SCHEME OF INSTRUCTION AND SYLLABI (R-20)
OF
B.E. III & IV SEMESTERS
IN
ARTIFICIAL INTELLIGENCE
& MACHINE LEARNING

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

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CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Scheme of Instructions of III Semester of B.E.-Artificial Intelligence & Machine Learning as per AICTE Model Curriculum 2022-23

S. No	CourseCode	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Durationof SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
SEMESTER – III									
THEORY									
1	21AMC01	Introduction to Algorithms & Data Structures	3	0	0	3	40	60	3
2	21AMC02	Discrete Mathematical Structures	2	1	0	3	40	60	3
3	21MATxx	Group Theory and Its Applications	2	1	0	3	40	60	3
4	21EEC01/21BTxx	BEE /Cognitive Neuroscience	2	1	0	3	40	60	3
5	21xxxx	UHV 2.0	2	1	0	3	40	60	3
6	21CSC11	Digital Logic Design	2	1	0	3	40	60	3
PRACTICAL									
7	21AMC03	Algorithms Lab-1	0	0	3	3	50	50	1.5
8	21AMC04	Introduction to Inference & Interpretation	0	1	3	3	50	50	2.5
9	21INT01	Internship – I				3	50	50	2
TOTAL			**13**	**6**	**6**	**-**	**390**	**510**	**24**
SEMESTER – IV									
THEORY									
1	21AMC05	Modern Computer System Architecture	3	0	0	3	40	60	3
2	21AMC06	Database Systems	2	1	0	3	40	60	3
3	21MTxx	Linear Regression Modeling for Data Analysis	2	1	0	3	40	60	3
4	21MBAxx	Strategic Entrepreneurship	2	1	0	3	40	60	3
5	21ECCxx	Signal Processing	2	1	0	3	40	60	3
6	21MEC39	Robotics and Automation	2	1	0	3	40	60	3
PRACTICAL									
7	21MEC40	Robotics and Automation Lab	0	0	3	3	50	50	1.5
8	21AMC07	Database Systems Lab	0	0	3	3	50	50	1.5
9	21AMC08	Building Large, Reliable Software Systems / SE Lab	0	2	2	3	50	50	3
TOTAL			**13**	**7**	**8**	**-**	**390**	**510**	**24**

L: Lecture T: Tutorial P: Practical

CIE - Continuous Internal Evaluation SEE - Semester End Examination

21AM01

INTRODUCTION TO ALGORITHMS AND DATA STRUCTURES

Instruction	3L-0T-0P
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives

1. Students should be able to describe and implement various data structures including lists, arrays, stacks, queues, binary search trees, graphs, hash tables, and matrices,
2. Student should analyze and apply various algorithms for shortest path calculation, sorting and searching applications.

Course Outcomes:

1. Understand the different types of data structure.
2. Choose the data structures that effectively model the information in a problem and analyses the efficiency trade-offs (run time and memory usage) among alternative data structure implementations or combinations.
3. Design, implement, test, and debug programs using a variety of data structures including stacks, queues, hash tables, binary and general tree structures, search trees, and graphs.
4. Distinguish between linear and non-linear data structures.
5. Apply efficient data structure (linked lists, stacks and queues) to solve a particular problem.
6. Evaluate various searching and sorting algorithms.

UNIT I:

Introduction and Elementary Data Structures - Introduction to Data Structures and Data types, efficient use of memory, Recursion, Time and Space complexity of algorithms, Big O Notation and Theta notations. **Elementary Data Structures**: Sacks, queues, infix, postfix, & prefix conversions, evaluation of expressions, multiple stacks and queues, priority queues as heaps, double ended queue, implementation of stacks and queues.

UNIT II:

Linked Lists - Singly Linked Lists, linked stacks and queues, polynomial addition, sparse matrices, doubly linked lists and dynamic storage management, circular linked list, applications of Stacks, Queues and Linked Lists, Garbage collection, Josephus Problem.

UNIT III:

Trees -Basic terminology, binary trees, binary tree traversal, representations of binary tree, application of trees, Decision Tree, Game Tree, threaded trees, Binary Search Tree, AVL tree, B-tree

UNIT IV:

Graph Theory - Graph Representations, Graph Traversals, Dijkstra's algorithm for shortest path, Prim's and Kruskal's Algorithm for Minimal Spanning Tree

UNIT V:

Sorting and Searching - Searching: Linear search, Binary Search and Hash Search. **Sorting:** Insertion sort, Selection Sort, Bubble Sort, Quick Sort, Heap Sort, and Bucket Sort

Text Books / Suggested References:

1. Data Structures, R.S. Salaria, Khanna Book Publishing, 2019.

2. Data Structures and Program Design in C By Robert L. Kruse,C.L. Tondo, Bruce Leung, Pearson Education, 2007.
3. Expert Data Structures with C/ 3rd Edition, R.B. Patel, Khanna Book Publishing, 2020.
4. Expert Data Structures with C++/ 2nd Edition, R.B. Patel, Khanna Book Publishing, 2020.
5. Data Structures Using C & C++, By Langsam, Augenstein, Tanenbaum, Pearson Education, 1989.
6. Fundamentals of Data Structures, By Ellis Horowitz and Sartaj Sahni, Computer Science Press, 2011.
7. An introduction to data structures with applications, By J.P. Trembley & P.G. Sorensen, TMH, 2004.

DISCRETE MATHEMATICAL STRUCTURES

Instruction	2L-1T-0P
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The main objectives of this course are to:

1. Students should be able to understand Discrete Mathematical Structures for the development of theoretical Computer Science, problem solving language using Discrete Structures
2. Understand the discrete structures towards simulation of a problem in Computer Science and Engineering.

Course Outcomes: At the end of the course, students will be able to:

1. Understand the basics of various discrete structures.
2. Write short proofs, and disprove algebraic statements by finding counter examples.
3. Apply discrete structures in the applications of Computer Science and Engineering.
4. Represent data using trees and graphs.
5. Gain skills to apply basic properties of rings and fields.
6. State the characteristics of an integral domain, and the field of quotients.

