

DEPARTMENT OF ROBOTICS AND INDUSTRIAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
KURUKSHETRA-136119



SCHEME AND SYLLABI
OF
B. TECH. (ROBOTICS AND AUTOMATION)
5th & 6th SEMESTER

(FOR STUDENTS ADMITTED IN ACADEMIC YEAR 2025-26)

As approved by Board of Studies meeting held on: 15.12.2025

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SCHEME OF EXAMINATION
B. Tech. Robotics & Automation 5th Semester

CODE	COURSE	L	T	P	Credits
RAPC301	Robot Programming & Control	3	0	0	3
RAPC302	Microprocessors & Microcontrollers#	3	0	0	3
RAPC303	Mechanics of Materials	3	0	0	3
RAPE3XX	Any one subject from Group III	3	0	0	3
RAPE3XX	Any one subject from Group IV	3	0	0	3
OE*		3	0	0	3
RAPC313	Robot Programming & Control (P)	0	0	2	1
RAPC314	Microprocessors and Microcontroller (P)	0	0	3	1
RAPC315	Mechanics of Materials (P)	0	0	2	1
RAIC316	Internship/Industrial Training/Project viva-voce (4-6 weeks duration after 4 th semester examination)				2
SWNC101	NCC/Sports/Yoga	0	0	2	1*
SWNC102	NSS/Clubs/Technical Societies	0	0	2	1*
	Total Credits				23

* Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester

PROGRAM ELECTIVES

GROUP - III		GROUP - IV	
CODE	COURSE	CODE	COURSE
RAPE304	Data Structure & Algorithms (2-0-2-3)	RAPE309	Introduction to Database Management System
RAPE305	Data Acquisition System	RAPE310	Natural Language Processing
RAPE306	Introduction to MEMS	RAPE311	Optimization Techniques
RAPE307	Advanced Control System	RAPE312	Introduction to Internet of Things
RAPE308	Introduction to Communication Systems		

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SCHEME OF EXAMINATION
B. Tech. Robotics & Automation 6th Semester

CODE	COURSE	L	T	P	Credits
RAPC317	CAD/CAM	3	0	0	3
RAPC318	Design of Machine Elements**	1	0	5	3
RAPE3XX	Any one subject from Group V	3	0	0	3
RAPE3XX	Any one subject from Group VI	3	0	0	3
OE*		3	0	0	3
RAPC325	Project-I	0	0	6	2
RAPC326	CAD/CAM (P)	0	0	3	1
RAPC327	Technical Discussions	0	0	2	1
SWNC101	NCC/Sports/Yoga	0	0	2	1*
SWNC102	NSS/Clubs/Technical Societies	0	0	2	1*
	Total Credits				21

* Continuous Evaluation Model as per guidelines and the credit to be awarded at the end of 6th Semester based on Cumulative performance up to 6th Semester

****Not to be counted towards integrated course**

PROGRAM ELECTIVES

GROUP - V		GROUP - VI	
CODE	COURSE	CODE	COURSE
RAPE 319	Computer Networks	RAPE 322	Embedded System Fundamentals
RAPE 320	Virtual Instrumentation (2-0-2-3)	RAPE323	Neural Network & Deep Learning (2-0-2-3)
RAPE321	Industrial Automation	RAPE324	Soft Computing

Course Code	RAPC301
Course Title	ROBOT PROGRAMMING AND CONTROL
Number of Credits	3
Prerequisites (Course code)	RAPC211, RAPC208
Course Type	PC

Brief Description about the course

This course introduces the students to the fundamentals of robot programming in addition to the basic and advanced concepts of robot control. The students will gain knowledge about the historical development of different robot programming languages along with their general structure, requirements and problems. This course also covers the important aspects related to robot programming, such as, online, offline, robot-oriented and task-space programming with an introduction to augmented reality. Besides, the students will also develop the skills required for designing linear and non-linear robot controllers. This course will impart a comprehensive knowledge pertaining to the performance and stability analysis of feedback control systems, selection of PID controller gains, design aspects of joint controllers etc. This course also covers the important areas like multivariable robot control, computed torque control, hybrid control etc. Furthermore, the students will also be introduced to the advanced topics like robust control, and adaptive control.

Unit – I

Robot Programming

Introduction; Robot programming languages, Generations of robot languages, Structure, requirements and problems of a robot language,; Online programming, Offline programming, Robot-oriented programming, Task-level programming, Programming using augmented reality; Introduction to latest software frameworks like Robot Operating System (ROS), Comparison of modern programming languages like Python and C++ for robotic applications
(10 hrs)

Unit – II

Robot Control

Linear Control. Robot Joint: Dynamics of a dc motor, Actuator dynamics; Performance and Stability of Feedback Control Systems: Performance, Lyapunov stability; Selection of PID Controller Gains: State-feedback Control; Joint Controllers (P, PD, PID) (8 hrs)

Unit – III

Nonlinear Control

Control of a Moving Block; Multivariable Robot Control: Stability of Multi-Degree-of-Freedom Robot; Linearized Control; PD Position Control; Computed Torque Control; Feedforward Control; Robust and Adaptive Control; Cartesian Control: Resolved motion control, Feedback linearization in Cartesian space
(12 hrs)

Unit – IV

Force Control and Hardware

Force Control of robotic manipulators: Hybrid position/force control; Impedance Force/Torque Control

Robot Control Considerations; Hardware Architecture; Hardware for Joint Controllers; Computational Speed **(10 hrs)**

Text / Reference Books

1. S. K. Saha, "Introduction to Robotics", McGraw Hill Education (India) Pvt. Ltd.
2. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modeling and Control", John Willey & Sons, Inc.
3. John J. Craig, "Introduction to Robotics Mechanics and Control", Pearson Prentice Hall.
4. Saeed B. Niku, "Introduction to Robotics", Pearson Education Asia.

Course Outcomes

The students will be able to:

1. Understand the history, general structure, requirements and problems of robot programming languages along with the various levels of robot programming, i.e., online, offline, robot-oriented, task-level programming etc
2. Design linear robot controller and understand how to select controller parameters for robot joints and evaluate its performance and stability
3. Design non-linear robot controller and understand the concepts of multi-variable control, robust control, adaptive control so as to design a robot controller according to the requirements
4. Understand and apply the concepts of force control, hybrid force/position control, impedance force/torque control etc along with the hardware requirements for robot controllers

Course Code	RAPC302
Course Title	MICROPROCESSORS & MICROCONTROLLERS
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PC

Course Learning Objectives

The objective of this course is to develop a comprehensive understanding of microprocessor and microcontroller architectures, their instruction sets and interfacing techniques. Students will study the architecture of 8085 and 8051, understand addressing modes, interrupts and timing mechanisms and gain hands-on experience in assembly language programming. The course also introduces the concept of embedded systems, highlighting their design principles, applications and integration with microprocessors and microcontrollers. Emphasis is placed on developing skills in program writing, hardware interfacing and understanding peripheral ICs used in embedded applications

UNIT-I

Microprocessor Architecture and Programming:

Architecture of 8085 Microprocessor: Functional blocks, timing and control unit, bus organization and interrupt structure.

Machine Cycles and Timing Diagrams: Instruction execution, control signals and timing concepts.

Programming with 8085: Addressing modes, instruction set, assembly language programming, programs for multi-byte addition/subtraction, multiplication, division, block transfer and other arithmetic/logic operations. **(10 hrs.)**

UNIT-II

Interfacing Techniques:

Principles of Interfacing: Input/output interfacing concepts and data transfer techniques, programmed I/O, interrupt-driven I/O and DMA.

Peripheral Interfacing Devices: Detailed study of 8255 (PPI) and 8253 (Timer/Counter).

A/D and D/A Converter Interfacing: Interfacing of digital-to-analog and analog-to-digital converters with 8085 microprocessors. **(10 hrs.)**

UNIT-III

Microcontrollers and Embedded Systems:

Introduction to Embedded Systems: Definition, characteristics, components and applications of embedded systems. Relationship between microcontrollers and embedded systems.

Architecture of 8051 Microcontroller: Internal structure, memory organization, ports and oscillator circuits.

Instruction Set and Programming: Addressing modes, instruction types and assembly programming examples.

