JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.TECH. MECHANICAL ENGINEERING (MECHATRONICS)
IV YEAR COURSE STRUCTURE & SYLLABUS (R16)

Applicable From 2016-17 Admitted Batch

IV YEAR I SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	MT701PC	Microprocessors and Microcontrollers	4	0	0	4
2		Professional Elective - II	3	1	0	3
3		Professional Elective - III	3	1	0	3
4		Professional Elective - IV	3	1	0	3
5	MT702PC	Robotics and its Applications	4	0	0	4
6	MT703PC	Microprocessors and Microcontrollers Lab	0	0	3	2
7	MT704PC	Motion Control Design and CNC & Robotics Lab	0	0	3	2
8	MT705PC	Industry Oriented Mini Project	0	0	3	2
9	MT706PC	Seminar	0	0	2	1
		Total Credits	**17**	**3**	**11**	**24**

IV YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1		Open Elective – III	3	0	0	3
2		Professional Elective - V	3	0	0	3
3		Professional Elective - VI	3	0	0	3
4	MT801PC	Major Project	0	0	30	15
		Total Credits	**9**	**0**	**30**	**24**

Professional Elective – II

MT721PE	Principles of Machine Design
MT722PE	Concurrent Engineering
EE724PE	Reliability Engineering
MT724PE	Mechanics of Composite Materials

Professional Elective - III

MT731PE	Advanced Kinematics & Dynamics of Machinery
MT732PE	Plant Engineering & Maintenance
MT733PE	Refrigeration and Air Conditioning
MT734PE	Operations Research

Professional Elective - IV

MT741PE	Automobile Engineering
MT742PE	Flexible Manufacturing System
MT743PE	Mathematical Modeling and Simulation

MT744PE	Engineering Metrology

Professional Elective - V

ME851PE	Automation in Manufacturing
MT852PE	Product Design and Assembly Automation
MT853PE	MATLAB Applications
MT854PE	Mechanical Vibrations

Professional Elective - VI

MT861PE	Computational Fluid Dynamics
MT862PE	Power Plant Engineering
MT863PE	MEMS Design
MT864PE	Automotive Pollution and Control

***Open Elective** subjects' syllabus is provided in a separate document.

***Open Elective –** Students should take Open Electives from the List of Open Electives Offered by Other Departments/Branches Only.

Ex: - A Student of Mechanical Engineering can take Open Electives from all other departments/branches except Open Electives offered by Mechanical Engineering Dept.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
LIST OF OPEN ELECTIVES OFFERED BY VARIOUS DEPARTMENTS FOR B.TECH. III AND IV YEARS

S. No.	Name of the Department Offering Open Electives	Open Elective – I (Semester – V)	Open Elective – II (Semester – VI)
1	Aeronautical Engg.	AE511OE: Introduction to Space Technology	AE621OE: Introduction to Aerospace Engineering
2	Automobile Engg.	CE511OE: Disaster Management MT512OE: Intellectual Property Rights	MT621OE: Data Structures MT622OE: Artificial Neural Networks
3	Biomedical Engg.	BM511OE: Reliability Engineering	BM621OE: Medical Electronics
4	Civil Engg.	CE511OE: Disaster Management.	CE621OE: Remote Sensing and GIS CE622OE: Geo-Informatics CE623OE: Intellectual Property Rights
5	Civil and Environmental Engg.	CE511OE: Disaster Management	CN621OE: Environmental Impact Assessment CE623OE: Intellectual Property Rights
6	Computer Science and Engg. / Information Technology	CS511OE: Operating Systems CS512OE: Database Management Systems	CS621OE: Java Programming CS622OE: Software Testing Methodologies CS623OE: Cyber Security
7	Electronics and Communication Engg. / Electronics and Telematics Engg.	EC511OE: Principles of Electronic Communications	EC621OE: Principles of Computer Communications and Networks
8	Electronics and Computer Engg.	EM511OE: Scripting Languages	EM621OE: Soft Computing Techniques
9	Electrical and Electronics Engg.	EE511OE: Non-Conventional Power Generation EE512OE: Electrical Engineering Materials EE513OE: Nanotechnology	EE621OE: Design Estimation and Costing of Electrical Systems EE622OE: Energy Storage Systems EE623OE: Introduction to Mechatronics
10	Electronics and Instrumentation Engg.	EI511OE: Electronic Measurements and Instrumentation	EI621OE: Industrial Electronics
11	Mechanical Engg.	ME511OE: Optimization Techniques ME512OE: Computer Graphics ME513OE: Introduction	ME621OE: World Class Manufacturing ME622OE: Fundamentals of Robotics ME623OE: Fabrication

		to Mechatronics ME514OE: Fundamentals of Mechanical Engineering	Processes
12	Mechanical Engg. (Material Science and Nanotechnology)	NT511OE: Fabrication Processes NT512OE: Non destructive Testing Methods NT513OE: Fundamentals of Engineering Materials	NT621OE: Introduction to Material Handling NT622OE: Non-Conventional Energy Sources NT623OE: Robotics
13	Mechanical Engg. (mechatronics)	MT511OE: Analog and Digital I.C. Applications MT512OE: Intellectual Property Rights MT513OE: Computer Organization	MT621OE: Data Structures MT622OE: Artificial Neural Networks MT623OE: Industrial Management
14	Metallurgical and Materials Engg.	MM511OE: Materials Characterization Techniques	MM621OE: Science and Technology of Nano Materials MM622OE: Metallurgy of Non Metallurgists
15	Mining Engg.	MN511OE: Introduction to Mining Technology	MN621OE: Coal Gasification, Coal Bed Methane and Shale Gas
16	Petroleum Engg.	PE511OE: Materials Science and Engineering PE512OE: Renewable Energy Sources PE513OE: Environmental Engineering	PE621OE: Energy Management and Conservation PE622OE: Optimization Techniques PE623OE: Entrepreneurship and Small Business Enterprises

S. No.	Name of the Department Offering Open Electives	Open Elective –III (Semester – VIII)
1	Aeronautical Engg.	AE831OE: Air Transportation Systems AE832OE: Rockets and Missiles
2	Automobile Engg.	AM831OE: Introduction to Mechatronics AM832OE: Microprocessors and Microcontrollers
3	Biomedical Engg.	BM831OE: Telemetry and Telecontrol BM832OE: Electromagnetic Interference and Compatibility
4	Civil Engg.	CE831OE: Environmental Impact Assessment CE832OE: Optimization Techniques in Engineering CE833OE: Entrepreneurship and Small Business Enterprises
5	Civil and Environmental Engg.	CN831OE: Remote Sensing and GIS CE833OE: Entrepreneurship and Small Business

		Enterprises
6	Computer Science and Engg. / Information Technology	CS831OE: Linux Programming CS832OE: R Programming CS833OE: PHP Programming
7	Electronics and Communication Engg. / Electronics and Telematics Engg.	EC831OE: Electronic Measuring Instruments
8	Electronics and Computer Engg.	EM831OE: Data Analytics
9	Electrical and Electronics Engg.	EE831OE: Entrepreneur Resource Planning EE832OE: Management Information Systems EE833OE: Organizational Behaviour
10	Electronics and Instrumentation Engg.	EI831OE: Sensors and Transducers, EI832OE: PC Based Instrumentation
11	Mechanical Engg.	ME831OE: Total Quality Management ME832OE: Industrial Safety, Health, and Environmental Engineering ME833OE: Basics of Thermodynamics ME834OE: Reliability Engineering
12	Mechanical Engg. (Material Science and Nanotechnology)	NT831OE: Concepts of Nano Science And Technology NT832OE: Synthesis of Nanomaterials NT833OE: Characterization of Nanomaterials
13	Mechanical Engg. (mechatronics)	MT831OE: Renewable Energy Sources MT832OE: Production Planning and Control CE833OE: Entrepreneurship and Small Business Enterprises
14	Metallurgical and Materials Engg.	MM831OE: Design and Selection of Engineering Materials
15	Mining Engg.	MN831OE: Solid Fuel Technology MN832OE: Health & Safety in Mines
16	Petroleum Engg.	PE831OE: Disaster Management PE832OE: Fundamentals of Liquefied Natural Gas PE833OE: Health, Safety and Environment in Petroleum Industry

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Ex: - A Student of Mechanical Engineering can take Open Electives from all other departments/branches except Open Electives offered by Mechanical Engineering Dept.

