

**Program Structure for
B.E. in Mechanical Engineering
University of Mumbai
(With Effect from 2017-2018)**

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned					
		Theory	Pract	Theory	Pract	Total			
MEC301	Applied Mathematics III**	04	--	04	--	04			
MEC302	Thermodynamics*	04	--	04	--	04			
MEC303	Strength of Materials*	04	--	04	--	04			
MEC304	Production Process I*	04	--	04	--	04			
MEC305	Material Technology*	03	--	03	--	03			
MEL301	Computer Aided Machine Drawing*	--	2 ^s +4	--	03	03			
MEL302	Strength of Material*	--	02	--	01	01			
MEL303	Material Technology*	--	02	--	01	01			
MEL304	Machine Shop Practice I*	--	04	--	02	02			
Total		19	14	19	07	26			
Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
MEC301	Applied Mathematics III**	20	20	20	80	03	--	--	100
MEC302	Thermodynamics*	20	20	20	80	03	--	--	100
MEC303	Strength of Materials*	20	20	20	80	03	--	--	100
MEC304	Production Process I*	20	20	20	80	03	--	--	100
MEC305	Material Technology*	20	20	20	80	03	--	--	100
MEL301	Computer Aided Machine Drawing*	--	--	--	--	--	50	50	100
MEL302	Strength of Material*	--	--	--	--	--	25	25	50
MEL303	Material Technology*	--	--	--	--	--	25	--	25
MEL304	Machine Shop Practice I*	--	--	--	--	--	50	--	50
Total				100	400		150	75	725

* Common with Automobile Engineering

** Common with Automobile Engineering, Production Engineering and Civil Engineering

\$ Theory for entire class to be conducted

Course Code	Course Name	Credits
MEC301	Applied Mathematics III**	04

Objectives

1. To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyse engineering problems.
2. To study the basic principles of Laplace Transform, Fourier Series, Complex variables.

Outcomes: Learner will be able to...

1. Demonstrate the ability of using Laplace Transform in solving the Ordinary Differential Equations and Partial Differential Equations
2. Demonstrate the ability of using Fourier Series in solving the Ordinary Differential Equations and Partial Differential Equations
3. Solve initial and boundary value problems involving ordinary differential equations
4. Identify the analytic function, harmonic function, orthogonal trajectories
5. Apply bilinear transformations and conformal mappings
6. Identify the applicability of theorems and evaluate the contour integrals.

Module	Detailed Contents	Hrs
1	Laplace Transform 1.1 Function of bounded variation, Laplace Transform of standard functions such as $1, t^n, e^{at}, \sin at, \cos at, \sinh at, \cosh at$ 1.2 Linearity property of Laplace Transform, First Shifting property, Second Shifting property, Change of Scale property of L.T. (without proof) $L\{t^n f(t)\}, L\left\{\frac{f(t)}{t}\right\}, L\left\{\int_0^t f(u)du\right\}, L\left\{\frac{d^n f(t)}{dt^n}\right\}$ Laplace Transform. of Periodic functions 1.3 Inverse Laplace Transform: Linearity property, use of theorems to find inverse Laplace Transform, Partial fractions method and convolution theorem(without proof). 1.4 Applications to solve initial and boundary value problems involving ordinary differential equations with one dependent variable	12
2	Complex variables: 2.1 Functions of complex variable, Analytic function, necessary and sufficient conditions for $f(z)$ to be analytic (without proof), Cauchy-Riemann equations in polar coordinates. 2.2 Milne- Thomson method to determine analytic function $f(z)$ when it's real or imaginary or its combination is given. Harmonic function, orthogonal trajectories 2.3 Mapping: Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations such as Rotation and magnification, inversion and reflection, translation	08
3	Complex Integration: 3.1 Line integral of a function of a complex variable, Cauchy's theorem for analytic functions(without proof)Cauchy's integral formula (without proof))Singularities and poles: 3.2 Taylor's and Laurent's series development (without proof) 3.3 Residue at isolated singularity and its evaluation 3.4 Residue theorem, application to evaluate real integral of type $\int_0^{2\pi} f(\cos \theta, \sin \theta) d\theta, \quad \& \quad \int_{-\infty}^{\infty} f(x) dx$	08
4	Fourier Series: 4.1 Orthogonal and orthonormal functions, Expressions of a function in a series of orthogonal functions. Dirichlet's conditions. Fourier series of periodic function with period 2π and $2l$	10

