B.Tech. in Mechanical Engineering (Mechatronics)
Scheme of Instruction and Examination
(Choice Based Credit System)

V Semester

S.No	Course Code	Course Title	Instruction			Examination			Credits
			Hours Per Week			Max. Marks		Duration of SEE in Hours	
			L	T	P/D	CIE	SEE		
1	MS501HS	Business Economics and Financial Analysis	3	0	0	40	60	3	3
2	ME501PC	Dynamics of Machinery	3	1	0	40	60	3	4
3	MT501PC	Mechanical Measurements and Control Systems	3	0	0	40	60	3	3
4	MT502PC	Manufacturing Process and Machine Tools	3	1	0	40	60	3	4
5	MT503PC	Principles of Machine Design	3	0	0	40	60	3	3
6	MC502ES	Artificial Intelligence	3	0	0	40	60	3	0
7	ME551PC	Kinematics and Dynamics Lab	0	0	2	40	60	3	1
8	MT551PC	Mechanical Measurements and Control Systems Lab	0	0	2	40	60	3	1
9	MT552PC	Manufacturing Process and Machine Tools Lab	0	0	2	40	60	3	1
Total Hours/Marks/Credits			18	**2**	**6**	**360**	**540**		**20**

VI Semester

S.No	Course Code	Course Title	Instruction			Examination			Credits
			Hours Per Week			Max. Marks		Duration of SEE in Hours	
			L	T	P/D	CIE	SEE		
1	EC631PC	Microprocessors and Microcontrollers	3	0	0	40	60	3	3
2	MT601PC	Motion Control Design	3	0	0	40	60	3	3
3	MT602PC	Robotics and its Applications	3	0	0	40	60	3	3
4		**Professional Elective – I**	3	0	0	40	60	3	3
5		**Open Elective – I**	3	0	0	40	60	3	3
6	MC601HS	Intellectual Property Rights	3	0	0	40	60	3	0
7	MC602ES	Cyber Security	3	0	0	40	60	3	0
8	EC661PC	Microprocessors and Microcontrollers Lab	0	0	2	40	60	3	1
9	EN651HS	Advanced English Communication Skills Laboratory	0	0	2	40	60	3	1
10	MT651PC	Motion Control Design and CNC &Robotics Lab	0	0	2	40	60	3	1
11	MT653PC	Industry Oriented Mini Project/ Internship	0	0	4	0	100	-	2
Total Hours/Marks/Credits			**21**	**0**	**10**	**400**	**700**		**20**
12	MC601BS	Environmental Science **(For Lateral Entry students)**	**3**	**0**	**0**	**40**	**60**	**3**	**0**

L: Lecture T: Tutorial D: Drawing P: Practical

CIE - Continuous Internal Evaluation SEE - Semester End Examination

VII Semester

S.No	Course Code	Course Title	Instruction			Examination			Credits
			Hours Per Week			Max. Marks		Duration of SEE in Hours	
			L	T	P/D	CIE	SEE		
1	ME701PC	CAD/CAM	2	0	0	40	60	3	2
2	ME702PC	Refrigeration and Air Conditioning	2	0	0	40	60	3	2
3		**Professional Elective II**	3	0	0	40	60	3	3
4		**Professional Elective III**	3	0	0	40	60	3	3
5		**Professional Elective IV**	3	0	0	40	60	3	3
6		**Open Elective - II**	3	0	0	40	60	3	3
7	ME751PC	CAD/CAM Lab	0	0	2	40	60	3	1
8	MT751PC	Project Stage 1	0	0	6	100	-	-	3
Total Hours/Marks/Credits			16	**0**	**8**	**380**	**420**		**20**

VIII Semester

S.No	Course Code	Course Title	Instruction			Examination			Credits
			Hours Per Week			Max. Marks		Duration of SEE in Hours	
			L	T	P/D	CIE	SEE		
1		**Professional Elective - V**	3	0	0	40	60	3	3
2		**Professional Elective - VI**	3	0	0	40	60	3	3
3		**Open Elective - III**	3	0	0	40	60	3	3
4	MT851PC	Project Stage – II (Including Seminar)	0	0	22	40	60	-	11
Total Hours/Marks/Credits			**9**	**0**	**22**	**160**	**240**		**20**

PROFESSIONAL ELECTIVES OFFERED IN -MR22

Professional Elective – I

ME611PE Finite Element Methods
MT611PE IOT Sensors
MT612PE Power Plant Engineering
MT613PE Alternative Materials

Professional Elective – II

ME711PE Automobile Engineering
MT711PE Drone Technology
MT712PE Operations Research
MT713PE Plant Engineering & Maintenance

Professional Elective – III

ME715PE Unconventional Machining Processes
ME716PE Composite Materials
MT714PE Concurrent Engineering
MT715PE Product Design and Assembly Automation

Professional Elective –IV

ME719PE CNC Technology
ME720PE Production Planning and Control
MT716PE 3D Printing Technology
MT717PE Mechanical Vibrations

Professional Elective – V

ME811PE Automation in Manufacturing
ME812PE Additive Manufacturing Technology
MT811PE Control Systems with DMX Technology
MT812PE Reliability Engineering

Professional Elective – VI

ME815PE Digital Manufacturing & Industry 4.0
ME816PE Electric and Hybrid Vehicles
MT813PE MEMS Design
MT814PE Animatronics

List of Open Electives:

Open Elective: I

MT621OE: Fundamentals of Electrical Vehicle Technology
MT622OE: Fundamentals of Mechatronics

Open Elective: II

MT721OE: Principles of Entrepreneurship
MT722OE: Fundamentals of MEMS Design

Open Elective: III

MT821OE: Fundamentals of Animatronics
MT822OE: Fundamentals of Robotics

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
MS501HS: Business Economics and Financial Analysis
(Common to CIVIL, EEE, MEC, ECE, MCT, MME & CSE (AI & ML))

Course Objectives: The Objective of the course are:

1. Students will understand various forms of Business and the impact of economic variables on the business, concepts of Business Economics and its significance.
2. Gain the knowledge on various market dynamics namely Demand, elasticity of demand, and demand forecasting.
3. To disseminate the knowledge on production function, Laws of production, Market structures, while dealing with the concept of cost and breakeven analysis.
4. To acquaint the students regarding Accounting and various books of accounts.
5. To enable the students to analyze a company's financial statements through ratios and come to a reasoned conclusion about the financial situation of the company.

Course Outcomes: After completion of the course the students will be able to:

1. Select a suitable business organization with available resources.
2. Analyze various aspects of Demand, Elasticity of demand and Demand Forecasting.
3. Gain knowledge on different market structures, production theories, cost variables and pricing methods.
4. Prepare Books of accounts and Financial Statements.
5. Analyze financial well-being of the business while using ratios.

UNIT – I: INTRODUCTION TO BUSINESS AND ECONOMICS

Economics: Significance of Economics, Micro and Macro Economic Concepts, National Income - Concepts and Importance, Inflation, Business Cycle - Features and Phases.

Business: Structure of Business Firm, Types of Business Entities – Sole Proprietorship – Partnership – Cooperative Societies - Limited Liability Companies, Sources of Capital – Conventional sources and Non - Conventional Sources of Finance.

Business Economics: Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

UNIT – II: DEMAND AND SUPPLY ANALYSIS

Demand Analysis: Demand - Meaning, Determinants of Demand, Law of Demand, Exceptions of Law of Demand, Demand Function, Changes in Demand – Increase and decrease in Demand - Extension and Contraction in Demand.

Elasticity of Demand: Elasticity – Meaning, Types of Elasticity – Price Elasticity – Income Elasticity – Cross Elasticity–Advertising Elasticity of Demand, Factors affecting Elasticity of Demand, Measurement and Significance of Elasticity of Demand, Elasticity of Demand in decision making.

Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting – Survey methods, Statistical methods.

Supply Analysis: Supply – Meaning, Determinants of Supply, Supply Function & Law of Supply.

UNIT III: PRODUCTION, COST, MARKET STRUCTURES & PRICING

Production Analysis: Production – Meaning, Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Cobb-Douglas production function.

Cost analysis: Cost–Meaning, Types of Costs, Short run and Long run Cost Functions.
Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition.
Pricing: Pricing -Meaning, Objectives of pricing, pricing methods – Cost based pricing methods – Demand based pricing methods – Competition based pricing methods – Strategy based pricing methods - Product Life Cycle based Pricing, Break Even Analysis (simple problems), Cost Volume Profit Analysis.

UNIT IV: FINANCIAL ACCOUNTING

Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts along with adjustments– Trading account – Profit and loss account – Balance sheet (simple problems).

UNIT – V: FINANCIAL ANALYSIS THROUGH RATIOS

Concept of Ratio Analysis, Importance, Liquidity Ratios- Current Ratio – Quick Ratio – Absolute Liquid Ratio, Profitability Ratios – Gross Profit Ratio – Net Profit Ratio – Operating Ratio, Turnover Ratios – Stock Turnover Ratio – Debtors Turnover Ratio – Creditors Turnover Ratio, Leverage Ratios
– Debt-to-Assets Ratio - Debt-Equity Ratio - Proprietary Ratios and interpretation (simple problems).

TEXT BOOKS:

1. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury,“Managerial Economics”, 2e, Tata McGraw Hill Education Pvt. Ltd. 2012.
2. Dhanesh K Khatri, “Financial Accounting”, Tata McGraw Hill, 2011.
3. Ramachandra Aryasri. A, “Business Economics and Financial Analysis”, McGraw Hill Education India Pvt. Ltd. 2020.

REFERENCE BOOKS:

1. P. L. Mehta, Managerial Economics, Analysis, Problems & Cases, 8th Edition, Sultan Chand & Sons, 2001.
2. S.N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.
3. D.D. Chaturvedi, S.L. Gupta, “Business Economics - Theory and Applications”, International Book House Pvt. Ltd. 2013.

L	T	P	C
3	1	0	4

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
ME501PC: Dynamics of Machinery
(Common to ME, MCT Branch)

Pre-requisite: Kinematics of Machinery

Course Objectives:

During the course the student will learn about
- Gyroscopic effects in ships, aero planes and road vehicles. Analysis static and dynamics of various planar mechanisms.
- How friction plays a role in design of clutches and bearings.
- Design of flywheels and centrifugal governors.
- Analysis of unbalanced forces in rotary and reciprocating machinery.
- Free and Forced vibrations of single degree freedom systems.

Course Outcomes:

At the end of the course, the student will be able to:
- Understand the gyroscopic effects in ships, aero planes, and road vehicles. Analyze the dynamics forces on various planar mechanisms.
- Apply the concept of friction in designing clutches, bearings, brakes & dynamometers
- Analyze, design flywheels and design centrifugal governors.
- Analyze balancing problems in rotating and reciprocating machinery.
- Determine free and forced vibrations of single degree freedom systems.

UNIT–I

Precession: Gyroscopes – effect of precession – motion on the stability of moving vehicles such as motorcycle–motorcar–aeroplanes and ships.

Static and Dynamic Force Analysis: Static force analysis of planar mechanisms – Dynamic Force Analysis – D'Alembert's principle, Dynamic Analysis of 4-link mechanism, Slider Crank Mechanism.

UNIT–II

Friction: pivots and collars–uniform pressure, uniform wear–friction circle and friction axis: lubricated surfaces– boundary friction – film lubrication. Clutches – Types – Single plate, multi-plate and cone clutches.

Brakes and Dynamometers: Types of brakes: Simple block brake, band and block brake-internal expandingshoe brake-effect of braking of a vehicle. Dynamometers–absorption and transmission types.

UNIT–III

Turning Moment Diagram and Flywheels: Engine Force Analysis – Piston Effort, Crank Effort, etc., Inertia Force in Reciprocating Engine, Turning moment diagram –fluctuation of energy – flywheels and their design.

Governors: Types of centrifugal governors - Watt, Porter and Proell governors. Spring loaded governors – Hartnell and Hartung with auxiliary springs. Sensitiveness, isochronism and hunting–stability–effort and power of the governors.

UNIT – IV

Balancing of rotating masses: Rotating masses in single and different planes
Balancing of Reciprocating masses: Primary and Secondary of reciprocating masses. Analytical and graphical methods. Unbalanced forces and couples. Examination of multi cylinder in-line and radial engines for primary and secondary balancing- locomotive balancing –Hammer blow– Swaying couple – variation of tractive effort.

UNIT–V

Vibrations: Free Vibration of mass attached to vertical spring– Damped free vibrations, Transverse loads–vibrations of beams with concentrated and distributed loads. Dunkerly's method – Raleigh's method. Whirling of shafts –critical speed – torsional vibrations– one, two and three rotor systems.

TEXTBOOKS:

1. Theory of Machines/S.S.Rattan/McGrawHill.
2. Theory of Machines/Sadhu Singh/Pearson

REFERENCEBOOKS:

1. Theory of Machines and Mechanisms/Joseph E.Shigley/Oxford
2. Theory of Machines/Rao,J.S & R.V.Duggipati/New Age

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
MT501PC: Mechanical Measurements and Control Systems

Course Objectives:

The objectives of the course is to make the students

- Educate the operating principles and functions of measuring instruments and behavioral characteristics
- Understand the construction, working, advantages, limitations and applications of Instruments used for the measurement of Pressure, Level and Flow.
- Learn the principles of measurement of Speed, Vibration, Acceleration, Stress and Strain.
- Understand the working and limitations of Humidity, Force measuring devices
- Learn the basic concepts of open & closed loop control systems and Transfer functions.

Course Outcomes:

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

- Understand the working of basic measuring instruments and their functionalities for Engineering and Process industries
- Analyze the use of various measuring systems for the measurement of Pressure, Level, andFlow
- Possess a reasonable level of competence in the use of different sensors/gauges for the measurement of Speed, Vibration, Acceleration Stress and Strain.
- Demonstrate the use of various sensors and transducers used for the measurement of Humidity, Force.
- Apply the knowledge of Open and Closed loop control systems and Transfer functions

UNIT – I

Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional description of measuring instruments – examples. Static performance characteristics– Classification of errors.

Measurement of Displacement: Theory and construction of various transducers to measure displacement – Piezo electric, Inductive, capacitance, resistance, and Photo electric transducers.

Measurement of Temperature: Classification – Ranges – Various Principles of measurement – Expansion, Electrical Resistance – Thermistor – Thermocouple –Radiation Pyrometer

UNIT – II

Measurement of Pressure: Units – classification – different principles used. Dead weight pressure gauge, Bourdon pressure gauges, Bellows – Diaphragm gauges. Low pressure measurement-Thermal conductivity gauges, Mcleod pressure gauge.

Measurement Of Level: Direct method – Indirect methods – capacitive, ultrasonic, Magnetic,– Bubbler level indicators.

Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot – wire anemometer and its applications

UNIT – III

Measurement of Speed: Mechanical Tachometers – Electrical tachometers – Stroboscope, Noncontact type of tachometer

Measurement of Acceleration and Vibration: Different simple instruments-Principles of Seismic instruments – Vibrometers and accelerometers.

Stress Strain Measurements: Various types of stress and strain measurements – electrical strain gauge – gauge factor – Use of strain gauges for measuring torque, Strain gauge Rosettes. Strain gaugeRosettes.

UNIT- IV

Measurement Of Humidity – sling psychrometer, Absorption psychrometer, Dew point meter

Measurement of Force - Elastic force meters, load cells.

UNIT-V

Elements Of Control Systems: Elements of Control Systems: Introduction, Importance– Classification – Open and closed systems-Difference between open and closed loop systems, systems-Transfer functions-First and Second order mechanical systems

TEXT BOOKS:

1. Mechanical Measurements and control –Dr. D.S. Kumar
2. Principles of Industrial Instrumentation & Control Systems, - Alavala, - Cengage Learning
3. Basic Principles – Measurements (Instrumentation) & Control Systems – S. Bhaskar – Anuradha Publications.
4. Industrial Instrumentation and control –S K Singh

REFERENCE BOOKS:

1. Measurement Systems: Applications & design, E. O. Doebelin, TMH
2. Instrumentation, Measurement & Analysis, B.C. Nakra& K.K. Choudhary, TMH
3. Experimental Methods for Engineers / Holman
4. Mechanical and Industrial Measurements / R. K. Jain/ Khanna Publishers.
5. Mechanical Measurements / Sirohi and Radhakrishna / New Age International.

L	T	P	C
3	1	0	4

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
MT502PC: Manufacturing Process & Machine Tools

Course Objectives:

The objectives of the course is to make the students

- Impart knowledge about principles/methods of casting, defects in cast objects and requirements for achieving sound casting, welding, understanding of common and newer welding techniques.
- Impart knowledge about principles and criteria of yielding during forming of metals, analysis of different bulk metal forming processes following different analysis approach. To understand the process mechanics with role of different controlling process parameters
- Study the fundamentals of Extrusion processes and Forging Process.
- Study the various process parameters and applications of machine tools and the mechanics of metal cutting tools in machine tools.
- Study and understand the concept of milling and various finishes operations like grinding, honing, lapping etc.