MICROPROCESSORS AND MICROCONTROLLERS

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MT701PC	**4**	**0**	**0**	**4**

Course Objectives:

- To develop an understanding of the operations of microprocessors and micro controllers; machine language programming and interfacing techniques.

Course Outcomes:

- Understands the internal architecture and organization of 8086, 8051 and ARM processors/controllers.
- Understands the interfacing techniques to 8086 and 8051 and can develop assembly language programming to design microprocessor/ micro controller based systems.

UNIT - I

8086 Architecture: 8086 Architecture-Functional diagram, Register Organization, Memory Segmentation, Programming Model, Memory addresses, Physical Memory Organization, Architecture of 8086, Signal descriptions of 8086, interrupts of 8086.

Instruction Set and Assembly Language Programming of 8086: Instruction formats, Addressing modes, Instruction Set, Assembler Directives, Macros, and Simple Programs involving Logical, Branch and Call Instructions, Sorting, String Manipulations.

UNIT - II

Introduction to Microcontrollers: Overview of 8051 Microcontroller, Architecture, I/O Ports, Memory Organization, Addressing Modes and Instruction set of 8051.

8051 Real Time Control: Programming Timer Interrupts, Programming External Hardware Interrupts, Programming the Serial Communication Interrupts, Programming 8051 Timers and Counters

UNIT – III

I/O And Memory Interface: LCD, Keyboard, External Memory RAM, ROM Interface, ADC, DAC Interface to 8051.

Serial Communication and Bus Interface: Serial Communication Standards, Serial Data Transfer Scheme, On board Communication Interfaces-I2C Bus, SPI Bus, UART; External Communication Interfaces-RS232,USB.

UNIT – IV

ARM Architecture: ARM Processor fundamentals, ARM Architecture – Register, CPSR, Pipeline, exceptions and interrupts interrupt vector table, ARM instruction set – Data processing, Branch instructions, load store instructions, Software interrupt instructions, Program status register instructions, loading constants, Conditional execution, Introduction to Thumb instructions.

UNIT – V

Advanced ARM Processors: Introduction to CORTEX Processor and its architecture, OMAP Processor and its Architecture.

TEXT BOOKS:

1. Advanced Microprocessors and Peripherals – A. K. Ray and K.M. Bhurchandani, MHE, 2nd Edition 2006.
2. The 8051 Microcontroller, Kenneth. J. Ayala, Cengage Learning, 3rd Ed.
3. ARM System Developers guide, Andrew N SLOSS, Dominic SYMES, Chris WRIGHT, Elsevier, 2012

REFERENCE BOOKS:

1. Microprocessors and Interfacing, D. V. Hall, MGH, 2nd Edition 2006.
2. Introduction to Embedded Systems, Shibu K.V, MHE, 2009
3. The 8051Microcontrollers, Architecture and Programming and Applications -K.Uma Rao, Andhe Pallavi, Pearson, 2009.

PRINCIPLES OF MACHINE DESIGN
(Professional Elective – II)

	L	T	P	C
B.Tech. IV Year I Sem.				
Course Code: MT721PE	**3**	**1**	**0**	**3**

UNIT - I

Introduction: General considerations in the design of Engineering Materials and their properties –selection –Manufacturing consideration in design. Tolerances and fits –BIS codes of steels. **Stresses in Machine Members:** Simple stresses – Complex Stresses – impact stress strain relations – Static theories of failure – factors of safety – Design for strength and rigidity – preferred numbers. The concept of stiffness in tension, bending, torsion, and combined situations. **Fatigue Loading:** Stress concentration – Theoretical stress Concentration factor – Fatigue stress concentration factor notch sensitivity – Design for fluctuating stresses – Endurance limit – Estimation of Endurance strength – Fatigue theories of failure Goodman and Soderberg's lines.

UNIT – II

Riveted and Welded Joints: Riveted Joints: Modes of failure f riveted joints-Strength equations –efficiency of riveted joints-Design of boiler joints – eccentricity loaded riveted joints. Welding Joints: Design of fillet welds- axial loads – Circular fillet welds-bending and torsion-eccentricity loaded joints.

Axially Loaded Joints and Shafts: Keys, cotters and knuckle joints: Design of Keys stresses in key- cottered joints-spigot and socket, sleeve and cotter, jib and cotter joints-knuckle joints. Design of shafts: Design of solid and hollow shafts for strength and rigidity – Design of shafts of complex loads- Shaft sizes – BIS code. Design of shafts for gear and belt drives

UNIT – III

Power Transmissions Systems, Pulleys: Transmission of power by Belt and Rope drives , Transmission efficiencies, Belts – Flat and V types – Ropes - pulleys for belt and rope drives, Materials, Chain drives

UNIT – IV

Spur & Helical Gear Drives: Spur gears& Helical gears – Load concentration factor – Dynamic load factor. Surface compressive strength – Bending strength – Design analysis of spur and helical gears – Estimation of centre distance, module and face width, check for plastic deformation. Check for dynamic and wear considerations.

UNIT - V

Bearings: Types of bearings – Basic modes of Lubrication – Bearing construction-Bearing design- bearing materials-Selection of Lubricants. Rolling contact bearings: Types of rolling contact bearings-Selection of bearing type-Selection of bearing life-Design for cyclic loads and speeds-static and dynamic loading of ball & roller bearings

TEXT BOOKS:

1. Mechanical Engineering Design by Bahl and Goel, Standard Publications
2. Design of Machine Elements by kulakarni-Mc Graw Hill-3rd

REFERENCE BOOKS:

1. Machine design by timothy H.Wenzell PE, Cengage
2. Machine design by r.L. Norton, Mc GRaw hill
3. Machine design by V.Bandari, TMH Publishers
4. Machine design – Pandya & shah.
5. Machine Desin, S MD Kakakuddin, Anuradha Publisher

*Note: Use of design data book is permitted in the examination

CONCURRENT ENGINEERING
(Professional Elective – II)

	L	T	P	C
B.Tech. IV Year I Sem.				
Course Code: MT722PE	**3**	**1**	**0**	**3**

UNIT - I

Introduction: Development of Concurrent Engineering. The mean and activity concepts and principles. Examples.

Concurrent Engineering Tools and Technologies: Changes in to Technologies, Tasks, Talents, and times into well managed resources product developments.

UNIT – II

Research in Engineering design and manufacturing: Theory applications using the concurrent Engineering concepts and Principles.

Simultaneous design and all related processes of a product.

UNIT –III

The mission and vision of C.E: Computer optimized manufacturing (COM).The next generation of computer integrated manufacturing (CIM).

Global competitiveness and development of high quality product. Offline reliability

UNIT –IV

Managing the concurrent Engineering: Contemporary Issues a modern Tools and methods Use of Computers and decision making. Reengineering concepts

UNIT-V

Automated Quality Control Application of CMM, Basic concepts, Zero defect, 6 sigma concept, Tolerancing, Examples, DFMA, Rapid Prototyping

TEXT BOOK:

1. Concurrent Engineering: Tools and Technologies for Mechanic Systems Design – Edward, J. Haug.

REFERENCES:

1. Research in Engineering Design : Theory, applications, and concurrent engineering : Vol. 7, No. 1, 1995.
2. Managing Concurrent Engineering. – Jon Turino

RELIABILITY ENGINEERING
(Professional Elective – II)

	L	T	P	C
B.Tech. IV Year I Sem.				
Course Code: MT723PE/EE724PE	**3**	**1**	**0**	**3**

Prerequisite: Mathematics III

Course Objectives:

- To introduce the basic concepts of reliability, various models of reliability
- To analyze reliability of various systems
- To introduce techniques of frequency and duration for reliability evaluation of repairable systems.

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

- model various systems applying reliability networks
- evaluate the reliability of simple and complex systems
- estimate the limiting state probabilities of repairable systems
- apply various mathematical models for evaluating reliability of irrepairable systems

UNIT – I

Basic Probability Theory: Elements of probability, probability distributions, Random variables, Density and Distribution functions- Binomial distribution- Expected value and standard deviation - Binomial distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution.

Definition of Reliability: Definition of terms used in reliability, Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate. Hazard models - Bath tub curve, Effect of preventive maintenance. Measures of reliability: Mean Time to Failure and Mean Time Between Failures.

