B.Tech. in Mechanical Engineering
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	30	70	3	3
2	ME501PC	Dynamics of Machinery	3	0	0	30	70	3	3
3	ME502PC	Thermal Engineering –II	3	0	0	30	70	3	3
4	ME503PC	Design of Machine Members -I	3	0	0	30	70	3	3
5	ME504PC	Operations Research	3	0	0	30	70	3	3
6		**Open Elective – I**	2	0	0	30	70	3	2
7	MC502ES	Cyber Security	3	0	0	30	70	3	0
8	ME551PC	Kinematics and Dynamics Lab	0	0	2	30	70	3	1
9	ME552PC	Thermal Engineering Lab	0	0	2	30	70	3	1
10	ME553PC	Machine Drawing Practice	0	0	4	30	70	3	2
11	MA554BS	Finishing School – III (Quantitave Aptitude and Analytical Ability**)**	0	0	2	30	70	3	1
Total Hours/Marks/Credits			**20**	**0**	**10**	**330**	**770**		**22**

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	ME601PC	Heat Transfer	3	1	0	30	70	3	4
2	ME602PC	Metrology and Machine Tools	3	0	0	30	70	3	3
3	ME603PC	Design of Machine Members -II	3	1	0	30	70	3	4
4		**Professional Elective – I**	3	0	0	30	70	3	3
5		**Professional Elective - II**	3	0	0	30	70	3	3
6		**Open Elective - II**	2	0	0	30	70	3	2
7	MC601HS	Intellectual Property Rights	3	0	0	30	70	3	0
8	MC601ES	Artificial Intelligence	3	0	0	30	70	3	0
9	ME651PC	Heat Transfer Lab	0	0	2	30	70	3	1
10	ME652PC	Metrology and Machine Tools Lab	0	0	2	30	70	3	1
11	EN653HS	Finishing School – IV (Advanced Communication Skills Lab)	0	0	2	30	70	3	1
Total Hours/Marks/Credits			**23**	**2**	**6**	**330**	**770**		**22**

12	MC601ESC	Environmental Science **(For Lateral Entry students)**	3	0	0	30	70	3	0

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

VII Semester

S.No	Course Code	Course Title	Instruction Hours Per Week			Examination Max. Marks		Examination Duration of SEE in Hours	Credits
			L	T	P/D	CIE	SEE		
1	ME701PC	CAD/CAM	3	1	0	30	70	3	4
2	ME702PC	Refrigeration & Air Conditioning	3	1	0	30	70	3	4
3		**Professional Elective - III**	3	0	0	30	70	3	3
4		**Professional Elective - IV**	3	0	0	30	70	3	3
5		**Open Elective – III**	2	0	0	30	70	3	2
6	ME751PC	CAD/CAM Lab	0	0	2	30	70	3	1
7	ME752PC	Industry Oriented Mini Project	0	0	2	-	100	-	1
8	ME753PC	Seminar	0	0	2	100	-	-	1
9	ME754PC	Project Stage - I	0	0	4	30	70	-	2
Total Hours/Marks/Credits			**14**	**2**	**10**	**310**	**590**		**21**

VIII Semester

S.No	Course Code	Course Title	Instruction Hours Per Week			Examination Max. Marks		Examination Duration of SEE in Hours	Credits
			L	T	P/D	CIE	SEE		
1	MS804HS	Fundamentals of Management for Engineers	2	0	0	30	70	3	2
2		**Professional Elective - V**	3	0	0	30	70	3	3
3		**Professional Elective - VI**	3	0	0	30	70	3	3
4	ME851PC	Project Stage - II	0	0	16	30	70	-	8
Total Hours/Marks/Credits			**8**	**0**	**16**	**120**	**280**		**16**

Grand Total of Credits

Semester	I	II	III	IV	V	VI	VII	VIII	**Total Credits**
Credits	18	19	21	21	22	22	21	16	**160**

Semester VI

Professional Elective – I

ME611PE Finite Element Methods
ME612PE Automobile Engineering
ME613PE Unconventional Machining Processes
ME614PE Alternative Materials

Professional Elective – II

ME615PE Machine Tool Design
ME616PE Renewable Energy Sources
ME617PE CNC Technology
ME618PE Production Planning and Control

Semester VII

Professional Elective – III

ME711PE Robotics
ME712PE Power Plant Engineering
ME713PE Automation in Manufacturing
ME714PE Entrepreneurship and Small Business Enterprises

Professional Elective – IV

ME715PE Computational Fluid Dynamics
ME716PE Mechanical Vibrations
ME717PE Additive Manufacturing Technology
ME718PE Sensors & Actuators

Semester VIII

Professional Elective – V

ME811PE Advanced Mechanics of Solids
ME812PE Turbo Machines
ME813PE Digital Manufacturing & Industry 4.0
ME814PE Electrical Vehicle Technology

Professional Elective – VI

ME815PE Advanced Materials Technology
ME816PE Fluid Power Systems
ME817PE 3D Printing Technology
ME818PE Animatronics

Semester V

Open Elective: I

ME521OE: Optimization Techniques
ME522OE: Fundamentals of Mechanical Engineering

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Semester VI

Open Elective: II

ME621OE: Non-conventional Sources of Energy
ME622OE: Fundamentals of Robotics

Semester VII

Open Elective: III

ME721OE: Industrial Management
ME722OE: Fundamentals of 3D Printing Technology

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering
V Semester Syllabus
MS501HS: Business Economics and Financial Analysis

Course Objectives:

The objectives of the course is to make the students

- Students will understand various forms of Business and the impact of economic variables on the business, concepts of Business economics and its significance.
- Gain the knowledge on various market dynamics namely Demand, elasticity of demand, and demand forecasting.
- Disseminate the knowledge on production function, laws of production, Market structures, while dealing with the concept of cost and breakeven analysis.
- Acquaint the students regarding Accounting and various books of accounts
- 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:

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

- Have ability to start a suitable business organization with available resources
- Analyze various aspects of Demand, Elasticity of demand and Demand Forecasting.
- Get associated with different market structures, production theories, and cost variables and pricing objectives and methods
- Prepare Financial Statements
- Analyze financial well-being of the business while using ratios

UNIT – I: Introduction to Business and Economics:

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.

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

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 – Consumer survey method – Sales force opinion method– Expert opinion method, Statistical methods – Trend Projection methods – Regression and Correlation Analysis – Barometric Technique, Test marketing.

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. Chaturvedi.D.D, S.L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
2. Dhanesh K Khatri, Financial Accounting, Tata McGraw Hill, 2011.
3. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e, Tata McGraw Hill Education Pvt. Ltd. 2012.

REFERENCE BOOKS:

1. Paresh Shah, Financial Accounting for Management 2e, Oxford Press, 2015.
2. Maheshwari. S.N, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering
V Semester Syllabus
ME501PC: Dynamics of Machinery

Pre-requisite: Kinematics of Machinery

Course Objectives:

During the course the student will learn about
- How friction plays a role in design of clutches and bearings
- Gyroscopic effects in ships, aero planes and road vehicles. Analysis static and dynamics of various planar mechanisms
- 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:
- Apply the concept of friction in designing clutches, bearings, brakes & dynamometers
- Understand the gyroscopic effects in ships, aero planes, and road vehicles. Analyze the dynamics forces on various planar mechanisms
- 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

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 expanding shoe brake-effect of braking of a vehicle. Dynamometers–absorption and transmission types.

UNIT–II

Precession: Gyroscopes – effect of precession – motion on the stability of moving vehicles such as motorcycle–motorcar–aeroplanes and ships.
Static and Dynamic force analysis of planar mechanisms, Engine Force Analysis – Piston Effort, Crank Effort

UNIT–III

Turning Moment Diagram and Flywheels: 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, isochronisms 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–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
V Semester Syllabus
ME502PC: Thermal Engineering –II

Course Objectives:

The objectives of the course is to make the students

- Deal with fundamentals of thermodynamics and Power plant engineering which helps an undergraduate student to have a better understanding.
- Understand the fundamentals phenomenon of combustion in boilers extended to reality in steam power plant.
- Expose students to different methods of generating power with specific applications and limitations.
- Help the student to learn calculation procedures for designing steam turbines, steam condensers, nozzles etc. used in thermal power plants, steam engines and other industrial applications.
- Design the steam equipments and jet propulsions so that R&D in industry is improved.

Course Outcomes:

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

- Apply the laws of Thermodynamics to implement on nozzles and condensers , how to analyze thermodynamic cycles.
- Differentiate between vapor power cycles and gas power cycles
- Infer from property charts and tables and to apply the data for the evaluation of performance parameters of the steam and gas turbine plants
- Understand the functionality of major components of steam and gas turbine plants and to do the analysis of these components
- Compare the working of various jet engines and calculate thrust & efficiency in jet propulsion using gas dynamics principles, Classify rocket engines, calculate efficiency in rocket propulsion

UNIT - I

Steam Power Plant: Rankine cycle - Schematic layout, Thermodynamic Analysis, Concept of Mean Temperature of Heat addition, Methods to improve cycle performance – Regeneration & reheating.
Boilers – Classification – Working principles with sketches including H.P.Boilers – Mountings and Accessories – Working principles- Boiler horse power, Equivalent Evaporation, Efficiency and Heat balance – Draught- Classification – Height of chimney for given draught and discharge- Condition for maximum discharge- Efficiency of chimney.

UNIT - II

Steam Nozzles: Function of nozzle – Applications and Types- Flow through nozzles- Thermodynamic analysis – Assumptions -Velocity of nozzle at exit-Ideal and actual expansion in nozzle- Velocity coefficient- Condition for maximum discharge- Critical pressure ratio- Criteria to decide nozzle shape- Super saturated flow, its effects, Degree of super saturation and Degree of under cooling - Wilson line.

UNIT - III

Steam Turbines: Classification – Impulse turbine; Mechanical details – Velocity diagram – Effect of friction – Power developed, Axial thrust, Blade or diagram efficiency – Condition for maximum efficiency. De-Laval Turbine - its features- Methods to reduce rotor speed-Velocity compounding and Pressure compounding- Velocity and Pressure variation along the flow – Combined velocity diagram for a velocity compounded impulse turbine.
Reaction Turbine: Mechanical details – Principle of operation, Thermodynamic analysis of a stage, Degree of

reaction –Velocity diagram – Parson‘s reaction turbine – Condition for maximum efficiency.