	4.2 Dirichlet's theorem(only statement), even and odd functions, Half range sine and cosine series,Parseval's identities (without proof) 4.3 Complex form of Fourier series	
5	Partial Differential Equations: 5.1. Numerical Solution of Partial differential equations using Bender-Schmidt Explicit Method, Implicit method (Crank- Nicolson method). 5.2. Partial differential equations governing transverse vibrations of an elastic string its solution using Fourier series. 5.3. Heat equation, steady-state configuration for heat flow 5.4. Two and Three dimensional Laplace equations	09
6	Correlation and curve fitting 6.1. Correlation-Karl Pearson's coefficient of correlation- problems, Spearman's Rank correlation problems, Regression analysis- lines of regression (without proof) –problems 6.2. Curve Fitting: Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References:

1. Higher Engineering Mathematics, Dr B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
3. Higher Engineering Mathematics, B.V. Ramana, McGraw Hill Education, New Delhi
4. Complex Variables: Churchill, Mc-Graw Hill
5. Integral Transforms and their Engineering Applications, Dr B. B. Singh, Synergy Knowledgeware, Mumbai
6. Numerical Methods, Kandasamy, S. Chand & CO
7. Fundamentals of mathematical Statistics by S.C.. Gupta and Kapoor

Course Code	Course Name	Credits
MEC302	Thermodynamics*	04

Objectives

1. To familiarize the concepts of Energy in general and Heat and Work in particular
2. To study the fundamentals of quantification and grade of energy
3. To study the effect of energy transfer on properties of substances in the form of charts and diagrams
4. To familiarize application of the concepts of thermodynamics in vapour power, gas power cycles

Outcomes: Learner will be able to...

1. Demonstrate application of the laws of thermodynamics to wide range of systems.
2. Write steady flow energy equation for various flow and non-flow thermodynamic systems
3. Compute heat and work interactions in thermodynamics systems
4. Demonstrate the interrelations between thermodynamic functions to solve practical problems.
5. Use steam table and mollier chart to compute thermodynamics interactions
6. Compute efficiencies of heat engines, power cycles etc.

Module	Detailed Contents	Hrs
01	Basic Concepts & definitions: Thermodynamics and its importance, Macroscopic and Microscopic view point, Concept of Continuum, Thermodynamic System, Surrounding and Boundary, Control Volume approach and Systems approach, Equilibrium – Thermal, Chemical, Mechanical and thermodynamic, Pure Substance, Property – Intensive and Extensive, State, Path, Process and Cycle. Point Function and Path Function, Quasi Static Process and processes like Isobaric, Isochoric, Isothermal, Polytropic Process, Temperature and different scales, Zeroth Law of Thermodynamics, Energy, sources of energy; forms of energy, Energy transfer by work and forms of work ; free Expansion, Energy transfer by heat ; Adiabatic Process, Equations of state, Ideal gas Equation-; Specific gas constant and Universal Gas Constant	08
02	First Law of Thermodynamics: Relation between Heat and Work- Joules Constant, First law of thermodynamics for a cyclic process, First law of thermodynamics for a closed system undergoing a process, Conservation principle, First Law of Thermodynamics applied to open system – Steady Flow Energy Equation, Perpetual motion Machine of First kind, Application of first law of thermodynamics to closed system or Non flow Process, Application of first law of thermodynamics to Open Systems like Steam Nozzle, Boiler, Steam Turbine, Pump, Heat Exchanger, Throttling Process – Joules Thompson Coefficient and its significance	07
03	Second Law of Thermodynamics: Limitation of first law of thermodynamics, Thermal Reservoir – Source and Sink, Concept of Heat Engine, Heat Pump and Refrigerator, Second law of thermodynamics – Kelvin Planck and Clausius Statements. Equivalence of Clausius and Kelvin Planck Statement, Reversible and Irreversible Process. Causes of Irreversibility, Perpetual Motion Machine of Second Kind, Need of Carnot theorem and its corollaries, Carnot cycle, Thermodynamic Temperature Scale and its equivalence with Ideal Gas Scale Entropy: Clausius Inequality, Clausius Theorem, Entropy is Property of a system, Isentropic Process, Temperature Entropy Plot and its relationship with heat interactions, Entropy Principle, Entropy change During a Process. Interpretation of concept of entropy	07
04	Thermodynamic Relations: Reciprocal Relation, Cyclic Relation Property relations, Maxwell Relations, TdS equations, Heat capacity relations, Volume Expansivity, Isothermal Compressibility, Clausius-Clapeyron Equation Availability:	10