Peripheral Interfacing: Timer/counter operations, serial communication, interrupts and interfacing with A/D and D/A converters. (10 hrs.)

UNIT-IV

Memory and System Design:

Semiconductor Memories: ROM, PROM, EPROM, EEPROM and RAM — structure and operation.

Memory Interfacing: Design and interfacing of external memories with 8085 and 8051.

Case Studies: Practical examples of small embedded system designs using microcontroller-based interfacing. (10 hrs.)

Text / Reference Books

1. R.S. Gaonkar, Microprocessor Architecture, Programming and Applications, Penram International, 6th Edition, 2013.
2. A.P. Mathur, Introduction to Microprocessor, TMH, 3rd Edition, 1990.
3. K.J. Ayala, The 8051 Microcontroller, Penram International, 2nd Edition, 1996.
4. D.V. Hall, Advanced Microprocessors.
5. Muhammad Ali Mazidi & Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems, PHI, 2nd Edition, 2009.

Course Outcomes

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

1. Understand and analyse the architecture of microprocessors, microcontrollers and embedded systems.
2. Design and implement assembly programs for 8085 microprocessor and 8051 microcontroller
3. Develop interfacing solutions for peripheral devices and memory with microprocessors and microcontrollers.
4. Build small-scale embedded systems integrating sensors, actuators and memory.

Course Code	RAPC303
Course Title	MECHANICS OF MATERIALS
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PC

Brief Description about the course

This course will introduce the students to a thorough understanding of structural members and their strength, stiffness, and stability. Develop an understanding of, and the capability to, solve practical engineering problems involving stress and strain analysis in elementary structural members, such as bars and beams. To this end, the learning objectives of this course are:

1. To learn about the simple and compound stresses at a point in a material.
2. To study the various theories of failure of materials.
3. To know about the shear forces, bending moments, bending stresses and shear stresses in a beam.
4. To study torsion of shafts and to find the deflection of beams.
5. To learn about various types of stresses in thin cylinders and columns.

UNIT-I

Simple Stress and Strain: Mechanical Properties of Materials, Concept of stress and strain, various type of stresses, stress-strain diagrams, composite sections, Thermal stresses, strain analysis, relation between elastic constants.

Compound Stress: Principal stresses and principal planes, Mohr's stress circle.

Theories of Failure: Different theories of failure, Significance, graphical representation. **(10 hrs)**

UNIT-II

Shear Force and Bending Moment Diagrams: Shear force and bending moment diagrams for various types of loading and supports, Point of contra flexure.

Bending Stress in Beams: Stresses due to simple bending, Composite beams.

Shear Stress in Beams: Shear stress distribution, Variation of shear stress in beams of various sections **(10 hrs)**

UNIT-III

Torsion: Derivation of torsion equation and its assumptions, applications of the equation to the hollow and solid circular shafts.

Slope and Deflection: Slope and deflection at a point using different methods, deflection of beams due to shear stress. **(10 hrs)**

UNIT-IV

Thin Cylinders and Spheres: Thin cylinders and spheres subjected to internal pressure, wire winding of thin cylinders.

Columns: Euler's theory for initially straight columns, assumptions and limitations, empirical formulae. **(10 hrs)**

Text / Reference Books

1. G H Ryder, "*Strength of Materials*", ELBS, 3rd edition, 1969
2. S S Rattan, "*Strength of Materials*", Tata McGraw Hill, India, 3rd Edition, 2017
3. Beer P F and Johnston (Jr) E R, "*Mechanics of Materials*", McGraw Hill Education, 7th edition, 2015.
4. Popov E P, "*Engineering Mechanics of Solids*", Prentice Hall of India, New Delhi, 2nd edition, 1999.

Course Outcomes

1. Determine the values of stresses in materials
2. Explain different theories of failure
3. Draw shear force and bending moment diagrams
4. Find shear and bending stresses in beams
5. Find stresses in shafts under torsion and to find the slope and deflection of beams
6. Find stresses in the thin cylinders and to calculate the crippling load in Columns

Course Code	RAPE304
Course Title	DATA STRUCTURES & ALGORITHM
Number of Credits	3
Prerequisites (Course Code)	CSIC103
Course Type	PE

Course Learning Objectives

1. This course introduces the concept of Data Structures used in various computer science applications
2. The students are introduced to understand and efficiently apply various data structures such as stacks, queues, linked lists, trees and graphs for solving various computing problems using C programming language.

Unit – I

Pointers & File Handling:

Revision of Pointers and Dynamic Memory, Files and related operations. Searching techniques: Linear and Binary, Sorting techniques: Selection, Bubble, Insertion, Merge sort, Quicksort.

(10 hrs.)

Unit – II

Simple Data Structures:

Arrays based Linear Data Structures: Array storage, sparse arrays; Transpose, addition, and multiplication of sparse matrices, Stacks and Queues and their applications, multiple stacks and queues in an array.

(10 hrs.)

Unit – III

Linked Data Structures:

Singly, Doubly & Circular Linked Lists; representation, operations and applications, linked stacks and queues. linked lists based polynomial addition.

(10 hrs.)

Unit – IV

Advanced Data Structures:

Trees, Basic concepts and definitions of a tree and binary tree and associated terminology, Binary tree traversal techniques, some more operations on binary trees, Heaps and heapsort.

(10 hrs.)

Text / Reference Books

1. E Horowitz and S. Sahni: Fundamentals of Data Structures in C, Second Edition, Universities Press, Hyderabad.
2. R.L. Kruse: Data Structures & Program Design in C, PHI.
3. D.F. Knuth: The art of Computer Programming Vol-1, Narosa Publications, 1985.
4. Byron S. Gottfried & J K Chhabra: Theory and Problems of Programming with C Language, Schaum's Outlines Series, TMH, 2005.

Course Outcomes

1. Develop skill to identify and determine the usage of various data structures, operations, associated algorithms and implement their applications.
2. Apply knowledge of pointers, memory allocation and string handling for solving programming problems.
3. Understand the concept of trees and graphs, their implementation and applications.
4. Able to implement standard algorithms for searching and sorting.
5. Analyze efficiency of different algorithms using time and space complexity.

Course Code	RAPE305
Course Title	DATA ACQUISITION SYSTEMS
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PE

Course Overview

This course focuses on the principles, methods, and technologies related to data acquisition (DAQ) systems in the context of Industrial Internet of Things (IIoT). Students will gain an understanding of various sensors, actuators, and communication technologies used to collect and process data from industrial systems. Additionally, students will explore how data acquisition systems play a key role in IIoT architectures for automation, monitoring, and control in industrial environments.

Course Learning Objectives

By the end of this course, students will be able to:

1. Understand the architecture of data acquisition systems in industrial environments.
2. Learn the types of sensors, actuators, and transducers used in IIoT applications.
3. Explore the importance of processing in data acquisition.
4. Design a Data Acquisition system.
5. Understand edge computing, data security and emerging trends in Data Acquisition Systems.

Unit - I

Introduction to Data Acquisition Systems (DAQ):

Overview of Data Acquisition Systems (DAQ): Definition, importance, and components of DAQ systems in IIoT, Role of DAQ in industrial automation and monitoring, Key components: Sensors, actuators, signal conditioning, and data processing.

Industrial Automation and Control Systems: Basics of Industrial Control Systems (ICS), Integration of DAQ systems in industrial automation, Data flow, feedback, and control mechanisms.

Types of Data Acquisition Systems: Analog vs. Digital DAQ systems, Wired and wireless methods of data acquisition.

(10 hrs)

Unit - II

Data Conversion and Processing:

Analog-to-Digital Conversion (ADC): Basics of ADC: Types, resolution, sampling rate, and accuracy, Techniques for efficient data conversion.

Digital Signal Processing (DSP) in DAQ Systems: Overview of DSP techniques for data analysis, Time-domain and frequency-domain processing, Filtering and noise reduction in IIoT systems.

Data Storage and Management: Real-time data storage techniques, Cloud integration for data storage and management, Data visualization and analytics.

(10 hrs)

Unit - III

IIoT Data Acquisition System Design:

System Architecture for IIoT Data Acquisition: Components of a DAQ system in IIoT: Sensing, conditioning, processing, communication, and storage, System design considerations for industrial environments.

