Programmer (language learned in Sem-1 and/or Sem-2 [C ,C + + ,Java, Python ] ) | | 8 |

# Teaching Scheme for Bachelor of Technology
# B. Tech. CSE (Artificial Intelligence and Machine Learning)
## (Semester - III)

| Sr. No. | Course Code | Course Name | Hours/Week | | | Credits | Maximum marks | | | ESE Exam Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Continuous Assessment | End Sem Exam | Total | |
| 1. | CAT3001 | Data Structures | 3 | 1 | 0 | 4 | 50 | 50 | 100 | 3 Hrs. |
| 2. | CAP3001 | Data Structures Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 3. | CAT3002 | Operating Systems | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 4. | CAP3002 | Operating Systems Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 5. | CAP3003 | Software Lab-I | 0 | 0 | 4 | 2 | 50 | - | 50 | - |
| 6. | MAT4001 | Probability and Statistics | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 7. | Open Elective | Open Elective I | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 8. | CAP3004 | Idea Lab | 0 | 0 | 4 | 2 | 50 | - | 50 | - |
| 9. | CAT3005 | Cyber Law and Ethics | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 10. | HUT3001 | Business Communication | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| | | **TOTAL** | **15** | **1** | **12** | **22** | | | **800** | |

## (Semester - IV)

| Sr. No. | Course Code | Course Name | Hours/Week | | | Credits | Maximum marks | | | ESE Exam Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Continuous Assessment | End Sem Exam | Total | |
| 1. | CAT4001 | Artificial Intelligence | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 2. | CAP4001 | Artificial Intelligence Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 3. | CAT4002 | Design and Analysis of Algorithms | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 4. | CAT4003 | Theory of Computation | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 5. | MAT4001 | Linear Algebra | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 6. | Open Elective | Open Elective II | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 7. | CAP4004 | Software Lab-II | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 8. | CAP4005 | Software Lab-III | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 9. | CAP4006 | Community Engagement Project | 0 | 0 | 4 | 2 | 50 | - | 50 | - |
| 10. | HUT4002 | Environment Education | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 11. | HUT4003 | Managerial Economics | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| | | **TOTAL** | **19** | **0** | **10** | **24** | | | **900** | |

| **Exit option : Award of UG Diploma in Major with 90 credits and an additional 8 credits** | | | |
|---|---|---|---|
| **Exit Courses** | | | |
| 1 | Application Development (Android) | Online/offline certification Course | 8 |
| 2 | Certified software Engineer (Devop) | | 8 |

# Teaching Scheme for Bachelor of Technology
# B. Tech. CSE (Artificial Intelligence and Machine Learning)
## (Semester - V)

| Sr. No. | Course Code | Course Name | Hours/Week | | | Credits | Maximum marks | | | ESE Exam Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Continuous Assessment | End Sem Exam | Total | |
| 1. | CAT5001 | Machine Learning | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 2. | CAP5001 | Machine Learning Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 3. | CAT5002 | Computer Networks | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 4. | CAP5002 | Computer Networks Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 5. | CAT5003 | Database Management Systems | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 6. | CAP5003 | Database Management Systems Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 7. | CAT5004 | Program Elective-1 | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 8. | CAT5005 | Microcontroller Design | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 9. | CAP5005 | Microcontroller Design Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 10. | Open Elective | Open Elective III | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| | | **TOTAL** | **18** | **0** | **8** | **22** | | | **800** | |

## (Semester - VI)

| Sr. No. | Course Code | Course Name | Hours/Week | | | Credits | Maximum marks | | | ESE Exam Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Continuous Assessment | End Sem Exam | Total | |
| 1. | CAT6001 | Deep Learning-I | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 2. | CAP6001 | Deep Learning-I Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 3. | CAT6002 | Computer Vision | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 4. | CAP6002 | Computer Vision Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 5. | CAT6003 | Program Elective-2 | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 6. | CAP6003 | Program Elective-2 Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 7. | CAT6004 | Program Elective-3 | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 8. | CAP6004 | Program Elective-3 Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 9. | CAT6005 | Internet of Things | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 10. | CAP6006 | Mini Project | 0 | 0 | 4 | 2 | 25 | 25 | 50 | - |
| | | **TOTAL** | **14** | **0** | **12** | **20** | | | **750** | |

| **Exit option : Award of UG Degree in Major with 131 credits and an additional 8 credits** | | | |
|---|---|---|---|
| **Exit Courses** | | | |
| 1 | Certified Network Engineer (CCNA,CISCO) | Online/offline certification Course | 8 |
| 2 | Certified Database Engineer (Oracle, DB2) | | 8 |
| 3 | Certified Cloud Engineer (AWS, AZURE) | | 8 |
| 4 | Certified AIML Engineer | | 8 |
| 5 | Certified Data Science Engineer | | 8 |

# Teaching Scheme for Bachelor of Technology
# B. Tech. CSE (Artificial Intelligence and Machine Learning)

## (Semester - VII)

| Sr. No. | Course Code | Course Name | Hours/Week | | | Credits | Maximum marks | | | ESE Exam Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Continuous Assessment | End Sem Exam | Total | |
| 1. | CAT7001 | Deep Learning-II | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 2. | CAP7001 | Deep Learning-II Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 3. | CAT7002 | Cloud Computing | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 4. | CAP7002 | Cloud Computing Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 5. | CAT7003 | Data Analytics & Visualization | 1 | 0 | 0 | 1 | 50 | - | 50 | - |
| 6. | CAP7003 | Data Analytics & Visualization Lab | 0 | 0 | 2 | 1 | 50 | - | 50 | - |
| 7. | CAT7004 | Program Elective-4 | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 8. | CAT7005 | Robotics and Intelligent Systems | 2 | 0 | 0 | 2 | 50 | 50 | 100 | 2 Hrs. |
| 9. | CAP7006 | Major Project-1 | 0 | 0 | 8 | 4 | 50 | 50 | 100 | - |
| | | **TOTAL** | **12** | **0** | **14** | **19** | | | **700** | |

## (Semester - VIII)

| Sr. No. | Course Code | Course Name | Hours/Week | | | Credits | Maximum marks | | | ESE Exam Duration (Hrs.) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | | Continuous Assessment | End Sem Exam | Total | |
| 1. | CAT8001 | Program Elective-5 | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 2. | CAT8002 | Program Elective-6 | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 3. | CAP8003 | Major Project-2 | 0 | 0 | 12 | 6 | 50 | 50 | 100 | - |
| | | **OR** | | | | | | | | |
| 1. | CAT8001 | Program Elective-5 | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 3 Hrs. |
| 2. | CAT8004 | Research Methodology | 3 | 0 | 0 | 3 | 50 | 50 | 100 | 2 Hrs. |
| 3. | CAT8005 | Research Project | 0 | 0 | 12 | 6 | 50 | 50 | 100 | - |
| | | **OR** | | | | | | | | |
| 1. | INTR-801 | Industry Internship | 0 | 0 | 24 | 12 | 100 | 100 | 200 | - |
| | | | | | | | | | | |

# Teaching Scheme for Bachelor of Technology
# B. Tech. CSE (Artificial Intelligence and Machine Learning)

## Electives Basket

| Elective-I | Elective-II | Elective-III | Elective-IV | Elective-V | Elective-VI |
|---|---|---|---|---|---|
| Software Engineering | Natural Language Processing | Customer Relationship Management | Big Data Analytics | Human Computer Interaction | Financial Analysis |
| Design Pattern | Data Mining and Warehousing | Software Testing | Reinforcement Learning | Generative Adversarial Network | Time Series Analysis |
| Robotic Process Automation | Compiler Design | Blockchain Technology | System Design | Information Retrieval | Edge Computing |

## List of Open Electives

| Sr. No. | Subject Code | Name of Subject |
|---|---|---|
| Open Elective-I | CAT2980 | Statistical Computing with R |
| Open Elective-II | CAT2990 | Fundamentals of Machine Learning |
| Open Elective-III | CAT3980 | Big Data Analytics |

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CHT1001** **Course : Chemistry of Smart Materials**

**L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 2**

### Course Outcomes

On successful completion of course student will learn:

1. Classify and explain the different types of sensors for various applications.
2. Discuss unique properties of nano-materials to solve challenges in our life and applications in computational world.
3. Discuss how spectroscopic methods are used for qualitative and quantitative analysis.
4. Analyze the utilization of green computing technology for environmental issues

**Unit - I : Smart Sensors and Materials**

RFID and IONT materials: Synthesis, properties and applications in logistic information, intelligent packaging systems (Graphene oxide, carbon nanotubes (CNTs) and polyaniline). Sensors: Introduction, types of sensors (Piezoelectric and electrochemical), nanomaterials for sensing applications (Strain sensors, gas sensor, biomolecules and volatile organic compounds).

**Unit - II : Nanomaterials**

Introduction, classification, size dependent properties, surface area, optical and catalytic properties, Synthesis methods of nanomaterials- Top down and bottom-up approach.

Carbon nanomaterials: Types, properties and applications of CNT and graphene. Applications of nano materials.

**Unit - III : Characterization Techniques and computational tools:**

Fundamentals of spectroscopy, Electronic Spectroscopy, Nuclear Magnetic Resonance Spectroscopy. Basics of Nuclear magnetic resonance quantum computer Synthesis of drugs, basic soft-wares for bio-chemical assessment of drugs.

**Unit - IV : Green Computing and Chemistry**

E-wastes- Types, environmental and health risks, segregation and recycling (Hydrometallurgical, pyrometallurgical and direct recycling), Extraction of precious metals from e-wastes, Twelve principles of Green Chemistry. Green Computing, Role of Green Computing in Environment and Research, Green devices and Green data Servers.

## Text Books

1. Shikha Agrawal, Engineering Chemistry: Fundamentals and Applications, Cambridge University Press.
2. Dr. Rajshree Khare, A Textbook of Engineering Chemistry (AICTE), S.K. Kataria & Sons.
3. S. S. Dara, A Textbook of Engineering Chemistry, S. Chand Publications.
4. A. K. Das and M. Das, An introduction to nanomaterials and nanoscience, CBS Publishers and Distributors
5. M Afshar Alam, Sapna Jain, Hena Parveen, Green Computing Approach Towards Sustainable Development, Wiley Interscience Publications.
6. Sensor & transducers, D. Patranabis, 2nd edition, PHI

## Reference Books

1. E-waste recycling and management: present scenarios and environmental issues, Khan, Anish, and Abdullah M. Asiri. 2019, Springer, Vol. 33. ISBN: 978-3-030-14186-8.
2. Hans-Eckhardt Schaefer, Nanoscience: The Science of the Small in Physics, Engineering, Chemistry, Biology and Medicine, Springer-Verlag Berlin Heidelberg.

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CHP1001** **Course : Chemistry of Smart Materials Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

The Chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.

### Course Outcomes

The students will learn to:

1. Apply the fundamental principles of measurement and skills in preparation and handling of hazardous chemicals and interpret the statistical data related to measurements.
2. Estimate the rate constants of reactions and order of the reaction and/or to validate adsorption isotherms.
3. Use of various computational tools for analysis of different spectral properties and bio-activities.

### List of Experiments

[1] Preparation of different Solutions: Molar solution, Normal solution and percent solution and Determination of concentration.

[2] Demonstration of Handling of hazardous chemicals, MSDS (material safety data sheet), waste minimization strategies and chemical waste disposal.

[3] Basic statistical analysis of results of neutralization of acid against the base and preparing acceptable graphs using software.

[4] Prediction of infrared/NMR spectral and analytical data of organic molecules using Computational Software.

[5]. Spectroscopic/Colorimetric determine of wavelength of maximum absorption of chemical/biological compound in solution and determination of concentration using Lambert-Beer's Law.

[6] To study chemical kinetics of peroxydisulphate and iodide ions reactions and to find out order of the reaction and analysis of experimental data using Computational Software.

[7] Molecular docking of drugs using open computational software.

[8] Determination of rate of the reaction at room temperature and analysis of experimental data using Computational Software

[9] Use of open access software for the interpretation of various parameters of materials including drugs

[10] Estimation of Copper from PCB

## Suggested Books/Reference Books

(1) S. S. Dara, A Textbook on Experiments and Calculations in Engineering Chemistry, S. Chand Publications.

(2) J. B. Yadav, Advanced Practical Physical Chemistry, Krishna's Prakashan Media (P) Limited.

(3) A. J. Elias, Collection of Interesting General Chemistry Experiments, Universities Press Publications.

(4) V. K. Ahluwalia, S. Dhingra and A. Gulati, College Practical Chemistry, Universities Press Publications.

(5) Ashutosh Kar , Advanced Practical Medicinal Chemistry, New Age International Publisher.

## Suggested Reference Books

(1) David Young, Computational Chemistry: A Practical Guide for Applying Techniques to RealWorld Problems, Wiley Interscience Publications

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : MAT1002** **Course : Calculus**

**L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 3**

### Course Objective

The objective of this course is to familiarize the prospective engineers with techniques in Calculus. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

### Course Outcomes

On successful completion of the course, student shall be able to

1. Apply the concepts of continuity and differentiability to find Taylor's and Maclaurin series.
2. Understand the methods of partial derivatives and apply these concepts to determine extreme values of the functions of two variables.
3. Demonstrate the basic knowledge of vector differentiation and line integral.
4. Understand proper and improper integrals and use it find area, length, volume and surface of revolution
5. Internalize convergence of sequences and apply it to determine whether infinite series convergent or divergent with appropriate tests.

### Syllabus

**Module - 1 : (8 Lectures)**

Differential Calculus: Functions of single variable: Review of limit, continuity and differentiability. Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem, Taylor's theorem, Taylor's and Maclaurin series.

**Module - 2 : (8 Lectures)**

**Partial Differentiation :** Partial derivatives, Euler's Theorem, chain rule, total derivative, Jacobians, Maxima, Minima for the functions of two variables.

**Module - 3 : (8 Lectures)**

**Vector Calculus :** Scalar and vector fields, gradient of scalar point function, directional derivatives, divergence and curl of vector point function, Line integral.