UNIT – II

Network Modeling and Evaluation Of Simple Systems: Basic concepts- Evaluation of network Reliability / Unreliability - Series systems, Parallel systems- Series-Parallel systems- Partially redundant systems- Examples.

Network Modeling and Evaluation of Complex systems: Conditional probability method- tie set, Cutset approach- Event tree and reduced event tree methods- Relationships between tie and cutsets- Examples.

UNIT – III

Time Dependent Probability: Basic concepts- Reliability function f(t). F(t), R(t) and h(t) - Relationship between these functions.

Network Reliability Evaluation Using Probability Distributions: Reliability Evaluation of Series systems, Parallel systems – Partially redundant systems- determination of reliability measure- MTTF for series and parallel systems – Examples.

UNIT – IV

Discrete Markov Chains: Basic concepts- Stochastic transitional probability matrix- time dependent probability evaluation- Limiting State Probability evaluation- Absorbing states – Examples

Continuous Markov Processes: Modeling concepts- State space diagrams- Unreliability evaluation of single and two component repairable systems

UNIT – V

Frequency and Duration Techniques: Frequency and duration concepts, application to multi state problems, Frequency balance approach.

Approximate System Reliability Evaluation: Series systems – Parallel systems- Network reduction techniques- Cut set approach- Common mode failures modeling and evaluation techniques- Examples.

TEXT BOOKS:

1. Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Plenum Press, 1983.
2. E. Balagurusamy, Reliability Engineering by Tata McGraw-Hill Publishing Company Limited, 2002.

REFERENCE BOOK:

1. K. K. Agarwal, Reliability Engineering-Kluwer Academic Publishers, 1993**.**

MECHANICS OF COMPOSITE MATERIALS
(Professional Elective - II)

	L	T	P	C
B.Tech. IV Year I Sem.				
Course Code: MT724PE	**3**	**1**	**0**	**3**

Course Overview:

This course is designed for building foundational knowledge in composites. It introduces the concept of: (1) Characterization and application of composite, (2) the methods of composite strengthening, and (3) production routes and performance of composites.

Course Objectives:

1. An ability to identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
2. An ability to predict the elastic properties of both long and short fiber composites based on the constituent properties.
3. An ability to rotate stress, strain and stiffness tensors using ideas from matrix algebra.

UNIT - I

Introduction to Composite Materials: Introduction, classification, polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon-carbon composites, fiber, reinforced composites and nature-made composites and applications.

Reinforcements: Fibers Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide, fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

UNIT - II

Manufacturing Methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM. Macro mechanical Analysis of a "Lamina": introduction, Definitions: stress, strain, Elastic Moduli, strain Energy. Hooke's Law for different types of materials, Hooks Law for a two dimensional unidirectional lamina, plane stress assumption, reduction of Hooks Law in three dimensions to two dimensions, relationship of compliance and stiffness matrix to engineering elastic constants of a lamina.

UNIT - III

Hooke’s Law for a Two-Dimensional Angle Lamina, Engineering constants of an Angle Lamina. Invariant Form of Stiffness and compliance Matrices for an Angle Lamina Strength Failure. Envelops, Maximum Strain Failure Theory, Tsai-Hill Failure Theory, Tsai-Wu Failure Theory Comparison of Experimental Results with Failure Theories.

Hygrothermal Stresses and Strains in a Lamina: Hygrothermal Stress-Strain Relationships for a Unidirectional Lamina, Hygrothermal Stress-Strain Relationships for a Angle Lamina.

UNIT - IV

Micromechanical Analysis of A Lamina: Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi Empirical Models Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion .

UNIT - V

Macro mechanical Analysis of Laminates: Introduction, Laminate Code, Stress-Strain Relations for a Laminate, In-Plane and Flexural Modules of a Laminate, Hygrothermal Effects in a Laminate, Warpage of Laminates.

Failure Analysis and Design of Laminates: Introduction Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, Other Mechanical Design Issues

TEXT BOOKS:

1. Engineering Mechanics of Composite materials by Issac and M Daniel
2. R.M Jones, Mechanics of composite Materials, McGraw Hill Company, New York, 1975

REFERENCE BOOKS:

1. D. Agarwal and L. Broutman, Analysis and performance of fibre Composites, Wiley-interscience.
2. L.R Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969
3. Mechanics of Composite Materials, Mukhopadhyay

ADVANCED KINEMATICS AND DYNAMICS OF MACHINERY
(Professional Elective – III)

	L	T	P	C
B.Tech. IV Year I Sem.				
Course Code: MT731PE	**3**	**1**	**0**	**3**

UNIT - I

Geometry of motion - Grublers Criterion for plain and spatial mechanisms - Grashoff's law for planar and spatial mechanisms, Kutn Batch criterion for planar and spatial mechanisms

Velocity and acceleration analysis, use of computers in analysis. Velocity and accelerations analysis of complex mechanisms.

UNIT - II

Coupler curves, Robert's Chebychev spacing method. Cognate linkages. Path curvature- Polodes- Euler Savery equation -Bobiller and Hartman's Construction- Equivalent mechanisms.

Space mechanisms and mobility equations: Positional problems. Vector analysis of velocity and accelerations.

UNIT - III

Theorem of angular velocities and accelerations –computer aided analysis.

Static force analysis of plane and spatial mechanisms: Inertia forces and torques. Dynamic force analysis, application of computer animation and simulation of motion studies.

UNIT- IV

Dynamic Motion Analysis: Quinn's energy distribution method, the equivalent mass and force method. The rate of change of energy method, dynamic motion simulation.

UNIT - V

Synthesis of linkages: Two position synthesis. Properties of rotopole, Chebychev spacing. Optimization of the transmission angles. The overlay method; Three-position synthesis; point position reduction; synthesis of dwell mechanisms;

Codes / Tables: No table/code books required for examination

TEXTBOOKS:

1. Kinematics and Dynamics and design of machinery, Waldron, Wiley Publishers.
2. Shigley: J.E. Kinematic Analysis of mechanism, McGraw 11.

REFERECES:

1. Hirschcom : J.K.. KinciBcs and Dynamics of Plane Mechanisms McGraw Hill.
2. Holewenko, A.R. Dynamics of machinery, John Wiley & Sons.

PLANT ENGINEERING AND MAINTENANCE
(Professional Elective – III)

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MT732PE/AM734PE	**3**	**1**	**0**	**3**

UNIT – I

Introduction: Need for maintenance, Facts and Figures, modern maintenance, problem and maintenance strategy for the 21st century, Engineering maintenance objectives and maintenance in equipment Life cycle, Terms and definitions.

Maintenance Management and control: Maintenance Manual, Maintenance, Facility evaluation, Functions of Effective Maintenance Management, Maintenance project control Methods, Maintenance Management control Indices.

UNIT – II

Types of maintenance: Preventive Maintenance, Elements of Preventive, Maintenance Program, Establishing Preventive Maintenance program, PM program Evaluation and Improvement, PM measures, PM models, Corrective Maintenance, Corrective Maintenance types, Corrective Maintenance steps and downtime components, Corrective Maintenance measures, Corrective Maintenance models.

Inventory control in Maintenance: Inventory control objectives and basic inventory decisions, ABC Inventory control method, Inventory control models two bi Inventory control and safety stock, Spares determination factors, spares calculation methods.

UNIT –III

Quality and Safety in Maintenance: Needs for quality Maintenance processes, Maintenance work quality, use of quality control charts in Maintenance work sampling, post Maintenance testing, reasons for safety problems in Maintenance, guidelines to improve safety in Maintenance work, safety officer's role in Maintenance work, and protection of Maintenance workers.

UNIT - IV

Maintenance costing: reasons for Maintenance costing, Maintenance budget preparation methods and steps, Maintenance labor cost estimation, material cost estimation, equipment life cycle Maintenance cost estimation, Maintenance cost estimation models.

UNIT – V

Reliability, Reliability centered Maintenance: RCM goals and principles, RCM process and Associated Questions, RCM Program components Effectiveness Measurement indicators, RCM benefits and Reasons for its failures, Reliability versus Maintenance and Reliability in support phase, Bathtub Hazard Rate Concept, Reliability Measures and Formulas, Reliability Networks, Reliability Analysis Techniques.

Maintainability: Maintainability Importance and objective, Maintainability in systems Life cycle, Maintainability

Design characteristics, Maintainability functions and measures, common Maintainability design errors.