UNIT - IV

Steam Condensers: Requirements of steam condensing plant – Classification of condensers – Working principle of different types – Vacuum efficiency and Condenser efficiency - Cooling water requirement.
Gas Turbines: Simple gas turbine plant – Ideal cycle, essential components – Parameters of performance – Actual cycle – Regeneration, Inter cooling and Reheating –Closed and Semi- closed cycles – Merits and Demerits- Combustion chambers and turbines of Gas Turbine Plant- Brief Concepts.

UNIT - V

Jet Propulsion: Principle of Operation –Classification of jet propulsive engines – Working Principles with schematic diagrams and representation on T-S diagram - Thrust, Thrust Power and Propulsion Efficiency – Turbo jet engines – Needs and Demands met by Turbo jet – Schematic Diagram, Thermodynamic Cycle, Performance Evaluation Thrust Augmentation – Methods.
Rockets: Application – Working Principle – Classification – Propellant Type – Thrust, Propulsive Efficiency – Specific Impulse – Solid and Liquid propellant Rocket Engines.

Text Books:

1. Thermal Engineering / Mahesh M Rathore/ Mc Graw Hill
2. Gas Turbines – V. Ganesan /Mc Graw Hill
3. Thermal Engineering, by R. K. Rajput.

Reference Books:

1. Gas Turbine Theory/ Saravanamuttoo, Cohen, Rogers/ Pearson
2. Fundamentals of Engineering Thermodynamics / Rathakrishnan/ PHI
3. Thermal Engineering/ Rajput/ Lakshmi Publications

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering
V Semester Syllabus
ME503PC: Design of Machine Members - I

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.
- Learn the design process of structural joints such as riveted, welded and bolted joints.
- Understand design process of assembled joints such as cotter joints, knuckle joints.
- Understand design process of shafts and shaft couplings.

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 riveted, welded and bolted joint parameters in design.
- Determine cotter and knuckle joint parameters in design.
- Determine shaft and shaft coupling parameters in design.

UNIT – I

Introduction: General considerations in the design of Engineering Materials and their properties - selection - Manufacturing consideration in design. Tolerances and fits - BIS codes of steels.

Design for Static Strength: Simple stresses - Combined stresses - Torsional and Bending stresses - Impact stresses - Stress strain relation - Various theories of failure - Factor of safety - Design for strength and rigidity - preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations.

UNIT – II

Design for Fatigue Strength: Stress concentration - Theoretical stress Concentration factor - Fatigue stress concentration factor - Notch Sensitivity - Design for fluctuating stresses - Endurance limit - Estimation of Endurance strength - Gerber‘s curve - Goodman‘s line - Soderberg‘s line.

UNIT – III

Riveted, Welded and Bolted Joints: Riveted joints - methods of failure of riveted joints -strength equations - efficiency of riveted joints - eccentrically loaded riveted joints.

Welded joints - Design of fillet welds - axial loads - circular fillet welds under bending, torsion. Welded joints under eccentric loading. Bolted joints - Design of bolts with pre-stresses - Design of joints under eccentric loading - locking devices - bolts of uniform strength.

UNIT – IV

Keys, Cotters and Knuckle Joints: Design of keys - stresses in keys - cotter joints -spigot and socket, sleeve and cotter, Gib and cotter joints - Knuckle joints.

UNIT – V

Shafts: Design of solid and hollow shafts for strength and rigidity - Design of shafts for combined bending and axial loads - Shaft sizes - BIS code - Gaskets and seals (stationary & rotary)
Shaft Couplings: Rigid couplings - Muff, Split muff and Flange couplings.Flexible couplings - Flange coupling (Modified).

TEXT BOOKS:

1. Design of Machine Elements / V. Bhandari / Mc Graw Hill
2. Machine Design / Jindal / Pearson

REFERENCE BOOKS:

1. Design of Machine Elements / V. M. Faires / Macmillan
2. Design of Machine Elements-I / Kannaiah, M.H / New Age

L	T	P	C
3	0	0	3

B.Tech. in Mechanical Engineering
V Semester Syllabus
ME504PC: Operations Research

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 problems.
- 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 generate 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 reorder level.
- 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

Basics of Operations Research and Linear Programming

Development- definition-characteristics and phases-Types of models-Operations Research models- applications. **Allocation:** Linear Programming Problem Formulation-Graphical solution- Simplex Method-Artificial variable techniques: Big-M method, Two-phase method.

UNIT - II

Transportation and Assignment Models

Transportation: Formulation-Optimal solution, unbalanced transportation problem-Degeneracy.
Assignment: Formulation-Optimal solution - Variants of Assignment problem- Travelling salesman problem.

UNIT - III

Sequencing and Replacement Models

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 and Inventory Models

Theory of Games: Introduction- Terminology- 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 or continuous
variable- single period model and no setup cost.

UNIT - V

Queuing Models and Dynamic Programming

Queuing: Introduction- Terminology- Single channel- Poisson arrivals and exponential service times with infinite population.

Dynamic Programming: Introduction- Terminology, Bellman's principle of optimality- Applications of Dynamic programming- shortest path problem- linear programming problem.

Text Books:

1. Operations Research/ J. K. Sharma 4e./ Mac Milan
2. Operations Research/ Premkumar Gupta and D.S. Hira/ S.Chand

Reference Books:

1. Introduction to OR/Taha/PHI
2. Problems in Operations Research (Methods and solutions)/P. K Gupta and Manmohan/Sultan Chand & Sons.
3. Introduction to OR/ Hillier &Libemann/TMH
4. Operations Research/ S.D. Sharma/Kedarnath Ram nath&Co
5. Operations Research/ S.R Yadav and A.K Malik/Oxford university press.
6. Operations Research/ V.K Kapoor/ Sultan Chand & Sons.
7. Operations Research/NVS Raju/SMS Education/3rd Revised Edition
8. Operations Research /A.M. Natarajan, P. Balasubramaniam, A. Tamilarasi/Pearson Education.
9. Operations Research/ Wagner/ PHI Publications.
10. Operations Research/Pradeep J Jha/ McGraw Hill Education.
11. Operations Research/M.V. Durga Prasad, K. Vijaya Kumar Reddy, J. Suresh Kumar/Cengage Learning.

L	T	P	C
2	0	0	2

Open Elective for other Departments
(Other than MECH, MCT, CSB, CSD & CSM)
V Semester Syllabus
ME521OE: Optimization Techniques (Open Elective-I)

Course Objectives:

The objectives of the course is to make the students

- various optimization techniques i.e classical, linear programming, transportation problem, simplex algorithm, dynamic programming.
- understand the characteristics of simplex method and its procedure and transportation problems for optimality.
- constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations.
- understand penalty method and basic approaches of Interior and Exterior penalty function methods for various applications.
- the concept of Dynamic programming and its applications to project implementation.

Course Outcomes:

Upon successful completion of this course, student should be able to:

- explain the need of optimization of engineering systems
- understand optimization of electrical and electronics engineering problems
- apply classical optimization techniques, linear programming, simplex algorithm, transportation problem
- apply unconstrained optimization and constrained non-linear programming and dynamic programming
- formulate optimization problems

Unit I

Introduction and Classical Optimization Techniques

Statement of an Optimization problem — design vector — design constraints — constraint surface — objective function — objective function surfaces — classification of Optimization problems. Solution by method of Lagrange multipliers — Multivariable Optimization with inequality constraints — Kuhn — Tucker conditions.

Unit II

Linear Programming Problem (LPP) and Transportation Problem (TP)

Standard form of a LPP — geometry of linear programming problems — definitions and theorems — solution of a system of linear simultaneous equations — pivotal reduction of a general system of equations — motivation to the simplex method — simplex algorithm. Introduction to TP-Finding initial basic feasible solution by north — west corner rule, least cost method and Vogel‘s approximation method — testing for optimality of balanced transportation problems.

Unit III

Unconstrained Optimization Techniques

Unconstrained Nonlinear Programming- One dimensional minimization methods, Classification, Fibonacci method and Quadratic interpolation method

Unconstrained Optimization Techniques- Univariant method, Powell‘s method and steepest descent method.

Unit IV

Constrained Nonlinear Programming

Characteristics of a constrained problem - classification - Basic approach of Penalty Function method - Basic approach of Penalty Function method - Basic approaches of Interior and Exterior penalty function methods - Introduction to convex programming problem.

Unit V

Dynamic Programming

Dynamic programming multistage decision processes — types — concept of sub optimization and the principle of optimality — computational procedure in dynamic programming — examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Text Books:

1. Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley andSons, 4° edition,2009.
2. H. S. Kasene & K. D. Kumar, Introductory Operations Research, Springer (India),Pvt. Ltd., 2004

Reference Books:

1. George Bernard Dantzig, Mukund Narain Thapa, ―Linear programming‖, Springer series in operationsresearch 3rd edition, 2003.
2. H.A. Taha, –Operations Research: An Introduction, 8'h Edition, Pearson/Prentice Hall, 2007.
3. Kalyanmoy Deb, –Optimization for Engineering Design — Algorithms and Examples‖, PHI Learning Pvt. Ltd, New Delhi, 2005.

L	T	P	C
2	0	0	2

Open Elective for other Departments
(Other than MECH, MCT, CSB, CSD & CSM)
V Semester Syllabus
ME522OE: Fundamentals of Mechanical Engineering (Open Elective – I)

Course Objectives:

To objectives of the course is to make the students

- Fundamentals of thermodynamics and energy resources,
- Properties of gases and steam and steam generators and its accessories and mountings
- Heat engine cycles and their thermal efficiencies
- Pumps, air compressors and cooling systems
- Power transmitting devices and engineering materials

Course Outcomes:

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

- Understand the heat energy resources and basics thermodynamics
- Understand the generation of steam and its properties and thermodynamic processes
- Know thermal efficiency of heat engine cycles and internal combustion engines
- Understand the working of pumps, air compressors and cooling systems
- Know engineering materials and power transmitting systems

UNIT - I

Introduction: Prime movers and its types, Concept of Force, Pressure, Energy, Work, Power, System, Heat, Temperature, Specific heat capacity, Change of state, Path, Process, Cycle, Internal energy, Enthalpy, Statements of Zeroth Law and First law.

Energy: Introduction and applications of Energy sources like Fossil fuels, Nuclear fuels, Hydel, Solar, wind, and biofuels, Environmental issues like Global warming and Ozone depletion.

UNIT – II

Properties of gases: Gas laws, Boyle's law, Charle's law, Combined gas law, Gas constant, Relation between Cp and Cv, Various non-flow processes like constant volume process, constant pressure process, Isothermal process, Adiabatic process, Poly-tropic process

Properties of Steam: Steam formation, Types of Steam, Enthalpy, Specific volume, Internal energy and dryness fraction of steam, use of Steam tables, steam calorimeters.