**Module - 4 : (8 Lectures)**

**Integral Calculus :** Fundamental theorem of Integral calculus, mean value theorems, evaluation of definite integrals, applications in area, length, volumes and surface of solids of revolutions, Improper integrals: Beta and Gamma functions.

**Module - 5 : (8 Lectures)**

**Infinite series :** Sequences, Infinite series of real and complex numbers, Cauchy criterion, tests of convergence, absolute and conditional convergence, uniform convergence, power series, radius of convergence.

## Textbooks/References


1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
6. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics Volume I & II, Pune Vidhyarthi Griha Prakashan, Pune-411030 (India).

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CAT1001** **Course : Digital Electronics**

**L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 3**

### Course Objectives

The objective of this course is to familiarize the prospective engineers with:

1. Logic functions using Boolean algebraic theorems and techniques
2. Conventional combinational and sequential circuits including conversions of flip-flops.
3. The exploration of the semiconductor memories and programmable logic devices.
4. The basic concept of microprocessor with addressing mode and instruction set for programming.

### Course Outcomes

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

1. Outline binary arithmetic operations and optimize Boolean functions using Karnaugh map (k-map) method.
2. Apply combinational circuits for realization of basic building blocks of conventional digital circuits.
3. Design sequential blocks like flip flops, counters, registers, simple finite state machine and similar circuits.
4. Describe the memory elements and combinational digital circuits implementation with programmable logic devices.
5. Use addressing modes and instruction set of target microprocessors for writing efficient assembly language programs.

### Syllabus

**Unit - I : Basics of Digital Electronics**

Motivation for digital systems: Logic and Boolean algebra, Number Systems. Logic Gates & Truth Tables, Demorgan's law, Minimization of combinational circuits using Karnaugh maps up to five variables. Map manipulation-essential prime implicants, non-essential prime implicants.

**Unit - II : Combinational Circuit Design**

Design procedure: Multiplexers, Demultiplexer, Encoders, Decoders, Code Converters, Adders, Subtractor (Half, Full), BCD Adder/ Subtractor, ripple and carry look-ahead addition booth's Algorithm, bit-pair recoding, Integer Division- restoring and non-restoring division.

**Unit - III : Sequential circuit Design-I**

Storage elements, Flip-flops and latches: D, T, J/K, S/R flip-flops. Master Slave Conversion of one of type of F/F to another Sequential circuit. Analysis –Input equations, state table, and analysis with J-K Flip flops. Sequential circuit Design, Design procedure, designing with D & J-K Flip flop.

**Unit - IV : Sequential circuit Design-II**

Counters, asynchronous and synchronous design using state and excitation tables. Registers & Shift registers., Mealey & Moore Machines

**Unit - V : Memory & Programmable logic Devices**

Semiconductor RAM memories, Static and Dynamic Memories, ROM, higher order memory design, multi-module memories, Memory interleaving, , Secondary storage – Magnetic disk, Optical disk, PLA, PAL.

**Unit - VI : Fundamental of Microprocessor**

Introduction to $\mu$p 8085, Addressing modes, Instruction set, Programming of $\mu$p 8085.

## Text Books

1. Morris Mano; Digital Logic Design; Fourth edition, McGraw Hill
2. R.P .Jain; Modern Digital Electronic; Fourth edition; Tata McGraw-Hill.
3. V.J.Vibhute; 8-Bit Microprocessor & Microcontrollers; fifth edition.

## Reference Books

1. A. Anand Kumar; Fundamental of Digital Electronics; Second Edition, PHI
2. A.P. Godse; Digital circuit & design; Technical Publications; 2009.
3. Ramesh Gaonkar; 8 bit Microprocessor; CBS Publishers; 2011.

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CAP1001** **Course : Digital Electronics Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Outcome

On Successful completion of course, students will be able to:

1. Use logic gates for designing digital circuits
2. Implement combinational circuits using VHDL
3. Implement sequential circuits using VHDL
4. Apply the knowledge gained for their project work based on the hardware digital circuits

**Practical based on above theory syllabus**

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAT1002** **Course : Programming for Problem Solving**

**L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 3**

### Course Outcomes

On successful completion of course student will learn:

1. Create C programs using loops and decision-making statements to solve and execute the given problem.
2. Develop programs and functions one dimensional and two-dimensional arrays.
3. Apply the concept of pointers, structures to develop programs.
4. Implement files in C to store the data for the given problem.

**Unit - I : Introduction to Programming**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)Idea of Algorithm: Steps to solve logical and numerical problems. Representation of Algorithm: Flowchart /Pseudo code with examples. Arithmetic expressions and precedence

**Unit - II : C Programming Language**

Introduction to C language: Keywords, Constant, Variable, Data types, Operators, Types of Statements, Pre-processor Directives, Decision Control Statement-if, if-else, nested if-else statement, switch case, Loops and Writing and evaluation of conditionals and consequent branching.

**Unit - III : Arrays and Basic Algorithms**

Arrays: 1-D, 2-D, Character arrays and Strings. Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

**Unit - IV : Functions and Recursion**

User defined and Library Functions, Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference. Recursion: As a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

**Unit - V : Pointers and Structures**

Structures, Defining structures, Array of Structures, Introduction to pointers, Defining pointers, Pointer arithmetic, pointer operators, Use of Pointers in self-referential structures, notion of linked list (no implementation)

**Unit - VI : File handling**

Streams in C, Types of Files, File Input/ Output Operations: Modes of file opening, Reading and writing the file, Closing the files, using fflush ().

## Text Books

1. Programming in ANSI C: E. Balguruswami McGraw Hill
2. Mastering C: K. R. Venugopal and S. R. Prasad, Tata McGraw Hill

## Reference Books

1. Programming with C: Byron Gottfried, Schaums Outline Series.
2. Let Us C: Yashwant Kanetkar, BPB Publication

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP1002** **Course : Programming for Problem Solving Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Outcomes

On successful completion of course student will be able to:

1. Create C programs using loops and decision making statements to solve and execute the given problem.
2. Develop programs and functions one dimensional and two dimensional arrays.
3. Apply the concept of pointers, structures to develop programs.
4. Implement files in C to store the data for the given problem.

**Practical based on above theory syllabus**

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAT1003** **Course : Computer Workshop-I**

**L: 1 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 1**

### Course Objectives

1. Understand the definition and principles of UI/UX in order to design with intention.
2. Achieve an understanding of the life-cycle of application design the process, purpose, and tools.
3. Learn the basics of HCI (human-computer interaction) and the psychology behind user decision-making.
4. Explore UI/UX tools to interpret requirements of modern applications.
5. Elaborate design decisions through presentations of assignments.

### Course Outcomes

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

1. Understand basics of UI/UX
2. Design and develop web pages using HTML, CSS and JavaScript
3. Infer the significance of Wire framing and build prototypes.

**Unit - 1 : UI/UX Overview**

Introduction to UI/UX, Principles of UI/UX, UI Components, Design Thinking, Interaction Design, Usability.

**Unit - 2 : UI Programming**

Basic of HTML5, Elements of HTML5, Background of CSS, Bootstrap CSS, Fundamentals of JavaScript, HTML DOM Manipulations.

**Unit - 3 : UX Programming**

Figma Basics, How to identify user needs, Wireframe and Prototype, Digital Storytelling.

### Text Books

1. UI/UX design for designer and developers: by Nathan Clark
2. Web Design: A Beginner's Guide Second Edition by Wendy Willard
3. User story mapping by Jeff Patton, O'Reilly Publication

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP1003** **Course : Computer Workshop-I Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

1. Understand the definition and principles of UI/UX in order to design with intention.
2. Achieve an understanding of the life-cycle of application design—the process, purpose, and tools.
3. Learn the basics of HCI (human-computer interaction) and the psychology behind user decision-making.
4. Explore UI/UX tools to interpret requirements of modern applications.
5. Elaborate design decisions through presentations of assignments.

### Course Outcomes

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

1. Design and develop static web pages using HTML and CSS
2. Develop dynamic web pages using JavaScript
3. Create high-fidelity designs and prototypes in Figma

### Syllabus

Practical based on Theory Syllabus

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUT1001** **Course : Foundational Literature of Indian Civilization**

**L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 2**

### Course Outcome

At the end of the course the students will be able to achieve the following:

**CO1 :** Understand the Indian knowledge system and its scientific approach

**CO2 :** Get introduced to the Vedic corpus and recognize the multi-faceted nature of the knowledge contained in the Vedic corpus

**CO3:** Understand the salient features of the philosophical systems of the Vedic and non-Vedic schools

**CO4:** Develop a basic understanding of the ancient wisdom recorded in various Indian literary work

### Syllabus

**Unit - 1 : Overview of Indian Knowledge System**

Importance of ancient knowledge, defining IKS, IKS classification framework, Historicity of IKS, Some unique aspects of IKS.

**Unit - 2 : The Vedic corpus**

Introduction of Vedas, four Vedas, divisions of four Vedas, six Vedangas, Distinct features of Vedic life.

**Unit - 3 : Indian Philosophical systems**

Development and unique features, Vedic schools of philosophy, Samkhya and Yoga School of philosophy, Nayay and Vaisesika school of philosophy, Purva-mimamsa and Vedanta schools of Philosophy, Non-vedic philosophies: Jainism, Buddhism, and other approaches

**Unit - 4 : Indian wisdom through ages**

Panchtantras, Purans: contents and issues of interests, Itihasa: uniqueness of the two epics (Ramayan and Mahabharata), Key issues and messages from Ramayana, Mahabharata – a source of worldly wisdom;

Indian ancient Sanskrit literature: Kalidas, Vishakadutta, Bhavbhuti, Shudraka**any one text as decided by the course teacher

### Reference Material

1. B. Mahadevan, Vinayak Rajat Bhar, Nagendra Pavana R. N., "Introduction to Indian Knowledge System: Concepts and Applications" PHI, 2022
2. S.C. Chatterjee and D.M. Datta, An introduction to Indian Philosophy, University of Calcutta, 1984

## Syllabus for Semester I, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : PET1001** | **Course : Sports-Yoga-Recreation**
**L: 1 Hrs, T: 0 Hr, P: 0 Hr, Per Week** | **Total Credits : 1**

**Course Code : PEP1001** | **Course : Sports-Yoga-Recreation**
**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** | **Total Credits : 1**

### Aim of the Course

The course aims at creating awareness about the fundamentals of Physical Education, Sports, Yoga, Recreation and its effectiveness to promote Health and wellness through Healthy Lifestyle.

### Course Objectives

1. To impart the students with basic concepts of Sports, Yoga and Recreational activities for health and wellness.
2. To familiarize the students with health-related Exercise and evaluate their Health-related Fitness.
3. To make Overall growth & development with team spirit, social values and leadership qualities among students through various sports, games and Yogic activities.
4. To create Environment for better interaction and recreation among students as neutralizer for stress through various minor and recreational games.

### Course Outcomes

On completion of the course, students will be able to:

1. Understand fundamental skills, basic principle and practices of sports and Yoga.
2. Practically learn the principles of implementing general and specific conditioning of physical exercises and yoga.
3. Develop Health-related fitness and Body-mind co-ordination through various fitness activities, sports, recreational games and yoga.
4. Practice Healthy & active living with reducing Sedentary Life style.

### Course Content

**Unit - 1 : Theory : Introduction**

- Meaning, Definition and Importance of Health & Wellness
- Dimensions of Health and Wellness
- Factors influencing Health and Wellness
- Physical Fitness, Nutrition, Habits, Age, Gender, Lifestyle, Body Types

- Health & Wellness through Physical Activities, Sports, Games, Yoga and Recreation activities
- Causes of Stress & Stress relief through Exercise and Yoga
- Safety in Sports

**Unit - 2 : Practical- Exercises for Health and Wellness**

- Warm-Up and Cool Down - General & Specific Exercises
- Physical Fitness Activities
- Stretching Exercises
- General & Specific Exercises for Strength, Speed, Agility, Flexibility, coordinative abilities
- Cardiovascular Exercises
- Assessment of BMI
- Relaxation techniques
- Physical Efficiency Tests

**Unit - 3 : Yoga**

- Shukshma Vyayam
- Suryanamaskar
- Basic Set of Yogasanas – Sitting, standing, supine and prone position
- Basic Set of Pranayama & Meditation

## References

1. Russell, R.P. (1994). Health and Fitness Through Physical Education. USA: Human Kinetics.
2. Uppal, A.K. (1992). Physical Fitness. New Delhi: Friends Publication.
3. AAPHERD "Health related Physical Fitness Test Manual."1980 Published by Association drive Reston Virginia
4. Kumar, Ajith. (1984) Yoga Pravesha. Bengaluru: Rashtrothanna Prakashana.
5. Dr. Devinder K. Kansal, A Textbook of Test Evaluation, Accreditation, Measurements and Standards (TEAMS 'Science)

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : PHT2001** **Course: Introduction to Quantum Computing**

**L: 2 Hrs, T: 1 Hr, P: 0 Hr, Per Week** **Total Credits : 3**

### Course Objectives

1. To introduce the fundamentals of quantum computing to students
2. The problem-solving approach using finite dimensional mathematics

### Course Outcomes

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

1. Use the basic quantum theory relating to the probabilistic behaviour of an electron in an atom.
2. Utilize the knowledge of complex vector space in the domain of quantum theory.
3. Analyse classical and quantum approach towards the quantum computation.
4. Classify deterministic and probabilistic systems and analyse quantum observations and quantum measurements.
5. Use quantum gates in building architecture and quantum algorithms.

**Module - 1 : Basic Quantum Theory**

Brief introduction about Quantum Computers and Quantum mechanics, Wave nature of Particles, Bohr's quantization condition, Heisenberg's Uncertainty principle, Wave function, probability, Schrodinger's wave equation, Operators, Electron in an infinite potential well, Eigen value and Eigen functions.

**Module - 2 : Complex Vector Spaces**

Algebra and Geometry of Complex numbers, Real and Complex Vector Spaces, definitions, properties, Abelian group, Euler's formula, Dr Moivre's formula, Matrix properties.

**Module - 3 : Linear Algebra in Quantum Computing**

Basis and Dimensions, Inner products, Hilbert Spaces, Eigenvalues and Eigenvectors, Hermitian and Unitary Matrices, Tensor Product, Applications of linear algebra in computer graphics.