Data Acquisition in Industrial Automation: Case studies of IIoT applications for industrial automation, implementing predictive maintenance and monitoring systems using DAQ.

Design and Implementation Project: Hands-on project: Design and implement a basic data acquisition system, Data collection, processing, and communication, Cloud integration for real-time monitoring.

(10 hrs)

Unit - IV

Advanced Topics in IIoT Data Acquisition:

Edge Computing and IIoT: Introduction to edge computing and its role in IIoT data acquisition, Advantages of edge computing over cloud processing, Edge analytics in industrial data processing.

Data Security in IIoT DAQ Systems: Security challenges in IIoT and DAQ systems, Techniques for data encryption, authentication, and access control, Ensuring the integrity and confidentiality of data.

Emerging Trends in IIoT: Integration of AI and machine learning in DAQ systems, Blockchain for secure data acquisition, Future trends and innovations in IIoT data acquisition technologies.

(10 hrs)

Text /Reference Books

1. "Industrial Communication Systems" by Bogdan M. Wilamowski, J. David Irwin, CRC Press, 2nd Edition, 2017.
2. "Introduction to Mechatronics and Measurement Systems" by David G.

Alciatore, Michael B. Hstand, Mc Graw Hill, 4th Edition, 2012.

3. "Data Acquisition Systems: From Fundamentals to Applied Design" by Maurizio Di Paolo Emilio, Springer, 1st Edition, 2013.
4. "The Internet of Things: A Look at Real-World Use Cases and Concerns" by Samuel Greengard, Kindle Edition, MIT Press, 2015.

Course Outcomes

At the end of the course, students will be able:

1. To understand the architecture of data acquisition systems in industrial environments.
2. To learn the types of sensors, actuators, and transducers used in IIoT applications.
3. To explore the importance of processing in data acquisition.
4. To design a Data Acquisition system.
5. To understand edge computing, data security and emerging trends in Data Acquisition Systems.

Course Code	RAPE306
Course Title	INTRODUCTION TO MEMS
Number of Credits	3
Prerequisites (Course code)	RAPC203, RAPC210
Course Type	PE

Brief Description about the course

This course introduces the students to the foundations of micro electro mechanical systems to the basic and recent applications of real-world MEMS. This course offers a foundational understanding of MEMS technology, which integrates mechanical elements, sensors, actuators, and electronics on a common silicon substrate. It is designed to equip Robotics and Automation students with the knowledge and skills to explore miniaturized systems used in modern robotics, biomedical devices, and smart sensors.

Unit – I

Introduction of Micro Electro Mechanical Systems:

Intrinsic Characteristics of MEMS, Energy Domains and Transducers, Sensors and Actuators, Introduction to Micro fabrication, Silicon based MEMS processes, New Materials, Review of Electrical and Mechanical concepts in MEMS, Semiconductor devices, Stress and strain analysis, Flexural beam bending, Torsional deflection.

(08 hrs)

Unit – II

Micro Fabrication Technologies:

Silicon Anisotropic Etching, Anisotropic Wet Etching, Dry Etching of Silicon, Plasma Etching, Deep Reaction Ion Etching (DRIE), Isotropic Wet Etching, Gas Phase Etchants, Basic surface micro machining processes, Structural and Sacrificial Materials, Acceleration of sacrificial Etch, Striction and Antistricition methods, LIGA Process, Assembly of 3D MEMS, Foundry process.

(14 hrs)

Unit – III

Electrostatic Sensing and Actuators:

Electrostatic sensors, Parallel plate capacitors, Applications, Interdigitated Finger capacitor, Comb drive devices, Micro Grippers, Micro Motors, Thermal Sensing and Actuation, Thermal expansion, Thermal couples, Thermal resistors, Thermal Bimorph, Applications, Magnetic Actuators, Micromagnetic components, Case studies of MEMS in magnetic actuators, Actuation using Shape Memory Alloys.

(10 hrs)

Unit – IV

Piezoresistive Sensing and Actuators:

Piezoresistive sensors, Piezoresistive sensor materials, Stress analysis of mechanical elements, Applications to Inertia, Pressure, Tactile and Flow sensors, Piezoelectric sensors and actuators, piezoelectric effects, piezoelectric materials, Applications to Inertia, Acoustic, Tactile and Flow sensors. **(08 hrs)**

Text / Reference Books

1. Chang Liu, "Foundations of MEMS", 2nd edition, Pearson, 2012
2. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", 2nd edition, Tata McGraw Hill, 2008
3. Senturia, S.D., "Microsystem Design", Kluwer Academic Publisher, 2000.
4. Rai-Choudhury P., "MEMS and MOEMS Technology and Applications", Prentice Hall of India Learning Private Limited, 2009.

Course Outcomes

The students will be able to:

1. Describe the fundamentals of Micro Electro Mechanical Systems (MEMS)
2. Explain standard micro fabrication techniques.
3. Understand and describe electrostatic sensing and actuation techniques of MEMS.
4. Understand and describe piezoresistive sensing and actuation techniques of MEMS.
5. Summarize the applications of MEMS in real-world systems.

Course Code	RAPE307
Course Title	ADVANCED CONTROL SYSTEM
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PE

Brief Description about the course

This course provides a comprehensive understanding of modern control theory, covering digital control systems, nonlinear control fundamentals, optimal control principles, and adaptive control methodologies. The syllabus emphasizes modeling, stability analysis, controller design, and real-world applications across these four major domains of advanced control engineering.

UNIT I

Digital Control Systems

Digital control design concepts; sampling, quantization, reconstruction; discretization methods (impulse/step invariance, bilinear transform, finite-difference); discrete-time modeling using pulse transfer functions and state-space forms; time/frequency response of discrete systems; stability analysis using z-plane, Jury test, and Lyapunov methods; basics of digital controller design (PID, lead/lag compensators).

(10 hrs.)

UNIT II

Nonlinear Control Systems

Characteristics and effects of nonlinearities; phase-plane analysis and phase portraits; singular points and qualitative behavior; describing function and quasi-linearization; limit cycles, bifurcation, jump resonance; Lyapunov-based methods for stability of nonlinear systems.

(10 hrs.)

UNIT III

Optimal Control

Optimal control fundamentals and performance indices; calculus of variations and optimality conditions; Hamiltonian and Pontryagin's Minimum Principle; design of linear quadratic regulator (LQR) overview of Linear Quadratic Gaussian (LQG) control; basics of dynamic programming and Bellman's principle; engineering applications of optimal control.

(10 hrs.)

Unit IV

Adaptive Control

Introduction to adaptive control; types of adaptive control (direct, indirect, hybrid); model reference adaptive control (MRAC); self-tuning regulators; parameter estimation and convergence in adaptive systems; applications in robotics, process control, and aerospace.

Industry-oriented case studies: Hands-on simulation modules for real-time advanced control implementation, visits to Siemens Centre of Excellence (SCoE) Labs, seminars, workshops, etc.

(10 hrs.)

Text / Reference Books

1. K. Ogata, Discrete-Time Control Systems, Prentice Hall.
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw-Hill.
3. H. K. Khalil, Nonlinear Systems, Prentice Hall.
4. J. E. Slotine & W. Li, Applied Nonlinear Control, Prentice Hall.
5. D. P. Bertsekas, Dynamic Programming and Optimal Control.
6. B. D. O. Anderson & J. B. Moore, Optimal Control: Linear Quadratic Methods.
7. K. J. Åström & B. Wittenmark, Adaptive Control, Addison-Wesley.

Course Outcomes (COs)

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

1. Understand the principles, modeling, and stability analysis of digital control systems.
2. Analyze nonlinear system behavior and apply nonlinear control techniques for stability and control design.
3. Apply optimal control concepts including LQR/LQG and Pontryagin's principles for optimal controller design.
4. Design adaptive controllers and understand parameter estimation, MRAC, and self-tuning regulators.

Course Code	RAPE308
Course Title	INTRODUCTION TO COMMUNICATION SYSTEMS
Number of Credits	3
Prerequisites (Course code)	RAPC204
Course Type	PE

Course Learning Objectives

The course will provide the fundamentals and basic concepts of different analog and digital modulation and demodulation schemes. The effect of AWG noise on these systems.

