B.Tech in Artificial intelligence and Data Science

CURRICULUM and SYLLABUS 2023
GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

<table>
<thead>
<tr>
<th>Abbreviation</th>
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<td>Practical</td>
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<tr>
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<td>Engineering Sciences (including General, Core and Electives)</td>
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<tr>
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<td>Humanities (including Languages and others)</td>
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<td>Basic Sciences (including Mathematics)</td>
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<tr>
<td>PRJ</td>
<td>Project Work (including Seminars)</td>
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Course Outcome (CO) – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

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

PROGRAM OUTCOMES FOR ENGINEERING

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and
design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
## SEMESTER I

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*These 3 slots are equivalent to 2 regular slots.

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Total Credits: 164

*Hands-on* Project-based Lab.

*Professional Elective - Electives categorized under Engineering, Science, Mathematics, Live-in-Labs, and NPTEL Courses. Student can opt for such electives across departments/campuses. Students with CGPA of 7.0 and above can opt for a maximum of 2 NPTEL courses with the credits not exceeding 8.
** Free Electives - This will include courses offered by Faculty of Humanities and Social Sciences/Faculty Arts, Commerce and Media / Faculty of Management/Amrita Darshanam -(International Centre for Spiritual Studies)

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

### Amrita Value Programmes I & II for UG programmes

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### Professional Electives

#### Robotics

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**Intelligent Security Systems**

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**PROGRAMME SPECIFIC OUTCOMES**

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

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

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

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

Course Outcomes

After completing this course, students will be able to

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

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Syllabus

Unit 1


Unit 2

Ordinary Linear differential equations, formulation - concept of slope, velocity and acceleration - analytical and numerical solutions- Impulse Response computations- converting higher order into first order equations - examples of ODE modelling in falling objects, satellite and planetary motion, Electrical and mechanical systems– Introduction to solving simple differential equations with Simulink- Introduction to one variable optimization - Taylor series- Computational experiments using Matlab /Excel/Simulink.
Unit 3
Introduction to random variables (continuous and discrete), mean, standard deviation, variance, sum of independent random variable, convolution, sum of convolution integral, probability distributions.

Unit 4
Introduction to quantum computing, Quantum Computing Roadmap, Quantum Mission in India, A Brief Introduction to Applications of Quantum computers, Quantum Computing Basics, Bracket Notation, Inner product, outer product, concept of state.

Text Books / References


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

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## Syllabus

### Unit 1  Kinematics and Statics

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

### Unit 2  Introduction to Kinetics

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

### Unit 3  Kinetics of Rigid Bodies

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

### Text Books / References

- "Introduction to Computational Mechanics" by B. S. Choo and S. H. Han - 2005, 1st edition
- "Mechanics of Materials" by James M. Gere and Barry J. Goodno - 2018, 9th edition
- "Introduction to Classical Mechanics: With Problems and Solutions" by David Morin - 2008, 1st edition

### Evaluation Pattern

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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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<td>Apply logical thinking to solve problems</td>
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<td>Develop skills to use spreadsheet for problem solving</td>
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<td>Develop skills to use matlab for problem solving</td>
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CO-PO Mapping

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Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Text Books / References

- Ferragina P, Luccio F. Computational Thinking: First Algorithms, Then Code. Springer; 2018
- Irfan Turk, Matlab programming, 2018

Evaluation Pattern

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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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<th>Demonstrate proficiency in performing number system conversion, manipulating Boolean Algebra expressions and realization of basic gates .</th>
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<td>Implement different combinational logic circuits.</td>
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<td>Implement different sequential logic circuits</td>
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<tr>
<td>CO4</td>
<td>Build a general-purpose computer using elementary NAND gates through a simulation software</td>
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CO-PO Mapping

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Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Text Books / References

Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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<th>Apply and analyse circuit laws and the analysis techniques for solving electric circuits</th>
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<td>Comprehend the transient behaviour of DC circuits and generate solutions computationally</td>
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<tr>
<td>CO3</td>
<td>Use the concepts of Thevenin and Norton equivalent networks to simplify complex circuits</td>
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<tr>
<td>CO4</td>
<td>Computationally solve the state space model of electric circuits</td>
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CO-PO Mapping

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Syllabus

Unit 1  DC Circuit


Unit 2  AC Circuit

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

Unit 3  Introduction to Control Systems
State Space Representation: State, State variable, and State Model – Canonical state space model for Series RLC Circuit – Solution using eigen values and eigen vectors.

Text Books / References


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping
Syllabus

Unit 1
Introduction to nucleic acid and protein sequence, structure, and function – introduction of drug molecules - Scripting language / Linux command to handle big biological data files (sequence and structure) – programming using python and R – Linux commands.

Unit 2
Explore different biological databases (RCSB, GenBank, DrugBank etc.) – introduction to protein family and onotology - protein functional database (Pfam, GO etc.) - extract data from database using scripting languages (awk, bash)

Unit 3
Biomolecular sequence descriptors – presents biomolecular structure using graph – quantify dynamics natures of biomolecules - scoring matrices to describe evolution relationship – fundamental of biomedical image analysis using python and MATLAB (CT scan, mammography, MRI etc.) – biomedical signal (ECG, EEG etc.) visualization and annotation using MATLAB -Virtualization software (PyMol, VMD etc) – TCL and Python programming to write code for PyMol and VMD.

Unit 4
Application of AI and machine learning to predict biological activity of biomolecules (regression) – AI-based biomolecular structure prediction models – Binary and multi classification problems related to biological data.

Text Books / References

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


UNIX: Concepts and Applications Sumitabha Das

“Bioinformatics: Sequence and Genome Analysis” by David mount


"Bio-Inspired Computation and Applications in Image Processing” by João Paulo Papa and Xin-She Yang Professor
ECG Signal Processing, Classification and Interpretation: A Comprehensive Framework of Computational Intelligence” by Witold Pedrycz and Adam Gacek.

Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO1</th>
<th>Be introduced to the cultural ethos of Amrita Vishwa Vidyapeetham, and Amma’s life and vision of holistic education</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Understand the foundational concepts of Indian civilization like puruśārtha-s, law of karma and varṇāśrama</td>
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<tr>
<td>CO3</td>
<td>Gain a positive appreciation of Indian culture, traditions, customs and practices</td>
</tr>
<tr>
<td>CO4</td>
<td>Imbibe spirit of living in harmony with nature, and principles and practices of Yoga</td>
</tr>
<tr>
<td>CO5</td>
<td>Get guidelines for healthy and happy living from the great spiritual masters</td>
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CO-PO Mapping

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Syllabus

Unit 1

Introduction to Indian culture; Understanding the cultural ethos of Amrita Vishwa Vidyapeetham; Amma’s life
and vision of holistic education.

**Unit 2**

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

**Unit 3**

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

**Text Books / References**

*Cultural Education Resource Material Semester-1*

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


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

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

**Evaluation Pattern**

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

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

**Course Outcomes**

After completing this course, students will be able to

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

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

A: Importance of meditation. How does meditation help to overcome obstacles in life (Pre-recorded video with Swami Shubhamritananda Puri)
Reading 1: Why Meditate? (Swami Shubamritananda ji)

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


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

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

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

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


Unit 3: The Science of Meditation

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


Unit 4: Practicing MA OM Meditation in Daily Life

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

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


Unit 5: Improving Communication and Relationships

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

Reading 1: Seppala E (2022, June 30th) 5 Unexpected Ways Meditation Improves
https://www.psychologytoday.com/intl/blog/feeling-it/202206/5-unexpected-ways-meditation-improves-relationships-lot


**Unit 6 Meditation and Compassion-driven Action**
Understand how meditation can help to motivate compassion-driven action. (Pre-recorded video with Dr Shobhana Madhavan)


**Evaluation Pattern**

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**19ENG111 Technical Communication**

L-T-P-C: 2-0-3-3

**Course Objectives**

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

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

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

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Syllabus

Unit 1

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

General Reading and Listening comprehension - rearrangement & organization of sentences

Unit 2

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

Formal Correspondence: Writing formal Letters Mechanics of Writing: impersonal passive & punctuation

Scientific Reading & Listening Comprehension

Unit 3

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

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

Technical presentations

Text Books / References


Evaluation Pattern

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SEMESTER 2

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
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<th>CO</th>
<th>Implement matrix decomposition techniques to solve linear systems of equations.</th>
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<tr>
<td>CO2</td>
<td>Formulate optimization problems and solve them using gradient based and Newton’s methods</td>
</tr>
<tr>
<td>CO3</td>
<td>Analyse data using fundamental techniques of probability.</td>
</tr>
<tr>
<td>CO4</td>
<td>Explain quantum entanglement, qubits and state vectors</td>
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CO-PO Mapping

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Syllabus

Unit 1

Unit 2
Taylor series expansion of multivariate functions-conditions for maxima, minima and saddle points-Concept of gradient and Hessian matrices- Impulse Response computations- converting higher order into first order equations – concept of eAT- Multivariate regression and regularized regression -Theory of convex and non-convex optimization-Newton method for unconstrained optimization- Signal processing with regularized regression- Computational experiments using MATLAB/Excel/Simulink

Unit 3
Random variables and distributions - Expectation, Variance, Moments, Cumulants- Moment generating functions - Sampling from univariate distribution- various methods - Bayes theorem, Concept of Jacobian, and its use in finding pdf of functions of Random variables (RVs), Box-muller formula for sampling normal distribution - Concept of correlation and Covariance of two linearly related RVs.