Steam Boilers: Introduction, Classification, Cochran, Lancashire and Babcock and Wilcox boiler, functioning of different mountings and accessories.

UNIT – III

Heat Engines: Heat Engine cycle and Heat Engine, working substances, Classification of heat engines, description, and thermal efficiency of Carnot; Rankine; Otto cycle and Dieselcycles.

Internal Combustion Engines: Introduction, Classification, Engine details, four- stroke/two-stroke cycle Petrol/Diesel engines, indicated power, Brake Power, Efficiencies.

UNIT – IV

Pumps: Types and operation of Reciprocating, Rotary and Centrifugal pumps, Priming
Air Compressors: Types and operation of Reciprocating and Rotary air compressors, significance of Multistage.
Refrigeration & Air Conditioning: Refrigerant, Vapor compression refrigeration system, vapor absorption refrigeration system, Domestic Refrigerator, Window, and split air conditioners.

UNIT – V

Couplings, Clutches and Brakes: Construction and applications of Couplings (Box; Flange; Pin type flexible; Universal and Oldham), Clutches (Disc and Centrifugal), and Brakes (Block; Shoe; Band and Disc).
Transmission of Motion and Power: Shaft and axle, Belt drive, Chain drive, Friction drive, Gear drive.
Engineering Materials: Types and applications of Ferrous & Nonferrous metals, Timber, Abrasive material, silica, ceramics, glass, graphite, diamond, plastic, and polymer.

TEXT BOOKS:

1. Basic Mechanical Engineering / Pravin Kumar/ Pearson
2. Introduction to Engineering Materials / B.K. Agrawal/ Mc Graw Hill

REFERENCE BOOKS:

1. Fundamental of Mechanical Engineering/ G.S. Sawhney/PHI
2. Thermal Science and Engineering / Dr. D.S. Kumar/Kataria

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B.Tech. in Mechanical Engineering (Mechatronics)

V Semester

MC502ES CYBER SECURITY

(Common to all Branches)

Prerequisites: NIL

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 various cyber-attacks and cybercrimes.
- Knowledge about cyberlaws and cyber forensics.
- Summarize cybercrimes in mobile and wireless devices, how to protect them
- Knowledge about IPR issues in cyber space and cyber terrorism

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, IP spoofing, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Comprehensive Cyber Security Policy.

UNIT - II

Cyberspace and the Law & Cyber Forensics: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace. 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.

UNIT- IV

Cyber Security: Organizational Implications: Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing.

Cybercrime and Cyber terrorism: Introduction, intellectual property in the 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.

TEXT BOOKS:

1. Nina God bole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, ComputerForensics and Legal Perspectives, Wiley, India 2012.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles,Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

REFERENCES:

1. Mark F. Grady, Fransesco Parisi, ― The Law and Economics of Cyber security‖, Cambridge University Press,2006.
2. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press, 2016.
3. Introduction to Cyber Security, Chwan - Hwa (john) Wu, J. David Irwin, CRC Press T&F Group.

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B.Tech. in Mechanical Engineering
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 undampedvibrations 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

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B.Tech. in Mechanical Engineering
V Semester Syllabus
ME552PC: Thermal Engineering Lab

Course Objectives:

The objectives of the course is to make the students

- Achieve practical knowledge of operating an IC engine, i.e Spark ignition Engine and combustion ignition engine
- Possess the opportunity to learn experimentally the performance of IC engines
- Analyze performance characteristics and gain knowledge about compressors
- Learn various components of steam boilers
- Draw valve and port timing diagrams experimentally.

Course Outcomes:

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

- Analyze the performance and operating characteristics of an IC engine using rope brake and electrical dynamometer.
- Draw the heat balance sheet for an IC engine.
- Able to analyze the performance of reciprocating air compressor.
- Know the principle of working of steam boilers and their accessories and mountings.
- Calculate & compare the performance characteristics and IC engine load variations with Air fuel ratio**.**

List of Experiments

1. I.C. Engines Valve / Port Timing Diagrams
2. I.C. Engines Performance Test for 4 Stroke SI engines
3. I.C. Engines Performance Test for 2 Stroke SI engines
4. I.C. Engines Morse, Retardation, Motoring Tests
5. I.C. Engine Heat Balance – CI/SI Engines
6. I.C. Engines Economical speed Test on a SI engine
7. I.C. Engines effect of A/F Ratio in a SI engine
8. Performance Test on Variable Compression Ratio Engine
9. IC engine Performance Test on a 4S CI Engine at constant speed
10. Volumetric efficiency of Air – Compressor UNIT
11. Dis-assembly / Assembly of Engines
12. Study of Boilers

Note: Perform any 10 out of the 12 Exercises.

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B.Tech. in Mechanical Engineering
V Semester Syllabus
ME553PC: Machine Drawing Practice

Course Objectives:

The objectives of the course is to make the students

- Familiarize with the standard conventions for different materials and machine parts in working drawings.
- Make part drawings including sectional views for various machineelements.
- Prepare assembly drawings given the details of part drawings.
- Learn the concept of fluid system and analyzing the applications of fluid systems in power transmission.
- Prepare CAD 2D and 3D part models using AUTOCAD and Solid works.

Course Outcomes:

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

- Prepare engineering and working drawings with dimensions and bill of material during design and development. Developing assembly drawings using part drawings of machine components.
- Use conventional representation of materials, common machine elements and parts such asscrews, nuts, bolts, keys, gears, webs and ribs, Sections
- Learn and draw different types of Drawings – working drawings for machine parts. Title boxes, their size, location and details–Methods of dimensioning.
- Understand the use of hydraulic and pneumatic systems and design of hydraulic and Pneumatic circuits for industrial applications.
- Preparation of 2DDrawings and 3D Basic solid models using CAD.

Machine Drawing Conventions:

Need for drawing conventions– introduction to BIS conventions, Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs and ribs.

I. Drawing of Machine Elements and simple parts

Selection of Views, additional views for the following machine elements and parts with easy Drawing proportions.

1) Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws and gears.
2) Keys, cotter joints and knuckle joint.
3) Rivetedjointsforplates.
4) Shaft coupling: Universal coupling, Oldham‘s coupling.
5) Journal, pivot and collar and foot step bearings.

II. Assembly Drawings:

Drawings of assembled views, detailing for the part drawings of the following using conventions and easy drawing proportions.

1) Engine parts – stuffing box, Eccentric, Petrol Engine connecting rod.
2) Machine tool parts: Tool Post, Machine Vice.
3) Other machine parts- Screws jack, Plummer block.
4) Valves: Air Cock, Rams bottom safety valve, blow-off cock valve.

NOTE: First angle projection to be adopted. The student should be able to provide working drawings of actual parts.

TEXTBOOKS:

1. Machine Drawing–Ajeet Singh, TMH Publications
2. Machine Drawing–K.L.Narayana, P.Kannaiah & K.VenkataReddy /NewAge/Publishers
3. MachineDrawing–N.D.Bhatt.
4. EngineeringGraphicswithAutoCAD–JamesD.Bethune–PHI2009Edition.

REFERENCEBOOKS:

1. Machine Drawing–P.S.Gill.
2. Machine Drawing–Luzzader
3. MachineDrawing-Rajput

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B.Tech. in Mechanical Engineering

VI Semester Syllabus

ME601PC: Heat Transfer

Course Objectives:

The objectives of the course is to make the students

- Learn the modes of heat transfer and applications of heat transfer
- Derive the equation for temp distribution in fins, & estimate the rate of heat transfer through conduction through slabs, cylindrical and spherical surfaces.
- Estimate the rate of heat transfer co-efficient for forced and free convection
- Analyze and design the boiling heat transfer problems and design the condensation heat transfer problems.
- Calculate the Effectiveness of heat exchangers, condensers & evaporator by using LMTD & NTU methods.

Course Outcomes:

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

- Understand the basic modes of heat transfer
- Compute one dimensional steady state heat transfer with and without heat generation
- Understand and analyze heat transfer through extended surfaces
- Interpret and analyze forced and free convective heat transfer
- Understand the principles of boiling, condensation, radiation heat transfer and design of heat exchangers.

UNIT-- I

Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady, and periodic heat transfer – Initial and boundary conditions

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders, and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation

UNIT-- II

One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat Generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.

UNIT-- III

Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations – Integral Method as approximate method -Application of Von Karman Integral Momentum Equation for flat plate with different velocity profiles.

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

UNIT-- IV

Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.
Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.
Heat Exchangers: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT-- V

Heat Transfer with Phase Change:
Boiling: Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling.
Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.
Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

Text Books:

1. Heat and Mass Transfer – Dixit /Mc Graw Hill
2. Heat and Mass Transfer / Altamush Siddiqui/ Cengage.
3. Heat Transfer – P.K.Nag/ TMH

Reference Books:

1. Fundamentals of Engg. Heat and Mass Transfer / R.C.Sachdeva / New Age International
2. Heat Transfer – Ghoshdastidar – Oxford University Press – II Edition
3. Heat and Mass Transfer –Cengel- McGraw Hill.
4. Heat and Mass Transfer – R.K. Rajput – S.Chand& Company Ltd.
5. Essential Heat Transfer - Christopher A Long / Pearson Education
7. Heat and Mass Transfer – D.S.Kumar / S.K.Kataria& Sons
8. Heat and Mass Transfer-Kondandaraman

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME602PC: Metrology and Machine Tools

Course Objectives:

The objectives of the course is to make the students

- Acquire the knowledge of Engineering metrology and its practice which is having increasing importance in industry.
- Improve applications aspect in the measurements and control of process of manufacture
- Impart the fundamental aspects of the metal cutting principles and their application in studying the behavior of various machining processes.
- Identify basic parts and operations of machine tools including lathe, shaper, planer, drilling, boring, milling and grinding machine.
- Select a machining operation and corresponding machine tool for a specific application in real time.

Course Outcomes:

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

- Identify techniques to minimize the errors in measurement.
- Identify methods and devices for measurement of length, angle, and gear & thread parameters, surface roughness and geometric features of parts.
- Understand working of lathe, shaper, planer, drilling, milling and grinding machines.
- Comprehend speed and feed mechanisms of machine tools.
- Estimate machining times for machining operations on machine tools

UNIT--I

Metal cutting: Introduction, elements of cutting process – Geometry of single point tools, Chip formation and types of chips. Engine lathe – Principle of working, types of lathe, specifications. Taper turning, Lathe attachments, Capstan and Turret lathe - Single spindle and multi-spindle automatic lathes, tool layouts.