	High grade and Low Grade Energy, Available and Unavailable Energy, Dead State, Available energy with respect to a process and a cycle, Decrease of Available Energy When heat is transferred through a finite temperature Difference, Second Law efficiency Properties of Pure Substance: Pure substance and Phase changes: Phase change processes of pure substance, Property diagrams for phase change process (T-v, T-s and p-h diagrams), Understanding of Steam Table and Mollier chart with suitable examples.	
05	Compressors: Reciprocating Air Compressor, Single stage compressor – computation of work done, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram, Multistage compressors – Constructional details of multistage compressors, Need of multistage, Computation of work done, Volumetric efficiency, Condition for maximum efficiency, Inter cooling and after cooling (numerical), Theoretical and actual indicator diagram for multi stage compressors Rotary Air Compressors- Classification, Difference between compressors and blowers, Working and constructional details of roots blower, Screw type and vane type compressors	08
06	Vapour Power cycle: Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Methods to improve thermal efficiency of Rankine cycle – Reheat cycle and Regeneration Cycle. Gas Power cycles: Assumptions of Air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Brayton Cycle, Sterling Cycle and Ericsson Cycle and Lenoir cycle and Atkinson cycle	10

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Reference Books:

1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael ABoles, 7th edition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, Longman Publishers Engineering
3. Engineering Thermodynamics by P Chattopadhyay, 2nd edition, Oxford University Press India
4. Thermodynamics by P K Nag, 5th edition, TMH
5. Thermodynamics by Onkar Singh, New Age International
6. Thermodynamics by C P Arora, TMH
7. Engineering Thermodynamics through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
8. Fundamentals of Thermodynamics by Moran & Shapiro
9. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., JohnWiley & Sons
10. Thermodynamics by W.C. Reynolds, McGraw-Hill & Co
11. Thermodynamics by J P Holman, McGraw-Hill & Co

Course Code	Course Name	Credits
MEC303	Strength of Materials*	04

* Course common to Mechanical and Automobile Engineering

Objectives:

1. To study different types of stresses, strain and deformation induced in the mechanical components due to external loads.
2. To study distribution of various stresses in the mechanical elements or bodies of finite dimensions that deform under loads.
3. To study the effects of component dimensions, materials and shapes on stresses and deformations

Outcomes: Learner will be able to...

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw the SFD and BMD for different types of loads and support conditions.
3. Analyse the stresses induced in basic mechanical components.
4. Estimate the strain energy in mechanical elements.
5. Analyse the deflection in beams.
6. Analyse buckling and bending phenomenon in columns, struts and beams.

