MANAKULA VINAYAGAR INSTITUTE OF TECHNOLOGY

Approved by AICTE, New Delhi and Affiliated to Pondicherry University
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Kalitheerthalkuppam, Puducherry - 605107

DEPARTMENT OF ROBOTICS AND AUTOMATION

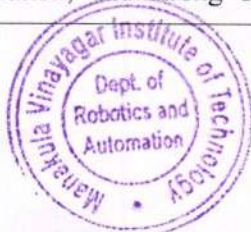| SEMESTER-III	
SUBJECT CODE	**NAME OF THE SUBJECT**
RA T31	LINEAR ALGEBRA
RA T32	ELECTRONIC DEVICES AND CIRCUITS
RA T33	PROGRAMMING IN PYTHON
RA T34	SENSORS AND INSTRUMENTATION
RA T35	ELECTRICAL MACHINES AND DRIVES
RA T36	STRENGTH OF MATERIALS

30.9.24

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LINEAR ALGEBRA-RA T31

C301.1	REMEMBERING: Recall basic definitions and properties of algebraic systems, groups, subgroups, homomorphisms, normal subgroups, cosets, and Lagrange's theorem.
C301.2	UNDERSTANDING: Explain the concepts of semi-groups, monoids, and normal subgroups in the context of group theory.
C301.3	APPLYING: Use the properties of groups, subgroups, and homomorphisms to solve mathematical problems.
C301.4	UNDERSTANDING: Explain the concept of Matrix representation of a linear transformation.
C301.5	APPLYING: Compute a matrix's eigenvalues and eigenvectors and determine the diagonalizability of a linear transformation.

ELECTRONIC DEVICES AND CIRCUITS-RA T32

C302.1	Understand in detail the operation, characteristics, and various parameters of diodes.
C302.2	Learn and gain insight into the operation, characteristics, and functional aspects of BJT in different configurations and to understand in depth the construction, operation, attributes, and various parameters of JFET and MOSFET.
C302.3	Study the construction, operation, and characteristics of several special semiconductor devices.
C302.4	Describe the different types of biasing in BJT, FET, and MOSFET.
C302.5	Describe the various rectifier circuits with filters, IC regulator circuits, and short circuit protection circuits.

PROGRAMMING IN PYTHON-RA T33

C303.1	Discuss the various foundations and history of artificial intelligence and its applications with real-time problems. Understand the problem space search concepts and their types by searching
C303.2	techniques like heuristic, Informed search, and Uninformed search. Describe Heuristic search techniques like BFS with Problem reduction, Constraint satisfaction, Mean end analysis, agents, and Environment.
C303.3	Interpret the approaches and issues in knowledge representation of propositional logic, predicate logic, and forward & backward reasoning and define its logical implications with unification, resolution, and strong & weak filler structures of knowledge-

	basedagents.
C303.4	Apply the basic concepts of non-monotonic reasoning with various probability notations. Summarize the concept of Bayes rule with its operations with Certainty factors and rule-based systems, Bayesian networks, Dempster Shafer Theory, and Fuzzy Logic.
C303.5	Describe the various concepts of Planning like partial order, conditional, continuous, multi-agent, with state space search. Explain the various forms of learning like inductive learning, learning decision trees, ensemble learning, Neural Net learning, and Genetic learning.

SENSORS AND INSTRUMENTATION-RA T34	
C303.1	Analysis of the basics of measurement, errors, and static and dynamic characteristics of transducers. Find the performance measures of sensors, classification of sensors, and Discuss the sensor calibration techniques and sensor output signal types.
C303.2	Analysis of the characteristics of motion, proximity, and ranging sensors.
C303.3	Analysis of the performance of force, magnetic, and heading sensors.
C303.4	Analysis of the characteristics of optical, pressure, and temperature sensors.
C303.5	Analysis of the characteristics of signal conditioning and DAQ systems.

ELECTRICAL MACHINES AND DRIVES-RA T35	
C305.1	Ability to analyse and comprehend the mechanical and operational aspects of electrical machines.
C305.2	Ability to comprehensively understand and apply the construction, operational principles, and characteristics of synchronous machines and special machines.
C305.3	Ability to systematically analyze and apply the fundamental elements and various types of electric drives.
C305.4	Comprehend and apply conventional and solid-state methods for speed control of DC drives.
C305.5	Comprehend and apply conventional and solid-state methods for speed control of AC drives.