Course Outcomes:

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

- Interpret foundry practices and gain knowledge in various welding techniques and Inspection defects in casting
- Differentiate various metal forming processes such as hot and cold working, Rolling, Drawing, deep drawing etc.,
- To gain insight in the concepts of Extrusion and forging
- Differentiate between the concepts of Extrusion and piercing Processes.
- Understand the principles of working of Shaping, Slotting, Planning & Drilling machines
- Gain knowledge on milling, grinding and super finishing process

UNIT –I

Casting: Steps involved in making a casting - Its applications - Patterns and Types of patterns – Pattern allowances and their construction. Types of casting processes – Solidification of casting.
Welding: Classification of Welding Processes - Arc welding, – Resistance welding, Thermit welding, Electron Beam Welding and Laser Beam Welding. Inert Gas Welding, TIG Welding, MIG welding, soldering and Brazing.

UNIT-II

Forming: Hot working, cold working, strain hardening, recovery, recrystallisation, and grain growth, Comparison of properties of Cold and Hot worked parts, rolling fundamentals – theory of rolling, types of Rolling mills and products. Blanking and piercing – Bending and forming – Drawing and its types – Wire drawing and Tube drawing – coining –Spinning – Types of presses and press tools.

UNIT-III

Extrusion of Metals: Basic extrusion process and its characteristics. Hot extrusion and cold extrusion - Forward extrusion and backward extrusion. Impact extrusion –Tube extrusion and Pipe making, Hydrostatic extrusion – Extruding equipment
Forging Processes: Forging methods - Forging operations and principle & working.

UNIT-IV

Machining: Introduction, elements of cutting process – Geometry of single point tool, chip formation and types of chips. Lathe – Principle of working, specification of lathe – types of lathe –Lathe Operations. Turret and capstan lathe, Automatic Lathes– Principal features.
Shaping, slotting, planning and drilling machines – Working Principle – machine parts – specification, classification, and operations performed.

UNIT-V

Milling machine – Working Principle – specifications – classification– Principal features of horizontal, vertical and universal milling machines – Geometry of milling cutters – methods of indexing – Accessories to milling machines.
Finishing Processes: Grinding fundamentals - theory of grinding – classification of grinding machines – cylindrical and surface grinding machine-Tool and cutter grinding machine.
Super Finishing Processes: Lapping, Honing- Broaching - Working Principle.

TEXT BOOKS:

1. Manufacturing Technology (Vol. 1 & Vol. 2) / P.N. Rao/TMH/ 2nd Edition

REFERENCE BOOKS:

1. Principles of Metal Castings /Rosenthal/TMH
2. A Course in Workshop Technology/B.S. Raghuwamshi /Dhanpatrai & Sons
3. Manufacturing Engineering and Technology/ Kalpakjin S / Pearson Edu.
4. Principles of Machine Tools/ Bhattacharya A and Sen. G.C/ New Central Book Agency.
5. Elements of Workshop Technology – Vol. II/ Hajra Choudhry/ Media Promoters.
6. Fundamentals of Metal Machining and Machine Tools/ Geofrey Boothroyd/ McGraw Hill.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
MT503PC: Principles of Machine Design

Note: Design Data Book is permitted. Design of all components should include design for strength and rigidity apart from engineering performance requirements.

Course Objectives:

The objectives of the course is to make the students

- Understand the stresses and strain in machine elements subjected to various loads.
- Learn static and fatigue failures criteria in the analysis and design of mechanical components.
- Analyze the design of shafts and power transmission systems such as flat belts, V-belts.
- Learn various terms associated and design process of spur and helical gears, static load factorand dynamic load factor.
- Understand design process of sliding contact bearings by calculating heat generated, heat dissipation and dynamic load carrying capacity.

Course Outcomes:

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

- Analyze the stress and strain on mechanical components and failure modes of mechanical parts.
- Calculate stresses and loads involved with fatigue effect and to create a Soderberg endurance failure line.
- Determine shaft parameters in design and design of belts such as flat belts, V-belts.
- Check the dynamic and wear considerations of designed spur gears and helical gears
- Calculate the heat dissipation in journal bearings and design the journal bearing, calculate the dynamic load carrying capacity and rated life of roller bearings.

UNIT–I

Introduction: General considerations in the design of Engineering Materials and their properties -selection - Manufacturing consideration in design. - 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 intension, bending, torsion and combined situations.

UNIT–II

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–III

Design of shafts: Design of solid and hollow shafts for strength and rigidity - Design of shafts subjected to torque, shafts subjected to bending, shafts subjected to torque and bending.

Power Transmission System: Transmission of power by Belt drive, Transmission efficiencies,Belts– Flat and V-types.

UNIT–IV

Spur & Helical Gear Drives: Spur gears & Helical gears - Load concentration factor – Dynamic load factor. Surface compressive strength – Bending strength – Design analysis is 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.

TEXTBOOKS:

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

REFERENCEBOOKS:

1. Machine design by timothy H. Wenzell PE, Cengage
2. Machine design by R.L.Norton, McGrawhill
3. Machine design by V. Bandari, TMH Publishers
4. Machine design–Pandya & shah.

L	T	P	C
3	0	0	0

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
MC502ES: Artificial Intelligence
(Common to all branches except CSE, IT, CSBS, CSE(AI&ML))

Course Objectives:

- To train the students to understand different types of AI agents, various AI search algorithms, fundamentals of knowledge representation, building of simple knowledge-based systems and to apply knowledge representation, reasoning.
- Study of Markov Models enable the student readyto step into applied AI.

UNIT - I

Introduction: AI problems, Agents and Environments, Structure of Agents, Problem Solving Agents **Basic Search Strategies**: Problem Spaces, Uninformed Search (Breadth-First, Depth-First Search, Depth-first with Iterative Deepening), Heuristic Search (Hill Climbing, Generic Best-First, A*), Constraint Satisfaction (Backtracking, Local Search)

UNIT – II

Advanced Search: Constructing Search Trees, Stochastic Search, A* Search Implementation, Minimax Search, Alpha-Beta Pruning
Basic Knowledge Representation and Reasoning: Propositional Logic, First-Order Logic, Forward Chaining and Backward Chaining, Introduction to Probabilistic Reasoning, Bayes Theorem

UNIT – III

Advanced Knowledge Representation and Reasoning: Knowledge Representation Issues, Non-monotonic Reasoning, Other Knowledge Representation Schemes

Reasoning Under Uncertainty: Basic probability, Acting Under Uncertainty, Bayes' Rule, Representing Knowledge in an Uncertain Domain, Bayesian Networks

UNIT – IV

Learning: What Is Learning? Rote Learning, Learning by Taking Advice, Learning in Problem Solving, Learning from Examples, Winston's Learning Program, Decision Trees.

UNIT – V

Expert Systems: Representing and Using Domain Knowledge, Shell, Explanation, KnowledgeAcquisition.

TEXT BOOK:

1. Artificial Intelligence, Elaine Rich, Kevin Knight, Shivasankar B. Nair, The McGraw Hillpublications, Third Edition, 2009

REFERENCE BOOKS:

1. Russell, S. and Norvig, P, Artificial Intelligence: A Modern Approach, Third Edition, Prentice-Hall, 2010.
2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 6th ed., 2009.

L	T	P	C
0	0	2	1

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
ME551PC: Kinematics and Dynamics Lab

Course Objectives:

The objectives of the course is to make the students
- Learn the types of motions of Cam and Followers.
- Study the effect of varying mass on the center of sleeve in Governors.
- Perform the effect of gyroscope for different motions.
- Study the time period and natural frequency of simple and compound pendulum.
- Identify the forces and torques acting through the static and dynamic analysis on rotating mass systems.
- Study the damped and undamped vibrations of spring mass system.

Course Outcomes:

At the end of the course the students will be able to
- Demonstrate different combinations of Cam and Follower arrangements.
- Design and operate the I.C, Engine valves by using the various types of Governors.
- Apply the knowledge of gyroscope principle in aerospace and ship applications.
- Analyze the effect of vibrations in various machines used in industrial mechanical applications.
- Implement the knowledge of static and dynamic analysis in turbines and propeller shaft applications
- Analyze the damped and undamped vibrations of various mechanical systems used in automobile applications.

Experiments: (A Minimum of 10 experiments are to be conducted)

1. Find the motion of the follower of the given profile of the cam
2. Determine the effect of varying mass on the centre of sleeve in porter governor
3. For a simple pendulum determine time period and its natural frequency
4. For a compound pendulum determine time period and its natural frequency
5. To determine the frequency of torsional vibration of a given rod
6. Determine the effect of varying mass on the centre of sleeve in proell governor
7. To balance the masses statically and dynamically for rotating mass systems
8. Determine the critical speed of a given shaft for different end conditions
9. Determine the effect of gyroscope for different motions
10. Determine time period, amplitude and frequency of undamped free longitudinal vibration of single degree spring mass systems
11. Determine the pressure distribution of lubricating oil at various load and speed of a Journal bearing
12. Determine time period, amplitude and frequency of damped free longitudinal vibration of single degree spring mass systems

L	T	P	C
0	0	2	1

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
MT551PC: Mechanical Measurements and Control Systems Lab

Course Objectives:

At the end of this course, the students are expected to:

- Study the working of Thermocouple, Thermistor and Resistance Temperature Detector (RTD) for temperature measurement.
- Study and use of LVDT transducer.
- Study the measurement of vibration using accelerometer.
- Study the working of Optical, Proximity and Tacho Pickups for the measurement of speed.
- Study the measurement and control of Process parameters like Flow, Pressure, Temperature and Level using SCADA

Course Outcomes:

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

- Understand the calibration of Thermocouple, Thermistor and Resistance Temperature Detector (RTD) for temperature measurement.
- Analyze the calibration of LVDT transducer for displacement measurement.
- Understand the calibration of accelerometers for the measurement of vibration amplitude of an engine bed at various loads.
- Apply the calibration using Optical, Proximity and Tacho Pickups used for the measurement of speed of a d.c motor.
- Design a Closed loop circuit for the measurement and control of Process parameters like Flow, Pressure, Temperature and Level using SCADA

LIST OF EXPERIMENTS:

Any 10 of the following experiments.

1. Calibration of Pressure Gauge.
2. Study and calibration of LVDT transducer for displacement measurement.
3. Calibration of capacitive transducer for angular displacement.
4. Calibration of thermocouple for temperature measurement.
5. Calibration of resistance temperature detector for temperature measurement.
6. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
7. Study and use of a Seismic pickup for the measurement of vibration parameters.
8. Study and calibration of McLeod gauge for low pressure.
9. Measurement and control of flow of a process using SCADA.
10. Measurement and control of Pressure of a process using SCADA.
11. Measurement and control of temperature of a process using SCADA.
12. Measurement and control of level in a tank using SCADA.

L	T	P	C
0	0	2	1

B.Tech. in Mechanical Engineering (Mechatronics)
V Semester Syllabus
MT552PC: Manufacturing Process and Machine Tools Lab

Manufacturing Process Lab

Course Objectives:

The objectives of the course is to make the students.

- Understand the testing of properties of moulding sand.
- Fabricate welded joints using Arc Welding.
- Fabricate welded joints using TIG Welding.
- Fabricate welded joints using Resistance Welding
- Study simple, compound and progressive dies and the process to perform blanking and piercing operations.

Course Outcomes:

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

- To test compressive strength, shear strength and permeability of moulding sand.
- To perform T-joint and Corner joint using Arc Welding.
- To perform TIG Welding for the given work pieces.
- To understand Resistance Welding process.
- Use various dies and perform blanking and piercing operations.

List of Experiments:

1. Sand properties testing - compressive strength, shear strength and permeability
2. ARC Welding-T-Joint
3. ARC Welding-Corner joint
4. TIG Welding
5. Spot Welding
6. Simple, Compound and Progressive press tool for performing Blanking & Piercing operations.

Machine Tools Lab

Prerequisites: Theoretical exposure to Machine tools.

Course Objectives:

The objectives of the course is to make the students

- Impart practical exposure to the Machine Tools
- Conduct experiments and understand the working of the same.
- Understand the basic operations involved in various machine tools such as lathe, drilling, milling anddifferent grinding machines.
- Identify and use different cutting tools for each machine tool.
- Plan and execute different sequence of machining operations for a given application.
- Understand and implement safety procedures while working in a machine shop.

Course Outcomes:

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

- Understand working of lathe, drilling, milling and grinding machines.
- Undertake machining operations such as step turning & thread cutting.
- Analyze plan and execute different sequence of machining operations for a given application.
- Prepare a cutting tool with required tool geometry using a tool and cutter grinder.
- Perform finishing operation on flat surfaces using Grinding Machine

List of Experiments:

1. Step turning, Thread cutting and taper turning operations on a lathe machine.
2. Drilling of holes using a drilling machine.
3. Making a flat surface and key way in a given bar using a milling machine.
4. Flat surface finishing for a given work piece using a surface grinding machine.
5. To make a single point cutting tool using tool and cutter grinding machine.
6. Measurement of cutting forces using lathe tool dynamometer.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
EC631PC: Microprocessors & Microcontrollers

Course Objectives:

1. To familiarize the architecture of microprocessors and micro controllers
2. To provide the knowledge about interfacing techniques of bus & memory.
3. To understand the concepts of ARM architecture
4. To study the basic concepts of Advanced ARM processors

Course Outcomes: Upon completing this course, the student will be able to

1. Understands the internal architecture, organization and assembly language programming of 8086 processors.
2. Understands the internal architecture, organization and assembly language programming of 8051/controllers
3. Understands the interfacing techniques to 8086 and 8051 based systems.
4. Understand the internal architecture of ARM processors.
5. Understand the basic concepts of advanced ARM processors.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	2	1	1	-	1	-	1	1	1	2
CO2	2	1	1	-	2	1	1	-	1	-	1	1	1	2
CO3	2	1	1	-	2	1	1	-	1	-	1	1	1	2
CO4	2	1	1	-	-	1	1	-	1	-	1	1	1	2
CO5	1	-	-	-	-	1	1	-	1	-	1	1	1	2

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 – Registers,, 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, TMH, 2nd Edition 2006.
2. The 8051 Microcontrollers, Architecture and Programming and Applications -K. Uma Rao, Andhe Pallavi, Pearson, 2009.
3. ARM System Developers guide, Andrew N SLOSS, Dominic SYMES, Chris WRIGHT, Elsevier, 2012

REFERENCE BOOKS:

1. The 8051 Microcontroller, Kenneth. J. Ayala, Cengage Learning, 3rd Ed, 2004.
2. Microprocessors and Interfacing, D. V. Hall, TMGH, 2nd Edition 2006.
3. Digital Signal Processing and Applications with the OMAP- L138 Experimenter, Donald Reay, WILEY 2012.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MT601PC: Motion Control Design

Course Objectives:

The objectives of the course is to make the students
- Impart the Knowledge on Mechatronics systems and their applications.
- Study the various types of transmission mechanics used in Mechatronics systems.
- Learn the various types of control systems used in precise motion control.
- Understand the components of hydraulic systems and design of hydraulic circuits for industrial applications
- Study the components of pneumatic systems and design of pneumatic circuits for industrial applications

Course Outcomes:

At the end of the course the students will be able to
- Demonstrate the concepts of Mechatronics systems and their applications.
- Apply various types of transmission mechanics used in Mechatronics systems.
- Understand the various types of control systems used in precise motion control.
- Attain the use of hydraulic systems and design of hydraulic circuits for industrial applications
- Design pneumatic systems through pneumatic circuits for industrial applications

UNIT-I

Mechatronic Systems: Introduction to Mechatronics, Definition, Key elements of Mechatronic system, Graphical representation of Mechatronic System, Mechatronics system design, Stages in design process, Scope of mechatronics, Objectives of Mechatronics, Approaches in Mechatronics, advantages and applications of Mechatronic Systems Introduction to automation, types of automation, Reasons for automation, .Arguments against automation.

UNIT-II

Power Transmission: Transmission mechanics – Types of power transmission, Linear power transmission, Rotary power transmission, - lead screw, Rack and pinion, timing belt, Belt drives, Rope drives, Rotary transmission – Types of gears and gear trains – Nomenclature of spur gears and planetary transmission. Motors – DC servo motors with encoded feedback – Brushless DC servo motors with Hall-effect sensor, Stepper motors – full step, half step, and micro-step. AC induction motors and their applications.

UNIT-III

Control system in Motion control: Control System: Open loop and Closed loop control system, closed loop PID control – feed forward control system, fundamental concept for adaptive control system, Fuzzy logic system – Fuzzification, Fuzzy rule association and De-Fuzzification, Problem on Fuzzy logic system. Programmable Logic Controller: Architecture of PLC, Input and Output module, Processor, Programming methods for PLC: Ladder Programming, Mnemonics and Advanced Programming.

UNIT-IV

Industrial Hydraulics: Introduction, Merits of Fluid power and its utility for increase in productivity, symbolic representation of hydraulic elements, Hydraulic control valves: Direction, Pressure and Flow control valves, Hydraulic Actuators: Cylinders and Motors, Hydraulic accessories: Reservoir, Accumulator, Pressure gauge, Hydraulic pumps: Gear,
Vane and Piston pumps, Hydraulic fluids, Hydraulic circuits using Hydraulic cylinders and other elements. Applications of Hydraulic systems.