UNIT - I

Amplitude Modulation (AM) and Demodulation, Double Sideband Suppressed Carrier (DSB-SC) Modulation and Demodulation, Single Sideband Modulation (SSB), Vestigial Sideband Modulation (VSB), Angle Modulation, Frequency Modulation (FM), Phase Modulation (PM), Modulation Index, Instantaneous Frequency, Carsons Rule for FM Bandwidth, FM Demodulation, Super-heterodyne receivers **(10 hrs)**

UNIT - II

Introduction to Sampling, Nyquist Criterion, Signal Reconstruction from Sampled Signal, Pulse Amplitude Modulation, Quantization, Uniform Quantizers – Midrise and Midtread, Quantization noise, Non-Uniform Quantizers, Pulse Code Modulation, DPCM Delta Modulation, Inter-Symbol Interference. **(10 hrs)**

UNIT - III

Geometric Representation of Signals, Maximum likelihood detection, Matched filter, Correlation receiver, Coherent Binary Digital Modulation Schemes (Binary PAM, BPSK, QPSK, BFSK), their Spectral Efficiency and Error Performance. **(10 hrs)**

UNIT – IV

M-ary Digital Modulation Schemes, Noncoherent Modulation and Demodulation, Principle of Spread Spectrum systems, Pseudo-Noise Sequences, Direct Sequence Spread Spectrum and Frequency-Hopped Spread Spectrum systems, CDMA.

(10 hrs)

Text / Reference Books

1. Simon Haykins, Communication Systems, Wiley & Sons, 3rd Edition, 2008.
2. Herbert Taub, and Donald L. Schilling, Principles of Communication Systems, McGraw-Hill, 2020
3. B.P. Lathi, Modern Digital and Analog Communications, Oxford, 4th Edition, 2011.
4. George Kennedy and Bernard Davis, Electronics & Communication Systems, Tata McGraw Hill, 4th Edition, 2008.

Course Outcomes

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

1. Understanding of communication fundamentals.
2. Understand different analog modulation and demodulation schemes.
3. Understand different digital modulation and demodulation schemes and analyse their performance.
4. Understand different spread spectrum systems and their applications.

Course Code	RAPE309
Course Title	INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PE

Course Learning Objectives

1. To understand data models and database systems.
2. To understand relational database theory,
3. To learn database design and its normalization.
4. To understand concepts of transaction, its processing, and management.
5. To learn concurrency control techniques.
6. To develop practical skill in using MySQL DBMS.

Unit – I

Introduction:

Data, Database, Database management system, Historical background from file systems to Database Systems, Data Models, Relational Data Model, ER model, Schemas and Instances, Database users, DBMS architecture.

(08 hrs.)

Unit – II

Relational Model and Query Language:

Theory of Relational Database, Key Integrity constraint, Relational Algebra, Relational Calculus: Domain Relational Calculus, Tuple Relational Calculus, SQL, queries writing in SQL.

(08 hrs.)

Unit – III

Database Design:

Normalization, Database Anomalies, Functional Dependencies, Candidate and Super Key, Non-loss Decomposition, Dependency Preservation, First, Second, Third Normal, BCNF, etc.

(08 hrs.)

Unit – IV

Transaction Processing:

Transaction concept, a simple transaction model, states, ACID Properties, implementation of ACID properties, Serializability.

(08 hrs.)

Unit – V

Concurrency Control:

Need for Concurrency, Lock-based protocols, Deadlock, Starvation, deadlock handling, time-stamp based protocols, validation-based protocols.

(08 hrs.)

Reference Books

1. A Silberschatz, H.F. Korth & S. Sudarshan: Data Base System Concepts, Mc Graw Hill, 4th, 5th or 6th edition.
2. Elmasri & Navathe : Fundamentals of Database Systems, 5th, 6th, or 7th edition Pearson.

Course Outcomes

1. To Design and Implement a small database for applications using MySQL DBMS.
2. To apply the concepts of normalization to database design.

Course Code	RAPE310
Course Title	NATURAL LANGUAGE PROCESSING
Number of Credits	3
Prerequisites (Course code)	CSIC104 and RAPE304
Course Type	PE

Course Learning Objectives

1. To learn the fundamentals of Natural language Processing and its algorithm.
2. To understand machine translation and applications of NLP.
3. Basic understanding of deep learning models for NLP.

Unit – I

Introduction to NLP:

Characteristics of Natural Language, Language structure, Sentence Structure, Language analyzer, Lexicon, word formation, Morphology, syntax analysis (parsing), semantics, ambiguity, pragmatics and discourse.

(08 hrs.)

Unit – II

NLP Algorithms:

Understanding Corpus and data attributes, Corpus Formats CSV, JSON, XML, LibSVM, Operations on Text Corpus, Tokenisation, stop words, Term Frequency Inverse Document Frequency (TF-IDF), Text Analysis and word embedding using word2vec, doc2vec, GLoVe, Bag-of-words (BoW).

(08 hrs.)

Unit – III

Machine Translation and Applications of NLP:

Introduction to Machine Translation (MT), Approaches, Structure of Anusaraka: an Interlingua based MT system, Example/Analogy based MT, Word/phrase based MT, Neural MT. Applications of NLP: Sentiment analysis, chatbots, conversational models (Question Answering system) for Digital Assistants

(08 hrs.)

Unit – IV

Deep learning models for NLP:

Neural Net based NLP models: Study of Convolutional Neural Network(CNN), Recurrent Neural Network(RNN), Long Short-Term Memory(LSTM) and Gated Recurrent Unit(GRU) using Natural Language Toolkit (NLTK).

(08 hrs.)

Text /Reference Books

1. Thanaki, Jalaj, "Python natural language processing". Packet Publishing Ltd, 2017.
2. Cole Howard, Hannes Max Hapke, and Hobson Lane," Natural Language Processing in Action: Understanding, Analyzing, and Generating Text with Python",Manning, 2019.
3. Daniel Jurafsky, James H. Martin,"Speech and Language Processing: An Introduction to Natural Language Processing", Computational Linguistics and Speech, Pearson Publication, 2014.
4. Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
5. Samuel Burns, "Natural Language Processing: A Quick Introduction to NLP with Python and NLTK" Independently Published, 2019

Course Outcomes:

1. After completion of the course the students will be able to:
2. Understand the algorithmic approach to NLP.
3. Understand the sentence structure and the Computational model of Natural Languages.
4. Understand the Data Science approach to Machine Translation and its applications.
5. Understand Machine Learning approach to NLP.

Course Code	RAPE311
Course Title	OPTIMIZATION TECHNIQUES
Number of Credits	3
Prerequisites	NA
Course Type	PE

Brief Description about the course

This course introduces students to the theory and application of optimization methods used in engineering, robotics, and intelligent systems. It covers classical optimization, linear and nonlinear programming, numerical techniques, and advanced metaheuristic algorithms. Students also explore soft computing tools such as fuzzy logic and neural networks for intelligent decision-making. Emphasis is placed on mathematical formulation, algorithmic implementation, and solving real-world engineering optimization problems.

UNIT I

Fundamentals of Optimization

Introduction: Optimization in engineering and robotics, Problem formulation: Decision variables, objective functions, constraints, Classification: Linear, nonlinear, integer, combinatorial, multi-objective, Classical optimization: Unconstrained and constrained methods

(06 hrs.)

UNIT II

Linear and Nonlinear Programming

Linear Programming: Graphical, Simplex, Big-M, Two-phase, Sensitivity analysis, Nonlinear Programming: Gradient-based, Penalty and barrier methods- Integer & Mixed-Integer Programming

(10 hrs.)

UNIT III

Numerical Optimization and Specialized Methods

Golden Section and Fibonacci search, Sequential Quadratic Programming (SQP), Interior Point Methods, Multi-objective optimization

(06 hrs.)

UNIT IV

Metaheuristic Optimization Techniques

Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Simulated Annealing (SA), Overview of ACO, ABC, Firefly, GWO, DE

(10 hrs.)