Module	Detailed Contents	Hrs
1	Moment of Inertia: Area moment of Inertia, Principal Axes and Principal Moment of Inertia, , Parallel Axis theorem, Polar moment of Inertia. Stresses and Strains: Definition – Stress, Strain, Hooke’s law, elastic limit, uni-axial, bi-axial and tri-axial stresses, tensile & compressive stresses, shear stress, Principal stresses and strains, Mohr’s circle. Elastic Constants: Poisson’s ratio, Modulus of elasticity, Modulus of rigidity, Bulk Modulus, yield stress, Ultimate stress. Factor of safety, state of simple shear, relation between elastic constants, volumetric strain, volumetric strain for tri-axial loading, deformation of tapering members, deformation due to self –weight, bars of varying sections, composite sections, thermal stress and strain.	12
2	Shear Force and Bending Moment in Beams: Axial force, shear force and bending moment diagrams for statically determinate beams including beams with internal hinges for different types of loading, relationship between rates of loading, shear force and bending moment.	08
3	Stresses in Beams: Theory of pure bending, Assumptions, Flexural formula for straight beams, moment of resistance, bending stress distribution, section modulus for different sections, beams for uniform strength, Flitched beams. Direct and Bending Stresses: Core of sections, Chimneys subjected to wind pressure. Shear Stress in Beams: Distribution of shear stress, across plane sections used commonly for structural purposes, shear connectors.	08
4	Torsion: Torsion of circular shafts- solid and hollow, stresses in shafts when transmitting power, shafts in series and parallel. Strain Energy: Resilience, Proof Resilience, strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to shear, bending and torsion.	08

5	Deflection of Beams: Deflection of Cantilever, simply supported and overhang beams using double integration and Macaulay's Method for different types of loadings Thin Cylindrical and Spherical Shells: Cylinders and Spheres due to internal pressure, Cylindrical shell with hemi spherical ends	08
6	Columns and Struts: Buckling load, Types of end conditions for column, Euler's column theory and its limitations, Rankine and Johnson formula	04

Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

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End Semester Examination:

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1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References:

1. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016
2. Strength of Materials by Ryder, Macmillan
3. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, 6thEd, 2009
4. Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
5. Strength of Materials by Basavrajiah and Mahadevappa, Khanna Publishers, New Delhi
6. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
7. Mechanics of Materials by Beer, Johnston, Dewolf and Mazurek, TMHPvt Ltd., New Delhi
8. Mechanics of Structures by S.B. Junnarkar, Charotar Publication
9. Mechanics of Materials by S.S. Ratan, Tata McGraw Hill Pvt. Ltd
10. Introduction to Solid Mechanics by Shames, PHI
11. Strength of Materials by Nag and Chandra, Wiley India
12. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
13. Strength of Materials by W. Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition

Course Code	Course Name	Credits
MEC304	Production Process*	04

Objectives

1. To study basic production processes.
2. To study how to select appropriate production processes for a specific application.
3. To study machine tools

Outcomes: Learner will be able to...

1. Demonstrate understanding of casting process
2. Illustrate principles of forming processes
3. Demonstrate applications of various types of welding processes.
4. Differentiate chip forming processes such as turning, milling, drilling, etc.
5. Illustrate the concept of producing polymer components and ceramic components.
6. Distinguish between the conventional and modern machine tools.

Module	Detailed Contents	Hrs
1	1.1 Metal casting: Classification of Production Processes: Examples and field of applications Pattern materials and allowances, Types of pattern, Sand properties, Sand moulding, Machine moulding Gating system :Types of riser, types of gates, solidification Melting- cupola& induction furnaces 1.2 Special casting processes : CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	10
2	2.1 Joining processes: Welding: Classification of welding, Oxy-acetylene welding, types of flames, equipment used, welding methods & applications, Arc welding principle and working of metal arc welding, TIG & MIG welding, submerged arc welding, electro-slag welding & stud welding PAM welding. Applications merits & demerits of above welding processes, fluxes used, Thermit welding, Resistance welding, Friction welding, ultrasonic, explosive, LASER, electron beam welding, Welding defects and remedies Soldering and brazing techniques & applications Fastening processes	10
3	3.1 Forming processes: Principles and process characteristics, Rolling types, Rolling parameters: Draught, spread, elongation, roll pressure, torque, work and power in rolling. Effect of front and back tension on rolling load and capacities, Rolling defects, Thread rolling roll forging, production of seamless tubes, Forging, Extrusion and Wire Drawing processes	08
4	4.1 Moulding with polymers: Moulding with polymers: Basic concepts related to Injection Moulding, Compression moulding, Transfer moulding, Blow Moulding, Rotational Moulding, Thermoforming and Extrusion. Applications of plastics in Engineering field 4.2 Moulding with ceramics: Blow moulding and extrusion of glass.	06
5	Classification, Selection and application of Machine Tools: 5.1 Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines, Broaching machines, Lapping/Honing machines and shaping/slotting/planning Machines. 5.2 Gear Manufacturing -Gear milling, standard cutters and limitations, gear hobbing, gear shaping, gear shaving and gear grinding processes	10
6	5.1 Modern Machine Tools: CNC machines: Introduction, principles of operation, Types – Vertical machining centres and horizontal machining centres, major elements, functions, applications, controllers, open loop and closed loop systems 5.2 Types of automatic machines, Transfer machines	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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End Semester Examination:

