COURSE STRUCTURE
M.Tech – Robotics & Artificial Intelligence
(Applicable for batches admitted from 2021-22)

I SEMESTER								
S.No	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs./Wk**	**C**
1	PCC	UR19PCMRA101	Introduction to Robotics	3	0	0	3	3
2	PCC	UR19PCMRA102	Introduction to Artificial Intelligence	3	0	0	3	3
3	PEC	UR19PEMRA103A	Elective –I 1) Automation in Manufacturing	3	0	0	3	3
		UR19PEMRA103B	2) Microcontrollers Architecture and Programming					
		UR19PEMRA103C	3) Mechatronics System Design					
		UR19PEMRA103D	4) Drivesand Control Systems for Robots					
4	PEC	UR19PEMRA104A	Elective –II 1) Advanced Control System	3	0	0	3	3
		UR19PEMRA104B	2) Mobile and Micro-robotics					
		UR19PEMRA104C	3) Advanced Sensor Systems					
		UR19PEMRA104D	4) Distributed Operating Systems					
5	PEC	UR19PEMRA105A	Elective –III 1) Image Processing	3	0	0	3	3
		UR19PEMRA105B	2) Expert Systems					
		UR19PEMRA105C	3) Computer Organization & Architecture					
		UR19PEMRA105D	4) Embedded Systems					
6	MC	UR19MCMRA106	Research Methodology and Intellectual Property Rights	2	0	0	2	2
7	BSC	UR19BSMRA107	Fundamentals of Mathematics	3	0	0	3	3
8	PCC	UR19PCMRA111	Laboratory-1 -Robot Programming Lab	0	0	3	3	1.5
9	PCC	UR19PCMRA112	Laboartory-2 -Artificial Intelligence based Programming Tools Lab	0	0	3	3	1.5
10	AC	UR19ACMRA100A	AuditCourse-1 1) English for Research Paper Writing	0	0	0	2	0
		UR19ACMRA100B	2) Disaster Management					
		UR19ACMRA100C	3) Sanskrit for Technical Knowledge					
		UR19ACMRA100D	4) Value Education					
Total credits				**20**	**0**	**6**	**28**	**23**

II SEMESTER								
S.No	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs./Wk**	**C**
1	PCC	UR19PCMRA201	Machine Learning	3	0	0	3	3
2	PCC	UR19PCMRA202	Advanced Robotics	3	0	0	3	3
3	PEC	UR19PEMRA203A	Elective –IV 1) Pattern Recognition	3	0	0	3	3
		UR19PEMRA203B	2) Soft Computing					
		UR19PEMRA203C	3) Cryptography & Network Security					
		UR19PEMRA203D	4) Intelligent Manufacturing Systems					
4	PEC	UR19PEMRA204A	Elective-V 1) MOOCs-1 (NPTEL/SWAYAM)-12 Week Program related to the programme which is not listed in the course structure	3	0	0	3	3
		UR19PEMRA204B	2) Cognitive Robotics					
		UR19PEMRA204C	3) Design of Intelligent Robotic Systems					
		UR19PEMRA204D	4) Optimization in Engineering Design					
5	OEC	UR19OEMRA205A	Open Elective 1) MOOCs-2 (NPTEL/SWAYAM)-Any 12 Week Course on Engineering /Management/ Mathematics offered by other than parent department	3	0	0	3	3
			2) Course offered by other departments in the college					
6	PCC	UR19PCMRA211	Laboratory-1 Machine Learning Lab	0	0	3	3	1.5
7	PCC	UR19PCMRA212	Laboartory-2 Robotics Lab	0	0	3	3	1.5
8	MP	UR19PJMRA213	Mini Project with Seminar	0	0	0	0	2
9	AC	UR19ACMRA200A	Audit Course-2 1) Constitution of India	0	0	0	2	0
		UR19ACMRA200B	2) Pedagogy Studies					
		UR19ACMRA200C	3) Stress Management by Yoga					
		UR19ACMRA200D	4) Personality Development through Life Enlightenment Skills					
Total credits				**15**	**0**	**6**	**23**	**20**

III SEMESTER								
S.No	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs./Wk**	**C**
1	PJ	UR19PJMRA311	Project work phase -I	0	0	0	0	10
Total credits				**0**	**0**	**0**	**0**	**10**

IV SEMESTER								
S.No	**Course Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**Contact Hrs./Wk**	**C**
1	PJ	UR19PJMRA411	Project work phase -II	0	0	0	0	15
Total credits				**0**	**0**	**0**	**0**	**15**

Open Electives

1. UR19OEMRA205B Robot Economics
2. UR19OEMRA205C Cost Management of Engineering Projects
3. UR19OEMRA205D Finite Element Methods in Engineering
4. UR19OEMRA205E Additive manufacturing technologies

M.Tech I semester **Course Code: UR19PCMRA101** **L T P C**

3 0 0 3

Introduction to Robotics

Internal Marks: 30

External Marks: 70

Course Objective:

To impart knowledge about kinematic and dynamic analysis of robot manipulators.

Unit-I

Introduction to Robotics: Classification of Robots, History of Robotics, Advantages and Disadvantages of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames, Programming Modes, Robot Characteristics, Robot Workspace, Robot Languages, Robot Applications

Unit-II

Kinematics of Robots: Position Analysis, Robots as Mechanisms, Conventions, Matrix Representation, Homogeneous Transformation Matrices, Representation of Transformations, Inverse of Transformation Matrices, Forward and Inverse Kinematics of Robots, Forward and Inverse Kinematic Equations: Position, Forward and Inverse Kinematic Equations, Forward and Inverse Kinematic Equations: Position and Orientation, Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots, The Inverse Kinematic Solution of Robots, Inverse Kinematic Programming of Robots, Degeneracy and Dexterity, The Fundamental Problem with the Denavit-Hartenberg Representation.

Unit-III

Trajectory Planning Introduction, Path versus Trajectory, Joint-Space versus Cartesian-Space Descriptions, Basics of Trajectory Planning, Joint-

Space Trajectory Planning, Cartesian-Space Trajectories, Continuous Trajectory Recording.

Unit-IV

Robot End Effector Types, Mechanical Grippers and Other types, Tools as End Effectors, The Robot/End Effectors Interface, Considerations in Gripper Selection and Design

Unit-V

Actuators and Drive Systems: Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Actuators, Pneumatic Devices, Electric Motors, Microprocessor Control of Electric Motors, Magneto strictive Actuators, Shape-Memory Type Metals, Electro-active Polymer Actuators (EAP), Speed Reduction, Other Systems

Text Book:

1. Saeed B. Niku, Introduction to Robotics Analysis, Application, Pearson Education Asia, 2001.

Reference Books:

1. R.K.Mittal and I J Nagrath, Robotics and Control, TMH, 2003.
2. Computational Intelligence, Davis Poole, Alan Mackwath, Randy Coehel, Oxford University Press1998.

Course Outcomes:

The students will be able to

1. Understand the history, evolution and anatomy of robot.
2. Comprehend the concept of Mapping and Transformations for kinematic of manipulator.
3. Understand and apply the concept of forward and inverse kinematics of manipulator and Trajectory Planning.
4. Program a robot to perform tasks in industrial applications.
5. Design intelligent robots using sensors.
6. Understand the need and implementation of related Instrumentation & control in robotics.

M.Tech I semester **Course Code: UR19PCMRA102** **L T P C**

3 0 0 3

Introduction to Artificial Intelligence

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Learning basic concepts of various machine learning methods is primary objective of this course.
2. To be able to formulate machine learning problems corresponding to different applications.
3. To understand a range of machine learning algorithms along with their strengths and weaknesses.
4. To be able to apply machine learning algorithms to solve problems of moderate complexity.
5. Make student able to learn mathematical concepts, and algorithms used in machine learning techniques for solving real world problems

Unit-I

Introduction: Artificial Intelligence, AI Problems, AI Techniques, the Level of the Model, Criteria for Success. Defining the Problem as a State Space Search, Problem Characteristics, Production Systems, Search: Issues in The Design of Search Programs, Un-Informed Search, BFS, DFS; Heuristic Search Techniques: Generate- And- Test, Hill Climbing, Best-First Search, A* Algorithm, Problem Reduction, AO*Algorithm, Constraint Satisfaction, Means-Ends Analysis.

Unit-II

Knowledge Representation: Procedural Vs Declarative Knowledge, Representations & Approaches to Knowledge Representation, Forward Vs Backward Reasoning, Matching Techniques, Partial Matching, Fuzzy Matching Algorithms and RETE Matching Algorithms; Logic Based Programming- AI Programming languages: Overview of LISP, Search

Strategies in LISP, Pattern matching in LISP, An Expert system Shell in LISP, Over view of Prolog, Production System using Prolog

Unit-III

Symbolic Logic: Propositional Logic, First Order Predicate Logic: Representing Instance and is-a Relationships, Computable Functions and Predicates, Syntax & Semantics of FOPL, Normal Forms, Unification &Resolution, Representation Using Rules, Natural Deduction; Structured Representations of Knowledge: Semantic Nets, Partitioned Semantic Nets, Frames, Conceptual Dependency, Conceptual Graphs, Scripts, CYC.

Unit-IV

Reasoning under Uncertainty: Introduction to Non-Monotonic Reasoning, Truth Maintenance Systems, Logics for Non-Monotonic Reasoning, Model and Temporal Logics; Statistical Reasoning: Bayes Theorem, Certainty Factors and Rule-Based Systems, Bayesian Probabilistic Inference, Bayesian Networks, Dempster-Shafer Theory, Fuzzy Logic: Crisp Sets, Fuzzy Sets, Fuzzy Logic Control, Fuzzy Inferences &Fuzzy Systems.

Unit-V

Experts Systems: Overview of an Expert System, Structure of an Expert Systems, Different Types of Expert Systems- Rule Based, Model Based, Case Based and Hybrid Expert Systems, Knowledge Acquisition and Validation Techniques, Black Board Architecture, Knowledge Building System Tools, Expert System Shells, Fuzzy Expert systems.

Text Books:

1. Artificial Intelligence, George F Luger, Pearson Education Publications
2. Artificial Intelligence, Elaine Rich and Knight, McGraw-Hill Publications

Reference Books:

1. Introduction to Artificial Intelligence & Expert Systems, Patterson, PHI

2. Multi Agent systems- a modern approach to Distributed Artificial intelligence, Weiss.G, MIT Press.
3. Artificial Intelligence: A modern Approach, Russell and Norvig, Printice Hall.

Course Outcomes:

The students will be able to

1. Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
3. Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
4. Learn about various learning and their types.
5. Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.
6. Demonstrate proficiency in applying scientific method to models of machine learning.

M.Tech I semester **Course Code: UR19PEMRA103A** **L T P C**

3 0 0 3

Elective –I

Automation in Manufacturing

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Describe the basic concepts of automation in manufacturing systems.
2. Acquire the fundamental concepts of automated flow lines and their analysis.
3. Classify automated material handling, automated storage and retrieval systems.
4. Illustrate adaptive control systems and automated inspection methods.

Unit-I

Overview of Manufacturing: Introduction to Production Systems, Automation in Production Systems, Overview of Manufacturing, Manufacturing Operations, Manufacturing Models and Metrics Automation.

Unit-II

Mechatronics and Control Technologies: Introduction to Automation, Definition of Mechatronics, Mechatronics in Manufacturing, Industrial Control Systems, Hardware Components for Automation, Mechatronics and Process Control (Data Conversion Devices, Sensors, Microsensors, Transducers, Signal Processing Devices, Relays, Contactors and Timers), Data Acquisition, Actuators and Mechanisms.

Unit-III

Material Handling and Identification Technologies: Introduction to Material Handling, Principles of Material Handling, Material Transport Systems, Automated Guided Vehicle System (AGVS), Conventional and

Automated Storage Systems, Engineering Analysis of Storage Systems, Automatic Identification and Data Capture Manufacturing Systems Introduction to Manufacturing Systems, Single Station Manufacturing Cells.

Unit-IV

Manual Assembly Lines: Single Model and Mixed Assembly Line Balancing, Automated Production Lines, Automated Assembly Systems

Automation and Principle of Hydraulic and Pneumatic Circuit Design and Analysis Hydraulic and Pneumatic Controls, Application in Machine Tools and other Mechanical Fields, Hydraulic and Pneumatic Circuit Design Considerations, Functional Diagram in Circuit Design, Pneumatic Circuit Analysis, Electrical Controls for Fluid Power Circuits, Fluid Logic Control Systems, Fluid Power Maintenance and Safety, Synthesis of circuits, circuit optimization techniques.

Unit-V

Control System and Controllers Transfer function and block diagram: Block Diagram Reduction, Controller Principles, Process Characteristics, Control System Parameters, Controller Modes, Control Actions Discrete Control Programmable Logic Controllers, Basic Structure, Ladder Logic Programming, Types and Selection of PLC

Text Books:

1. Mikell P. Groover, Automation, Production Systems, and Computer Integrated Manufacturing, Third Edition, Prentice-Hall of India Private Limited.
2. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Limited.