TEXT BOOKS:

1. Engineering Maintenance a modern approach B.S. Dhallon 2002 C.R.R. Publishers
2. Maintenance Engineering and management – K. Venkataraman - PHI

REFERENCE BOOKS:

1. Reliability Engineering – Balaguruswamy
2. Reliability Engineering – L.S. Srinath
3. Industrial Safety Management – L.M. Deshmukh – TMH

REFRIGERATION AND AIR CONDITIONING
(Professional Elective – III)

	L	T	P	C
B.Tech. IV Year I Sem.				
Course Code: MT733PE	**3**	**1**	**0**	**3**

Pre-requisite: Thermodynamics

Course Objective: To apply the principles of Thermodynamics to analyze different types of refrigeration and air conditioning systems and to understand the functionality of the major components.

Course Outcomes: At the end of the course, the student should be able to Differentiate between different types of refrigeration systems with respect to application as well as conventional and unconventional refrigeration systems. Thermodynamically analyse refrigeration and air conditioning systems and evaluate performance parameters. Apply the principles of Psychometrics to design the air conditioning loads for the industrial applications.

UNIT – I

Introduction to Refrigeration: - Necessity and applications – Unit of refrigeration and C.O.P. – Mechanical Refrigeration – Types of Ideal cycle of refrigeration.

Air Refrigeration: Bell Coleman cycle and Brayton Cycle, Open and Dense air systems – Actual air refrigeration system – Refrigeration needs of Air crafts- Air systems – Actual Air refrigeration system – Refrigeration needs of Air crafts – Application of Air Refrigeration, Justification – Types of systems – Problems.

UNIT – II

Vapour compression refrigeration – working principle and essential components of the plant – Simple Vapour compression refrigeration cycle – COP – Representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – Actual cycle Influence of various parameters on system performance – Use of p-h charts – Problems.

UNIT - III

System Components: Compressors – General classification – comparison – Advantages and Disadvantages. Condensers – classification – Working Principles. Evaporators – classification – Working Principles. Expansion devices – Types – Working Principles. Refrigerants – Desirable properties – common refrigerants used – Nomenclature – Ozone Depletion – Global Warming – Azeotropes and Zeotropes.

UNIT - IV

Vapor Absorption System – Calculation of max COP – description and working of NH3 – water system – Li – Br system. Principle of operation Three Fluid absorption system, salient features.

Steam Jet Refrigeration System – Working Principle and Basic Components
Principle and operation of (i) Thermoelectric refrigerator (ii) Vortex tube or Hilsch tube.

UNIT – V

Introduction to Air Conditioning: Psychometric Properties & Processes – Sensible and latent heat loads – Characterization – Need for Ventilation, Consideration of Infiltration – Load concepts of RSHF, ASHF, ESHF and ADP.
Concept of human comfort and effective temperature –Comfort Air conditioning – Industrial air conditioning and Requirements – Air conditioning Load Calculations.
Air Conditioning systems - Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, deodorants, fans and blowers.
Heat Pump – Heat sources – different heat pump circuits – Applications.

TEXT BOOKS:

1. Refrigeration and Air conditioning / CP Arora / Mc Graw Hill
2. Refrigeration and Air-Conditioning / RC Aora / PHI

REFERENCE BOOKS:

1. Principles of Refrigeration - Dossat / Pearson
2. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / Mc Graw Hill

OPERATIONS RESEARCH
(Professional Elective – III)

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: ME724PE/MT734PE/AM743PE	**3**	**1**	**0**	**3**

Course Objectives: Understanding the mathematical importance of development of model in a particular optimization model for the issue and solving it.

Course Outcome: Understanding the problem, identifying variables & constants, formulas of optimization model and applying appropriate optimization Tech

UNIT – I

Development – Definition– Characteristics and Phases – Types of models – Operations Research models – applications.

Allocation: Linear Programming Problem - Formulation – Graphical solution – Simplex method – Artificial variables techniques: Two–phase method, Big-M method; Duality Principle.

UNIT – II

Transportation Problem – Formulation – Optimal solution, unbalanced transportation problem – Degeneracy.

Assignment problem – Formulation – Optimal solution - Variants of Assignment Problem; Traveling Salesman problem.

UNIT – III

Sequencing – Introduction – Flow **–**Shop sequencing – n jobs through two machines – n jobs through three machines – Job shop sequencing – two jobs through 'm' machines-graphical model. **Replacement:** Introduction – Replacement of items that deteriorate with time – when money value is not counted and counted – Replacement of items that fail completely- Group Replacement.

UNIT – IV

Theory of Games: Introduction –Terminology– Solution of games with saddle points and without saddle points- 2 x 2 games –m x 2 & 2 x n games - graphical method – m x n games - dominance principle.

Inventory: Introduction – Single item, Deterministic models – Types - Purchase inventory models with one price break and multiple price breaks –Stochastic models – demand discrete variable or continuous variable – Single Period model with no setup cost.

UNIT – V

Waiting Lines: Introduction–Terminology-Single Channel–Poisson arrivals and Exponential Service times – with infinite population and finite population models– Multichannel – Poisson arrivals and exponential service times with infinite population.

Dynamic Programming: Introduction – Terminology- Bellman's Principle of Optimality – Applications of dynamic programming- shortest path problem – linear programming problem.

TEXT BOOKS:

1. Operations Research / N.V.S. Raju / SMS
2. Operations Research / ACS Kumar / Yes Dee

REFERENCE BOOKS:

1. Operations Research /J. K. Sharma / MacMilan.
2. Operations Research /A. M. Natarajan, P. Balasubramaniam, A. Tamilarasi / Pearson.

AUTOMOBILE ENGINEERING
(Professional Elective – IV)

B.Tech. IV Year I Sem.	L	T	P	C
Course Code: MT741PE	3	1	0	3

UNIT – I

Introduction: Layout of automobile – introduction chassis and body components. Types of Automobile engines. – Power unit – Introduction to engine lubrication – engine servicing

Fuel System: S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pump – filters – carburetor – types – air filters – petrol injection. Introduction to MPFI and GDI Systems.

C.I. Engines: Requirements of diesel injection systems, types of injection systems, DI Systems IDI systems. fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps. Introduction CRDI and TDI Systems.

UNIT – II

Cooling System : Cooling Requirements, Air Cooling, Liquid Cooling, Thermo, water and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporative cooling – pressure sealed cooling – antifreeze solutions.

Ignition System: Function of an ignition system, battery ignition system, constructional features of storage, battery, auto transformer, contact breaker points, condenser and spark plug – Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.

Electrical System : Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.

UNIT – III

Transmission System: Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, constant mesh, synchro mesh gear boxes, epicyclic gear box , over drive torque converter. Propeller shaft – Hotch – Kiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres.

Suspension System: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.

UNIT – IV

Braking System: Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder tandem master cylinder Requirement of brake fluid, Pneumatic, and vacuum brakes.

Steering System: Steering geometry – camber, castor, king pin rake, combined angle toein, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

UNIT – V

Emissions from Automobiles – Pollution standards National and international – Pollution Control – Techniques – Multipoint fuel injection for SI Engines. Common rail diesel injection Energy alternatives – Solar, Photo-voltaic, hydrogen, Biomass, alcohols, LPG, CNG, liquid Fuels and gaseous fuels, Hydrogen as a fuel for IC Engines. - Their merits and demerits. Standard Vehicle maintenance practice.

TEXT BOOKS:

1. Automobile Engineering / William H Crouse
2. A Text Book Automobile Engineering–Manzoor, Nawazish Mehdi & Yosuf Ali, Frontline Publications.

REFERENCES:

1. A Text Book of Automobile Engineering by R K Rajput. Laxmi Publications.
2. Automotive Mechanics / Heitner
3. Automotive Engineering / Newton Steeds & Garrett
4. Automotive Engines / Srinivasan
5. A Text Book of Automobile Engineering By Khalil U Siddiqui New Age International

FLEXIBLE MANUFACTURING SYSTEM
(Professional Elective – IV)

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MT742PE	**3**	**1**	**0**	**3**

UNIT – I

Introduction: Types of production, characteristics, applications, need for FMS, where to apply FMS technology. Components of FMS, FMS layout configurations, planning the FMS, FMS's Work- stations. Flexible Manufacturing Cell: Characteristics, Flexible Machining systems, achieving flexibility in machining systems, Machine cell design, quantitative techniques

UNIT – II

Group Technology(GT) –Part classification and coding systems: Part families, Optiz system, structure, MULTICODE, differences between Optiz and MULTICODE systems, relative benefits. GT- production flow analysis: Composite part concept, numerical problems for parts clustering, advantages of GT in manufacturing and design.