UNIT-V

Industrial Pneumatics: Introduction, Advantages and applications of pneumatic systems, Symbolic representations of Pneumatic elements, Air Compressors and Air-line installation diagram, Pneumatic control valves: Direction, Pressure and Flow control valves,
Pneumatic actuators: Cylinders and Motors, Pneumatic circuits using Pneumatic cylinders and other elements. Fluidics and fluid logic systems. Applications of Pneumatic systems.

Text Books:

1. Introduction to Mechatronics and measurement Systems, Alciatore, 2009, 3e, TMH
2. Pneumatic systems - Principles and maintenance, SR Majumdar, TMH
3. Hydraulic systems – Principles and Maintenance, SR Majumdar, TMH

Reference Books:

1. Mechatronics system design – Devdasshetty & Richard A. Kolk, Thomson, 2007
2. Mechatronics – W. Bolten, Pearson, 2010
3. Principles of Machine Tools – Sen & Bhattacharya
4. Introduction to Mechatronics, AppuKuttan KK, Oxford Universities Press
5. Mechatronic systems: Fundamentals, Isermann, Springer.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MT602PC: Robotics and its Applications

Course Objectives:

The objectives of the course is to make the students
- Acquainted with the theoretical aspects of Robotics
- Understand the importance of robots in various fields of engineering
- Perform forward and Inverse kinematics of a given Robot
- Expose the students to various robots and their operational details
- Enable the students to acquire practical experience in the field of Robotics through design projects and case studies.

Course Outcomes:

At the end of the course the students will be able to
- Understand the basic components of robots.
- Demonstrate the types of robots based on configuration grippers.
- Modeling of forward and inverse kinematics of robot manipulators.
- Design intelligent robots using sensors.
- Programme a robot to perform tasks in industrial applications.

UNIT – I

Introduction: Automation and Robotics, An over view of Robotics – present and future applications, Components of the Industrial Robotics, Classifications of Robots – Configuration& Control System, degrees of freedom of a Robot, Wrist Configuration, Robot Specifications.
End Effectors: Types of Grippers - Mechanical, Pneumatic, Magnetic & Adhesive, Considerations in Gripper selection and design.

UNIT – II

Motion Analysis: Types of frames, Basic Rotation Matrices, Composite Rotation Matrices, Euler Angles - types, Homogeneous transformations as applicable to rotation and translation – problems.
Manipulator Kinematics: D-H notation, D-H method of Assignment of frames, D-H Transformation Matrix, Forward and Inverse kinematics – problems on industrial robot manipulators.

UNIT – III

Differential transformation of manipulators: Introduction to Jacobian - problems, types of singularities & significance of singularities.
Trajectory planning: Types – Cartesian & Joint Space, Path planning vs. Trajectory Planning, Cubic Polynomial & Linear Trajectory Planning with parabolic blend without via points, 4-3-4 & 3-5-3 Trajectory Planning, Slew motion, joint interpolated motion, straight line motion – Problems.

UNIT-IV

Robot actuators and Feedback components: Actuators: Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison of Actuators, Feedback components: Internal & External Sensors, Position sensors – potentiometers, resolvers, encoders, Velocity sensors, Tactile and Range sensors.

Programming of Robots and Vision System: Lead through programming - Teach pendent- overview of various textual programming languages – VAL & AML.

UNIT-V

Machine (robot) vision:

Introduction to Machine Vision, Functions of Machine Vision, Robotic Applications in Machine Vision.

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. Industrial Robotics / Groover M P /Mc Graw Hill
2. Robotics and its control / R. K. Mittal & I. J. Nagarath

REFERENCE BOOKS:

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada , Slotine / Wiley Inter-Science

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
ME611PE Finite Element Methods (Professional Elective – I)

Pre-requisites: Mechanics of Solids

Course Objectives:

The objectives of the course is to make the students
- To understand the concept of FEA, interpolation elements and stiffness matrix.
- To derive stiffness matrix for Truss and Beam elements and formulate problems.
- To derive stiffness matrix and formulate CST and axisymmetric problems
- To formulate one Dimensional steady state heat transfer problems.
- To formulate mass matrix and Eigen values for a stepped bar, truss and Beam

Course Outcomes:

At the end of the course, the student will be able to, apply finite element method
- Formulate a stiffness matrix and determine the stress and strain in a 1D Bar element using FE methods
- Formulate or Evaluate stiffness matrix and determine stress, strain in Truss and Beam element
- Derive the stiffness matrix and determine stresses in a CST, axisymmetric element.
- Solve heat transfer problems of 1D, 2D slab and fins.
- Formulate mass matrices of Bar, Truss and Beam, Evaluate eigen values and vectors of stepped bar, Truss, Beam

UNIT – I

Introduction to Finite Element Methods: General Procedure – Engineering Applications – Stress and Equilibrium, Strain – Displacement relations. Stress – strain relations: Finite Elements: 1- Dimensional, 2 – Dimensional, 3-Dimensional & Interpolation Elements

One Dimensional Problems: 1-D Linear and 1-D Quadratic Elements - Finite element modelling, Coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

UNIT – II

Analysis of Trusses: Derivation of Stiffness Matrix for Plane Truss and Space Truss, Displacement and Stress Calculations.

Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection.

UNIT – III

Finite element modelling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of Load Vector, Stresses Finite element modelling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. Two dimensional four noded Isoparametric elements and numerical integration.

UNIT – IV

Steady State Heat Transfer Analysis: one dimensional analysis of Slab, fin and two-dimensional analysis of thin plate.

UNIT – V

Dynamic Analysis: Formulation of finite element model, element - Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss and beam. Finite element – formulation to 3 D problems in stress analysis, convergence requirements, Mesh generation. techniques such as semi-automatic and fully Automatic use of software's such as ANSYS, ABAQUS, NASTRAN using Hexahedral and Tetrahedral Elements.

TEXT BOOKS

1. Finite Element Methods: Basic Concepts and applications/Alavala/PHI
2. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu /Pearson

REFERENCE BOOKS:

1. An Introduction to the Finite Element Method / J. N. Reddy/ Mc Graw Hill
2. Finite Element Analysis / SS Bhavikatti / New Age
3. Finite Element Method/ Dixit/Cengage

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MT611PE: IOT Sensors (Professional Elective – I)

Course Objectives:

The objectives of the course is to make the students
- Attain exposure towards fabrication of sensors and its application in real world
- Provide an understanding on modern day micro sensors and micro actuators
- understand basics of sensors, actuators and their operating principle
- educate the students on different types of micro fabrication techniques for designing and developing sensors
- The students will have an idea about how to simulate some of those sensors and characterise before fabricating it
- explain working of various types of electrochemical sensors and actuators

Course Outcomes:

At the end of the course the students will be able to
- provide information about interfacing of sensors and signal conditioning circuits to establish any control system or monitoring system
- to provide knowledge about simulation and characterization of different sensors
- To provide an understanding on characteristic parameters to evaluate sensor performance.
- Identify the Components that forms part of IoT Architecture
- determine the most appropriate IoT Devices and Sensors analyze the communication protocols for IoT

UNIT- I

Environmental Parameters Measurement and Monitoring: Importance of measurement and monitoring, effects of adverse parameters for the living being Introduction to IOT, Understanding IoT fundamentals, IOT Architecture and protocols

UNIT- II

Industrial sensors: Important Characteristics, First Generation- Description and Characteristics. Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc., Selection of Sensors for Practical Applications

UNIT- III

Integrated IoT Sensors – Description & Characteristics–Polytronics Systems – Description & **Characteristics–Sensors' Swarm –** Description & Characteristics–Printed Electronics –Description & Characteristics–IoT Generation Roadmap

Impedance Spectroscopy: Equivalent circuit of Sensors and Modeling of Sensors, Importance and Adoption of Smart Sensors.

Architecture of Smart Sensors: Important components, their features

UNIT- IV

Fabrication of Sensor and Smart Sensor: Electrode fabrication: Screen printing, Photolithography, **Electroplating Sensing film deposition:** Physical and chemical Vapor, Anodization, Sol-gel. Interface Electronic Circuit for Smart Sensors and Challenges for Interfacing the Smart Sensor, Usefulness of Silicon Technology in Smart Sensor and Future scope of research in smart sensor

UNIT- V

Wireless sensor network (WSN) and Internet of Things (IoT), Internet of Things Application Domains, Internet of Things-Design and development of Security and Privacy Technologies, Design and Implementation of IoT for Environmental Condition Monitoring, Various Platforms for IoT, Real-time Examples of IoT, Overview of IoT components and IoT Communication Technologies, Challenges in IoT

REFERENCE BOOKS:

1. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, 'Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024, Yole Development Copyrights ,2014
2. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer, Fourth Edition, 2010.
3. David Hanes and Gonzalo Salgueiro, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, 2017
4. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York.
   Editors Ovidiu Vermesan Peter Friess,'Internet of Things – From Research and Innovation to Market Swarm Intelligence In Wireless Sensor Networks by Nor Azlina Ab Aziz
5. Foundations of MEMS /Chang Liu / Pearson
6. Micro electro mechanical Systems / Bhattacharyya / Cengage
7. Microsystem Design, Kluwer Academic Publisher, 2001 J.D. Plummer, M.D. Deal, P.G. Griffin

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MT612PE: Power Plant Engineering (Professional Elective – I)

Course Objective:

At the end of the course the students will be able to
- 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 diesel power plant and gas turbine power plant
- A working knowledge of hydro power plants, solar ,wind, tidal power plants and about direct energy conversion systems
- A working knowledge of nuclear power plant and radioactive waste disposal
- 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 working of steam power plants
- Understand working of diesel and gas turbine power plants
- Understand the working of hydro plants and non-conventional energy sources.
- Understand the working of nuclear power plants and waste disposal importance
- Will get awareness of economics and also the importance of power plants waste disposals

UNIT–I

Introduction to the Sources of Energy–Resources and Development of Power in India.
Steam Power Plant: Plant Layout, Working of different Circuits, Properties of coal- Fuel and handling equipment's, types of coals coal handling, choice of handling equipment, coal storage,
Combustion Process: – Stokers: overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion need sand draught system, cyclone furnace, design and construction, Dust collectors, Ash handling systems, 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– supercharging.
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.

UNIT–III

Hydro Electric Power Plant: Water power – Hydrological cycle / flow measurement – drainage area characteristics–Hydrographs–storage and Pondage–classification of dams and spillways. Classification–Typical layouts–plant auxiliaries–plant operation pumped storage plants.
Non-conventional Energy: solar cell, solar collectors, Direct energy conversion systems, wind energy-vertical axis and horizontal axis wind turbines, tidal power

UNIT–IV

Nuclear Power Station: Nuclear fuel – breeding and fertile materials – Nuclear reactor – react or 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.

TEXTBOOKS:

1. Power plant engineering /P.C.Sharma/kataria
2. Power Plant Engineering/P.K.Nag/McGrawHill
3. Power Plant Engineering/Hegde/Pearson.

REFERENCE BOOKS:

1. Power Plant Engineering/Gupta/PHI
2. Power Plant Engineering/AKRaja/Newage

.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MT613PE Alternative Materials (Professional Elective – I)

Course Objectives:

The objectives of the course is to make the students
- Introduce with different carbon-based materials and their applications
- Understand the importance of functionally graded materiasl
- Understand the concept of optics and its use in the in the industry
- Learn and make aware about concept of spintronics and superconductivity
- Know the principle of smart materials and their applications

Course Outcomes:

At the end of the course the students will be able to
- Understand the different forms of carbon materials which is available naturally and its method of fabrication and its potential uses
- Apply the properties of functionally graded materials for getting required characteristics in materials
- Outline the advantages, disadvantages and potential uses of optical and Optoelectronic Materials in different fields
- Analyse the potential uses of superconducting materials and use the concept of spintronics to get tailored properties in materials
- Create devices and products by application of different combination of smart materials.

UNIT- I

Carbon Nanotube and Carbon nanostructure: Introduction, carbon molecule, carbon small clusters, carbon big clusters, fullerenes, discovery of C_{60}, properties of C_{60}, other buckeyballs, CNT, structure, fabrication methods, defects, chemistry of CNT, electrical properties, vibrational properties, chemical properties, mechanical properties, physical properties, optical properties, applications of CNT, CNT reinforced composites, Applications of CNTs, other nanostructures.

UNIT- II

Functionally Graded Materials: Introduction: Definition, History of development, Present state of the art, Applications. Morphological characteristics of biological tissues, A natural optimization process, Graded Microstructure, Structure, Microstructure, Microstructure characterization, Microstructural analysis, Nonuniform materials, Characteristic dimensions, Spatial variation, Volume fraction, Connectivity, Field parameters

UNIT- III

Optical and Optoelectronic Materials: Optical properties, Solar cell, Principles of photoconductivity. Simple models, effect of impurities. Principles of luminescence, types; semiconductor lasers; LED materials, binary, ternary photo electronic materials, effect of composition on band gap, crystal structure and properties. LCD materials, photo detectors, application of photo electronic materials, introduction to optical fibers, light propagation, electro-optic effect, Kerr effect, Pockel's effect

UNIT- IV

Spintronics: materials and devices, Diamond semiconductors, Ferromagnetic semiconductors, Giant magneto- resistance (GMR), Left handed materials, Left and right handed (LH & RH) composite materials, Diluted magnetic semiconductor etc.
Superconductivity: Concept of superconductivity, Phenomenon, properties of superconductors, Meissner effect, Critical magnetic field & critical temperature. Types of superconducting materials, Type I & II superconductors, Silsbee rule, Mechanism of super conduction, BCS theory, Debye temperature. London's & Glag theories, High temperature ceramic superconductors, applications: NMR, Maglev, MHO etc., recent advances and related calculations.

UNIT- V

Smart Materials: Basic concepts of smartness, Definition and characteristics and Behaviors of Smart Materials, Piezoelectric, electrostrictive, magnetostrictive, pyroelectric, electro optic, Piezomagnetism, Pyromagnetism, Piezoresitivity, Thermoelectricity, photon striction, shape memory alloy, Super elastic, Viscoelastic, Elastorestrictive, electrorheological, Thermochromic materials.

REFERENCE BOOKS:

1. Zhang M, Naik RR, Dai L, editors. Carbon nanomaterials for biomedical applications. Springer; 2015 Nov 6.
2. Manijeh Razeghi, 'Optoelectronic Materials and Device Concepts', SPIE-International Society for Optical Engine, 1991.
3. Jasprit Singh, 'Smart electronic materials: Fundamentals and Applications', Cambridge University Press, 2005.
4. Functionally Graded Materials- Design, Processing and Applications , Miyamoto, Y.; Kaysser, W.A.; Rabin, B.H.; Kawasaki, A.; Ford, R.G. (Eds.).
5. Advanced Materials and Structures for Extreme Operating Conditions , Jacek J. Skrzypek, Artur W. Ganczarski, Franco Rustichelli and Halina Egner.
6. Adaptronics and Smart Structures- Basics, Design and Applications- Janocha Harmut (Ed.), Springer-Verlag Berlin Heidelberg, 1999
7. Smart Materials and Structures- M.V. Gandhi, B.S. Thompson, Chapman and Hall, London 1992
8. Dekker A.J., 'Solid State Physics', Macmillan India, 1995.
9. Robert C., O' Handley, 'Modem Magnetic Materials: Principles and Applications', Wiley Interscience, 1999.

L	T	P	C
3	0	0	0

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MC601HS: Intellectual Property Rights
(Common to CIVIL, MECH, ECE, MCT & MME)

Course Objectives: The objectives of the course are:

1. To enable the students to have an overview of Intellectual Property Rights.
2. To provide comprehensive knowledge to the students regarding Trademarks Registration process and law related to it.
3. To disseminate knowledge on Copyrights, its related rights and recent developments.
4. To make the students understand Patent Regime in India and abroad.
5. To understand the framework of Trade secrets.

Course Outcomes: By the end of the course students shall:

1. Gain knowledge on Intellectual property rights and their importance.
2. Understand Indian and International Trademark Law and procedure for registration of Trademarks.
3. Acquire knowledge on Copyright Law, and the privileges awarded to the copyright owners.
4. Familiarized with the process of acquiring the patent and relevant laws.
5. Learn the importance of trade secrets for business sustainability.

UNIT – I: INTRODUCTION TO INTELLECTUAL PROPERTY

Introduction of IPR-Meaning of intellectual property, types of intellectual property-trademarks, copyrights, patents, trade secrets, importance of intellectual property rights, International organizations-WTO-WIPO-USPTO-INTA, International Conventions, agencies and treaties- Paris Convention-Berne Convention- Madrid Protocol-NAFTA-PCT-GATT-TRIPS.

UNIT – II: TRADEMARKS

Trademarks: Purpose and functions of Trademarks-Categories of marks, acquisition of trademark rights - Protectable matter - Selecting and evaluating Trademark- Trademark registration process – Trademark Infringement - Remedies for infringement of Trademarks-New developments in Trademark Law-International Trademarks Law.