STRENGTH OF MATERIALS-RA T36	
C306.1	To Understand the stress and strain of materials under various loads and shear force and bending moment variation of the beams under loads.

C306.2	To determine the bending stress and shear variation in the different cross-sections of the beams.
C306.3	To calculate the deflections and slopes of the beams under and the strain energy induced in the materials.
C306.4	To analyse the twist and sheer force of the shaft and springs under various types of loads
C306.5	To analyse the stresses and strains on thin and thick cylindrical vessels and Columns and struts subjected to axial loads.

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DEPARTMENT OF ROBOTICS AND AUTOMATION

SEMESTER-IV	
SUBJECT CODE	**NAME OF THE SUBJECT**
RA T41	FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS
RA T42	PRINCIPLES OF ROBOTICS
RA T43	ANALOG AND DIGITAL ELECTRONICS
RA T44	AUTOMATIC CONTROL SYSTEMS
RA T45	KINEMATICS AND DYNAMICS OF MACHINES
RA T46	HYDRAULICS AND PNEUMATICS

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FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS-RA T41

C401.1	Express any periodic function as Fourier series solve General Fourier series Expansion of periodic function into Fourier series Fourier series for odd and even functions Half-range Fourier cosine and sine series Change of interval related problems.
C401.2	Calculating Root Mean Square Value Parseval's theorem on Fourier Coefficients. The complex form of Fourier series Harmonic Analysis. Fourier series for numerical values of any function.
C401.3	Form the partial differential equation by elimination of arbitrary constants and functions to solve the types of first-ordernon-linear partial differential equations.
C401.4	Lagrange's linear equation solves the linear partial differential equation of second and higher order with constant coefficients.
C401.5	Solve Fourier series solution for one-dimensional and two- dimensional heat equations in steady state for both Cartesian and Polar coordinates.

PRINCIPLES OF ROBOTICS-RA T42

C402.1	Use the concepts in common methods for design, construction, operation, and use of robots and computer systems for their control, sensory feedback, and information processing.
C402.2	Classify the need for direct and inverse kinematics for controlling of manipulators.
C402.3	Analyze the study of the differential motion and statics in robotics for robot dynamics is the application of rigid-body dynamics to robots.
C402.4	Predict the expected performance as Path planning in an autonomous vehicle or a robot finds the shortest and most obstacle-free path from the start to the goal state.
C402.5	Study about Data Acquisition: Single channel and multi-channel data acquisition, Data logging, applications, Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

ANALOG AND DIGITAL ELECTRONICS-RA T43

C403.1	Discuss in detail the theory and applications of analogy multipliers and PLL.
C403.2	Learn and gain insight into the special function ICs and IC Voltage Regulators namely 555 Timer. PLL. Functional Block, 723 general purpose voltage regulators.
C403.3	Study the operation, characteristics, and functional aspects of Analog and Digital Data Conversions, D/A converter.

| C403.4 | Design of Combinational and Sequential Logic like Binary BCD adders and subtractors, Decoders, and Encoders. |
| C403.5 | Discuss and describe the digital logic families and programmable logic devices. |

AUTOMATIC CONTROL SYSTEMS-RA T44	
C404.1	Discuss the mathematical modeling of MTS and MRS and derive the transfer function, find the TF by using the block diagram reduction technique and Signal flow graph approach.
C404.2	Analysis of the transient response of first and second-order systems using standard test signals, estimate the time domain specifications, and find the steady-state error.
C404.3	Describe the concept and analysis the response of frequency using the Bode plot and Polar plot.
C404.4	Analysis of stability using Routh's stability criterion, Nyquist stability criterion and Root locus techniques.
C404.5	Analysis of the properties of Z transform and Inverse Z transform, response of linear discrete-time systems using Pulse transfer function. Analysis the Jury's stability criterion. State space analysis representation using physical, phase and canonical variables-diagonal canonical form and Jordan canonical form.