UNIT - III

Material Handling systems, Automatic Guided vehicle systems, automated storage and retrieval systems and Computer control systems.

UNIT - IV

Implementing FMS: FMS Layout configurations, Quantitative Analysis methods for FMS, Applications and benefits of FMS, problems in implementing FMS.

UNIT – V

Computer Aided Process planning: Importance, generative and retrieval systems, advantages and disadvantages, Generation of route sheets, selection of optimal machining parameters, methods. **Computer aided quality control and testing**: Coordinate measuring machines, over view, contact and non contact inspection principles, Part programming coordinate measuring machines, In-cycle gauging.

TEXT BOOKS:

1. Automation, Production systems and Computer Integrated Manufacturing System – Mikell P. Groover
2. The design and operation of FMS –Dr. Paul Ranky Nort –Holland Publishers

REFERENCES:

1. Flexible Manufacturing systems in practice by Joseph talvage and roger G. Hannam, Marcel Dekker Inc., New york
2. Hand book of FMS – Nand Jha .K.
3. FMS and control of machine tools - V. Ratmirov, MIR publications
4. Flexible Manufacturing – David J. Parrish

MATHEMATICAL MODELING AND SIMULATION
(Professional Elective – IV)

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MT743PE	**3**	**1**	**0**	**3**

UNIT - I

Art of Modeling, Types of models, mathematical models – solution methods – analytical, Numerical and Heuristic. L.P.P. – Formulation – Graphical Method, simplex method, dual simplex method and application.

Transportation models – Assignment models, Integer programming, Non-linear programming.

UNIT – II

Deterministic Inventory models – General Inventory model, Static E.O.Q. Models, Dynamic Inventory model, Probabilistic Inventory models, continuous Review models, single period model, and multiple period models.

Selective Inventory control – ABC, VED, FSN Analysis. Inventory systems – Fixed order quantity system, two bin system, periodic review systems, Optional Replenishment system and M R P.

UNIT – III

Queuing Theory – Basic Structure of Queuing Models, Role of Exponential Distribution, Birth-and-Death Process, Queuing Models Based on the Birth-and- Death Process, Queuing Models involving Non-exponential Distributions, Priority-Discipline Queuing Models and Queuing Networks. Applications of Queuing Theory – Decision Making, Formulation of Waiting – Cost Function and Decision Models.

UNIT – IV

CPM and PERT – Network Representation, Critical path calculation, construction of Time schedule.

Simulation – Introduction, General principles, Random-Number Generation, Random-Variate Generation, Simulation Software.

UNIT – V

Input modeling, verification and validation of simulation models, Output Analysis for a single model, Comparison and Evaluation of Alternative System Designs, Simulation of Computer Systems.

TEXT BOOKS:

1. Introduction to Operations Research, Frederick S Hiller and Gerald J Lieberman, 7th Edition, Tata McGraw Hill, 2001 (Chapters 17 and 18 for Unit-III).
2. Discrete-Event System Simulation, Jerry Banks, John S Carson II, Barry L. Nelson and David M. Nicol, 3rd edition, PHI/Pearson Education (Chapters 1, 3, 4, 7 and 8 for Unit-IV; Chapters 9,10,11,12 and 14 for Unit-V).

3. Operations Research – An Introduction, 7^{th} edition, Prentice-Hall of India, 1999 (Chapter 1 to 5 for Unit-I and Chapters 11 and 16 for Unit II, Section 6.7 for Unit-IV).

REFERENCE BOOKS:

1. Operation Research – S. K. Jain and D. M. Mehta, Galgotia.
2. Introductory Operations Research: Theory & Applications, Kasana, Springer.
3. Applied Simulation Modelling – Seila, Ceric and Tadikamalla
4. Simulation Modeling and Analysis – Averil M Law – TMH
5. Operation Research – An Introduction 7 th Edition, Prentice Hall of India, 1999 (Chapter 1 to 5 for Unit – I and Chapters 11 and 16 for Unit II, Section 6,7 for Unit – IV)

ENGINEERING METROLOGY
(PROFESSIONAL ELECTIVE – IV)

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MT744PE	**3**	**1**	**0**	**3**

Course overview: To provide a basic understanding of the wide range of activities encompassed by personnel working in standards and calibration laboratories. It covers the measurement process, types and correct use of measurement and test equipment, and measurement standards. It provides an opportunity for students to learn about measurement uncertainty and risk analysis. The course includes the procedures necessary to set up and to have knowledge on calibration. At the end of this subject the student is expected: It is expected to enforce, validate and verify predefined standards for traceability, accuracy, reliability, and precision. All of these are factors that would affect the validity of measurement. Although these standards vary widely, these are mandated by the government, the agencies, and some treaties. Consequently, these standards are verified and tested against a recognized quality system in calibration laboratories

Course Objectives:

1. To be familiar with the different instruments those are available for linear, angular, roundness and roughness measurements.
2. To be able to select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy, etc.)
3. It is the aim of this course to provide students with practical skills associated with each of these areas. Metrology activities include precision measurement of component features, form and geometry utilizing specialized measuring instruments and equipment.
4. Effectively designing product processing methods.
5. To enhance the ability of students to apply scientific methods of protection

Course Outcomes:

1. Graduates will demonstrate basic knowledge in mathematics, science and engineering
2. Graduates will demonstrate an understanding of their professional and ethical responsibilities
3. Graduates will demonstrate the ability to function on engineering and science laboratory teams, as well as on multidisciplinary design teams
4. Graduates will demonstrate the ability to identify, formulate and solve mechanical engineering problems
5. Graduates will have the confidence to apply engineering solutions in global and societal contexts. Graduates should be capable of self-education and clearly understand the value of life-long learning. Graduates will have ability to communicate in written, oral and graphical forms.

UNIT - I

Systems of limits and fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types - unilateral and bilateral tolerance system, hole and shaft basis systems - interchangeability and selective assembly. Indian standard Institution system - British standard system, International Standard system for plain ad screwed work.

UNIT - II

Linear Measurement: Length standard, line and end standard, slip gauges - calibration of the slip gauges, Dial indicator, micrometers. **Measurement of Angles and Tapers**: Different methods - Bevel protractor - angle slip gauges - spirit levels - sine bar - Sine plate, rollers and spheres used to determine the tapers. **Limit Gauges**: Taylor's principle - Design of go and No go gauges, plug ring, snap, gap, taper, profile and position gauges.

UNIT - III

Optical Measuring Instruments: Tool maker's microscope and its uses - collimators, optical projector - optical flats and their uses, interferometer. **Flat Surface Measurement:** Measurement of flat surfaces - instruments used - straight edges - surface plates - optical flat and auto collimator.

UNIT - IV

Surface Roughness Measurement : Differences between surface roughness and surface waviness-Numerical assessment of surface finish - CLA, R, R.M.S Values - Rz values, Rz value, Methods of measurement of surface finish-profilograph. Talysurf, ISI symbols for indication of surface finish.

UNIT - V

Screw Thread Measurement: Element of measurement - errors in screw threads - measurement of effective diameter, angle of thread and thread pitch, profile thread gauges. **Measurement Through Comparators:** Comparators - Mechanical, Electrical and Electronic Comparators, pneumatic comparators and their uses in mass production. MACHINE TOOL **Alignment Tests**: Requirements of Machine Tool Alignment Tests, Alignment tests on lathe, milling, drilling machine tools.. Preparation of acceptance charts.

Gear Measurement: Gear measuring instruments, Gear tooth profile measurement. Measurement of diameter, pitch pressure angle and tooth thickness. Coordinate Measuring Machines: Types of CMM, Role of CMM, and Applications of CMM.