UNIT III: COPYRIGHT

Copyrights-Fundamentals of Copyright Law - Requirements of Copyrightability - Originality of material, fixation of material, Authorship works, exclusions from copyright protection- Rights of Copyright Owner-Right of reproduction of copyrighted work, right to do derivative works ,right to distribute copies of the copyrighted work, right to perform the work publicly, right to display the copyrighted work, – Copyright Ownership issues – Joint Works, Works made for Hire, Specially commissioned works, Copyright Registration - Notice of Copyright – Copyright Infringement - Remedies for infringement in Copyrights- New developments in Copyright Law- International Copyright Law.

UNIT IV: PATENTS

Concept of Patent - Classification – Utility Patents – Design Patents and Plant Patents, Patent searching process-Types of Patent Applications-Patent Registration Process, Ownership, Transfer, Assignment and Licensing of Patent-Patent Infringement, Remedies for Infringement of Patents, New developments in Patent Law- International Patent Law.

UNIT – V: TRADE SECRETS & LAW OF UNFAIR COMPETITION

Trade Secrets: Trade secret law, determination of trade secret status, measures for protecting trade secret - Liability for misappropriation of trade secrets, protection for submissions, trade secret litigation. New developments in Trade secrets Law - International Trade Secret law.

Law of Unfair Competition: Passing off, Misappropriation, Right of publicity, Dilution of trademarks, Product disparagement, False advertising, Internet Piracy.

TEXT BOOKS:

1. Deborah. E.Bouchoux, Intellectual property, Cengage learning India Pvt.Ltd., 4th edition, 2013.
2. Prabuddha Ganguli, Intellectual Property Right, Tata McGraw Hill Publishing Company, 8th edition, 2016.

REFERENCES:

1. Richard Stim, Intellectual Property, Cengage learning India Pvt. Ltd. 3rd edition, 2017.
2. Vinod.V. Sope, Managing Intellectual Property, Asoka K. Ghosh, 2nd edition, 2010.

L	T	P	C
3	0	0	0

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MC602ES – Cyber Security
(Common to all branches except CSE, IT, CSBS)

Course objectives:

- To familiarize various types of cyber-attacks and cyber-crimes
- To give an overview of the cyber laws
- To study the defensive techniques against these attacks

Course Outcomes:

- The students will be able to understand cyber-attacks, types of cybercrimes, cyber laws and how to protect them self and ultimately the entire Internet community from such attacks.

UNIT - I

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Spectrum of attacks, Taxonomy of various attacks, IP spoofing, Methods of defence, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

UNIT - II

Cyberspace and the Law & Cyber Forensics: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

UNIT - III

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

UNIT- IV

Cyber Security: Organizational Implications: Introduction cost of cybercrimes and IPR issues, web Threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing, and the associated challenges for organizations.
Cybercrime and Cyber terrorism: Introduction, intellectual property in cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

UNIT - V

Privacy Issues: Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.
Cybercrime: Examples and Mini-Cases Examples: Official Website of Maharashtra Government Hacked, Indian Banks Lose Millions of Rupees, Parliament Attack, Pune City Police Bust Nigerian Racket, e-mail spoofing instances.
Mini-Cases: The Indian Case of online Gambling, An Indian Case of Intellectual Property Crime, Financial Frauds in Cyber Domain.

TEXT BOOKS:

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles,
3. Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

REFERENCES:

4. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press.
5. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&F Group.

L	T	P	C
0	0	2	1

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
EC661PC: Microprocessors & Microcontrollers Laboratory

Course Objectives:

1. Introduce ALP concepts and features.
2. Write ALP for arithmetic and logical operations in 8086 and 8051.
3. Differentiate Serial and Parallel Interface.
4. Interface different I/Os with Microprocessors.
5. Basic ARM programming.

Course Outcomes:

1. Acquire the knowledge 0f 8086 architecture and its programming.
2. Work on 8051 and ARM microcontrollers programming using some simulation tools.
3. Hands-on experience to interface various peripherals with microcontrollers.
4. Able to understand the difference between programming of microprocessor and microcontroller.
5. Able to develop programs for simple real time applications.

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	1	-	-	2	-	-	1	1	2
CO2	3	2	1	1	2	1	-	-	2	-	-	1	1	2
CO3	3	3	2	1	2	1	-	-	2	-	-	1	1	2
CO4	3	3	2	1	2	1	-	-	2	-	-	1	1	2
CO5	3	3	2	1	2	1	-	-	2	-	-	1	1	2

Task 1: Using 8086 Processor Kits and/or Assembler, Assembly Language Programs to perform

1. Arithmetic, Logical, String Operations, sorting on 16/32 bit numbers.
2. Bit level Logical Operations, Rotate, Shift, Swap and Branch Operations.

Task 2: 8051 Microcontroller programming using Keil IDE

1. 8051 Assembly Language Programs for Arithmetic and Logical Operations.
2. Time delay Generation Using Timers of 8051.
3. 8051 Serial Communication.
4. Program Using Interrupts to Generate Square Wave 10 KHZ Frequency on P2.1 Using Timer 0 8051 in 8 bit Auto reload Mode and Connect a 1 HZ Pulse to INT1 pin and Display on Port 0. Assume Crystal Frequency as 11.0592 MHZ
5. ARM Basic Programming in KEIL

Task 3: Interfacing I/O Devices to 8051

1. LEDs and Switches
2. LCD display
3. Matrix Keypad to 8051
4. 8 bit-ADC /DAC Interface to 8051

L	T	P	C
0	0	2	1

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
EN651HS: Advanced English Communication Skills Laboratory
(Common to CE, ECE, EEE, ME, MCT & MME)

Introduction:

The introduction of the Advanced English Communication Skills Lab is considered essential at the B.Tech 3rd year level. At this stage, the students need to prepare themselves for their career which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalized context.

The proposed course should be a laboratory course to enable students to use appropriate English and perform the following:

1. Gathering ideas and information to organize ideas relevantly and coherently.
2. Making oral presentations.
3. Writing formal letters.
4. Transferring information from non-verbal to verbal texts and vice-versa.
5. Writing project/research reports/technical reports.
6. Participating in group discussions.
7. Engaging in debates.
8. Facing interviews.
9. Taking part in social and professional communication.

Course Objectives:
This Lab focuses on using multi-media instruction for language development to meet the following targets:

1. Improve the students' fluency in English, with a focus on vocabulary.
2. Enable them to listen to English spoken at normal conversational speed by educated English speakers.
3. Respond appropriately in different socio-cultural and professional contexts.
4. Communicate their ideas relevantly and coherently in writing.
5. Prepare the students for placements.

Course Outcomes:

Students will be able to:

1. Enhance listening proficiency and reading comprehension and cultivate critical thinking ability.
2. Acquire essential vocabulary and develop strategic planning skills for effective technical writing and gain expertise in E-Correspondence and (N) etiquette.
3. Understand the nuances of oral skills (Speaking skills), gain competence in delivering effective presentations, employing suitable language and body language.
4. Communicate confidently in group discussions and enhance the employability skills of students.
5. Apply effective techniques and strategies for successful job interviews.

Syllabus:

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills (AECS) Lab:

1. **Activities on Listening and Reading Comprehension:** Active Listening – Development of Listening Skills Through Audio clips - Benefits of Reading – Methods and Techniques of Reading – Basic Steps to Effective Reading – Common Obstacles – Discourse Markers or Linkers - Sub-skills of reading - Reading for facts, negative facts and Specific Details- Guessing Meanings from Context, Inferring Meaning - Critical Reading — Reading Comprehension – Exercises for Practice.

2. **Activities on Writing Skills**: Vocabulary for Competitive Examinations - Planning for Writing – Improving Writing Skills - Structure and presentation of different types of writing – Free Writing and Structured Writing - Letter Writing –Writing a Letter of Application –Resume vs. Curriculum Vitae – Writing a Résumé **–** Styles of Résumé - e-Correspondence – Emails – Blog Writing - (N)etiquette – Report Writing – Importance of Reports – Types and Formats of Reports– Technical Report Writing– Exercises for Practice.

3. **Activities on Presentation Skills –** Dealing with Glossophobia or stage fear, starting a conversation – responding appropriately and relevantly – using the right language and body language – Role Play in different situations including Seeking Clarification, Making a Request, Asking for and Refusing Permission, Participating in a Small Talk – Oral presentations (individual and group) through JAM sessions- PPTs – Importance of Presentation Skills – Planning, Preparing, Rehearsing and Making a Presentation - Understanding Nuances of Delivery - Presentations through Posters/Projects/Reports – Checklist for Making a Presentation and Rubrics of Evaluation.

4. **Activities on Group Discussion (GD):** Types of GD and GD as a part of a Selection Procedure - Dynamics of Group Discussion - myths and facts (Dos and Don'ts) of GD - Intervention, Summarizing - Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas - GD Strategies – Exercises for Practice.

5. **Activities on Interview Skills**: Concept and Process - Interview Preparation Techniques - Types of Interview Questions – Pre-interview Planning, Opening Strategies, Answering Strategies - Interview Through Tele-conference & Video-conference - Mock Interviews.

Suggested Books:

1. Effective Technical Communication by M Ashraf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition.
2. Academic Writing: A Handbook for International Students by Stephen Bailey, Routledge, 5th Edition.

Reference Books:

2. Rizvi, M. Ashraf (2018). *Effective Technical Communication*. (2nded). McGraw Hill Education (India) Pvt. Ltd.
3. Suresh Kumar, E. (2015). *Engineering English.* Orient BlackSwan Pvt. Ltd.
4. Bailey, Stephen. (2018). Academic *Writing: A Handbook for International Students.* (5th Edition). Routledge.
5. Koneru, Aruna. (2016). *Professional Communication.* McGraw Hill Education (India) Pvt. Ltd.
6. Raman, Meenakshi & Sharma, Sangeeta. (2015). *Technical Communication, 3E: Principles and Practice.*Oxford University Press.

7. Anderson, Paul V. (2007). *Technical Communication***.** Cengage Learning Pvt. Ltd. New Delhi.
8. McCarthy, Michael; O'Dell, Felicity & Redman, Stuart. (2017). *English Vocabulary in Use* Series. Cambridge University Press.
9. Sen, Leela. (2009). *Communication Skills.* PHI Learning Pvt Ltd., New Delhi.
10. Elbow, Peter. (1998). *Writing with Power.* Oxford University Press.
11. Goleman, Daniel. (2013). *Emotional Intelligence*: *Why it can matter more than IQ*. Bloomsbury Publishing.
12. Professional Communication by Aruna Koneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
13. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
14. How to Write and Speak Better, Reader's Digest, 2003.
15. TOEFL Reading & Writing Workout, The Princeton Review.
16. How to prepare for Group Discussions and Interviews by Harimohan Prasad and Rajneesh Prasad,TataMcgrawHill.
17. Keep Talking, Frederick Klippel, Cambridge University Press, South Asian edition (6 May 2010).
18. Objective English, Edgar Thorpe & Showick Thorpe, Pearson; 5th edition (1 August 2013).
19. Communication Skills for Engineers, Sunitha Mishra, C.Murali Krishna, Pearson; 4th Edition.

****

L	T	P	C
0	0	2	1

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MT651PC: Motion Control Design and CNC & Robotics Lab
Part A: Motion Control Design

Course Objectives:

The objectives of the course is to make the students

- Impart knowledge on basic concepts of Mechatronic Systems.
- Study the principle & operation of basic pneumatic & electro-pneumatic elements.
- Study the principle & operation of basic hydraulic& electro - hydraulic elements.
- Study and operation of pneumatic, electro-pneumatic, hydraulic & electro – hydraulic circuits.
- Study the performance of electro – pneumatic & electro – hydraulic systems using simulation software.

Course Outcomes:

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

- Demonstrate the concepts of Mechatronic Systems.
- Analyze pneumatic, hydraulic, electro-pneumatic and electro-hydraulic systems.
- Integrate mechanical, pneumatic, and hydraulic systems with the help of electronic systems.
- Design and operate electro-pneumatic and electro-hydraulic systems.
- Simulate the pneumatic and hydraulic circuits using P-Simulator and H-Simulator software.

List of Experiments:

Note: Any **Six** from the following**:**

1. Study of the following equipment:
a. Flow Control Valves
b. Directional Control Valves
c. Pressure Control Valves
2. Circuits for reciprocating motion of a single acting and double acting Pneumatic cylinders
3. Circuits for reciprocating motion of double acting hydraulic cylinders.
4. Circuits for speed control of a
   i. Single acting pneumatic cylinder
   ii. Double acting Pneumatic cylinder
5. Circuits for semi-automatic and automatic operation of a double acting Pneumatic cylinders
6. Circuits for semi-automatic and automatic operation of a double acting Hydraulic cylinders
7. Circuits for sequencing motion of two pneumatic cylinder using a sequence valve
8. Circuit for Measurement of pressure of oil in a hydraulic system
9. Simulation of pneumatic circuits using simulation software
10. Simulation of hydraulic circuits using simulation software

Part B: CNC & Robotics Lab

Course Objectives:

The objectives of the course to make the students

- Work on CNC lathe machine.
- Work on CNC milling machine.
- Understand the tool offsets used for CNC lathe machine
- Understand the tool offsets used for CNC milling machine.
- Understand to operate a robot.

Course Outcomes:

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

- Simulate and operate CNC lathe machine.
- Simulate and operate CNC milling machine.
- Demonstration of tool offsets used in CNC lathe machine.
- Demonstration of tool offsets used in CNC milling machine.
- Operate the Robot.

List of Experiments:

1. Study and operation of CNC lathe machine.
2. Study and operation of CNC milling machine.
3. Part programming on CNC lathe machine.
4. Part programming on CNC milling machine.
5. Demonstration of tool offsets for CNC lathe machine.
6. Demonstration of tool offsets for CNC milling machine.
7. Generation of CNC codes using CAM Software for CNC lathe machine.
8. Generation of CNC codes using CAM Software for CNC milling machine.
9. Robot Programming for pick and place.

L	T	P	C
3	0	0	0

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MC601BS: Environmental Science
(Common to all branches**)**

Course Objectives

- To understand the natural resources and their conservation.
- To understand the importance of ecosystem, biodiversity and ecological balance for sustainable development.
- To gain knowledge about environmental pollution, effects and controlling measures.
- To study about global environmental problems and global issues.
- To understand the environmental policies, regulations and sustainable development.

Course Outcomes:

After completing the course, the student will be able to:

- Learn about different types of natural resources and take up the measures to protect the resources.
- Get the information about ecosystem, biodiversity and their usage and conservation.
- Get the information about the types of pollution, understand their effects and controlling measures.
- Gain the knowledge about current global environmental issues and initiations to be taken to protect the environment.
- Gain the knowledge about environmental acts, EIA, sustainable development and follow the rules and regulations.

UNIT – I

Ecosystems: Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity.

UNIT – II Natural Resources:

Classification of Resources: Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and using mineral resources, **Land resources:** Forest resources, **Energy resources:** growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

UNIT – III

Biodiversity and Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In- Situ and Ex-situ conservation. National Biodiversity act.

UNIT – IV

Environmental Pollution and Control Technologies: Environmental Pollution: Classification of pollution, **Air Pollution:** Primary and secondary pollutants, causes and effects, Ambient air quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.

Global Environmental Issues and Global Efforts: Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol. NAPCC-GoI Initiatives.

UNIT – V

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act- 1981, Water Act, biomedical waste management and handling rules, hazardous waste management and handling rules.
Environmental Impact of Assessment (EIA): structure, methods of baseline data acquisition. Concepts of Environmental Management Plan (EMP).
Towards Sustainable Future: Concept of Sustainable Development Goals, Population and its explosion, Environmental Education, Human health, Environmental Ethics, Concept of Green Building, Green chemistry principles, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

TEXT BOOKS:

1 Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
2 Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.

REFERENCE BOOKS:

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Studies by R. Rajagopalan, Oxford University Press.
4. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BSPublications.
6. Introduction to Environmental Science by Y. Anjaneyulu, BS. Publications.

L	T	P	C
2	0	0	2

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
ME701PC: CAD/CAM

Course Objectives:

The Objectives of the Course are to make students

- Understand an overview on the applications of computers in mechanical Design
- Generate different geometric curves viz. 2D and 3D, surfaces and solids using mathematical tools.
- Develop NC Part Program and APT Part Program for part designs
- To impart the basic understanding of Group Technology, CAPP, MRP
- To understand the concepts of CIM in manufacturing automation

Course Outcomes:

After completion of the Course the student will be able to

- Understand use of computers in Design and Manufacturing.
- Develop geometric 2D and 3D models with suitable tools.
- Develop NC part programs and part programs using APT language.
- Describe GT, CAPP and MRP Techniques.
- Understand CIM, CAQC, FMS concepts related to automated manufacturing environment.

UNIT-I

Fundamentals of CAD/CAM, Types of Production Systems, Automation, Design and Product cycle, Application of computers for design, Benefits of CAD, Computer configuration for CAD applications, Computer peripherals for CAD, Design workstation, Graphic terminal, CAD software- definition of system software and application software, CAD Software Standards, CAD database and structure. Reverse Engineering and its Applications

UNIT-II

Geometric Modeling: **3-D Wire frame modeling**, wire frame entities and their definitions, Curve fitting techniques, and Introduction to Hermite, Bezier, and B-spline curves.
Surface modeling: Analytic and synthetic surfaces
Solid Modelling: Sweep representation, Constructive solid geometry, Boundary representations. Parametric representation of all Geometric Modeling Entities

UNIT-III

NC Control Production Systems: Numerical control, Elements of NC system, Methods of NC part programming, Computer assisted part programming (APT). DNC, Adaptive Control Systems.