**Module - 4 : Classical and Quantum Systems**

Deterministic and Probabilistic Systems, Quantum Systems, Stochastic billiard ball, Probabilistic double slit experiment with bullet and photon, Superposition of states, assembling systems, Entangled states.

**Module - 5 : Quantum representation of systems**

Dirac notations, Stern-Gerlach experiment, transition amplitude, norm of the ket, Bloch Sphere, Observables, Spin matrices, commutator operator, expectation values, variance, standard deviation, Heisenberg's uncertainty principle in matrix mechanics, measuring, dynamics, observations.

**Module - 6 : Architecture and Algorithms**

Bits and Qubits, Classical Gates and their equivalent quantum representation, Reversible Gates: CNOT, Toffoli, Fredkin, gates, outline of Pauli X, Y, Z gates, Hadamard gates, Deutsch Gate.

**Quantum Algorithms:** Deutsch's algorithm, Grover's search algorithm.

Applications of quantum computing in Cryptography, Quantum teleportation, Cybersecurity, banking, finance, advance manufacturing and artificial intelligence.

## Text Book

1. Quantum computing for computer scientists, Noson S. Yanofsky, Mirco A. Mannucci, Cambridge University Press 2008
2. Introduction to Quantum Mechanics, 2nd Edition, David J. Griffiths, Prentice Hall New Jersey 1995

## Reference Books

1. Quantum computing explained, David McMahon, Wiley-interscience, John Wiley & Sons, Inc. Publication 2008
2. Quantum computation and quantum information, Michael A. Nielsen and Isaac L. Chuang, Cambridge University Press 2010

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : PHP2001** **Course: Quantum Computing Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Outcomes

The physics laboratory will consist of experiments and programming exercises illustrating the principles of quantum physics and quantum computing relevant to the study of computer science and engineering.

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

1. Develop skills required for experimentation and verification of physics laws.
2. Utilise Mathematica software for graph plotting and for least squares fitting of the experimental data.
3. Compare the properties of real and complex matrices with reference to their use in quantum system.
4. Apply the computational methods to solve eigenvalues and eigenfunctions, tensor products.
5. Simulate classical and quantum gates.

### List of Experiments

1. Introduction to IBM quantum computer.
2. Simulation of classical gates by quantum representation of the gates and inputs.
3. Arithmetic operations using IBM Quantum computer.
4. Simulation of quantum gates: CNOT gate, Toffoli gate, Fredkin gate, Hadamard gate on IBM quantum computer.
5. Linear and Nonlinear data fitting by least squares fit method
6. Working with Vectors.
7. Working with Matrices: Real and Complex numbers.
8. Eigen values, Eigen functions, Properties of Inner Product and Unitary Matrices, Tensor Product.
9. Verification of Ohm's law and error analysis of the data using Linear Least Square Fit (LLSF) method.
10. Analysis of energy values and wave function using Mathematica software

### Reference Books

1. Lab manual prepared by Physics Department, RCOEM, Nagpur

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : MAT2002** **Course: Discrete Mathematics**

**L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 3**

### Course Objective

The objective of this course is to expose student to understand the basic importance of Logic, Number theory, Algebraic structures like groups and Field, combinatory and graph theory in computer science and Information technology.

### Course Outcomes

On successful completion of the course, student shall be able to

1. Formulate problems and solve recurrence relations
2. Apply techniques of number theory to solve problems from linear congruence's, coding theory etc. in cryptography.
3. Internalize logical notations to define and reason about fundamental mathematical concepts and use it derive logical inference.
4. Apply groups and fields in coding theory.
5. Understand the Lattice as algebraic structure and use it for pattern recognition and in cryptography.

### Syllabus

**Module - 1 : (9 Lectures)**

**Combinatorics:** Addition and multiplication rule in combinatorics, Linear and Circular permutation, Combination, Binomial Identities, Inclusion and Exclusion Principle, distribution Principle, recurrence relations, generating function, examples using ordinary power series and exponential generating functions.

**Module - 2 : (8 Lectures)**

**Modular Arithmetic:** Modular Arithmetic, Euclid's Algorithm, primes, Fermat's theorem, Euler's theorem, Diophantine equations, Linear congruence's, Chinese Remainder theorem, application to Cryptography.

**Module - 3 : (7 Lectures)**

**Mathematical Logic :** Statement and notations, connectives, Negation, conjunction, disjunction, conditional & bi-conditional statement. Tautologies, equivalence of formulas, Duality law, Tautological implications, Theory of inference for statement calculus.

**Module - 4 : (9 Lectures)**

**Groups and Fields :** Group definitions and examples, cyclic group, permutation groups, subgroups and homomorphism, co-sets, Lagrange's theorem and Normal subgroup, Error correcting codes, Hamming codes. Finite field, Galois field.

**Module - 5 : (7 Lectures)**

**Lattice theory :** Lattices as partially ordered set, Properties of Lattice, Lattices as algebraic system, sub lattices, direct product, homomorphism, some special Lattices.

## Text Books

1. Discrete Mathematical Structures with Applications to Computer Science: J. P. Tremblay and R. Manohar, Tata McGraw-hill.
2. Discrete Mathematics: Babu Ram, Pearson Publication.
3. Combinatorial Mathematics: C. L. Liu & D. P. Mohapatra, 3rd edition, Tata McGraw-hill.
4. David M Burton, 'Elementary Number Theory', McGraw Hill, Seventh edition 2014.

## Reference Books

1. Foundations of Discrete Mathematics: K. D. Joshi, New age international Publication.
2. Discrete Mathematics: Kolman, Busby & Ross, Pearson Publication.

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : MAP2001** **Course : Computational Mathematics Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

The computational Mathematics Lab course will consist of experiments demonstrating the principles of Mathematics relevant to the study of Science and Engineering. Students will show that they have learnt Laboratory skills that will enable them to properly acquire and analyze the data in the lab and draw valid conclusions.

### Course Outcomes

By using open source software SageMath Students will be able to

**CO1:** Download SageMath and use it as an advance calculator.

**CO2:** Sketch and analyze function graphs.

**CO3:** Apply the concepts of differential calculus to find extreme value of continuous functions and analyze solutions of difference equations

**CO4:** Evaluate improper integrals and its applications to find length, area, volume, centre of gravity and mass.

**CO5:** Understand and Analysis Data inscription standards.

**CO6:** Analyze the data to find best fit curve.

**Mapping of Course outcomes (COs) with Experiments**

| Exp. No. | Name of Experiments | Mapped COs |
|---|---|---|
| 1 | To use SageMath as advanced calculator | CO1 |
| 2 | 2D Plotting with SageMath | CO2 |
| 3 | 3D Plotting with SageMath | CO2 |
| 4 | Differential Calculus with SageMath | CO3 |
| 5 | Solution of difference equations in SageMath | CO3 |
| 6 | To Learn Cryptography by using SageMath | CO5 |
| 7 | Curve Fitting by using SageMath | CO6 |
| 8 | Integral Calculus with SageMath | CO4 |

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CHT2007** **Course : Bioinformatics**

**L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 2**

## Course Outcomes

After the successful completion of the course, students shall be able to

**CO1:** Explain the functioning of various metabolic processes in the human body.

**CO2:** Acknowledge the importance of metabolic simulations in drug discovery,

**CO3:** Explain the functioning of various types of the drugs for therapeutic applications.

**CO4:** Use knowledge of bioinformatics for basic formulation of drug design

**Unit - I : Introduction to Biomolecules Carbohydrates**

Introduction and classification Amino Acid: Chemistry properties and metabolism.

Proteins: primary, Secondary, tertiary and quaternary structure,

Lipids: Chemistry, Metabolism of fatty acids, Phospholipids, Cholesterol regulation of metabolism. Nucleic Acid: Chemistry of DNA and RNA, Vitamins: Structure and functions of some vitamins.

**Unit - II : Introduction to bioinformatics**

**Introduction, Biological data:** Sequence, gene expression, pathways and molecular interaction: Data bases: Sequence, Gene bank, Dogmass- central and peripheral, The standard genetic code, applications.

**Unit -III Drug and Data Bases**

**Drug and Data bases:** Introduction, classification of drugs, Drug Solubility/permeability, Drug Likeness Introduction to metabolic engineering and systems biology, role of metabolic simulations in drug discovery.

**Unit - IV : Computer Aided Drug Design**

Introduction to molecular docking, rigid docking, flexible docking, 3D pharmacophore, 3D data base searching and virtual searching, pharmacophore modelling, brief introduction about various online tools for drug designing and molecular docking.

## Text Books

1. Upadhayay, K. Upadhayay, N. Nath, Biophysical Chemistry (Principles and Techniques), Himalaya Publishing House, 2009.
2. David L. Nelson and Michael M. Cox, Lehninger Principles of Biochemistry, Fifth Edition, W. H. Freeman and Company, New York, 2008.

3. Young David. Computational drug design: A Guide for Computational and Medicinal Chemists. Publisher: Wiley. 2009. ISBN: 9780470126851

## Reference Books

1. Bioinformatics: Sequence and Genome Analysis, Mount. D. W, CSHL Press, New York 2nd Edition 2004.
2. Introduction to Bioinformatics by Arthur M. Lesk University of Cambridge, Published in the United States by Oxford University Press Inc., New York
3. Introduction to Computational Biology: Maps, Sequences and Genomes, Waterman, M., Chapman and Hall, 1995.
4. Abraham, Donald (Ed). Burger's medicinal chemistry and drug discovery. Publisher: John Wiley & Sons, Inc. 2003. ISBN: 0471270903
5. Schlick, T. Molecular modelling and simulation: an interdisciplinary guide. Publisher: Springer. 2002. ISBN: 0-387-95404-X
6. Leach, Andrew. Molecular Modelling: Principles and Applications. Publisher: Prentice Hall. 2001. ISBN: 0582239338.
7. Jensen, Jan H. Molecular Modeling Basics. Publisher: CRC Press. 2010. ISBN: 978- 1420075267
8. Hinchliffe Alan. Molecular modelling for beginners. Publisher: John Wiley and Sons Ltd. 2008. ISBN: 978 0470513149

## E- Text Book

1. Computer Aided Drug Design by Prof. Mukesh Doble, Biotechnology, IIT, Madras (Swayam NPTEL)

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CAT2001** **Course : Object Oriented Programming**

**L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 3**

### Course Objectives

1. To make students understand Fundamental features of an object oriented language like Java: object classes and interfaces, exceptions and libraries of object collections
2. Introduce students with fundamental concepts like exception handling, generics, collection classes and streams.

### Course Outcomes

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

1. Understand the object-oriented programming features, classes, objects and methods.
2. Develop efficient programs by implementing the concept of Inheritance, polymorphism exception handling.
3. Use the concept of generics, collections, streams to develop solution to the given problem.
4. Analyze characteristics and need of design pattern in software design process.

### Syllabus

**Unit - I**

Features of Object-Oriented Programming languages, Abstraction, Encapsulation, Inheritance, polymorphism and late binding. Programming paradigms, Bytecode, JDK, JRE, JVM.

Concept of a class and object, ways of representing objects, access control of members of a class, instantiating a class, constructor.

**Unit - II**

Concept of overloading: Constructor Overloading, Function Overloading.

Arrays and Array of objects, Wrapper classes (Integer, Double etc.), String Class, creating packages, importing packages.

Lambda Expressions Introduction, Block, Passing Lambda expression as Argument

**Unit - III**

Concept of inheritance, methods of derivation, use of super keyword and final keyword in inheritance, run time polymorphism, abstract classes and methods, Interface, implementation of interface, static and non-static members.

**Unit - IV**

Exceptions, types of exception, use of try catch block, handling multiple exceptions, using finally, throw and throws clause, user defined exceptions, Introduction to streams, byte streams, character streams, file handling in Java, Serialization.

**Unit - V**

Generics, generic class with two type parameter, bounded generics.

Collection classes: Arraylist, LinkedList, TreeSet, HashMap, Iterator, ListIterator, Comparator, Comparable

**Unit - VI**

Introduction to Design Patterns, Need of Design Pattern, Classification of Design Patterns, Role of Design Pattern in Software design, Creational Patterns, Structural Design Patterns and Behavioral Patterns.

## Text Books

1. Herbert Schildt; JAVA The Complete Reference; Ninth Edition, Tata McGraw- Hill Publishing Company Limited.
2. Design Patterns By Erich Gamma, Pearson Education

## Reference Books

1. Paul Deitel, Harvey Deitel; Java 9 for Programmers; Pearson
2. Herbert Schildt and Dale Skrien; Java Fundamentals A Comprehensive Introduction; Tata McGraw- Hill Education Private Ltd 2013.

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CAP2001** **Course : Object Oriented Programming Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

1. To develop ability of students to implement basic concepts and techniques of object oriented programming paradigm like encapsulation, inheritance, polymorphism, exception handling.
2. Develop solution to problems using collection classes, generics, streams, multithreading.

### Course Outcomes

On completion of the course the student will be able to

1. Develop the solutions using basic features of Object-Oriented Programming.
2. Design efficient and reusable solutions using inheritance and exception handling techniques.
3. Create and use type-safe object through generics and collection classes

### Syllabus

Experiments based on above Syllabus.

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CAT2002** **Course : Computer Architecture**

**L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 2**

### Course Objectives

The objective of this course is to familiarize the prospective engineers with:

1. Concepts of computer architecture by developing understanding of various functional units, components of computers and working of all the modules.
2. Design principles of modern computers including memory, bus system, input/output operation, interrupt handling mechanism and parallelization.

### Course Outcomes

On Successful completion of course, students will be able to:

1. Demonstrate the understanding about the functional units of a digital computer system.
2. Execute complete instruction on different types of bus architectures with control signal generation.
3. Analyse memory, multiprocessor and multicore architectures and their implications in parallel computing.

**Syllabus**

**Unit - I : Basic Structure of Computers**

Functional units of computer, basic operational concepts- Instruction, processor and memory, operating steps, address, Big- and Little-endian assignments, Instructions set architecture of a CPU- Instruction Formats, Instruction sequencing, addressing modes, and instruction set classification, subroutine & parameter passing, expanding opcode, RISC and CISC.