Reference Books:

1. S. R. Majumdar, Pneumatic Systems: Principles and Maintenance, Tata McGrawHill

2. N. P. Mahalik, Mechatronics: Principles, Concepts and Applications, Tata McGraw Hill
3. S. R. Majumdar, Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw Hill HMT Ltd.
4. Joji P. Pneumatic Controls, Wiley India.

Course Outcomes:

The students will be able to

1. Enumerate the overview of manufacturing operations in the perspective of automation
2. Identify the elements of mechatronics and automation in manufacturing systems.
3. Choose automation and control technology for implementation of automation in manufacturing
4. Analyze the material handling technologies used in factory automation
5. Evaluate various manufacturing systems of industrial environment. Build basic logical circuit for fluid power systems used in factory automation.
6. Identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system.

M.Tech I semester **Course Code: UR19PEMRA103B** **L T P C**

3 0 0 3

Elective –I

Microcontrollers Architecture and Programming

Internal Marks: 30

External Marks: 70

Course Objectives:

1. To introduce students with the architecture and operation of typical microprocessors and microcontrollers.
2. To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
3. To provide strong foundation for designing real world applications using microprocessors and microcontrollers.
4. Understand 8051 microcontroller concepts, architecture and programming

Unit-I

Introduction to Microprocessors: Registers - File registers - Memory Organization - Tristate logic – Buses - Memory Address register – Read/Write operations. ROM, RAM, PROM, EPROM, E2PROM.

Unit-II

Introduction to Elementary Processor: Organization - Data Transfer Unit (DTU)operation - Enhanced Data Transfer Unit (EDTU) – opcode – machine language - assembly language - pipeline and system clock. Architecture of 8085 – Addressing modes - Data transfer, data processing and program flow control instructions - Simple assembly language programs.

Unit-III

Introduction to Microcontrollers: PIC16F877 Architecture - Program and Data memory organization - Special Function Registers - Addressing modes,

Instruction set. MPLAB Integrated Development Environment – Introduction to Assembly language and Embedded C programming – Stack – Subroutines - Interrupt structure – Peripherals – Input/output Ports.

Unit-IV

PIC Peripherals: Timers/Counters - Watchdog Timer Capture/Compare/PWM (CCP) - Analog to Digital Converter (ADC) – EEPROM - Serial Communication – USART - Development of Application Programs and interfacing - LED, LCD, Keyboard, DC and Stepper motor interface. Introduction to 8051 Microcontroller: Architecture – Ports - Timers.

UNIT-V

8051 Real Time Control: Programming Timer interrupts, programming external hardware interrupts, Programming the serial communication interrupts, Programming 8051 timers and counters.

Text Books:

1. Kenneth J. Ayala, "The 8051 Microcontroller Architecture, Programming & Applications", Penram International.
2. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill Education, 2008.

Reference Books:

1. The 8051 microcontrollers, architecture and programming and applications-K. Uma Rao, Andhe Pallavi., Pearson, 2009.
2. Micro computer system 8086/8088 family architecture, programming and design- By Liu and GA Gibson, PHI, 2nd Ed.,
3. Microcontrollers and application, Ajay.V. Deshmukh, TMGH,2005
4. The 8085 microprocessors: Architecture, programming and interfacing- K. Uday Kumar, B.S. Umashankar, 2008, Pearson
5. Microprocessors and microcontrollers- S.V.Altaf.

Course Outcomes:

The students will be able to

1. Understand the basic principles of Microcontroller based design and development.

2. Design real world applications using Microcontroller
3. Understand interfacing technologies and its applications.
4. Identify problem and strategy for designing the solution using appropriate Microcontrollers.
5. Evaluate assembly language programs and download the machine code that will provide solutions real-world control problems.
6. Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.

M.Tech I semester **Course Code: UR19PEMRA103C** **L T P C**

3 0 0 3

Elective –I

Mechatronics System Design

Internal Marks: 30

External Marks: 70

Course Objective:

Mechatronics system design deals with the design of controlled electro mechanical systems by the integration of functional elements from a multitude of disciplines. It starts with thinking how the required function can be realized by the combination of different subsystems according to a systematic step-by-step engineering design approach applied to a realistic mechatronics design problem.

Unit-I

Mechanical Systems and Design: Mechatronics approach - Control program control, adaptive control and distributed systems - Design process - Types of Design - Integrated product design - Mechanisms, load conditions, design and flexibility Structures, load conditions, flexibility and environmental isolation – Man machine interface, industrial design and ergonomics, information transfer from machine from machine to man and man to machine, safety.

Unit-II

Real time interfacing: Introduction Elements of data acquisition and control Overview of I/O Process-Installation of I/O card and software - Installation of application software- Over framing.

Unit-III

Microcontrollers: Introduction to use of open-source hardware (Arduino & Raspberry Pi); shields/modules for GPS, GPRS/GSM, Bluetooth, RFID, and Xbee, integration with wireless networks, databases and web pages; web and mobile phone apps.

Unit-IV

Case studies on Data Acquisition: Transducer calibration system for Automotive applications Strain Gauge weighing system - Solenoid force - Displacement calibration system - Rotary optical encoder - Inverted pendulum control - Controlling temperature of a hot/cold reservoir -Pick and place robot - Carpark barriers.

Unit-V

Case studies on Data Acquisition and Control - Thermal cycle fatigue of a ceramic plate - pH control system - De-Icing Temperature Control System - Skip control of a CD Player - Autofocus Camera, exposure control.

Case studies on design of Mechatronics products - Motion control using D.C. Motor, A.C. Motor & Solenoids - Car engine management - Barcode reader.

Text Books:

1. W. Bolton, Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering-, 2nd Edition, Addison Wesley Longman Ltd., 1999.
2. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, PWS Publishing company, 1997

Reference Books:

1. Bradley, D. Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, Chapman and Hall, London, 1991.
2. Brian Morris, Automated Manufacturing Systems - Actuators, Controls, Sensors and Robotics, Mc Graw Hill International Edition, 1995.
3. Gopal, Sensors- A comprehensive Survey Vol I & Vol VIII, BCH Publisher.

Course Outcomes:

The students will be able to

1. Demonstrate how mechatronics integrates knowledge from different disciplines in order to realize engineering and consumer products that are useful in everyday life.
2. Apply theoretical knowledge: understanding selection of suitable sensors and actuators; designing electro-mechanical systems.
3. Work with mechanical systems that include digital and analogue electronics as a data acquisition model.
4. Analyze the different systems and its design.
5. Demonstrate an understanding of real time interfacing.
6. Develop the ability to address a broad range of requirements, including most of the following: performance, economic, marketing, environmental, sustainable, manufacturing, ethical, safety, social, and regulatory.

M.Tech I semester **Course Code: UR19PEMRA103D** **L T P C**

3 0 0 3

Elective –I

Drives and Control Systems for Robots

Internal Marks: 30

External Marks: 70

Course Objective:

To impart knowledge about various drive systems and its selection for particular applications

Unit I

Robot Drive Mechanism: Objectives, motivation, open loop control, closed loop control with velocity and position feedback, Types of drive systems. Functions of drive system. Lead Screws, Ball Screws, Chain & linkage drives, Belt drives, Gear drives, Precision gear boxes, Harmonic drives, Cycle speed reducers.

Unit II

Hydraulic Drives: Introduction, Requirements, Hydraulic piston and transfer valve, hydraulic circuit incorporating control amplifier, hydraulic fluid considerations, hydraulic actuators Rotary and linear actuators. Hydraulic components in robots.

Unit III

Pneumatic Drives: Introduction, Advantages, pistons-Linear Pistons, Rotary pistons, Motors- Flapper motor, Geared motor, Components used in pneumatic control. Pneumatic proportional controller pneumatically controlled prismatic joint.

Unit IV

Electric Drives: Introduction, Types, DC electric motor, AC electric motor, stepper motors, half step mode operation, micro step mode. Types of stepper motors, Direct drive actuator.

Unit V

Servo Systems for Robot Control: General aspects of robot control. Basic control techniques, mathematical modeling of robot servos, error responses and steady state errors in robot servos, feedback and feed forward compensations, hydraulic position servo, computer-controlled servo system for robot applications, selection of robot drive systems.

Text Books:

1. R Kelly, D. Santibanez, LP Victor and Julio Antonio, "Control of Robot Manipulators in Joint Space", Springer, 2005.
2. A Sabanovic and K Ohnishi, "Motion Control Systems", John Wiley & Sons (Asia), 2011.

Reference Books:

1. Francis N-Nagy Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.
2. Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Phi Learning., 2009.
3. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata Mc Graw Hill Publishing company Ltd., 1995.
4. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, Tata McGraw-Hill Education, 2012.
5. Bernard Hodges, Industrial Robotics, Second Edition, Jaico Publishing house, 1993.
6. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning., 2009.
7. Tsuneo Yohikwa, Foundations of Robotics Analysis and Control, MIT Press., 2003.
8. John J. Craig, Introduction to Robotics Mechanics and Control, Third Edition, Pearson, 2008.

Course Outcomes:

The students will be able to

1. Understand various types of drive systems.
2. Select a drive system for a particular application.
3. Know the accurate positioning of the robot end effectors with error compensation by servo control.
4. To understand working principles of various types of motors, differences, characteristics and selection criteria.
5. To apply the knowledge in selection of motors, heating effects and braking concepts in various industrial applications.
6. Develop nonlinear observer schemes.

M.Tech I semester **Course Code: UR19PEMRA104A** **L T P C**

3 0 0 3

Elective –II

Advanced Control System

Internal Marks: 30

External Marks: 70

Course Objective:

To learn the methods for analyzing the behavior of nonlinear control systems and the designing of control systems.

Unit I

State Space Analysis: The Concept of State and State Models, State Diagram, State Space and State Trajectory, State Space Representation using Phase Variable and Canonical Variables, Solution of State Equation, State Transition Matrix and its Properties, Eigen Values, Eigen Vectors, Model Matrix, Diazotization, Generalized Eigen vectors, Computation of State Transition Matrix using Laplace Transformation, Power Series Method, Cayley-Hamilton Method, Similarity Transformation Method. Controllability and Observability Tests: Kalman's test, Gilbert's Test, Controllability and Observability Canonical Forms.

Unit II

Pole Placement Techniques: Controller Design by State Feedback, Necessary and Sufficient Condition for Arbitrary Pole Placement-State Regulator Problem and State Regulator Design, Evaluation of State Feedback Gain Matrix K, Selection of Location of Desired Closed Loop Poles, State Observer Design, Full Order/Reduced Order Observer Design, Observer Based State Feedback Control, Separation Principle.

Unit III

Nonlinear Control System: Introduction, Properties of Nonlinear System, Behavior of Non-Linear System, Classification of Nonlinearities, Common Physical Nonlinearities: Saturation, Friction, Backlash, Dead-Zone, Relay, On-Off Nonlinearity, Nonlinear Spring, Limit cycle, Jump resonance. Phase-

Plane Method, Singular points, Stability of Nonlinear System, Construction of Phase Trajectories, Describing Functions Method, Stability Analysis by Describing Function Method. Lyapunov's Stability Analysis, Lyapunov's Stability Criterion, Direct Method of Lyapunov and the Linear Systems, Method of Construction of Lyapunov Functions for Nonlinear Systems.

Unit IV

Optimal Control: Introduction to Optimal Control, Parameter Optimization: Servomechanism, Optimal Control Problem: Transfer Function and State Variable Approach, State Regulator Problem, Infinite Time Regulator Problem, Output Regulator and the Tracking Problem, Parameter Optimization: Regulators.

Unit V

Digital Control Systems: Introduction to Discrete Time Systems, Necessary for Digital Control System, Spectrum Analysis of Sampling Process, Signal Reconstruction, Difference Equations, Z transforms, and the Inverse Z transform, Pulse Transfer Function, Time Response of Sampled Data Systems, Stability using Jury Criterion, Bilinear Transformation.

Text Books:

1. Slotine & Li, Applied Non-Linear Control, Englewood Cliffs, NJ: Prentice-Hall, (1991).
2. Bandyopadhyay, M.N., Control Engineering: Theory and Practice, Prentice-Hall of India Private Limited (2003).
3. Ogata, K., Discrete-time Control Systems, Pearson Education (2005).

Reference Books:

1. Katsuhiko Ogata, Modern Control Engineering Prentice-Hall of India, New Delhi.
2. I. J. Nagarath and M. Gopal, Control system Engineering, New Age International (P) Ltd.
3. Katsuhiko Ogata, State Space Analysis of Control Systems, Prentice Hall Inc, New Jersey.
4. Benjamin C. Kuo and Farid Golnaraghi, Automatic Control Systems, 8th Edition, John Wiley &Sons.