UNIT I: Mathematical Reasoning: Mathematical reasoning, propositions, negation, disjunction and conjunction, implication and equivalence, truth tables, predicates, quantifiers, natural deduction, rules of Inference, Methods of proofs, resolution principle, applications to PROLOG.

UNIT II: Set Theory: Paradoxes in set theory, inductive definition of sets and proof by induction, Peano postulates, Relations, properties of relations, equivalence relations and partitions, partial ordering, posets, linear and well-ordered sets

UNIT III: Combinatorics and Functions: Elementary Combinatorics, counting techniques, recurrence relations, generating functions. Functions: mappings, injection and surjections, composition of functions, inverse functions, special functions, Pigeonhole principle, and recursive function theory.

UNIT IV: Graph Theory: Elements of graph theory, Euler graph, Hamiltonian path, trees, spanning trees, representation of relations by graphs.

UNIT V: Rings and Fields: Rings, Ideals, and Homomorphisms; Quotient rings; Integral domains; Finite fields; Polynomial rings, elliptic curves, Factoring polynomials; Eisenstein's irreducibility criterion.

Textbooks:

1. K. H. Rosen, Discrete Mathematics and applications, 6th Edition, Tata McGraw Hill 2007.
2. S.B. Singh, Discrete Structures/ 3rd Edition, Khanna Book Publishing, 2019.
3. S.B. Singh, Combinatorics and Graph Theory/ 3rd Edition, Khanna Book Publishing, 2018.
4. C. L. Liu, Elements of Discrete Mathematics, 2nd Edn., Tata McGraw-Hill 2000.
5. J .L. Mott, A. Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists and Mathematicians, Second edition, Prentice Hall of India 1986.
6. W. K. Grassmann and J. P. Trembnlay, Logic and Discrete Mathematics, A Computer Science Perspective, Prentice Hall Inc 1996
7. Charles C. Pinter: *A Book of Abstract Algebra*, 2nd edition.

GROUP THEORY AND ITS APPLICATIONS

Instruction	2-1T-0P
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic Algebra, transformations, computer vision/image analysis, robotics

Course Objectives: The main objectives of this course are to:

1. Introduce the importance of group theory and explore the real-world applications involving group theory.
2. Emphasize on motivations and justifications for the algorithmic usage of group theory in different domains, computational issues, and hands-on experimentation and illustration
3. Make the students to understand the representation and computation of 3D spaces using Euclidian geometry for regularity/non-regular patterns and symmetry detection

Course Outcomes: at the end of this course, student shall be able to

1. Understand the need of Group Theory and basic concepts related to Group Theory
2. Recognize the real-world applications that use group theory
3. Apply group theory for identifying symmetric and non-symmetric y patterns in real-time images and structures
4. Evaluate various symmetry detection algorithms
5. Formulate solutions using group theory for real problems involving different patterns in the domains of Robotics, Computer Vision and Computer Graphics

Unit-I

Introduction to Group theory: Regularity and symmetry; **Basic concepts**: definition of a group, subgroup, different types of groups/subgroups, discrete, continuous, finite, infinitely countable, subgroup hierarchies, transform groups, matrix representations with concrete examples from robotics, computer vision (periodic pattern perception), paper cut-art form, biomedical structures/images (the bio-lateral symmetry of human anatomy.

Unit-II

Representation and Computation of Groups: Example: Finding relative positions of solids in surface contact using symmetry group representation and computation for assembly planning in robotics; Representation and computation of the proper Euclidian Group and all its subgroups, geometric invariants, Hilbert's 18^{th} problem and computational model for periodic pattern perception.

UNIT-III

Symmetry Detection Algorithms: Review of symmetry detection algorithms, Computational challenges in symmetry group applications (from human and animal gaits, to the formalization of papercut-art forms), a symmetry-based grammar of forms in architecture design.

UNIT-IV

Non-symmetric structures and Statistical Computation: Global distortions and symmetry groups, local distortions and near-regular texture analysis/synthesis/manipulation/tracking, skewed symmetry groups: wallpaper groups and frieze groups; Non-regular structures: basic symmetry group concepts meet statistical computation.

UNIT-V

Group Theory Applications: Group theory in Material Science, continuous and discrete cases: Lie group, Group theory applications in medical image analysis, group theory and statistics, pattern theory.

Text Books:

1. D. S. Dummit and R. M. Foote, Abstract Algebra, Third edition, John Wiley & Sons, 2004.
2. Symmetry Groups in Robotics Assembly Planning and Specifications", Yanxi Liu, the Mathematical Methods in Technology series
3. C C Pinter, “A Text Book of Abstract Algebra”, 2nd Edition, Dover Books in /mathematics, 2010

References:

1. https://www.cs.cmu.edu/~yanxi/newtest.htm
2. https://mdpi-res.com/d_attachment/symmetry/symmetry-10-00263/article_deploy/symmetry-10-00263.pdf?version=1530710440
3. http://vision.cse.psu.edu/research/symComp13/index.shtml
4. http://vision.cse.psu.edu/research/performanceEvaluation/NEWeval-1.pdf
5. https://www.researchgate.net/profile/Yanxi-Liu-4/publication/248804899_A_Quantitative_Evaluation_of_Symmetry_Detection_Algorithms/links/54d54b650cf2464758075693/A-Quantitative-Evaluation-of-Symmetry-Detection-Algorithms.pdf?origin=publication_detail
6. https://paperswithcode.com/task/symmetry-detection
7. https://springerplus.springeropen.com/track/pdf/10.1186/s40064-015-1156-7.pdf

BASICS OF ELECTRICAL ENGINEERING

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Course Objectives: The objectives of this course are

1. To understand the behavior of different circuit elements R, L & C, and the basic concepts of electrical AC circuit analysis
2. To understand the basic principle of operation of AC and DC machines
3. To know about different types of electrical wires and cables, domestic and industrial wiring. safety rules and methods of earthing

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

1. Understand the concepts of Kirchhoff's laws and to apply them in superposition, Thevenin's and Norton's theorems to get the solution of simple dc circuits
2. Obtain the steady state response of RLC circuits with AC input and to acquire the basics, relationship between voltage and current in three phase circuits.
3. Understand the principle of operation, the emf and torque equations and classification of AC and DC machines
4. Explain various tests and speed control methods to determine the characteristic of DC and AC machines.
5. Acquire the knowledge of electrical wiring, types of wires, cables used and Electrical safety precautions to be followed in electrical installations.
6. Recognize importance of earthing, methods of earthing and various low-tension switchgear used in electrical installations

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

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

UNIT-I

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation, Superposition, Thevenin and Norton Theorems, Time-domain analysis of first-order RL and RC circuits.