Unit 4

Textbooks / References

Evaluation Pattern

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Course Objectives
- This course introduces students to the concepts and techniques of computational applied Mechanics, providing them with a solid foundation in analyzing and solving mechanical engineering problems using computational methods.
• This course equips students with the necessary skills to apply the Finite Element Method (FEM) and Computational Fluid Mechanics (CFD) for the analysis of common robotic applications.
• This course familiarizes students with the basic robotic control and its implementation for simple robotic systems.

**Course Outcomes**

After completing this course, students will be able to

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

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**Syllabus**

**Unit 1  Solid Mechanics**


**Unit 2  Fluid Mechanics**

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

**Unit 3  Introduction to Robotics Control**

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

**Text Books / References**


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO1</th>
<th>Represent the problems using objects and classes.</th>
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</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Implement object-oriented concepts using the Java language</td>
</tr>
<tr>
<td>CO3</td>
<td>Apply object-oriented concepts to design and visualize programs using UML.</td>
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<tr>
<td>CO4</td>
<td>Implement applications using object-oriented features.</td>
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CO-PO Mapping

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Syllabus

Unit 1
Introduction to Java Language and Runtime Environment, JVM, Bytecode, Basic program syntax, Datatypes, Variables, Operators, Control statements, Loops, Arrays, Functions.

Unit 2
Object-oriented concepts - Abstraction, Encapsulation, Inheritance and Polymorphism. Class and objects, Constructor functions, Class members and methods, Class Instance variables, Garbage collector, Method overloading.

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

Unit 3
Introduction to exception handling, Hierarchy of exception, Usage of try, catch, throw, throws and finally. Built-in and user defined exceptions, Threads, Creating Threads, Thread lifecycle, Concept of multithreading.

Unit 4
Applets - Applet class, Delegation event model - events, event sources, event listeners, event classes, mouse and keyboard events, JLabel, JText, JButton, JList, JComboBox.

Text Books / References

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

Evaluation Pattern

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<tr>
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23AID112 Data Structures & Algorithms L-T-P-C: 2-0-2-3

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

| CO1 | Choose an appropriate data structure as applied to a specified problem |
| CO2 | Use various techniques for representation of the data in the real world |
CO3 | Develop applications using data structures.
---|---
CO4 | Test the logical ability for solving problems

### CO-PO Mapping

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

### Syllabus

#### Unit 1

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

#### Unit 2

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

#### Unit 3

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

#### Unit 4

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

### Text Books / References


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

CO1  Develop and execute programs in low-level languages such as Hack machine language and assembly language

CO2  Create virtual machine specification or VM code for high-level and assembly languages

CO3  Develop programs in object-based language ‘Jack’

CO4  Execute experiments related to basic concepts and functions of operating systems/compilers

CO-PO Mapping

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

Syllabus

Unit 1


Unit 2

Unit 3


Text Books / References

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


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO1</th>
<th>Explain the basic concepts of analogy and digital electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Design and implement various electronic circuits using diodes and transistors and demonstrate an understanding of their applications in electronic devices and systems.</td>
</tr>
<tr>
<td>CO3</td>
<td>Design and implement operational amplifier circuits for a range of applications and demonstrate an understanding of their operation and behaviour in electronic systems</td>
</tr>
<tr>
<td>CO4</td>
<td>Model and analyse engineering problems and demonstrate the ability to propose and implement electronic solutions to these problems.</td>
</tr>
</tbody>
</table>

CO-PO Mapping
Syllabus

Unit 1  Semiconductor Physics

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

Unit 2  Transistors

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

Unit 3  Operational Amplifiers (Op-Amps)

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

Text Books / References


Evaluation Pattern

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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO</th>
<th>Course Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Apply modern material informatics tools including machine learning, simulations. Modelling, visualizations to solve a specific challenge most significantly.</td>
</tr>
<tr>
<td>CO2</td>
<td>Analysis material failure and sustainability</td>
</tr>
<tr>
<td>CO3</td>
<td>Design new materials and solve inverse design problem using AI.</td>
</tr>
<tr>
<td>CO4</td>
<td>Developed efficient predictive model using small, spares and low-quality dataset.</td>
</tr>
</tbody>
</table>

CO-PO Mapping

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<th>PO/PSO</th>
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Syllabus

Unit 1
Introduction to material science – structure, properties, and process spaces - process-structure-property linkages – foundation of material informatics – introduction to molecular mechanism and force field – quantification of dynamics properties of polymers (monte carlo simulation, molecular dynamics simulation, normal mode analysis) – electronics structure of atoms (Gaussian, Gauss view, density functional theory)

Unit 2
Quantification and screening of materials properties - property prediction and optimization using AI - materials design and discovery using AI – how to handle small, spared, and low-quality dataset using AI.

Unit 3
Materials failure and sustainability analysis – new material and inverse materials design concept – solve inverse design using AI – enhance speed, efficacy and cost-effectiveness of material using AI - basic concept of quantum computing in material informatics.

Unit 4
Case studies of materials informatics (use of AI) in different fields (e.g. energy, aerospace, biomedical, etc.) - ethical considerations and limitations of materials informatics - future directions and challenges in materials informatics.
Text Books / References

“Material Informatics: Methods, Tools and Applications” by Olexandr Isayev, Alexander Tropsha and Stefano.

“Informatics for Materials Science and Engineering” by Krishna Rajan

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

Evaluation Pattern

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<tr>
<th>Assessment</th>
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22ADM111 Glimpses of Glorious India L-T-P-C: 2-0-1-2

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1
To the World from India; Education System in India; Insights from Mahabharata; Human Personality. India’s Scientific System for Personality Refinement.

Unit 2
The Vedas: An Overview; One God, Many Forms; Bhagavad Gita – The Handbook for Human Life; Examples of Karma Yoga in Modern India.

Unit 3
Chanakya’s Guidelines for Successful Life; Role of Women; Conservations with Amma.

Textbooks / References

- Cultural Education Resource Material Semester-2
- Cultural Heritage of India. R.C.Majumdar. Ramakrishna Mission Institute of Culture.
- Indian Culture and India’s Future. Michel Danino. DK Publications.
- The Beautiful Tree. Dharmapal. DK Publications.
- India’s Rebirth. Sri Aurobindo. Auroville Publications

Evaluation Pattern

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

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO</th>
<th>Course Description</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Apply the fundamental techniques of optimization theory to solve data science problems.</td>
</tr>
<tr>
<td>CO2</td>
<td>Analyse and solve computationally, physical systems using the formalism of partial differential equations.</td>
</tr>
<tr>
<td>CO3</td>
<td>Apply Markovian concepts in stochastic sequential systems.</td>
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<tr>
<td>CO4</td>
<td>Explain Bells Inequality and Quantum gates.</td>
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CO-PO Mapping

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Syllabus

Unit 1

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

Unit 2
Introduction to PDEs - Formulation and numerical solution methods (Finite difference and Fourier) for PDEs in Physics and Engineering- Computational experiments using Matlab/Excel/Simulink.

Unit 3

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

Unit 4

Introduction to quantum computing-Bells inequality-Quantum gates

Text Books / References


Evaluation Pattern

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<th>Weightage (%)</th>
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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping
Syllabus

Unit 1
Introduction to modelling - Examples of models, Modelling of dynamic systems, Introduction to simulation - Matlab as a simulation tool, Bond graph modelling - Bond graph model and causality, Generation of system equation, Methods of drawing bond graph models - Mechanical systems, Electrical systems. Basic system models – Mechanical systems, Electrical systems, Hydraulic systems, Pneumatic systems, and Thermal systems

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

Unit 3

Text Books / References


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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1 Overview of Robotics

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

Unit 2 Kinematics of Simple Robotic Systems

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

Unit 3 Dynamics and Control of Simple Robotic Systems

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


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO1</th>
<th>Analyse different signal attributes related to communication system</th>
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<tbody>
<tr>
<td>CO2</td>
<td>Design and implement basic analog communication techniques using software defined radio platforms</td>
</tr>
<tr>
<td>CO3</td>
<td>Design and implement basic digital communication techniques using software defined radio platforms</td>
</tr>
<tr>
<td>CO4</td>
<td>Develop an appreciation of the role of AI in communication systems</td>
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CO-PO Mapping

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**Syllabus**

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Text Books / References**


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


**Evaluation Pattern**

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Course Objectives

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

Course Outcomes

After completing this course student will be able to,

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<td>CO1</td>
<td>Develop skills for analyzing algorithmic strategies</td>
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<tr>
<td>CO2</td>
<td>Analyse and apply appropriate algorithmic technique for a given problem</td>
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<tr>
<td>CO3</td>
<td>Implementing standard algorithms on arrays, strings, trees and graphs</td>
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<tr>
<td>CO4</td>
<td>Visualize multidimensional geometry of data structure and concurrency.</td>
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CO-PO Mapping

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Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

Text Books / References


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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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<tr>
<td>Analyse different elements of an AI system.</td>
<td>Analyse different types of data representation.</td>
<td>Apply concepts of AI and Data Science to solve canonical problems.</td>
<td>Implement basic computational tools pertinent to AI and Data Science to solve canonical problems.</td>
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**CO-PO Mapping**