5. H. Khalil, Nonlinear Control systems, Prentice Hall Inc, New Jersey.
6. Brogan W. L., Modern Control theory, Prentice Hall International, New Jersey.
7. Jean-Jacques E, Slotine, Weiping Li, Applied Nonlinear Control, Prentice Hall Inc., and New Jersey.
8. Donald Kirk, Optimal Control Theory, an Introduction, Prentice Hall, Inc, Englewood Cliffs, New Jersey.
9. Brain D., Anderson and J. B. Moore, Optimal Control, Prentice Hall.
10. Andrew P., Sage, Optimum Systems Control, Prentice Hall.
11. M. Gopal, Digital Control & State Variable Methods, TMH.
12. A. Nagoor Kani, Control System, RBA Publications.

Course Outcomes:

The students will be able to

1. Analyze dynamics of a linear system by State Space Representation.
2. Determine the stability of a linear system using pole-placement technique. Design state observers.
3. Analyze basics of Non-linear control system.
4. Formulate and solve deterministic optimal control problems in terms of performance indices.
5. Realize the structure of a discrete time system and model its action mathematically.
6. Derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform).

M.Tech I semester **Course Code: UR19PEMRA104B** **L T P C**

3 0 0 3

Elective –II

Mobile and Micro-robotics

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Provide brief introduction to micromachining and the principles of microsystems
2. Understand the various flexures, actuators and sensor systems.
3. Discuss the methods of implementation of micro robots.

Unit-I

Introduction to Mobile Robots: Tasks of mobile robots, robots manufacturers, type of obstacles and challenges, tele-robotics, philosophy of robotics, service robotics, types of environment representation.

Unit-II

Ground Robots: Wheeled and Legged Robots, Aerial Robots, Underwater Robots and Surface Robots. Kinematics and Dynamics of Wheeled Mobile Robots (two, three, four - wheeled robots, Omni-directional and macanum wheeled robots).

Unit-III

Sensors for localization: magnetic and optic position sensor, gyroscope, accelerometer, magnetic compass, inclinometer, GNSS and Sensors for navigation: tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual system, Kinect. Localization and Mapping in mobile robotics.

Motion Control of Mobile Robots (Model and Motion based Controllers): Lyapunov-based Motion Control Designs and Case Studies. Understand the current application and limitations of Mobile Robots. Introduction to Mobile Manipulators and Cooperative Mobile Robots.

Unit-III

Micro Robotics: Introduction, Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots.

Unit-IV

Implementation of Micro Robots: Arrayed actuator principles for micro-robotic applications – Micro-robotic actuators - Design of locomotive micro-robot devices based on arrayed actuators. Micro-robotics devices: Micro-grippers and other micro-tools - Micro-conveyors - Walking MEMS Micro-robots – multi-robot system: Micro-robot powering, Micro-robot communication.

Unit-V

Micro Fabrication and Micro Assembly: Micro-fabrication principles - Design selection criteria for micromachining - Packaging and Integration aspects – Micro-assembly platforms and manipulators.

Text Books:

1. Mohamed Gad-el-Hak, "The MEMS Handbook", CRC Press, New York, 2002.
2. Yves Bellouard, "Micro robotics Methods and Applications", CRC Press, Massachusetts, 2011.

Reference Books:

1. R Siegwart, IR Nourbakhsh, D Scaramuzza, Introduction to Autonomous Mobile Robots, The MIT Press, USA, 2011,
2. SG Tzafestas, Introduction to Mobile Robot Control, Elsevier, USA, 2014,
3. A Kelly, Mobile Robotics, Mathematics, Models, and Methods, Cambridge University Press, USA, 2013,
4. G Dudek, M Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, USA,
5. Mohamed Gad-el-Hak, ―The MEMS Handbook‖, CRC Press, New York, 2002.

6. Yves Bellouard, ―Micro robotics Methods and Applications, CRC Press, Massachusetts, 2011.

7. Patnaik, Srikanta, "Robot Cognition and Navigation An Experiment with Mobile Robots", Springer-Verlag Berlin and Heidelberg, 2007.
8. Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, ―Principles of Robot Motion-Theory, Algorithms, and Implementation, MIT Press, Cambridge, 2005.
9. Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg 2008.

Course Outcomes:

The students will be able to

1. Identify and design a suitable manufacturing process for micro robots.
2. Understand the importance of visual perception and recognition for cybernetic view.
3. Program a robot for wandering and teleportation.
4. Outline the various methods of implementation of micro robots.
5. Discuss about the principle of micro fabrication and micro assembly.
6. Specify the characteristics of various flexures, actuators and sensor systems

M.Tech I semester **Course Code: UR19PEMRA104C** **L T P C**

3 0 0 3

Elective –II

Advanced Sensor Systems

Internal Marks: 30

External Marks: 70

Course Objectives:

1. To provide in depth knowledge in physical principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.
2. To introduce the students to sources and detectors of various Optical sensing mechanisms and provide in-depth understanding of the principle of measurement, and theory of instruments and sensors for measuring velocity and acceleration
3. To give a fundamental knowledge on the basic laws and phenomena on which operation of sensor transformation of energy is based.
4. To impart a reasonable level of competence in the design, construction, and execution of mechanical measurements strain, force, torque and pressure

Unit-I

Principles of Physical and Chemical Sensors: Sensor classification, Sensing mechanism of Mechanical, Electrical, Thermal, Magnetic, Optical, Chemical and Biological Sensors.

Unit-II

Sensor Characterization and Calibration: Study of Static and Dynamic Characteristics, Sensor reliability, aging test, failure mechanisms and their evaluation and stability study.

Unit-III

Sensor Modeling: Numerical modeling techniques, Model equations, Different effects on modeling (Mechanical, Electrical, Thermal, Magnetic, Optical, Chemical and Biological) and examples of modeling.

Unit-IV

Sensor Design and Packaging: Partitioning, Layout, technology constraints, scaling, compatibility study. Sensor Technology: Thick and thin films fabrication process, Micro machining, IOC (Integrated Optical circuit) fabrication process, Ceramic material fabrication process, Wire bonding, and Packaging.

Unit-V

Sensor Interfaces: Signal processing, Multi sensor signal processing, Smart Sensors, Interface Systems. Sensor Applications: Process Engineering, Medical Diagnostic and Patient monitoring, Environmental monitoring etc.

Text Books:

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Stephen D Senturia, Microsystem Design, Springer Publication, 2000.
3. Tai Ran Hsu, MEMS & Micro systems Design and Manufacture Tata McGraw Hill, New Delhi, 2002.
4. Jacob Fraden /Handbook of Modern Sensors, 2nd Ed.
5. M J Usher, Sensors and Transducers, MacMillan, 1985.

Reference Books:

1. Eric Udd, Fiber Optic Sensors: An Introduction for Engineers and Scientists, John Wiley & Sons, New York, 1991 (ISBN: 0471830070).
2. André Preumont, Vibration Control of Active Structures: An Introduction, 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966).
3. Hojjat Adeli, Control, Optimization, and Smart Structures: High-Performance Bridges and Buildings of the Future, John Wiley, New York, 1999 (ISBN: 047135094X).

4. T.T. Soong, Passive Energy Dissipation Systems in Structural Engineering, Wiley, Chichester; New York, 1997 (ISBN: 0471968218).
5. G. Engdahl, Handbook of Giant Magnetostrictive Materials, Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X).
6. K. Otsuka and C.M. Wayman, Shape Memory Materials, Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X).

Course Outcomes:

The students will be able to

1. Learn fundamentals and technical knowledge of advanced sensor systems
2. Understand the problem and select a sensor and design, model the system.
3. Select Sensor Interfaces and signal processing
4. Understand sensor applications in various fields.
5. Describe the various applications of smart sensors. Discuss advanced sensing technology.
6. Discuss advanced sensing technology.

M.Tech I semester **Course Code: UR19PEMRA104D** **L T P C**

3 0 0 3

Elective –II

Distributed Operating Systems

Internal Marks: 30

External Marks: 70

Course Objectives:

1. To provide hardware and software issues in modern distributed systems.
2. To get knowledge in distributed architecture, naming, synchronization, consistency and replication, fault tolerance, security, and distributed file systems.
3. To analyze the current popular distributed systems such as peer-to-peer (P2P) systems will also be analyzed.

Unit-I

Introduction to Distributed Systems: What is a Distributed System? Hardware concepts, Software concepts, Design issues.

Unit-II

Communication in Distributed Systems Lay Red Protocols, ATM networks, The Client – server model, Remote Procedure call, Group communication.

Unit-III

Synchronization in Distributed System, Clock Synchronization, Mutual Exclusion, Election algorithms, atomic transactions, Deadlocks in Distributed Systems.

Unit-IV

Process and processors in Distributed System threads, System Models, Processor's allocation, Scheduling in Distributed System, Fault tolerance, Real-time Distributed System.

Unit-V

Distributed File Systems, Distributed File System Design, Distributed File System implementation, Trends in Distributed File System.

Distributed Shared Memory, Introduction, what is Shared memory? Consistency models, Page based Distributed Shared memory, shared –

variable Distributed Shared memory, Object based Distributed Shared Memory.

Text Book:

1. Distributed Operating Systems, Andrew S. Tanenbanm

Reference Book:

1. Advanced Concepts in Operating Systems, Makes Singhal and Niranjan G.Shivaratna.

Course Outcomes:

The students will be able to

1. To provide hardware and software issues in modern distributed systems.
2. To get knowledge in distributed architecture, naming, synchronization, consistency and replication, fault tolerance, security, and distributed file systems.
3. To analyze the current popular distributed systems such as peer-to-peer (P2P) systems will also be analyzed.
4. To know about Shared Memory Techniques.
5. Have Sufficient knowledge about file access
6. Have knowledge of Synchronization and Deadlock.

M.Tech I semester **Course Code: UR19PEMRA105A** **L T P C**

3 0 0 3

Elective –III

Image Processing

Internal Marks: 30

External Marks: 70

Course Objective:

To treat the 2D systems as an extension of 1D system design and discuss techniques specific to 2D systems.

Unit-I

Fundamentals of Image Processing: Image Acquisition, Image Model, Sampling, Quantization, Relationship between Pixels, Distance Measures, Connectivity, Image Geometry, Photographic Film. Histogram: Definition, Decision of Contrast Basing on Histogram, Operations Basing on Histograms Like Image Stretching, Image Sliding, Image Classification. Definition and Algorithm of Histogram Equalization.

Image Transforms: A Detail Discussion on Fourier Transform, DFT, FFT, Properties WALSH Transform, WFT, HADAMARD Transform, DCT

Unit-II

Image Enhancement:

a) Arithmetic and Logical Operations, Pixel or Point Operations, Size Operations,

b) Smoothing Filters-Mean, Median, Mode Filters – Comparative Study

c) Edge Enhancement Filters – Directorial Filters, Sobel, Laplacian, Robert, KIRSCH Homogeneity

d) DIFF Filters, Prewitt Filter, Contrast Based Edge Enhancement Techniques–

Comparative Study

e) Low Pass Filters, High Pass Filters, Sharpening Filters. – Comparative Study

f) Color Fundamentals and Color Models

g) Color Image Processing.

Unit-III

Image Enhancement: Design of Low Pass, High Pass, EDGE Enhancement, Smoothening Filters in Frequency Domain. Butter Worth Filter, Homomorphic Filters in Frequency Domain Advantages of Filters in Frequency Domain, Comparative Study of Filters in Frequency, Domain and Spatial Domain.

Image Compression: Run Length Encoding, Contour Coding, Huffman Code, Compression Due to Change in Domain, Compression Due to Quantization Compression at the Time of Image Transmission. Brief Discussion on: -Image Compression Standards.

Unit-IV

Image Segmentation: Characteristics of Segmentation, Detection of Discontinuities, Thresholding Pixel Based Segmentation Method. Region Based Segmentation Methods, Segmentation by Pixel Aggregation, Segmentation by Sub Region Aggregation, Histogram Based Segmentation, Spilt and Merge Technique, Motion in Segmentation

Unit-V

Morphology: Dilation, Erosion, Opening, Closing, Hit-And-Miss Transform, Boundary Extraction, Region Filling, Connected Components, Thinning, Thickening, Skeletons, Pruning Extensions to Gray– Scale Images Application of Morphology in I.P

Image, Video& Multimedia Communications: Multi-scale and multi-orientation representation; Geometry and texture representation; Object based representation; Hierarchical representation; Sparse representation, Multimedia with image and video content; Multimedia event synchronization.

Text Book:

1. Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Addision Wesley

Reference Books:

1. Fundamentals Of Electronic Image Processing By Arthyr– R – Weeks,Jr.(PHI)

2. Image Processing, Analysis, And Machine Vision by Milan Sonka Vaclan Halavac Roger Boyle, Vikas Publishing House.
3. Digital Image Processing, S. Jayaraman, S. Esakkirajan & T. VeeraKumar, TMH.