UNIT V – Soft Computing Techniques (8 Hours)

Fuzzy Logic: Sets, membership functions, rules, inference, defuzzification, ANN: Neuron model, MLP, Backpropagation, Applications

(08 hrs.)

Text/ Reference Books

1. *Principles of Soft Computing*, S. N. Sivanandam & S. N. Deepa, 3rd Edition, Wiley India Pvt. Ltd., New Delhi, 2019.
2. *Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications* by S. Rajasekaran & G. A. Vijayalakshmi Pai, 2nd Edition, PHI Learning Pvt. Ltd., New Delhi, 2017.
3. *Nature-Inspired Optimization Algorithms* by Xin-She Yang, 1st Edition, Elsevier/Academic Press, 2014.
4. *Engineering Optimization: Theory and Practice* by S. S. Rao, 4th Edition, John Wiley & Sons, New York, 2009.
5. *Numerical Optimization with Applications* — Suresh Chandra, Jayadeva & Aparna Mehra, Narosa Publishing House, New Delhi, 2009.
6. *Numerical Methods and Optimization* — Hari Arora, S.K. Kataria & Sons, New Delhi, 2008.

Course Outcomes

The students will be able to:

1. Formulate and analyze optimization problems.
2. Apply linear and nonlinear programming techniques.
3. Use numerical methods for optimization.
4. Implement metaheuristic algorithms.
5. Apply fuzzy logic and neural networks.

Course Code	RAPE312
Course Title	INTRODUCTION TO INTERNET OF THINGS
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PE

Course Learning Objectives

This course will be focused on introducing students to new trends, applications, system architecture and challenges involved in developing/deploying internet of things systems using real industrial use cases. A number of systems are getting connected to the internet, where the sensor data is analysed to monitor and control the systems. Correctly analysing data coming from multiple sensors, choosing the right hardware given the power and performance trade-off, hardware heterogeneity and security are some of the challenges involved in developing

UNIT-I

Concept of IoT, Vision, Impact, Challenges in IoT, IoT network architecture, Reference Model, Functional stack, Machine to Machine Communication, Standardization

(10 hrs.)

UNIT-II

Smart 'Things', Sensors, Actuators, Devices for IoT, Interfaces, Data Aggregation, Data analytics for IoT, Big data analytics, IoT security and Privacy

(10 hrs.)

UNIT-III

Communication technologies- IEEE 802.15.24, IEEE 802.15.4e, IEEE 802.11ah, NB-IoT, IoT network layer, 6LoWPAN, 6Lo, IoT application layer, Transport methods- CoAP, MQTT, AMQP

(10 hrs.)

UNIT-IV

Applications and Case Studies, Implementation of IoT with Raspberry Pi, Case studies: smart homes, smart cities, connected vehicles, Agriculture, Healthcare, environmental monitoring, smart manufacturing

(10 hrs.)

Text Books / Reference

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, 2018, Pearson India,
2. Rajkumar Buyya, Amir V. Dastjerdi, "Internet of Things: Principles and Paradigms", 2016, Morgan Kaufmann Publisher

Course Outcomes

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

1. To understand fundamentals of IoT and its architectural framework
2. Ability to use sensors and wireless sensor networks for data collection
3. Ability to perform big data analysis
4. Ability to use IoT technology in real life scenarios

Course Code	RAPC313
Course Title	ROBOT PROGRAMMING & CONTROL (P)
Number of Credits	1
Prerequisites (Course Code)	NA
Course Type	PC

Course Learning Objectives

The objectives of the course are

1. Understand the structure, components, and coordinate systems of industrial robots and their control mechanisms.
2. Develop and implement robot programs for basic and advanced industrial tasks such as pick-and-place, palletizing, and path planning.
3. Integrate sensors, vision systems, and external control devices (e.g., PLCs) with robots for adaptive automation.
4. Analyze and evaluate robot performance parameters such as trajectory accuracy, repeatability, and operational safety using real-time data and simulations.

List of Experiments

1. To study robot architecture, coordinate systems, DOF, controller interface.
2. To practice joint, world, tool, and user frame jogging.
3. To calibrate TCP using 4-point and 6-point calibration methods.
4. To write basic motion programs using PTP commands.
5. To execute linear (LIN) and circular (CIRC) trajectories.
6. To control trajectory smoothing using blending zones.
7. To verify Forward Kinematics / Inverse Kinematics using software and physical robot.
8. To perform Pick-and-Place Programming with Grippers.
9. To perform Programming of End-Effector Control (Digital I/O).
10. To study Vision-Guided Robotics: Object Detection & Alignment based on camera coordinates.
11. To study Force/Torque Controlled Operations with an objective to Implement compliant motion for surface-follow or insertion.
12. To study Path Optimization & Workspace Analysis to optimize cycle time, avoid singularities, map workspace.
13. To study PLC–Robot Integration using Industrial Protocols.
14. To study Safety Programming & Emergency Handling of industrial robot.

Course Outcomes

At the end of the course, the students would be able to

1. Demonstrate understanding of robot configurations, kinematics, and control architectures.
2. Write, execute, and troubleshoot robot programs for industrial operations using teach pendants and offline simulators.
3. Integrate and interface robots with vision systems, sensors, and PLCs to perform coordinated tasks.
4. Evaluate robot motion characteristics and performance metrics through experiments and simulation tools.

Course Code	RAPC314
Course Title	MICROPROCESSORS AND MICROCONTROLLERS (P)
Number of Credits	1
Prerequisites (Course code)	RAPC302
Course Type	PC

Laboratory experiments will be based upon the corresponding theory course RAPC302. Updated list of experiments will be floated by the course coordinator before the beginning of each semester.

Course Outcomes

Upon successful completion of this course, students will be able to:

1. Write and execute assembly language programs for 8085 microprocessor and 8051 microcontroller.
2. Interface peripheral devices such as ADC/DAC, timers, and I/O ports with microprocessors and microcontrollers.
3. Develop simple embedded system applications using 8051 microcontroller.
4. Test, debug, and troubleshoot microprocessor and microcontroller-based circuits and systems.

Course Code	RAPC315
Course Title	MECHANICS OF MATERIALS (P)
Number of Credits	1
Prerequisites (Course Code)	NA
Course Type	PC

Brief Description

This course will introduce the students to the instruments and experimental methods used in Material Testing. Therefore, the learning objectives of this course are:

1. To understand the behavior of materials under different tests like hardness, impact, tensile, etc.
2. To understand the basic principles of strength of materials and structural analysis.
3. To understand the concept of stress and strain under different loading conditions.
4. To understand the mechanics of different testing machines like Servo hydraulic UTM, Servo electric UTM, etc.

List of Experiments

1. To study the Impact testing machine and to perform the impact tests (Izod and Charpy impact test).
2. To study the Rockwell Hardness testing machine and find the Rockwell Hardness of the given specimen.
3. To study the Vickers Hardness testing machine and find the Vickers Hardness of the given specimen.
4. To study the Brinell Hardness Testing machine and find the Brinell Hardness of the given specimen.
5. To study the Erichsen Cupping machine and find out the Erichsen value of the given specimen of Sheet Metal.
6. To study the Bending stress in a Beam Structure and to find the Bending Stress in a Beam.
7. To study the Torsion testing machine and to perform the Torsion test on a given specimen.
8. To study the Universal Testing Machine(UTM) and to perform the Tensile test.
9. To perform the Compression test on Universal Testing Machine (UTM).
10. To perform the Bending Test on Universal Testing Machine (UTM).
11. To study the Strut-Testing Structure and to determine

12. The Buckling Load of a Pinned-End Strut
13. The effect of End Conditions on the Buckling Load.

Course Outcomes

1. Understand the procedure of doing different tests like hardness, compression, torsion, tension, impact, etc. in various materials.
2. Understand the effect of stress and strain in different types of machines/structures under different loading conditions.
3. Describe the behavior of materials upon normal external loads.
4. Predict the behavior of the material under impact conditions.
5. Recognize the mechanical behavior of materials.
6. Measure the properties of the materials such as impact strength, tensile strength, compressive strength, hardness, ductility, etc.

Robotics & Industrial Engineering Department

B.Tech. Robotics & Automation

Course Code	RAIC316
Course Title	Internship/Industrial Training/Project viva-voce
Number of Credits	2

The student will present his/her work carried out during Internship/Industrial Training/Project before a group of faculty members and the student will be evaluated by them.