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**Syllabus**

**Unit 1**

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

**Unit 2**


**Unit 3**

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

**Text Books / References**


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

**Evaluation Pattern**

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</tr>
<tr>
<td>Mid-Term Examination</td>
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</tr>
<tr>
<td>Term Project/ End Semester Examination</td>
<td>External</td>
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</tr>
</tbody>
</table>
Course Objective

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

Course Outcomes

After completing this course, students will be able to

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<tr>
<th>CO</th>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Analyze the requirements for a given organizational structure to select the most appropriate networking architecture and technologies.</td>
</tr>
<tr>
<td>CO2</td>
<td>Analyze the working of protocols in the internet protocol stack for network applications.</td>
</tr>
<tr>
<td>CO3</td>
<td>Configure a router using simulator/emulator.</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze the network data to detect potential security threats in a network</td>
</tr>
</tbody>
</table>

Syllabus

Unit 1

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

Unit 2


Unit 3
Network security- analyze the network traffic. Introduction to Software Define Networks

Text Books / References


Evaluation Pattern

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Internal/External</th>
<th>Weightage (%)</th>
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<tr>
<td>Assignments (minimum 2)</td>
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</table>

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

Syllabus

Chapter 1 - Introduction to the Great Itihasa

Chapter 2 - Bala-Kāṇḍa: (Preparing for the renowned mission.)
And Ayodhya-Kāṇḍa: (Harbinger of an Entire Tradition of Nobleness.)

Chapter 3 - Aranya-Kāṇḍa: (Tale of the forest life)
And Kishkindha-Kāṇḍa: (The Empire of Holy Monkeys.)

Chapter 4 - Sundara-Kāṇḍa: (Heart of the Ramayana)
And Yuddha-Kāṇḍa: (The most popular part of the Ramayana)

Chapter 5 - Ramayana and Modern-day learning

Chapter 6 - Ecological Awareness in the Ramayana

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

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

Text Books / References

2. Skanda Purana
3. Ramayana - C Rajagopalachari
Course Objective

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

<table>
<thead>
<tr>
<th>PO/PSO</th>
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</tbody>
</table>

Syllabus

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

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

Problem Solving I


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

Averages: Basics, and Weighted Average.

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

Verbal

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

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

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

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

Text Books / References

The hard truth about Soft Skills, by Amazon Publication.
Verbal Skills Activity Book, CIR, AVVP
English Grammar & Composition, Wren & Martin
Nova’s GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
Cracking the New GRE 2012
Kaplan’s – GRE Comprehensive Programme
Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
How to Prepare for Data Interpretation for the CAT, Arun Sharma.

Evaluation Pattern

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</table>
Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO</th>
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</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Apply proximal algorithms, augmented Lagrangian, and ADMM to solve convex and non-convex optimization problems.</td>
</tr>
<tr>
<td>CO2</td>
<td>Develop optimization algorithms used in neural networks.</td>
</tr>
<tr>
<td>CO3</td>
<td>Apply statistical estimation theory and hypothesis testing to data analysis applications.</td>
</tr>
<tr>
<td>CO4</td>
<td>Apply quantum computing concepts to solve problems in various fields including cryptography and optimization.</td>
</tr>
</tbody>
</table>

CO-PO Mapping

<table>
<thead>
<tr>
<th>PO/PSO</th>
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</tbody>
</table>

Syllabus

Unit 1


Unit 2

Matrix splitting and Proximal algorithms - Augmented Lagrangian- Introduction to ADMM, ADMM for LP and QP - Optimization methods for Neural Networks: Gradient Descent, Stochastic gradient descent- loss functions and learning functions
Unit 3
Basics of statistical estimation theory and testing of hypothesis.

Unit 4
Introduction to quantum computing- Bells’s circuit, Superdense coding, Quantum teleportation. Programming using Qiskit, Matlab.

Text Books / References


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


Evaluation Pattern

<table>
<thead>
<tr>
<th>Assessment</th>
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</table>

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

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

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

<table>
<thead>
<tr>
<th>CO</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>Apply the fundamentals of deep learning.</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply deep learning algorithms using Matlab/Python.</td>
</tr>
<tr>
<td>CO3</td>
<td>Apply deep learning models for signal analysis</td>
</tr>
<tr>
<td>CO4</td>
<td>Implement deep learning models for image analysis.</td>
</tr>
</tbody>
</table>

CO-PO Mapping

<table>
<thead>
<tr>
<th>PO/PSO</th>
<th>PO1</th>
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</tbody>
</table>

Amrita Vishwa Vidyapeetham. BTC-AIE B.Tech Curriculum June 2021
# Syllabus

## Unit 1
Introduction to neural networks – Gradient Descent Algorithm - Deep Neural Networks (DNN) – Convolutional Neural Network (CNN) – Recurrent Neural Network (RNN): Long-Short-Term-Memory (LSTM).

## Unit 2
Pre-processing: Noise Removal using deep learning algorithms - Feature Extraction - Signal Analysis: Time Series Analysis, CNNs, Auto encoders.

## Unit 3
Image Analysis: Transfer Learning, Attention models- Ensemble Methods for Signal and Image Analysis.

### Textbooks & References:


### Evaluation Pattern

<table>
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<tr>
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<th>Internal/External</th>
<th>Weightage (%)</th>
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<td>Term Project/ End Semester Examination</td>
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</table>

### Course Objectives

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

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

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

CO-PO Mapping

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</table>

Syllabus

Unit 1
Introduction to IOT Overview of machine-to-machine communication - Sensing – Actuations-Basics of Networking- Introduction to Micro-Controllers-Introduction to Embedded systems.

Unit 2
Basics of networking for device-to-device communication, Communication Protocols – wired and wireless communication – Network Topology-Sensor Networks-Introduction to Arduino and Raspberry-Pi-Introduction to IOT protocols-MQTT-COAP-Wi-Fi and Bluetooth connections in Arduino-Raspberry-Pi Ethernet and Wi-Fi connectivity

Unit 3

Unit 4
Introduction to cloud and IOT cloud Services - Cloud services for IOT storage-Introduction to cloud services to visualize IOT data- Streaming IOT data to cloud-Plot and Visualize data using cloud tools- Adding IOT devices to cloud- Integrating Arduino and Raspberry-Pi to ThingSpeak /IBM Watson.
Textbooks/References:


Evaluation Pattern

<table>
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<tr>
<th>Assessment</th>
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23AID213 Operating Systems L-T-P-C: 3-0-2-4

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO</th>
<th>Illustration</th>
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<tbody>
<tr>
<td>CO1</td>
<td>Illustrate the use of system calls to perform basic Operating System functionalities.</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply the algorithms for resource management</td>
</tr>
<tr>
<td>CO3</td>
<td>Analyze the usage of Synchronization techniques.</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze memory management techniques.</td>
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</table>

CO-PO Mapping

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Syllabus

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

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

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

Textbook / References


Evaluation Pattern

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<th>Assessment</th>
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<th>Weightage(%)</th>
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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1


Unit 2


Unit 3

Text Books / References


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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1

Unit 2
CSS Basics –Features of CSS – Implementation of Borders - Backgrounds- CSS3 - Text Effects -Fonts -Page Layouts with CSS.

Unit 3

Text Books / References


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

Syllabus

Unit 1 – Unit 4
Mahābhārata - A Brief Summary
A Preamble to the Grand Itihāsa
The Unbroken Legacy
Dharmic insights of a butcher

Unit 5 - 8
The Vows we take: Pratijñā
Mahābhārata - The Encyclopaedia for Kingship and Polity Acumen
Karna: The Maestro that Went Wide of the Mark
Strategical Silhouette of An Extraordinary Peace Mission

Unit 9 -11
Yajñaseni, A Woman from Fire.
Popular Regional Tales
Death and Deathlessness

Unit 12 -14
Mahabharata- An All-Encompassing Text
Mahabharatha- What and What Nots
Mahābhārata in Adages

Text Books / References

The Mahabharata by Bibek Debroy (Translator)
Some exemplary characters of Mahabharata by Geeta press.
Epic India: by C V Vaidya
The Mahabharata as a History and Drama: by Rai Promatha Nath Mullick
The Mahabharata- A Criticism: by C V Vaidya
The Mahabharata Abridged: by C V Vaidya

23LSE211 Life Skills for Engineers II L-T-P-C: 10 2-2

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
<thead>
<tr>
<th>CO1</th>
<th>Soft Skills: To develop greater morale and positive attitude to face, analyse, and manage emotions in real life situations, like placement process.</th>
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</thead>
<tbody>
<tr>
<td>CO2</td>
<td>Soft Skills: To empower students to create better impact on a target audience through content creation, effective delivery, appropriate body language and overcoming nervousness, in situations like presentations, Group Discussions and interviews.</td>
</tr>
<tr>
<td>CO3</td>
<td>Aptitude: To analyze, understand and employ the most suitable methods to solve questions on arithmetic and algebra.</td>
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<tr>
<td>CO4</td>
<td>Aptitude: To investigate and apply suitable techniques to solve questions on logical reasoning and data analysis.</td>
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<tr>
<td>CO5</td>
<td>Verbal: To learn to use more appropriate words in the given context. To have a better understanding of the nuances of English grammar and become capable of applying them effectively.</td>
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</table>
**CO6** Verbal: To be able to read texts critically and arrive at/predict logical conclusions. To learn to organize speech and incorporate feedback in order to convey ideas with better clarity.