Course Outcomes:

The students will be able to

1. Understand the need for image transforms different types of images transforms and their properties and develop any image processing application.
2. Understand the rapid advances in Machine vision.
3. Learn different techniques employed for the enhancement of images.
4. Learn different causes for image degradation and overview of image restoration techniques.
5. Understand the need for image compression and to learn the spatial and frequency domain techniques of image compression
6. Learn different feature extraction techniques for image analysis and recognition.

M.Tech I semester **Course Code: UR19PEMRA105B** **L T P C**

3 0 0 3

Elective –III

Expert Systems

Internal Marks: 30

External Marks: 70

Course objective:

Expert systems are aimed at rebuilding human reasoning on the expertise obtained from experts, stores knowledge, establishes links between knowledge, have the knowledge and ability to perform human intellectual activities.

Unit-I

Introduction: Introduction to Expert System, Definitions, Importance of Expert System, and Charactestic features of Expert System, Applications of Expert System, and Different categories of Expert Systems, Rule Based System Archicture, and Neural Network Archicture

Unit-II

Knowledge Representations: Components of a Knowledge in Expert system, OAV Triplets, Semantic Networks, Frames Representation via Logic Statements, Production Systems, Clause, Properties Rule properties, Rule Conversions, Multiple Conclusions, Neural Networks via Rule Based System

Knowledge Acquisition: Introduction Knowledge Acquisition and domain Expert, Selection of the domain, Selection of the Knowledge Engineers, Selection of the Expert, Meetings and Plans, Organization of Meetings, Documentation, Multiple domain Experts, Knowledge Acquisition -An Example, Knowledge Acquisition using Rule induction, Generating Rules from Trees, ID3 algorithm for Rule Generation

Unit-III

Design of Expert System: Introduction, Selecting the appropriate Problem, Strategies in the Developing Expert System, Errors in Development stages, Software Engineering and Expert Systems, The Expert System Life Cycle, Expert System Design Examples- Certainty factors, Decission tress

Inference Engine: Inference Engine, Insight of Inference Engine, Search Strategies, Forward Chaining Algorithm, Algorithms for forward Chaining-Baseline Version, Backward Chaining Algorithm, Algorithms for Back word Chaining-Baseline Version, Mixed Modes of Chaining, Work sheets for Forward and Back word Chaining

Unit-IV

Reasoning Under Uncertainty: Uncertainty, Types of Error, Error and Induction, Classic Probability, Temporal Reasoning and Morcov Chines, TMS, Fuzzy Logic and Natural Languages computations, Probabilistic Reasoning, probabilistic Networks, Bayesian Networks. Use of Probability and Fuzzy logic in Expert System, Rule Induction by Machine Learning

Unit-V

Software Tools and Architectures: Overview of Expert System Tools, Expert System Shells, Multiple Paradigm Environments, Abstract architectures, Potential Implementation Problems, selecting a Software Tool, Implantation Mechanism of tools, Black Board Architecture, Reasoning under uncertainty and Truth Maintains Systems

Case-study: A case-study on financial planning Expert System, Sale Expert system, DENDRAL and MYCIN

Text Books:

1. Expert System principals and Programming-Giarratano.Rilev.2003
2. Introduction to Expert Systems V-James P.Iginizo. Mc.Graw-Hill.inc
3. Introduction to Expert Systems Peter Jackson, Addison Wesley Publishing Company

Reference Books:

1. Introduction to artificial Intelligence & Expert System-PanW.patterson.PHI
2. A Comprehensive Guide to AI and Expert systems, R.I.Levine D.E. Drang, Barry Edelson.

Course Outcomes:

The students will be able to

1. Explain and describe the concepts related to the creation of knowledge

bases and expert systems.

2. Use the tools and the processes for the creation of an expert system.
3. Conduct an in-depth examination of an existing expert system with an emphasis on basic methods of creating a knowledge base.
4. Examine properties of existing systems in a case-study manner, comparing differing approaches.
5. Demonstrate proficiency developing applications in expert system shell.
6. Design and develop Hybrid expert system for real world problems.

M.Tech I semester **Course Code: UR19PEMRA105C** **L T P C**

3 0 0 3

Elective –III

Computer Organization & Architecture

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Discuss the basic concepts and structure of computers.
2. Understand concepts of register transfer logic and arithmetic operations.
3. Explain different types of addressing modes and memory organization.
4. Learn the different types of serial communication techniques.
5. Summarize the Instruction execution stages.

Unit-I

Register Transfer and Micro operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit.

Unit-II

Basic Computer Organization and Design: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instructions, Input-Output and Interrupt, Complete Computer Description, Design of Basic Computer, Design of Accumulator Logic.

Micro programmed Control: Control Memory, Address Sequencing, Micro program Example, Design of Control Unit.

Unit-III

Central Processing Unit: Introduction, General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer (RISC).

Input/output Organization: Peripheral Devices, I/O interface, Asynchronous data transfer, Modes of transfer, priority Interrupt, Direct memory access, Input-Output Processor (IOP), Serial Communication.

Unit-IV

Memory Organization: Memory Hierarchy, Main memory, Auxiliary memory, Associate Memory, Cache Memory, and Virtual memory, Memory Management Hardware.

Unit-V

Overview of Computer Architecture: Evolution of Computer Systems, Parallelism in Uni- processor System, Parallel Computer Structures, Architectural Classification Schemes, Parallel Processing Applications.

Text Books:

1. Computer System Architecture, M. Morris Mano, Prentice Hall of India Pvt. Ltd.,Third Edition, Sept. 2008.
2. Computer Architecture and Parallel Processing, Kai Hwang and Faye A. Briggs,McGraw Hill, InternationalEdition1985.

Reference Books:

1. Computer Architecture and Organization, William Stallings, PHI Pvt. Ltd.,Eastern Economy Edition, Sixth Edition,2003.
2. Computer System Architecture‖, John. P.Hayes.
3. ComputerArchitectureAquantitativeapproach3rdeditionJohnL.Hennessy&David A. Patterson Morgan Kufmann (An Imprint of Elsevier).

Course Outcomes

The students will be able to

1. Understand the theory and architecture of central processing unit.
2. Analyze some of the design issues in terms of speed, technology, cost, performance.
3. Design a simple CPU with applying the theory concepts.
4. Use appropriate tools to design verify and test the CPU architecture.
5. Understand the architecture and functionality of central processing unit and exemplify in a better way the I/O and memory organization.
6. Develop language program for assembly.

M.Tech I semester **Course Code: UR19PEMRA105D** **L T P C**

3 0 0 3

Elective –III

Embedded Systems

Internal Marks: 30

External Marks: 70

Course Objective:

This course emphasizes on comprehensive treatment of embedded hardware and real time operating systems along with case studies, in tune with the requirements of Industry. The objective of this course is to enable the students to understand embedded-system programming and apply that knowledge to design and develop embedded solutions.

Unit-I

Examples of Embedded Systems: Typical Hardware, Memory, Microprocessors Busses, Direct Memory Access, Introduction to 8051 Microcontroller, Architecture-Instruction set, Programming.

Microprocessor Architecture: Interrupt Basics, The Shared-Data problem, Interrupt Latency.

Unit-II

Round–Robin Architecture: Round–Robin with Interrupts Architecture, Function- Queue, Scheduling Architecture, Real-Time Operating Systems Architecture, Selection of Architecture.

Tasks and Task States: Tasks and Data, Semaphores and Shared Data, Semaphore Problems, Semaphore variants.

Unit-III

Message Queues: Mailboxes, Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in RTOS Environment.

Unit-IV

RTOS Design: Principles, Encapsulation Semaphores and Queues, Hard Real-Time Scheduling Considerations, Saving Memory Space, Saving Power.

Unit-V

Host and Target Machines: Linker/Locator for Embedded Software, Getting

Embedded Software into the Target System.

Testing on your Host Machine: Instruction Set Simulators, Laboratory Tools used for Debugging.

Text Books:

1. The 8051 Microcontroller Architecture, Programming & Applications, Kenneth J. Ayala, Penram International.
2. An Embedded Software Primer, David E. Simon, Pearson Education, 2005.

Reference Book:

1. Embedded Systems Architecture, Programming and Design, Raj Kamal, Tata McGraw- Hill Education, 2008.

Course Outcomes:

The students will be able to

1. Understand the concept of embedded system, microcontroller, different components of microcontroller and their interactions.
2. Become aware of the architecture of the ATOM processor and its programming aspects (assembly Level)
3. Become aware of interrupts, hyper threading and software optimization.
4. Design real time embedded systems using the concepts of RTOS.
5. Analyze various examples of embedded systems based on ATOM processor.
6. Understand the key concepts of embedded systems such as I/O, timers, interrupts and interaction with peripheral devices.

M.Tech I semester **Course Code: UR19MCMRA106** **L T P C**

2 0 0 2

Research Methodology and Intellectual Property Rights

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Identify an appropriate research problem in their interesting domain.
2. Understand ethical issues Understand the Preparation of a research project thesis report.
3. Understand the Preparation of a research project thesis report
4. Understand the law of patent and copyrights.
5. Understand the Adequate knowledge on IPR

Research Methodology

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Effective literature studies approaches, analysis Plagiarism, Research ethics

Effective technical writing, how to write report, Paper

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Intellectual Property Rights

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act , Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional

and Non-Provisional Patent Application and Specification, Plant Patenting, Idea Patenting,

Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies

New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development,

International Scenario: WIPO, TRIPs, Patenting under PCT

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step-by-Step Guide for beginners".

Reference Books:

1. Aswani Kumar Bansal: Law of Trademarks in India
2. B L Wadehra: Law Relating to Patents, Trademarks, Copyright, Designs and Geographical Indications.
3. G.V.G Krishnamurthy: The Law of Trademarks, Copyright, Patents and Design.
4. Satyawrat Ponkse: The Management of Intellectual Property.
5. S K Roy Chaudhary & H K Saharay : The Law of Trademarks, Copyright, Patents
6. Intellectual Property Rights under WTO by T. Ramappa, S. Chand.
7. Manual of Patent Office Practice and Procedure
8. WIPO: WIPO Guide to Using Patent Information
9. Resisting Intellectual Property by Halbert, Taylor & Francis
10. Industrial Design by Mayall, Mc Graw Hill
11. Product Design by Niebel, Mc Graw Hill
12. Introduction to Design by Asimov, Prentice Hall
13. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

Course Outcomes:

The students will be able to

1. Understand research problem formulation and approaches of investigation of solutions for research problems
2. Learn ethical practices to be followed in research
3. Apply research methodology in case studies
4. Acquire skills required for presentation of research outcomes (report and technical paper writing, presentation etc.)
5. Discover how IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario and study the national & International IP system.
6. Comprehend concepts related to patents, trademark and copyright.

M.Tech I semester **Course Code: UR19BSMRA107** **L T P C**

3 0 0 3

Fundamentals of Mathematics

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Compute with integers, fractions, and decimals.
2. Apply the rules of order of operation to simplify numerical expressions.
3. Perform calculations and conversions using the U.S. and metric systems of measurement.
4. Demonstrate the use of ratios, proportions, and percentages.
5. Calculate the perimeter, circumference, area, and volume of geometric figures.

Unit-I

Linear Algebra Basics: Vector spaces and subspaces, basis and dimensions, linear transformation, four fundamental subspaces.

Unit-II

Matrix Theory: Norms and spaces, Eigen values and eigenvectors, Special Matrices and their properties, least squared and minimum normed solutions.

Matrix Decomposition Algorithms-SVD: Properties and applications, low rank approximations, Gram Schmidt process, polar decomposition.

Unit-III

Dimensions Reduction Algorithms and JCF: Principal component analysis, linear discriminate analysis, minimal polynomial and Jordan canonical form.

Calculus: Basic concepts of calculus: Partial derivatives, gradient, directional derivatives, Jacobian, hessian, convex sets, convex functions and its properties.

Unit-IV

Optimization: Unconstrained and Constrained optimization, Numerical optimization techniques for constrained and unconstrained optimization: Newton's method, Steepest descent method, Penalty function method.

Unit-V

Probability: Basic concepts of probability: Conditional probability, Bayes' theorem, independence, theorem of total probability, expectation and variance, few discrete and continuous distributions, joint distributions and covariance.

Support Vector Machines: Introduction to SVM, Error minimizing LPP, concepts of duality, hard and soft margin classifiers.

Text Books:

1. W. Cheney, Analysis for Applied Mathematics. New York: Springer Science + Business Medias, 2001.
2. S. Axler, Linear Algebra Done Right (Third Edition). Springer International Publishing, 2015.