UNIT-- II

Drilling and Boring Machines – Principles of working, specifications, types, operations performed, twist Drill, Types of Boring machines and applications. Shaping, slotting and planing machines –Principles of working – machining time calculations.

UNIT-- III

Milling machines – Principles of working – Types of milling machines – Geometry of milling cutters - methods of indexing. Grinding – theory of grinding – classification of grinding machines.Types of abrasives, bonds.Selection of a grinding wheel. Lapping, honing and broaching machines.

UNIT-- IV

Limits, fits and tolerances- Types of Fits - Unilateral and bilateral tolerance system, hole and shaft basis system. Interchangeability and selective assembly.
Limit Gauges: Taylor's principle, Design of GO and NO-GO gauges, Bevel protractor, Sine bar, auto collimator.

UNIT-- V

Surface Roughness Measurement: Roughness, Waviness. CLA, RMS, Rz Values. Methods of measurement of surface finish, Talysurf. Gear Measurement, Screw thread measurement, Machine Tool Alignment Tests on lathe, milling and drilling machines.

TEXT BOOKS:

1. A course in Workshop Technology, Vol. II, B.S.Raghuvamshi
2. Machine Tool Practices / Kibbe, Johne. Neely, T. White, Rolando O. Meyer/ Pearson
3. Engineering Metrology / R.K. Jain/ Khanna Publishers.

REFERENCE BOOKS:

1. Principles of Machine Tools, Bhattacharyya A and Sen.G.C / New Central Book Agency.
2. Fundamentals of Dimensional Metrology / Connie Dotson / Thomson
3. Fundamentals of Metal Machining and Machine Tools / Geoffrey Boothroyd / McGraw Hill
4. A Text book of Metrology, M. Mahajan Dhanpat Rai & sons.

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME603PC: Design of Machine Members - II

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 design process of sliding contact bearings by calculating heat generated, heat dissipation of bearings.
- Design of ball and roller contact bearings by calculating dynamic load carrying capacity.
- Learn the design process of piston, connecting rod of internal combustion Engine.
- Understand transmission of power by flat belts, V- belts and rope drives.
- Learn the design process of spur gears and helical gears which are subjected to dynamic loads.

Course Outcomes:

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

- Calculate the dynamic load carrying capacity of selected suitable series of ball and roller bearings and its rated life.
- Determine the forces acting on the internal combustion engine parts by applying the principles of columns and struts by using Euler and Rankine's formula.
- Determine the deflections and energy storage capacity of the springs.
- Analyze the design parameters of pulleys and belts such as flat belts, V- belts and rope drives.
- Check the dynamic and wear considerations of designed spur gears and helical gears.

UNIT--I

Sliding contact bearings: Types of Journal bearings - Lubrication - Bearing Modulus - Full and partial bearings - Clearance ratio - Heat dissipation of bearings, bearing materials - journal bearing design.

UNIT– II

Rolling contact bearings: Ball and roller bearings - Static load - dynamic load - equivalent radial load - design and selection of ball & roller bearings.

UNIT– III

Engine Parts: Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends - Pistons, Forces acting on piston - Construction, Design and proportions of piston.

UNIT– IV

Mechanical Springs: Stresses and deflections of helical springs - Extension and compression springs - Design of springs for fatigue loading - natural frequency of helical springs - Energy storage capacity - helical torsion springs - Design of co-axial springs, Design of leaf springs.

Belts & Pulleys: Transmission of power by Belt and Rope Drives, Transmission efficiencies, Belts - Flat and V types - Ropes - pulleys for belt and rope drives.

UNIT– V

Gears: Spur gears& Helical gears - Brief introduction involving important concepts - Design of gears using AGMA procedure involving Lewis and Buckingham equations. Check for wear.

TEXT BOOKS:

1. Design of Machine Elements / Spotts/ Pearson
2. Machine Design / Pandya & Shah / Charothar

REFERENCE BOOKS:

1. Design of Machine Elements-II / Kannaiah / New Age
2. Design of Machine Elements / Sharma and Purohit/PHI
3. Design Data Book/ P.V. RamanaMurti& M. Vidyasagar/ B.S. Publications
4. Design Data Handbook/ S. Md. Jalaludeen/ Anuradha Publishers

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME611PE: Finite Element Methods

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 students will be able to

- 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 modeling, 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, 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 modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of Load Vector, Stresses Finite element modeling 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

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME612PE: Automobile Engineering

Course Objectives:

The objectives of the course is to make the students

- Anatomy of the automobile and 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
- Understanding and designing 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 the principles/types of brakes and different types of master cylinders in the braking system.
- An ability to 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

- Gain 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 – carburetor, types, air filters – petrol injection.

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

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, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

UNIT– V

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

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME613PE: Unconventional Machining Processes

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 be able 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

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B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
ME614PE Alternative Materials

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.

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME615PE: Machine Tool Design

Pre-requisites: Machine Design, Machine Tools and Metrology, Machining Science.

Course Objectives:

The objectives of the course is to make the students

- Implement the tool design process when designing tooling for the manufacturing of aproduct.
- Apply Geometric Tolerancing principles in the designs of tooling.
- Evaluate and select appropriate materials for tooling applications.
- Design, develop, and evaluate cutting tools and work holders for a manufacturedproduct.
- Design, develop, and evaluate appropriate gauging /gauging systems to define limits and specifications of a work piece during the manufacturing process.
- Apply ANSI standards to tool design drawings and layouts.
- Use CAD and conventional techniques in creating tooling drawings.

Course Outcomes:

After successful completion of the course, student will be able to:

- Understand basic motions involved in a machine tool. Design machine tool structures.
- Design and analyze systems for specified speeds and feeds.
- Select subsystems for achieving high accuracy in machining.
- Understand control strategies for machine tool operations.
- Apply appropriate quality tests for quality assurance.

UNIT- I

Introduction to Machine Tools Drives: Classification of machine tool drives, group Vs individual drives, and Mechanisms: Introduction to the course, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission.

UNIT- II

Regulation of Speeds and Feeds: Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of SpeedGear Boxes, Feed Drives, Feed Box Design.

UNIT- III

Design of Machine Tool Structures: Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Too1 Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables,Saddles and Carriages.

UNIT- IV

Design of Guideways, Power Screws and Spindles: Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slideways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws.

Design of Spindles and Spindle Supports: Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings.

UNIT- V

Dynamics of machine tools: General procedure for assessing the dynamic stability of cutting process Machine Tool Elastic System, Static and Dynamic Stiffness Acceptance Tests

TEXT BOOKS

1. Machine Tool Design and Numerical Control/ N.K. Mehta / Mc Graw Hill
2. Principles of Machine Tools/ G.C. Sen and A. Bhattacharyya / , New Central BookAgency

REFERENCE BOOKS

1. Design of Machine Tools / D. K Pal, S. K. Basu / Oxford
2. Machine Tool Design, Vol. I, II, III and IV / N. S. Acherkhan / MIR
3. Machine Tool Design Handbook by CMTI,McGraw-Hill.

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B.Tech. in Mechanical Engineering

VI Semester Syllabus
ME616PE: Renewable Energy Sources

Course Objectives:

The objectives of the course is to make the students
- explain the concepts of Non-renewable and renewable energy systems
- analyze and understand the growth of renewable energy utilization in the sustainable economy of India.
- outline utilization of renewable energy sources for domestic, commercial and industrial Applications
- Design the renewable energy-based energy systems and analyse their performance for domestic, commercial and industrial applications.
- Capability to carry out basic design of renewable energy systems

Course Outcomes:

- Understanding of renewable energy sources
- Knowledge of working principle of various energy systems
- Analyze & understand various design principles of renewable energy systems
- Analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.
- Validate the use of each Renewable energy source

UNIT- I

Global and National Energy Scenario: Over view of conventional & renewable energy sources, need & development of renewable energy sources, types of renewable energy systems, Future of Energy Use, Global and Indian Energy scenario, Renewable and Non-renewable Energy sources, Energy for sustainable development, Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO_2 reduction potential of renewable energy.

UNIT- II

Solar Energy: Solar energy system, Solar Radiation, Availability, Measurement and Estimation, Solar Thermal Conversion Devices and Storage- design aspects, Solar Photovoltaic Conversion, Design of solar photovoltaic systems – Off grid and On grid power plants, Solar water pumping systems, solar thermal systems- types and design principles, applications of solar energy systems.

UNIT- III

Wind Energy: Wind Energy Conversion, Nature of the wind, power in the wind, factors influencing wind, wind speed monitoring, classification of wind, characteristics, Wind resource assessment, Wind energy potential measurement, site selection, Betz limit, wind data and energy estimation. Types of wind turbines, Wind farms, Wind Energy Generation and Control. Applications of wind turbines, offshore wind energy systems and concept of Hybrid systems, Wind mill component design Economics and demand side management, energy wheeling, and energy banking concepts. Safety and environmental aspects, wind energy potential and installation in India.

UNIT- IV

Biomass Energy: Properties of biogas (Calorific value and composition), biogas plant technology and status, Bio energy system, design and constructional features. Biomass resources and their classification, Biomass conversion

processes, Thermo chemical conversion, direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, types of biogas Plants, applications, alcohol production from biomass, biodiesel production, Urban waste to energy conversion, making of biochar, Biomass energy programme in India.

UNIT- V

1. **Ocean Thermal Energy:** Principle of Ocean Thermal Energy Conversion (OTEC), ocean thermal power plants.
2. **Tidal energy conversion,** Tidal and wave energy its scope and development, Scheme of development of tidal energy, Wave energy conversion plants.
3. **Small hydro Power Plant:** Importance of small hydro power plants and their Elements, types of turbines for small hydro, estimation of primary and secondary power.
4. **Geothermal Energy:** Geothermal power plants, various types, hot springs and steam generation.

TEXT BOOKS:

1. G.D Rai, Non-Conventional Energy Sources, Khanna Publishers, ISBN: 9788174090738
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1986. ISBN-13: 9780415584371 (978-0-415-58437-1)

REFERENCE BOOKS:

1. Bryan Leyland, Small Hydroelectric Engineering practice, CRC Press, 2014. International Standard Book No – 13: 978-1-315-81653-1 (e-PDF)
2. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.
3. Kishore VVN, Renewable Energy Engineering and Technology, Teri Press, New Delhi,2012
4. Siraj Ahmed, Wind Energy Theory & Practice, PHI Learning Publishing House, ISBN : 9788120351639
5. SP Sukhatme and JK Nayak, Solar Energy- Principles of Thermal Collection and Storage by, Tata McGraw-Hill, 1996.