TEXT BOOKS:

1. Engineering Metrology / I C Gupta./ Danpath Rai
2. Engineering Metrology / R.K. Jain / Khanna Publishers

REFERENCE BOOKS:

1. BIS standards on Limits & Fits, Surface Finish, Machine Tool Alignment etc.
2. Principles of Engineering Metrology, Rajendra
3. Metrology & Measurement, Bewoor, Anand K

ROBOTICS AND ITS APPLICATIONS

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MT702PC	**4**	**0**	**0**	**4**

UNIT – I

Introduction: Automation and Robotics, CAD/CAM and Robotics – An over view of Robotics – present and future applications – classification by coordinate system and control system. **Components of the Industrial Robotics:** End effectors- types, mechanical grippers, and other types of grippers, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.

UNIT – II

Motion Analysis: Homogeneous transformations as applicable to rotation and translation – problems. **Manipulator Kinematics:** Specifications of matrices, D-H notation joint coordinates and world coordinates. Forward and inverse kinematics – problems.

UNIT – III

Manipulator jacobians: Differential transformation and manipulators, Jacobians – problems.
Dynamics: Lagrange – Euler and Newton– Euler formations – Problems.

UNIT - IV

Trajectory planning: path planning and avoidance of obstacles, , Slew motion, joint interpolated motion – straight line motion. **Programming Languages**: Robot programming, languages and software packages.

UNIT - V

Robot actuators and Feed-back components: Actuators: Pneumatic, Hydraulic actuators, electric, & stepper motors. Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors. **Robot Application in Manufacturing:** Material Transfer - Material handling, loading and unloading - Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.

TEXT BOOKS:

1. Robo Technology Fundamentals, James G. Keramas, CENGAGE Publications
2. Industrial Robotics / Groover M P /Pearson Edu.
3. Robotics and Control/ Nagrath and Mittal.

REFERENCES:

1. Introduction to Robotics / John J Craig / Pearson Edu
2. Applied Robotics / Edwin Wise / Cengage Publications
3. Robotics / Fu K S / McGraw Hill.
4. Robotic Engineering / Richard D. Klafter, Prentice Hall
5. Robot Analysis and Intelligence / Asada and Slow time / Wiley Inter-Science.
6. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) Pte Ltd.

MICROPROCESSORS AND MICROCONTROLLERS LAB

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MT703PC	**0**	**0**	**3**	**2**

Note:

- Minimum of 12 experiments are o be conducted.
- The Following programs/experiments are to be written for assembler and to be executed the same with 8086 and 8051 kits.

List of Experiments:

1. Programs for 16 bit arithmetic operations for 8086 (using Various Addressing Modes).
2. Program for sorting an array for 8086.
3. Program for searching for a number or character in a string for 8086.
4. Program for string manipulations for 8086.
5. Program for digital clock design using 8086.
6. Interfacing ADC and DAC to 8086.
7. Parallel communication between two microprocessors using 8255.
8. Serial communication between two microprocessor kits using 8251.
9. Interfacing to 8086 and programming to control stepper motor.
10. Programming using arithmetic, logical and bit manipulation instructions of 8051.
11. Program and verify Timer/ Counter in 8051.
12. Program and verify Interrupt handling in 8051
13. UART Operation in 8051.
14. Communication between 8051 kit and PC.
15. Interfacing LCD to 8051.
16. Interfacing Matrix/ Keyboard to 8051.
17. Data Transfer from Peripheral to Memory through DMA controller 8237 / 8257.

MOTION CONTROL DESIGN AND CNC & ROBOTICS LAB

B.Tech. IV Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MT704PC	**0**	**0**	**3**	**2**

Note: Any Six from each Laboratory

MOTION CONTROL ROBOTICS LAB

1. Study of the following equipment:
   a. Relief Valve b. Flow Control Valves c. Directional Control Valves
   d. Pressure Control Valves
2. Circuits for reciprocating motion of a single acting and double acting pneumatic cylinders.
3. Circuits for reciprocating motion of hydraulic cylinders.
4. Circuits for speed control of a
   (a) Double acting pneumatic cylinder. (b) Double acting hydraulic Cylinder.
5. Circuits for semi automatic and automatic operation of double acting Pneumatic cylinders.
6. Circuits for semi automatic and automatic operation of double acting hydraulic cylinders.
7. Circuits for sequencing motion of two pneumatic cylinder
   (a) by cascading (b) by using a sequence valve
8. Circuits for Measurement of pressure of air/oil in fluid power system.
9. Design and simulation of pneumatic circuits using simulation software
10. Design and simulation of hydraulic circuits using simulation software

CNC &ROBOTICS LAB

1. Study and operation of CNC lathe
2. Study and operation of CNC milling machine
3. Preparation of typical part programs of CNC lathe
4. Preparation of typical part programs on CNC milling machine.
5. Exercises using CAM software.
6. Part program generation through G and M Codes for turning, contouring, drilling, and Milling.
7. Development of tool path simulation by setting tool offsets for multi operations.
8. Machining of various Components by generation of CNC code by CAM Software
9. Study of various CNC post Processors
10. Robot Programming

AUTOMATION IN MANUFACTURING
(Professional Elective - V)

B.Tech. IV Year II Sem.	**L**	**T**	**P**	**C**
Course Code: MT851PE	**3**	**0**	**0**	**3**

UNIT – I

Introduction Types and strategies of automation, pneumatic and hydraulic components circuits, Automation in machine tools. Mechanical feeding and too changing and machine tool control transfer the automaton.

UNIT – II

Automated flow lines: Methods or work part transport transfer Mechanical buffer storage control function, design and fabrication consideration.

Analysis of Automated flow lines: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

UNIT – III

Assembly system and line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

Automated material handling: Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems.

UNIT - IV

Automated storage systems, automated storage and retrieval systems, work in process storage, interfacing handling and storage with manufacturing.

Adaptive control systems: Introduction, adaptive control with optimization, Adaptive control with constraints, Application of A.C. in machining operations. Use of various parameters such as cutting force, Temperatures, vibration and acoustic emission.

UNIT – V

Business process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE, concurrent Engineering, Techniques of Rapid Proto typing.

TEXT BOOKS:

1. Automation, Production Systems and Computer Integrated Manufacturing/M.P. Groover. / Pearson
2. Computer control of Manufacturing Systems by Yoram Coreom / Mc Graw Hill

REFERENCE BOOKS:

1. CAD / CAM/ CIM / Radhakrishnan / New Age
2. Advanced Manufacturing Technology/ K Vara Prasada Rao / Kanna Publications

PRODUCT DESIGN AND ASSEMBLY AUTOMATION
((Professional Elective - V)

	L	T	P	C
B.Tech. IV Year II Sem.				
Course Code: MT852PE	**3**	**0**	**0**	**3**

UNIT – I

Automatic Feeding and Orienting Devices: Vibrator feeders, Mechanics of vibratory conveying, load sensitivity, solutions to load sensitivity, spiral elevators, balanced feeders. Types of oriental systems, effect of active orienting devices on feed rate, natural resting aspects of parts for automatic handing, out-of-bowl tooling, Reciprocating - tube hopper feeder

UNIT - II

Automatic Assembly Transfer Systems: Assembly machines classification, Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine, choice of assemble method, advantages and disadvantages of automation.

UNIT - III

Product design for High speed Automatic Assembly and Robot Assembly : Introduction, design of parts for: high speed, feeding and orienting, example, additional feeding difficulties, high speed automatic insertion, example, analysis of an assembly, general rules for product design for automation, product design for robot assembly.

UNIT - IV

Design for Manual Assembly : General design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time, reducing disk assembly problems.

UNIT - V

Performance and Economics of Assembly Systems: Indexing machines-effects of parts quality on down time and production time, free transfer machines- performance of free transfer machine, comparison of indexing and free - transfer machines.

TEXT BOOKS:

1. Geoffrey Boothroyd, “Assembly Automation and Product Design", Marcel Dekker Inc., NY, 1992.
2. Geoffrey Boothroyd, Peter Dewhurst, Winston Knight, “Product design for Manufacture and assembly”, 2e, CRC Press

REFERENCE BOOKS:

1. A.K. Chitale, RC Gupta, “Product design and Manufacturing”, PHI
2. Geoffrey Boothroyd, "Hand Book of Product Design" Marcel and Dekken, N.Y. 1990.
3. A Delbainbre "Computer Aided Assembly London, 1992.