Reference Books:

1. J. Nocedal and S.J. Wright, Numerical Optimization. New York: Springer Science + Business Media, 2006.
2. J.S. Rosenthal, A First Look at Rigorous Probability Theory (Second Edition). Singapore: World Scientific Publishing, 2006.
3. Marc Perter Deisenroth, A. Aldo Faijal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
4. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Publication, 2001

Course Outcomes:

The students will be able to

1. Understand and apply basic concepts of linear algebra and matrix theory.
2. Define various concepts in multivariable calculus and solve problems.
3. Apply various techniques of optimization.
4. Use probability theory in problem solving.

5. Understand support vector machines and error minimization.
6. Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts from the foundations of mathematics.

M.Tech I semester **Course Code: UR19PCMRA111** **L T P C**

0 0 3 1.5

Robot Programming Lab

Internal Marks: 15

External Marks: 35

1. Robot Programming using Flex Pendant- Lead through programming including Coordinate systems of Robot,
2. Wrist Mechanism-Interpolation-Interlock commands
3. VAL language commands motion control, hand control, program control, pick and place applications,
4. Palletizing applications using VAL,
5. Object detection and Sorting
6. Robot welding application using VAL program-
7. RAPID Language and AML
8. Programming using Robot studio software
9. Demonstration of robot with 2 DOF, 3 DOF, 4DOF etc.
10. Two case studies of applications in industry
11. Demonstrations on Robot Mechanisms and their design
12. Robot Hardware and Control System Design

Course Outcomes:

The students will be able to

1. Use fundamental and technical knowledge of robot Programming
2. Learn Robot Programming using teach Pendant for various applications
3. Use RAPID Language and AML
4. Program using Robot studio software
5. Learn robot hardware and control systems
6. Learn robot configurations

Note: Minimum 90% experiments of duration 3 periods each must be completed for the eligibility to appear for the semester end examinations.

In case if the student fails to get eligibility for semester end exams in the current semester, he has to take the permission of HOD and complete the required number of experiments and appear for semester end exam as and when conducted.

M.Tech I semester **Course Code: UR19PCMRA112** **L T P C**

0 0 3 1.5

Artificial Intelligence based Programming Tools Lab

Internal Marks: 15

External Marks: 35

1. Python Editors &IDE's (PyCharm, Jupiter, Spyder etc…) ·
2. Understand Jupiter notebook & Spyder and Installing & loading Packages & Name Spaces·
3. Introduction to strings, Tuples, Lists, Dictionaries. · List, Set and Dictionary Comprehensions
4. Modules for Machine Learning (scikit-learn library, scipy, nltk)
5. AI based programming tools like Classical AI - LISP, Prolog, Tensor Flow
6. H20.AI, Cortana and IBM WATSON

Course Outcomes:

The students will be able to

1. Use python editors and IDE's
2. Understand Jupiter notebook &Spyder
3. Use Modules for Machine Learning
4. Use AI based Programming tools and ANN experiments

Note: Minimum 90% experiments of duration 3 periods each must be completed for the eligibility to appear for the semester end examinations.

In case if the student fails to get eligibility for semester end exams in the current semester, he has to take the permission of HOD and complete the required number of experiments and appear for semester end exam as and when conducted.

M.Tech I semester **Course Code: UR19ACMRA100A** **L T P C**

0 0 0 0

Audit Course-1
English for Research Paper Writing

Internal Marks: 100

External Marks: 00

Course Objectives:

1. Research Skills (using primary and library research to discover and employ information)
2. Correspondence Skills (learning the generic conventions of each)
3. Promotional Writing Skills (may or may not use primary research; to disseminate information; to inform and persuade public audiences that organizations communicate with)
4. Visual Communication Skills (may appear as separate assignments or as components of other assignments)

Unit-I

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit-II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit-III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit-IV

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature

Unit-V

skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Text Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Adrian Wall work, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Reference Books:

1. Hyland K., 2009. Teaching and Researching Writing. Pearson Education Limited.
2. Swales J.M., Feak C.B., 2004. Academic Writing for Graduate Students. Ann Arbor: University of Michigan Press.

Course Outcomes:

The students will be able to:

1. Demonstrate writing meaningful sentences and coherent paragraphs
2. Show conciseness, clarity and avoid redundancy in writing
3. Summarize, evaluate literature, and write methodology, results and conclusion

4. Describe how to develop title, write abstract and introduction
5. Apply correct style of referencing and use punctuation appropriately
6. Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

M.Tech I semester **Course Code: UR19ACMRA100B** **L T P C**

0 0 0 0

Audit Course-1
Disaster Management

Internal Marks: 100

External Marks: 00

Course Objectives:

1. To increase the knowledge and understanding of the disaster phenomenon, its different contextual aspects, impacts and public health consequences.
2. To increase the knowledge and understanding of the International Strategy for Disaster Reduction (UN-ISDR) and to increase skills and abilities for implementing the Disaster Risk Reduction (DRR) Strategy.
3. To ensure skills and abilities to analyses potential effects of disasters and of the strategies and methods to deliver public health response to avert these effects.
4. To ensure skills and ability to design, implement and evaluate research on disasters.

UNIT-I

Introduction Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions Of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man- made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT-III

Disaster Prone Areas in India: Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

UNIT-IV

Disaster Preparedness and Management: Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V

Risk Assessment: Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co- Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Text Books:

1. Disaster Management Guidelines, GOI-UND Disaster Risk Program (2009-2012)
2. Damon, P. Copola, (2006) Introduction to International Disaster Management, Butterworth Heineman.
3. Gupta A.K., Niar S.S and Chatterjee S. (2013) Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
4. Murthy D.B.N. (2012) Disaster Management, Deep and Deep Publication PVT. Ltd. New Delhi.
5. Modh S. (2010) Managing Natural Disasters, Mac Millan publishers India LTD

Reference Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

Course Outcomes:

The students will be able to:

1. Understand foundations of hazards, disasters and associated natural/social phenomena
2. Familiarize with disaster management theory (cycle, phases)
3. Gain knowledge about existing global frameworks and existing agreements (e.g. Sendai)
4. Know the methods of community involvement as an essential part of successful DRR
5. Understand humanitarian Assistance before and after disaster
6. Gain knowledge on eechnological innovations in Disaster Risk Reduction: Advantages and problems

M.Tech I semester **Course Code: UR19ACMRA100C** **L T P C**

0 0 0 0

Audit Course-1
Sanskrit for Technical Knowledge

Internal Marks: 100

External Marks: 00

Course Objectives:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

UNIT-I

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

UNIT-II

Order, Introduction of roots, technical information about Sanskrit Literature

UNIT-III

Technical concepts of Engineering-Electrical

UNIT-IV

Technical concepts of Engineering - Mechanical.

UNIT-V

Technical concepts of Engineering - Architecture.

Technical concepts of Engineering – Mathematics.

Text Books:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati

Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication

3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Outcomes:

The students will be able to

1. Understand basic Sanskrit language
2. Know Ancient Sanskrit literature
3. Develop logic in mathematics, science & other subjects
4. Get working knowledge in illustrious Sanskrit
5. Learn Sanskrit to improve brain functioning.
6. Enhance the memory power

M.Tech I semester **Course Code: UR19ACMRA100D** **L T P C**

0 0 0 0

Audit Course-1
Value Education

Internal Marks: 100

External Marks: 00

Course Objectives:

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let they should know about the importance of character

UNIT-I

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

UNIT-II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature, Discipline

UNIT-III

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking.

UNIT-IV

Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT-V

Character and Competence –Holy books vs Blind faith. Self-management and good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women.
All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

Text Books:

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

Course Outcomes:

The students will be able to

1. Acquire Knowledge of self-development
2. Learn the importance of Human values
3. Develop the overall personality
4. Learn importance of cultivation of values
5. Learn self-management and good health
6. Learn about the importance of character

M.Tech II semester **Course Code: UR19PCMRA201** **L T P C**

3 0 0 3

Machine Learning

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Students understand issues and challenges of Machine Learning.
2. Able to select data, model selection, model complexity etc.
3. Understanding of the strengths and weaknesses of many popular machine learning approaches.

Unit-I

Introduction: Introduction to Machine Learning, learning task- illustration, Approaches to Machine Learning, Machine Learning algorithms- Theory, Experiment in biology and Psychology.

Concept Learning: Introduction, Concept Learning Task- Notation, Concept Learning Search, Version spaces, Candidate Elimination Algorithm, Inductive Bias, Biased hypothesis Space, Unbiased Learner, Bias-free Learning, Active queries, Mistake bound/PAC model – basic results. Overview of issues regarding data sources, success criteria

Unit-II

Decision Tree Learning: Decision Tree Representation, Basic decision Tree Learning, Inductive bias in Decision tree Learning, Issues in Decision Tree Learning, Minimum Description Length Principle, Occam's razor, learning with active queries

Unit-III

Neural Network Learning: Neural Network Representation, Problems for Neural Network Learning, Perceptions and gradient descent, Multi Layer Network and Back propagation Algorithm, Illustrative Example of Back Propagation Algorithm- Face Recognition, Advanced Topics in ANN.

Unit-IV

Bayesian Approaches: Basics of Bayes Theorem and Concept Learning, Expectation Maximization, Minimum Description Length Principle, Navie Bayes Classifier, Bayesian Belief Networks, EM Algorithm, K-Means

Algorithm, Hidden Markov Models Instance-Based Techniques; Lazy vs. eager generalization, k nearest neighbor, Locally Weight Representation, Case-based Reasoning

Unit-V

Analytical Learning: Inductive and Analytical Learning problems, Learning with perfect Domain Theory, Explanation Based Learning, Inductive Bias in EBL, Search Control Knowledge with EBL, Inductive- Analytical Approaches to Learning, Using prior Knowledge for Initialize the Hypothesis, and Altering Search objective, FOCL Algorithm.

Genetic Algorithms: Representation of Hypothesis as GA,, Genetic Operators, Fitness function and Selection, Hypothesis Space search, Genetic Programming, Models of Evolution and Learning, Parallelizing GA, Different search methods for induction

Text Books:

1. Machine Learning, Tom Mitchell, McGraw Hill,1997
2. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani & Jerome Friedman, Springer Verlag, 2001

Reference Books:

1. Pattern Classification, Richard 0. Duda, Peter E. Hart and David G. Stork, John Wiley & Sons Inc., 2001
2. Neural Networks for Pattern Recognition, Chris Bishop, Oxford University Press, 1995.

Course Outcomes:

The students will be able to

1. Identify the characteristics of datasets and compare the trivial data and big data for various applications.
2. Understand machine learning techniques and computing environment that are suitable for the applications under consideration.
3. Solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.
4. Develop scaling up machine learning techniques and associated computing techniques and technologies for various applications.

5. Implement various ways of selecting suitable model parameters for different machine learning techniques.
6. Understand the inference and learning algorithms for the hidden Markov model.

M.Tech II semester **Course Code: UR19PCMRA202** **L T P C**

3 0 0 3

Advanced Robotics

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Understanding of the role of automation technology in robot industry.
2. To develop high level mathematical skills for analysis and synthesis of an articulated arm robot.
3. To develop skills in the selection and application of different robots for various tasks

Unit-I

Control Systems and Components: Basic Control Systems Concepts and Models, Controllers, Control System Analysis, Robot Activation and Feedback Components, Power Transmission Systems, Robot Joint Control Design.

Sensors: Sensor Characteristics, Sensor Utilization, Position Sensors, Velocity Sensors, Acceleration Sensors, Force and Pressure Sensors, Torque Sensors, Micro switches, Visible Light and Infrared Sensors, Touch and Tactile Sensors, Proximity Sensors, Range Finders, Sniff Sensors, Taste Sensors,

Unit-II

Image Processing and Analysis with Vision Systems: Basic Concepts, Fourier Transform and Frequency Content of a Signal, Frequency Content of an Image; Noise, Edges , Resolution and Quantization, Sampling Theorem, Image-Processing Techniques, Histogram of Images, Thresholding, Spatial Domain Operations: Convolution Mask, Connectivity, Noise Reduction, Edge Detection, Sharpening an Image, Hough Transform, Segmentation, Segmentation by, Region Growing and Region Splitting, Binary Morphology Operations, Gray Morphology Operations, Erosion, Dilation, Object Recognition by Features, Depth Measurement with Vision Systems, Scene Analysis versus Mapping

Unit-III

Robot Programming: Programming methods, Robot program as path in space, Motion Interpolation, WAIT, SIGNAL DELAY Commands, Branching.

Robot Languages: The Textual Robot languages, Generations of Robot programming languages, Robot language Structures, Constants, Variables, and other data Objects, Motion Commands, program Control and Subroutines

Unit-IV

Robot Applications in Manufacturing: Material Transfer and Machine Loading/ Unloading, an Approach for Implementing Robotics

Unit-V

Future Applications: Characteristics of Future Robot Tasks, Future manufacturing Applications, Hazardous and Inaccessible Non-manufacturing Environments

Text Books:

1. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey Industrial Robotics: Technology, Programming, and Applications, 1st edition, McGraw-Hill International Edition, 1986
2. Saeed B. Niku, Introduction to Robotics Analysis, Application, Pearson Education Asia,2001.