UNIT-IV

Group Technology: Part families, Parts classification, and coding system. Production flow analysis, Machine cell design.

Computer aided process planning: Difficulties in traditional process planning, Computer aided process planning with retrieval type and generative type. Computer aided manufacturing resource planning: Material resource planning, inputs to MRP, MRP output records, Benefits of MRP.

UNIT-V

Flexible manufacturing system: FMS layouts, Analysis and its benefits

Computer aided quality control: Automated inspection- Off-line, On-line, contact, Non- contact; Coordinate measuring machines, Machine vision.

Computer Integrated Manufacturing: CIM system, Benefits of CIM

TEXT BOOKS:

1. M. Groover, CAD/CAM, Pearson education, 2003.
2. Ibrahim Zeid, R Sivasubramanian, CAD/CAM : Theory and Practice: Special Indian Edition, McGraw Hill Education; 2nd edition, 2009

REFERENCE BOOKS:

1. P.N. Rao, CAD/CAM Principles and Applications, McGraw Hill Education; 3rd edition, 2017.
2. Alavala Chennakesava R, CAD/CAM Concepts and Applications, Prentice Hall India Learning Private Limited, 2008.
3. Radhakrishnan and Subramanian, CAD / CAM / CIM, New Age International Pvt Ltd; Fourth edition, 2018.

L	T	P	C
2	0	0	2

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
ME702PC: Refrigeration and Air-Conditioning

Course Objectives:

The objectives of the course is to make the students

- Apply the principles of Thermodynamics to analyze different types of refrigeration systemsand to understand the concepts of Air-refrigeration.
- Understand the concept of vapor compression systems and its analysis.
- Know the various components of a refrigeration system in detail.
- Understand the concepts of Vapor absorption systems, steam jet refrigeration system, and thermoelectric refrigeration and Vortex tube.
- Study the various principles of Psychrometric and to design air conditioning loads for various applications.

Course Outcomes:

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

- Differentiate between different types of refrigeration systems with respect to application and evaluate the performance parameters of air-refrigeration systems.
- Thermodynamically analyze Vapor Compression systems and evaluate performance parameters
- Differentiate between the various components of a refrigeration system.
- Thermodynamically analyze Vapor absorption systems and evaluate performance parameters
- Apply the principles of Psychometrics to design the air conditioning loads for various 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 – 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.

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.

NOTE: Usage of refrigeration tables and steam tables are permitted.

Text Books:

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

Reference Books:

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

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
ME711PE: Automobile Engineering (Professional Elective – II)

Course Objectives:

The objectives of the course is to make the students

- Develop and understand the anatomy of the automobile, analyze the concept of frames , location and importance of each part of automobile and working of mechanical systems like lubrication and Fuel supply systems for S.I and C.I Engines
- Understand and design the automotive vehicle cooling and ignition systems and its trouble shooting and the basic knowledge in electronic devices which are using for Automobile.
- Analyze the concepts of different types of transmission systems of gear , clutches and suspension system such as leaf springs, hydraulic springs, telescopic shock absorbers
- Apply fundamental knowledge of automobile engineering for design of comfort systems like power steering, type of steering systems and understand principles/types of brakes and different types of master cylinders in the braking system.
- Understand and identify social, environmental issues related to automobile emission characteristic of an S.I ,C.I Engine and Present international standards and alternative fuel technological systems and vehicle maintenance

Course Outcomes:

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

- Obtain the knowledge on automobile and its types and basic knowledge about engine and its lubrication, fuel supply system to the practical problems.
- Analyze the Type of cooling and new technology processes of cooling and ignition systems and its trouble shooting of simple problems on fuel, ignition, cooling, and electrical systems
- Develop an ability to analyze of transmission types, suspension system and braking systems.
- Analyze new technical challenges and design of Power steering systems and new technical advancements in the automotive industry and braking systems.
- Gain the knowledge about the alternative fuels used in automobile, performance and Emissions of automobile and its control of international standards.

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 – carburettor, types, air filters – petrol injection.

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.

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.

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, centre 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.
Modern Vehicles: Introduction to Electric Vehicle & Hybrid Vehicle, advantages and Limitations

TEXT BOOKS:

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

REFERENCE BOOKS:

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

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
MT711PE- Drone Technology (Professional Elective – II)

Course Objectives:

The objectives of the course is to make the students

- Understand drone components, equipment and technology
- Learn programming a drone flight and its assembly
- Understand the factors impacting drone flight
- Know the maintenance of drone and troubleshooting
- Learn the safety regulations of operating a drone

Course Outcomes:

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

- Selection of proper components and material for operating a drone
- Program to fly a drone
- Integrate various factors impacting the flight
- Perform maintenance and could do R&D for testing and stability control
- Apply drone operation ethics in every operation

UNIT- I

Introduction to Drone Technology : Introduction to concept of aviation, types of flying machines, Concept of UAVs, Concept of drones, History of drones, India and drones, tinkering, Vocabulary Terminology used for drones, Types of current generation of drones based on their method of propulsion, Classifications of the UAVs, Structural classification of drones: - fixed wing structure, lighter than air systems, rotary wings aircraft, and applications of drones, Overview of the main drone parts, technical characteristics of the parts, subsystems in drone, Drone Mechanics.

UNIT- II

Drone design and programming: Functions of the component parts, Criterion for material selection for drone design:-description of all components, Assembling a drone, drone propeller materials, design parameters for propellers, composition and structuring of electronic speed controller, flight control board, characteristics of FCB and their structure The energy sources, Level of autonomy, Drones configurations, methods of programming drones, Introduction to programming language used in drone: C and Python. Installation of cards, Auto Pilot software – Ardupilot and Openpilot

UNIT- III

Drone flying and operation: Concept of operation for drone, Flight modes, Operate a small drone in a controlled environment, Drone controls, Flight operations, management tool, Introduction to Pluto, assembly using augmented reality application, configuration and testing, stability and control, calibration and testing

UNIT- IV

Drone accessories and maintenance: Sensors used in drones, On board storage capacity, Removable storage devices, Linked mobile devices and applications. Methods of drone inspection, Charging the battery, Cleaning the drone Storage, Maintenance resources and standards, Battery and its management, Motors, sensors, Radio Control System, Connections and Interfaces of Devices in Drone

UNIT- V

Drone Safety, Regulations and commercial applications: Key features of drone regulations:- Notification of final regulations for civil use, operational and procedural requirements, no drone zones, operations through digital platform, enforcement actions, relevant sections of aircraft act-1934 Regulations of drones, choosing a drone based on the application, Drones in the insurance sector, Drones in delivering mail, parcels and other cargo, Drones in agriculture, Drones in inspection of transmission lines and power distribution Drones in filming and panoramic picturing, Drone Technology as a tool for social inclusion, Future of drones

REFERENCES

1. Robert L. Boylestad / Louis Nashelsky ―Electronic Devices and Circuit Theory‖, Latest Edition, Pearson Education.
2. D. P. Kothari and I. J. Nagrath, ―Basic Electrical Engineering‖, Tata McGraw Hill.
3. J.B. Gupta, Basic Electrical Engineering, Kataria& Sons.
4. H S Kalsi, ―Electronic Instrumentation‖, Latest Edition, TMH Publication.
5. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost (Green Energy and Technology) by Gianfranco Pistoia, Boryann Liaw , Springer.
6. An Introduction to Analog and Digital Communication by Simon Haykin, Wiley Student Edition.
7. Electronics Communication System by Kennedy, Tata McGraw Hill Education Pvt Ltd, New Delhi.
8. Wireless Communications, Second Edition, By Pearson: Principles and Practice.
9. Programmable Microcontrollers With Applications (Cem Unsalan, H. Deniz Gurhan)
10. Drone Technology in Architecture, Engineering and Construction (Tal Daniel).

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
MT712PE Operations Research (Professional Elective – II)

Course Objectives:

The objectives of the course is to make the students

- Set-up simplex tables and solves LP problems using simplex algorithm and interpret the optimal solution of LP problems.
- Recognize and formulate a transportation problem involving a large number of shipping routes and to drive optimal solution by using MODI method. And to apply the Hungarian method to solve an assignment problem.
- Study sequencing techniques and use Johnson‘s rule of sequencing or scheduling. And to realize the need to study replacement and maintenance analysis techniques.
- Apply various methods to select and execute various optimal strategies to win the game. And to know a broad classification of deterministic and probabilistic inventory control models.
- Identify and examine the situations that generates queuing problems. And develop recursive function based on Bellman‘s principle of optimality to get optimal solution.

Course Outcomes:

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

- Formulate a real-world problem as a mathematical programming model and understand the theoretical working of the simple method of linear programming and perform iterations of it by hand.
- Solve specialized linear programming problems like the transportation and assignment problems.
- Study sequencing techniques and use Johnson‘s rule of sequencing or scheduling. And to apply replacement policy for items whose efficiency deteriorates with time and for items that fail completely.
- Understand how optimal strategies are formulated in conflict and competitive environment. And to calculate the EOQ for minimizing total inventory cost and compute the cycle time.
- Analyze the variety of performance measures (operating characteristics) of a queuing system. And understand how to construct a model and solve problems using dynamic programming problems.

UNIT-I

Linear Programming Problem: Operations Research-Development-Definition-Characteristics and Phases-Types of models-Operations Research models- applications.
Allocations: Linear Programming Problem Formulation-Graphical solution- Simplex method: Maximization and Minimization Problems - Artificial variable techniques: Big-M method, Two-phase method.

UNIT-II

Transportation: Formulation - Methods to find basic feasible solution-testing for optimality solution, unbalanced transportation problem-Degeneracy in transportation problem.

Assignment: Formulation - Optimal solution, - Variants of Assignment problem- Travelling salesman problem

UNIT-III

Sequencing: Introduction: Assumptions -Flow-Shop sequencing- n jobs through two machines – n jobs through three machines- Job shop sequencing-two jobs through _m' machines.
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, assumptions - Solution of games with saddle points and without saddle points.2 x 2 games- dominance principle- m x 2 & 2 x n games- Graphical method.
Inventory: Introduction - Single item, Deterministic models- purchase inventory models with one price break - Stochastic models _ Demand may be discrete variable and continuous variable- single period model and no setup cost.

UNIT-V

Queuing: Introduction – Terminology, characteristics - Single channel- Poisson arrivals and Exponential service times with infinite population and unrestricted queue.
Dynamic Programming: Introduction - Terminology, characteristics, Bellman's principle of optimality- Applications of Dynamic programming- shortest path problem- linear programming problem to DPP.

TEXT BOOKS:

1. Sharma J.K., Operations Research, MacMillan Publishers, Fourth Edition, 2010
2. Prem Kumar Gupta and Hira. D.S., Operations Research, S. Chand Publishers, 7th Revised Edition, 2014.

REFERENCE BOOKS:

1. Hillier F.S., Libemann G.J., Nag B. and Basu P., Introduction to Operations Research, TMH, 10th Edition, 2017
2. Raju N.V.S., Operations Research, BS Publications, 3rd Revised Edition, 2017
3. Panneerselvam R., Operations Research, PHI Learning, Second Edition,2009
4. Ravindran.A, Philips D.T. and Solberg J.J., Operations Research: Principles and Practice, Wiley Publications, Second Edition, 2014.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
MT713PE Plant Engineering & Maintenance (Professional Elective – II)

Course Objectives:

The students should be able to
- Understand the concept of maintenance and efficient use of machine equipment and personnel.
- Understand Preventive Maintenance, Corrective Maintenance, Inventory control method and th models.
- To improve the quality of maintenance and also to ensure safety of personnel through regul inspection etc.
- To minimize the total maintenance cost which may consist of cost of repairs, cost of preventi maintenance and inventory costs.
- Understand Reliability and techniques to prevent or to reduce frequency of failures.

Course Outcomes:

At the end of this course students should be able to
- Understand the principles and objectives of Maintenance Engineering
- Describe the various categories of maintenance and inventory control.
- Understand various Quality processes and safety measures in maintenance.
- Explain various cost estimation methods in maintenance.
- Understand the concepts of reliability and maintainability.

UNIT-I

Introduction, Maintenance Management and control: **Introduction:** Need for maintenance, Facts and Figures, modern maintenance, problem and maintenance strategy for the twenty first 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, Inventory control in Maintenance. 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 down time 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, Maintainability 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 insupport 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 BS.Dhallon2002CRR.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

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)

VII Semester Syllabus

ME715PE: Unconventional Machining Processes (Professional Elective – III)

Course Objectives:

The objectives of the course is to make the students

- To differentiate conventional and unconventional machining process and need of unconventional machining in the current scenario and to understand the basic principle of USM, the elements of the process, MMR, process parameters, economic considerations, applications and limitations.
- To state the modern machining process and process selection. Understand the basic principle of AJM, AWJM and also the study the fundamentals of tool design, surface finishing and metal removal rate of electro chemical grinding, electro chemical machining and electro chemical honing.
- To Classify the various thermal & non thermal machining processes and Machine tool selection in EDM & Electric Discharge grinding and wire cut process.
- To calculate Metal Removal Rate and surface finish of different materials using different process parameters.
- To study the various process parameters and applications of plasma arc machining in manufacturing industries and also to study the Principle of chemical machining and the terms maskants, etchants and their applications

Course outcomes:

At the end of the course, the students will develop the ability to:

- Identify the selection of processes. Understand the Ultrasonic Machining Process and its applications.
- Understand the working Principle of above AJM, AWJM, ECM & the metal removal rate
- Differentiate thermal & non thermal processes and also the working principle of EDM Process.
- To estimate the metal removal rate in EBM. Match the material & tool with respect to process.
- Know the working and real time application of PAM process. Develop the economic aspects of the different unconventional machining process.

UNIT–I

Introduction–Need for non-traditional machining methods-classification of modern machining processes–considerations in processes selection. Materials. Applications.

Ultrasonic machining – Elements of the process, mechanics of metal removal process, parameters, economic considerations, applications and limitations, recent development.

UNIT-II

Abrasive Jet Machining, Water Jet Machining And Abrasive Water Jet Machining: Basic principles, equipment, process variable, and mechanics of metal removal, MRR, applications and limitations.

Electro–Chemical Processes: Fundamentals of electro chemical machining, electrochemical grinding, electrochemical honing and deburring processes, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate.

UNIT–III

Thermal Metal Removal Processes: General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.

UNIT–IV

Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes –General Principle and application of laser beam machining –thermal features, cutting speed and accuracy of cut.

UNIT-V

Application of plasma for machining, metal removing mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries. Chemical machining –principle-maskants- applications. Magnetic abrasive finishing, Abrasive flow finishing, Electro stream drilling, shaped tube electrolyte machining.

TEXTBOOKS:

1. Advanced Machining Processes/VK Jain /Allied publishers
2. Modern Machining Processes-P.C. Pandey, H.S. Shan / Mc Graw Hill

REFERENCEBOOKS:

1. Unconventional Manufacturing Processes/Singh M.K/New Age Publishers
2. Advanced Methods of Machining/J.A. Mc Geough/ Springer International
3. Non-Traditional Manufacturing Processes/ Benedict G.F./CRC Press

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)

VII Semester Syllabus

ME716PE: Composite Materials (Professional Elective – III)

Course objectives:

- Develop understanding of the structure of ceramic materials on multiple length scales.
- Develop knowledge of point defect generation in ceramic materials, and their impact ontransport properties.
- To describe key processing techniques for producing metal, ceramic, and polymer-matrixcomposites.
- To demonstrate the relationship among synthesis, processing, and properties in compositematerials.

Course Outcomes:

At the end of the course student will be able to

- Understand the crystal structures of a wide range of ceramic materials and glasses.
- explain how common fibers are produced and how the properties of the fibers are related to theinternal structure.
- select matrices for composite materials in different applications.
- describe key processing methods for fabricating composites

UNIT – I:

Introduction: Definition, Classification of Composite materials based on structure, based on matrix, Advantages of composites, Applications of composites, Functional requirements of reinforcement andmatrix.

UNIT – II:

Types of reinforcements and their properties: Fibers: Carbon, Boron, Glass, Aramid, Al2O3, SiC, Nature and manufacture of glass, carbon and aramid fibres, Comparison of fibres. Role of interfaces: Wettability and Bonding, The interface in Composites, Interactions and Types of bonding at the Interface, Tests for measuring Interfacial strength.

UNIT – III:

Fabrication of Polymeric Matrix Composites, Structure and properties of Polymeric Matrix Composites, Interface in Polymeric Matrix Composites, Applications; Fabrication of Ceramic Matrix Composites, Properties of Ceramic Matrix Composites, Interface in Ceramic Matrix Composites, Toughness of Ceramic Matrix Composites Applications of Ceramic MatrixComposites.