MATLAB APPLICATIONS
(Professional Elective - V)

	L	T	P	C
B.Tech. IV Year II Sem.				
Course Code: MT853PE	**3**	**0**	**0**	**3**

UNIT - I

Starting with MATLAB: Command Window, Arithmetic Operations, Display Formats, Built-In Functions, Variables, Useful Commands, Script Files, Examples of MATALAB Applications

UNIT - II

Arrays and Mathematical Operations: One and two-dimensional Array, zero's ones and, eye Commands, Array Addressing, Vector Matrix, Strings and Strings as Variables

Addition, Subtraction, Multiplication and Array Division, Built-in MATH Functions, Generation of Random Numbers, Script File operations, Examples

UNIT - III

Programming in MATLAB: Plot, line, hold on and hold off Commands, Formatting a Plot, Polar Plots.

Relational and Logical Operators, Conditional Statements, Nested Loops and Nested Conditional Statements, User-Defined Functions and Function Files, Comparison Between Script Files and Function Files, Anonymous and Inline Functions, Function Functions, Sub-functions, Nested Functions, Examples

UNIT - IV

Polynomials, Curve Fitting, and Interpolation: Polynomials, Value of Polynomial, Roots of Polynomial, Addition, Multiplication, Derivatives and Division of Polynomials, Curve Fitting Curve Fitting with Polynomials, The polyfit Function

UNIT - V

Applications in Numerical Analysis: One variable, Integration, Ordinary Differential Equations, Mesh, surface, special graphs, view commands, symbolic objects and expressions, algebraic equation, differentiation, integration, Examples

TEXT BOOKS

1. MATLAB An Introduction with Applications, 4th Edition, Amos Gilat, WILEY Publishers
2. MATLAB Programming for Engineers, 4th Edition, Stephen J. Chapman, CENGAGE Publishers

REFERENCES

1. Essential-MATLAB for Engineers and Scientists, 4th Edition, Brian H. Hahan and Daniel T. Valentine, Elsevier Publications
2. MATLAB-A practical Introduction to programming and problem solving, 2nd Edition, Stormy Attaway, Elsevier BH

MECHANICAL VIBRATIONS
(Professional Elective - V)

	L	T	P	C
B.Tech. IV Year II Sem.				
Course Code: MT854PE	**3**	**0**	**0**	**3**

Pre-requisites: Engineering Mechanics

Course objectives: Understand various levels of vibrations and remedies for each of them.

Course Outcomes: At the end of the course, the student will be able to, Understand the causes and effects of vibration in mechanical systems. Develop schematic models for physical systems and formulate governing equations of motion. Understand the role of damping, stiffness and inertia in mechanical systems Analyze rotating and reciprocating systems and compute critical speeds. Analyze and design machine supporting structures, vibration isolators and absorbers.

UNIT - I

Single degree of Freedom systems - I: Undamped and damped free vibrations; forced vibrations coulomb damping; Response to excitation; rotating unbalance and support excitation; vibration isolation and transmissibility.

UNIT - II

Single degree of Freedom systems - II: Response to Non Periodic Excitations: unit impulse, unit step and unit Ramp functions; response to arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method.

UNIT - III

Two degree freedom systems: Principal modes- undamped and damped free and forced vibrations; undamped vibration absorbers;

Multi degree freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi- rotor systems and geared systems; Discrete- Time systems.

UNIT - IV

Continuous system: Free vibration of strings – longitudinal oscillations of bars- traverse vibrations of beams- Torsional vibrations of shafts.

Critical speeds of shafts: Critical speeds without and with damping, secondary critical speed.

Numerical Methods: Rayleigh’s stodola's, Matrix iteration, Rayleigh- Ritz Method and Holzer's methods.

Vibration measuring instruments: Vibrometers, velocity meters & accelerometers

UNIT - V

Sound level and subjective response to sound: Subjective response to sound, frequency dependent human response to sound, sound-pressure dependent human response, the decibel scale, relationship among sound power, sound intensity and sound pressure level, relationship between sound power level and sound intensity, relationship between sound intensity level and sound pressure level, sound measuring instruments.

TEXT BOOKS:

1. Elements of Vibration Analysis / Meirovitch/ Mc Graw Hill
2. Principles of Vibration / Benson H. Tongue/Oxford

REFERENCE BOOKS:

1. Mechanical Vibrations / SS Rao / Pearson
2. Mechanical Vibration /Rao V. Dukkipati , J Srinivas/ PHI

COMPUTATIONAL FLUID DYNAMICS
(Professional Elective - VI)

B.Tech. IV Year II Sem.	**L**	**T**	**P**	**C**
Course Code: MT861PE	**3**	**0**	**0**	**3**

UNIT - I:

Basic Aspects of the Governing Equations – Physical Boundary Conditions – Methods of solutions of Physical Problems – Need for Computational Fluid Dynamics – Different numerical/CFD techniques – FDM, FEM, FVM etc., - Main working principle - CFD as a research and design tool – Applications in various branches of Engineering

Mathematical behavior of Partial Differential Equations (Governing Equations): Classification of linear/ quasi linear PDE – Examples - Physical Processes: Wave Equations and Equations of Heat Transfer and Fluid Flow – Mathematical Behavior - General characteristics – Its significance in understanding the physical and numerical aspects of the PDE – One way and Two Way variables – Well posed problems – Initial and Boundary Conditions

Solution of Simultaneous Algebraic Equations: Direct Method – Gauss Elimination – LU Decomposition – Pivoting – Treatment of Banded Matrices – Thomas Algorithm

Iterative Method: Gauss Seidel and Jordan Methods - Stability Criterion

UNIT - II:

Finite Difference Method: Basic aspects of Discretization – Finite Difference formulae for first order and second order terms – Solution of physical problems with Elliptic type of Governing Equations for different boundary conditions - Numerical treatment of 1D and 2D problems in heat conduction, beams etc., - Solutions –Treatment of Curvelinear coordinates – Singularities – Finite Difference Discretization – Solution of 1D heat conduction problems in Heat conduction in curve linear coordinates

UNIT - III:

FDM: Solution of physical problems with Parabolic type of Governing Equations – Initial Condition –Explicit, implicit and semi implicit methods – Types of errors – Stability and Consistency – Von Neumann Stability criterion– Solution of simple physical problems in 1D and 2D – Transient Heat conduction problems- ADI scheme - Simple Hyperbolic type PDE - First order and Second order wave equations – Discretization using Explicit method - Stability criterion – Courant Number – CFL Condition - Its significance - Treatment of simple problems

UNIT - IV:

Finite Difference Solution of Unsteady Inviscid Flows: Lax – Wendroff Technique – Disadvantages – Maccormack's Technique

Fluid Flow Equations – Finite Difference Solutions of 2D Viscous Incompressible flow problems – Vorticity and Stream Function Formulation – Finite Difference treatment of Lid

Driven Cavity Problem - Application to Cylindrical Coordinates with example of flow over infinitely long cylinder and sphere – Obtaining Elliptic Equations

UNIT - V:

Finite Difference Applications in Fluid flow problems: Fundamentals of fluid Flow modeling using Burger's Equation – Discretization using FTCS method with respect to Upwind Scheme and Transport Property – Upwind Scheme and Artificial Viscosity

Solutions of Navier Stokes Equations for Incompressible Fluid Flows: Staggered Grid – Marker and Cell (MAC) Formulation – Numerical Stability Considerations – Pressure correction method - SIMPLE Algorithm

REFERENCE BOOKS:

1. Computational Fluid Flow and Heat Transfer – K Muralidharan and T Sudarajan, Narosa Publishers
2. Computational Fluid Dynamics : The basics with applications – John D Anderson, McGraw Hill Publications

POWER PLANT ENGINEERING
(Professional Elective - VI)

	L	T	P	C
B.Tech. IV Year II Sem.				
Course Code: MT862PE	**3**	**0**	**0**	**3**

Pre-Requisites: None

Course Objective: The goal of this course is to become prepared for professional engineering design of conventional and alternative power-generation plants. The learning objectives include

- Analysis and preliminary design of the major systems of conventional fossil-fuel steam-cycle power plants.
- A working knowledge of the basic design principles of nuclear, gas turbine, combined cycle, hydro, wind, geothermal, solar, and alternate power plants.
- Awareness of the economic, environmental, and regulatory issues related to power generation.

Course Outcomes: At the end of the course students are able to:

- Understand the concept of Rankine cycle.
- Understand working of boilers including water tube, fire tube and high pressure boilers and determine efficiencies.
- Analyze the flow of steam through nozzles
- Evaluate the performance of condensers and steam turbines
- Evaluate the performance of gas turbines

UNIT – I

Introduction to the Sources of Energy – Resources and Development of Power in India. **Steam Power Plant:** Plant Layout, Working of different Circuits, Fuel and handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, Ash handling systems.