Reference Book:

1. K.S.Fu, R.C Gonzalez, C.S.G.Lee , ROBOTICS , Control, Sensing , Vision and Intelligence , 1st edition, McGraw-Hill International Edition, 1987.

Course Outcomes:

The students will be able to

1. Understand basics and the latest technology of sensors used in robotics.
2. Analyze the image processing and vision systems
3. Understand the components and their working principles of a robotic system.
4. Learn forward kinematics, inverse kinematics and dynamic modeling of manipulators.

5. Learn robot programming and industrial application of robots.
6. Formulate and reflect on robot solutions to real-world problems

M.Tech II semester **Course Code: UR19PEMRA203A** **L T P C**

3 0 0 3

Elective –IV
Pattern Recognition

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Understand basic concepts in pattern recognition
2. Gain knowledge about state-of-the-art algorithms used in pattern recognition research
3. Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.
4. Apply pattern recognition techniques in practical problems.

Unit-I

Introduction: Overview of Pattern Recognition- Relations of PR with other Systems, PR Applications, Different Approaches to Pattern Recognition- Statistical Approach to PR, Syntactic Approach to PR, Neural Approach to PR, Examples of PR Approaches. Other Approaches to PR.

Unit-II

Structure of PR System: Abstract Representation of PR Mappings, Structure of PR System, Patterns and Feature s, Feature Extraction Examples, Object Description and Classification, Figure Recognition, Numerical Results and Analysis. Feature Vector and Feature Space, training and Learning in PR System.

Statistical Pattern Recognition: Introduction, Gaussian Case and Class Dependency, Discriminate Function, Examples, Classifier Performance,

Unit-III

Training: Parametric Estimation and Supervised Learning, Maximum Likely Hood Estimation, Bayesian Parameter Estimation Approach, Parzen Windows, Direct Classification Using Training set., Unsupervised Learning and Clustering, Clustering for Unsupervised Learning and Classification

Unit-IV

Syntactic Pattern Recognition: Overview of Syntactic Pattern Recognition, Grammar Based Approaches and Applications, Examples of String Generation as Pattern Description, 2-D line Drawing Description Grammar, Character Description using PDL, Object Description using Projected Cylinder Models, Block World Description Models, Heuristic Generation of Grammars,

Recognition of Syntactic Description: Recognition by Matching, Recognition by Parsing, CYK Parsing Algorithm, Augmented Transition Nets in Parsing, Graph Based structure representation, Structured Strategy to Compare Attributed Graphs.

Unit-V

Neural Pattern Recognition: Introduction to Neural Networks, Neural Network Structure for PR Applications, Physical Neural Networks, ANN Model, NN Based PR Association, Matrix Approaches and Examples

Feed Forward Neural Networks: Training by Back Propagation, Hope field Approach to Neural Computing, Other related Neural Approaches and Extensions

Text Book:

1. Pattern Recognition- Statistical, Structural and Neural Approaches, Rober.J. Shelkoff, John Wiley & Sons, NY1992, ISBN0-471-52974-5

Reference Books:

1. Neural Networks for pattern recognition, Christopher M.Bishop Oxford University Press.
2. Pattern Classification, Richard O.Duda, Wiley India Edition.

Course Outcomes:

The students will be able to

1. Understand and apply various algorithms for pattern recognition.
2. Realize the clustering concepts and algorithms.
3. Bring out structural pattern recognition and feature extraction techniques.
4. Identify, analyze, formulate, and solve engineering problems.

5. Design, analyze, the Neural Network Structure.
6. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

M.Tech II semester **Course Code: UR19PEMRA203B** **L T P C**

3 0 0 3

Elective –IV
Soft Computing

Internal Marks: 30

External Marks: 70

Course Objectives:

1. To familiarize the salient approaches in soft computing based on artificial neural networks, fuzzy logic, and genetic algorithms.
2. To introduce applications of soft computing to different research areas in Computer Science / Information Technology.

Unit-I

Introduction to Intelligent systems and Soft Computing: Intelligent Systems, Knowledge based Systems, Knowledge representation and Processing, Soft Computing

Unit-II

Fundamentals of Fuzzy logic systems: Evolution of Fuzzy logic, developmental stages and utility in Expert system development, Fuzzy sets, Fuzzy operators, generalized operators, implication, support set and alpha cut, fuzzy resolution, measures of fuzziness fuzzy relations, composition and inference, fuzzy decision making

Fuzzy logic Control: Basics of fuzzy control, Defuzzification, Fuzzification, fuzzy control surface, Fuzzy control architectures, Properties of fuzzy control, robustness and stability

Unit-III

Fundamentals of Artificial Neural networks: Learning and acquisition of knowledge, features of ANN, topologies, learning algorithms, Fundamentals of Connectionist Modeling

Major classes of Neural networks: Multi-layer perception, RBF networks, Korhonen's self organizing networks, Hopfield networks, Industrial and commercial applications of ANN

Unit-IV

Dynamic Neural networks and their Applications: Basics concepts,

dynamic and architecture of Recurrent networks (RNN), training algorithms, Dynamic neural networks for identification and control, Dynamic neural networks for chaos time series prediction, ANN for chaos prediction.

Unit-V

Neuro-fuzzy Systems: Architectures of Neuro-fuzzy systems, cooperative Neuro-fuzzy systems, Hybrid Neuro-fuzzy systems, construction of Neuro-fuzzy systems, structure identification and parameter learning phases.

Text Book:

1. Soft Computing and Intelligent Systems Design, Fakhreddine O.Karray and Clarence De Silva, Pearson Edu

Reference Books:

1. Fuzzy Logic With Engineering Application, Timothy J.Ross, John Wiley & Sons Publishing Company
2. Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms, Samir Roy, Ist Edition, Pearson Edu.

Course Outcomes:

The students will be able to

1. Apply soft computing techniques to research problems.
2. Apply basics of Fuzzy logic and neural networks.
3. Discuss the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience
4. Relate with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems
5. Describe with genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations.
6. Develop some familiarity with current research problems and research methods in Soft Computing Techniques.

M.Tech II semester **Course Code: UR19PEMRA203C** **L T P C**

3 0 0 3

Elective –IV
Cryptography& Network Security

Internal Marks: 30

External Marks: 70

Course Objectives:

1. To understand basics of Cryptography and Network Security.
2. To be able to secure a message over insecure channel by various means.
3. To learn about how to maintain the Confidentiality, Integrity and Availability of a data.
4. To understand various protocols for network security to protect against the threats in the networks.

Unit-I

Overview: Computer Security Concepts, Threats, Attacks, and Assets, Security Functional Requirements, Security Architecture for Open Systems, Computer Security Trends, Computer Security Strategy. Cryptographic Tools: Confidentiality with Symmetric Encryption, Message Authentication and Hash Functions, Public-Key Encryption, Digital Signatures and Key Management, Random and Pseudorandom Numbers, Practical Application: Encryption of Stored Data. User Authentication: Means of Authentication, Password-Based Authentication, Token-Based Authentication, Biometric Authentication, Remote User Authentication, Security Issues for User Authentication, Practical Application: An Iris Biometric System, Case Study: Security Problems for ATM Systems.

Unit-II

Access Control: Access Control Principles, Subjects, Objects, and Access Rights, Discretionary Access Control, Example: UNIX File Access Control, Role-Based Access Control, Case Study: RBAC System for a Bank. Database Security: The Need for Database Security, Database Management Systems, Relational Databases, Database Access Control, Inference, Statistical

Databases, Database Encryption, Cloud Security.

Unit-III

Malicious Software: Types of Malicious Software (Malware),Propagation—Infected Content—Viruses, Propagation—Vulnerability Exploit—Worms, Propagation—Social Engineering—SPAM E-mail, Trojans, Payload—System Corruption, Payload—Attack Agent—Zombie, Bots, Payload—Information Theft—Key loggers, Phishing, Spyware, Payload—Steal thing—Backdoors, Root kits, Counter measures.

Unit-IV

Denial-of-Service Attacks: Denial-of-Service Attacks, Flooding Attacks, Distributed Denial-of-Service Attacks, Application-Based Bandwidth Attacks, Reflector and Amplifier Attacks, Defenses Against Denial-of-Service Attacks, Responding to a Denial-of-Service Attack.

Intrusion Detection: Intruders, Intrusion Detection, Host-Based Intrusion Detection, Distributed Host-Based Intrusion Detection, Network-Based Intrusion Detection, Distributed Adaptive Intrusion Detection, Intrusion Detection Exchange Format, And Honeypots, Example System: Snort. Firewalls and Intrusion Prevention Systems: The Need for Firewalls, Firewall Characteristics, Types of Firewalls, Firewall Basing, Firewall Location and Configurations, Intrusion Prevention Systems, Example: Unified Threat Management Products.

Unit-V

Buffer Overflow: Stack Overflows, Defending Against Buffer Overflows, Other Forms of Overflow Attacks, Software Security: Software Security Issues, Handling Program Input, Writing Safe Program Code, Interacting with the Operating System and Other Programs, Handling Program Output. Operating System Security: Introduction to Operating System Security, System Security Planning, Operating Systems Hardening, Application Security, Security Maintenance, Linux/Unix Security, Windows Security, Virtualization Security.

Text Book:

1. Computer Security - Principles and Practices (Except the Chapters 13, 14, 15, 16, 17, 18, 19), 2ndEdition by William Stallings,

Pearson Education, Inc.

Reference Books:

1. Cryptography and Network Security by William Stallings, Pearson Education Asia, New Delhi.
2. Network Security Essentials Applications and Standards, by William Stallings,Pearson Education Asia, NewDelhi.

Course Outcomes:

The students will be able to

1. Understand various Cryptographic Techniques.
2. Apply various public key cryptography techniques.
3. Implement Hashing and Digital Signature techniques.
4. Understand the various Security Applications.
5. Implement system level security applications.
6. Protect any network from the threats in the world.

M.Tech II semester **Course Code: UR19PEMRA203D** **L T P C**

3 0 0 3

Elective –IV
Intelligent Manufacturing Systems

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Planning manufacturing systems
2. Computer integrated manufacturing and enterprise integration
3. Group Technology
4. Knowledge based systems

Unit-I

Introduction to CIM: Manufacturing - Types, Manufacturing Systems, CIM Definition, CIM wheel, CIM components, Evolution of CIM, needs of CIM, Benefits of CIM, basic components of NC system, NC motion control system, applications of NC, advantages and disadvantages of NC, computer Numerical control, advantages of CNC, functions of CNC, Direct Numerical Control, components of a DNC system, functions of DNC, advantages of DNC.

Unit-II

CAD: Development of computers, CIM Hardware & Software, Data-Manufacturing data, types, sources, Structure of data models, Data base and DBMS- requirement, RDBMS, SQL, Computer Aided Design - benefits, Graphic Standards, Interfaces, CAD software, Integration of CAD/CAM/CIM.

Unit-III

Flexible Manufacturing Systems: FMS concept, Components of FMS, FMS Layouts, FMS planning and implementation, Tool Management Systems-Tool monitoring, Work holding devices- Modular fixturing, flexible fixturing, flexibility, quantitative analysis of flexibility, application and benefits of FMS, automated material handling system –AGVs, Guidance methods, AS/RS.

Unit-IV

Automated Process Planning: Group Technology, Part families, Part classification and coding, Production flow analysis, Machine cell design, Applications and Benefits of Group Technology, Structure of a Process Planning, Process Planning function, CAPP - Methods of CAPP, CAD based Process Planning, Inventory management - Materials requirements planning - basics of JIT

Unit-V

Monitoring And Quality Control: Types of production monitoring system, process control & strategies, Direct digital control - Supervisory computer control - computer aided quality control - objectives of CAQC, QC and CIM, contact, non-contact inspection methods, CMM and Flexible Inspection systems. Integration of CAQC with CIM.

Text Books:

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", 8th edition, PHI, 2008.
2. Yagna Narayana, "Artificial Neural Networks", PHI, 2009.

Reference Books:

1. Kant Vajpayee. S., "Principles of Computer Integrated Manufacturing", Prentice Hall of India, 1999
2. Radha krishnan.P, Subramanyan. S, "CAD/CAM/CIM", New Age International publishers, 200
3. Scheer.A.W., "CIM- Towards the factory of the future" Springer - Verlag, 1994
4. Daniel Hunt.V., "Computer Integrated Manufacturing Hand Book", Chapman & Hall, 1989
5. Groover M.P, "Computer Aided Design and Manufacturing", Prentice Hall of India, 1987
6. Yorem Koren, "Computer Control of Manufacturing System", McGraw Hill, 1986
7. Ranky Paul. G., "Computer Integrated Manufacturing", Prentice Hall International, 1986

Course Outcomes:

The students will be able to

1. Know the basic components of CIM and its hardware and software.
2. Understand CAD/CAM and its integration with CIM.
3. Know FMS and its applications.
4. Understand principles of computer aided process planning, JIT and GT.
5. Gain knowledge on different monitoring systems used in CIM and Computer Aided Quality Control and FIS.
6. Suggest new procedures to improve the productivity of existing manufacturing systems

M.Tech II semester **Course Code: UR19OEMRA204A** **L T P C**

3 0 0 3

Elective-V
MOOCs-1 (NPTEL/SWAYAM)-Any 12 Week Course duration related to the program which is not listed in the course structure

Internal Marks:

External Marks:

Student has to register in any one of the courses as mentioned above and need to submit a certificate.