UNIT – IV:

Fabrication of Metal Matrix Composites: Solid state fabrication, Liquid state fabrication and In-situ fabrication techniques; Interface in Metal Matrix Composites: Mechanical bonding, Chemical bonding and Interfaces in In-situ Composites; Discontinuously reinforced Metal Matrix Composites, Properties and Applications. Fabrication of Carbon fiber composites, properties, interface and applications.

UNIT – V:

Micromechanics of Composites: Density, Mechanical Properties: Prediction of Elastic constants, Micro mechanical approach, Halpin-Tsai equations, Transverse stresses; Thermal properties: Hydrothermalstresses and Mechanics of Load transfer from matrix to fiber.

TEXTS BOOKS:

1. Composite Materials – Science & Engineering, K.K. Chawla, Springer-Verlag, New York, 1987.
2. An Introduction to Composite Materials, Hull, Cambridge, 2nd Edt. 1997.

REFERENCE BOOKS:

1. Composites, Engineered Materials Handbook, Vol. 1, ASM International, Ohio, 1988.
2. Structure and Properties of Composites, Materials Science and Technology, Vol. 13, VCH, Weinheim, Germany, 1993.
3. Composite Materials: Engineering and Science, F.L. Matthews and R.D. Rawlings, Chapman & Hall, London, 1994.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
MT714PE: Concurrent Engineering (Professional Elective – III)

Course Objectives:

The objectives of the course is to make the students

- Understand product design, concurrent engineering, product life cycle, and establish a systematic approach to integrated product development that emphasizes the response to custom expectations.
- Relate theory with applications using the concurrent engineering principles.
- Learn the next generation of CIM and develop the high quality of product.
- Understand the tools and methods using computers and decision making.
- Develop skills in team dynamics, management of concurrent engineering projects, including tdesign for manufacturing and design for assembly methodologies

Course Outcomes:

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

- Understand the importance of product design in leveraging both manufacturing cost and produ lifecycle cost, and to plan and implement a product development program.
- Participate in multi-discipline Integrated Product Development teams and also ability benchmark competitive products and develop best industry practices.
- Calculate the reduced product development time, reduced design rework, reduced produ development cost and improved communications.
- Gain good understanding of the concurrent engineering principles and design methodologies. Measure the three-dimensional dies in automobile parts and various mechanical parts, thre dimensional objects such as prototypes, and measurement of differences in drawings. And also learn advanced topics DFMA, rapid prototyping and its applications.

UNIT-I

Introduction: Development of concurrent engineering, The mean and activity concepts and principles, Examples. Concurrent Engineering Tools and Technologies: Changes in technologies, Tasks, Talents and times into well managed resources, and Product Development.

UNIT- II

Research in Engineering Design and Manufacturing

Theory and applications using the concurrent Engineering concepts and Principles. Simultaneous design all related processes of a product.

UNIT- III

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 in modern Tools and methods, Use of computers in decision making, Re-engineering Concepts.

UNIT-V

Automated Quality Control of CMM:

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

TEXT BOOKS:

1. Concurrent engineering: Tools and Technologies for Mechanic systems Design- Edward J. Haug.
2. Product Design and Development, by Karl T. Ulrich and Steven D. Eppinger, McGrawHill, ISBN: 0-07-065811-0

REFERENCE BOOKS:

1. Research in engineering Design: Theory, Applications and concurrent engineering: Vol. 7 No. 1, 1995.
2. Managing concurrent Engineering – Jon Turino.
3. Managing New Product and Process Development, Kim B. Clark and Steven C. Wheelwright, Free Press, ISBN: 0-02-905517-2

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus

MT715PE: Product Design and Assembly Automation (Professional Elective – III)

Course Objectives:

The objectives of the course is to make the students
- Competent with set of tools and methods for product design and development
- Confident in your own abilities to create a new product
- Awareness of the role of multiple functions in creating a new product
- Ability to coordinate multiple, interdisciplinary tasks
- Develop Automation techniques in Assembly

Course Outcomes:

Upon successful completion of this course, students will be able to
- Understand the product design and development
- Apply creative thinking skills for idea generation
- Translate conceptual ideas into products
- Present various techniques for product development
- Design automated processes in Assembly

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 handling, 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.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
ME719PE: CNC Technology (Professional Elective – IV)

Course Objectives:

The objectives of the course is to make the students

- Familiar with CNC Machine
- Able to write computer aided part programming
- Study the different tooling for CNC.
- Study the various types of post processors
- Use computers in the area of manufacturing to reduce manual processing and linking compute to all manufacturing machines and increase the productivity with DNC

Course Outcomes:

After completing this course, the students should be able to

- Familiarize the components of computer aided manufacturing CNC machines and its constructional features
- Know Part Programming Techniques
- Obtain knowledge of Tools and Automation process used in CNC
- Understand Postprocessor significance and its functions
- Analyze DNC and Adaptive Control System

UNIT-I

Introduction to CNC: Fundamentals of Numerical control machines, Advantages of NC machines, Classification of NC Machines, Features of NC Machines, Design considerations of NC Machines, Methods of Improving accuracy and Quality, Calculations of BLU, frequency, linear velocity For Various machines

UNIT-II

CNC Hardware Components: Machine structures of NC Machine Guide ways, feed drives spindle, Spindle bearings In NC Machines Measuring system, Tool monitoring systems

UNIT-III

CNC Tooling: Tooling for CNC machines, Interchangeable tooling Systems, Preset and qualified tools, Coolant fed tooling system, Modular fixturing, quick change tooling system, Automatic head changers

UNIT-IV

Part Programming: NC Part Programming, Manual Part Programming, Basic Concepts, Point to point and contour programming, Canned cycles, Parametric Programming, Computer aided Part Programming, General information on CNC. APT Programming, NC part programming, The Design and implementation of post processor, CAM Software, Automatic tool path generations

UNIT-V

DNC Systems and Adaptive Control Introduction, types of DNC, Advantages and disadvantages of DNC, Adaptive control Systems with Optimization and Adaptive control system with Constraints, Adaptive control of machining processes like turning, grinding.

Text Books:

1. Computer Cotrol of Manufacturing Systems /Yoram Koren/Mc Graw Hill Int.1983
2. CAD/CAM Principles and Applications – by P.N.Rao/Tata Mc Graw Hill Int.2002

Reference Books:

1. CAD/CAM –Michel Groove, TMH Publications
2. Machining Tools Handbook vol 3, (Automation & control)/ Manfred Weck /John Wiley and Sons,1984.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)

VII Semester Syllabus
ME720PE: Production Planning and Control
(Professional Elective – IV)

Course Objectives:

The objectives of the course is to make the students

- To understand the problems and opportunities faced by the operations manager in manufacturi and service organizations.
- To develop an ability to apply PPC concepts in various areas like marketing, accounting, financ engineering, personnel management, logistics, etc.
- To integrate operations concepts with other functional areas of business
- To understand the PPC function in both manufacturing and service organizations.
- To examine several classic Operations Management planning topics including producti planning and inventory control.

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

After completing this course, the students should be able to

- Recognize the objectives, functions, applications of PPC and forecasting techniques.
- Summarize different Inventory control techniques.
- Solve routing and scheduling problems
- Summarize various aggregate production planning techniques.
- Describe way of integrating different departments to execute PPC functions

UNIT – I

Introduction: Definition, Objectives of Production Planning and Control Functions of production planning and control - Types of production systems - Organization of production planning and control department.

Forecasting, Definition- uses of forecast- factors affecting the forecast- types of forecasting- their uses general principle of forecasting. Forecasting techniques- quantitative and qualitative techniques. Measures of forecasting errors.

UNIT – II

Inventory management Functions of inventories, relevant inventory costs, ABC analysis, VED analysis, Basic EOQ model- Inventory control systems –continuous review systems and periodic review systems, MRP I, MRP II, ERP, JIT Systems - Basic Treatment only.

Aggregate planning, Definition, aggregate-planning strategies, aggregate planning methods transportation model.

UNIT – III

Line Balancing: Terminology, Methods of Line Balancing, RPW method, Largest Candidate method and Heuristic method.

Routing, Definition, Routing procedure, Factors affecting routing procedure, Route Sheet.

UNIT – IV

Scheduling Definition, Scheduling Policies, types of scheduling methods, differences with loading flow shop scheduling**,** job shop scheduling, line of balance (LOB) , objectives - steps involved.

UNIT – V

Dispatching: Definition, activities of dispatcher, dispatching procedures, various forms used in dispatching.

Follow up: definition, types of follow up, expediting, definition, expediting procedures -Applications of computers in planning and control.

TEXT BOOKS:

1. Operations management – Heizer- Pearson.
2. Production and Operations Management / Ajay K Garg / Mc Graw Hill.

REFERENCE BOOKS:

1. Production Planning and Control - Text & cases/ SK Mukhopadhyaya /PHI.
2. Production Planning and Control - Jain & Jain – Khanna publications
3. Production and operations Management/ R. Panner Selvam/PHI
4. Operations Management /Chase/ PHI
5. Production and Operations Management (Theory and Practice)/ Diparkar Kumar Bhattacharyya / University Press.
6. Operations Management/S.N. Chary/TMH.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
MT716PE - 3D Printing Technology (Professional Elective – IV)

Course Objectives:

The objectives of the course is to make the students

- Impart fundamentals of 3D printing technology
- Learn how to convert part file into STL format
- Understand the method of manufacturing liquid based, powder based and solid based technologies
- Understand numerous applications of 3D printing technology in various field
- Learn the fundamentals of DFM in manufacturing and Technology

Course Outcomes:

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

- Apply 3D printing techniques for various Industrial needs
- Use software tools for 3D printing
- Know how to prepare 3D printed modules
- Learn how to construct products using LOM and FDM technologies
- Analyze various processes in 3D printing to properly choose for varied applications

UNIT- I

Introduction to 3D printing: History of 3D printing, Materials and costs involved, 3D printing eco system, future scope of 3D printing, 3D Printing, Generic 3D Printing Process, Benefits of 3D Printing, Distinction Between 3D Printing and CNC Machining, Other Related Technologies Development of 3D Printing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, The Use of Layers, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World

UNIT- II

3D Printing Technologies I : Liquid Based 3D Printing: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working ,principle, applications, advantages and disadvantages, case studies

UNIT- III

3D Printing Technologies II: Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration

UNIT- IV

3D Printing Design and Required Tools

Design for 3D Printing - Design for Manufacturing and Assembly, Core DFM for 3D Printing Concepts and Objectives, 3D Printing Unique Capabilities, Exploring Design Freedoms, Design Tools for 3D Printing. Guidelines for Process Selection - Selection Methods for a Part, Challenges of Selection, Preliminary Selection, Production Planning and Control. Software Issues for 3D Printing - Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist 3D Printing. Basics of 3D design sketching and types of softwares used. Introduction to sketching and sketchbook basics, Expressing sketching in 3D, Fusion 360 Basics

Introduction to Fusion 360, navigating the user interface, working with primitives, sketch-based construction and creating components, Open SCAD, 3D Scanning: Examples of 3D scanning, concept of postprocessing, creating digital designs into physical objects

UNIT- V

Applications & Future Directions for 3d Printing: Medical Applications for 3D Printing - Use of 3D Printing to Support Medical Applications, Software Support for Medical Applications, Limitations of 3D Printing for Medical Applications, Further Development of Medical 3D Printing Applications. Use of Multiple Materials in 3D Printing - Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Embedded Component 3D Printing, Commercial Applications Using Multiple Materials, Future Directions, Business Opportunities and Future Directions

REFERENCES BOOKS:

1. Ian Gibson, David W Rosen, Brent Stucker., ―Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing‖, Springer, 2010
2. Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles an Applications, World Scientific publications, 3rdEd., 2010
3. Terry Wohlers, ― Wholers Report 2000‖, Wohlers Associates, 2000
4. Paul F. Jacobs, ― Rapid Prototyping and Manufacturing‖–, ASME Press, 1996
5. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001.
6. Ali K. Kamrani, Emand Abouel Nasr, ―Rapid Prototyping: Theory & Practice‖, Springer, 2006.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
MT717PE: Mechanical Vibrations (Professional Elective – IV)

Course Objectives:

The objectives of the course is to make the students
- Understand various levels of vibrations and remedies.
- Understand the basic fundamentals of undamped, damped, free and forced vibrating system.
- Understand the causes and effects of vibration in mechanical systems.
- Understand the role of damping, stiffness and inertia in mechanical systems.
- Understand the role longitudinal, traverse vibrations and critical speed of the shaft in vibrati system.

Course Outcomes:

At the end of the course the students will be able to
- Analyze the vibrating equations for identifying the various levels of vibrations.
- Develop schematic models for physical systems and formulate governing equations of motion.
- Analyze rotating and reciprocating systems and compute critical speeds.
- Analyze and design machine supporting structures, vibration isolators and absorbers.
- Analyze the longitudinal, traverse vibrating equations and calculating the critical speed of the sha for various industrial applications.

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

UNIT – III
Multi degree freedom systems: Matrix formulation, stiffness and flexibility influence coefficients;; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion.

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

UNIT – V
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.

TEXT BOOKS:

1. Elements of Vibration Analysis / Meirovitch/ McGraw 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
3. Mechanical Vibrations/ G.K. Grover/ Nemchand & Brothers

L	T	P	C
0	0	2	1

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
ME751PC: CAD/CAM Lab

Course Objectives:

- Understand and handle design problems in a systematic manner.
- Able to apply CAD in real life applications for 3D Modeling and assembly interface.
- Understand and analyze the basic principles of different types of analysis.
- Understand the various aspects in of manufacturing using CAM Software
- Learn the Manufacturing of 3 dimensional component using CNC.

Course Outcomes:

After completion of the Course the student be able to

- Create 2D, 3D CAD Models using different CADD Modeling Packages.
- Utilize CAD Modeling packages for Conversion of 3D object into 2-D drawings.
- Analyze and perform the displacements and stresses in 1D, 2D, 3D mechanical components.
- Generate NC Program with various aspects in manufacturing using CAM Software
- Manufacture of 3D component using CNC MILLING and TURNING Machines.

List of Experiments

1. 2D Drafting of orthographic Drawings for various Parts Using AutoCAD
2. 3D Part Modeling of various components through parent features like Extrude, Revolve, and Sweep using any 3D CAD Software.
3. 3D Part Modeling of various components through advanced features like Loft, Rib, Hole wizard using any 3D CAD Software.
4. Creation of Assembly Model from the part models of Knuckle Joint, Universal Coupling, IC Engine using any 3D CAD Software
5. Conversion of Part model and assembly model into Drawing Files with sectional views, detailing, Dimensions and Tolerances and other annotations using any 3D CAD Software
6. Determination of deflection, stresses of 2D and 3D trusses and beams with various types of loads using Ansys Software.
7. Determination of deflections, principal and Von-mises stresses in plane stress, plane strain and Axi-symmetric components using Ansys Software.
8. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam using Ansys Software.
9. Steady state heat transfer analysis of plane and axi-symmetric components Ansys Software.
10. Generation of NC code using any CAM software
11. Programming and simulation for Milling using CNC MILL
12. Programming and simulation for Turning operation using CNC LATHE

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
ME811PE Automation in Manufacturing (Professional Elective – V)

Course Objectives:

The objectives of the course is to make the students

- Know the basic principles of automation , types, understanding the pneumatic and hydraulic component circuits in automation, machine tool control transfer the automation
- Understand the construction and working of work part transfer mechanisms, transfer methods, analysis of buffer storage with and without buffer storage and partial automation in automated flow lines.
- Learn the principles of line balancing methods, design of material handling systems, Automated guided vehicle systems.
- Understand the automated storage and retrieval systems, work in process, advantages and applications of adaptive control systems.
- Learn the basic concepts of Enterprise resource planning, rapid prototyping technology.

Course Outcomes:

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

- Familiarize with the basic Illustrate the basic concepts of automation, strategies of automation, principles of importance of hydraulic and pneumatic controls circuits.
- Design and fabrication consideration of transfer machines, General
- Analyze various automated flow lines, to implementation of automated flow lines in processing lines.
- Possess for apply line balancing methods in assembly flow line, flexible assembly line, Describe the importance of automated material handling system and applications of automated guided vehicle system in assembly and manufacturing lines.
- Demonstrate automated storage and retrieval systems, interfacing handling and storage with manufacturing, Interpret the importance of adaptive control systems and applications of adaptive control systems in manufacturing line.
- Obtain knowledge of Business process re-engineering, software configuration of BPE, Concurrent engineering.

UNIT – I

Introduction: Types of automation, strategies of automation, Advantages and disadvantages of automation, pneumatic and hydraulic components circuits, reasons for automating, Arguments against automation, arguments in favour of automation, applications of automation

UNIT – II

Automated flow lines: Introduction, configuration of an automated flow line, Methods of work part transport, transfer mechanisms, buffer storage, control functions, automation for machining operations.

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

UNIT – III

Assembly system and line balancing: Assembly process, assembly systems, manual assembly lines, line balancing problem, methods of line balancing.

UNIT – IV

Automated material handling: Material handling function, Types of material handling equipment, Conveyor systems, types of conveyors, quantitative relationships and analysis of conveyor systems, automated guided vehicle systems.