UNIT-II

AC Circuits: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits consisting of R, L, C, RL, RC. Three phase balanced circuits, voltage and current relations in star and delta connections.

UNIT-III

Transformers: Construction, Working principle, EMF Equation, Ideal and Practical transformer, Equivalent circuit of Transformer, OC and SC tests on a transformer, Efficiency and Regulation

UNIT-IV

DC and AC Machines: DC Generators: Construction, Principle of operation, EMF equation, Classification, Characteristics of shunt, series and compound generators.

DC Motors: Classification, Torque equation, Characteristics, Efficiency, Speed Control of Series and Shunt Motors. **Three - Phase Induction Motors:** Principle of operation, Applications.

UNIT-V

Electrical Installations: Electrical Wiring: Types of wires and cables, Electrical Safety precautions in handling electrical appliances, electric shock, first aid for electric shock, safety rules.

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, Earthing (Elementary Treatment only), Elementary calculations for energy consumption

Text Books:

1. L. S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011.
2. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.

Suggested Reading:

1. D. P. Kothari & I. J. Nagrath, "Basic Electrical Engineering", Tata Mc Graw Hill, 2010.
2. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989.
3. D.C. Kulshreshtha, "Basic Electrical Engineering", McGrawHill,2009
4. P.V. Prasad, S. sivanagaraju, R. Prasad, "Basic Electrical and Electronics Engineering" Cengage Learning, 1st Edition, 2013.

21BTCCxx

COGNITIVE NEUROSCIENCE

Instruction	2L-1T-0P
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The main objectives of this course are to:

1. Understanding the brain effects that give rise to our abilities to perceive, act and think
2. Gain skills on the way that cognition is associated with neural activity
3. Compare and contrast the organization and function of numerous systems within the brain

Course Outcomes: At the end of the course, students will be able to:

1. Gain familiarity and basic knowledge about brain systems and functions.
2. Understand brain's neurotransmitters system.
3. Understanding the brain's methods gives rise to behavior whether we engage in any activity (e.g., walking, talking, etc.)
4. Identify the patterns of varied activities in neurons that correspond to a person's attempts to move in particular ways.

UNIT I:

Introduction to neuroscience: Outline of neuroanatomical; Neurogenesis, migration Axon path-finding; cell death; Role of neural activity in development; Membranes and membrane potentials.

UNIT II:

Action potential: Conductance mechanisms; Chemical and electrical transmission; Postsynaptic potentials; neural integration; Energy consumption in the brain; Attention; Methods jigsaw; Executive Control; Evolution/development; Sheep's brain dissection.

UNIT III:

Neurotransmitter systems: Visual information processing; Visual cortex; Visual plasticity; critical periods; Somatosensory system; Pain; Chemoreception; Auditory system; Spinal mechanisms; Brain mechanisms.

UNIT IV:

Human and Animal Memory: Pattern completion and separation; LTP and synapses; Spatial cognition; Social cognition; Cellular mechanisms of neural plasticity.

UNIT V:

Feedback System and Brain Disorders: Endocrine systems; feeding behavior, Stress, Addiction, Depression, Schizophrenia, Alzheimer's, Huntington's disease.

Textbooks:

1. Principles of Cognitive Neuroscience, 2nd Edition (2013) *Dale Purves, Roberto Cabeza, Scott A. Huettel, Kevin S. LaBar, Michael L. Platt, and Marty G. Woldorff*. Sinauer Associates, Inc.
2. Mark Bear, Brian Connors, and Michael Paradiso (2007) Neuroscience: Exploring the Brain. 3rd ed. Baltimore: Lippincott, Williams & Wilkins.

21EGMO3

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY

(**B.E/B.Tech II/III Year** -Common to all Branches)

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

Introduction

This course discusses the role of human values in one's family, in society and in nature. In the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

Course Objectives

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in human being, family, society and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Course Outcomes

By the end of the course,

1. Students are expected to become more aware of themselves, and their surroundings (family, society, nature)
2. They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. They would have better critical ability.
4. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

The course has 28 lectures and 14 practice sessions:

Unit 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

- Purpose and motivation for the course, recapitulation from Universal Human Values-I

- Self-Exploration–what is it? - Its content and process; ‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration
- Continuous Happiness and Prosperity- A look at basic Human Aspirations
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Unit 2: Understanding Harmony in the Human Being - Harmony in Myself

- Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’
- Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility
- Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of ‘I’ and harmony in ‘I’
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one’s own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Unit 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

 Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship

 Understanding the meaning of Trust; Difference between intention and competence

 Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship

 Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals

 Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc.

Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

Unit 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

- Understanding the harmony in the Nature
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature
- Understanding Existence as Co-existence of mutually interacting units in all - pervasive space
- Holistic perception of harmony at all levels of existence.

Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Unit 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

- Natural acceptance of human values
- Definitiveness of Ethical Human Conduct
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems
- Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

Mode of Conduct (L-T-P-C 2-1-0-3)

- Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions.
- While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self- exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.
- Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practicals are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

Assessment:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.
Example:

Assessment by faculty mentor: 10 marks

Self-assessment/Assessment by peers: 10 M

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 60 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

Text Books

The Text Book

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

The teacher's manual

2. R R Gaur, R Asthana, G P Bagaria, "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. A Nagaraj Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. A. N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
3. Cecile Andrews, Slow is Beautiful
4. Gandhi - Romain Rolland (English)
5. Dharampal, "Rediscovering India"
6. E. FSchumacher. "Small is Beautiful"

7. J. C. Kumarappa “Economy of Permanence”
8. Pandit Sunderlal “Bharat Mein Angreji Raj”
9. Mohandas Karamchand Gandhi “The Story of My Experiments with Truth”
10. Mohandas K. Gandhi, “Hind Swaraj or Indian Home Rule”
11. Maulana Abdul Kalam Azad, India Wins Freedom -
12. Vivekananda - Romain Rolland (English)
13. The Story of Stuff (Book)

21CSCXX

DIGITAL LOGIC DESIGN

Instruction	3 Hours per week
Duration of End Examination	3 Hours
Semester End Examination	60 Marks
Continuous Internal Evaluation	40 Marks
Credits	3

Course Objectives: The objectives of this course are

1. To understand the basic building blocks of digital hardware and various minimization techniques.
2. To analyse and design the Combinational and Sequential circuits.
3. To design the circuits using verilog HDL.

Course Outcomes: On Successful completion of this course, student will be able to

1. Demonstrate the number system conversions and simplify Boolean functions.
2. Recall basic theorems and properties of Boolean algebra to represent logical functions in canonical and standard forms.
3. Analyze and simplify Boolean expressions using karnaugh-maps and tabulation method.
4. Analyze and Design various combinational circuits and Sequential circuits used in Computer Hardware.
5. Understand the designs of Combinational and Sequential circuits using Verilog HDL.
6. Develop different applications by configuring registers, counters and memories.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

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

UNIT - I

Digital Systems and Binary Numbers: Digital systems, Binary numbers, Number base conversions, Octal and Hexadecimal numbers, Complements of Numbers, Binary codes. **Boolean Algebra and logic Gates:** Binary logic, Basic Definitions, Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms, Other Logic Operations, Digital Logic Gates, Integrated Circuits.

UNIT - II

Minimization of Switching Functions: Introduction, the map method, minimal functions and their properties, the tabulation procedure, the prime implicant chart. **NAND and NOR Gates**: NAND Circuits, Two-level Implementation, Multilevel NAND Circuits, NOR Circuits. **Exclusive OR Gates**: Odd Function, Parity Generation and Checking.

UNIT - III

Combinational Logic Design: Combinational Circuits. **Analysis Procedure:** Derivation of Boolean Functions, Derivation of the Truth Table, Logic Simulation. **Design Procedure:** Decoders, Encoders, Multiplexers - Designing Combinational Circuits using Multiplexers, Binary Adders, Adder-Subtractor, Binary Multiplier, HDL Representations – Verilog.

UNIT - IV

Sequential Circuits: Sequential circuit definitions, Latches, Flip Flops, Sequential circuit analysis, Sequential circuit design, Design with D Flip Flops, Designing with JK Flip-Flops, HDL representation for sequential circuits - Verilog.

UNIT - V

Registers: Registers, Shift registers. **Counters**: Ripple Counters, Synchronous Binary counters, Other Counters. **Memory and Programmable Logic**: Introduction, Random-Access Memory, Memory Decoding, Error Detection and Correction, Read-Only Memory, Programmable Logic Array (PLA), Programmable Array Logic (PAL).

Text Books:

1. Morris Mano M. and Michael D. Ciletti, "Digital Design, With an Introduction to Verilog HDL", Pearson 5th edition, 2013.
2. ZVI Kohavi, "Switching and Finite Automata Theory", Tata McGraw Hill 2nd Edition, 1995.

Suggested Reading:

1. Ronald J Tocci, Neal Widmer, Greg Moss, "Digital Systems: Principles and Applications", Pearson 11th Edition, 2011.
2. Stephen Brown, ZvonkoVranesic, "Fundamentals of Digital Logic with VHDL design, McGraw Hill 2nd Edition, 2009.

21AM02

ALGORITHMS LAB-1

Instruction	0L-0T-3P
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objectives

1. Implement various data structures including lists, arrays, stacks, queues, binary search trees, graphs, hash tables, and matrices,
2. Analyze and apply various algorithms for shortest path calculation, sorting and searching applications.

Course Outcomes

1. Derive abstract data types for linear and non-linear data structures.
2. Implement different types of data structures using any programming language.
3. Choose and Implement the data structures that effectively model the information in a problem and analyses the efficiency trade-offs (run time and memory usage) among alternative data structure implementations or combinations.
4. Test and debug programs using a variety of data structures including stacks, queues, hash tables, binary and general tree structures, search trees, and graphs.
5. Apply efficient data structure (linked lists, stacks and queues) to solve a particular problem.
6. Evaluate various searching and sorting algorithms.

Laboratory/ Practical Experiments:

1. Implement infix to postfix conversion using Stack
2. Implement Queue using arrays
3. Write a program for swapping nodes in a linked list without swapping data.
4. Write a program to reverse a Linked List in groups of given size.
5. Write a program for finding the first circular tour that visits all petrol pumps.
6. Implement In order tree traversal without recursion.
7. Write a program to Check whether a given graph is Bipartite or not.
8. Implement Quick Sort and Heap Sort

Text Books / Suggested References:

1. Data Structures, R.S. Salaria, Khanna Book Publishing, 2019.
2. Data Structures and Program Design in C By Robert L. Kruse,C.L. Tondo, Bruce Leung, Pearson Education, 2007.
3. Expert Data Structures with C/ 3rd Edition, R.B. Patel, Khanna Book Publishing, 2020.
4. Expert Data Structures with C++/ 2nd Edition, R.B. Patel, Khanna Book Publishing, 2020.
5. Data Structures Using C & C++, By Langsam, Augenstein, Tanenbaum, Pearson Education, 1989.
6. Fundamentals of Data Structures, By Ellis Horowitz and Sartaj Sahni, Computer Science Press, 2011.
7. An introduction to data structures with applications, By J.P. Trembley & P.G. Sorensen, TMH, 2004.