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME617PE: CNC Technology

Course Objectives:

- To make the students familiar with CNC Machine
- To Make students to be able to write computer aided part programming
- To Study the different tooling for CNC.
- To study the various types of post processors
- To use computers in the area of manufacturing to reduce manual processing and linking computers 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
- Tools and its Automation process used in CNC
- Postprocessor significance and its functions
- 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

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 (9 hours)

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 Cotrolof 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 ToolsHand book vol3, (Automation & control)/ Manfred Weck /John Wiley and Sons,1984.

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME618PE: Production Planning and Control

Course Objectives:

- To understand the problems and opportUNIT--ies faced by the operations manager in manufacturing andservice organizations.
- To develop an ability to apply PPC concepts in various areas like marketing, accounting, finance, 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 production planning and inventory control.

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

- Students can recognize the objectives, functions, applications of PPC and forecasting techniques.
- Students can summarize different Inventory control techniques.
- Students can solve routing and scheduling problems
- Students can summarize various aggregate production planning techniques.
- Students can 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.

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Open Elective for other Departments
(Other than MECH, MCT, CSB, CSD & CSM)
VI Semester Syllabus
ME621OE: Non-conventional Sources of Energy (Open Elective – II)

Course Objectives

The objectives of the course is to make the students
- Explain the concepts of Non-renewable and renewable energy systems
- Outline utilization of renewable energy sources for domestic, commercial and industrial Applications
- Design the renewable energy-based energy systems and analyze their performance for domestic, commercialand industrial applications.
- Capability to carry out basic design of renewable energy systems
- Understand various direct energy conversion systems and their effective utilization

Course Outcomes:

At the end of the course, the student will be able to:
- Identify renewable energy sources and their utilization. Understand the basic concepts of solar radiation and analyze the working of solar and thermal systems.
- Understand the operation of various energy conversion systems
- Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.
- Identify methods of energy storage for specific applications
- Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas and hydrogen.

UNIT – I

Principles of Solar Radiation: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power - Physics of the sun, the solar constant, extra-terrestrial and terrestrial solar radiation, Solar radiation on titled surface, Instruments for measuring solar radiation and sun shine, solar radiation data.
Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT – II

Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/cooling techniques, solar distillation and drying, photovoltaic energy conversion.
Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

UNIT – III

Bio-Mass: Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of biogas, utilization for cooking, I.C. Engine operation, and economic aspects.

UNIT – IV

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India.
Ocean Energy – OTEC, Principles, utilization, setting of OTEC plants, thermodynamic cycles. Tidal and Wave energy: Potential and conversion techniques, mini-hydel power plants, their economics.

UNIT –V

Direct Energy Conversion: Need for DEC, Carnot cycle, limitations, Principles of DEC. Thermoelectric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principle, faraday's laws, thermodynamic aspects, selection of fuels and operating conditions.

TEXT BOOKS:

1. Renewable Energy Resources / Tiwari and Ghosal / Narosa
2. Non- conventional Energy Sources / G.D. Rai/ Khanna Publishers
3. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/ E&FN Spon.

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Open Elective for other Departments
(Other than MECH, MCT, CSB, CSD & CSM)
VI Semester Syllabus
ME622OE: Fundamentals of Robotics (Open Elective – II)

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, Vaccume 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

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
MC601HS: Intellectual Property Rights

Course Objectives:

The objectives of the course is to make the students
- Enable the students to have an overview of Intellectual Property Rights
- Attain comprehensive knowledge to the students regarding Trademarks Registration process laws related to it.
- Disseminate knowledge on Copyrights, its related rights and recent developments.
- Understand Patent Regime in India and abroad.
- Understand the framework of Trade secrets

Course Outcomes:

At the end of the course the students will be able to
- Gain knowledge on Intellectual property rights and their importance
- Understand Indian and international Trademark Law and procedure for registration of Trademarks.
- Acquire the knowledge of Copyright Law, and the privileges awarded to the copyright owners.
- Familiarize with the process of acquiring the patent and relevant laws.
- Understand the importance of trade secrets for sustainability.

UNIT– I

Introduction to Intellectual property

Introduction-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- Trademarks registration process – Trademark Infringement - Remedies for infringement in Trademarks-New developments in Trademark Law- International Trademarks Law.

UNIT– III

Copyright

Copyrights-Fundamental of Copyright Law -Requirements of Copyright ability- Originality of material, fixation of material, Authorship works, exclusions form 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

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 secrete status, measures for protecting trade secret status- Liability for misappropriations of trade secrets, protection for submissions, trade secret litigation. New developments in Trade secrets Law- International Trade Secrets.

Law of Unfair competition: Passing off, Misappropriation, right of publicity, dilution of trademarks, product disparagement, false advertising.

Text Books:

1. Deborah. E. Bouchoux, Intellectual property, Cengage learning India Pvt.Ltd., 4th edition, 2013
2. PrabuddhaGanguli, Intellectual property right, Tata McGraw Hill Publishing company, 8tth 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

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B.Tech. in Mechanical Engineering (Mechatronics)
VI Semester Syllabus
MC601ES: ARTIFICIAL INTELLIGENCE
(Common to all Branches except CSE(AI&ML)

Course Objectives:

To learn the distinction between optimal reasoning Vs. human like reasoning
- To understand the concepts of state space representation, exhaustive search, heuristic search together with the time and space complexities.
- To learn different knowledge representation techniques.
- To understand the applications of AI, namely game playing, theorem proving, and machine learning.

Course Outcomes:

Ability to formulate an efficient problem space for a problem expressed in natural language.
- Select a search algorithm for a problem and estimate its time and space complexities.
- Possess the skill for representing knowledge using the appropriate technique for a given problem.
- Possess the ability to apply AI techniques to solve problems of game playing, and machine learning.

UNIT - I

Introduction: AI Definition, Agents and Environments, Structure of Agents, Types of Agents. Problem Solving Agents: Problem spaces, states, goals and operators.

Uninformed Search Strategies: Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening depth first search, Bidirectional Search.

UNIT – II

Informed Search: Heuristic Search strategies, Hill Climbing, A*, Hill climbing search.

Game Playing: Adversarial Searches. Two player games. Min-max Search: Algorithm, Problems. Draw Back of Min-Max Algorithm. Alpha-beta pruning: Algorithm, Problems.

Constraint Satisfaction Problems: Definition, Crypt-Arithmetic Problems, Map Coloring, Backtracking.

UNIT – III

Basic Knowledge Representation and Reasoning: Propositional Logic: Basics of logic, truth tables and sentence conversions.

First order logic: Difference between Proposition & First order logic. Conjunctive Normal form. Disjunctive Normal Form. Conversion of English sentences into First order logic. Resolution and theorem proving. Problems of Resolution. Forward Chaining: Definition, Example problems. Backward Chaining: Definition, Example problems.

UNIT – IV

Planning: Classical Planning: Definition of Classical Planning, Algorithms for Planning with State-Space Search, Planning Graphs, other Classical Planning Approaches, Analysis of Planning approaches.

Planning and Acting in the Real World: Time, Schedules, and Resources, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Multi agent Planning.

UNIT – V

Uncertain knowledge and Learning Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Independence, Bayes' Rule and Its use.

Probabilistic Reasoning: Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Approximate Inference in Bayesian Networks, Relational and First-Order Probability

Learning: Forms of Learning, Supervised Learning, Learning Decision Trees.

Knowledge in Learning: Logical Formulation of Learning, Knowledge in Learning, Explanation-Based Learning, Learning Using Relevance Information, Inductive Logic Programming.

Text Books:

1. Artificial Intelligence: A Modern Approach by S. Russell and P. Norvig, Prentice Hall. 2010, third edition.
2. Artificial Intelligence by Elaine Rich, Kevin Knight and Shivashankar B Nair, Tata McGraw Hill.

Reference Books:

1. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Pearson Education.
2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 6th ed., 2009.
3. Artificial Intelligence – Patric Henry Winston – Third Edition, Pearson Education

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME651PC: Heat Transfer Lab

Course Objectives:

The objectives of the course is to make the students

- Attain practical knowledge of operating various heat transfer equipments
- Know the of different types of thermocouples and temperature indicators (including their calibration via voltmeters); measurement of current, voltage, temperature, flow rate/velocity, etc.
- Predict of transient behavior of various equipment during start–up period and finding heat transfer rates, heat transfer coefficients, efficiency, effectiveness, etc. in free and forced convection,.
- Evaluate radiation heat exchange between black and real surfaces, emissivity and Stefan Boltzmann constant.
- Find critical heat transfer during pool boiling and visualization of the phenomena.
- Determine thermal conductivity of insulating material and conductance of a heat pipe.

Course Outcomes:

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

- Perform steady state conduction experiments to estimate thermal conductivity of different materials
- Perform transient heat conduction experiment
- Estimate heat transfer coefficients in forced convection, free convection, condensation and correlate with theoretical values
- Obtain variation of temperature along the length of the pin fin under forced and free convection
- Perform radiation experiments: Determine surface emissivity of a test plate and Stefan-Boltzmann's constant and compare with theoretical value.

Minimum twelve experiments from the following:

1. Composite Slab Apparatus – Overall heat transfer co-efficient.
2. Heat transfer through lagged pipe.
3. Heat Transfer through a Concentric Sphere
4. Thermal Conductivity of given metal rod.
5. Heat transfer in pin-fin
6. Experiment on Transient Heat Conduction
7. Heat transfer in forced convection apparatus.
8. Heat transfer in natural convection
9. Parallel and counter flow heat exchanger.
10. Emissivity apparatus.
11. Stefan Boltzman Apparatus.
12. Critical Heat flux apparatus.
13. Study of heat pipe and its demonstration.
14. Film and Drop wise condensation apparatus

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B.Tech. in Mechanical Engineering
VI Semester Syllabus
ME652PC: Metrology and Machine Tools Lab

Prerequisites: Theoretical exposure to Metrology and machine tools.

Course Objectives:

The objectives of the course is to make the students

- Impart practical exposure to the metrology equipment & 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, and grinding.
- 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.
- Generate knowledge and skill in use of various measuring tools and measuring techniques.
- Learn a basic understanding of various measuring instruments for the dimensional and geometric features of a given component.

Course Outcomes:

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

- Undertake machining operation such as step turning, taper turning and thread cutting on lathe machine
- 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.
- Apply the procedures to measure length, angles diameters, bore diameters, and surface roughness by using different instruments.
- Identify procedure for measurement of gear tooth profile using gear tooth Vernier.