### CO-PO Mapping

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### Syllabus

#### Soft Skills

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

#### Aptitude

**Problem Solving II**

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

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

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

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

#### Verbal

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

**Grammar (Basic-intermediate):** Help students master usage of grammatical forms and enable students to identify errors and correct them.
Reasoning: Emphasize the importance of avoiding the gap (assumption) in arguments/statements/communication.

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

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

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

Evaluation Pattern

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Text Books / References

- The hard truth about Soft Skills, by Amazon Publication.
- Verbal Skills Activity Book, CIR, AVVP
- English Grammar & Composition, Wren & Martin
- Nova’s GRE Prep Course, Jeff Kolby, Scott Thornburg & Kathleen Pierce
- Cracking the New GRE 2012
- Kaplan’s – GRE Comprehensive Programme
- Student Workbook: Quantitative Aptitude & Reasoning, Corporate & Industry Relations, Amrita Vishwa Vidyapeetham.
- Quantitative Aptitude for All Competitive Examinations, Abhijit Guha.
- How to Prepare for Quantitative Aptitude for the CAT, Arun Sharma.
- How to Prepare for Data Interpretation for the CAT, Arun Sharma.

SEMESTER 5

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Course Objectives

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

Course Outcomes

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

CO-PO Mapping

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Syllabus

Unit 1
Introduction to probabilistic graphical models, Probabilistic AI, Introduction to Bayesian Networks, Representation Learning in Bayesian Networks, Inference in Bayesian Networks

Unit 2
Markov Networks, Independencies in Markov Networks, Hidden Markov Models

Unit 3
Markov Random Fields (MRF), Decision Networks, From Bayesian Networks to Markov Networks

Text Books / References


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</table>
Course Objectives

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

Course Outcomes

After completing this course, students will be able to

<table>
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<tr>
<th>CO</th>
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<td>CO2</td>
<td>To use different deep learning based object detection algorithms for real time applications</td>
</tr>
<tr>
<td>CO3</td>
<td>To use various deep learning based object tracking algorithms on video data</td>
</tr>
<tr>
<td>CO4</td>
<td>To implement 3D reconstruction algorithms for real time applications</td>
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CO-PO Mapping

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Syllabus

Unit 1


Unit 2


Unit 3

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


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

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Syllabus

Unit 1
Introduction to Big Data Analytics: Definition, characteristics, and importance of big data, tools and technologies for big data analytics, State-of-the-art computing paradigms/platforms, Hadoop ecosystem in Brief, Mapper, Reducer.

Unit 2
Introduction to Functional Programming (FP), FP concepts in Scala Programming, Mutable and Immutable Data structures, Scala Collections, Type Hierarchy, Higher Order Functions, Closures, ConsList, Tail Recursion, Object Oriented Programming in Scala, Introduction to concurrency

Unit 3
Basic entity classes and objects in Scala, Spark Architecture, Spark Cluster, Resilient Distributed Datasets (RDDs), Spark Transformations and Actions APIs, DataFrames and Datasets in Spark, Basic Operations on RDDs and DataFrames, lazy evolutions and optimization, Directed Acyclic Graph (DAG)

Unit 4
Introduction to Machine Learning with Spark, MLlib and its algorithms, Building a Machine Learning Pipeline in Spark, Case Study in Healthcare, Finance, etc.

Text Books / References

Evaluation Pattern

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

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1

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

Unit 2

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

Unit 3

NISQ-era quantum algorithms, Variational Quantum Algorithms

Unit 4

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

Unit 5

Applications

Text Books / References


Yuly Billing, Quantum Computing for High School Students.


Evaluation Pattern

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Mid-Term Examination | Internal | 20  
Term project/End semester examination | External | 30  

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1


Unit 2

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

Unit 3
Overview of GPU architecture and its evolution – introduction to GPGPU and CUDA – CUDA programming – thread execution in CUDA programming – matrix computing in CUDA - introduction to cuBLAS and cuDNN libraries for linear algebra and deep learning - case studies of GPU: accelerated applications in scientific computing, data analytics, and machine learning

Unit 4
Introduction to cloud computing and its importance – benefits and challenges of cloud computing - types of cloud services (IaaS, PaaS, SaaS) and their characteristics - cloud computing architecture and its components - cloud storage and its types - cloud networking and its challenges - cloud security and its importance - cloud application - benefits and challenges of HPC and AI - synergy between HPC and AI - training and inference of AI models using HPC

Text Books / References
"High Performance Computing: Modern Systems and Practices" by Thomas Sterling and Matthew Anderson
"CUDA by Example: An Introduction to General-Purpose GPU Programming" by Jason Sanders and Edward Kandrot
"Parallel Programming with MPI" by Peter S. Pacheco

Evaluation Pattern

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

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

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

<table>
<thead>
<tr>
<th>CO1</th>
<th>Explain the fundamental principles that govern control systems.</th>
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<tr>
<td>CO2</td>
<td>Apply analytical techniques to evaluate and characterize basic control systems.</td>
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<tr>
<td>CO3</td>
<td>Evaluate the performance and stability of control systems</td>
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<tr>
<td>CO4</td>
<td>Apply control system theory to practical applications in engineering.</td>
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CO-PO Mapping

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Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Text Books / References


Evaluation Pattern

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</table>
Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Soft Skills

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

Aptitude

Problem Solving III

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


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

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

Verbal

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

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

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

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

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

References:


The hard truth about Soft Skills, by Amazon Publication.

Verbal Skills Activity Book, CIR, AVVP

English Grammar & Composition, Wren & Martin

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

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

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

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

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**SEMESTER 6**

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

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

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

**CO-PO Mapping**

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Syllabus

Unit 1
Introduction to Neuro-Symbolic AI: Definition and overview of Neuro-Symbolic AI- Advantages and disadvantages of Neuro-Symbolic AI- Applications of Neuro-Symbolic AI.

Unit 2
Knowledge Representation and Reasoning: Reasoning in neuro-symbolic AI - Types of reasoning. Logical Neural Networks-Markov Random Fields-Hybrid Models

Unit 3
Explainable AI, Multi-Modal Neuro-Symbolic AI, Future Directions in Neuro-Symbolic AI

Text Books / References


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

Evaluation Pattern

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<thead>
<tr>
<th>Assessment</th>
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<td>Term Project/ End Semester Examination</td>
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23AID311 Analog Computing L-T-P-C: 2-0-2-3

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

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</table>

Syllabus

Unit 1

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

Unit 2

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

Unit 3

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

Unit 4

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

Unit 5

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

Textbooks / References

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

Evaluation Pattern

<table>
<thead>
<tr>
<th>Assessment</th>
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Amrita Vishwa Vidyapeetham. BTC-AIE B.Tech Curriculum June 2021
**23AID312 Reinforcement Learning  L-T-P-C: 2-0-2-3**

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

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

**CO-PO Mapping**

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**Syllabus**

**Unit 1**

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

**Unit 2**


**Unit 3**

Unit 4
Planning and Learning with Tabular Methods – Models and planning – Prioritized sweeping – Trajectory sampling – Heuristic search – Rollout algorithms

Text Books / References


Evaluation Pattern

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<th>Assessment</th>
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<th>Weightage (%)</th>
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23xxxxxx Foundations of Indian Heritage L-T-P-C: 2-0-2-3

Syllabus

Unit 1 – Unit 4
Educational Heritage of Ancient India
Life and Happiness
Impact of Colonialism and Decolonization
A timeline of Early Indian Subcontinent

Unit- 5 - 8
Pinnacle of Selflessness and ultimate freedom
Indian approach towards life
Circle of Life
Ocean of love; Indian Mahatmas.

Unit 9 - 13
Man's association with Nature
Celebrating life 24/7.
Metaphors and Tropes

Become A Strategic Thinker (Games / Indic activity)

India: In the Views of Other Scholars and Travellers

Unit 14-16

Personality Development Through Yoga.

Hallmark of Indian Traditions: Advaita Vedanta, Theory of oneness

Conversations on Compassion with Amma

Text Books / References

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

SEMESTER 7

19ENV300 Environmental Science P/F

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1


Unit 2


Unit 3


Text Books / References


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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

| CO1          | Understand the functions of the Indian government |
Course Objectives

- Project Phase – 1 aims at helping students to identify the research problems by conducting a thorough understanding and abide the rules of the Indian constitution. Understand and appreciate different culture among the people.
- literature review
- The course introduces the students to real world problems associated with AI
- The course also aims at helping students to publish scientific articles in peer reviewed scientific publications.