**Unit - II : Basic Processing Unit and Data Representation**

Basic Concepts- Instruction execution, Bus architecture- One bus and Multi-bus, Execution of a Complete Instruction, sequencing of control signals, Hardwired control, Micro-programmed Control. Floating point numbers-representation, guard bits and rounding.

**Unit - III : Memory & Input/output**

Cache memory, Cache size vs. block size, mapping functions, replacement algorithms, Cache read/write policy, Virtual Memory, I/O mapped I/O and memories mapped I/O, interrupt and interrupt handling mechanisms, vectored interrupts, synchronous vs. asynchronous data transfer, Bus Arbitration, Direct Memory Access

**Unit - IV : Pipelining**

Basic concepts of pipelining, throughput and speedup, Introduction of Parallel Computing: SISD, MISD, SIMD, MIMD

## Text Books

1. V. C. Hamacher, Z. G. Vranesic and S. G. Zaky; Computer Organisation; 5th edition; Tata McGraw Hill, 2002.
2. W. Stallings; Computer Organization & Architecture; PHI publication; 2001.
3. J. P. Hayes; Computer Architecture & Organization; 3rd edition; McGraw-Hill; 1998.

## Reference Books

1. M Mano; Computer System and Architecture; PHI publication; 1993.
2. A. S. Tanenbaum; Structured Computer Organization; Prentice Hall of India Ltd.

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CAT2003** **Course : Computer Workshop-II**

**L: 1 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 1**

### Course Objective

The objective of this course is to familiarize the students with an important web framework for developing user interfaces. It aims for developing high end web applications by the use of ReactJS features.

### Course Outcomes

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

1. Implement the fundamentals of React with Java Script and JSX
2. Understand Templating concept along with different types of components, props and state in React JS
3. Implement Router with React Router.

### Course Contents

**Unit - I : Introduction to React**

React JS Introduction, Advantages of React JS, Introduction to JSX, Difference between JS and JSX.

**Unit - II : Components in React**

React Components overview, Types of components, Controlled, Split Up, Composable, Reusable, Component Declarations and Styling Components

State and it significance, Read state and set state, Passing data to component using props, Validating props using prop Types, Supplying default values to props using default Props

**Unit - III : Routing with react router**

Introduction to React Router, Routing in single page applications, Browser Router and Hash Router components Configuring route with Route component.

### Text Books

1. Pure React- a step by step guide - Dave Ceddia
2. Road to learn react - Robin Wieruch
3. React in Action 1st Edition - Mark Tielens Thomas

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CAP2003** **Course : Computer Workshop-II Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objective

The objective of this course is to familiarize the students with an important web framework for developing user interfaces. It aims for developing high end web applications by the use of ReactJS features.

### Syllabus

**Practical based on Theory Syllabus**

### Course Outcomes

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

1. Understanding the fundamentals of ReactJS including components, props, state, and lifecycle methods.
2. Design and implement complex applications by composing smaller, reusable components together.
3. Building Web Applications to create dynamic and interactive web applications using React and other related technologies like JSX and ES6.
4. Implement React Router to handle client-side routing and create single-page applications.

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUT2002** **Course : English for Professional Communication**

**L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 2**

### Course Objectives

The main objective of this course is to enhance the employability skills of students as well as prepare them for effective work place communication.

### Course Outcomes

On successful completion of the course the students will be able to achieve the following:

**CO1 :** Demonstrate effective use of word power in written as well as oral communication.

**CO2 :** Understand the techniques of listening and apply the techniques of reading comprehension used in professional communication.

**CO3 :** Apply the principles of functional grammar in everyday as well as professional communication.

**CO4 :** Effectively implement the comprehensive principles of written communication by applying various writing styles.

**CO5 :** Create precise and accurate written communication products.

**Unit - 1 : Vocabulary Building**

1.1 Importance of using appropriate vocabulary

1.2 Techniques of vocabulary development

1.3 Commonly used power verbs, power adjectives and power adverbs.

1.4 Synonyms, antonyms, phrases & idioms, one-word substitutions and standard abbreviations

**Unit - 2 : Listening and Reading Comprehension**

2.1 Listening Comprehension: active listening, reasons for poor listening, traits of a good listener, and barriers to effective listening

2.2 Reading Comprehension: types and strategies.

**Unit - 3 : Functional Grammar and Usage**

3.1 Identifying Common Errors in use of: articles, prepositions, modifiers, modal auxiliaries, redundancies, and clichés

3.2 Tenses

3.3 Subject-verb agreement, noun-pronoun agreement

3.4 Voice

**Unit - 4 : Writing Skills**

4.1 Sentence Structures

4.2 Sentence Types

4.3 Paragraph Writing: Principles, Techniques, and Styles

**Unit - 5 : Writing Practices**

5.1 Art of Condensation: Précis, Summary, and Note Making

5.2 Correspondence writing techniques and etiquettes – academic writing

5.3 Essay Writing

## Books

1. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan.2007
4. On Writing Well. William Zinsser. Harper Resource Book. 2001
5. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP2002** **Course : English for Professional Communication Lab**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

To enhance competency of communication in English among learners

### Course Outcomes

On completion of English Lab course, students will be able to achieve the following:

**CO1 :** Apply effective listening and speaking skills in professional and everyday conversations.

**CO2 :** Demonstrate the techniques of effective Presentation Skills

**CO3 :** Evaluate and apply the effective strategies for Group Discussions

**CO4 :** Analyse and apply the effective strategies for Personal Interviews

**CO5 :** Implement essential language skills- listening, speaking, reading, and writing

### Syllabus

**List of practical**

Computer Assisted + Activity Based Language Learning

**Practical - 1 :** Everyday Situations: Conversations and Dialogues – Speaking Skills

**Practical - 2 :** Pronunciation, Intonation, Stress, and Rhythm

**Practical - 3 :** Everyday Situations: Conversations and Dialogues – Listening Skills Activity Based Language Learning

**Practical - 4 :** Presentation Skills: Orientation & Mock Session

**Practical - 5 :** Presentation Skills: Practice

**Practical - 6 :** Group Discussions: Orientation & Mock Session

**Practical - 7 :** Group Discussions: Practice

**Practical - 8 :** Personal Interviews: Orientation & Mock Session

**Practical - 9 :** Personal Interviews: Practice

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-1** **Course : Fundamentals of Indian Classical Dance: Bharatnatayam**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objective

The course aims to introduce the students to Bharatnatyam, an important element of Indian traditional knowledge system. The course will not only provide the learning and skill to perform this art but would also enhance many mental and physical aspects of the students such as strength, flexibility, discipline, self-confidence, creativity, focus, coordination, etc.

### Course Outcomes

On completion of the course, students will be able to achieve the following:

**CO1:** Understand the importance of dance and Bharatnataym as an Indian dance form

**CO2:** Develop skills to perform the dance form at its basic level.

**CO3:** Evaluate their strengths and interest to take bridge course to give Pratham (1st level formal exam of Bharatnatayam).

### Syllabus

**Practical -1:** Orientation in Bharatnatayam

**Practical-2:** Tattu Adavu till 8, Naatta Adavu 4 Steps, Pakka Adavu 1 step, Metta Adavu 1 Step, Kuditta Metta Adavu 4 Steps,

**Practical -3:** Practice sessions

**Practical-4:** Tatta Kuditta Adavu (Metta), Tatta Kuditta Adavu (Metta) 2 Steps, Tirmanam Adavu 3 Steps, Kattu Adav - 3 Steps, Kattu Adav - 3 Steps

**Practical-5:** Practice sessions

**Practical-6:** Tiramanam (front) 3 Steps, Repeat of Tiramanam (Overhead) 3 Steps, Practical-7: Practice sessions

**Practical – 8:** Final practice sessions and performances.

### Recommended Reading

1. Introduction to Bharata's Natyasastra, Adya Rangacharya, 2011
2. The Natyasastra and the Body in Performance: Essays on the Ancient Text, edited by Sreenath Nair, 2015
3. Bharatanatyam How to ... : A Step-by-step Approach to Learn the Classical Form, Eshwar Jayalakshmi, 2011

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-2** **Course : Fundamentals of Indian Classical Dance: Kathak**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objective

The course aims to introduce the students to Kathak, an important element of Indian traditional knowledge system. The course will not only provide the learning and skill to perform this art but would also enhance many mental and physical aspects of the students such as strength, flexibility, discipline, self-confidence, creativity, focus, coordination, etc.

### Course Outcomes

On completion of the course, students will be able to achieve the following:

**CO1:** Understand the importance of dance and Kathak as an Indian dance form

**CO2:** Develop skills to perform the dance form at its basic level.

**CO3:** Evaluate their strengths and interest to take bridge course to give Prarambhik (1st level formal exam of Kathak).

### Syllabus

**Practical -1:** Orientation in Kathak. Correct posture of kathak, Basic Movements and exercise Stepping, Chakkar of 5 count (Bhramari),

**Practical -2:** Practice sessions of practical 1

**Practical -3:** Hastaks, Hastaks and Steppings, Reciting asamyukta Mudra shloka, Hastak and steppings

**Practical -4:** Practice sessions of practical 3

**Practical -5:** Todas and Asamyukta hasta mudra shlok, Vandana of Shlok, 2 Todas and Vandana, Ghante Ki Tihai,

**Practical -6:** Practice sessions of practical 5

**Practical -7:** 2 1 Chakkardar Toda and Ginnti Ki Tihai, 2 Todas and 1 Chakkardar Toda, practice sessions

**Practical -8:** Final performances.

### Recommended Reading

1. Kathak Volume1 A "Theoretical & Practical Guide" (Kathak Dance Book), Marami Medhi & Debasish Talukdar, 2022, Anshika Publication (13 September 2022)

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-3** **Course : Introduction to Digital Photography**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objective

The course aims to develop basic skills of students in digital photography to lay a foundation for them as a hobby and/or a profession.

**Course Outcome**

At the end of the course the students will be able to achieve the following:

**CO1:** Develop an understanding of the technical aspects and aesthetics of Photography.

**CO2:** Apply the rules of digital photography for creating photographs.

**CO3:** Develop skills to enhance photographs through post processing.

**CO4:** Create a portfolio of their photographs in selected genre.

### Syllabus

**Practical 1:** Orientation in digital photography: Genres, camera handling and settings

**Practical 2:** Rules of Composition

**Practical 3:** Rules of Composition: practice sessions

**Practical 4:** Understanding Exposure and Art of Pre-Visualization

**Practical 5:** Rules of Composition and Art of Pre-Visualization: practice sessions

**Practical 6:** Post Processing Photographs and Portfolio creation

**Practical 7:** Post Processing Photographs: practice sessions

**Practical 8:** Portfolio finalization and presentation in selected genre.

### Reference Material

1. Scott Kelby (2020) The Digital Photography Book: The Step-by-Step Secrets for how to Make Your Photos Look Like the Pros, Rocky Nook, USA
2. Larry Hall (2014) Digital Photography Guide: From Beginner to Intermediate: A Compilation of Important Information in Digital Photography, Speedy Publishing LLC, Newark
3. J Miotke (2010) Better Photo Basics: The Absolute Beginner's Guide to Taking Photos Like a Pro, AMPHOTO Books, Crown Publishing Group, USA

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-4** **Course : Introduction to Japanese Language and Culture**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objective

The course aims to develop basic communication skills in Japanese Language and help develop a basic understanding of Japanese culture in cross-cultural communication.

### Course Outcome

**CO1:** Gain a brief understanding about Japan as a country and Japanese culture.

**CO2:** Develop ability to use vocabulary required for basic level communication in Japanese language.

**CO3:** Able to write and read the first script in Japanese language.

**CO4:** Able to frame simple sentences in Japanese in order to handle everyday conversations

**CO5:** Able to write in basic Japanese about the topics closely related to the learner.

### Syllabus

**Practical-1:** Orientation about Japan, its language, and its culture

**Practical-2:** Communication Skills 1: Vocabulary for basic Japanese language

**Practical -3:** Practice sessions

**Practical-4:** Writing Skills 1: Reading and writing first script in Japanese

**Practical-5:** Practice sessions

**Practical- 6:** Communication Skills 2: framing sentences

**Practical- 7:** Practice sessions

**Practical- 8:** Writing Skills 2: Write basic Japanese and practice

### Recommended Reading

1. Marugoto Starter (A1) Rikai - Course Book for Communicative Language Competences, by The Japan Foundation, Goyal Publishers & Distributors Pvt. Ltd (ISBN: 9788183078047)
2. Japanese Kana Script Practice Book – Vol. 1 Hiragana, by Ameya Patki, Daiichi Japanese Language Solutions (ISBN: 9788194562900)

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-5** **Course : Art of Theatre**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

The course aims to develop in the students, an actor's craft through physical and mental training.

### Course Outcomes

On completion of the course, students will be able to achieve the following:

**CO1:** Understand and synthesize the working of the prominent genres of theatre across the world.

**CO2:** Apply the skill of voice and speech in theatre and public speaking

**CO3:** Apply the art of acting and also develop generic skills such as confidence, communication skills, self-responsibility, motivation, commitment, interpersonal skills, problem solving, & self-discipline.

**CO4:** Apply skills acquired related to technical/production aspects of theatre and also develop problem solving and interpersonal skills.

### Syllabus

**Practical - 1 :** Orientation in theatre

**Practical - 2 :** Voice and Speech training

**Practical - 3 :** Voice and Speech training: practice sessions

**Practical - 4 :** Art of acting

**Practical - 5 :** Art of acting: practice sessions

**Practical - 6 :** Art of script writing

**Practical - 7 :** Art of script writing: practice sessions

**Practical - 8 :** Final performances

### Reference Books

1. Boleslavsky, R. (2022). Acting: The First Six Lessons (1st ed., pp. 1-92). Delhi Open Books.
2. Shakthi, C. (2017). No Drama Just Theatre (1st ed., pp. 1-171). Partridge.
3. Bruder, M., Cohn, L. M., Olnek, M., Pollack, N., Previto, R., & Zigler, S. (1986). A Practical Handbook for the Actor (1st ed.). Vinatge Books New York.