List of Experiments:

1. Step turning on lathe machine
2. Taper turning on lathe machine
3. Thread cutting and knurling on lathe machine(2exercises)
4. Measurement of cutting forces on lathe
5. Machining of holes using Drilling machine.
6. Slot cutting on the Milling machine
7. Grinding of Tool angles using Tool & cutter grinding machine.
8. Measurement of lengths, heights, diameters by vernier calipers, micrometers.
9. Measurement of Diameter of bores by internal micrometers and dial bore indicators.
10. Useofgearteethverniercalipersforcheckingthechordaladdendumandchordalheight of the spur gear.
11. Angle and taper measurements by Bevel protractor and sine bars.
12. Threadmeasurementby2-wireand3-wiremethods.
13. Surface roughness measurement by Tally Surf.
14. Use of mechanical comparator

L	T	P	C
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B.Tech. in Mechanical Engineering
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.

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B.Tech. in Mechanical Engineering
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 systems and 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

Vapor compression refrigeration – Working principle and essential components of the plant – SimpleVapour compression refrigeration cycle – COP – Representation of cycle on T-S and p-h charts – effectof sub cooling and super heating – cycle analysis – Actual cycle Influence of various parameters onsystem performance – Use of p-h charts – Problems.

UNIT-III

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

UNIT-IV

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

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

UNIT-V

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

Text Books:

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

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME711PE: Robotics

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, grippers.
- Modeling of forward and inverse kinematics of robot manipulators.
- Design of 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 – Sensing & Digitizing and Image Processing & Analysis, 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

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME712PE: Power Plant Engineering

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

The objectives of the course is to make the students
- Analysis and preliminary design of the major systems of conventional fossil-fuel steam-cycle power plants.
- Obtain working knowledge of the basic design principles of diesel power plant and gas turbine power plant
- Understand working of hydro power plants, solar, wind, tidal power plants and about direct energy conversion systems
- Obtain working knowledge of nuclear power plant and radioactive waste disposal
- Get awareness of the economic, environmental, and regulatory issues related to power generation

Course Outcomes:

At the end of the course the students will be 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 needsand 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 – super charging.
Gas Turbine Plant: Introduction – classification - construction – Layout with auxiliaries – Principles of working of closed and open cycle gas turbines. Combined Cycle Power Plants and comparison.

UNIT – III

Hydro Electric Power Plant: Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – storage and Pondage – classification of dams and spill ways.
Hydro Projects and Plant: Classification – Typical layouts – plant auxiliaries – plant operation pumpedstorage 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 – reactor operation. **Types of Reactors:** Pressurized water reactor, Boiling water reactor, sodium-graphite reactor, fast Breeder Reactor, Homogeneous Reactor, Gas cooled Reactor, Radiation hazards and shielding – radioactive waste disposal.

UNIT – V

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

TEXT BOOKS:

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

REFERENCES BOOKS:

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

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME713PE Automation in Manufacturing

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 BOOK:

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. Varaprasad Rao

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME714PE: Entrepreneurship and Small Business Enterprises

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 techniques.
- Know the various labor acts to be adhered to while running a business enterprise

Course Outcomes:

At the end of the course the students will be able to
- Be aware of the basics of Entrepreneurship and a business plan
- Understand the various activities related to financing and starting the newventures
- 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

Entrepreneurial Perspectives:
Evolution, Concept of Entrepreneurship, Types of Entrepreneurs, Entrepreneurial Competencies, Capacity Building for Entrepreneurs. Entrepreneurial Training Methods; Entrepreneurial Motivations; Models for Entrepreneurial Development, The process of Entrepreneurial Development.

UNIT–II

New Venture Creation:
Introduction, Mobility of Entrepreneurs, Models for Opportunity Evaluation; Business plans –Purpose, Contents, Presenting Business Plan, Procedure for setting up Enterprises, Central level-Startup and State level-THub ,Other Institutions initiatives.

UNIT–III

Management of MSMEs and Sick Enterprises
Challenges of MSMEs, Preventing Sickness in Enterprises – Specific Management Problems; Industrial Sickness; Industrial Sickness in India – Symptoms, process and Rehabilitation of Sick Units.

UNIT–IV

Managing Marketing and Growth of Enterprises:
Essential Marketing Mix of Services, Key Success Factors in Service Marketing, Cost and Pricing ,Branding, New Techniques in Marketing, International Trade.

UNIT–V

Strategic perspectives in Entrepreneurship:

Strategic Growth in Entrepreneurship, The Valuation Challenge in Entrepreneurship, The Final Harvest of New Ventures, Technology, Business Incubation, India way– Entrepreneurship; Women Entrepreneurs– Strategies to develop Women Entrepreneurs, Institutions supporting Women Entrepreneurship in India.

Text Books:

1. Entrepreneurship Development and Small Business Enterprises, PoornimaM. Charantimath,2e, Pearson, 2014.
2. Entrepreneurship, A South – Asian Perspective, D.F.Kuratko and T.V.Rao, 3e,Cengage,2012.

Reference Books:

1. Entrepreneurship, Arya Kumar, 4e,Pearson2015.
2. The Dynamics of Entrepreneurial Development and Management, Vasant Desai, Himalaya PublishingHouse,2015.

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME715PE: Computational Fluid Dynamics

Course Objectives:

The objectives of the course is to make the students
- Introduce them to widely used techniques in the numerical solution of fluid flow equations
- Emphasize on "learning by doing", as they will work on class room projects and assignments.
- Provide them with basic mathematical and numerical concepts of fluid flow and heat transfer problems.
- Get exposed to modern trends in CFD.
- Enhance their skills related to computer design and evaluation in fluid flow, critical thinking and lifelong learning.

Course Outcomes:

At the end of the course, the students will be able to:
- Understand the basic principles of mathematics and numerical concepts of fluid dynamics.
- Develop governing equations for a given fluid flow system.
- Adapt finite difference techniques for fluid flow models.
- Apply finite difference method for heat transfer problems.
- Solve computational fluid flow problems using finite volume techniques.

UNIT I

Elementary details in numerical techniques: Number system and errors, representation of integers, fractions, floating point arithmetic, loss of significance and error propagation, condition for instability, computational methods for error estimation, convergence of sequences. Applied Numerical Methods: Solution of a system of simultaneous Linear Algebraic Equations, iterative schemes of Matrix Inversion, Direct Methods for Matrix inversion, Direct Methods for banded matrices.

UNIT II

Finite Difference Applications in Heat conduction and Convection – Heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure. Finite Differences, discretization, consistency, stability, and Fundamentals of fluid flow modeling: Introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

UNIT III

Introduction to first order wave equation; Stability of hyperbolic and elliptic equations, fundamentals of fluid flow modeling, conservative property, the upwind scheme.

UNIT IV

Review of Equations Governing Fluid Flow and Heat Transfer: Introduction, conservation of mass, Newton's second law of motion, expanded forms of Navier-stokes equations, conservation of energy principle, special forms of the Navier-stokes equations.

UNIT V

Finite volume method: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

Text Books:

1. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hema shava Publishers corporation & Mc Graw Hill.
2. Computational Fluid Flow and Heat Transfer/ Muralidaran/ Narosa Publications.
3. Computational Fluid Dynamics: An Introduction, John F. Wendt, John David Anderson, Springer.

Reference Books:

1. Computational Fluid Dynamics: Basics with applications/John D. Anderson/ Mc Graw Hill.
2. Fundamentals of Computational Fluid Dynamics/Tapan K. Sengupta / Universities Press.
3. Introduction to Theoretical and Computational Fluid Dynamics/C. Pozrikidis/Oxford University Press/2nd Edition.

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME716PE: Mechanical Vibrations

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 vibrating 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 shaft 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; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi- rotor systems and geared systems; Discrete - Time systems.

UNIT – IV

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

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/ Mc Graw Hill
2. Principles of Vibration / Benson H. Tongue/Oxford

REFERENCE BOOKS:

1. Mechanical Vibrations / SS Rao / Pearson
2. Mechanical Vibration /Rao V. Dukkipati, J Srinivas/ PHI
3. Mechanical Vibrations/ G.K. Grover/ Nemchand & Brothers

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME717PE: Additive Manufacturing Technology

Course Objectives:

- 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:

- Describe various CAD issues for 3D printing/additive manufacturing and related operations.
- Formulate and solve typical problems on reverse engineering for surface reconstruction 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 Modeling (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, Jewelry 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., & Khorasan, 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

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B.Tech. in Mechanical Engineering
VII Semester Syllabus
ME718PE: Sensors and Actuators

Course Outcomes:

The objectives of the course is to make the students

- Learn fundamentals and applications of different types of sensors, transducers and selection
- Learn different types of actuators and selection criteria extensively used in Industrial and agricultural purposes
- Understand the basic concepts of signal processing, and decision making for analysis
- Understand the concept of smart sensors and their construction

Course Objectives

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

- Classify different sensors and transducers used based on characteristics
- Collaborate the standard communication protocols between Sensors, actuators , and control units
- Develop a sensor and actuator for practical applications
- Understand implementation of MEMS for smart sensors
- Distinguish performances of various Electro mechanical and Thermal sensors based on

UNIT – I

Sensors / Transducers: Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP), Characterization. Mechanical and Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges, Inductive Sensors- Sensitivity and Linearity of the Sensor, Types- Capacitive Sensors, Electrostatic Transducer, Force/Stress Sensors using Quartz Resonators, Ultrasonic Sensors.

UNIT – II

Thermal Sensors: Introduction, Gas thermometric Sensors, Thermal Expansion Type Thermometric Sensors, Acoustic Temperature Sensor, Dielectric Constant and Refractive Index Thermo-sensors, Helium Low Temperature Thermometer, Nuclear Thermometer, Magnetic Thermometer, Resistance Change Type Thermometric Sensors, Thermo-EMF Sensors, Junction Semiconductor Types, Thermal Radiation Sensors, Quartz Crystal Thermo-electric Sensors, NQR Thermometry, Spectroscopic Thermometry, Noise Thermometry, Heat Flux Sensors. Magnetic Sensors: Introduction, Sensors and the Principles Behind, Magneto-resistive Sensors, Anisotropic Magneto-resistive Sensing, Semiconductor Magneto-resistors, Hall Effect and Sensors, Inductance and Eddy Current Sensors, Angular/Rotary Movement Transducers, Synchros, Synchroresolvers, Eddy Current Sensors, Electromagnetic Flowmeter, Switching Magnetic Sensors, SQUID Sensors.