KINEMATICS AND DYNAMICS OF MACHINES-RA T45	
C405.1	Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, four bar chains, and slider crank mechanisms.
C405.2	Analyze the mechanisms for position, velocity, and acceleration.
C405.3	Synthesize four bar and slider crank mechanisms for specified kinematic conditions.
C405.4	Design cams and followers for specified motion profiles.
C405.5	Evaluate gear tooth geometry and select appropriate gears for the required applications.

HYDRAULICS AND PNEUMATICS-RA T46	
C406.1	Understand: Analysis - Understand Fluid Power Fundamentals: Identify and Select Appropriate Fluids: Apply Pascal's Law and Flow Principles: Evaluate Hydraulic Power Sources: Analyze Work. Power, and Torque: Solve Practical Fluid Power Problems: Solve Practical Fluid Power Problems:
C406.2	Understand Hydraulic Actuators: Apply Knowledge of Hydraulic Understand AnalysisCushioning: Analyze Contrel Components: Utilize Advanced Valves: Integrate Hydraulic Accessories: Interpret Fluid Power Symbols: Interpret Fluid Power Symbols
C406.3	Understanding Hydraulic Accumulators: Hydraulic Intensitiers: Design and Analysis of Industrial Hydraulic Circuits: Pressure Intensifiges: Air-over-Oil Circuits: Sequenceand Reciprocation Circuits Synchronization and Fail-Safe Circuits:

	Synchronization and Fail- Safe Circuits: Hydrostatic Transmission: Electro-Hydraulic Circuits: knowledge to solve real- world hydraulic system problems in industrial settings.
C406.4	Understand: Design: Understanding Properties of Air: Understanding Properties of Air: Compressor Systems: Pneumatic Components: Design of Pneumatic Circuits: Electro-Pneumatic system
C406.5	Apply: Design: Apply theoretical knowledge to practical scenarios involving the installation. maintenance, and troubleshooting of hydraulic and pneumatic systems. Design hydraulic and pneumatic circuits for real-world industrial applications, ensuring optimal performance and efficiency. Implement low-cost automation solutions using hydraulic and pneumatic systems to improve productivity and efficiency in manufacturing processes.

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DEPARTMENT OF ROBOTICS AND AUTOMATION

SEMESTER-V	
SUBJECT CODE	**NAME OF THE SUBJECT**
RAT51	STATISTICS AND NUMERICAL METHODS
RA T52	MICROCONTROLLER AND EMBEDDED SYSTEM DESIGN
RA T53	PROGRAMMABLE CONTROLLERS LOGIC
RA T54	ROBOTIC CONTROL SYSTEMS
RA T55	CNC MACHINE AND METROLOGY
RA E04	FIELD AND SERVICE ROBOTICS

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STATISTICS AND NUMERICAL METHODS- RA T51

C501.1	Find the Sampling distributions and Estimation of parameters applyingStatistical hypothesis, large sample tests based on Normal distribution for single mean and difference of means, and Tests based on Chi-square and FA distributions for mean, variance, and proportion, Contingency table (test for independent), Goodness of fit.
C501.2	Statistical method for making inferences about a population parameter based on a sample of data. Apply the basic concepts of classifications of design of experiments by one-way and two-way ANOVA, completely randomized design, Randomized block design, Latin square design, and factorial design
C501.3	Determine Solution of algebraic and transcendental equations, Fixed point iteration method, Newton Raphson method, and Solution of linear system of equations. Solve Gauss elimination method, Pivoting, Gauss Jordan method. Iterative methods of Gauss Jacobi and Gauss-Seidel, Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.
C501.4	Calculate Lagrange's and Newton's divided difference interpolations, Newton's forward and backward difference interpolation, and approximate derivates using interpolation polynomials. Solve Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.
C501.4	Find the Single-step methods: Taylor's series method, Euler's method, Modified Euler's method, and fourth-order Runge-Kutta method for solving first-order equations. Find and solve the step methods of Milne and Adams, Bash forth predictor-corrector methods for solving first-order equations