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-6** **Course : Introduction to French Language**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

To help build a foundation and interest in French language so that the students can pursue the proficiency levels of the language in higher semesters.

### Course Outcomes

On successful completion of the course the students will be able to achieve the following:

**CO1:** Demonstrate basic knowledge about France, the culture and similarities/differences between India and France

**CO2:** Learn to use simple language structures in everyday communication.

**CO3:** Develop ability to write in basic French about themselves and others.

**CO4:** Develop ability to understand beginner level texts in French

### Syllabus

**List of Practicals**

**Practical - 1 :** Orientation about France, the language, and culture

**Practical - 2 :** Communication Skills 1: Vocabulary building for everyday conversations

**Practical - 3 :** Practice sessions

**Practical - 4 :** Reading and writing Skills : Reading and writing simple text in French

**Practical - 5 :** Practice sessions

**Practical - 6 :** Communication Skills 2: listening comprehension

**Practical - 7 :** Practice sessions

**Practical - 8 :** Writing Skills: Write basic French and practice

### Recommended Reading

1. 15-minute French by Caroline Lemoine
2. Cours de Langue et de Civilisation Françaises by G. Mauger Vol. 1.1
3. Cosmopolite I by Natalie Hirschsprung, Tony Tricot

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-7** **Course : Introduction to Spanish Language**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

To help build a foundation and interest in Spanish language so that the students can pursue the proficiency levels of the language in higher semesters.

### Course Outcomes

On successful completion of the course the students will be able to achieve the following:

**CO1:** Demonstrate basic knowledge about Spain, the culture and similarities/differences between India and France

**CO2:** Learn to use simple language structures in everyday communication.

**CO3:** Develop ability to write in basic Spanish about themselves and others.

**CO4:** Develop ability to read and understand beginner level texts in Spanish

### Syllabus

**List of Practicals**

**Practical - 1 :** Orientation about Spain, the language, and culture

**Practical - 2 :** Communication Skills 1: Vocabulary building for everyday conversations

**Practical - 3 :** Practice sessions

**Practical - 4 :** Reading and writing Skills : Reading and writing simple text in Spanish

**Practical - 5 :** Practice sessions

**Practical - 6 :** Communication Skills 2: listening comprehension

**Practical - 7 :** Practice sessions

**Practical - 8 :** Writing Skills: Write basic Spanish and practice

### Recommended Reading

1. 15-Minute Spanish by Ana Bremon
2. Aula Internacional 1 by Jaime Corpas ,Eva Garcia, Agustin Garmendia.
3. Chicos Chicas Libro del Alumno by María Ángeles Palomino

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-8** **Course : Art of Painting**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

Painting is fundamentally about learning to see, and to transport that vision onto paper through a variety of mark making techniques. This course aims to develop basic skills of students in painting to lay a foundation for them as a hobby and/or a profession.

### Course Outcome

At the end of the course the students will be able to achieve the following:

**CO1:** Become familiar with the basic methods, techniques & tools of painting.

**CO2:** Train the eye and hand to develop sense of balance, proportion and rhythm.

**CO3:** Develop the ability to observe and render simple natural forms.

**CO4:** Enjoy the challenging and nuanced process of painting.

### Syllabus

**Practical - 1 :** Orientation in Painting tools & basics of lines, shapes, light, shadows and textures

**Practical - 2 :** The art of observation how to see shapes in drawing

**Practical - 3 :** Introduction Water color how to handle water paints

**Practical - 4 :** Introduction to acrylic colors how to handle acrylic paints

**Practical - 5 :** Explore layering paint and capturing the quality of light with paint.

**Practical - 6 :** Create landscape painting

**Practical - 7 :** Create Abstract painting

**Practical - 8 :** Paint on Canvas (try to recreate any famous painting)

### Reference Material

1. Drawing made easy by Navneet Gala; 2015th edition
2. Alla Prima II Everything I Know about Painting--And More by Richard Schmid with Katie Swatland
3. Daily Painting: Paint Small and Often To Become a More Creative, Productive, and Successful Artist by Carol Marine

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-9** **Course : Art of Drawing**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

Drawing is fundamentally about learning to see, and to transport that vision onto paper through a variety of mark making techniques. This course aims to develop basic skills of students in drawing to lay a foundation for them as a hobby and/or a profession.

### Course Outcome

At the end of the course the students will be able to achieve the following:

**CO1:** Become familiar with the basic methods, techniques & tools of drawing.

**CO2:** Train the eye and hand to develop sense of balance, proportion and rhythm.

**CO3:** Develop the ability to observe and render simple natural forms.

**CO4:** Enjoy the challenging and nuanced process of drawing.

### Syllabus

**Practical - 1 :** Orientation in Drawing tools & basics of lines, shapes, light, shadows and textures

**Practical - 2 :** The art of observation how to see shapes in drawing

**Practical - 3 :** One/two-point basic linear perspective

**Practical - 4 :** Nature drawing and landscapes

**Practical - 5 :** Gestalt principles of visual composition

**Practical - 6 :** Figure drawing: structure and proportions of human body

**Practical - 7 :** Gesture drawing: expression and compositions of human figures

**Practical - 8 :** Memory drawing: an exercise to combine the techniques learnt

### Reference Material

1. Drawing made easy by Navneet Gala; 2015th edition
2. Perspective Made Easy (Dover Art Instruction) by Ernest R. Norling

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUP0001-10** **Course : Nature Camp**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

To create an opportunity for the students to develop affinity with nature and thus subsequently impact their ability to contribute towards sustainability of nature.

### Course Outcome

After the completion of the course the students will be able to do the following:

**CO1:** Develop an affinity with nature by observing and understanding it marvels with guidance from experts

**CO2:** Develop an understanding of the challenges and solutions associated with nature and its conservation.

### Course content

In collaboration with the Forest Department and/or a local NGO working in the field of environment conservation, this course would be conducted in 24 hours. Students will be taken to a tiger reserve in Central Indian region or Forest fringe villages or work with an NGO from Central Indian region working on natural resource management. The camps (for 2 days) will cover any one of the following topics as decided by the course coordinator:

1. Awareness about each element of biodiversity (camps on moths, butterflies, birds, other wildlife etc)
2. Environment management (water, forest, wildlife) – practices of Forest Department in managing a tiger reserve, and other aspects of water and forest conservation.
3. Sustainable natural resource management - initiatives by rural communities and local NGOs
4. Man-animal conflict and solutions (socio-economic and technical) – role of local communities and Forest Department
5. Traditional practices in environment conservation – role of local communities and local NGOs

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : PEP0001-21** **Course : Disaster Management Through Adventure Sports**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Objectives

**To enable the student**

1. To inculcate rational thinking and scientific temper among the students.
2. To develop critical awareness about the social realities among the students.
3. To build up confidence, courage and character through adventure sports.

### Course Outcomes

On completion of the course, students will be able to:

1. Understand the meaning and importance of Adventure sports.
2. Learn the various types of adventure sports, the equipment and resources required to practice disaster Management activities.
3. Learn the safety measures about different risk and their management.
4. To apply Disaster management theory to institutional & Societal problems and situations.

### Course Content

1. Basic adventure
2. First AID
3. Various types of knots
4. Shelter making
5. Disaster management
6. Team building and goal setting
7. Realization of fear, risk and their roles and analyzing safety Management Plan

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : PEP0001-22** **Course : Self-Defense Essentials and Basics Knowledge of Defense Forces**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Outcomes

On completion of the Course the student will be able to:

- Understand the meaning, need and fitness requirements to implement self-defense
- Learn the basic techniques of selected combative sports.
- Learn to prepare basic Physical Training for Defense forces.
- Implement survival techniques during emergencies.

### Course Content

- General conditioning and self-defense specific conditioning
- Applications of techniques of combative sports for self-defense.
- Self-defense techniques for specific situations: chain snatching, knife or stick attack, holding from back or front etc.
- Basic Military Knowledge and exposure making students Confident, bold, disciplined and trains them to join Armed Forces.

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CHP0001-31** **Course : Art of Indian Traditional Cuisine**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Outcome

At the end of the course the students will be able to achieve the following:

**CO1:** Understand the factors that affect regional eating habits and the unique ingredients found in various states of India

**CO2:** Get insight to prepare popular dishes from various regions of India.

**Module - 1 :** Indian Regional foods and snacks - factors effecting eating habits.

**Module - 2 :** Indian gravies – ingredients, their importance

**Module - 3 :** Indian Sweets - ingredients, their importance

**Module - 4 :** Presentation of Indian Meals, Menu Planning, Food Costing

**Module - 5 :** Food Preservatives and Safety

### List of Experiments

1) Introduction to cookery : does and don'ts
2) Introduction to Indian cuisine, philosophy and classification.
3) Regional influence on Indian Food- factors affecting eating habits
4) Preparation of Garam masala and or Chat masala with ingredients and their importance
5) Preparation of different gravies such as white, yellow or brown gravies with ingredients and their importance
6) Preparation of Indian sweets like Besan ke laddu with ingredients and their importance
7) Presentation of meal, Menu planning and Food costing
8) Common chemical food preservatives and their safety standards.

### Reference Books

[1] Arora, K.,; Theory of cookery; First Edition, Frank Brothers Company (Pub) Pvt. Ltd., 2008 ISBN:9788184095036, 8184095031

[2] Philip, Thangam. E.,; Modern Cookery: Vol. 1; Sixth Edition, Orient BlackSwan., 2008 ISBN:9788125040446, 8125040447ali

[3] Parvinder S; Quantity Food Production Operations and Indian Cuisine (Oxford Higher Education); First Edition; Oxford University Press, 2011 ISBN 10: 0198068492 ISBN 13: 9780198068495

[4] Singh, Yogesh; A Culinary Tour of India; First Edition I.K. International Publishing House Pvt. Ltd.

ISBN 978-93-84588-48-9

[5] Singh Shakesh; Simplifying Indian Cuisine; First Edition, Aman Publications, ISBN81-8204-054-X

[6] Dubey Krishna Gopal; The Indian Cuisine; PHI Learning Pvt. Ltd.ISBN978-81 203-4170-8

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : CHP0001-32** **Course : Introduction to Remedies by Ayurveda**

**L: 0 Hrs, T: 0 Hr, P: 2 Hr, Per Week** **Total Credits : 1**

### Course Outcome

At the end of the course the students will be able to achieve the following

**CO1:** Know basic principle of Ayurvedic formulations.

**CO2:** Different types of Natural Remedies.

**CO3:** Basic idea about their Characterization

**Module - 1 :** Introduction to Ayurveda

**Module - 2 :** Different types of Ayurvedic formulations: Churn, Bhasma, Vati, Tailum

**Module - 3 :** Introduction to Methods of preparation

**Module - 4 :** Characterization, applications

### Practicals based on above syllabus

1) Preparations of some medicinal oils like Bramhi tel, Bramhi Awala, Vatnashak Tel, Bhurngraj Tel etc.
2) Preparation of Churn, like Trifala Churn, Hingastak Churn, Trikut Churn etc.
3) Preparation of some Bhasmas and vati

### Books

1) Chemistry and Pharmacology of Ayurvedic Medicinal Plants by Mukund Sabnis, Chaukhambha Amarbharati Prakashan.
2) Everyday Ayurveda by Shailesh Rathod
3) A text Book of Rasashastra by Vikas Dhole and Prakash Paranjpe
4) A text Book of Bha ajya Kalpana Vij¯nana

## Syllabus for Semester II, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code : HUT2004** **Course : Foundation Course in Universal Human Values**

**L: 1 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits : 1**

### Course Objectives

- To help the student see the need for developing a holistic perspective of life
- To sensitize the student about the scope of life – individual, family (inter-personal relationship), society and nature/existence
- To strengthen self-reflection
- To develop more confidence and commitment to understand, learn and act accordingly

### Course Outcome

On completion of course, students will be able to achieve the following:

**CO1:** Develop a holistic perspective of life

**CO2:** Better understanding of inter-personal relationships and relationship with society and nature.

**CO3:** An ability to strengthen self-reflection

### Syllabus

**Unit - 1 : Aspirations and concerns**

Need for Value Education: Guidelines and content of value education.

Exploring our aspirations and concerns: Knowing yourself, Basic human aspirations Need for a holistic perspective, Role of UHV; Self-Management: harmony in human being

**Unit - 2 : Health**

Harmony of the Self and Body, Mental and physical health; Health for family, friends and society.

**Unit - 3 : Relationships and Society**

Harmony in relationships, Foundational values: Trust, Respect, Reverence for excellence, Gratitude and love; harmony in society; harmony with nature.

### Reference Material

The primary resource material for teaching this course consists of

## Text Book

1. R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi, 2010, ISBN 978-8-174-46781-2

## Reference Books

1. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
2. PL Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Purblishers.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, limits to Growth, Club of Rome's Report, Universe Books.
6. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen(Vaidik) Krishi Tantra Shodh, Amravati.
7. A Nagraj, 1998, Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak.
8. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
9. A.N. Tripathy, 2003, Human Values, New Age International Publishers.

# Syllabus for Semester III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAT3001** **Course: Data Structures**
**L: 3 Hrs, T: 1 Hr, P: 0 Hrs, Per Week** **Total Credits: 4**

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**Course Prerequisite**
Basic knowledge of computer programming and common programming concepts.

**Course Outcomes**

On successful completion, of course student will able to:
1. Identify different ADTs, their operations and specify their complexities.
2. Apply linear data structures to address practical challenges and analyze their complexity.
3. Implement different sorting, searching, and hashing methods and analyze their time and space requirements.
4. Analyse non-linear data structures to develop solutions for real-world applications.

**Syllabus:**

**UNIT I: Data Structures and Algorithms Basics (8 Hours)**

**Introduction:** Basic terminologies, elementary data organizations, data structure operations; abstract data types (ADT) and their characteristics.
**Algorithms**: Definition, characteristics, analysis of an algorithm, asymptotic notations, time and space trade-offs.
**Array ADT**: Definition, operations and representations – row-major and column- major.