**Course Outcomes**

After completing this course, students will be able to

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<td>Identify a valid research problem by conducting literature review in the appropriate area</td>
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<td>Identify the appropriate methodology to solve the research problem.</td>
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<td>CO3</td>
<td>Apply the AI tools &amp; techniques to solve the identified problem.</td>
</tr>
<tr>
<td>CO4</td>
<td>Communicate scientific discoveries through peer-reviewed publications.</td>
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**CO-PO Mapping**

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SEMESTER 8

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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<td>CO2</td>
<td>Implement the appropriate methodology to solve the research problem.</td>
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<td>Apply the AI tools &amp; techniques to solve the identified problem.</td>
</tr>
<tr>
<td>CO4</td>
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</tr>
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CO-PO Mapping

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### ELECTIVES

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

### Course Objectives

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

### Course Outcomes

After completing this course, students will be able to

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

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

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**Evaluation Pattern**

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Amrita Vishwa Vidyapeetham.  
BTC-AIE  
B.Tech Curriculum June 2021
Syllabus

Unit 1: Industrial Robots – Kinematics

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

Unit 2: Industrial Robots - Dynamics and Control


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


Text Books / References


Evaluation Pattern

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<td>Term Project/ End Semester Examination</td>
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Course Objectives

- This course aims to introduce students to the fundamentals of Robotic Operating System (ROS2) and Gazebo simulation, including key concepts such as nodes, topics, services, and actions, as well as the development of ROS2 packages.
- This course aims to equip students with the knowledge and skills required to apply ROS2 to mobile and industrial robots, including navigation, SLAM, robot arm control, perception, and communication.
• This course aims to provide students with hands-on experience working with ROS2 and Gazebo, allowing them to design, implement, and test robotic applications using these tools.

Course Outcomes

After completing this course, students will be able to

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

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</table>

Syllabus

Unit 1: Introduction to ROS2

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

Unit 2: Advanced ROS2 Concepts

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

Unit 3: ROS2 Applications in Mobile and Industrial Robotics

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

Text Books / References


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

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

**Course Objectives**

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

**Course Outcomes**

After completing this course, students will be able to

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

**CO-PO Mapping**

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**Syllabus**

**Unit 1**


**Unit 2**

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

**Unit 3**


**Text Books / References**


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1

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

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

Text Books / References


Evaluation Pattern

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Course Objectives

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

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

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

**CO-PO Mapping**

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**Syllabus**

**Unit 1: Introduction to Mobile Robotics**


**Unit 2: Perception and Control**


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

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

**Text Books / References**


**Evaluation Pattern**

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</table>
Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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

Syllabus

Unit 1: Introduction to AI for Robotics

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

Unit 2: Machine Learning for Robotics

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

Unit 3: Deep Learning for Robotics

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

Text Books / References

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

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1
Introduction to Biomedical Informatics – different biomedical data and databases – methods of data integration of heterogenous data – data retrieval and acquisition - Querying biomedical databases using SQL – heterogeneous data standardization.

Unit 2
Application of data mining and AI techniques in biomedical information – Querying biomedical databases using SQL- Biomedical Imaging Informatics.

Unit 3
Clinical Informatics and Electronic Health Record Systems – AI and mathematical model in clinical trial – community and population health - tackles disease treatment and prevention.

Unit 4
Agro informatics - nutri informatics - ethics of AI in biomedical informatics

Text Books / References

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

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

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

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


Evaluation Pattern

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Course Objectives

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

After completing this course, students will be able to

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<td>Apply the basic concepts on various application of gene therapy.</td>
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<td>Design familiar with experimental design.</td>
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<td>create automated pipelines for identifying the associations between multiple genome editions.</td>
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CO-PO Mapping

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Syllabus


Textbooks / References

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

Evaluation Pattern

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Course Objectives

- The course will lay down the basic concepts of computational techniques to analyse the coordinate systems in molecular construction.
- It will explore the concepts initially through basic formats to represent synthetic and biomolecules.
- It will provide an appreciation for the broad application of AI in drug design.
• Goal of the course is to provide a connection between the concepts of organic chemistry and simulation studies.

Course Outcomes

After completing this course, students will be able to

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<tr>
<th>CO1</th>
<th>To develop an understanding of the basic concepts of Machine Learning Techniques in Computer Aided Drug Design.</th>
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<td>To evaluate the suitability of molecular file formats in 2-D and 3-D analysis.</td>
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<tr>
<td>CO3</td>
<td>To connect the concepts of 2-D and 3-D Modeling of Synthetic and Biomolecules.</td>
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<tr>
<td>CO4</td>
<td>To evaluate the biologically active point of biomolecular confirmations.</td>
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CO-PO Mapping

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Syllabus


Textbooks / References


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


Evaluation Pattern

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

Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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<td>CO1</td>
<td>Application of AI in omics research.</td>
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<tr>
<td>CO2</td>
<td>Develop the ability to integrate data from multiple omics platforms using AI-based approaches.</td>
</tr>
<tr>
<td>CO3</td>
<td>Identify limitations of existing AI-based software tools and overcome the computational limitations of models</td>
</tr>
<tr>
<td>CO4</td>
<td>Develop critical thinking and problem-solving skills (real-world problems in biomedical, agriculture etc.) to design and carry out experiments in transcriptomics, proteomics, and metabolomics and analyse and interpret the resulting data.</td>
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CO-PO Mapping

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Syllabus

Unit 1
Overview of omics technologies (transcriptomics, proteomics, metabolomics) - history and evolution of omics technologies – the importance of application of AI omics research – the role of omics research in biological research.

Unit 2


Unit 3

Protein separation and identification using mass spectrometry - quantitative proteomics and label-free quantification - proteome analysis using bioinformatics tools and AI-based algorithm - proteins and pathways - protein-protein interactions and network analysis - structural proteomics and protein modifications.

Unit 4


Unit 5

Multi-omics data integration and analysis - correlation and causation analysis - AI-based predictive models - biomarker discovery and validation - A-based method to analyse biomarker data – the future direction of omics research with AI.

Text Books / References

"Transcriptomics and Gene Regulation" by Simon Tavaré and Nancy R. Zhang

"Proteomics: Methods and Protocols" edited by Daniel J. Liebler

"Metabolomics: From Fundamentals to Clinical Applications", edited by Ute Roessner and J. Cameron Thrash

"Integrated Omics Analysis: Methods and Applications" edited by Andrew J. Percy and David S. Wishart

"Transcriptome Analysis: Methods and Applications" edited by Vinita Chauhan, Rakesh Sharma, and Debmalya Barh

"Proteomics in Systems Biology: Methods and Protocols” edited by Daniel J. Kliebenstein

"Metabolomics in Practice: Successful Strategies to Generate and Analyze Metabolic Data” by Michael Lammerhofer and Wolfram Weckwerth Recent literature

Evaluation Pattern

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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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<tr>
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<td>Apply high-performance computing in different research field.</td>
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<tr>
<td>CO2</td>
<td>Design OpenMPI programme and CUDA programme</td>
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<tr>
<td>CO3</td>
<td>Simulate on cloud computing system.</td>
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<td>CO4</td>
<td>Evaluate how the convergence of HPC and AI is transforming the data science.</td>
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CO-PO Mapping

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Syllabus

Unit 1

Introduction to basic architecture and OS concepts - multi-core CPUs - high-speed interconnects - overview of High-Performance Computing (HPC) and its importance - hardware and software requirements for HPC - parallel programming and their applications (MPI/OpenMP) – brief introduction to workload manager and job schedulers.

Unit 2

Overview of GPU architecture and its evolution - comparison of CPU and GPU architecture - introduction to CUDA programming and its basic concepts - optimizing CUDA kernels for maximum performance - advanced CUDA programming techniques, such as shared memory, constant memory, and texture memory - introduction to cuBLAS and cuDNN libraries for linear algebra and deep learning - case studies of GPU: accelerated applications in scientific computing, data analytics, and machine learning.

Unit 3

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

**Text Books / References**

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

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

"Parallel Programming with MPI" by Peter S. Pacheco


**Evaluation Pattern**

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**Course Objectives**

- Provide a strong foundation in genomics.
- Teach computational and statistical tools for analysing large-scale genomics data, gene sequence and expression analysis.
- Familiarize students with the tools, algorithm, data structure and principles of contemporary genomics (DNA sequencing, cancer genomics, single-cell sequencing and next-generation sequencing etc.)
- Introduced Python and R for DNA sequencing.

**Course Outcomes**

After completing this course, students will be able to

<table>
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<tr>
<th>CO1</th>
<th>Design sequence assembly in Genomics Data Science.</th>
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<tr>
<td>CO2</td>
<td>Develop the ability to apply advanced computational methods to analyse genomics data.</td>
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<td>CO3</td>
<td>Develop the ability to identify the main results from a genomics research study and interpret figures from primary research papers.</td>
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<tr>
<td>CO4</td>
<td>Analyse genomics data and design simulation experiments and interpret results.</td>
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**CO-PO Mapping**

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Syllabus

Unit 1
Introduction to genomics – functional genomics – gene – different genomics experimental technology (next-generation sequencing, CRISPR/Cas9 etc.) – programming in R

Unit 2

Unit 3

Unit 4
Precision medicine and personalised genomics – Cancer genomics and analysis – Infectious disease genomics and analysis

Text Books / References

“Bioinformatics: Sequence and Genome Analysis” by David Mount
“Genomics and Personalized Medicine: What Everyone Needs to Know” by Michael Snyder
“Practice Computing for Biologists” by Steven Haddock and Casey Dunn
“Bioinformatics and Functional Genomics” by Jonathan Pevsner

Evaluation Pattern

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Course Objectives

- The goal of this is to cover the basic concept and principles of artificial intelligence and their application in field system biology.
- Explore AI and other computational methods to analyse biological networks and complex biological systems.
- Explore enzyme kinetics, metabolic pathway, flux balance analysis and signal transduction.
- Cover mathematical, statistical and dynamics modelling of biological networks.