MICROCONTROLLER AND EMBEDDED SYSTEM DESIGN- RA T52

C502.1	Interpret the architecture & instruction set of 8085, 8086, 8051 microcontrollers to develop assembly language programs
C502.2	Illustrate the application of 8051 microcontroller on chip peripherals toimplement the functions of I/O port, timer/Counter, serial port & interrupts
C502.3	Demonstrate the peripheral devices 8255 PPI and 8279 for integrating keyboard, 7 segment display, LCD display, and traffic light controller & 8259 PIC for handling multiple interrupts I/O
C502.4	Design 8051 Microcontroller-based systems for measuring electrical and physical quantities & Motor control. Interpret the hardware and software components of an embedded system for an application and infer the architecture and programming model of the ARM processor.
C502.4	Infer the instruction set and exception types of ARM processor to develop Assembly language programs

PROGRAMMABLE CONTROLLERS LOGIC-RA T53

C503.1	Understand the different versions of industrial systems, & various control elements used in industrial automation, IEC and ISA standards for control elements in industrial automation, selection criteria, Evolution
C503.2	Apply relay Logic using a Ladder diagram
C503.3	understand the hardware organization and operation of a programmable logic controller (PLC), Wiring PLC
C503.4	Apply Ladder logic programs using basic instructions, Usea timer, counter, and math instructions to develop PLC applications.
C503.5	Demonstrate Servo Drive Control and Stepper Motor Control

ROBOTIC CONTROL SYSTEMS-RA T54

C504.1	Apply forward and inverse dynamics, analyze dynamic models through case studies, and introduce nonlinear systems and control schemes for engineering applications.
C504.2	Understand the Lyapunov stability analysis using both direct and indirect methods, incorporating relevant lemmas and theorems for advanced stability analysis.
C504.3	Proficiently apply joint space and task space control schemes, including position, velocity, trajectory, and force control, for effective manipulation of robot manipulators.
C504.4	Apply nonlinear control schemes, including implementing proportional and derivative control with gravity compensation, computed torque control, sliding mode control, adaptive control, observer-based control, robust control, and optimized control for robot manipulators.
C504.5	Apply nonlinear observer schemes, design based on acceleration, velocity, and position feedback, and conduct numerical simulations using MATLAB/MATHEMATICA.

CNC MACHINE AND METROLOGY-RA T55

C505.1	To understand the basic in CNC machineries
C505.2	Understand Evolution and principle of CNC machine tools and different measurement technologies
C505.3	Able to write simple programs for CNC machinery
C505.4	Impart knowledge about linear and angular measurements in metrology
C505.4	Know about the advancement in metrology

FIELD AND SERVICE ROBOTICS -RA E04

C506.1	Explain the basic concepts of working of robot.
C506.2	Analyze the function of sensors in the robot.
C506.3	Developing programs to use a robot for a typical application.
C506.4	Use Robots in different applications.
C506.5	Know about the humanoid Robots functions & its operations
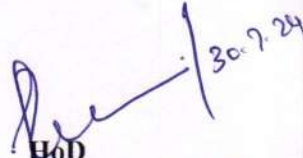
DEPARTMENT OF ROBOTICS AND AUTOMATION

SEMESTER-VI	
SUBJECT CODE	**NAME OF THE SUBJECT**
RA T61	MODELING AND SIMULATION
RA T62	ROBOT KINEMATICS AND DYNAMICS
RA T63	PROGRAMMING FOR ROBOTICS
RAT64	AUTOMATION SYSTEM DESIGN
RAT65	DESIGN OF MECHANICAL TRANSMISSION SYSTEMS
RA E10	WIRELESS SENSOR NETWORKS FOR ROBOTICS

30.7.24

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MODELING AND SIMULATION-RA T61

C601.1	Know the basic concepts of modelling and assembly for different mechanical components.
C601.2	Understand the different types of CAD standards used in modeling of mechanical components.
C601.3	Know about basic concepts of FEA and analysis software for analysing mechanical components.
C601.4	Apply the principles of second-order 2D equations and vectors for solving field problems, particularly in the context of thermal analysis.
C601.5	Understand and apply diverse mathematical techniques used in finite element analysis to solve two-dimensional vector variable problems pertaining to structural and thermal analysis

ROBOT KINEMATICS AND DYNAMICS-RA T62

C602.1	Gaining the basic knowledge of robot and its applications in different fields.
C602.2	Estimating the coordinates and the fundamentals of forward and inverse kinematics of robots.
C602.3	Analysing the workspace of robotic systems for a set of linkages, designinga few linkage mechanisms and specified output motions.
C602.4	Gaining knowledge about differential motion is crucial in dynamic systems and the analysis of objects in motion.
C602.5	Analyse the dynamic model of the Robot for optimum design.