Automated storage systems: Storage system performance, Automated storage/ retrieval systems; basic components of an AS/RS, special features, applications, work in process storage.

UNIT – V

Fundamentals of Industrial controls: Sensors and actuators, Business process Re-engineering: Introduction to BPE logistics, ERP, Concurrent Engineering.

TEXT BOOKS:

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover
2. 3e./PE/PHI, 2009.
3. Computer control of manufacturing systems- Yoramcoreom
4. Automation by W. Buekinsham.

REFERENCE BOOKS:

1. Computer Aided Manufacturing, Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang,
2. Pearson, 2009.
3. CAD/CAM/CIM by Radhakrishnan
4. 3.Advanced Manufacturing Technology , K. VaraprasadRao

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
ME812PE: Additive Manufacturing Technology (Professional Elective -V)

Course Objectives:

The objectives of the course is to make the students

- Understand the fundamental concepts of Additive Manufacturing (i.e.Rapid Prototyping) / 3-D printing, its advantages and limitations.
- Classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc.
- Study methods of additive manufacturing with introduction to common machines used for the technology.
- Learn the file formats and softwares used for additive manufacturing.
- To have a holistic view of various applications of these technologies in relevant fields such as mechanical, bio-medical, aerospace etc.

Course Outcomes:

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

- Describe various CAD issues for 3D printing / additive manufacturing and related operations.
- Formulate and solve typical problems on reverse engineering for surface re construction from physical prototype models through digitizing and spline- based surface fitting.
- Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.
- Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
- Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts.

UNIT – I

Introduction: Historical development, Fundamentals of Additive Manufacturing/Rapid Prototyping, Advantages and Limitations; Commonly used Terms; Classification of Additive Manufacturing process, Additive Manufacturing Process Chain: Fundamental Automated Processes.

UNIT – II

Additive Manufacturing Systems: Process, working principle, Applications, Advantages, Disadvantages, Case studies, Models and Specifications of: Liquid-based Additive Manufacturing Systems - (a) Stereo lithography Apparatus (SLA) and (b) Solid ground curing (SGC); Solid-based Additive Manufacturing Systems - (a) Laminated Object Manufacturing (LOM) and (b) Fused Deposition Modelling (FDM).

UNIT – III

Additive Manufacturing Systems: Process, working principle, Applications, Advantages, Disadvantages, Case studies, Models and Specifications of Powder Based Additive Manufacturing Systems - (a) Selective laser sintering (SLS) and (b)Three dimensional Printing (3DP):

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

UNIT – IV

Additive Manufacturing Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution; Other Translators, Newly Proposed Formats.

Additive Manufacturing Softwares: Features of various softwares like Magics, Mimics, Solid View, View Expert, 3D View, Velocity 2, Rhino, Data Expert and 3D doctor.

UNIT – V

Additive Manufacturing Applications: Applications in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewellery Industry, Coin Industry, GIS application, Arts and Architecture. Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices.

TEXT BOOKS:

1. 3D Printing and Additive Manufacturing: Principles and Applications (Fifth Edition of Rapid Prototyping) - Chee Kai Chua and Kah Fai Leong - World Scientific Publications
2. Additive Manufacturing Technologies - Gibson, I., Rosen, D., Stucker, B., &Khorasani, M. - Springer.

REFERENCE BOOKS:

1. Rapid Manufacturing - D.T. Pham and S.S. Dimov - Springer
2. Terry Wohlers, Wholers Report 2000, Wohlers Associates
3. Rapid Prototyping and Manufacturing - PaulF. Jacobs - ASME

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
MT811PE - Control Systems with DMX Technology
(Professional Elective -V)

Course Objectives:

The objectives of the course is to make the students

- Provide the basics of illumination and properties
- Learn the designing procedure of lightning technology in interior and exterior environments
- Understand the control systems in lightning
- Learn about DMX technology, controls, and its extensive usage as a Light control system
- Understand the technology used in Laser art applications

Course Outcomes:

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

- Understand the working of various types of Lamps and properties associated with illumination
- Perform design calculations for interior and exterior environments
- Describe the importance of control system technology
- Understand DMX512 protocol, architecture of DMX in control systems, advantages, and applications
- Apply the Laser control systems in various art forms along with safety considerations

UNIT- I

Introduction: Review of Light, color and photometry: Laws of illumination, illumination entities, Radiometric and photometric standards, photometric measurement procedure- assessment of lamp efficacy, color Temperature, Calorimetry Measurement of CRI, Glare Lamps and Luminaries Lamp: Review of development, construction and characteristics: Incandescent lamps, Discharge lamps, Fluorescent lamps, CFL, Mercury vapor, Sodium vapor, metal halide, Induction lamp, and LED lamp

UNIT- II

Interior Lighting design and calculation: Objectives, Quality and Quantity of Lighting, Lamp and Luminaire, selection and placement, Design consideration and calculations. Glare consideration and control. Indoor lighting design by Lumen method, by point-by-point method, Applications in various places.

Exterior Lighting design and calculation: Exterior Lightning system, Road lightning system, Utility area lightning, sports lightning, Decorative flood lightning, Applicable standards.

UNIT- III

Lightning control: Introduction to Lighting control, controls, Selection of Lighting controls, Design of Lighting control scheme, Lighting and LEED, Lighting controls and the ASHRAE/IES 90.1-1999. Personal Lighting control, Day lighting control, Lighting Control for Fluorescent Lamps and electronic Ballasts in frequently switched Applications, Linear Fluorescent Dimming Ballasts, Dimming of high intensity Discharge Lamps, Controlling LED Lightning systems, Smart lightning fixtures, Digital lightning networks

UNIT- IV

DMX control: Protocols for Lighting control, DMX Technology overview, Advantages, DMX-512 standard, DMX Input vs output, DMX wiring and addressing, combining and splitting DMX, DMX solutions and Applications, DMX future

UNIT- V

Laser: Fundamentals of Laser & its application , General Rules for Laser Safety, Laser Classifications , Laser Projection Systems , Power Unit Connection , Water Connection , Connecting Laser to Animation Program , Laser Art, Animation and Atmospheric , Selecting a Theme, Building a Storyboard , Drawing Art – Graphics – Animation , Recording with Music or Sound Effects , Adding Atmospherics , Projecting on Flat Screen , Projecting on Water Screen , Diffraction Gratings , Projecting with Live Action , Water as Rear Projection 3D Screen , Projecting with Video Images , Laser Safety During Running a Show, Laser Maintenance

REFERENCES

1. Lamps and Lighting – Edited by J.R. Coaton and A.M. Marsden, 4th Edition Arnold
2. The Scientific Basis of Illuminating Engineering – P.Moon Dover Publications
3. Lighting Engineering Applied Calculations – R. H. Simons & A.R. Bean, Architectural Press
4. Lighting for energy efficient luminous environments- Ronald N.Helms & M Clay Belcher. Prentice Hall.
5. Fundamentals of Illumination Engineering – V.V. Meshkov , Mir Publication, Russia .
6. IES Lighting Handbook – IES North America.
7. Fundamentals of Illumination Engineering – V.V. Meshkov, MIR Publishers Moscow
8. Light Science – Rossing Chanerina, Springer, Wilson, J. & Hawkes, J.F.B. (1987). Prentice Hall. ISBN 0-13-523697-5
9. Laser Dynamics – Thomas Erneux & Pierre Glorieux, Cambridge.
10. The Light Fantastic - A Modern Introduction to Classical and Quantam Optics – Ian R. Kenyon, Oxford.
11. Lasers: Principles and Applications, Prentice Hall International Series in Optoelectronics
12. Designing with Light – J. M. Gillette, Mayfield Publishing Company.
13. Concert Sound and Lighting Systems – John Vasey, Focal

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
MT812PE: Reliability Engineering (Professional Elective -V)

Course Objectives:

The objectives of the course is to make the students
- Introduce the basic concepts of reliability, various models of reliability
- Identify correct causes of failures that occur despite the efforts to prevent them
- Analyze reliability of various systems
- To determine ways of coping with failures that occur
- Introduce techniques of frequency and duration for reliability evaluation of repairable and irreparable systems.

Course Outcomes:

At the end of this course students will be able to
- Understand the concept of Reliability
- Evaluate the reliability of simple and complex systems
- Model various systems applying reliability networks
- Estimate the limiting state probabilities of repairable systems
- Apply various mathematical models for evaluating reliability of irreparable systems

UNIT-I

Concept of Reliability; 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, Para11e1 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 and Continuous Markov Processes: Discrete Markov Chains: Basic concepts- Stochastic transitional probability matrix- time dependent probability evaluation- Limiting State Probability evaluation- Absorbing states — Examples Continuous Markov Processes: Modelling 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 modelling and evaluation techniques- Examples.

TEXT BOOKS:

1. Roy Billinton and Ronald N Allan, Reliability Evaluation of Engineering Systems, Plenum Press, 1983.
2. Balagurusamy, E., Reliability Engineering, Tata McGrawHill Publishers, 2002.

REFERENCE BOOKS:

1. Agarwal, K.K., Reliability Engineering, Kluwer Academic Publishers, 1993.
2. Srinath, L.S., Reliability Engineering, Affiliated East-West Press Limited, New Delhi, 2002.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
ME815PE - Digital Manufacturing & Industry 4.0 (Professional Elective – VI)

Course Objectives:

The objectives of the course is to make the students
- Introduce basics of Industry 4.0 and its application in the business world
- Understand the smart cities, smart factories concept
- Understand various systems used in Industry 4.0
- Learn integration of Robotics, IoT and smart sensors in manufacturing
- Know the benefits of any organization and individuals to reap benefits while relying on Industry 4.0

Course Outcomes:

At the end of the course the students will be able to
- Understand the drivers and enablers of 4.0
- Apply the technology to build future smart devices and services
- Outline the advantages of manufacturing unit in Industry 4.0
- Realize the power of cloud computing in a networked economy
- Understand the opportunities and challenges brought by Industry 4.0

UNIT- I
Introduction: core idea of Industry 4.0, origin concept of Industry 4.0, Industry 4.0 production system, current state of Industry 4.0, Technologies, how is India preparing for Industry 4.0

UNIT- II
A conceptual framework for Industry 4.0: Introduction, Main concepts and components of Industry 4.0, state of Art, supportive Technologies, Proposed Framework for Industry 4.0

UNIT- III
Technology Roadmap for Industry 4.0: Introduction, proposed framework for Technology road map, strategy Phase, New product and process development phase

UNIT- IV
Advances in Robotics in the Era of Industry 4.0: Introduction- recent technological components of the Robots – Advanced sensor technologies, Internet of Robotic things, Cloud Robotics, and cognitive Architecture for cyber – physical robotics, Industrial robotic applications – Manufacturing, Maintenance and Assembly

UNIT- V

The role of Augmented Reality in the age of Industry 4.0: Introduction, AR hardware and software Technology, Industrial Applications of AR

Obstacles and Framework conditions for Industry 4.0: Digital strategy alongside Resource scarcity, standards and data security, financing conditions, availability of skilled workers, comprehensive broad-band infrastructure, state support, legal framework, protection of corporate data, liability, handling personal data

REFERENCE BOOKS

1. ―Industry 4.0: Managing The Digital Transformation‖ by Alp Ustundag
2. ―The Concept Industry 4.0‖ by Christoph Jan Bartodzie
3. ―The fourth Industrial revolution‖ by Klaus Scab
4. ―The Challenges of Industry 4.0 for Small and Medium-sized Enterprises‖ by Christian Schröder

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
ME816PE - ELECTRIC AND HYBRID VEHICLES (Professional Elective – VI)

Prerequisites: Should have Knowledge of basic electrical principles.

Course Objectives:

- Explain the history of Electric vehicles and development
- Discuss the Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies
- Explore to basic concept of electric traction, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives etc.
- Analyse the Fuel Cell based energy storage and Super Capacitor based energy storage etc.
- Explore to types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others) etc.

Course Outcomes:

At the end of the course student will be able to

- Choose the appropriate source of energy for the hybrid electric vehicle based on driving cycle.
- Analyze the power and energy need of the various hybrid electric vehicle and Measure and Estimate the energy consumption of the Hybrid Vehicles
- Evaluate energy efficiency of the vehicle for its drive trains
- Elaborate the types of storage systems such as battery based, fuel cell based etc.
- Explain the types of Driving Cycles, Fuel Cell EV, Solar Powered Vehicles

UNIT- I:

Introduction To Electric Vehicle: History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces actingon the Vehicle in static and dynamic conditions.

UNIT- II:

Introduction To Hybrid and Electric Vehicles: Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Vehicle Fundamentals: Vehicle resistance, Types: Rolling Resistance, grading resistance, Aerodynamic drag vehicle performance, calculating the Acceleration Force, maximum speed, Finding The Total Tractive Effort, Torque Required On The Drive Wheel, Transmission: Differential, clutch & gear box, Braking performance.

UNIT- III:

Electric Drive Trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configurationand control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency

UNIT- IV:

Types of Storage Systems: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Calculation for the rating.

UNIT- V:

Modelling of Hybrid Electric Vehicle Range: Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2 wheeler, 3 wheeler and 4 wheeler vehicles.

TEXT BOOKS

1. James Larminie, J. Lowry, ―Electric Vehicle Technology Explained‖, John Wiley & Sons Ltd.2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, –Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design‖, CRC Press, 2004.

REFERENCE BOOKS

1. S. Onori, L. Serrao and G. Rizzoni, –Hybrid Electric Vehicles: Energy Management Strategies‖, Springer, 2016.
2. Iqbal Hussein, –Electric and Hybrid Vehicles: Design Fundamentals‖, CRC Press, 2010.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
MT813PE: MEMS Design (Professional Elective – VI)

Course Objectives

The objectives of the course is to make the students
- introduce micro-electro-mechanical systems with special focus on optical applications.
- learn the concepts of lithography methods such as UV photolithography, X-ray photolithography, electron beam lithography, soft-lithography, and their comparisons.
- Elucidate the role of micro sensors, micro actuators, and principles of sensing and actuation.
- Learn the properties of light and their exploitation with respect to MOEMS, applications and Fundamentals of MOEMS.
- Learn basic applications of MEMS in radio frequency (RF) communication and Microfluidic applications.

Course Outcomes:

At the end of this course students will be able to
- understand the basics of micro fabrication, develop models, and simulate electrostatic and electromagnetic sensors and actuators.
- determine the most appropriate dry etchant and dry etching process to selectively micro machine features into one or more materials, given the simultaneous presence of other materials that are not to be etched.
- understand the material properties importants for MEMS system performance, analyze dynamics of resonant micromechanical structures.
- understand the design process and validation for MEMS devices and systems and learn the state of the art in optical microsystems.
- understand the basic communications systems, RF frequency MEMS, micro fluidic systems and its applications.

UNIT-I

Introduction to MEMS: Integrated Circuits, MEMs, Micro sensors, Micro actuators, Microelectronics, Fabrication, micromachining, Mechanical MEMS, Thermal MEMs, MOEMS, Magnetic MEMEs, RF MEMS, Micro fluid systems, Bio and thermo-devices, Nanotechnology.

Micromachining: Introduction, Photolithography, Structural and sacrificial materials, other lithography methods, Thin film deposition, etching, Problems with Bulk Micro Machining and Surface Micro Machining.

UNIT-II

System Modeling, properties of material: Introduction, Need for modeling, system types, basic Model elements in mechanical systems, Electrical system, Fluid system and Thermal systems, Translational pure mechanical system with spring, damper and mass –Rotational pure mechanical system with spring, damper and mass, Properties of materials, Relation between E, G, K and μ.

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, captive Effects, Piezo Electric Material as sensing and actuating elements, strain measurement, flow measurement using integrated paddle cantilever structure.

Thermal sensors and actuators: Introduction, Thermal energy basics and heat transfer process, Thermistors, Thermo devices, Thermocouple, Micro machined thermocouple probe, Peltier effect heat pumps, Thermal flow sensors, Shape memory Alloys, Thermally activated MEMEs relay.

UNIT-IV

Micro-Opto-Electromechanical Systems: Introduction, fundamental principle of MOEMs Technology, Review on properties of light, Light Modulators, beam Splitters, Microlens, Micro mirrors, light detectors, grating light valve, optical switch, waveguide and tuning, shear Stress measurement.

UNIT-V

Radiofrequency MEMS: Introduction, Review of RF –based communication systems, RF MEMS, MEMs Inductors, varactors, tuners/filter, resonator, clarification of Tuner, filter, resonators, MEMS switches, phase shifter.

Micro fluidic systems: Introduction, Properties of fluids and Applications.

TEXT BOOKS:

1. MEMS, Nitaigour Premchand Mahalik, TMH.
2. MEMS & Micro Systems design and Manufacture, Tai-ran HSU, TMH, 2006.
3. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf, Kirt Williams, Artech House microelectromechacnical library, second edition.