In case a student fails to complete the NPTEL/SWAYAM course offered by NPTEL/SWAYAM providers, he/she may be allowed to register again for the same with any of the providers from the list approved by the department.

M.Tech II semester **Course Code: UR19PEMRA204B** **L T P C**

3 0 0 3

Elective –V
Cognitive Robotics

Internal Marks: 30

External Marks: 70

Course Objectives:

1. To provide brief introduction to robot cognition and perception
2. Understanding the concepts of path planning algorithms.
3. To gain knowledge on the robot programming packages used in localization and mapping.

Unit-I

Cybernetic View of Robot Cognition and Perception: Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, Soft Computing Tools and Robot Cognition.

Unit-II

Map Building: Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Traverse Boundary, An Illustration of Procedure Map Building, Robot Simulation, Execution of the Map Building Program.

Unit-III

Randomized Path Planning: Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Verona diagrams, Potential Fields and Cell Decomposition, Planning with moving obstacles, Probabilistic Roadmaps, Rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

Unit-IV

Simultaneous Localization and Mapping (SLAM): Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization

Techniques, Particle Methods Relation of Paradigms.

Unit-V

Robot Programming Packages: Robot Parameter Display, Program for Bot Speak, Program for Sonar Reading Display, Program for Wandering Within the Workspace, Program for Tele-operation, A Complete Program for Autonomous Navigation.

Imaging Geometry: Introduction – Necessity for 3D Reconstruction – Building Perception – Imaging Geometry – Global Representation – Transformation to Global Co-ordinate System.

Text Books:

1. Patnaik, Srikanta, "Robot Cognition and Navigation - An Experiment with Mobile Robots", Springer Verlag Berlin and Heidelberg, 2007.
2. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, “Principles of Robot Motion-Theory, Algorithms, and Implementation”, MIT Press, Cambridge, 2005.

Reference Books:

1. Sebastian Tharun, Wolfram Burgard, Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.
2. Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg 2008.
3. Hooman Somani,” Cognitive Robotics”, CRC Press, 2015.
4. Jared Kroff,” Cognitive Robotics: Intelligent Robotic Systems”, Wilford Press, 2016.

Course Outcomes:

The students will be able to

1. Discuss about the basics of robot cognition and perception
2. Illustrate the different methods of map building and the robot simulation and execution of a program
3. Analyze the various path planning techniques by briefing about the robot’s environment and explaining about the programs used
4. Develop knowledge about simultaneous localization and mapping-

based techniques and paradigms.

5. Elaborate the various robot programming packages for display, tele-operation and other applications and describe the aspects of Imaging Techniques used in Robotic Applications.
6. Describe the aspects of Imaging Techniques used in Robotic Applications.

M.Tech II semester **Course Code: UR19PEMRA204C** **L T P C**

3 0 0 3

Elective –V
Design of Intelligent Robotic Systems

Internal Marks: 30

External Marks: 70

Course Objectives:

1. The primary objective of this course is to provide an introduction to the basic principles, techniques, and applications of Artificial Intelligence.
2. The emphasis of the course is on teaching the fundamentals and not on providing a mastery of specific commercially available software tools or programming environments.
3. Upon successful completion of the course, students will have an understanding of the basic areas of artificial intelligence search, knowledge representation, learning and their applications in design and implementation of intelligent agents for a variety of tasks in analysis, design, and problem solving.
4. Aim of this course is to know about Lisp and Prolog and use of these languages in AI. Graduate students are expected to develop some familiarity with current research problems and research methods in AI by working on a research or design project.

Unit-I

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

Unit-II

Components of Knowledge Based Systems - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

Unit-III

Machine Learning - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks -Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

Unit-IV

Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approaches in KBSES, Structure of the KRSES.

Unit-V

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology -Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

Text Books:

1. Elaine Rich, Kevin Knight, Artificial Intelligence TMH (Any Edition).
2. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education., 2009
3. Max Braber, Logic Programming with Prolog, Springer, 2005

Reference Books:

1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2. Artificial Neural Networks/ Yagna Narayana/PHI/2006
3. Automation, Production Systems and CIM / Groover M.P./PHI/2007
4. Neural networks: A comprehensive foundation/ Simon Hhaykin/ PHI.
5. Artificial neural networks/ B.Vegnanarayana/PHI
6. Neural networks in Computer intelligence/ Li Min Fu/ TMH/2003
7. Neural networks/ James A Freeman David M S kapura/ Pearson education/2004.

8. Introduction to Artificial Neural Systems/Jacek M. Zurada/JAICO Publishing House Ed. 2006.

Course Outcomes:

The students will be able to:

1. Classify the different techniques for Computer Integrated Manufacturing Systems Structure and functional areas of CIM system.
2. Model a Knowledge Based System.
3. Design, Models and write Algorithms for various Specific applications for Intelligent Automated Manufacturing Process.
4. Suggest new procedures to improve the productivity of existing manufacturing systems
5. Utilize online collaboration tools to work in complex teams.
6. Design and perform an empirical evaluation of different algorithms on a problem formalization

M.Tech II semester **Course Code: UR19PEMRA204D** **L T P C**

3 0 0 3

Elective –V
Optimization in Engineering Design

Internal Marks: 30

External Marks: 70

Course Objectives:

1. Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems.
2. Learn classical optimization techniques and numerical methods of optimization.
3. Know the basics of different evolutionary algorithms.
4. Explain Integer programming techniques and apply different optimization techniques to solve various models arising from engineering areas.

Unit-I

Introduction: Introduction to optimization – adequate and optimum design principles of optimization – statement of an optimization problem – classification – formulation of objective function, design constraints.

Unit-II

Classical Optimization Techniques: Single variable optimization – multivariable optimization with no constraints – exhaustive search, Fibonacci method, golden selection, and Random, pattern and gradient search methods – Interpolation methods: quadratic and cubic, direct root method.

Unit-III

Multivariable-Unconstrained and Constrained Optimization: Direct search methods – descent methods – conjugate gradient method. Indirect methods – Transformation techniques, penalty function method

Unit-IV

Non-Traditional Optimization Techniques: Genetic Algorithms - Simulated Annealing - Tabu search methods.

Unit-V

Optimum Design of Machine Elements: Desirable and undesirable effects – functional requirement – material and geometrical parameters – Design of simple axial, transverse loaded members for minimum cost and minimum weight – Design of shafts, springs, Vibration absorbers.

Text Books:

1. Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers
2. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers

Reference Books:

1. Rao, S.S., "Optimization – Theory and Applications", Wiley Eastern
2. Fox, R.L., Optimization Methods for Engineering Design, Addition – Wesley, Reading, Mass, 1971.
3. Wilde, D.J., "Optimum Seeking Methods", Prentice Hall, Englewood Cliffs, New Jersey, 1964.
4. Johnson, Ray C., "Optimum Design of Mechanical Elements", 2nd Ed., John Wiley & sons, Inc., New York, 1980.

Course Outcomes:

The students will be able to

1. Know the principles of optimization and its need.
2. Understand various conventional optimization techniques
3. Solve multivariable problems
4. Solve problems using unconventional optimization techniques
5. Apply optimization to design machine elements
6. Use classical optimization techniques and numerical methods of optimization

M.Tech II semester **Course Code: UR19OEMRA205A** **L T P C**

3 0 0 3

Open Elective
MOOCs-2 (NPTEL/SWAYAM)-Any 12 Week Course on Engineering /Management/ Mathematics offered by other than parent department

Internal Marks:

External Marks:

Student has to register in any one of the courses as mentioned above and need to submit a certificate.

In case a student fails to complete the NPTEL/SWAYAM course offered by NPTEL/SWAYAM providers, he/she may be allowed to register again for the same with any of the providers from the list approved by the department.

M.Tech II semester **Course Code: UR19OEMRA205B** **L T P C**

3 0 0 3

Open Elective
Robot Economics

Internal Marks: 30

External Marks: 70

Course Objective:

To learn various economic and social aspects of Robotics and its installation Procedure

Unit- I

Robot Components and Theirs Selection: Power supply, movement and drive systems, sensors, end effector and grippers, Control techniques, Characteristics and factor considered for selection.

Unit -II

Economic Analysis for Robotics: Economic analysis for robotics. Economic analysis, basic data required methods of Economic analysis, subsequent uses of robot, Difference in production rates, other factors Robot project analysis form.

Unit-III

Implementing Robotics: Familiarization with robotics technology, plant survey to identify potential applications, Selection of the best applications, Selection of a robot, Detailed economic analysis, planning and installation.

Unit -IV

Social Issues: Safety in Robotics, Training, Maintenance, Quality improvement, productivity and capital formation, Robotics and labour. Education and training, international impacts, future applications.

Unit-V

Robotics Technology of the Future: Robot intelligence, Advanced Sensors, Capabilities, Tele robotics, Mechanical design Features, Mobility, locomotion and Navigation. The universal Hand Systems Integration and Networking. Robots in RPT.

Text Books:

1. Mikell P. Groover& Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, “Industrial Robotics, Technology Programming and Applications”, McGraw Hill, 2012.
2. Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin, “Robotics Engineering an Integrated Approach”, Phi Learning., 2009.
3. Radhakrishnan. P, Srivatsavan. R, Mohan Ram. P.V and Radharamanan. R, CAD/CAM, “Robotics and factories of the future, Proceeding of the 14thInternational Conference on CAR and FOF”, 98 editors, Narosa Publishing house, 2003.

Reference Book:

1. Gonzalez Fu .K.S, . Lee R.S, .C.S.G, “Robotics Control, Sensing Vision and Intelligence”, Tata McGraw Hill Education, 2008.

Course Outcomes:

The students will be able to:

1. Analyze various costs and potential benefits associated with the robot installation.
2. Understand several methods for analyzing these factors to determine economic merits of the project.
3. Know the logical sequences/procedures to implement the robotic installation and social issues, applications.
4. Understand the concepts in selection of robot.
5. Understand the installation and planning process.
6. Understand the various integration and network systems in using robot.

M.Tech II semester **Course Code: UR19OEMRA205C** **L T P C**

3 0 0 3

Open Elective
Cost Management of Engineering Projects

Internal Marks: 30

External Marks: 70

Course Objectives:

1. To introduce the basic principles of strategic cost management and the related terminology
2. To familiarize the project planning and execution process involving technical/nontechnical activities
3. To acquaint the student with detailed engineering activities and their cost management analysis
4. To impart the knowledge of cost analysis and profit planning of engineering projects
5. To familiarize the quantitative techniques for optimization of budget allocation

Unit-I

Introduction and Overview of the Strategic Cost Management Process Cost concepts indecision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost.

Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Unit-II

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Unit-III

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing

and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Unit-IV

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

Unit-V

Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Text Books:

1. 1.Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.
2. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Reference Books:

1. Charles T. Horngren, Srikant M. Datar, Cost Accounting A Managerial Emphasis, Pearson, 13th Edition, 2009.
2. Ahmed Riahi- Belkaoui., Advanced Management Accounting, Greenwood Publication Group, 2001.
3. Robert S Kaplan Anthony A. Alkinson, Management Accounting, Prentice Hall, 4thEdition, 2003.
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1998.
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw

Hill Book Co. Ltd.,2015.

Course Outcomes:

The students will be able to

1. Understand the concept of Strategic Cost Management Determine losses of pre-stress in pre-stressed concrete structures.
2. Understand the concept of Strategic Cost Analysis - Target Costing, Life Cycle Costing & Kaizen Costing.
3. Analyze the decision making and Pricing Strategies.
4. Understand the concept of cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost.
5. Determine costing system and inventory valuation.
6. Create database for operational control.

M.Tech II semester **Course Code: UR19OEMRA205D** **L T P C**

3 0 0 3

Open Elective
Finite Element Methods in Engineering

Internal Marks: 30

External Marks: 70

Course Objectives:

1. To understand the mathematics behinds the main components of finite element methods: formulation of finite element methods, matrices assembly for implementation, construction of finite element spaces, approximation theories, error estimates
2. To carry out standard mathematical analysis and derivations related to constructing and
3. Analyzing finite element methods
4. To implement finite element methods for 1D and 2D model problems, and to evaluate and to interpret the numerical results

Unit-I

Introduction to Finite Element Method: General description of the finite element method. Engineering applications of finite element method. Boundary conditions: homogeneous and non homogeneous for structural, heat transfer and fluid flow problems. Potential energy method, Rayleigh Ritz method, Galerkin's method, Displacement method of finite element formulation. Convergence criteria, Discretization process, Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain displacement relations, Stress strain relations, Plain stress and Plain strain conditions, temperature effects.