**UNIT II: Sorting, Searching and Hashing (10 Hours)**

**Sorting:** Different approaches to sorting, properties of different sorting algorithms (insertion, Shell, quick, merge, heap, counting), performance analysis and comparison.
**Searching:** Necessity of a robust search mechanism, searching linear lists (linear search, binary search) and complexity analysis of search methods.
**Hashing:** Hash functions and hash tables, closed and open hashing, randomization methods (division method, mid-square method, folding), collision resolution techniques.

**UNIT III: Stacks and Queues (8 Hours)**

**Stack ADT:** Allowable operations, algorithms and their complexity analysis, applications of stacks–expression conversion and evaluation (algorithmic analysis), multiple stacks.
**Queue ADT:** Allowable operations, algorithms and their complexity analysis for simple queue and circular queue, introduction to double-ended queues and priority queues.

**UNIT IV: Linked Lists (10 Hours)**

**Singly Linked Lists:** Representation in memory, algorithms of several operations: traversing, searching, insertion, deletion, reversal, ordering, etc.
**Doubly and Circular Linked Lists**: Operations and algorithmic analysis.
**Linked representation of stacks and queues**.

**UNIT V: Trees and Graphs** **(8 Hours)**

**Trees:** Basic tree terminologies, binary tree and operations, binary search tree (BST) and operations with time analysis of algorithms, threaded binary trees.
**Self-balancing Search Trees:** Tree rotations, AVL tree and operations,
**Graphs:** Basic terminologies, representation of graphs, traversals (DFS, BFS) with complexity analysis, path finding (Dijkstra's SSSP, Floyd's APSP), and spanning tree (Prim's and Kruskal's algorithms).

**Text Books**


1. G.A.V. Pai, Data Structures and Algorithms: Concepts, Techniques and Application, First Edition, McGraw Hill, 2017.
2. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Third Edition, Pearson Education, 2007.
4. Thomas H Cormen, Algorithms Unlocked, MIT Press, 2013


**Reference Books**


1. Reema Thareja, Data Structures using C, Third Edition, Oxford University Press, 2023
2. Narasimha Karumanchi, Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles Fifth Edition, CareerMonk Publications, 2016.
3. Aditya Bhargava, Grokking Algorithms: An Illustrated Guide for Programmers and Other Curious People, First Edition, Manning Publications, 2016.
4. K. R. Venugopal and Sudeep R. Prasad, Mastering C, Second Edition, McGraw Hill, 2015.
5. A. K. Sharma, Data Structures using C, Second Edition, Pearson Education, 2013.

# Syllabus for Semester III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP3001** **Course: Data Structures Lab**
**L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week** **Total Credits: 1**

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**Course Prerequisite**
Basic knowledge of computer programming and common programming concepts.

**Course Outcomes**

On successful completion, of course student will able to:
1. Identify different ADTs, their operations and specify their complexities.
2. Apply linear data structures to address practical challenges and analyze their complexity.
3. Implement different sorting, searching, and hashing methods and analyze their time and space requirements.
4. Analyse non-linear data structures to develop solutions for real-world applications.

**Syllabus:**

Experiments based on **CAT3001** Syllabus in C, C++, Java.

Few lab sessions shall be conducted using virtual lab platforms to enhance learning experiences and accessibility.

**Text Books**


1. G.A.V. Pai, Data Structures and Algorithms: Concepts, Techniques and Application, First Edition, McGraw Hill, 2017.
2. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, Second Edition, Universities Press, 2008.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Third Edition, Pearson Education, 2007.
4. Thomas H Cormen, Algorithms Unlocked, MIT Press, 2013


**Reference Books**


1. Reema Thareja, Data Structures using C, Third Edition, Oxford University Press, 2023
2. Narasimha Karumanchi, Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles Fifth Edition, CareerMonk Publications, 2016.
3. Aditya Bhargava, Grokking Algorithms: An Illustrated Guide for Programmers and Other Curious People, First Edition, Manning Publications, 2016.
4. K. R. Venugopal and Sudeep R. Prasad, Mastering C, Second Edition, McGraw Hill, 2015.
5. A. K. Sharma, Data Structures using C, Second Edition, Pearson Education, 2013.

# Syllabus for Semester III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAT3002** **Course: Operating Systems**
**L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week** **Total Credits: 3**

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**Course Prerequisite**
Basic knowledge of the Computer Architecture

**Course Outcomes:**
On successful completion of the course, students will be able to:
1. Demonstrate LINUX system calls and implement system commands.
2. Implement processes and process schedulers.
3. Design and implement solution to handle synchronization and deadlock
4. Implement Memory management and File management solutions.

**Syllabus:**

**UNIT I: Introduction:** Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine.
**File Management**: File System structure, Allocation methods, Free-space management, and case study on File Systems in LINUX operating System.
**Disk Management**: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK,

**UNIT II:** Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching. Threads: Definition, Various states, Benefits of threads, Types of threads, Concept of multi threads. Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non-pre-emptive, FCFS, SRTF, Priority, RR, Case study on Process Management in LINUX Operating System.

**UNIT III: Inter-process Communication**: Critical Section, Race Conditions, Mutual Exclusion, Peterson's solution, Hardware Solution, Semaphores, Monitors, Message Passing, Classical IPC Problems: Producer- Consumer Problem, Reader-Writer Problem, Dining Philosopher Problem etc.

**UNIT IV:** Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock Detection and Recovery.

**UNIT V:** Memory Management: Basic concept, Logical and Physical address mapping, Memory allocation: Contiguous Memory allocation – Fixed and variable partition, Internal and External fragmentation and Compaction, Paging: Principle of operation – Page allocation, Hardware support for paging, Protection and sharing, Advantages and Disadvantages of paging. Virtual Memory: Basics of Virtual Memory, Hardware and control structures, Locality of reference, Page fault, Dirty page/ Dirty bit, Demand paging; Page Replacement, algorithms: First in First Out (FIFO), Least Recently used (LRU), and Optimal.

**Text Books**

1. Operating System Concepts, 8th Editionby A. Silberschatz, P.Galvin, G. Gagne, Wiley India.
2. Modern Operating Systems, 2nd Edition by Andrew Tanenbaum, PHI.

**Reference Books:**

1. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
2. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly

# Syllabus for Semester III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP3002** **Course: Operating System Lab**
**L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week** **Total Credits: 1**

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**Course Outcomes**

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

1. Demonstrate LINUX system calls and implement system commands.
2. Implement processes and process schedulers.
3. Design and implement solution to handle synchronization and deadlock
4. Implement Memory management and File management solutions.

**Syllabus:**

Experiments based on **CAT3002** Syllabus in C/C++/Java, etc.

**Text Books**

1. Operating System Concepts, 8th Edition by A. Silberschatz, P.Galvin, G. Gagne, Wiley India.
2. Modern Operating Systems, 2nd Edition by Andrew Tanenbaum, PHI.

Reference Books:

1. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
2. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly

# Syllabus for Semester III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP3003** **Course: Software Lab - I**
**L: 0 Hrs, T: 0 Hr, P: 4 Hrs, Per Week** **Total Credits: 2**

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**Course Outcomes**
On successful completion, of course student will able to:

1. Use Python libraries for data manipulation, visualization, and statistical analysis.
2. Create and manage virtual machines using VMWare and VirtualBox.
3. Write shell scripts using TCL for automating tasks and creating user interfaces.
4. Design and simulate VHDL models using Modelsim.

**Syllabus:**

**Python Basic Libraries**

- **NumPy:** A library for scientific computing with Python. It provides a high-performance multidimensional array object, and tools for working with these arrays.
- **Pandas:** A library for data analysis and manipulation. It provides data structures and operations for manipulating numerical tables and time series.
- **Seaborn:** A library for data visualization. It provides a high-level interface for drawing statistical graphics.
- **Matplotlib:** A library for creating static, animated, and interactive visualizations in Python.
- **Scipy:** A library for scientific computing with Python. It provides modules for optimization, linear algebra, statistics, and signal processing.
- **EDA:** A library for exploratory data analysis. It provides tools for visualizing and summarizing data.

**Virtual Machine**

- **VMWare:** A software for creating and running virtual machines. It allows you to run multiple operating systems on a single computer.
- **VirtualBox:** A software for creating and running virtual machines. It is free and open-source.
- **Jira:** A software for project management and issue tracking. It is used to plan, track, and release software.

**Shell Scripting (TCL)**

- **TCL:** A scripting language for Unix-like operating systems. It is used for automating tasks and creating user interfaces.

**VHDL**

- **VHDL:** A hardware description language used to describe the behavior of electronic circuits. It is used in the design and verification of integrated circuits.

**Modelsim**

- **Modelsim:** A software for simulating VHDL designs. It allows you to verify the behavior of electronic circuits before they are manufactured.

**Text/Reference Books**


1. "Python Data Science Handbook" by Jake VanderPlas
2. "The Elements of Statistical Learning" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman
3. "Data Visualization with Seaborn" by Michael Waskom
4. "VHDL: A Tutorial and Practical Guide" by William J. Dally and John W. Poulton
5. "ModelSim User's Guide" by Mentor Graphics Corporation
6. "TCL Programming for System Administration" by Brent B. Welch

# Syllabus for Semester III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: MAT3002** **Course: Probability and Statistics**
**L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week** **Total Credits: 3**

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**Course Pre-requisite:** Basics of Probability and Statistics**.**

**Course Objective:**

The objective of this course is to expose student to understand the basic importance fundamental principles of probability, including probability distributions, random variables, basic statistical methods used for data analysis, inferential statistics, hypothesis testing, confidence intervals, and regression analysis in computer science and Information technology.

**Course Outcomes**

On successful completion of the course, student shall be able to

1. Grasp the meaning of discrete and continuous random variables, probability distribution. Interpret the meaning of probabilities derived from distributions. This involves understanding what the calculated probabilities represent in practical terms and drawing conclusions from the results.
2. To analyze and interpret stochastic models, including calculating probabilities, transition probabilities, and steady-state probabilities within stochastic systems.
3. Grasp the fundamental concepts of curve fitting like regression techniques, model selection, and the use of different types of curves or functions to approximate data.
4. Understand the fundamental concept of hypothesis testing, including the null hypothesis (H0) and alternative hypothesis (H1), significance levels, p-values, and the basic logic behind hypothesis testing.
5. To apply MLE to various statistical models, such as linear regression, exponential distribution, etc. They should understand how to formulate likelihood functions and derive estimators for unknown parameters.

**Syllabus**

**Module 1** (8 hours)

Probability spaces, conditional probability, independence; Discrete random variables, Binomial distribution, Poisson distribution, Normal distribution. Relation between binomial, Poisson and Normal distributions.

**Module 2: (8 Lectures)**

Joint probability function, Introduction to stochastic process, random walk, stationary and auto regressive process, transition probability Matrix, Discrete time Markov chain.

**Module 3: (8 hours)**

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves, correlation and regression – Rank correlation, Multiple regression and correlation.

**Module 4: (8 Lectures)**

Sampling Distributions, Point and Interval Estimations, Testing of Hypothesis for single mean and proportion.

**Module 5: (7 Lectures):**
Testing of Hypothesis for difference of mean and proportion, Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes, maximum likelihood estimation

**Text Books:**


1. M R. Spiegal , Theory and Problems of probability and statistics :,2nd ed :,Schaum series
2. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.


**Reference Books:**


1. Maurtis Kaptein, Statistics for data science, An introduction to probability, statistics and Data Analysis, Springer 2022.
2. Jay L Devore,Probability and Statistics for Engineering and sciences, 8th edition, Cenage learning.

# Syllabus for Semester III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP3004** **Course: Idea Lab**
**L: 0 Hrs, T: 0 Hr, P: 4 Hrs, Per Week** **Total Credits: 2**

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**Course Outcomes**
On successful completion, of course student will able to:

1. Identify problems across various domains and effectively frame them that facilitates creative solution generation.
2. Understand business models, pricing strategies, and ethical considerations in innovations.
3. Apply for patents/copyrights under IPR activities.
4. Design prototypes or proof-of-concepts to test and validate their ideas.
5. Enhance their presentation and communication skills as they pitch ideas, articulate concepts, and engage with stakeholders.

**Syllabus:**

1. Introduction of idea generation techniques and methodologies based on case studies of successful innovations.
2. Conducting market research, such as surveys, interviews, focus groups, and observational studies.
3. Brainstorming exercises and group discussions on problem framing and the solutions.
4. Hands-on activities for developing prototypes and refining ideas through user feedback.
5. Technical report writing and research proposals that match technology readiness levels (TRLs).
6. Practice sessions for pitching ideas and receiving constructive feedback.
7. Discussion on concepts such as business models, value proposition, pricing strategies and ethical implications for scalable innovations.

**Text Books**


1. Jacob Goldenberg and David Mazursky, Creativity in Product Innovation, Cambridge University Press, 2022.
2. Jessica Livingston, Founders at Work: Stories of Startups' Early Days", Fourth Edition, Apress, 2008.
3. Bill McGowan, Pitch Perfect: How to Say It Right the First Time, Every Time, Reprint Edition, Harper Business, 2016.


**Reference Books**


1. Bjarki Hallgrimsson**,** Prototyping and Modelmaking for Product Design**,** Laurence King Publishing Ltd**,** 2012.
2. David Bornstein and Susan Davis**,** Social Entrepreneurship: What Everyone Needs to Know**,** Oxford University Press**,** 2010.

# Syllabus for Semester III, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAT3005** **Course: Cyber Law and Ethics**
**L: 2 Hrs, T: 0 Hr, P: 0 Hrs, Per Week** **Total Credits: 2**

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**Prerequisites: Basic Knowledge of Internet**

**Course Outcomes**
On successful completion, of course student will able to learn:

1. Analyse the role of ethics in IT organization.
2. Identify various cyber laws with respect to legal dilemmas in the Information Technology field.
3. Interpret various intellectual property rights, Privacy, Protection issues in Information Technology field.
4. Describe the ways of precaution and prevention of Cyber Crime as well as Human Rights.