21AMCxx

INTRODUCTION TO INFERENCE AND INTERPRETATION

Instruction	0L-1T-3P
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	2.5

Course Objectives: The main objectives of this course are to:

1. Achieve competency in identifying causal effects using varied modeling approaches, starting with the essential experimental designs to complex observational models
2. Implement a variety of computational statistical tools and strategies for causal inference
3. Develop programming skills to relate different ways of explaining the data, and data collection strategies

Course Outcomes: At the end of the course, students will be able to:

1. Develop awareness of causal thinking and understand selection bias.
2. Understand counterfactual vital ideas and assumptions of causal inference methods.
3. Apply causal inference methods to assess whether these assumptions are reasonable, and finally, the ways to interpret the quantity being estimated.
4. Use R to work on data science related projects.
5. Develop scripts for data visualization, analytics and dashboards.

UNIT I:

Introduction to R and Causality– Introduction to R, operators, objects, vectors, functions, data files, saving objects, packages

UNIT II:

Causality - Racial discrimination in the labour market, sub-setting data in R, causal effects and the Counterfactual, randomized controlled trials, observational studies, descriptive statistics for a single variable.

UNIT III:

Measurement & Visualization – Handling missing data, visualizing univariate distribution, survey sampling, summary of bivariate relationships, clustering.

UNIT IV:

Prediction and Discovery – Linear regression, Regression and Causation, textual data, network data, spatial data, animation using R.

UNIT V:

Probability - Conditional Probability, Random Variable and Probability Distributions, Large Sample Theorems, Estimation, Hypothesis Testing, Linear Regression Model with Uncertainty.

Textbooks:

1. Kousuke Imai, Quantitative Social Science: An Introduction, Princeton University Press, 2017.
2. Jonas Peters, Domnik Janzig and Bernhard Scholkopf, " Elements of Causal Inference – Foundations of Machine Learning", 2017, MIT, Open Access (https://mitp-content-server.mit.edu/books/content/sectbyfn?collid=books_pres_0&id=11283&fn=11283.pdf)

21INT

INTERNSHIP-1

Instruction	3 Hours per week
Duration of End Examination	-
Semester End Examination	-
Continuous Internal Evaluation	-
Credits	2

Course Objectives: The objectives of this course are

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

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Scheme of Instructions of IV Semester of
B.E.-Artificial Intelligence & Machine Learning
as per AICTE Model Curriculum 2022-23

SEMESTER – IV

S. No	CourseCode	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Durationof SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	21AMC06	Modern Computer System Architecture	3	0	0	3	40	60	3
2	21AM07	Database Systems	2	1	0	3	40	60	3
3	21MTC/Amxx	Linear Regression Modeling for Data Analysis	2	1	0	3	40	60	3
4	21MBAxx	Strategic Entrepreneurship	2	1	0	3	40	60	3
5	21EECxx	Signal Processing	2	1	0	3	40	60	3
6	21MECxx	Robotics and Automation	2	1	0	3	40	60	3
PRACTICAL									
7	21MECxx	Robotics and Automation Lab	0	0	3	3	50	50	1.5
8	21AMxx/CS	Database Systems Lab	0	0	3	3	50	50	1.5
9	21CSCxx	Building Large, Reliable Software Systems / SE Lab	0	2	2	3	50	50	3
TOTAL			**13**	**7**	**8**	**-**	**410**	**440**	**24**

L: Lecture **T: Tutorial** **P: Practical**
CIE - Continuous Internal Evaluation **SEE - Semester End Examination**

21AMCxx

MODERN COMPUTER ARCHITECTURE

(BE AI/ML)

Instruction	3L-0T-0P
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of this course are:

1. Students should be able understand basic principles of Computer Systems.
2. Students should be able to understand various logic design techniques and their applications.
3. Students should be capable of using high performance computing architecture.

Course Outcomes: After completion of course, students would be able to:

1. Understand the organization of the Control, arithmetic, logic, and memory unit and the I/O.
2. Interpret various memory technologies and hierarchy
3. Understand distributed computing architecture and high-performance computing.
4. Analyze different computer architectures and their applications.
5. Identify various distributed computing technologies and coordination algorithms.
6. Develop applications using CUDA programming.

UNIT I:

Basics: Designing combinational and sequential logic, computers registers and instructions, timing, and control, instructions cycle, memory reference instruction, I/O interruption, Adder and Subtractor circuits, Booth Multiplication algorithm, pipelining review, control hazards and the motivation for caches, cache characteristics and basic superscalar architecture basics.

UNIT II:

Multi-core Architectures: Memory Technologies, memory hierarchy, locality principle and caching, advanced optimizations, performance improvement techniques; *DRAM*– organization, access techniques, scheduling algorithms and signal systems. Tiled Chip Multi-core Processors (TCMP), Network on Chips(NoC); NoC router – architecture, design, routing algorithms and flow control techniques, compression, prefetching, QoS.

UNIT III:

Distributed Computing Systems and Concurrency: Relation to Parallel Multiprocessors/ multicomputer Systems, Distributed and Concurrent Program, Message Passing vs. Shared Memory Systems, Synchronous vs. Asynchronous executions, design issues and challenges, Distributed Computing Technologies, Clocks and Synchronization, Coordination and Agreement Algorithms, Global State and Distributed Transactions.

UNIT IV:

High Performance Computing (HPC): HPC Architecture, Parallel Processing, Parallel Memory Models, Data vs. Task Parallelism, High Throughput Computing, Vectorization, Multithreading.

UNIT V:

High Performance Computing with CUDA - CUDA programming model, basic principles of CUDA programming, concepts of threads and blocks, GPU and CPU data exchange.

Text Books and References:

1. M. Morris Mano, Computer System & Architecture, Prentice Hall of India, 2002.
2. John L. Hennessy and David A Patterson, Computer Architecture-A quantitative approach, Morgan Kaufmann/ Elsevier, 4th Edition, 2007.
3. Hayes. J.P, Computer architecture and organization by McGraw-Hill Companies, 1998
4. David Culler and J.P. Singh with Anoop Gupta, "Parallel Computer Architecture: A Hardware/Software Approach", Morgan Kaufmann, 1998.
5. https://onlinecourses.nptel.ac.in/noc20_cs41/preview
6. https://www.coursera.org/learn/introduction-high-performance-computing#syllabus

NPTEL/SWAYAM Course:

1. Computer Architecture, Prof. Smruti Ranjan Sarangi, IIT Delhi.
2. Advanced Computer Architecture, Prof. John Jose, IIT Gowhati.