Course Code	RAPC317
Course Title	CAD/CAM
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PC

Brief Description about the course

This course will introduce the students to the geometric modelling and engineering analysis techniques required to model and analyze objects for application in CAD, CAM, Computer Graphics and many other engineering applications. To this end, the learning objectives of this course are:

1. To understand 2D & 3D geometric transformation techniques and apply the same to obtain orthographic, perspective, axonometric and oblique projections
2. To develop mathematical models to represent curves and surfaces
3. To understand and generate solid geometries
4. To understand the fundamentals of NC control

Unit – I

Introduction: Introduction to design process and role of computer in design, Historical developments, Industrial look at CAD/CAM, Basics of geometric and solid modeling, explicit, implicit, intrinsic, extrinsic and parametric equations coordinate systems

Transformations: Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, 3D rotation about an arbitrary axis, 3D reflection through an arbitrary plane, orthographic, Axonometric, Oblique and perspective projections. **(10 hrs)**

Unit – II

Curves: Algebraic and geometric forms, Analytical & Synthetic Curves, tangents and normal, blending functions, re-parametrization, straight lines, conics, cubic splines, bezier curves and B-spline curves; Rational curves, Non-uniform Rational curves, NURBS; Curve manipulation.

Surfaces: Algebraic and geometric forms, Analytical and Synthetic Surfaces, tangents and twist vectors, normal, blending functions, sixteen-point form, four curve form, plane

surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-spline surfaces, Coons surface, Triangular patches. **(10 hrs)**

Unit – III

Solids: Solid models and representation scheme, Fundamentals of Solid Modeling, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration, Half spaces, Octree Encoding, Pure Primitive Instancing. **(10 hrs)**

Unit – IV

Introduction to Numerical Control, Basic components of an NC system, The NC procedure, ND coordinate system, NC motion control systems, Applications of numerical control. Introduction to CNC, DNC and adaptive control manufacturing systems.

Introduction to part programming, Tape coding and format (NC tape coding, formation of instructions, NC words), Manual part programming, Computer assisted part programming. **(10 hrs)**

Text / Reference Books

1. CAD/CAM by Groover and Zimmer, Prentice Hall
2. CAD/CAM: Theory and Practice by I. Zeid, Tata McGraw Hill
3. Mathematical Elements for Computer Graphics by Rogers & Adams, McGraw Hill.
4. Computer Aided Engineering Design by Anupam Saxena and Birendra Sahay, Springer
5. An Introduction to the Finite Element Method by J.N.Reddy, McGraw Hill
6. The Finite Element Method in Engineering by S.S. Rao, Pergamon Press
7. Textbook of Finite Element Analysis by P. Seshu, PHI Learning

Course Outcomes

1. Geometrically transform 2D & 3D entities (such as, lines, surfaces and solids)
2. Generate curves and surfaces by developing mathematical models
3. Model components using solid modeling techniques
4. NC Control and part programming

Course Code	RAPC318
Course Title	DESIGN OF MACHINE ELEMENTS
Number of Credits	3
Prerequisites (Course code)	RAPC201 and RAPC303
Course Type	PC

Brief Description about the course

This course will introduce the students to the design procedures involved in various machine elements. The learning objectives of this course are:

1. To understand the behavior of a machine component subjected to different loads and recognizing the failure criterion.
2. To identify the stresses induced in a machine component and design it to avoid failure using theories of failure.
3. Apply design methods for mechanical components such as gears, springs to meet the required criteria, along with strength requirements.
4. Apply engineering principles to open ended design problems

Unit – I

Basics Concepts & Design for Strength: Design methodology, Design criterion based on fracture, deformation and elastic stability, design stress, factor of safety Selection of Engineering Materials, Theories of Failure

Stress concentration, causes and mitigation, Endurance limit, Notch sensitivity, Factors affecting endurance limit, Design for finite and infinite life. Soderberg and Goodman diagram.

(10 hrs)

Unit – II

Design of Joints & Springs: Riveted joints for boiler shell according to I.B.R., riveted structural joint and riveted joint with eccentric loading. Types of welded joints, strength of welds under axial load, welds under eccentric loading. Designation of various types of bolts and nuts. Design of bolted joints, bolts of uniform strength. Bolted joints with eccentric load.

Introduction Helical springs: stress analysis, deflection analysis, spring materials, styles of ends. Design against static and fluctuating loads: Design of leaf springs.

(10 hrs)

Unit – III

Design of Shaft, Keys, Couplings & Gears: Design of shafts subjected to pure torsion, pure bending load. Combined bending and torsion, combined torsion, bending

and axial loads. Design of keys, Types of shaft couplings. Design of sleeve or muff coupling, flange coupling and bush type flexible couplings.

Introduction: spur gear, helical gear. Calculation of load carrying capacity, design of spur and helical gears for dynamic and wear loads, bearings reactions. **(10 hrs)**

Unit – IV

Design of Bearing: Introduction, Classification of bearings, selection of bearings, sliding contact bearings. types, materials, lubricants, properties of lubricants, hydrodynamic lubrication and design of hydrodynamic journal bearing: Rolling contact bearings: types, selection of rolling contact bearings and comparison of rolling and sliding contact bearing.

Case studies: Concepts of Manual, Automated Manual, Automatic and Dual Clutch transmission systems of automobiles and their working principles be studied. **(10 hrs)**

Text / Reference Books

1. Shigley, J.E., and Mischke, C.R., Mechanical Engineering Design, McGrawHill International Editions, New York, Edition VI, 2003
2. V B Bhandari, Design of Machine Elements, 2nd Ed., Tata Mcgraw Hill, 2007.
3. Design Data Book of Engineers, Compiled by Faculty of Mechanical Engineering, PSG College of Technology, Publisher Kalaikathir Achchagam, Coimbataore, 2009.
4. M.F Spotts, T.E Shoup, L.E. Hornberger, S.R Jayram, and C. V. Venkatesh, Design of Machine Elements, 8th Ed., Person Education, 2006
5. Paul H Black and O. E. Adams, P., Machine Design, 3/e, Mc Graw Hill Book Company, Inc., New York, USA., 2007.
6. R. C Juvinall and K. M Marshek, Fundamentals of Machine Component Design, 3rd Ed., Wiley Student Edition, 2007.
7. Robert L. Norton, Machine Design – An Integrated Approach, Prentice-Hall Inc.
8. V B Bhandari, Machine Design Data Book

Course Outcomes

1. Apply and implement design concepts
2. Design a machine component to meet strength requirements
3. Identify the failure modes and design the components like gears, springs etc.

Course Code	RAPE319
Course Title	COMPUTER NETWORKS
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PE

Course Learning Objectives:

1. Understand computer network basic, different models used for study of computer networks, ability to identify different designs, understanding of the issues surrounding wired and wireless Networks.
2. Design, calculate, and apply subnet masks to fulfil networking requirements and building the skills of routing mechanisms.
3. Analyse the features and operations of various application layer protocols such as Http, DNS, SMTP and FTP.
4. Analyse the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.
5. Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

Unit – I

Introduction:

History and development of computer networks, Network Functions, Network Topology, Network Services, Switching Approaches, Transmission media and systems, OSI Reference Model, Overview of TCP/IP architecture.

(10 hrs.)

Unit – II

Physical, MAC and Data Link Layer:

Different types of transmission media, errors in transmission: attenuation, noise, multiplexing and signalling techniques, Encoding (NRZ, NRZI, Manchester, 4B/5B, etc). Aloha, CSMA, CSMA/CD, CSMA/CA protocols, Ethernet, including Gigabit Ethernet and WiFi (802.11), Token Ring, Bluetooth and Zigbee. Error detection, Sliding Window, Stop and Wait protocols, ARQ, Sliding Window Protocols, HDLC, PPP protocols.

(10 hrs.)

Unit – III

Network layer:

Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Subnetting, Classless addressing, Network Address

Translation, IPv4 to IPv6 Translation strategies, Packet network topology, Datagrams and Virtual Circuits, Structure of Switch/Router, Connectionless and Virtual Circuit packet Switching, Traffic management and QoS – FIFO, Priority Queues, Fair Queuing, MPLS.