REFERENCE BOOKS:

1. Micro and Smart Systems-Technology and Modelling, G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat and V.K.Aatre, John Wiley& Sons,Inc 2012.
2. Mechatronics Systems Fundamentals-Rolf Isermann-Springer International Edition.
3. The science and engineering of Micro Electronic Fabrication, 2nd ed. By. S.A. Cambell, Published by Oxford University Press (2001).
4. Fundamentals of Micro Fabrication: The science of Miniaturization, 2nd Edition by M.J. Madou, published by CRC Press (2002).
5. Introductory MEMS: Fabrication and application by Adams, Thomas M. Layton Richard A., 1st Edition 2010 IBNL 978-0-387-09510-3, Springer.
6. Microsystems Design, Stephen D.Senturia, Springer International Edition.
7. Nano and Micro Electromechanical Systems, Sergey Edward Lyshevski, CRC Press, 2001.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
MT814PE – Animatronics (Professional Elective – VI)

Course Objectives:

The objectives of the course is to make the students

- Know the evolution of Animatronics concept and its interdisciplinary relation with Arts, Design and Electronics
- Learn Engineering design and product development that facilitates Animatronics products
- List various materials used for fabrication of Animatronics figures along with advantages and disadvantages
- Understand various metal removal and cutting operations and shell fabrication
- Understanding the operations of various drives used in Automation system

Course Outcomes:

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

- Understand the challenges and scope of Animatronics
- Apply principles of DFMA in Industrial design
- Analyze various designs and processes used for obtaining Animatronics objects
- Apply suitable material removal process that suits a required application and the use of soft plastics in various Animatronics products
- Distinguish various drives that are used in Animatronic objects

UNIT- I

Engineering Design and Product Development Process: Methodology involved in engineering and product, prototyping and testing, DFMA (design for manufacture and assembly), Industrial design, Product-life cycle and continuous improvement

UNIT- II

Concept Development and Artistic Design, Concept development, Artistic design via various type art drawings and story-boarding, modelling with clays to be utilized as visual aids or patterns for moulding

UNIT- III

Mold Design and Fabrication, Sand-casting, Plastics processing including injection moulding, gravity based moulding processes using various materials including Plaster of Paris or Urethane, Shell fabrication by use of Rubber Latex and soft plastics

UNIT- IV

Mechanism Design and Armature Fabrication, Joints, Mechanisms - Continuous and Intermittent, Power Transmission and related components such as drives and gears, Metal removal, NC laser cutting, and forming processes in shaping links, linkages and structural components, Costuming through Fabrics, Soft Plastics and Painting.

UNIT- V

Actuators and Sensors o Fundamentals of Electricity and Electronics , Electric motors (DC, RC, servo or stepper), switches, sensors , Controllers and Programming , RC or autonomous systems and Interactive C programming

REFERENCE BOOKS:

1. Robots, Androids and Animatrons by John Iovin
2. AC 2011-190: Employing Animatronics in Teaching Engineering Design by Arif Sirinterlikci, Robert Morris University

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MT621OE: Fundamentals of Electrical Vehicle Technology (Open Elective – I)

Course Objectives:

The objectives of the course is to make the students

- Familiarize with the basic electric components configuration and layout of Electrical vehicles
- Familiarize with different energy storage systems and Hybrid vehicles
- Understand the dynamics of automobile
- Learn the working of various electric motors
- Understand the rules and safety measures related to electrical vehicles

Course Outcomes:

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

- Distinguish various advantages and scope for Electrical vehicles
- Apply energy management system strategies for various problems
- Evaluate the performance of the vehicle
- Apply the controls of different motors for drive system efficiency
- Understand various driver circuits and commercial applications including policies and regulations

UNIT- I

Electric Vehicles: History, Components of Electric Vehicle, General Layout of EV, EV classification Comparison with Internal combustion Engine: Technology, Advantages & Disadvantages of EV, Overview of Tesla car.

UNIT- II

Hybrid Electric Vehicles: History, Components of Hybrid Electric Vehicle, General Layout of Hybrid EV, Comparison with Electric Vehicles, Advantages & Disadvantages of Hybrid EV, Overview of Toyota prius

UNIT- III

Vehicle Fundamentals: Vehicle resistance, Types: Rolling Resistance, grading resistance, Torque Required On The Drive Wheel, Transmission: Differential, clutch & gear box, Braking performance.

UNIT- IV

Motors: Principle and working of DC motor, Characteristics and Types of DC Motors, Overview (Speed torque characteristics) of Permanent Magnet motor, BLDC Motor, Induction motor. Comparison of all motors

UNIT- V

Converts: Introduction of DC-DC, AC-AC AC-DC, DC-AC, four-quadrant operation, Driver circuits.

Indian and Global Scenario: Technology Scenario, Market Scenario, Policies and Regulations, Payback and commercial model, Polices in India.

REFRERENCE BOOKS:

1. Electrical vehicle technology: John Lowry and James Larminie
2. Modern electric, hybrid electric, and fuel cell vehicles: Fundamentals theory and design Mehrdad Ehsani and Yimin Gao, power electronics and applications series, secondedition
3. Electric and hybrid vehicles: Design fundamentals, Iqbal Hussain
4. Build your own electric vehicles, Seth Leitman and Bob Brant
5. introduction to hybrid vehicle system modelling and control, Wei Liu

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MT622OE: Fundamentals of Mechatronics (Open Elective – I)

Course Objectives:

The Objective of this course is
- To develop an ability to identify, formulate, and solve engineering problems
- To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
- To understand and develop PLC Programs
- To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Course Outcomes:

At the end of the course, the student will be able to,
- Model, analyze and control engineering systems
- Analyze the design aspects in machine structures
- Identify sensors, transducers and actuators to monitor and control the behavior of a process or product
- Develop PLC programs for a given task
- Evaluate the performance of mechatronic systems.

UNIT – I

Introduction:
Definition – Trends - Control Methods: Standalone, PC Based (Real Time Operating Systems, Graphical User Interface, Simulation) - Applications: identification of sensors and actuators in Washing machine, Automatic Camera, Engine Management, SPM, Robot, CNC, FMS, CIM. Signal Conditioning: Introduction – Hardware - Digital I/O , Analog input – ADC, resolution, Filtering Noise using passive components – Resistors, capacitors – Amplifying signals using OP amps –Software - Digital Signal Processing – Low pass , high pass , notch filtering

UNIT – II

Precision Mechanical Systems: Modern CNC Machines – Design aspects in machine structures, guide ways, feed drives, spindle and spindle bearings, measuring systems, control software and operator interface, gauging and tool monitoring. Electronic Interface Subsystems: TTL, CMOS interfacing - Sensor interfacing – Actuator interfacing – solenoids, motors Isolation schemes- opto- coupling, buffer IC's – Protection schemes – circuit breakers, over current sensing , resettable fuses , thermal dissipation -Power Supply - Bipolar transistors / mosfets

UNIT – III

Electromechanical Drives:
Relays and Solenoids - Stepper Motors - DC brushed motors –DC brushless motors - DC servo motors - 4-quadrant servo drives , PWM's - Pulse Width Modulation – Variable Frequency Drives, Vector Drives - Drive System load calculation. Microcontrollers Overview: 8051 Microcontroller,

micro-processor structure – Digital Interfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications. Programming –Assembly, C (LED Blinking, Voltage measurement using ADC).

UNIT – IV

Programmable Logic Controller: Basic Structure - Programming : Ladder diagram –Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling -Analog input / output - PLC Selection - Applications.

UNIT – V

Programmable Motion Controllers:
Introduction - System Transfer Function – Laplace transform and its application in analysing differential equation of a control system – Feedback Devices : Position , Velocity Sensors - Optical Incremental encoders - Proximity Sensors :Inductive , Capacitive , Infrared - Continuous and discrete processes - Control System, Performance & tuning - Digital Controllers - P , PI , PID Control - Control modes – Position, Velocity and Torque - Velocity Profiles – Trapezoidal- S. Curve - Electronic Gearing - Controlled Velocity Profile - Multi axis Interpolation , PTP , Linear , Circular – Core functionalities – Home , Record position , GOTO Position - Applications : SPM, Robotics.

TEXT BOOKS:

1. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering - Bolton/ Pearson.
2. Introduction to Mechatronics, Appukuttan, OxfordPress

REFERENCE BOOKS:
1. Mechatronics Principles concepts & Applications / N.P.Mahalik/ McGraw Hill
2. “Designing Intelligent Machines”. open University, London.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)

VII Semester Syllabus

MT721OE: Principles of Entrepreneurship (Open Elective – II)

Course Objectives:

The objectives of the course is to make the students

- Transform their ideas into feasible and successful enterprise.
- Comprehend the financing and managing of new ventures.
- Understand the various industrial financial support services.
- Be acquainted with various production and marketing management
- Know the various labor acts to be adhered to while running a business enterprise

Course Outcomes

After completing this course, the students should be able to

- Be aware of the basics of Entrepreneurship and a business plan.
- Understand the various activities related to financing and starting the new ventures.
- Understand the functions of government bodies in implementation of policies and schemes for providing infrastructure and support services.
- Be aware of production techniques and marketing the products.
- Gain knowledge of Labour Legislation in India.

UNIT – I

Introduction to Entrepreneurship: Definition of Entrepreneur Entrepreneurial Traits. Entrepreneur vs Manager, creating and starting the venture: sources of new ideas, method of generating ideas, creative problem solving – writing business plan, evaluating business plans. Launching formalities.

UNIT – II

Financing and Managing the new ventures: sources of capital, record keeping, recruitment, motivating and leading teams, financial controls. Marketing and sales controls. E commerce and Entrepreneurship, internet advertising – new venture expansion strategies and issues.

UNIT – III

Industrial Financial Support: schemes and functions of directorate of industries, District industries centre (DICs) Industrial development corporation (IDC), State Financial corporation (SFCs), small scale industries development corporation (SSIDCs) Khadhi and village industries commission (KVIC) Technical Consultancy organisation (TCO), Small industries service institute (SISI), national small industries corporation (NSIC), small industries development bank of india (SIDBI).

UNIT – IV

Production and marketing management: Thrust areas of production management, selection of production techniques, plant utilisation and maintenance, designing the work place, inventory control, material handling and quality control. Marketing functions, market segmentation market research and channels of distribution, sales promotion and product pricing.

UNIT – V

Labour legislation, salient provision of health, safety, and welfare under Indian factories Act, Industrial dispute act, employees state insurance act, workmen's compensation act and payment of bonus act .

TEXT BOOKS:

1. Robert Hisrich, & Michael Peters: Entrepreneurship, TMH, 2009.
2. Dollinger: Entrepreneurship, Pearson, 2009.

REFERENCE BOOKS:

1. Vasant Desai, Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 2009.
2. Harvard Business Review on Entrepreneurship, HBR Paper Back.
3. Robert J. Calvin: Entrepreneurial Management, TMH, 2009.
4. Gurmeet Naroola: The entrepreneurial Connection, TMH, 2009.
5. Bolton & Thompson: Entrepreneurs—Talent, Temperament and Techniques, Butterworth Heinemann, 2009.
6. Agarwal: Indian Economy, Wishwa Prakashan 2009.
7. Dutt & Sundaram: Indian Economy, S. Chand, 2009.
8. B D Singh.: Industrial Relations & Labour Laws, Excel, 2009.
9. Aruna Kaulgud: Entrepreneurship Management by, Vikas publishing house, 2009.
10. Essential of entrepreneurship and small business management by Thomas W. Zimmerer & Norman M. Searborough, PHI-2009.
11. ND Kapoor: Industrial Law, Sultan Chand & Sons, 2009.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VII Semester Syllabus
MT722OE – Fundamentals of MEMS Design (Open Elective-II)

Course Objectives:

The objective of the course is to make the students
- Introduce micro-electro-mechanical systems.
- learn the working principles of MEMS
- Learn the concepts of micro-fabrication and micro -machining.
- Elucidate the role of packaging techniques
- Learn basic applications of MEMS.

Course Outcomes:

At the end of this course students will be able to
- understand the basics of MEMS design
- Learn the micro fabrication, develop models, and simulate electrostatic and electromagnetic sensors and actuators
- understand the material properties importants for MEMS system performance, analyze dynamics of resonant micromechanical structures.
- understand the design process and validation for MEMS devices and
- Familiarize with different packaging techniques in micro systems

UNIT 1
Definition of MEMS. MEMS devices. Silicon as a MEMS material – mechanical properties of silicon. Mechanical components in MEMS. Design concepts of mechanical components.

UNIT 2
Working Principles of Microsystems. Engineering Science for Microsystems design and Fabrication. Scaling laws – Scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, electricity-fluid mechanics, and heat transfer.

UNIT 3
Materials for MEMS and Microsystems. Fabrication technologies – Photolithography – Ion implantation – diffusion – oxidation – CVD – Physical Vapor Deposition – Etching.

UNIT 4
Micro manufacturing – Bulk and surface micro machining – LIGA. Microsystems Design – Design considerations – Process design – Mechanical Design – CAD

UNIT 5
Micro system packaging – Levels – Bonding – Interfaces – Assembly – Selection of Packaging Materials. Applications

Reference Books:

1. BoTai–Ran Hsu – ‘Mems & Microsystems Design and Manufacturing’ – John Wiley & Sons – 2008 – 2nd Edition

2. ResourceMarc J Madou – ‘Fundamentals of Microfabrication’ – CRC Press – 2002 – 2nd Edition

3. Mohamed Gad-el-Hak – ‘The MEMS Handbook’ – CRC Press – 2002

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
MT821OE: - Fundamentals of Animatronics (Open Elective – III)

Course Objectives:

The objectives of the course is to make the students

- Know the evolution of Animatronics concept and its interdisciplinary relation withArts, Design and Electronics
- Learn Engineering design and product development that facilitates Animatronics products
- List various materials used for fabrication of Animatronics figures along with advantages and disadvantages
- Understand various metal removal and cutting operations and shell fabrication
- Understanding the operations of various drives used in Automation system

Course Outcomes:

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

- Understand the challenges and scope of Animatronics
- Apply principles of DFMA in Industrial design
- Analyze various designs and processes used for obtaining Animatronics objects
- Apply suitable material removal process that suits a required application and the useof soft plastics in various Animatronics products
- Distinguish various drives that are used in Animatronic objects

UNIT- I

Engineering Design and Product Development Process: Methodology involved in engineering and product, prototyping and testing, DFMA (design for manufacture and assembly), Industrial design, Product-life cycle

UNIT- II

Concept Development and Artistic Design, Concept development, Artistic design, boarding, modelling with clays to be utilized as visual aids or patterns for moulding

UNIT- III

Mould Design and Fabrication, Sand casting, Plastics processing, injection moulding, gravity based moulding processes using various materials including Plaster of Paris or Urethane, Shell fabrication by use of Rubber Latex and soft plastics

UNIT- IV

Mechanism Design and Armature Fabrication, Joints, Mechanisms - Continuous and Intermittent, Power Transmission and related components such as drives and gears, forming processes in shaping links, linkages and structural components, Costuming through Fabrics, Soft Plastics and Painting

UNIT- V

Actuators and Sensors Fundamentals of Electricity and Electronics, Electric motors (DC, RC, servo or stepper), switches, sensors, Controllers and Programming, RC or autonomous systems and Interactive C programming

REFERENCE BOOKS

1. Robots, Androids and Animatrons by John Iovin
2. AC 2011-190: Employing Animatronics in Teaching Engineering Design by ArifSirinterlikci, Robert Morris University

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering (Mechatronics)
VIII Semester Syllabus
MT822OE: Fundamentals of Robotics (Open Elective – III)

Course Objectives:

The objectives of the course is to make the students
- Understand the fundamental of robotics and robot anatomy
- Analyze the DH table and apply for serial manipulators
- Apply and analyze equations for dynamic control of a robot
- Understand the variations of robot programming and its advancement
- Understand the integration of all components of the robot

Course Outcomes:

At the end of the course, the student will be able to:
- Explain the fundamentals of robotics and its components
- Illustrate the forward and Inverse kinematics of robots
- Predict the trajectory of the robot and dynamic control of robot
- Programme a robot to perform tasks in industrial applications.
- Integrate the robot to its actuators, sensors

UNIT – I

Robotics-Introduction-classification with respect to geometrical configuration (Anatomy), Controlled system & chain type: Serial manipulator & Parallel Manipulator. Components of Industrial robotics, Specifications of Robot, Wrist Configuration, Degree of Freedom.

UNIT – II

Grippers - Mechanical Gripper-Grasping force-Engelberger-g-factors-mechanisms for actuation, Magnetic gripper, Vacuum cup gripper-considerations in gripper selection & design, Selection based on the Application.

UNIT – III

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, D-H transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots

UNIT IV

Trajectory planning: Types – Cartesian & Joint Space, Path planning vs. Trajectory Planning, Cubic Polynomial & Linear Trajectory Planning with parabolic blend without via points, 4-3-4 & 3-5-3 Trajectory Planning, Slew motion, joint interpolated motion, straight line motion – Problems.

Robot actuators and Feedback components:
Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors.

UNIT V

Programming of Robots and Vision System-Lead through programming methods- Teach pendent-overview of various textual programming languages like VAL etc. Machine (robot) vision:

TEXT BOOKS:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Robotics and its control / R. K. Mittal & I. J. Nagarath

REFERENCE BOOKS:

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada , Slotine / Wiley Inter-Science