21AMCxx

DATABASE SYSTEMS

(BE AI/ML)

Instruction	2L-1T-0P
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Course Objectives: The objectives of this course are:

1. Students should be able to understand various basics of DBMS and query languages
2. Student should learn different types of database systems and their applications in different scenarios

Course Outcomes: After completion of course, students would be able to:

1. Understand the basics of databases and data management
2. Understand various theoretical and practical principles involved in the design and use of database systems with the help of a database
3. Design and implement databases for various scenarios
4. Design a database scenario for handling big data

UNIT I: Introduction - Characteristics and fundamental characteristics of Databases, Types of Data Models and Data Modeling, Elements of Database Systems, Classification and comparison of Database Management Systems (Regular and NoSQL Page), concurrency control, Lock-based concurrency control, Time-stamping methods.

UNIT II: Structured and Semi-structured Data Management - Structured data, relational databases, Relational model, Functional Dependencies, Normal Forms, algorithms for query optimization, semi-structured data, document-databases, semi-structured data abstraction, representation and search.

UNIT III: Transaction Management - Transaction concept, transaction state, ACID properties, serializability, recover-ability, implementation of isolation, Testing for Serializability.

UNIT IV: Unstructured Data Management - Unstructured text, Information Retrieval Systems, Document and Ranking.

UNIT V: Big Data Management - Platforms for Big Data, algorithms for Map-Reduce & Hadoop, Platforms for Big Graphs, algorithms for large Graphs.

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Tata MH, 2006
2. Elmsari and Navathe, , “Fundamentals of Database Systems”, Pearson Education 2013
3. Ramakrishnan and Gehrke, “Database Management Systems”, McGrawHill 2003
4. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Pearson Ed., 2006
5. R.P. Mahapatra, “Database Management Systems”, Khanna Book Publishing 2016.
6. J. D. Ullman, “Principles of Database Systems”, 2nd Ed., Galgotia Publications.
7. Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia, “Learning Spark: Lightning-Fast Big Data Analysis” O'Reilly Media; 1st edition.
8. Serge Abiteboul, Peter Buneman, Dan Suciu, “Data on the Web: From Relations to Semi structured Data and XML”, 1st Edition.
9. Christopher Manning, Prabhakar Raghavan, Hinrich Schütze, “Introduction to Information Retrieval”, book and slides available online.

NPTEL/SWAYAM Course:

1. Data Base Management System, Prof. Partha Pratim Das, Prof. Samiran Chattopadhyay, IIT Kharagpur.
2. Introductioon to Database Systems, Prof. Srinivas Kumar, IIT Madras.

LINEAR REGRESSION MODELING FOR DATA ANALYSIS
(BE AI/ML)

Instruction	2L-1T-0P
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Basic Algebra, transformations, computer vision/image analysis, robotics

Course Objectives: The main objectives of this course are to:

1. Develop a rigorous understanding of the statistical thinking behind the fundamental techniques of statistical analysis used by data scientists
2. Apply statistical techniques to data, understand why they work and how to use the analysis results to make informed decisions
3. Learn to write and run data-science centric Python scripts to apply the statistical concepts

Course Outcomes: at the end of this course, student shall be able to

1. Obtain, clean, process, and transform data using data management techniques
2. Analyze and interpret data to derive insights
3. Apply computing algorithms, mathematical and statistical models, and optimization methods to solve underlying problems

Unit-I

Introduction to Simple Linear Regression Model: Introduction, Simple linear regression model; least squares; residuals; Normal error regression model; maximum likelihood; Convex optimization: least-squares, least-absolute deviation, least-maximal deviation; Inference in simple normal regression model; Proof of Gauss-Markov theorem; Prediction of new observations; ANOVA; F-test; General linear test; coefficient of determination.

UNIT-II

Normal correlation model; Rank correlation; model diagnostics; Goodness of fit; Remedial measures: weighted least-squares and transformations; Nonparametric estimations; regression through the origin.

UNIT-III

Linear algebra: matrix version of simple linear regression; Linear algebra review: geometry of quadratic forms, multivariate Gaussians; PCA, change of basis, Cochran's theorem, and chi-square degrees of freedom.

UNIT-III: Multiple linear regression, regression with nonlinear terms; Geometry of normal equations, joint inferences; More generalized linear tests, standardized variables, and introduction to multicollinearity; Handling quantitative vs. qualitative predictors.

UNIT-V

Model Selection: prediction error, cross-validation, BIC; Outlier detection and handling; Regularization: ridge regression, robust regression; Intro to logistic regression; More on logistic regression; classification; support vector machines.

Text Books:

1. Applied Linear Regression Models. Kutner, Nachtsheim, and Neter. McGraw-Hill, 2004

STRATEGIC ENTREPRENEURSHIP
(BE AI/ML)

Prerequisites: Nil

Course Objectives:

1. To understand the importance of generating new ideas through Entrepreneurship and identify the skills for making informed Business Decisions.
2. To provide insights on various branding, promotion, commercialization and financial planning.
3. To help the students develop their abilities for applying various Strategic Management Concepts in solving real time problems in Business.

Course Outcomes: at the end of this course, students will be able to:

1. Use innovative skills to generate ideas for new products and services.
2. Evaluate the feasibility of ideas, and develop a strategy from commercialization.
3. Use technology to select target markets, profile target customers, define venture's mission, and create business plans.
4. Take initial steps to establish a business
5. Calculate and forecast costs, breakeven, and sales
6. Establish brand, setting prices, promoting products, and managing customer relationships.

UNIT-I:

Becoming your own Boss: Identifying possible rewards and risks of business ownership, risks vs. rewards, risk factors, reasons for business success or failure; challenges with the growth of new business success, life cycle of an entrepreneurial business and challenges at different parts of the life cycle, necessary characteristics of an entrepreneur.