(10 hrs.)

Unit – IV

Transport and Application layer:

UDP, TCP. Connection establishment and termination, sliding window revisited, flow and congestion control, timers, retransmission, TCP extensions, etc. Client Server Model, HTTP, DNS, SMTP, FTP, and TFTP.

(10 hrs.)

Text / Reference Books

1. Behrouz A. Forouzan: Data Communications and Networks, Fifth Edition, McGraw Hill, 2017.
2. Leon Garcia and Indra Widjaja: Communication Networks – Fundamental Concepts and Key Architectures, Second Edition TMH.
3. A.S. Tanenbaum: Computer Networks, Sixth Edition, Pearson Education, 2022.
4. William Stallings: Data and Computer Communications 10/e, Pearson Education.

Course Outcomes

At the end of the course students will be able to.....

1. Understand computer network basic, different models used for study of computer networks, ability to identify different designs, understanding of the issues surrounding wired and wireless Networks.
2. Design, calculate, and apply subnet masks to fulfil networking requirements and building the skills of routing mechanisms.
3. Analyse the features and operations of various application layer protocols such as Http, DNS, SMTP and FTP.
4. Analyse the requirements for a given organizational structure and select the most appropriate networking architecture and technologies.
5. Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

Course Code	RAPE320
Course Title	VIRTUAL INSTRUMENTATION
Number of Credits	3
Prerequisites (Course code)	NA
Course Type	PE

Brief Description about the course

The students will gain an understanding of the fundamental building blocks of virtual instrumentation. They will learn to work with LabVIEW software, the platform used for implementing virtual instruments (VIs). The course will also introduce how sensor signals from robotic and automation systems are acquired, transmitted to the computer, and processed using algorithms developed in LabVIEW. Furthermore, students will be expected to design and implement various VI-based systems to address real-world engineering and automation problems.

UNIT I

Introduction to Virtual Instrumentation, A brief history of the development of Virtual Instrumentation (VI) systems, Block diagram of VI, the role of hardware & software in VI, VI for Test, Industrial I/O & Control and Design, VI applications in the engineering process (Research and Development, Test and Validation, Manufacturing Test), Difference between the traditional/conventional instrument and the VI: Flexibility and cost cutting, Mode of interaction, Architecture & computational capability. Data-Flow Techniques: Graphical & textual programming in the data flow, Comparison with conventional programming.

(10 hrs.)

UNIT II

Programming Techniques: Front panel & block diagram, controls, indicators & data types, various functions/operations in block-diagram, the concept of sub-VIs, the Icon, and the Connector pane, Repetition and Loops: For & while Loops, Case and sequence structures, structure tunnels, shift & stacked registers, Feedback nodes, Arrays.

(10 hrs.)

UNIT III

Output Verification Tools: Graphs: waveform graphs & charts, files I/O, local and global variables, Matrix & Clusters and their operations & conversions, Polymorphism, Formula nodes etc.

(08 hrs.)

UNIT IV

Data Acquisition Systems: Sampling fundamentals, Analog, discrete and digital signals, resolution, Brief overview of registers and counters, Analog to Digital Converters (R-2R ladder network, weighted resistor method, etc.), Digital to Analog converters (Counter type, tracking type, dual slope, and flash type, SAR, etc.), Digital I/O, counters and timers, Direct Memory Access.

Some case studies and applications of VI related to Robotics & automation systems, Control systems, PID Controller, etc.

(12 hrs.)

Text / Reference Books

1. Gary Johnson, LabVIEW Graphical Programming, Second edition, McGraw-Hill, New York, 1997.
2. Lisa K. Wells & Jeffery Travis, LabVIEW for Everyone, Prentice Hall, New Jersey, 1997.
3. Travis, J., LabVIEW for Everyone, Dorling Kingsley (2009).
3. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement.
4. Gupta, S. and Gupta, J.P., PC Interfacing for Data Acquisition and Process Control, Instrument Society of America (1994) 2nd ed.

COURSE OUTCOMES

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

1. Students will be familiarized with Virtual Instrumentation.
2. Students will be able to do Graphical language programming.
3. Students will know various functionalities of the LabVIEW software
4. Students can build the VI for various applications

Course Code	RAPE321
Course Title	INDUSTRIAL AUTOMATION
Number of Credits	3
Prerequisites (Course code)	RAPC203
Course Type	PE

Brief Description about the course

This course focuses on automation technologies employed in Industries. This course offers understanding of various components of state-of-the art automation technologies encountered in modern manufacturing industries. Also, introduces the students to the advanced automatic control of machines, processes and systems through various automation approaches such as pneumatic control, electro-pneumatic relay logic control, programmable logic controller and IIoT.

Unit – I

Need of Automation and Integration:

Introduction to automation technologies, strategies, application around us and in mechanical industries, Types of systems – Mechanical, Electrical, Electronics.

Hydraulic and Pneumatic Systems:

Elements of Hydraulic / pneumatic systems, fluid power control elements and standard graphical symbol for them, hydraulic and pneumatic cylinders, hydraulic pumps, hydraulic and pneumatic valves for pressure, flow and direction control, safety valve.

(12 hrs.)

Unit – II

Circuit Design approach for hydraulic and pneumatic control system:

Design and operation of logic control circuits for real time examples, sequence and synchronize the operation of two or more than two cylinders as per design requirements to automate the various systems in modern industries and equipments, Hydraulic and pneumatic safety and their application in clamping, traversing, and releasing operations, hydraulic system analysis.

(10 hrs.)

Unit – III

Design approach for electro-pneumatic control circuit:

Elements of electro-pneumatic systems, advantages over hydraulic and pneumatic control, solenoid valves, relays, factory automation sensors and their interfaces, electro-pneumatic control circuit design using relay logic approach and examples, sequence control of a lifting device, sequencing and synchronizing for more than two actuators / cylinders.

(08 hrs.)

Unit – IV

Industrial Control Systems:

Programmable Logic Controller (PLC), advantages over electropneumatic relay logic control system, programming and instruction sets for ladder logic and their applications with various automation examples in manufacturing industries, various types of time delay and counting operations, electrical connection diagram or interfacing of various input and output devices with PLC. **(10 hrs.)**

Text / Reference Books

1. Mikell P. Groover, "Automation, Production Systems, and Computer- Integrated Manufacturing," Pearson Education.
2. Frank Lamb, "Industrial Automation: Hands-On," McGraw-Hill Education.
3. Olushola Akande, "Industrial Automation from Scratch", Packt Publishing.
4. A. Esposito, "Fluid Power with Applications", Pearson Education, 6th ed., 2009.
5. J. R. Hackworth & F. D. Hackworth Jr., "Programmable Logic Controllers – Programming Methods and Applications", Pearson, 2011.
6. S. R. Majumdar, "Pneumatic Systems", McGraw Hill, 2005

Course Outcomes

The students will be able to:

1. Identify the advantages and applications of automation technologies in various manufacturing industries.
2. Design and analyze hydraulic/pneumatic system or process using relevant system components.
3. Understand, design and analyze electropneumatic logic circuits for process control in industry and differentiate them from hydraulic/pneumatic system.
4. Understand and apply the PLC automation approach to control the complex industrial processes.

Course Code	RAPE322
Course Title	EMBEDDED SYSTEMS FUNDAMENTALS
Number of Credits	3
Prerequisites (Course code)	
Course Type	PE

Course Learning Objectives

This course emphasizes on comprehensive treatment of embedded hardware and real time operating systems, 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

Introduction to Embedded Systems:

Embedded systems Overview. Processor in the System, Other Hardware Units. Software Embedded into a System. Embedded System – On-Chip (SOC).

Processor and Memory Organization: Structural Units in a Processor, Processor Selection for an Embedded System, Memory Devices, Memory Selection for an Embedded Systems, Interfacing Processors, Memories and Input Output Devices

(10 hrs)

UNIT - II

Introduction to ARM Processors:

Introduction to ARM processors, Evolution of ARM processors, ARM Processor cores and CPU cores.