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3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References

1. Workshop Technology By W. A. J. Chapman part I, II & III
2. A Textbook of Foundry Technology by M. Lal
3. Production Technology by R. C. Patel and C. G. Gupta Vol I, II.
4. Production Technology by Jain & Gupta
5. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R. Schmid, Prentice Hall
6. Production Technology by HMT
7. Elements of Workshop Technology Hazra Chaudhary Vol I, II.
8. Foundry technology by P.L. Jain
9. Production Technology by P.C. Sharma
10. Manufacturing processes by P. N. Rao, Vol. 1 and 2

Course Code	Course Name	Credits
MEC305	Material Technology*	03

Objectives

1. To study basic engineering materials, their structure-property-performance
2. To study strengthening processes including heat treatment processes in order to enhance properties.
3. To study new materials and their applications

Outcomes: Learner will be able to...

1. Identify various crystal imperfections, deformation mechanisms, and strengthening mechanisms
2. Demonstrate understanding of various failure mechanisms of materials.
3. Interpret Iron-Iron carbide phase diagram, and different phases in microstructures of materials at different conditions.
4. Select appropriate heat treatment process for specific applications.
5. Identify effect of alloying elements on properties of steels
6. Illustrate basics of composite materials, Nano- materials and smart materials.

Module	Detailed Contents	Hrs
1	<p>1.1 Classification of Materials: Metallic materials, Polymeric Materials, Ceramics and Composites: Definition, general properties, applications with examples</p> <p>1.2 Lattice Imperfections: Definition, classification and significance of Imperfections Point defects: vacancy, interstitial and impurity atom defects, Their formation and effects, Dislocation - Edge and screw dislocations Burger's vector, Motion of dislocations and their significance, Surface defects - Grain boundary, sub-angle grain boundary and stacking faults, their significance, Generation of dislocation, Frank Reed source, conditions of multiplication and significance.</p> <p>1.3 Deformation: Definition, elastic and plastic deformation, Mechanism of deformation and its significance in design and shaping, Critical Resolved shear stress, Deformation in single crystal and polycrystalline materials, Slip systems and deformability of FCC, BCC and HCP lattice systems.</p> <p>1.4 Strain Hardening: Definition importance of strain hardening, Dislocation theory of strain hardening, Effect of strain hardening on engineering behaviour of materials, Recrystallization Annealing: stages of recrystallization annealing and factors affecting it</p>	08
2	<p>Failure mechanisms:</p> <p>1.1 Fracture: Definition and types of fracture, Brittle fracture: Griffith's theory of fracture, Orowan's modification, Dislocation theory of fracture, Critical stress and crack propagation velocity for brittle fracture, Ductile fracture: Notch effect on fracture, Fracture toughness, Ductility transition, Definition and significance</p> <p>1.2 Fatigue Failure: Definition of fatigue and significance of cyclic stress, Mechanism of fatigue and theories of fatigue failure, Fatigue testing, Test data presentation and statistical evolution, S-N Curve and its interpretation, Influence of important factors on fatigue, Notch effect, surface effect, Effect of pre-stressing, corrosion fatigue, Thermal fatigue.</p> <p>1.3 Creep: Definition and significance of creep, Effect of temperature and creep on mechanical behaviours of materials, Creep testing and data presentation and analysis, Mechanism and types of creep, Analysis of classical creep curve and use of creep rate in designing of products for load bearing applications, Creep Resistant materials</p>	08
3	<p>3.1 Theory of Alloys & Alloys Diagrams : Significance of alloying, Definition, Classification and properties of different types of alloys, Solidification of pure metal, Different types of phase diagrams (Isomorphous, Eutectic,</p>	08