UNIT - II:

Identifying the Possibilities: Skills needed to make decisions based on the limited information, essential questions, generate and develop ideas into new products and services for commercialization, steps and factors to turn an idea into revenue.

UNIT-III:

Market Analysis: determining the influencing factors on purchases, effects of branding, promotion types, benefits, promotion channels, importance of small and large marketing segments

UNIT-IV:

Business Finance: Create, analyze and interpret financial documents, purpose of budget, income statement, balance sheet, understanding and interpretation of information to make business decisions, tools, strategies, and systems to plan and monitor financial resources.

UNIT-V:

Planning your Business: basic necessary requirements to own and operate a business, differences between sole partnership, partnership and corporation; a public and private business; profit and nonprofit corporation. Concept of insurance, advertisement strategies, Business and law, Corporate Social Responsibility (CSR), actualization of business and Performance assessment.

Text Books/ Suggested Readings:

1. Greene, C. (2004), "Entrepreneurship Ideas in Action", Thomson: South-Western
2. Kennedy B. Reed, "Strategic Management", Virginia Tech, 2020.
3. Michaele A. Hitt, R D Ireland, Michael Camp, Dianal Sexton, "Strategic Entrepreneurship – Creating a New Mindset", John Wiley & Sons., 2017
4. Philip A . Wickham, "Strategic Entrepreneurship", 4t hEdition, Pearson, 2006.
5. https://vtechworks.lib.vt.edu/bitstream/handle/10919/99282/Strategic-Management.pdf?sequence=22&isAllowed=y

6. http://www.chillicothecityschs.oh.schools.bz/userfiles/319/My%20Files/Course%20syllabi%202017-2018/PRCTC/Black/2017-2018%20Strategic%20Entrepreneurship%20Syllabus.pdf?id=4228

21ECxx

SIGNAL PROCESSING

(BE AI/ML)

Instruction	2L-1T-0P
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisites: Understanding of system dynamics and elementary linear systems theory.

Course Objectives: The main objectives of this course are to:

1.
2.

Course Outcomes: At the end of the course, students will be able to:

1.
2.

UNIT I:

Review of Linear Continuous – Time Signal Processing: Fourier methods, Laplace transform, convolution, frequency/time domain processing, passive and active continuous filters, linear filter implementation using op-amps. Data converters (A/D, D/A), machine architecture, sampled data systems, software considerations.

UNIT II:

Sampling and Reconstruction: Sampling theorem, aliasing, quantization, sample data systems, cardinal (Whitaker) reconstruction, zero-, first-, second-order hold re-constructors, interpolators, non-resetting re-constructors, machine filtering, interpolation and decimation

UNIT III:

Discrete-Time Signal Processing: Z transform, difference equations, relationship between F(z) and F*(jw), mapping between s-domain and z-domain, inverse z transform, discrete-time stability.

UNIT IV:

Discrete Spectral Analysis: DFT and relation to the continuous FT, FFT and implementations (decimation in time and frequency), radix-2 implementation, leakage, windowing. Uses of DFT: convolution – (overlap and add, select savings), correlation, random processes, power spectral density (PSD) estimation- methods of smoothing the periodogram (Welch's method, windowing the correlation function, etc.), ARIMA methods.

UNIT V:

Real-Time Simulation Methods using Difference Equations: Impulse, step-, ramp-invariant simulations. Tustin's method, matched poles/zeros bilinear transform methods. Error Analysis.

Filter Design –Continuous and Discrete: Butterworth, elliptic, Chebyshev low-pass filters, low-pass design methods, conversion to high-pass, band-pass, base-band filters. Discrete-Time filters: IIR, FIR. Linear phase filters, Frequency sampling filters. Least Square filter design, adaptive filtering.

Check for simplification/removal of some topics

Textbooks:

1. Proakis, John G., and Dmitris K. Manolakis. *Digital Signal Processing*. 4th ed. Upper Saddle River, NJ: Prentice Hall, 2006. ISBN: 9780131873742.
2. Oppenheim, Alan V., Ronald W. Schafer, and John R. Buck. *Discrete-Time Signal Processing*. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 1999. ISBN: 9780137549207.

References:

1. Cartinhour, Jack. *Digital Signal Processing: An Overview of Basic Principles*. Upper Saddle River, NJ: Prentice Hall, 1999. ISBN: 9780137692668.

2. Stearns, Samuel D., and Don R. Hush. *Digital Signal Analysis*. 2nd ed. Englewood Cliffs, NJ: Prentice Hall, 1990. ISBN: 9780132131179
3. Syllabus | Signal Processing: Continuous and Discrete | Mechanical Engineering | MIT OpenCourseWare

21ME C39

ROBOTICS AND AUTOMATION

(BE AI/ML)

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

Course Objective:

1. Impart basic knowledge about the Mechanical, Electrical and Electronic systems of robot
2. Impart the basic knowledge about the robot vision and application of AI in robots
3. To serve as prerequisite for the elective courses like Full Stack Robotics, Mobile Robotics, AI for Robotics, Human Robot Interaction, Deep Learning Robotics etc

Course Outcomes: At the end of the course, students shall be able to:

1. Perform kinematic and dynamitic analysis with simulation
2. Design control laws for a simple robot
3. Integrate mechanical and electrical hardware for a real prototype of robotic device
4. Select a robotic system for a given industrial application
5. Apply AI Technologies to the robot

Unit I

Introduction to Robotics: Introduction, classification of robots.
Kinematics systems: mechanisms and manipulators, degrees of freedom.
Robot Kinematics and Dynamics: Kinematics, coordinate transformation, DH parameters, forward and inverse kinematics, Jacobian, Singularity, Forward and invers dynamics, equations of motion using Euler-Lagrange formulation, Newton Euler formulation

Unit II

Sensors and Machine vision: Various sensors - Contact and proximity, position, velocity, force, tactile etc., **Machine vision:** geometry of image formation, Euclidian/Similarity/Affine/Projective transformations, Vision for robotic applications

Unit III

Robotic Actuation Systems - Actuators: Electric, hydraulic and pneumatic. Transmission: Gears, timing belts and bearings, parameters for selection of actuators.
Robot Control: Basic control: open-loop, closed loop, transfer functions, control laws P, PD, PID, linear and non-linear controls

Unit IV:

Control Hardware and Interfacing: Microcontroller architectures and integration with sensors, actuators, components, Programming the robot.
AI in Robotics: Applications in unmanned systems, defense, medical, industries etc., Robotics and Automation for Industry 4.0, Robotics safety and social robotics

UNIT V:

Automation: Purpose of automatic control, Implementation of industrial control system, Introduction to automatic control theory, Building blocks of an automated system, working principle, Selection of various components of an automated system, Specifications of various elements.
Introduction to robotic automation: Artificial Intelligence (AI) based systems, IOT in manufacturing industries.