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

<table>
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<tr>
<th>CO1</th>
<th>Analysis biological networks</th>
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<tr>
<td>CO2</td>
<td>Develop the ability to apply ML/DL techniques to understand and analyse biological networks, signal transduction, metabolic network, and gene regulatory network in physiology and pathology.</td>
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<tr>
<td>CO3</td>
<td>Design and simulate network-based mathematical and statistical models.</td>
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<td>CO4</td>
<td>Develop pipelines for biochemical pathway analysis based on recent Omics studies and AI developments.</td>
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**Syllabus**

**Unit 1**
Introduction to complex systems - cell signalling – metabolic network – experimental technologies - network building analysis - enzyme kinetics – metabolic analysis – flux balance analysis

**Unit 2**
Modelling, construction and simulation of the biological network using AI - dynamic modelling of biological systems – network structure analysis using AI– ML/DL algorithm to design gene circuit

**Unit 3**
Modelling the behaviour of single cells using AI – AI accelerated cell and gene therapy – AI to analyse cryo-electron tomogram.

**Unit 4**
Ethical and legal considerations of AI in System biology - Future directions and opportunities for AI in Biotechnology

**Text Books / References**


**Evaluation Pattern**

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Amrita Vishwa Vidyapeetham.  
BTC-AIE  
B.Tech Curriculum June 2021
Assignments (minimum 2) Internal 30
Quizzes (minimum 2) Internal 20
Mid-Term Examination Internal 20
Term Project/ End Semester Examination External 30

23AID448  AI in drug design  L-T-P-C: 2-0-2-3

Course Objectives

- To educate students on fundamentals stages of drug discovery pipeline and how computational and informatics techniques can accelerate the pace of drug discovery.
- To teach them how to encode a molecule into numerical molecular descriptors and strings, allowing computational treatment of molecules.
- Discuss drug-likeness, informatics approaches to the prediction of chemical properties - QSAR, pharmacophores, pharmacokinetics, and pharmacodynamics.
- To teach them how to apply AI / ML techniques and construct validated classification and regression models for biological endpoints.

Course Outcomes

After completing this course, students will be able to

| CO  | Explain the drug discovery pipeline and the role of computational drug discovery in the process. |
| CO2 | Construct SMILES Representations of Molecular Structures |
| CO3 | Extract chemical information from Molecular Structures in different chemical file formats. |
| CO4 | Compute different kinds of Molecular Descriptors and Fingerprints, and construct similarity kernels from them. |
| CO5 | Construct validated Classification and Regression models for pharmacological endpoints and evaluate model performance and Domain of Applicability. |

CO-PO Mapping

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Syllabus

Unit 1

Why Computational Drug Design? The Drug Discovery pipeline; Chemical Space; Cheminformatics and Virtual High Throughput Screening; Lipinski’s Rules of 5 and ADMET Modelling; Pharmacodynamics and pharmacokinetics; Structure-Based and Ligand-Based Drug Design.
Unit 2
Chemical File Formats and Representations; Topological Indices; Substructural Descriptors and 2D fingerprints; Local Molecular Surface Property Descriptors; 3D Shape and Chiral descriptors; Molecular Similarity Measures and Kernels; Chemical and Biological Networks.

Unit 3
Linear Free Energy Relationships; Pharmacophores and Molecular Interaction Fields; Model Validation; Structure Based Methods - Docking & Scoring; Molecular Simulation (Monte-Carlo, Molecular dynamics) – Structure and dynamics properties (normal mode analysis) – Gaussian and Gauss view – Density functional theory.

Unit 4
Linear and Non-Linear Models; Classification, Regression and Ranking; Data preprocessing, Performance Measures and unbalanced datasets; Dimensionality reduction and Feature selection; Evolutionary computing; Kernel methods; Best Practices in Predictive Modeling; Applications of Deep Learning in Pharma.

Text Books / References

Jürgen Bajorath (Editor), Chemoinformatics and Computational Chemical Biology (Methods in Molecular Biology) (Humana Press, 2004)
Andrew R. & Leach, Valerie Gillet, An Introduction to Chemoinformatics (Springer International, New Delhi, 2009)


Evaluation Pattern

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Course Objectives

- To understand the underlying fundamentals of classical and modern cryptography
- To understand about the cryptographic systems used over the Internet.
- To help the students to study cryptographic protocols, common attacks and their prevention.
Course Outcomes

After completing this course, students will be able to

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

CO-PO Mapping

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Syllabus

Unit 1

Number theory concepts – Divisibility, GCD, modular exponential, congruence, Chinese remainder theorem, Groups, rings, fields.

Unit 2

Overview of Cryptography, Symmetric key cryptography, stream ciphers, block ciphers, DES and Enhancements, AES, Attacks on block ciphers, Message integrity, Message integrity: definition and applications, Hashing, collision resistance, Public key cryptography, Arithmetic modulo primes, Cryptography using arithmetic modulo primes, Public key encryption, Arithmetic modulo composites, RSA, Attacks on RSA, Rabin Cryptosystem, Discrete Logarithm Problem and related Algorithms, ElGamal Cryptosystem.

Unit 3

Introduction to Elliptic Curve Cryptography, Digital signatures: definitions and applications, More signature schemes and applications, Identification protocols, Authenticated key exchange and SSL/TLS session setup, Zero knowledge protocols, Key agreement protocols, Diffie-Hellman protocol, variations.

Text Books / References


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23AID452  Network and Wireless security  L-T-P-C: 2-0 -2-3

Course Objectives

- To understand the various techniques for network protection.
- To gain knowledge on security and privacy issues on various networks.
- To study the use of modern tools and techniques used in analysing various security parameters of the network.

Course Outcomes

After completing this course, students will be able to

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<td>Evaluate the various network security threats.</td>
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<td>Apply modern tools to simulate network attacks.</td>
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<td>CO4</td>
<td>Interpret the ethical aspects of network security.</td>
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Syllabus

Unit 1

Overview of network security principles, concepts, and terminology. Threats to network security, including attacks on confidentiality, integrity, and availability. Network security goals and objectives. IP tables, NAT, Intrusion detection systems. Types, Honeypots.

Unit 2


Unit 3

**Text Books / References**


**Evaluation Pattern**

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**Course Objectives**

- This course helps the students to understand the basics of intrusion detection and prevention systems, including concepts of intrusion detection, types of intrusions, vulnerabilities, and threats.
- This course helps the students to learn the different types of intrusions and their potential impacts.
- This course also provides methods to explore different techniques and methodologies for intrusion detection and prevention.
- This course will help students to gain practical experience with popular intrusion detection and prevention systems.

**Course Outcomes**

After completing this course, students will be able to

| CO1 | Analyze the characteristics of various network attacks and select appropriate intrusion detection and prevention techniques to mitigate the associated risks. |
| CO2 | Configure open-source intrusion detection and prevention systems to detect and prevent network attacks |
| CO3 | Implement machine learning and deep learning models for detecting intrusions |
| CO4 | Analyze the effectiveness of intrusion detection and prevention systems |

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**Amrita Vishwa Vidyapeetham. BTC-AIE B.Tech Curriculum June 2021**
Syllabus

Unit 1
Introduction to Intrusion Detection and Prevention Systems - Overview of Intrusion Detection and Prevention Systems - Types of Intrusions - Goals and Requirements of Intrusion Detection and Prevention Systems - Differences between IDS and IPS

Unit 2

Unit 3
Intrusion Prevention Systems - IPS Architecture and Mechanisms - Signature-Based IPS - Behavior-Based IPS

Text Books / References


Evaluation Pattern

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23AID454 Software Vulnerability Analysis L-T-P-C: 2-0-2-3

Course Objectives

- This course teaches software engineering techniques for building security into software as it is developed.
• This course introduces students to the discipline of designing, developing, and testing secure and dependable software-based systems.
• This course provides hands on experience in software security analysis and development
• This course helps students to learn how to mitigate software vulnerabilities through secure software development practices

**Course Outcomes**

After completing this course, students will be able to

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<tr>
<td>CO1</td>
<td>Analyse the security risk of a system under development.</td>
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<tr>
<td>CO2</td>
<td>Apply secure coding practices to prevent common vulnerabilities from being injected into software.</td>
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<tr>
<td>CO3</td>
<td>Design security requirements (which include privacy requirements).</td>
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<td>Validate security requirements.</td>
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**CO-PO Mapping**

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**Syllabus**

**Unit 1**
Introduction to Software Vulnerability Analysis - Overview of software vulnerabilities - Importance of vulnerability analysis in software development - Types of Software Vulnerabilities

**Unit 2**
Common types of software vulnerabilities - Code Injection vulnerabilities - Authentication and Authorization vulnerabilities - Input Validation vulnerabilities - Static Analysis - Source code analysis techniques - Dynamic Analysis - Types of dynamic analysis techniques - Binary Analysis - Overview of binary analysis - Reverse engineering techniques

**Unit 3**
Mitigation Strategies - Overview of software security mitigation strategies - Secure coding practices - Input validation and output encoding - Security testing and verification techniques - Security standards and best practices

**Text Books / References**


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23AID455 Cybercrime Investigations & Digital Forensics  L-T-P-C: 2 0 2 3

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

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

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| CO1  | Enable the student to define and describe the nature and scope of cybercrime.
| CO2  | Develop knowledge of major incidents of cybercrime and their resulting impact. |
| CO3  | Facilitate the student to analyse and discuss national and global digital law enforcement efforts |
| CO4  | Evaluate the specific AI and ML enabled technology that facilitates cybercrime and digital law enforcement |

CO-PO Mapping

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Syllabus

Amrita Vishwa Vidyapeetham. BTC-AIE B.Tech Curriculum June 2021
Introduction to cybercrime, criminal law, courts, and lawmakering, Types of computer-related crimes, Sources of cybercrime law (substantive and procedural), Technology, cybercrime, and police investigations, Technology and crime, Cyber deviance, cybercrime, and cyber terror, Computer misuse crimes, Malware and automated computer attacks, Malware, DDoS attacks, and Botnets, Digital piracy and Intellectual property theft, Digital piracy, Copyright, trademark, and trade secrets, Pornography, prostitution, and sex crime, The Fourth Amendment, computers, and computer networks, Digital/Computer Forensics - Introduction to digital and computer forensics, Legal issues related to digital investigations, National security and international.