UNIT – III

Radiation Sensors: Introduction – Basic Characteristics – Types of Photosensistors/Photo detectors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors. Electro Analytical Sensors: Introduction – The Electrochemical Cell – The Cell Potential – Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization-– Reference Electrodes – Sensor Electrodes – Electro ceramics in Gas Media .

UNIT – IV

Smart Sensors: Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, the Automation. Sensors Applications: Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring.

UNIT – V

Actuators: Pneumatic and Hydraulic Actuation Systems- Actuation systems, Pneumatic and hydraulic systems, Directional Control valves, Pressure control valves, Cylinders, Servo and proportional control valves, Process control valves, Rotary actuators, Mechanical Actuation Systems Types of motion, Kinematic chains, Cams, Gears, Ratchet and pawl, Belt and chain drives, Bearings, Mechanical aspects of motor selection, Electrical Actuation Systems, Electrical systems, Mechanical switches, Solid-state switches, Solenoids, D.C. Motors, A.C. Motors, Stepper motors.

TEXT BOOKS:

- D. Patranabis, “Sensors and Transducers”, PHI Learning Private Limited.
- W. Bolton, “Mechatronics”, Pearson Education Limited.

REFERENCE BOOKS:

- Patranabis, “Sensors and Actuators”, 2nd Edition, PHI, 2013.

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Open Elective for other Departments
(Other than MECH, MCT, CSB, CSD & CSM)

VII Semester Syllabus
ME721OE: Industrial Management (Open Elective – III)

Course Objectives:

At the end of this course students are expected:

- To learn the management concepts.
- To understand the application of Concepts in Practical aspects of business.
- To understand the various organizational structures available.
- To understand the various production systems, plant Layouts, value analysis.
- To understand work study, work sampling and statistical quality control.
- To learn the methods of Job evaluation and Project management

Course Outcomes:

After successful completion of the course:

- Student is able to understand the functions and applications of Management. Student is able to apply principles of management in his / her extra and co-curricular activity in college and in industrial in-plant training.
- Student is able to summarize the suitability of various organizational structures.
- Student is able to understand the purposes of various production systems, plant Layouts, value analysis.
- Student is able to understand various productivity management techniques like method study, work measurement for improved ways of doing work and statistical process control techniques. Student is able to apply these techniques in an organization where he undergoes for in-plant training.
- Student is able to demonstrate knowledge and understanding of various methods of Job Evaluation and Project management techniques and apply these to one's own work, as a member and leader in a team.

UNIT-I

Introduction to Management

Entrepreneurship and organization – Nature and Importance of Management, Functions of Management, Taylor's Scientific Management Theory, Fayol's Principles of Management, Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation, Systems Approach to Management, Leadership Styles, Social responsibilities of Management

UNIT-II

Designing Organizational Structures

Departmentalization and Decentralization, Types of Organization structures – Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization, Cellular Organization, team structure, boundary less organization, inverted pyramid structure, lean and flat organization structure and their merits, demerits and suitability.

UNIT-III

Operations Management

Objectives- product design process- Process Selection-Types of production system (Job, batch and Mass Production), Plant location-factors- Urban-Rural sites comparison- Types of Plant Layouts- Design of product layout- Line balancing (RPW method). Value analysis-Definition-types of values- Objectives- Phases of value analysis- Fast diagram

UNIT-IV

Productivity Management Techniques

Work Study: Introduction - definition - objectives - steps in work study - Method study - definition, objectives - steps of method study. Work Measurement - purpose - types of study - stop watch methods - steps - key rating - allowances - standard time calculations -work sampling. Statistical Quality Control: variables-attributes, Shewhart control charts for variables- X bar chart, R chart, – Attributes- Defective-Defect- Charts for attributes-p-chart -c chart (simple Problems), Acceptance Sampling- Single sampling- Double sampling plans-OC curves

UNIT-V

Job Evaluation and Project Management

Job Evaluation: Methods of job evaluation - simple routing objective systems - classification method factor comparison method, point method, benefits of job evaluation and limitations. Project Management (PERT/CPM): Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing. (Simple problems)

Text Books:

1. Khanna, O.P., Industrial Engineering and Management, DhanpatRai Publications, 17th Edition, 2018.
2. Sharma, S.C. and Banga, T.R., Industrial Engineering and Management, Khanna Publishers, First Edition, 2017.

Reference Books:

1. Ralph M Barnes, Motion and Time Study:Design and Measurement of Work, John Willey & Sons, Seventh Edition, 1980
2. Ernest J McCormick, Human factors in Engineering & Design, TMH, Seventh Edition,1992
3. PaneerSelvam, R., Production & Operation Management, PHI, Third Edition, 2012
4. NVS Raju, NVS., Industrial Engineering & Management,Cengage Learning, First Edition,2013
5. Maynard, Industrial Engineering Handbook, McGraw-Hill, Fifth Education, 2001.
6. Ravi Shankar, Industrial Engineering and Management, Galgotia Publications, Second Edition, 2000

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Open Elective for other Departments
(Other than MECH, MCT, CSB, CSD & CSM)

VII Semester Syllabus
ME722OE – Fundamentals of 3D Printing Technology (Open Elective – III)

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, Milestones in 3D Printing Development, 3D Printing around the World

UNIT- II

3D Printing Technologies I: Basics of various 3D printing technologies, types. Introduction to **Liquid** Based 3D Printing: Stereo lithography apparatus (SLA): Models and specifications, process, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages

UNIT- III

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

UNIT- IV

3D Printing Design and Required Tools

Design for 3D Printing - Design for Manufacturing and Assembly, basics of DFM for 3D Printing Concepts and Objectives, Design Tools for 3D Printing. Guidelines for Process Selection - Selection Methods for a Part, Challenges of Selection, Preliminary Selection, Production Planning and Control.

Overview of software related to 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 post processing, 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.

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

Course Objectives:

The objectives of the course is to make the students

- 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:

At the end of the course the students will 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.

Note: conduct any TEN exercises from the list given below:

1. 2D Drafting: Development of orthographic and Isometric Drawings for various Parts.
2. Part Modeling: Generation of various 3D Models through Extrude, revolve, sweep.
3. Creation of various features like Loft, Rib, Hole wizard etc.
4. Assembly Modeling: Assembly of simple components like Knuckle Joint, Universal Coupling, IC Engine
5. Conversion of Part model, assembly model into Drawing Files with Dimensions and Tolerances and other annotations.
6. Determination of deflection and stresses in 2D trusses and beams (Demo).
7. Determination of deflection and stresses in 3D trusses and beams (Demo).
8. Determination of deflections, principal and Von-mises stresses in plane stress, plane strain and Axi-symmetric components (Demo).
9. Determination of stresses in 3D and shell structures (Demo)
10. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam (Demo).
11. Steady state heat transfer analysis of plane and axi-symmetric components (Demo).
12. Development and Simulation of NC code using CAM software.

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
MS804HS: Fundamentals of Management for Engineers

(Common to EEE, MECHANICAL, MME & MECHATRONICS)

Course Objectives: The objectives of the course are:

- To enable the students, understand the evolution and functions of Management.
- To make the students learn planning process and decision making in the organization.
- To enable the students to learn the application of the principles in an organization.
- To learn the ability of directing and leading the organization.
- To study the system and process of effective controlling in the organization.

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

- Understand the significance of Management and its functions.
- Analyze the planning process in the organization.
- Comprehend the concept of organization.
- Demonstrate the ability to direct and exhibit leadership qualities effectively.
- Formulate best control methods for effective management.

Unit I:

Introduction to Management

Definition, Nature and Scope of Management, Functions of management, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management. Evolution of Management- Classical Approach- Scientific and Administrative Management; The Behavioural Approach; The Quantitative Approach; The Systems Approach; Contingency Approach, IT Approach.

Unit II:

Planning and Decision Making:

Planning- Concept, Definition, Types of Plans, Planning Process, Importance of Planning, Management by Objectives; Production Planning and Control. **Decision making and Problem Solving** – Concept, Types of Decisions-Programmed and Non-Programmed Decisions, Decision making Process, Bounded Rationality and Influence on Decision Making; Group Problem Solving and Decision Making,

Unit III:

Organization and HRM:

Organization: Definition, Principles of Organizations, Formal and informal organizations, Importance, Organizational Design & Organizational Structures- mechanistic and organic structures; Departmentalization, Delegation of authority; Empowerment, Centralization, Decentralization, Recentralization; Span of Control.

Human Resource Management & Business Strategy: Job Analysis, Recruitment- sources, process, Selection process; Training and Development- importance, on-the-job and off-the job training methods; Performance Appraisal-meaning, methods. Job Satisfaction, Job Enrichment, Job Enlargement,

Unit IV:
Leading and Motivation

Leading: Definition, Elements of Leading, importance and characteristics of Leading, Leadership, Power and Authority, Leadership Styles- Behavioural Leadership, Situational Leadership, Leadership Skills, Leader as Mentor and Coach, Leadership during adversity and Crisis; Handling Employee and Customer Grievances, Team Leadership.

Motivation-Definition, importance, Types of Motivation; Content Motivational Theories- Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y. Relationship between Motivation, Performance and Engagement.

Unit V:
Controlling:

Definitions, Importance, Limitations, characteristics, Control Process, Types and Strategies for Control, Establishing control systems, Elements of good Control system, Control frequency and Methods, Budgetary and Non-Budgetary Controls.

Text Books:

1. Andrew DuBrin, Management Essentials, 9th Edition, CengageLearning,2012.
2. Stephen P. Robbins, Fundamentals of Management, Pearson Education,2009.
3. R. Satyaraju, A.Parthasarthy, Management: Texts and Cases, 2nd Edition,PHI Learning Pvt. Ltd, 2009.

Reference Books:

1. Harold Koontz, Heinz Weihrich, Essentials of Management, Tata McGraw-Hill.
2. Robert N Lussier, Management Fundamentals,5th EditionCengageLearning,2013.
3. T.R.Banga,S.C.Sharma, Industrial Engineering and Management: Including Production Management, Khanna Publishers.

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
ME811PE: Advanced Mechanics of Solids

Course Objectives:

The objectives of the course is to make the students

- Understand basic concepts of stresses in symmetrical and unsymmetrical bending.
- Concepts of curved beams with a focus on closed rings.
- Understanding the concepts of torsion in various cross sections.
- Learn the concepts of contact stresses and methods for calculating the stresses.
- Understanding the problems related three dimensional sections subjected to bending or shear.