PROGRAMMING FOR ROBOTICS-RA T63

C603.1	Ability to build a robot drive mechanism and use software tools such as Robot Operating System (ROS) and simulation environments like Gazebo to simulate and test robot behaviour.
C603.2	Design and build a chefbot by integrating robotic actuators, wheel encoders, DC geared motors, quadrature encoders, and Dynamixel actuators.
C603.3	Ability to apply knowledge and understanding of ultrasonic distance sensors, IR proximity sensors, and IMUs to interface with ChefBot's microcontroller.
C603.4	Demonstrate proficiency in programming a Kinect sensor with Python using ROS, OpenCV, and OpenNI.
C603.5	Gain practical experience in integration of Chef Bot hardware into Institu ROS using Python, including writing drivers, working with launch files and Python nodes, calibration and testing, and GUN testing.

AUTOMATION SYSTEM DESIGN-RA T64

C604.1	Explain the basic concepts of fundamental concepts of industrialautomation its strategies, levels and importance.
C604.2	Knowledge of industrial automation by transfer lines and automated assembly lines. Ability to design an automated system.
C604.3	Understanding of automated controls using pneumatic and hydraulic systems.
C604.4	Ability to understand the electronic control systems in metal machining and other manufacturing processes.
C604.5	To understand advancement in hydraulics and pneumatics systems.

DESIGN OF MECHANICAL TRANSMISSION SYSTEMS-RAT65

C605.1	Formulate and analyze stresses and strains in machine elements subjected to various loads.
C605.2	Analyze and design structural joints such as Riveted joints, welded joints, Belts.
C605.3	Analyze and design the components for power transmission like shaft and couplings.
C605.4	Analyze and design different types of gears and belts for engineering applications.
C605.5	Analyze and design mechanical springs and bearings.

WIRELESS SENSOR NETWORKS FOR ROBOTICS-RA E10

C606.1	Illustrate the overview of wireless sensor networks.
C606.2	Analyze the architectures and sensor network scenarios.
C606.3	Analyze the MAC Protocols for Wireless Sensor Networks, Energy- Efficient Routing and Geographic Routing.
C606.4	Interpret the topology control, clustering, localization and positioning.
C606.5	Explain the concept of Sensor Node Hardware and node-level software platforms and tools.
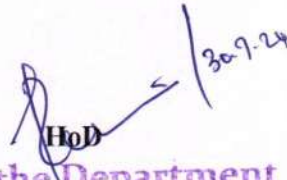
DEPARTMENT OF ROBOTICS AND AUTOMATION

| SEMESTER-VII	
SUBJECT CODE	**NAME OF THE SUBJECT**
RA T71	INDUSTRIAL ROBOTICS AND MATERIAL HANDLING
RA T72	ARTIFICIAL INTELLIGENCE FOR ROBOTICS
RA T73	TOTALLY INTEGRATED AUTOMATION
RA E14	MEDICAL ROBOTICS
RA E18	RELIABILITY AND QUALITY CONTROL
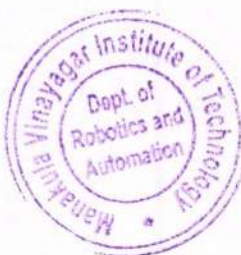
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INDUSTRIAL ROBOTICS AND MATERIAL HANDLING-RA T71

C701.1	Learn about the basic concepts, parts of robots and types of robots.
C701.2	To design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.
C701.3	Ability in selecting the required robot.
C701.4	Know various applications of robots.
C701.5	Apply their knowledge in handling the materials.