Text Books / References


Evaluation Pattern

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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

| CO1                              | Understand the distributed systems and threats against distributed systems and how to protect against them |

Amrita Vishwa Vidyapeetham. BTC-AIE B.Tech Curriculum June 2021
CO2  To have a foundation for designing and developing secure distributed systems, and for evaluating the security of existing solutions.

CO3  To have knowledge of standards, security protocols, technologies, principles, methods and cryptographic mechanisms applicable for securing modern distributed systems.

CO4  Design and Development of AI enabled distributed security systems.

Syllabus

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

Text Books / References


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Course Objectives

- To familiarize with various components of power systems, including generators, transformers, transmission lines, distribution systems, and loads
- To perform load flow studies and how to simulate using software tools.
- To acquire knowledge about fault analysis and stability analysis
- Understand the fundamentals of power system protection and power quality

Course Outcomes

After completing this course, students will be able to

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<td>Identify and describe the various components of power systems, including generators, transformers, transmission lines, distribution systems, and loads.</td>
<td>Perform load flow analysis to determine the steady-state operating conditions of power systems and understand the flow of active and reactive power in the network.</td>
<td>Analyse fault conditions in power systems, calculate fault currents and voltages, and design appropriate protection schemes to ensure system safety and reliability.</td>
<td>Identify power quality issues such as voltage sag, swell, flicker, harmonics, and propose solutions to maintain the desired quality of power supply.</td>
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CO-PO Mapping

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Syllabus

Unit 1 Introduction to power systems and transmission lines

Overview of power systems, types of power generation, power systems components, transmission lines, transmission line parameters, insulators, cables, grading, complex power calculations, power factor correction.

Unit 2 Load flow analysis and power system control

Load flow analysis, Gauss Siedel Method, Newton Raphson method, Fast decoupled method, load frequency control, automatic voltage regulator, MATLAB experiments on load flow and power system control.

Unit 3 Power system Protection, stability and security

Types of faults, symmetrical unsymmetrical faults, power system stability and dynamics, power quality, power system security, Assessment of stability, protection and quality using MATLAB and python.
Textbooks / References


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| 23AID462 Sustainable Energy Technologies | L-T-P-C: 2-0-2-3 |

Course Objectives

- To understand global energy challenges and recognize the need for sustainable energy technologies as a solution
- To gain knowledge about renewable energy sources and understand their characteristics
- To familiarize energy storage technologies
- To analyse sustainable transportation solutions and energy management challenges

Course Outcomes

After completing this course, students will be able to

<table>
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<tr>
<th>CO1</th>
<th>Able to describe the basic principles of sustainable energy technologies and their significance in addressing global energy challenge</th>
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<tbody>
<tr>
<td>CO2</td>
<td>Able to evaluate and categorize renewable energy source.</td>
</tr>
<tr>
<td>CO3</td>
<td>Able to familiarize energy storage technologies and its basic operations</td>
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<tr>
<td>CO4</td>
<td>Competent to understand basic concepts of smart grid, energy management and sustainable transportation options.</td>
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Syllabus

Unit 1 Introduction to sustainable energy

Overview of global energy challenges and the need for sustainable energy technologies, Environmental influences of conventional energy sources, United Nations Framework Convention on Climate Change (UNFCC) sustainable development. Definition and criteria for sustainable energy technologies.

Unit 2 Renewable Energy Sources


Unit 3 Sustainable transportation, smart grid and energy management


Textbooks / References


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Course Objectives

- The course shall teach the students to analyse power system stability using both traditional and data-driven techniques.
- The course aims to enable students to understand and develop control strategies that can improve power system stability.
- By the end of the course, students should be able to simulate and analyse power system stability using synchronous machine models.
- The course intends to equip students with the critical thinking and problem-solving skills needed to tackle power system stability challenges.

Course Outcomes

After completing this course, students will be able to

| CO1 | Comprehend the fundamentals of power system stability |
| CO2 | Apply mathematical modelling techniques to simulate power system stability |
| CO3 | Familiarize and compare different techniques for improving power system stability |
| CO4 | Apply data-driven techniques for power system stability analysis and improvement |

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Syllabus

Unit 1

Introduction to Power System Stability: Definition, types, and causes of power system instability - Overview of power system modelling - Synchronous generator models - Excitation system models - Governor models - Load models.

Unit 2


Unit 3

Improving Power System Stability: Power System Stabilizers - FACTS and HVDC systems for power system stability - Microgrids for power system stability - Data-driven Techniques for power system stability.
Text Books / References

Prabha Kundur ,Power System Stability and Control,1998

Evaluation Pattern

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23AID464 Micro Grids L-T-P-C: 2-0-2-3

Course Objectives

- To enable students to identify and analyse the benefits and hurdles of Microgrids in various industries and applications.
- To equip students with the ability perform comparative analysis of different control strategies and energy management systems.
- To develop the skillset towards applying optimization techniques for modelling and analysing Microgrids to achieve optimal performance.
- To develop the knowledge and proficiency for incorporating AI and ML-based to Microgrid optimization and control problems.

Course Outcomes

After completing this course, students will be able to

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| CO2  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| CO3  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| CO4  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

CO-PO Mapping

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Syllabus

Unit 1
Introduction to Microgrids: Introduction - Overview of Microgrid architecture and components - Advantages and challenges of Microgrids - Applications of Microgrids in different industries

Unit 2
Microgrid Control: Control strategies for Microgrids - Energy management systems for Microgrids - Microgrid stability analysis and control - Microgrid protection and islanding

Unit 3
Microgrid Optimization: Microgrid modeling for optimization - Linear and nonlinear programming for Microgrid optimization - Convex optimization for Microgrid optimization

Unit 4
Advanced Topics in Microgrid Optimization and Control: Distributed optimization for Microgrids - Stochastic optimization for Microgrids - Artificial intelligence and machine learning for Microgrid control and optimization - Integration of renewable energy sources in Microgrids

Text Books / References

Nikos Hatziargyriou, Hassan Bevrani, and Jacob Ostergaard, "Microgrids: Control and Operation", 2017
S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks", 2009
Weerakorn Ongsakul and Vo Ngoc Dieu, "Artificial Intelligence in Power System Optimization", 2013

Evaluation Pattern

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23AID465 Intelligent Energy Management Systems L-T-P-C: 2-0-2-3

Course Objectives

- The course aims to help the students to identify and describe the fundamental concepts and principles of intelligent energy management.
- Students will learn to differentiate and categorize the key components of intelligent energy management systems, including sensors, controllers, and algorithms.
- The course will enable students to apply data analysis techniques to extract insights and trends from energy usage data and propose opportunities for energy savings and efficiency improvements.
- Students will learn to evaluate and compare potential benefits and challenges associated with implementing intelligent energy management in different contexts.
Course Outcomes

After completing this course, students will be able to

| CO1 | Identify and explain the key components of intelligent energy management systems and their application in optimizing energy consumption, using data analytics tools and techniques |
| CO2 | Analyse energy usage data using various data analytics techniques to identify opportunities for energy savings and efficiency improvements and develop recommendations for implementation. |
| CO3 | Evaluate the benefits and challenges of implementing intelligent energy management systems in buildings and other applications, using quantifiable metrics and data-driven approaches |
| CO4 | Formulate simple intelligent energy management systems, using data analytics tools and techniques to optimize energy consumption and efficiency. |

CO-PO Mapping

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Syllabus

Unit 1

Introduction to Energy Management:Overview - Types of energy management systems - Key components of intelligent energy management systems – Types of controllers and algorithms used in energy management systems - Algorithms for energy management and optimization - Data analytics techniques for energy management.

Unit 2


Unit 3

Demand Response:Introduction - Techniques for implementing demand response programs - Data-driven approaches to demand response.

Unit 4

Renewable Energy Integration & Storage:Challenges and opportunities for renewable energy integration with data-driven approaches - Overview of energy storage technologies - Integration of energy storage into energy management systems - Benefits and challenges of energy storage with data-driven approaches.

Text Books / References

Evaluation Pattern

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Course Objectives

- The course aims to enable students to understand the fundamental concepts of power quality management.
- The course shall empower the students to identify the various sources of power quality problems.
- The course aims to equip students with the ability to analyse power quality data and draw conclusions about the nature of the issues.
- Finally, the course shall enable students to develop data-driven solutions for power quality problems.