Combustion Process: Properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, Dust collectors, cooling towers and heat rejection. Corrosion and feed water treatment.

UNIT – II

Internal Combustion Engine Plant:

Diesel Power Plant: Introduction – IC Engines, types, construction– Plant layout with auxiliaries – fuel supply system, air starting equipment, lubrication and cooling system – super charging. **Gas Turbine Plant:** Introduction – classification - construction – Layout with auxiliaries – Principles of working of closed and open cycle gas turbines. Combined

Cycle Power Plants and comparison. **Direct Energy Conversion:** Solar energy, Fuel cells, Thermo electric and Thermo ionic, MHD generation.

UNIT – III

Hydro Electric Power Plant: Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – storage and Pondage – classification of dams and spill ways. **Hydro Projects and Plant:** Classification – Typical layouts – plant auxiliaries – plant operation pumped storage plants. **Power From Non-Conventional Sources:** Utilization of Solar- Collectors- Principle of Working, Wind Energy – types – HAWT, VAWT -Tidal Energy.

UNIT – IV

Nuclear Power Station: Nuclear fuel – breeding and fertile materials – Nuclear reactor – reactor operation. **Types of Reactors:** Pressurized water reactor, Boiling water reactor, sodium-graphite reactor, fast Breeder Reactor, Homogeneous Reactor, Gas cooled Reactor, Radiation hazards and shielding – radioactive waste disposal.

UNIT – V

Power Plant Economics and Environmental Considerations: Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Load curves, load duration curve. Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor – related exercises. Effluents from power plants and Impact on environment – pollutants and pollution standards – Methods of Pollution control.

TEXT BOOKS:

1. Power Plant Engineering/ P. K. Nag / Mc Graw Hill
2. Power Plant Engineering / Hegde / Pearson.

REFERENCES BOOKS:

1. Power Plant Engineering / Gupta / PHI
2. Power Plant Engineering / A K Raja / New age

MEMS DESIGN
(Professional Elective - VI)

B.Tech. IV Year II Sem.	**L**	**T**	**P**	**C**
Course Code: MT863PE	**3**	**0**	**0**	**3**

UNIT – I

Introduction, Integrated Circuits, MEMS, Micro sensors, Micro actuators, Microelectronics Fabrication, Micromachining, Mechanical MEMS, Thermal MEMS, MOEMS, Magnetic MEMS, RF MEMS, Microfluid systems, Bio and Chemo-devices, Nanotechnology, Modeling and Simulation.

Micromachining: Introduction, Photolithography, Structural and sacrificial materials, other lithography methods, Thin film deposition, Impurity doping, Etching, Problems with bulk Micro machining, Surface Micromachining, Bulk Vs. Surface micromachining.

UNIT – II

System Modeling and Properties of Material: Introduction, Need for modeling, system types, Basic Modeling elements in mechanical systems, Electrical systems, Fluid systems and Thermal systems, Translational pure mechanical system with spring, damper and mass-Rotational pure mechanical system with spring, damper and mass

Passive components and systems: Introduction, System-on-a-chip, Passive electronic systems, Passive mechanical systems

UNIT – III

Mechanical Sensors and Actuators: Introduction, Principles of sensing and actuation, Beam and cantilever, Micro plates, Capacitive Effects, Piezo electric material as sensing and actuating elements, strain measurement, pressure measurement, Flow measurement using Integrated paddle-cantilever structure.

Thermal Sensors and Actuators: Introduction, Thermal energy basics and heat transfer processes, Thermistors, Thermo devices, Thermocouple, Micro machined thermocouple probe, Peltier effect heat pumps, Thermal flow sensors, Micro hot plate gas sensors, Shape memory Alloys, U-shaped horizontal and vertical Electro thermal Actuator, Thermally activated MEMS Relay.

UNIT – IV

Micro-opto-Electromechanical systems: Introduction, fundamental principle of MOEMS Technology, Review on properties of Light, Light modulators, Beam Splitter, Microlens, Micro mirrors, Digital micro mirror device, Light detectors, Grating Light valve, Optical switch, Waveguide and tuning, Shear – Stress measurement. Magnetic Sensors and Actuators

UNIT – V

Radio frequency MEMS: Introduction, Review of RF-based communication systems, RF, MEMS, MEMS Inductors, Varactors, Tuner / Filter, Resonator, Clarification of Tuner, Filter, Resonator, MEMS Switches, Phase Shifter, Micro fluidic Systems, Introduction, Applications.

TEXT BOOKS:

1. MEMS, Nitaigour Premchand Mahalik, TMH
2. MEMS & Micro Systems Design and Manufacture, Tai-Ran HSU, TMH, 2006

REFERENCES:

1. Mechatronics Systems Fundamentals – Rolf Isermann – Springer International Edition
2. The Science and Engineering of Microelectronic Fabrication, 2nd Ed. By S.A. Cambell, Published by Oxford University Press (2001
3. Fundamentals of Micro Fabrication: The science of Miniaturization, 2nd Edition by M.J. Madou, published by CRC press (2002)
4. Introductory MEMS: Fabrication and Applications by Adams, Thomas M, Layton Richard A., 1st Edition 2010 IBNL 978-0-387-09510-3, Springer
5. Microsystems Design, Stephen D. Senturia, Springer International Edition

AUTOMOTIVE POLLUTION AND CONTROL
(Professional Elective -VI)

	L	T	P	C
B.Tech. IV Year II Sem.				
Course Code: MT864PE	**3**	**0**	**0**	**3**

UNIT - I

Laws and Regulation: Historical background. Regulatory test procedures (European cycles). Exhaust gas pollutants (European rail road limits), particulate pollutants, European statutory values, inspection of vehicles in circulation (influence of actual traffic conditions and influence of vehicle maintenance).Euro norms, Bharat stages.

Automobile pollutants: Carbon and Nitrogen Compounds - (CO, CO2, NOx), Ammonia and Amines, Hydrocarbons, volatile compounds, evaporative losses, analysis of particulates.

UNIT - II

Pollutants from SI engines; Mechanism & formation of HC, CO, and NOx in SI engines. Engine and operating variables affecting pollutants in SI engines. Control technologies like catalytic converter and Exhaust Gas Recirculation systems.

Pollution from CI engines; Mechanism of formation of HC, CO, NOx, and Soot in CI engines. Factors affecting emissions in CI engines.

UNIT - III

Lean burn & stratified charge engines. Multipoint fuel injection and Gasoline direct injection methods. Common rail fuel injection in diesel engines. Exhaust gas recirculation.

Post combustion treatments: Introduction, exhaust gas composition before treatment, catalytic converters, oxidation and three way types thermal reactors, installation of catalysts in exhaust lines, NOx treatment in diesel engines, particulate traps for diesel engines, particulate trap regeneration.

UNIT - IV

Instrumentation for pollution measurements: NDIR-analysers, thermal conductivity and flame ionization detectors, analysers for Nox, Gas chromatograph. Orsat apparatus, smoke meters- spot sampling and continuous indication types like Bosch, Hartridge. Particulate measuring systems. Dilution tunnels – full flow and partial flow.

UNIT - V

SI and CI engine fuel requirements Knock in SI and CI engines. Knock rating of SI and CI Engine fuels. Alternative fuel like Hydrogen, Natural gas, LPG, Vegetable oil and biodiesel, their production, properties, storage and performance as engine fuels.

Economic challenges: Introduction, cost of improvement to SI engines, cost of injection systems, cost of improvement in Diesel engines, economic consequences of introducing the catalyst, additional costs incurred by diesel traps. cost of periodic inspection of pollution control systems and evaporative control systems.

TEXT BOOKS:

1. Bosch – Gasoline fuel injection – Bosch Publications
2. Bosch – Diesel fuel injection – Bosch Publications

REFERENCES:

1. Automobiles and Pollution –Paul Degobert (SAE) .
2. Diesel engine operation manual- V.L Maleev, CBS Pub
3. I.C. Engines -E.F. Obert, Harper& Row
4. Engine emission -Springer and Patterson, Plenum Press
5. Heins Aeisth – Internal Combustion Engines – SAE Publications.