**Syllabus:**

**UNIT I:** Ethics in business world & IT professional malpractices, Introduction to firewalls, IDS System, Distortion and fabrication of information

**UNIT II:** Ethics of IT Organization: Contingent Workers H- IB Workers, Whistle- blowing, Protection for Whistle- Blowers, Handling Whistle- blowing situation, Digital divide.

**UNIT III:** Intellectual Property: Copyrights, Patents, Trade Secret Laws, Key Intellectual property issues, Plagiarism, Privacy: The right of Privacy, Protection, Key Privacy and K-Anonymity issues, Identity Theft, Consumer Profiling,

**UNIT IV:** Cyber laws and rights in today's digital age, Emergence of Cyberspace, Cyber Jurisprudence, Cyber Crimes against Individuals, Institution and State, Hacking, Digital Forgery, Cyber Stalking/Harassment, Cyber terrorism, cyber tort, Cyber Defamation & hate speech, Competitive Intelligence, Cybersquatting, The Indian information technology act 2000 IT Act.

**Text Books:**

1. George Reynolds, "Ethics in information Technology",5th edition, Cengage Learning
2. Hon C Graff, Cryptography and E-Commerce - A Wiley Tech Brief, Wiley Computer Publisher, 2001.

**Reference Books:**
1. Michael Cross, Norris L Johnson, Tony Piltzecker, Security, Shroff Publishers and Distributors Ltd.
2. Debora Johnson," Computer Ethic s",3/e Pearson Education.
3. Sara Baase, "A Gift of Fire: Social, Legal and Ethical Issues, for Computing and the Internet," PHI Publications.
4. Chris Reed & John Angel, Computer Law, OUP, New York, (2007).
5. Dr Pramod Kr. Singh, "Laws on Cyber Crimes [Along with IT Act and Relevant Rules]" Book Enclave Jaipur India.

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: HUT3001** **Course: Business Communication**
**L: 2 Hrs, T: 0 Hr, P: 0 Hrs, Per Week** **Total Credits: 2**

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**Course Objective**

The course aims to develop the skills of students to proficiently craft compelling business documents and employ strategic verbal communication techniques. By honing these skills, students will gain the ability to convey ideas persuasively and interact confidently in diverse business contexts.

**Course Outcomes**

On successful completion of the course the students will be able to achieve the following:
CO1: Understand the fundamentals of business communication.
CO2: Apply tools and techniques to create effective workplace correspondence.
CO3: Analyse and apply visual design principles to create business documents.
CO4: Understand and evaluate information to draft reports.
CO5: Apply and evaluate strategies for effective communication for employment.

**Syllabus:**

**UNIT 1: Fundamentals of Business Communication (6 Hours)**

Definition of communication, Emergence of communication as a key concept in the Corporate and Global world, Types- Internet, Blogs, E-mails, social media, Channels- Formal and Informal: Vertical, Horizontal, Diagonal, Grapevine, Persuasive Communication- Negotiation Skills, PAC concept

**UNIT 2: Business Correspondence (6 Hours)**

Planning, Writing, and Completing Business Messages
**Personnel Correspondence:** Job Application Letter, Letter of Acceptance of Job Offer, Letter of Resignation, Letter of Appointment, Promotion and Termination, Letter of Recommendation
**Trade Correspondence:** Inquiry, Order, Credit and Status Enquiry, Complaints, Claims, Adjustments, Consumer Grievance Letters

**UNIT 3: Visual and Content Creation (6 Hours)**

Visual design principles, Ethics of visual communication, selecting visuals for presenting data, Content Creation: Website, Help file, User Guides, Promotional leaflets and fliers

**UNIT 4: Reports (4 Hours)**

Basic formats and types of reports - Feasibility, Progress, Project, Case Study Evaluation, Agenda, Notices, Minutes of Meeting, Organizational announcements, Statement of Purpose.

**UNIT 5: Communication for Employment (4 Hours)**

Pre-interview technique- NOISE Analysis, Job Description and Resume, Creating LinkedIn Profile, Effective use of job portals, Business etiquette.

**Text Books**


1. Sharon Gerson, Steven Gerson, “Technical Communication: Process and Product”, 2018, Pearson
2. Courtland L Bovee, John V Thill and Roshan Lal Raina “Business Communication Today”, 14th edition Pearson
3. P.D. Chaturvedi and Mukesh Chaturvedi, Fundamentals of Business Communication, Pearson Publications, 2012.


**Reference Books**


1. Shalini Verma, Business Communication, Vikas Publishing House Pvt. Ltd., 2015.
2. Sanjay Kumar, Pushpa Lata, Communication Skills, 2nd Edition, Oxford Publication, 2018
3. William Strunk Jr. and E.B. White, The Elements of Style, Allyn & Bacon, A Pearson Education Company, 2000

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAT4001** **Course: Artificial Intelligence**
**L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week** **Total Credits: 3**

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**Course Prerequisite**
Basic knowledge of the data structure and probability.

**Course Outcomes**
On successful completion, of course student will be able to:

1. Apply uninformed and informed search techniques and represent given problem using state space representation.
2. Utilize different AI techniques to solve fully informed two player games and constraint satisfaction problems.
3. Solve the AI problems by using logic programming.
4. Identify the uncertainty theory-based techniques for solving diverse problems.

**Syllabus:**

**UNIT I: Introduction to Artificial Intelligence (7 Hours)**
History, applications, task domains, Basics of problem solving, problem characteristics, problem representation (toy problems and real-world problems); Structure of agent, rational agent, specifying task environment, Properties of task environment; measuring problem solving performance.

**UNIT II: Uninformed & Informed search techniques (9 Hours)**
Uninformed Search: Depth, Breadth, Uniform Cost, Depth Limited, Iterative deepening DFS, Bidirectional Search.
Informed Search: Heuristic Based Search, Greedy Best First Search, A* Search; Local Search algorithms: Hill-climbing, Genetic Algorithms.

**UNIT III: Adversarial Search (6 Hours)**
Two player Games, The min-max algorithm, Alpha-Beta pruning. Constraint Satisfaction Problems: Constraint propagation, backtracking search.

**UNIT IV: Knowledge Representation (7 Hours)**
Propositional logic, First Order Logic: Syntax and Semantics of FOL, Inference in FOL: Unification Algorithm, Resolution, Forward Chaining, Backward Chaining.

**UNIT V: Uncertain Knowledge and Reasoning (7 Hours)**
Probability and Bayes' Theorem, Statistical reasoning: Bayesian networks, Bayes optimal classifier, Naïve bayes algorithm, Fuzzy Logic: properties and operations, Introduction to expert system.

**Text Books**


1. Stuart Russel and Peter Norvig; Artificial Intelligence: A Modern Approach; Fourth Edition; Pearson Education, 2022.
2. E. Rich, K. Knight, S.B. Nair; Artificial Intelligence ,3rd Edition, Tata McGraw Hill, 2009.
3. G. Luger, Artificial Intelligence: Structures and Strategies for complex problem solving, Sixth Edition, Pearson Education, 2009.

**Reference Books**


1. Dan W Patterson, Introduction to Artificial Intelligence & Expert System, Pearson Education India; First Edition, 2015.
2. By Patrick D. Smith, David Dindi, Hands-On Artificial Intelligence for Beginners: An introduction to AI concepts, algorithms, and their implementation, First edition, Packt Publishing Ltd, 2018.
3. Denis Rothman; Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases; Kindle Edition, Packt Publishing Ltd, 2018.
4. Richard E. Neapolitan, Xia Jiang, Artificial Intelligence with an Introduction to Machine Learning, Chapman and Hall/CRC; 2nd edition, 2018.

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP4001** **Course: Artificial Intelligence Lab**
**L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week** **Total Credits: 1**

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**Course Prerequisite**
Basic knowledge of the data structure and probability.

**Course Outcomes**
On successful completion, of course student will be able to:

1. Apply uninformed and informed search techniques and represent given problem using state space representation.
2. Utilize different AI techniques to solve fully informed two player games and constraint satisfaction problems.
3. Solve the AI problems by using logic programming.
4. Identify the uncertainty theory-based techniques for solving diverse problems.

**Syllabus:**

Experiments based on **CAT4001** Syllabus.

**Text Books**


1. Stuart Russel and Peter Norvig; Artificial Intelligence: A Modern Approach; Fourth Edition; Pearson Education, 2022.
2. E. Rich, K. Knight, S.B. Nair; Artificial Intelligence ,3rd Edition, Tata McGraw Hill, 2009.
3. G. Luger, Artificial Intelligence: Structures and Strategies for complex problem solving, Sixth Edition, Pearson Education, 2009.


**Reference Books**


1. Dan W Patterson, Introduction to Artificial Intelligence & Expert System, Pearson Education India; First Edition, 2015.
2. By Patrick D. Smith, David Dindi, Hands-On Artificial Intelligence for Beginners: An introduction to AI concepts, algorithms, and their implementation, First edition, Packt Publishing Ltd, 2018.
3. Denis Rothman; Artificial Intelligence By Example: Develop machine intelligence from scratch using real artificial intelligence use cases; Kindle Edition, Packt Publishing Ltd, 2018.
4. Richard E. Neapolitan, Xia Jiang, Artificial Intelligence with an Introduction to Machine Learning, Chapman and Hall/CRC; 2nd edition, 2018.

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAT4002** **Course: Design and Analysis of Algorithms**
**L: 3 Hrs, T: 0 Hr, P: 0 Hrs, Per Week** **Total Credits: 3**

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**Course Prerequisite**

Basic knowledge of the algorithms and its complexity, computer programming and common programming concepts.

**Course Outcomes**

On successful completion, of course student will be able to:

1. Describe mathematical formulation, complexity analysis and methodologies to solve the recurrence relations for algorithms.
2. Design Greedy and Divide & Conquer algorithms and their usage in real life examples.
3. Apply the principles of dynamic programming for problem-solving and optimization.
4. Utilize the graph theory, traversal, search algorithms, and backtracking techniques in real life usages.
5. Understand the NP class problems and formulate solutions using standard approaches.

**Syllabus:**

**UNIT I:** Recurrence relations and their solutions, Principles of designing algorithms and complexity calculation, Asymptotic notations for analysis of algorithms, worst case and average case analysis, amortized analysis and its applications.

**UNIT II:** Divide and Conquer - basic strategy, Strassen's matrix multiplication, Maximum subarray problem, Closest pair of points problem.
Greedy method – basic strategy, fractional knapsack problem, Huffman Coding, activity selection problem, Find maximum sum possible equal to sum of three stacks.

**UNIT III:** Dynamic Programming -basic strategy, Bellman-Ford algorithm, all pairs shortest path, multistage graphs(backward), optimal binary search trees, traveling salesman problem, Longest Common Subsequence problem and its variations.

**UNIT IV:** Basic Traversal and Search Techniques, breadth first search and depth first search, connected components. Backtracking basic strategy, 8-Queens' problem, graph coloring, Hamiltonian cycles, sum of subset problem.

**UNIT V:** NP-hard and NP-complete problems, basic concepts, non-deterministic algorithms, NP-hard and NP complete, decision and optimization problems, polynomial reduction, graph based problems on NP Principle, vertex cover problem, clique cover problem.

**Text Books:**

1. Thomas H. Cormen et.al; "Introduction to Algorithms": 3 Edition, Prentice Hall, 2009.
2. Horowitz, Sahani and Rajasekaran;"Computer Algorithms", SiliconPress,2008.
3. Brassard and Bratley; "Fundamentals of Algorithms", 1 Edition; Prentice Hall, 1995.
4. Richard Johnsonbaugh, "Algorithms", Pearson Publication, 2003.

**Reference Books**

1. Parag Himanshu Dave, Balchandra Dave, "Design and Analysis of Algorithms", Pearson Education, O'relly Publication.
2. Richard Johnson Baugh, "Algorithms", Pearson Publication, 2003.

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAT4003** **Course: Theory of Computation**
**L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits: 3**

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**Course Prerequisite**
Basic knowledge of the algorithms and its complexity, computer programming and common programming concepts.

**Course Outcomes**
On successful completion of the course, students will be able to:
1. Describe the formal relationships among machines, languages and grammars.
2. Design and Optimize finite automata for given regular languages.
3. Design context free grammar for a given language.
4. Design Pushdown Automata, Turing Machine for given languages.

**SYLLABUS**

**UNIT-I:** Basics of Theory of Computation, Basics of Sets and Relation, Countability and Diagonalization, Principle of mathematical induction, Pigeon- hole principle. Fundamentals of formal languages and grammars, Chomsky hierarchy of languages.

**UNIT-II:** Finite Automata, Deterministic finite automata (DFA), Nondeterministic finite automata (NFA) and equivalence with DFA, Minimization of finite automata, NFA with Epsilon Transitions, Finite Automata with output.

**UNIT-III:** Regular expressions and Regular languages, Regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, Context-free grammars (CFG) and language (CFL), parse trees, ambiguity in CFG, Reduction of CFGs, Chomsky and Greibach normal forms.

**UNIT-IV:** Push Down Automata, Deterministic pushdown automata and Non-Deterministic pushdown automata, Acceptance by two methods: Empty stack and Final State, Equivalence of PDA with CFG, closure properties of CFLs.

**UNIT-V:** Turing Machines, The basic model for Turing machines (TM), Turing recognizable recursively enumerable) and Turing-decidable (recursive) languages, variants of Turing machines, unrestricted grammars and equivalence with Turing machines, TMs as enumerators.

**Text Books**
1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.

**Reference Books**
1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson Education Asia.
2. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
3. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
4. John Martin, Introduction to Languages and the Theory of Computation, Tata McGraw Hill

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: MAT4001** **Course: Linear Algebra**
**L: 3 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits: 3**

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**Course Pre-requisite:** Basic knowledge of Matrices and MAT2002 (Discrete Mathematics)

**Course Objective:**
The objective of this course is to provide a foundational understanding and application of linear algebra concepts relevant to various aspects of computer science and related fields

**Course Outcomes**
On successful completion of the course, student shall be able to

1. Check the consistency of system of equations and able to solve systems of linear equations by using Gaussian elimination method.
2. Determine which set is a vector space and able to find the basic elements of vector space.
3. Understand the fundamental concepts of linear transformations including mappings, kernel, image, null space, rank, and linear independence.
4. Find the orthogonal basis elements from given basis elements.
5. To find eigen values, eigen vectors and singular value decomposition of matrix

**Syllabus**
**Module 1** (6 hours)
Row echelon form, Reduced row echelon form of Matrix, rank of matrix, system of Linear Equations.