	Peritectic, Eutectoid, Peritectoid) and their analysis, Importance of Iron as engineering material, Allotropic forms of Iron, Influence of carbon in Iron- Carbon alloying Iron-Iron carbide diagram and its analysis, TTT diagram, CCT diagram Hardenability concepts and tests, Graphitization of Iron- Grey iron, white iron, Nodular and malleable irons, their microstructures, properties and applications	
4	4.1 Heat treatment Process: Technology of heat treatment, Classification of heat treatment process, Annealing- Principle process, properties and applications of full annealing, Diffusion annealing, process annealing and Cyclic annealing, Normalizing, Hardening heat treatment, Tempering, Subzero treatment, Austempering, Martempering, Maraging and Ausforming process, Surface hardening: Hardening and surface Hardening methods. Carburizing, Nitriding, Cyaniding, Carbonitriding, induction hardening and flame hardening processes	06
5	5.1 Effect of Alloying Elements in Steels: Limitation of plain carbon steels, Significance of alloying elements, Effects of major and minor constituents, Effect of alloying elements on phase transformation Classification of tool steels and metallurgy of tool steels and stainless steel	04
6	Introduction to New materials: 6.1 Composites: Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites and their applications 6.2 Nano Materials: Introduction, Concepts, synthesis of nanomaterials, examples, applications and Nano composites 6.3 An overview to Smart materials (e.g.: Rheological fluids)	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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End Semester Examination:

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1. Question paper will comprise of total **six questions, each carrying 20 marks**
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3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References

1. Materials Science and Engineering by William D. Callister, Jr. – Adapted by R.Balasubramaniam, Wiley India (P) Ltd
2. Material Science and Metallurgy by V.D. Kodgire, Everest Publishing House
3. Mechanical Behaviour of Materials by Courtney, McGraw Hill International New Delhi
4. Introduction of Engineering Materials, by B.K. Agrawal, McGraw Hill Pub. Co. Ltd
5. Mechanical Metallurgy by G.E. Dieter, McGraw Hill International New Delhi
6. A text book of Metallurgy by A.R.Bailey, Macmillan & Co. Ltd., London
7. The Structure and Properties of Engineering Alloys by W.F. Smith, McGraw hill Int.
8. Engineering Physical Metallurgy, by Y. Lakhtin, Mir Publishers, Moscow
9. Introduction to Physical Metallurgy by SydneyAvner, McGraw Hill
10. Metallurgy for Engineers by E.C. Rollason - ELBS SOC and Edward Arnold, London

Course Code	Course Name	Credits
MEL301	Computer Aided Machine Drawing*	03

Objectives:

1. To familiarise conversion of an object into a drawing
2. To study conventional representation of various machining and mechanical details as per IS
3. To become conversant with 2-D and 3-D drafting

Outcomes: Learner will be able to...

1. Visualize and prepare detail drawing of a given object.
2. Read and interpret the drawing
3. Draw details and assembly of different mechanical systems.
4. Convert detailed drawing into assembly drawing using modelling software
5. Convert assembly drawing into detailed drawing using modelling software
6. Prepare detailed drawing of any given physical object/machine element with actual measurements