Course Outcomes

After completing this course, students will be able to

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<td>Analyse the impact of various power quality problems on electrical systems and equipment.</td>
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<td>Evaluate different power quality improvement techniques, towards the design optimal solutions</td>
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<td>Interpret power quality data and formulate data-driven solutions for the quality improvement.</td>
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CO-PO Mapping

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Pengwei Du and Ning Lu, "Energy Storage for Smart Grids: Planning and Operation for Renewable and Variable Energy Resources (VERs)",2014
Syllabus

Unit 1

Introduction to Power Quality Management: Definition and importance of power quality - Power quality terminology and units of measurement - Common power quality problems and their sources - Effects of power quality problems on electrical systems and equipment - Power quality indices and their significance – Power quality standards - Overview of power quality measurements and monitoring

Text Books / References


Jos Arrillaga, Bruce C. Smith, Neville R. Watson, and Alan R. Wood, “Power System Harmonic Analysists”, 2013


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Course Objective

- To understand the principles of speech processing, human speech production and perception system.
- To estimate excitation and vocal tract features using time and frequency domain processing techniques.
- To explore the various conventional, machine learning and deep learning models for speech classification, recognition, synthesis, and detection tasks

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

| CO1 | Analyse the acoustic/articulatory characteristics of different speech regions and speech sounds |
| CO2 | Apply time and frequency domain processing techniques to speech signals |
| CO3 | Analyse and extract relevant spectral parameters and temporal parameters of speech signal |
| CO4 | Evaluate the performance of a model or algorithm (conventional/Machine learning/Deep learning) developed for a speech technology application |

**CO-PO Mapping**

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**Syllabus**

**Unit 1**

Introduction to Speech Processing. Overview of the human speech production system, acoustic and physiological mechanisms of speech production, glottal signal characteristics and source features, significance of glottal activity regions, speech signal characteristics, acoustic/articulatory characteristics of different speech sounds - vowels and consonants.

**Unit 2**

Short time processing of speech for estimation of excitation and vocal tract features - Time Domain processing - Energy, magnitude, zero crossing rate, STACF, Linear Prediction Analysis, Frequency domain processing and Spectro-temporal representation of speech signal - Narrowband, wideband spectrograms, Cepstral Analysis, Melspectrogram, MFCC feature extraction.

**Unit 3**

Speech data preparation and feature engineering, machine learning versus deep learning models in speech classification tasks (age, gender, dialect/accent), Automatic speech recognition (ASR) - statistical models - Hidden Markov Models (HMMs) for ASR, Deep learning speech recognition pipeline (end-to-end models), overview of other speech technology applications such as emotion recognition, speaker recognition, speech synthesis, and speech pathology detection.

**Text Books / References**


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Course Objectives

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

Course Outcomes

After completing this course, students will be able to

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<td>Apply modern tools for solving problems in computational linguistics</td>
<td>Implement word representation models to solve NLP problems</td>
<td>Develop machine learning/deep learning models for solving NLP applications</td>
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CO-PO Mapping

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Amrita Vishwa Vidyapeetham. BTC-AIE B.Tech Curriculum June 2021
Syllabus

Unit 1
Computational linguistics- Introduction, syntax, semantics, morphology, collocation and other NLP problems.

Unit 2
Word representation: One-hot encoding, Bag-of-Words (BoW) Dictionary: Term Frequency – Inverse Document Frequency (TF-IDF), Language Model-n-gram – Neural Network-based word embedding algorithms

Unit 3
Sequences and sequential data: Machine learning and deep learning for NLP, Sequence to sequence modelling - BERT, GPT, Graph NLP, Hidden Markov Model, Conditional Random Field, Topic modelling

Unit 4
Applications of NLP: Part-of-Speech tagging, Named Entity recognition, Dependency parsing, - Sentiment Analysis, Machine translation, Question answering, Text summarization, Evaluation metrics for NLP models and Visualization

Text Books / References

Daniel Jurafsky, James H Martin, Speech & language processing, preparation [cited 2020 June 1]


Evaluation Pattern

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Course Objectives

- To Understand Document as Vector
- Performance evolution metric for IR
- Learn to write code for text indexing and retrieval.
- Learn to evaluate information retrieval systems
- Learn about text similarity measure
- Understanding about search engine
Course Outcomes

After completing this course, students will be able to

| CO1  | Use various techniques to represent a document as a vector |
| CO2  | Implement IR systems using various techniques             |
| CO3  | Apply methods to evaluate IR systems                       |
| CO4  | Develop applications                                       |

CO-PO Mapping

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</table>

Syllabus

Unit 1

Goals and history of IR, impact of web in IR, basic concepts: query, document, corpus, text representation and evaluation, Boolean model, TF-IDF, vector-space retrieval models, Probabilistic retrieval models

Unit 2

Text similarity metrics, Tokenizing, language models, KL-divergence, performance metrics, reference collections and evaluation of IR systems, query languages for IR, relevance feedback, query expansion-local and global

Unit 3

Web search, web crawling, link analysis – hits, page rank, matrix decompositions and latent semantic indexing, Deep learning for IR- word embeddings, neural language models

Text Books / References


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**23AID474 Introduction to Chatbots**  
**L-T-P-C: 2- 0- 2- 3**

### Course Objectives
- This course helps the students to develop a functional chatbot that can respond to user queries and complete simple tasks.
- Apply NLP techniques to improve the chatbot's ability to understand and respond to user input.
- Apply appropriate evaluation metrics to assess the performance of a chatbot.
- Evaluate the performance of a chatbot and make necessary adjustments to improve its functionality.
- Critically analyze and evaluate the ethical implications of using chatbots in various contexts, and propose ethical solutions to address these issues.

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

<table>
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<tr>
<th>CO</th>
<th>Implement chatbots with different frameworks</th>
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<tr>
<td>CO1</td>
<td>Apply NLP techniques to improve chatbot capabilities</td>
</tr>
<tr>
<td>CO2</td>
<td>Develop machine learning/deep learning models for chatbots</td>
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<tr>
<td>CO3</td>
<td>Evaluate the performance of chatbots using various metrics and techniques.</td>
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#### CO-PO Mapping

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### Syllabus

#### Unit 1
Introduction to chatbots - definition and characteristics of chatbots - brief history of chatbots - types of chatbots - Use cases and applications

#### Unit 2
Natural Language Processing (NLP) for Chatbots - Understanding language processing - Syntax and Semantics - Pre-processing and Tokenization - Fundamental Methods of NLP for Building Chatbots

#### Unit 3
Machine Learning/Deep Learning for Chatbots - Machine Learning/Deep Learning Algorithms used in chatbots - Data collection and annotation - Training and evaluation of chatbots - Designing and Implementing Chatbots - Designing conversational interfaces - Implementing chatbots using frameworks like Dialogflow, Rasa, etc. - Integration with different messaging platforms

Unit 4
Ethics in Chatbot Development - Responsible AI and ethics - Bias and fairness considerations in chatbot development - Human-in-the-loop approaches for chatbot development

Text Books / References


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23AID475 Machine Translation and Sequence-to-Sequence Models L-T-P-C: 2-0-2-3

Course Objectives

- The main objective of the course is to obtain basic understanding and implementation skills for modern methods for machine translation
- This course introduces different approaches to build machine translation systems
- This course helps the students to understand various evaluation metrics used for assessing the performance of a machine translation model
- This course introduces different deep learning architectures used for implementing the machine translation system.

Course Outcomes

After completing this course, students will be able to

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<td>Implement a neural machine translation system using transformer-based encoder-decoder architecture</td>
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<td>CO4</td>
<td>Evaluate the performance of machine translation models</td>
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CO-PO Mapping
Syllabus


Text Books / References

Daniel Jurafsky, James H Martin, Speech & language processing, preparation [cited 2020 June 1]


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23AID476 Speech Recognition and Understanding L-T-P-C: 2-0-2-3

Course Objectives

- The main objective of the course is to give an introduction to recognition and understanding of the speech
- This course introduces different approaches to build a speech recognition system
- This course helps the students to understand language model and acoustic models required for building a speech recognition system
- This course introduces different deep learning architectures used for implementing the end to end automatic speech recognition system

Course Outcomes

After completing this course, students will be able to

| CO1 | Implement language and acoustic models required for a speech recognition system |
| CO2 | Develop a feature extraction model for speech recognition |
| CO3 | Implement a speech recognition model |
CO4 | Develop a deep learning based end to end speech recognition model

**CO-PO Mapping**

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**Syllabus**


**Text Books / References**


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**23AID477 Social Media Text Analysis L-T-P-C: 2-0-2-3**

**Course Objectives**

- The main objective of the course is to give an introduction to the key concepts about social media text data
- This course introduces machine/deep learning and topic modelling approaches to build a social media text classification model
- This course helps the students to monitor consumers and competitors and glean deeper consumer insights based on advanced social media data modelling
This courses helps the students to make better business decisions by leveraging social media dat

Course Outcomes

After completing this course, students will be able to

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Syllabus

Introduction to Social Media Analytics - Social media data collection - Processing unstructured and semi-structured data – Monitoring user engagement in social media - Identifying Opinions through Sentiment Analysis and Topic Modeling - Social Network Analysis and Metrics - Identifying Influencers in Social Network

Text Books / References


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