Course Outcomes:

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

- Determine the point of location of applied load to avoid twisting in thin sections used in various applications.
- Understand the concept of distinguish between neutral and centroidal axes in curved beams.
- Calculate the torque and shear stresses in thin wall, hollow and connected sections.
- Analyze and compute contact stresses in various load conditions
- Undertake problem identification, formulation, and solution using a range of analytical methods.

UNIT –I

Shear center: Bending axis and shear center - shear center for symmetric and unsymmetrical sections. Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending, Deflection of straight beams due to nonsymmetrical bending.

UNIT –II

Curved beam theory: Winkler-Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – Closed ring subjected to concentrated and uniform loads-stresses in chain links.

UNIT –III

Torsion: Linear elastic solution, Prandtl elastic membrane analogy (Soap-Film); Narrow rectangular cross Section, Hollow thin wall torsion members, Multiply connected Cross Section.

UNIT –IV

Contact stresses: Introduction, problem of determining contact stresses, Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses, Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact) Loads normal to area, Stresses for two bodies in line contact, Normal and Tangent to contact area.

UNIT –V

Introduction to Three Dimensional Problems: Uniform stress stretching of a prismatic bar by its own weight, twist of circular shafts of constant cross section, pure bending of plates.

TEXTBOOKS:

1. Advanced Mechanics of materials by Arthur P. Boresi, Richard J. Schmidt - 6th Edition, Wiley International.
2. Theory of elasticity by Timoshenko S. and Goodier J.N., (2017), McGraw-Hill Publishers.

REFERENCES:

1. Advanced strength of materials by Den Hortog J.P., Dover Publications Inc.
2. Theory of plates and shells by Timoshenko S., McGraw Hill Education
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia, Laxmi Publications.
4. Strength of materials by Sadhu Singh, Khanna Publishers.

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
ME812PE: Turbo Machines

Course Objectives:

The objectives of the course is to make the students
- Provide the knowledge of basic principles, governing equations and applications of Turbo machines
- Provide opportunities to apply basic flow equations
- acquire the knowledge and skill of analyzing different turbo machines.
- How to compare and chose machines for various operations
- Explain working and evaluate the performance characteristics of Turbo Machines

Course Outcomes:

At the end of the course the students will be able to
- Ability to design and calculate different parameters for turbo machines
- Prerequisite to CFD and Industrial fluid power courses
- Ability to formulate design criteria
- Ability to understand thermodynamics and kinematics behind turbo machines
- Predict performance of Turbo machines using model analysis

UNIT-I

Fundamentals of Turbo Machines: Classifications, Applications, Thermodynamic analysis, Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations, Euler's flow through variable cross-sectional areas, Unsteady flow in turbomachines

UNIT-II

Steam Nozzles: Convergent and Convergent-Divergent nozzles, Energy Balance, Effect of back pressure of analysis. Designs of nozzles.

Steam Turbines: Impulse turbines, Compounding, Work done and Velocity triangle,Efficiencies, Constant reactions, Blading, Design of blade passages, Angle and height, Secondary flow. Leakage losses, Thermodynamic analysis of steam turbines.

UNIT-III

Gas Dynamics: Fundamental thermodynamic concepts, isentropic conditions, mach numbers, and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Supersonic flow, oblique shock waves. Normal shock recoveries, detached shocks, Aerofoil theory.

Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodol as formula's, Effect of inlet mach numbers, Pre whirl, Performance

UNIT-IV

Axial Flow Compressors: Flow Analysis, Work, and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance. **Cascade Analysis**: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

UNIT-V

Axial Flow Gas Turbines: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis,
Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design performance.

Text Books:

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Turbines, Pumps, Compressors/Yahya/ Mc Graw Hill

Reference Books:

1. A Treatise on Turbo machines / G. Gopal Krishnan and D. Prithviraj/ SciTech
2. Gas Turbine Theory/ Saravanamuttoo/ Pearson
3. Turbo Machines/ A Valan Arasu/ Vikas Publishing House Pvt. Ltd.

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
ME813PE - Digital Manufacturing & Industry 4.0

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

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
ME814PE - Electrical Vehicle Technology

Prerequisites: Should have Knowledge of basic electrical principles and electrical technology.

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 electrical vehicle
- Apply the controls of different motors for improving 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, 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- 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.

RESOURCES 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, second edition
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

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
ME815PE: Advanced Materials Technology

Course Objectives:

The objectives of the course is to make the students
- Types of composite materials and Micro Mechanical Analysis
- Concept of Macro mechanics of a lamina
- Concept of Engineering constants in laminate composite
- Different methods of manufacturing of composites
- Application of composites in various engineering applications

Course Outcomes:

At the end of the course the students will be able to
- Classify composites on different criteria and analyze the Mechanical properties
- To apply Hooks Law for different materials/composites and evaluation of engineering constants
- Model the composites materials and its deformation for analysis
- Decide the process for manufacturing of particular composite for given properties
- Decide the application of composites for various applications suitably.

UNIT-I

Introduction to composite materials Definition, Classification, Types of matrices & reinforcements, characteristics &selection, Fiber composites, laminated composites, particulate composites, prepregs, sandwich construction. Micro mechanical analysis of a lamina, Introduction, Evaluation of the four elastic moduli – Rule of mixture, ultimate strengths of unidirectional lamina.

UNIT-II

Macro mechanics of a lamina Hooke's law for different types of materials, number of elastic constants, Two – dimensional relationship of compliance & stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants – angle lamina, Invariants, Theories of failure.

UNIT-III

Macro Mechanical analysis of Introduction, code, Kirchoff hypothesis – CLT, A, B, & D matrices, Engineering constants, Special cases of laminates, Failure criterion.

UNIT-IV

Manufacturing Layup and curing – open and closed mould processing – Hand lay –up techniques – Bag moulding and filament winding. Pultrusion, pulforming, Thermoforming, Injection moulding, Quality assurance – Introduction, material qualification, types of defects, NDT methods.

UNIT-V

Applications of Composite Materials Application developments - aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites. Metal matrix composites: Reinforcement materials, types, Characteristics & selection, base metals- selection, applications.

Text Books:

1. Composite Materials handbook - Mein Schwartz - McGraw Hill Book Company - 1984.
2. Mechanics of composite materials - Autar K. - Kaw CRC Press New York. –1st edition, 1997.

Reference Books:

1. Mechanics of composite materials - Rober M. Joness - McGraw Hill KogakushaLtd. 2008.
2. Stress analysis of fiber Reinforced composite materials - Michael W Hyer - McGraw Hill International -1999.
3. Composite material science and Engineering - Krishan K - Chawla Springer - 1999.
4. Fibre reinforced composites - P.C. Mallik Marcel Decker- 2nd edition, New York -1993.

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B.Tech. in Mechanical Engineering

VIII Semester Syllabus
ME816PE: Fluid Power System

Course Objectives:

The Objective of this course is
- To impart the Knowledge on Hydraulic and Pneumatic systems
- To study the various components of fluid power systems.
- To study the various Control valves used in fluid power systems.
- To understand the governing laws and design of hydraulic and pneumatic circuits
- To study the trouble shooting of fluid power systems.

Course Outcomes:

At the end of the course, the student will be able to,
- Demonstrate the concepts of Hydraulic and Pneumatic systems
- Understand the working of various components of hydraulic and pneumatic systems.
- Understand the hydraulic systems and Pneumatic systems,
- Understand the working of control valves and their importance
- Understand the use of hydraulic and pneumatic systems, design of hydraulic and pneumatic circuits for industrial applications

UNIT-I

Introduction: Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. ISO symbols, energy losses in hydraulic systems. Applications, Basic types and constructions of Hydraulic pumps and motors. Pump and motor analysis. Performance curves and parameters.

UNIT-II

Elements of Hydraulic systems: Hydraulic actuators, types and constructional details, lever systems, control elements: direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve Analysis and Design.

UNIT-III

Control Valves: Proportional control valves and servo valves. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Design and analysis of typical hydraulic circuits. Regenerative circuits, Synchronization circuits, and accumulator sizing.

UNIT-IV

Pneumatic systems: Intensifier circuits Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counterbalancing circuits, accessories used in fluid power system, Filtration systems and maintenance of system. Components of pneumatic systems; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits. Valves for logic functions; Time delay valve; Exhaust and supply air throttling;

UNIT-V

Circuit diagrams: Examples of typical circuits using Displacement – Time and Travel-Step diagrams. Will dependent control, Travel-dependent control and Time dependent control, combined control, Program Control, Electro-pneumatic

control and air-hydraulic control, Ladder diagrams. Applications in Assembly, Feeding, Metalworking, materials handling and plastics working.

TEXT BOOKS:

1. John Watton: Fundamentals of Fluid Power Control. 1 st Ed. Cambridge University Press, 2009
2. Blackburn, J. F., G.Reethof, and J. L.Shearer, Fluid Power Control, New York:Technology Press of M. I.T. and Wiley.
3. Anthony Esposito, "Fluid Power with applications", Pearson Education.
4. Ernst, W., Oil Hydraulic Power and its Industrial Applications, New York: McGrawHill.
5. Lewis,E.E., and H.Stern, Design of Hydraulic Control Systems, New York: McGrawHill.
6. Morse,A. C., Electro hydraulic Servomechanism, New York: McGraw Hill.
7. Pippenger, J.J., and R. M. Koff, Fluid Power Control systems, New York: McGrawHill.
8. Fitch, Jr., E.C., Fluid Power Control Systems, New York: McGraw Hill.
9. Khaimovitch, "Hydraulic and Pneumatic Control of Machine Tools"
10. John Watton, "Fluid Power Systems: modeling, simulation and microcomputer control", Prentice Hall International.
11. Herbert E. Merritt: Hydraulic control systems, John Wiley and Sons Inc.

REFERENCE BOOKS:

1. Ian Mencal, Hydraulic operation and control of Machine tools Ronald Press
2. Sterwart Hydraulic and Pneumatic power for production-Industrial Press.
3. Hasebrink J.P., and Kobler R., "Fundamentals of Pneumatics/electropeumatics", FESTO Didactic publication No. 7301, Esslingen Germany, 1979.
4. Werner Deppert and Kurt Stoll, "Pneumatic Control-An introduction to theprinciples", Vogel-Verlag.
5. Blaine W. Andersen, "The analysis and Design of Pneumatic Systems", John Wiley

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
ME817PE – 3D Printing Technology

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.

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B.Tech. in Mechanical Engineering
VIII Semester Syllabus
ME818PE - Animatronics

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