Module	Detailed Contents	Theory	Practical
1	1.1 Machine Elements: Preparation of 2-D drawings of standard machine elements (nuts, bolts, keys, cotter, screws, spring etc) 1.2 Conventional representation of threaded parts, Types of threads; thread designation, Conventional representation of machine components and materials, Designation of standard components 1.3 Solid Geometry: Intersection of surfaces and interpenetration of solids- Intersection of prism or cylinder with prism; cylinder or cone, both solids in simple position only. Primary auxiliary views	02 01 04	04 -- --
2	2.1 Geometric Dimensioning and Tolerancing (GD&T) : Dimensioning with tolerances indicating various types of fits, 2.2 Details and assembly drawing: Types of assembly drawings, part drawings, drawings for catalogues and instruction manuals, patent drawings, drawing standards, 2.3 Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa, 2.4 Preparation of details and assembly drawings of any three from: Clapper block, Single tool post, Lathe and Milling tail stock, jigs and fixtures 2.5 Cotter, Knuckle joint, Keys: keys-sunk, parallel woodruff, saddle, feather etc. 2.6 Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling	02 02 02 01 02	-- -- 08 -- 06
3	3.1 Preparation of details and assembly drawings of Bearings: Simple, solid, Bushed bearing, I.S. conventional representation of ball and roller bearing, Pedestal bearing, footstep bearing	02	06
4	4.1 Preparation of details and assembly drawings of pulleys, Pipe joints: Classification of Pulleys, pipe joints 4.2 Pulleys: Flat belt, V-belt, rope belt, Fast and loose pulleys. 4.3 Pipe joints(any two): Flanged joints, Socket and spigot joint, Gland and stuffing box, expansion joint	02 -- --	-- 06 06
5	5.2 Preparation of details and assembly drawings of Valves, I.C. Engine parts: Types of Valves, introduction to I.C. Engine 5.3 Preparation of details and assembly drawings(any three): Air cock; Blow off cock, Steam stop valve, Gate valve, Globe valve, Non return Valve, I.C. Engine parts: Piston, Connecting rod, Cross head, Crankshaft, Carburettor, Fuel pump, injector, and Spark plug	02 --	-- 08

6	6.1 Reverse Engineering of a physical model: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions	02	06
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Assessment:

Term work

- A. Minimum two questions from theory part of each module should be solved as a home work in A-3 size sketch book.
- B. A-3 size Printouts/plots of the problems solved in practical class from the practical part of each module. Problems from practical parts of each module should be solved using any standard CAD packages like IDEAS, PRO-E, CATIA, Solid Works, Inventor etc.

The distribution of marks for Term work shall be as follows:

- Home work sketch book 20 marks
- Printouts/Plots 20 marks
- Attendance 10 marks

End Semester Practical/Oral examination:

To be conducted by pair of Internal and External Examiner

1. Practical examination duration is **three hours**, based on Part-B of the Term work, and should contain two sessions as follows:

Session-I: Preparation of 3-D models of parts, assembling parts and preparing views of assembly from given 2-D detailed drawing.

Session-II: Preparation of minimum five detailed 3-D part drawings from given 2-D assembly drawing.

Oral examination should also be conducted to check the knowledge of conventional and CAD drawing.

2. Questions provided for practical examination should contain minimum five and not more than ten parts.

3. The distribution of marks for practical examination shall be as follows:

- **Session-I** 20 marks
- **Session-II** 20 marks
- **Oral** 10 marks

4. Evaluation of practical examination to be done based on the printout of students work

5. Students work along with evaluation report to be preserved till the next examination

References:

1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L. Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M. B. Shah
5. A text book of Machine Drawing by R. B. Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I.Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by ShamTickoo and SurinderRaina, Dreamtech Press
9. Engineering Drawing by P J Shah
10. Engineering Drawing by N D Bhatt

Course Code	Course Name	Credits
MEL302	Strength of Materials*	01

Objectives:

1. To familiarise material behaviour under different loading conditions
2. To acquaint with surface hardness measurement method
3. To familiarise with impact test methods for different materials

Outcomes: Learner will be able to...