Text Books:

1. Nagrath and Mittal, Robotics and Control, Tata McGraw-Hill, 2003.
2. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley and sons, 2008.
3. Mikell P. Groover, Industrial Robotics, McGraw-Hill, 2008.

Suggested Reading:

1. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
2. Steve LaValle, Planning Algorithms, Cambridge Univ. Press, New York, 2006

21MEC40

ROBOTICS AND AUTOMATION LAB

(BE AI/ML)

Instruction	2P	Hours per week
Duration of SEE	3	Hours
SEE	50	Marks
CIE	50	Marks
Credits	1	

Objectives:

1. Impart basic knowledge about the Mechanical, Electrical and Electronic systems of robot
2. Impart to serve as prerequisite for the elective courses like Full Stack Robotics, Mobile Robotics, AI for Robotics, Human Robot Interaction, Deep Learning Robotics etc

Course Outcomes: At the end of the course, students shall be able to:

1. Demonstrate the understanding of assembly and working of a robot
2. Analyze the robot kinematics with the help of suitable software
3. Program a robot for a specific requirement
4. Apply the computer vision to the robot for a given application
5. Apply AI Technologies to the robot

Practical Experiments:

1. Study components of an industrial robot (PUMA, KUKA, FANUC, MTAB, UR , etc) and its DH parameters.
2. Forward kinematics and validation using software (Robo Analyser/MathLab or any other free software tool).
3. Inverse kinematics of an industrial robot and validation using any open source software.
4. Industrial Robot programming using VAL II or equivalent.
5. Microcontroller lab – programming (free software /open source)
6. Integration of assorted sensors (IR, Potentiometer, strain gages etc.), micro controllers and ROS (Robot Operating System) in a robotic system. (Free software, Matlab)
7. Control experiment using available hardware or software. (Open source or Matlab).
8. Use of open source computer vision programming tool/ MatLab, open CV)
9. Research related experiment in AI, e.g. multi agent system, unmanned systems control using ROS, etc.
10. Small group project work relevant to Industrial automation

Text Books:

1. Nagrath and Mittal, Robotics and Control, Tata McGraw-Hill, 2003.
2. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley and sons, 2008.
3. Mikell P. Groover, Industrial Robotics, McGraw-Hill, 2008.

Suggested Reading:

1. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
2. Steve LaValle, Planning Algorithms, Cambridge Univ. Press, New York, 2006

21AMC7

DATABASE SYSTEMS LAB

Instruction	0L-0T-3P
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Course Objective: The main objectives of this course are to:

Course Outcomes: At the end of the course, students shall be able to:

Laboratory/ Practical:

1. Implementation of normal forms in databases.
2. Implementation of basic SQL commands on a database
3. Implementation of information and ranking using any language
4. Implement document retrieval and ranking using any algorithm
5. Implement Map-Reduce algorithm on any big data task

21AMCxx

BUILDING LARGE, RELIABLE SOFTWARE SYSTEMS/SE LAB

(BE AI/ML)

Instruction	0L-2T-2P
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	3

Course Objectives: The main objectives of this course are to:

1. Gain tangible programming skills that will turn you into a systems hacker with works covering C/Unix programming, process/threads, GNU tools, socket programming, and the implementation of complex standalone and embedded software systems.
2. Gain good ways to deal with Exception handling and fault tolerance techniques systematically.
3. Understand principles of concurrency and be able to build concurrent software

Course Outcomes: At the end of the course, students will be able to:

1. Apply software construction and maintenance heuristics to build code, such as ways to eliminate global variables and methods to test complex code.
2. Execute software modernization techniques such as reverse engineering, reengineering, salvaging, and restructuring.
3. Organize software user documentation that enhances long-term software sustainability.
4. Construct software to meet clients' expectations.
5. Describe the ways configuration management is used in production systems.

UNIT I:

Introduction – Basic Java syntax and semantics, exceptions, input/output, classes, access control, static, Subclassing and interfaces, downcasting, anonymous classes.

Designing state machines: state machine design, graphical and textual notation, state machine syntax, parallel combinations of machines.

UNIT II:

State machine implementation: patterns, concurrency and queues, modularity and interfaces. State machine invariants; Designing stream processors; Decoupling and interfaces; Testing and coverage

UNIT III:

Designing an SAT solver; Debugging; Rep invariants, equality, visitors, little languages; Basics of mutable types;

Unit-IV-

Basics of mutable types- heap semantics, reachability and conceptual storage leaks, object contract and equality properties, hash maps and their representation invariant, problems caused by mutation of keys; **Event-based programming**- Fundamentals of GUI interfaces, view hierarchy, composite pattern, Publish-Subscribe pattern, Model-View-Controller (MVC), pitfalls of event-driven programming; Designing and Implementing a project;

UNIT - V:

Concurrency – shared memory and message-passing paradigms, race conditions and deadlock, threads and blocking queues in Java, concurrency issues in GUIs; **Usability**: UI design principles, learnability, visibility efficiency, errors, simplicity, interactive design, sketching and paper prototyping, user testing; **Relational databases**: using a database to represent an object model, relational algebra and SQL, transactions.

Textbooks:

1. Lecture Notes | Elements of Software Construction | Electrical Engineering and Computer Science | MIT OpenCourseWare

with effect from the Academic Year 2022-23