ARTIFICIAL INTELLIGENCE FOR ROBOTICS-RA T72

C702.1	Analyze the historical development, current state, and the essential role of AI in robotics.
C702.2	Gain proficiency in designing, evaluating, and applying diverse planning techniques.
C702.3	Develop expertise in employing probabilistic reasoning methodologies and decision-making processes.
C702.4	Comprehensively grasp various forms of learning and apply these techniques to enhance robotic cognition, interaction, and perceptual understanding.
C702.5	Demonstrate the ability to analyze, apply, and critically evaluate key aspects of robotics.

TOTALLY INTEGRATED AUTOMATION-RA T73

C703.1	Acquiring a foundational understanding of industrial automation fundamentals, TIA architecture, component selection, the role of PACS, and vertical integration enables the recognition of their significance in creating streamlined and efficient automation systems.
C703.2	Apply comprehensive SCADA system knowledge to troubleshoot, design custom solutions, create user-friendly interfaces, utilize alarms, analyze trend data, leverage historical information, generate insightful reports, and enhance automation through VB and C scripts.
C703.3	Apply comprehensive understanding of SCADA communication protocols, including proprietary and open protocols, messaging, recipe management, user administration, and interfacing with PLCs, drives, and field devices.
C703.4	Gain a comprehensive understanding of Distributed Control Systems, including their architecture, local control units, programming languages, communication facilities, operator interfaces, and engineering interfaces.
C703.5	Acquiring a foundational understanding of industrial automation fundamentals, TIA architecture, component selection, the role of PACS, and vertical integration enables the recognition of their significance in creating streamlined and efficient automation systems.

MEDICAL ROBOTICS-RA E14

C704.1	Identify and describe different types of medical robots and their potential applications.
C704.2	Analysis of the basic concepts in localization and tracking relevant to Medical Robotics.
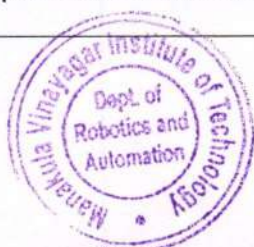
C704.3	Analysis of the performance of surgical robotics.
C704.4	Analysis of the characteristics rehabilitation of robotics can play in healthcare.
C704.5	Analysis of the characteristics of gestures in the design of robots.

RELIABILITY AND QUALITY CONTROL-RA E18	
C705.1	To apply statistical methods and control chart techniques to monitorand improve the quality of processes and products in a variety ofindustries.
C705.2	Construction, interpretation, and application of various control charts for both variables and attributes.
C705.3	To design, implement, and evaluate various sampling plans for quality control, taking into account the specific needs and requirements of different industries and production processes.
C705.4	To apply reliability engineering principles to improve product and system performance, make informed design and maintenance decisions, and contribute to overall system safety and reliability.
C705.5	Analyze, design, and optimize the reliability of complex systems across various industries.

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DEPARTMENT OF ROBOTICS AND AUTOMATION

SEMESTER-VIII	
SUBJECT CODE	**NAME OF THE SUBJECT**
RAT82	MAINTENANCE AND SAFETY ENGINEERING
RA E22	MACHINE LEARNING FOR ROBOTICS
RA E27	ENTREPRENEURSHIP DEVELOPMENT

30-7-24

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MAINTENANCE AND SAFETY ENGINEERING- RAT82

C802.1	Maintain the industry without any risk in its operation Improve the production.
C802.2	Analyze the hazards in maintenance and to solve it.
C802.3	Identify and prevent chemical, environmental mechanical, fire hazard through analysis.
C802.4	Apply proper safety techniques on safety engineering and management.

MACHINE LEARNING FOR ROBOTICS-RA E22

C803.1	Gain knowledge about basic concepts of Machine Learning Environment.
C803.2	Identify machine learning techniques suitable for a given problem.
C803.3	Solve the problems using various machine learning techniques.
C803.4	Apply Dimensionality reduction techniques.
C803.5	Design application using machine learning techniques.

ENTREPRENEURSHIP DEVELOPMENT-RA E27

C804.1	Know the basic concept of entrepreneurial processes and skills needed to run a business successfully.
C804.2	Know the basic concept of entrepreneurial processes and skills needed to run a business successfully.
C804.3	Understand the concept of identify forms of business organization
C804.4	Utilizing financial knowledge to assess and calculate the financial requirements of a new business
C804.5	The ability to use industry, competitor, and market analysis techniques and methods in practical situations.