Unit-II

One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Nodded Tetrahedral Element (TET 4), Eight-Nodded Hexahedral Element (HEXA8), 2D iso-

parametric element, Lagrange interpolation functions, Numerical integration: Gaussian quadrature one point, two-point formulae, 2D integrals. Fore terms: Body force, traction force and point loads, Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach, Analysis of trusses

Unit-III

Beams and Shafts: Boundary conditions, Load vector, Hermite shape functions, Beam stiffness matrix based on Euler-Bernoulli beam theory, Examples on cantilever beams, propped cantilever beams, Numerical problems on simply supported, fixed straight and stepped beams using direct stiffness method with concentrated and uniformly distributed load. Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.

Unit-IV

Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, energy generated in solid, energy stored in solid, 1D finite element formulation using vibrational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins.

Unit-V

Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels.

Dynamic Considerations: Formulation for point mass and distributed masses, Consistent element mass matrix of one-dimensional bar element, truss element, axisymmetric triangular element, quadrilateral element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

Text Books:

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

Reference Books:

1. J.N.Reddy, "Finite Element Method"- McGraw -Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
2. Cook R. D., et al. "Concepts and Application of Finite Elements Analysis"- 4th Edition, Wiley & Sons, 2003.

Course Outcomes:

The students will able to

1. Understand the concepts behind formulation methods in FEM.
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.
3. Develop element characteristic equation and generation of global equation.
4. Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi symmetric and dynamic problems and solve them displacements, stress and strains induced.
5. Comprehend quantitative and analytical methods
6. Understand and perform engineering analysis of machine systems and simple structures

M.Tech II semester **Course Code: UR19OEMRA205E** **L T P C**

3 0 0 3

Open Elective
Additive Manufacturing Technologies

Internal Marks: 30

External Marks: 70

Course Objective:

The objective of the Course is to study methods used in additive manufacturing, theories governing the additive manufacturing, give information on materials, explain relations between materials to be processed and methods of additive manufacturing with introduction to common machines used for the technology and show applications and business opportunities with future directions.

Unit–I

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

Unit–II

Liquid-based AM Systems: Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Poly jet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Micro fabrication.

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and

specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Unit–III

Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

Unit–IV

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques.

AM Software's: Need for AM software, features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, Surgi Guide,3-matic, Simplant, Mesh Lab.

Unit–V

AM Applications: Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace

Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Bio molecules. Web Based Rapid Prototyping Systems

Text Book:

1. Rapid prototyping: Principles and Applications by Chua C.K., Leong K.F. and LIM C.S, World Scientific publications, Third Edition, 2010.

Reference Books:

1. Rapid Manufacturing by D.T. Pham and S.S. Dimov, Springer, 2001.
2. Wholers Report 2000 by Terry Wohlers, Wohlers Associates, 2000.
3. Rapid Prototyping & Engineering Applications by Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.

Course outcomes:

The students will be able to:

1. Understand the fundamentals for additive manufacturing and how it is different and discuss about various types of liquid based, solid based and powder-based AM technologies.
2. Understand the various types of Pre-processing, processing, post-processing errors in AM.
3. Know various types of data formats and software's used in AM.
4. Know various applications of AM in design analysis, aerospace, automotive, biomedical and other fields.
5. Describe the effects of surface finish and microstructural properties on behavior for components produced using additive manufacturing
6. Display an awareness of residual stresses that may occur during additive manufacturing and their effects.

M.Tech II semester **Course Code: UR19PCMRA211** **L T P C**

0 0 3 1.5

Machine Learning Lab

Internal Marks: 15

External Marks: 35

1. The programs can be implemented in either JAVA or Python.
2. For Problems 1 to 6 and 10, programs are to be developed without using the built-in classes or APIs of Java/Python.
3. Data sets can be taken from standard repositories (https://archive.ics.uci.edu/ml/datasets.html) or constructed by the students.

Lab Experiments:

1. Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.

2. For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.

3. Write a program to demonstrate the working of the decision tree based ID3algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

4. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.

5. Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

6. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task. Built-in Java classes/API can be used to write the program. Calculate the accuracy, precision, and recall for your data set.

7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API.

8. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Note: Minimum 90% experiments of duration 3 periods each must be completed for the eligibility to appear for the semester end examinations.

In case if the student fails to get eligibility for semester end exams in the current semester, he has to take the permission of HOD and complete the required number of experiments and appear for semester end exam as and when conducted.

M.Tech II semester **Course Code: UR19PCMRA212** **L T P C**

0 0 3 1.5

Robotics Lab

Internal Marks: 15

External Marks: 35

This Lab is intended to get familiarized with mechanical, electrical, and electronics structures of different types of robots for monitoring, controlling and developing applications like pick and place, swapping, etc., by either stand alone controller in the robot structure or interfacing to PC.

1. Programming a simple Robot on Wheels.

2. Programming a Walking Robot.

3. Experiments based on Bipedal Robot.

4. Experiments based on Humanoid Robot-ROOBONOVA.

5. Pick and Place Application Programming with 4 DOF Robot Arm by Interfacing to PC.

6. Swap Application Programming with 4 DOF Robot Arm by Interfacing to PC.

7. Pick and Place Application Programming with 5 DOF Robot Arm by Interfacing to PC.

8. Swap Application Programming with 5 DOF Robot Arm by Interfacing to PC.

9. Pick and Place Application Programming with 6 DOF Robot Arm by Interfacing to PC.

10. Swap Application Programming with 6 DOF Robot Arm by Interfacing to PC.

11. Studies on Existing Robots, Computer-Aided-Design of Robots

12. Topics in Machine Elements

Note: Minimum 90% experiments of duration 3 periods each must be completed for the eligibility to appear for the semester end examinations.

In case if the student fails to get eligibility for semester end exams in the current semester, he has to take the permission of HOD and complete the required number of experiments and appear for semester end exam as and when conducted.

M.Tech II semester **Course Code: UR19PJMRA213** **L T P C**

0 0 0 2

Mini Project with Seminar

Internal Marks: 30

External Marks: 00

Guidelines to be followed:

1. A Brief report to be submitted at the end of semester.
2. Project may be design based/fabrication based/experimental or testing based.
3. Simulation or analysis works will be permitted with prior permission of Head of the Department
4. Project should have novelty and address real life problems.

Evaluation:

All the students should present a demonstration in front of evaluation committee constituted by the Head of the department.

M.Tech II semester **Course Code: UR19 ACMRA200A** **L T P C**

0 0 0 0

Audit Course-2
Constitution of India

Internal Marks: 100

External Marks: 00

Course Objectives:

1. To understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT-I

History of Making of the Indian Constitution:

History, Drafting Committee, (Composition & Working)

UNIT-II

Philosophy of the Indian Constitution:

Preamble Salient Features

UNIT-III

Contours of Constitutional Rights & Duties:

Fundamental Rights

Right to Equality

Right to Freedom

Right against Exploitation

Right to Freedom of Religion

Cultural and Educational Rights

Right to Constitutional Remedies

Directive Principles of State Policy

Fundamental Duties.

UNIT-IV:

Organs of Governance:

Parliament

Composition

Qualifications and Disqualifications

Powers and Functions

Executive

President Governor

Council of Ministers

Judiciary, Appointment and Transfer of Judges, Qualifications

Powers and Functions

UNIT-V

Local Administration:

District's Administration head: Role and Importance,

Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

Pachayati raj: Introduction, PRI: ZilaPachayat.

Elected officials and their roles, CEO ZilaPachayat: Position and role.

Block level: Organizational Hierarchy (Different departments),

Village level: Role of Elected and Appointed officials,

Importance of grass root democracy

Election Commission:

Election Commission: Role and Functioning.

Chief Election Commissioner and Election Commissioners.

State Election Commission: Role and Functioning.

Institute and Bodies for the welfare of SC/ST/OBC and women.

Text Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

The students will able to:

1. Understand the emergence and evolution of Indian Constitution.
2. Understand the structure and composition of Indian Constitution
3. Understand and analyses federalism in the Indian context.
4. Analyze Panchayati Raj institutions as a medium of decentralization
5. Understand and analyze the three organs of the state in the contemporary scenario.
6. Understand and Evaluate the Indian Political scenario amidst the emerging challenges.

M.Tech II semester **Course Code: UR19 ACMRA200B** **L T P C**

0 0 0 0

Audit Course-2
Pedagogy Studies

Internal Marks: 100

External Marks: 00

Course Objectives:

Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

UNIT-I

Introduction and Methodology:

Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education.

Conceptual framework, Research questions**.** Overview of methodology and Searching.

UNIT-II

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT-III

Evidence on the effectiveness of pedagogical practices Methodology for the in-depth stage: quality assessment of included studies.

How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT-IV

Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-V

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes

Research gaps and future directions

Research design

Contexts Pedagogy

Teacher education

Curriculum and assessment Dissemination and research impact.

Text Books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to:

1. Understand pedagogical practices being used by teachers in formal and informal classrooms in developing countries
2. Know the evidence on the effectiveness of these pedagogical practices and conditions, and population of learners
3. Learn teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?
4. Demonstrate the challenges undertaken and developing new skills.
5. Identify own strengths and develop areas for growth.
6. Understand cognitive strategy.

M.Tech II semester **Course Code: UR19ACMRA200C** **L T P C**

0 0 0 0

Audit Course-2
Stress Management by Yoga

Internal Marks: 100

External Marks: 00

Course Objectives:

1. To achieve overall health of body and mind
2. To overcome stress

UNIT-I

Definitions of Eight parts of yog. (Ashtanga)

UNIT-II

Yam and Niyam. Do`s and Don't's in life. Ahinsa, satya, astheya, bramhacharya and aparigraha

UNIT-III

Yam and Niyam. Do`s and Don't's in life. Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT-IV

Asan and Pranayam Various yog poses and their benefits for mind & body

UNIT-V

Regularization of breathing techniques and its effects-Types of pranayam

Text Books:

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami YogabhyasiMandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Outcomes:

Students will be able to:

1. Use practical tools for stress management in educational environments;
2. Foster resilience and Scope with stressful situations at the workplace to increase their well-being;
3. Improve their emotional intelligence to better deal with stress;
4. Integrate emotional intelligence skills into the curricula;
5. Help students to deal with school stress;
6. Understand the best relaxation techniques for educators and students.

M.Tech II semester **Course Code: UR19ACMRA200D** **L T P C**

0 0 0 0

Audit Course-2
Personality Development through Life Enlightenment Skills

Internal Marks: 100

External Marks: 00

Course Objectives:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

UNIT-I

Neetisatakam-Holistic development of personality

Verses- 9,20,21,22 (wisdom)

Verses- 29, 31, 32 (pride & heroism)

Verses- 26,28,63,65 (virtue)

UNIT-II

Neetisatakam-Holistic development of personality

Verses- 52, 53, 59 (dont's)

Verses- 71,73,75,78 (do's)

Approach to day-to-day work and duties.

Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,

UNIT-III

Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,

Chapter 18-Verses 45, 46, 48.

UNIT-IV

Statements of basic knowledge.

Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68

Chapter 12 -Verses 13, 14, 15, 16,17, 18

UNIT-V

Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17,

Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

Text Books:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar vairagya) by P.Gopinath, Rashtriy Sanskrit Sansthanam, New Delhi.

Course Outcomes:

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta
2. Develop his personality and achieve the highest goal in life
3. Know how to lead the nation after studying Geeta
4. Make mankind with peace and prosperity
5. Understand Neetishatakam
6. Develop versatile personality of students

M.Tech III semester **Course Code: UR19PJMRA311** **L T P C**

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Project work phase-I

Internal Marks: 20

External Marks: 30

Guidelines to be followed:

1. A brief report to be submitted at the end of semester.
2. Project may be design based/fabrication based/experimental or testing based.
3. Simulation or analysis works will be permitted with prior permission of Head of the Department
4. Project should have novelty and address real life problems.

Evaluation:

All the students should present a demonstration in front of evaluation committee constituted by the Head of the department.

M.Tech IV semester **Course Code: UR19PJMRA411** **L T P C**

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Project work phase-II

Internal Marks: 60

External Marks: 90

Guidelines to be followed:

1. A brief report to be submitted at the end of semester.
2. Project may be design based/fabrication based/experimental or testing based.
3. Simulation or analysis works will be permitted with prior permission of Head of the Department
4. Project should have novelty and address real life problems.

Evaluation:

All the students should present a demonstration in front of evaluation committee constituted by the Head of the department.