**Module 2: ( 8 hours)**
Vector space, subspace, properties of subspaces, spanning set, Linearly independent and dependent vectors, Basis and dimensions of vector space.

**Module 3: (6 hours)**
Linear Transformation, range space and null space of Linear Transformation, Rank-Nullity Theorem, matrix representation of linear transformation.

**Module 4: (8 hours)**
Inner Product Spaces, Norm; Orthonormal Sets, Gram Schmidt orthogonalisation process, projections, positive definite matrices, QR decomposition.

**Module 5: (8 hours):** Eigen values and eigenvectors, diagonalization, spectral theorem of Matrix, Singular value decomposition, Least square method and introduction to PCA.

**Text Books:**

1. Hoffman and Kunze : Linear Algebra, Prentice Hall of India, New Delhi
2. Gilbert Strang : Linear Algebra And Its Applications (Paperback) , Nelson Engineering (2007)

**Reference Books:**

1. Seymour Lipschutz et al: Linear Algebra, 3rd ed: Schaum series.
2. V. Krishnamoorthy et al : An introduction to linear algebra , Affiliated East West Press, New Delhi P.G. Bhattacharya, S.K. Jain and S.R.

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP4004** **Course: Software Lab - II**
**L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week** **Total Credits: 1**

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**Course Outcomes**

On successful completion, of course student will able to:

1. Demonstrate proficiency in utilizing popular machine learning tools and libraries such as Scikit-learn, Keras, TensorFlow, and PyTorch
2. Apply natural language processing techniques using NLTK and Spacy libraries to process, analyze, and extract information from textual data
3. Develop skills in web scraping by utilizing tools like Beautiful Soup and Scrapy to extract relevant data from websites and understand the fundamentals
4. Gain hands-on experience in Internet of Things (IoT) development by working with Arduino, Raspberry Pi, and related tools

**Syllabus:**

1. Introduction to Machine Learning Tools
    - Overview of Scikit-learn library
    - Exploring various machine learning algorithms
    - Data preprocessing and feature engineering techniques
2. Deep Learning Frameworks
    - Introduction to Keras, TensorFlow, and PyTorch
    - Neural network architectures and training
    - Transfer learning and fine-tuning pre-trained models
3. Natural Language Processing (NLP) Libraries
    - Introduction to NLTK (Natural Language Toolkit)
    - Text preprocessing and cleaning
    - Text classification and sentiment analysis using NLTK
4. Advanced NLP with Spacy
    - Overview of Spacy library for NLP tasks
    - Named Entity Recognition (NER)
    - Dependency parsing and text processing
5. Web Scraping Techniques
    - Introduction to web scraping
    - Extracting data using Beautiful Soup library
    - Building web spiders with Scrapy
6. Data Visualization and Monitoring
    - Introduction to data visualization with Grafana
    - Monitoring and analyzing data using Grafana dashboards
    - Integrating data sources with Minikube
7. Internet of Things (IoT) Development
    - Introduction to Arduino and Raspberry Pi platforms
    - Building IoT applications using Python
    - Sensor integration and data acquisition
8. Project Work
    - Hands-on project to apply the learned concepts and tools
    - Students will work on a real-world problem using the acquired skills

**Text/Reference Books**


1. Scikit-learn: Machine Learning in Python. Pedregosa, F., et al. (2011). Journal of Machine Learning Research, 12, 2825-2830.
2. Deep Learning with Python. Chollet, F. (2017). Manning Publications.
3. Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit. Bird, S., et al. (2009). O'Reilly Media.
4. Web Scraping with Python: A Comprehensive Guide. Ryan Mitchell. (2018). O'Reilly Media.

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP4005** **Course: Software Lab - III**
**L: 0 Hrs, T: 0 Hr, P: 2 Hrs, Per Week** **Total Credits: 1**

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**Course Outcomes**
On successful completion, of course student will able to:

1. Master version control using Git/GitHub for effective collaboration and code management.
2. Containerize applications seamlessly using Docker and Portainer for efficient deployment and scalability.
3. Automate CI/CD pipelines proficiently with Jenkins to enhance software delivery and integration.
4. Develop web applications using Flask/Django and Docker Compose, alongside advanced FPGA development using Xilinx Vivado for comprehensive software engineering skills.

**Syllabus:**

**DevOps**

- **Version Control (Git/GitHub):** Learn the basics of version control using Git and how to use GitHub for collaboration and code sharing.
- **Implementation of Flask application:** Learn how to create and deploy a simple web application using the Flask framework and Python.
- **Containerization (Docker, Portainer):** Understand the concept of containerization and how to use Docker to create and manage containers. Learn how to use Portainer to manage Docker containers.
- **Integration, Development, and Building (Jenkins):** Learn how to use Jenkins for continuous integration and continuous development. Understand how to build and test software projects using Jenkins.
- **Django, Docker Compose:** Learn how to create and deploy a more complex web application using the Django framework and Python. Learn how to use Docker Compose to manage multiple containers for a Django application.

**FPGA**

- **Xilinx, Vivado:** Learn the basics of FPGA (Field-Programmable Gate Array) technology and how to use Xilinx Vivado to design and implement digital circuits on FPGAs.

**Text/Reference Books**


1. "Version Control with Git" by Jon Loeliger
2. "Flask Web Development" by Miguel Grinberg
3. "Docker: Up and Running" by Scott Lowe
4. "Jenkins: The Definitive Guide" by John Ferguson Smart
5. "Django: The Complete Beginner's Guide" by William S. Vincent
6. "Vivado Design Suite User Guide" by Xilinx, Inc.

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: CAP4006** **Course: Community Engagement Project**
**L: 0 Hrs, T: 0 Hr, P: 4 Hrs, Per Week** **Total Credits: 2**

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**Course Outcomes**

On successful completion, of course student will able to:

1. Gain an understanding of rural life, Indian culture & ethos and social realities
2. Develop a sense of empathy and bonds of mutuality with local community
3. Appreciate significant contributions of local communities to Indian society and economy
4. Learn to value the local knowledge and wisdom of the community
5. Identify opportunities for contributing to community's socioeconomic improvements

**Syllabus:**

**Week 1-2:** Appreciation of Rural Society: Rural lifestyle, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaboration of "soul of India lies in villages' (Gandhi), rural infrastructure.

**Week 3-4:** Understanding rural and local economy & livelihood: Agriculture, farming, land ownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets, migrant labour.

**Week 5-7:** Rural and local Institutions: Traditional rural & community organisations, Self-help Groups, Panchayati raj institutions (Gram Sabha, Gram Panchayat, Standing Committees), Nagarpalikas and municipalities, local civil society, local administration.

**Week 8-10:** Rural & National Development Programmes: History of various /development in India, current national programmes: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swatchh Bharat, PM Awaas Yojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA, SHRAM, Jal Jeevan Mission, SFURTI, Atma Nirbhar Bharat, etc.

**Teaching/ Learning Methodology**

- Classroom discussions, Group discussions, Field visit, Group presentation, Written assignment
- Interaction with self-help groups women members, and study of their functions and challenges; planning for their skill building and livelihood activities
- Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan (GPDP)
- Participate in Gram Sabha meetings, and study community participation
- Associate with Social audit exercises at the Gram Panchayat level, and interact with programme beneficiaries
- Visit MGNREGS project sites, interact with beneficiaries and interview functionaries at the site
- Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solving measures
- Visit Rural Schools / mid-day meal centres, study academic and infrastructural resources and gaps
- Visit local Anganwadi Centre and observe the services being provided
- Visit local NGOs, civil society organisations and interact with their staff and beneficiaries,
- Organize awareness programmes, health camps, Disability camps and cleanliness camps
- Organise orientation programmes for farmers regarding organic cultivation, rational use of irrigation and fertilizers and promotion of traditional species of crops and plants
- Formation of committees for common property resource management, village pond maintenance and fishing

**Online Reference Course**

- https://onlinecourses.swayam2.ac.in/ugc23_ge04/preview

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: HUT4002** **Course: Environment Education**
**L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits: 2**

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**Course Outcomes**
**On successful completion, of course student will able to do the following:**
CO1: Understand and appreciate the historical context of human interactions with the environment.
CO2: Understand the concept of natural resources and their sustainable development
CO3: Develop a critical understanding of the environmental issues of concern
CO4: Understand the concepts of ecosystems, biodiversity and conservation
CO5: Understand broad aspects of environmental management and assessment systems

**Syllabus:**

**UNIT 1: Humans and the Environment (4 Hours)**
Great ancient civilizations and the environment, Indic Knowledge and Culture of sustainability; Middle Ages and Renaissance; Industrial revolution and its impact on the environment; Population growth and natural resource exploitation; Global environmental change; emergence of environmentalism

**UNIT 2: Natural Resources and Sustainable Development (4 Hours)**
Definition of resource; Classification of natural resources
Water resources; Soil and mineral resources; Energy resources; Sustainable Development Goals (SDGs)

**UNIT 3: Environmental Issues: Local, Regional and Global (6 Hours)**
Environmental issues and scales, Pollution, Land use and Land cover change, Global change, case studies/field visit

**UNIT 4: Conservation of Biodiversity and Ecosystems (6 Hours)**
Biodiversity and its distribution – India and the world; Ecosystems and ecosystem services, Threats to biodiversity and ecosystems; Major conservation policies and practises, case studies/field visit

**UNIT 5: Environmental Management (6 Hours)**
Introduction to environmental laws and regulation, Concept of Circular Economy, Life cycle analysis; Cost-benefit analysis; Environmental audit and impact assessment; Concept of 3R (Reduce, Recycle and Reuse) and sustainability; Ecolabeling /Ecomark scheme, case studies/field visit.

**Books**

1. Fisher, Michael H. (2018) An Environmental History of India- From Earliest Times to the Twenty-First Century, Cambridge University Press.
2. Headrick, Daniel R. (2020) Humans versus Nature- A Global Environmental History, Oxford University Press.
3. Simmons, I. G. (2008). Global Environmental History: 10,000 BC to AD 2000. Edinburgh University Press

4. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications https://sdgs.un.org/goals
5. Harris, Frances (2012) Global Environmental Issues, 2nd Edition. Wiley- Blackwell.
6. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.
7. Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK
8. Singh, Kartar and Anil Shishodia (2007) 'Environmental Economics: Theory and Applications", Sage,
9. Karpagam. M (2019) Environmental Economics: A textbook, Sterling
10. Jørgensen, Sven Marques, Erik João Carlos and Nielsen, Søren Nors (2016) Integrated Environmental Management, A transdisciplinary Approach. CRC Press.
11. Theodore, M. K. and Theodore, Louis (2021) Introduction to Environmental Management, 2nd Edition. CRC Press.
12. Barrow, C. J. (1999). Environmental management: Principles and practice. Routledge.
13. Tiefenbacher, J (ed.) (2022), Environmental Management - Pollution, Habitat, Ecology, and Sustainability, Intech Open, London. 10.5772/
14. Richard A. Marcantonio, Marc Lame (2022). Environmental Management: Concepts and Practical Skills. Cambridge University Press.
15. N. Mani (2020) Environmental Economics, New NC Century
16. Subhashini Muthukrishnan (2015) Economics of Environment, PHI
17. Rabindra N. Bhattacharya (2001) Environmental Economics: An Indian Perspective, Oxford University press

# Syllabus for Semester IV, B. Tech - Computer Science & Engineering (Artificial Intelligence and Machine Learning)

**Course Code: HUT4003** **Course: Managerial Economics**
**L: 2 Hrs, T: 0 Hr, P: 0 Hr, Per Week** **Total Credits: 2**

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**Course Outcomes**
On successful completion, of course student will able to learn:
CO1: Gain basic knowledge of Economics to take managerial decisions.
CO2: Apply the knowledge of the mechanics of supply and demand to explain working of markets
CO3: To understand the concepts of production, cost, and revenue from a business perspective
CO4: To understand the various market types
CO5: Understand the concepts of macroeconomics for better understanding of the functioning of the economy for taking informed managerial decisions.

**Syllabus:**

**UNIT 1: Introduction to Managerial Economics: (4 Hours)**
Nature & scope of Managerial Economics: Concepts of Managerial Economics.
Economic theory & Managerial theory. Role & responsibilities of Managerial Economists

**UNIT 2: Micro Economics: (6 Hours)**
Demand Analysis: Individual & market, Law of demand. Elasticity of demand its meaning and importance. Price elasticity, Income elasticity & Cross elasticity Using elasticity in Managerial decisions
Supply Analysis: Supply and Stock, Law of supply, supply function, determinants and elasticity of supply, Equilibrium of Demand and Supply.

**UNIT 3: Theory of Production, Costs, and Revenue: (6 Hours)**
Meaning of production, factors of production, laws of variable proportion, Economies and diseconomies of scale, Cost and Revenue concepts

**UNIT 4: Market System: (6 Hours)**
Meaning of Market, Types of market - Perfect Competition Market, Monopoly and Monopolistic market, Oligopoly, Duopoly

**Unit 5: Macroeconomics for Management (4 Hours)**
**Concepts and Issues:** Consumer Price Index, Wholesale Price Index, BOP, Current and Capital account, GDP, GNP, PI, Inflation, Business cycles, Monetary policy

**Text Books:**

1. Ahuja H.L., (2017) Managerial Economics, Analysis of managerial Decision making, S. Chand and company Limited, New Delhi, 9th ed.
2. Dwivedi D.N., (2015). Managerial Economics, Vikas publishing house Pvt. Ltd, Nodia, 8th ed.


**Reference Books**

1. Mankiw G., (2008) Principles of Economics (Kindle Edition) South Western Cengage Learning, Nodia 6th ed.
2. Salvatore, D., (2007) Managerial Economics. London: Oxford University Press, 6th ed.