Device Drivers and Interrupts Servicing Mechanics: Device Drivers, Parallel Port and Serial Port Device Drives in a System, Device Drivers for Internal Programmable Timing Devices, Interrupt Servicing Mechanism.

(10 hrs)

UNIT - III

Embedded Systems Interfacing:

I/O Devices. Timer and Counting Devices. Serial Peripheral Interface (SPI), Inter-Integrated Circuit, RS-232, Universal Serial Bus, CAN, IrDA, Bluetooth, PCI and AMBA bus protocols. Computer Parallel Communication between the Networked I/O. Advanced I/O Buses

(10 hrs)

UNIT - IV

Hardware-Software Co-Design in an Embedded System:

Embedded System Project Management. Embedded System Design and Co-Design issues in System Development Process.

Design Cycle in the Development Phase for an Embedded System: Use of Target Systems, Use of Software Tools for Development of an Embedded System, Hardware Tests, Issues in Embedded System Design.

Applications: Flashing of LEDS using Shift Register, Interfacing stepper motor, Interfacing temperature sensor, Interfacing ADC. **(10 hrs)**

Text Books/ References

1. Joseph Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Newnes Publications, Elsevier, Third Edition, 2014.
2. Santanu Chattopadhyaya, Embedded System Design, Second Edition, PHI, 2013.
3. T. Noergaard, "Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers", Elsevier Pvt. Ltd. Publications, 2005.
4. F. Vahid and T. D. Givargis, "Embedded system Design: A Unified Hardware/Software Introduction", John Wiley & Sons Inc, 2002.
5. P. Marwedel, "Embedded System Design", Science Publishers, 2007.
6. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", TMH.

Course Outcomes

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

1. Understand the processor and memory organization.
2. Learn different types of I/O Devices, timer and counting devices.
3. Understand the exception, interrupts and interrupt handling schemes
4. Understand the importance of Hardware-Software Co-design in an Embedded System.

Course Code	RAPE323
Course Title	NEURAL NETWORK & DEEP LEARNING
Number of Credits	2
Prerequisites (Course code)	CSIC221
Course Type	PE

Course Learning Objectives

The objective Deep Learning course is to cover the fundamentals of neural networks as well as some advanced topics such as recurrent neural networks, long short-term memory cells and convolutional neural networks. This course also covers the basic applications of the deep learning.

Unit – I

History of Deep Learning, Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.

(08 hrs.)

Unit - II

Feedforward Networks:

Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, autoencoders. Deep Neural Networks: Difficulty of training deep neural networks, Greedy layerwise training.

(08 hrs.)

Unit - III

Newer optimization methods for neural networks (Adagrad, adadelata, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization), Recurrent Neural Networks: Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

(08 hrs.)

Unit – IV

Convolutional Neural Networks:

LeNet, AlexNet, ZF-Net, VGGNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks, Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.

(08 hrs.)

Unit – V

Recent Trends:

Variational Autoencoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning, Applications: Image based classification, Vision, NLP.

(08 hrs.)

Text / Reference Books

1. Ian J. Goodfellow, BengioYoshua, and Aaron Courville. "Deep Learning." An MIT Press book in preparation, 2016.
2. Charu C. Aggarwal "Neural Networks and Deep Learning: A Textbook" Springer Nature, 2018.
3. Seth Weidman "Deep Learning from Scratch: Building with Python from First Principles" O'REILLY, 2019
4. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola "Dive into Deep Learning: Tools for Engagement" CORWIN, 2019
5. Ian J. Goodfellow, BengioYoshua, and Aaron Courville. "Deep Learning." An MIT Press book in preparation, 2016.

Course Outcomes

At the end of the course, student will have understanding of following concepts/ theories/ application:

1. Fundamental Understanding of Neural network.
2. Basic and Advance concept of Deep Learning.
3. Application of Deep Learning.

Course Code	RAPE324
Course Title	SOFT COMPUTING
Number of Credits	3
Prerequisites	NA
Course Type	PE

Course Learning Objectives

1. Introduction and awareness of problem-solving strategies of artificial intelligence.
2. Understanding of evolutionary computation concepts.
3. Inception of biologically inspired algorithm concepts.
4. Overview of fuzzy systems.

Unit – I

Introduction:

Introduction of Soft Computing, Soft Computing vs. Hard Computing, Various Types of Soft Computing Techniques, Applications of Soft Computing. **(08 hrs.)**

Unit – II

AI Problem Solving:

Uninformed Search Strategies, Informed Search Strategies, Local Search Strategies, Adversarial Search, Search for Constraint Satisfaction Problems. **(08 hrs.)**

Unit – III

Knowledge and Reasoning:

Logical Agents, First-Order Logic Inference in First-Order Logic, Knowledge Representation, Automated Planning. **(08 hrs.)**

Unit - IV

Nature Inspired Algorithms:

Genetic Algorithms, Genetic Programming, Evolutionary Programming, Swarm Intelligence: Ant Colony Optimization, Artificial Bee colony, Particle Swarm Optimization. **(08 hrs.)**

Unit – V

Fuzzy Logic:

Fuzzy Sets, Fuzzy rules, Fuzzy Reasoning, Fuzzification and Defuzzification Methods, Fuzzy inference system. **(08 hrs.)**

Text / Reference Books

1. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach, Prentice Hall, Fourth Edition, 2022.
2. Zbigniew Michalewicz, Genetic Algorithm+ Data Structures = Evolutionary Programs, Springer, Third Edition.
3. James Kennedy, Russell C. Eberhart and Yuhui Shi, Swarm Intelligence, Morgan Kaufmann, First Edition.
4. Jang J.S.R., Sun C.T. and Mizutani E , Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Pearson Education India, First Edition.
5. D.E. Goldberg, Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y.
6. Marco Dorigo and Thomas Stützle, Ant Colony Optimization, The MIT Press, First Edition.
7. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill, Third Edition.

Course Outcomes

1. Design proficiency of various artificial intelligence problem solving strategies.
2. Comprehensive understanding of evolutionary computation.
3. Extensive exposure of nature inspired computational concepts.
4. Knowledge of fuzzy applications.

Robotics & Industrial Engineering Department

B.Tech. Robotics & Automation

Course Code	RAPC325
Course Title	Project-I
Number of Credits	2

The Student will carry out group/independent project under the supervision of an allotted faculty member.

Course Code	RAPC326
Course Title	CAD/CAM (P)
Number of Credits	1
Prerequisites (Course Code)	NA
Course Type	PC

List of Exercises

Note: Any twelve of the following exercises are to be performed

1. Demonstration of 3D modelling software, Sketch Based Features, Dress Up features- Part Drawings
2. Study of parent-child relation, feature and boolean based modeling and assembly model
3. Create a 3-D solid model and convert into orthographic, isometric and sectional views and find their mass properties
4. Generation of different types of analytic and synthetic surfaces using CAD features
5. Development of different types of curves, surfaces and solids using set of data points
6. Surface modeling of turbine blade using sketch based features
7. Generate IGES and STEP files for given 3-D solid model and perform reflection, transmission and loopback test
8. Demonstration of MASTERCAM software, basic geometries & Simulation
9. Simulation and generation of NC part program for drilling operation -I
10. Simulation and generation of NC part program for drilling operation-II
11. Simulation and generation of NC part program for milling operation-I
12. Simulation and generation of NC part program for milling operation-II
13. Simulation and generation of NC part program for turning operation-I
14. Simulation and generation of NC part program for turning operation-II
15. Perform plane and step turning operation on CNC lathe
16. Perform taper and circular turning operation on CNC lathe

Software Packages: SOLIDWORKS, MASTERCAM

Course Outcomes

At the end of the course, the student will be able to

1. Use 3d Modelling features to develop different types of curves, surfaces and solids

2. Use feature and Boolean based modeling to develop surface model of turbine blade
3. Analyze different views, neutral file and find mass properties of geometric models
4. Use CAM software to simulate and generate part program for various machining operations
5. Demonstrate the execution of part program to perform various operations using CNC machine

Robotics & Industrial Engineering Department

B.Tech. Robotics & Automation

Course Code	RAPC327
Course Title	Technical Discussions
Number of Credits	1

Every student will present a seminar on the latest developments in the area of Robotics and Automation before his/her classmates and will answer their queries.