1. Analyse the stress - strain behaviour of materials
2. Measure ultimate tensile/compression strength of material
3. Measure torsional strength of material
4. Perform impact test using Izod and Charpy method
5. Measure the hardness of materials.
6. Perform flexural test with central and three point loading conditions

a) List of Experiments (Minimum Eight)

Module	Detailed Contents	Laboratory Sessions
1	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	2 Hrs
2	Bending test on UTM	2 Hrs
3	Torsion test on mild steel bar / cast iron bar	2 Hrs
4	Impact test on metal specimen (Izod test)	2 Hrs
5	Impact test on metal specimen (Charpy test)	2 Hrs
6	Hardness test on metals - Brinell Hardness Number	2 Hrs
7	Hardness test on metals - Rockwell Hardness Number	2 Hrs
8	Flexural test on beam (central loading)	2 Hrs
9	Flexural test on beam (three point loading)	2 Hrs

b) Assignments: Atleast one problem on each of the following topics:

1. Simple stress strain
2. SFD and BMD
3. Stresses in beams
4. Strain energy and deflection.
5. Torsion, Columns and struts

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be incorporated by judiciously reducing number of assignments.**

Assessment:

Term Work: Including Part a and b both

Distribution of marks for Term Work shall be as follows:

Part a	:	15marks.
Part b	:	05 Marks
Attendance	:	05 marks.

End Semester Practical/Oral Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral

Course Code	Course Name	Credits
MEL303	Materials Technology*	03

Objectives:

1. To familiarise with use of optical laboratory microscope
2. To acquaint with microstructures of ferrous (steel and cast iron) metals
3. To familiarise with microstructures of steel under different heat treated conditions
4. To study hardenability, fatigue test for fatigue strength and corrosion rate test

Outcomes: Learner will be able to...

1. Demonstrate the understanding of the procedure to prepare samples for studying microstructure using microscope (metallography)
2. Interpret different phases present in different plain carbon steels and cast irons.
3. Perform different heat treatment processes for a steel and observe microstructures in these conditions
4. Identify effects of Annealing, Normalizing and Hardening on microstructure of medium carbon steel
5. Determine hardenability of steel using Jominy end Quench test
6. Determine S-N curve by Fatigue Test.

Sr No	Details
1	Study of metallurgical microscope
2	Metallographic sample preparation and etching
3	Microstructures of plain carbon steels
4	Microstructures of cast irons
5	Annealing, Normalizing and Hardening of medium carbon steel and observation of microstructures
6	Study of tempering characteristics of hardened steel
7	Determination of hardenability of steel using Jominy end Quench Test
8	Fatigue test – to determine number of cycles to failure of a given material at a given stress

Assignments: Assignment on following topics

1. Crystal imperfections-deformation-strengthening mechanisms
2. Fracture-failure of metals
3. Iron –Iron carbide phase diagram/TTT diagram/CCT diagram.
4. Heat treatment processes
5. Alloy steels (e. g. alloy steels, tool steels)
6. New materials

Note: Preferably, the assignments shall be based on live problems. **Project Based Learning may be incorporated by judiciously reducing number of assignments**

Assessment:

Term Work: Including Laboratory Work and Assignments both

Distribution of marks for Term Work shall be as follows:

Laboratory work	15 marks
Assignments	05 Marks
Attendance	05 marks

Course Code	Course Name	Credits
MEL304	Machine Shop Practice I*	02

Objectives:

1. To study basic machining processes.
2. To familiarise various machining operations and machine protocols

Outcomes: Learner will be able to...

1. Operate various machines like lathe, shaper etc.
2. Perform plain turning, taper turning, and screw cutting etc. on lathe machine.
3. Perform machining operations on shaper.
4. Demonstrate metal joining process like compressive welding.
5. Perform forging operations
6. Perform shaping operations

Module	Details	Hrs
1	Introduction to Lathe Machine, demonstration of various machining processes performed on lathe machine. One Job on Plain and Taper Turning One job on Precision Turning, Taper Turning and Screw Cutting	18
2	Introduction to Shaping Machine and various machining processes performed on Shaping Machine One job on shaping machine to make horizontal and inclined surface	12
3	Introduction to various forging tools Two jobs on Forging of Cutting Tools used on Lathe Machine	12
4	One simple exercise on Welding, Preparation of a component using Compressive Welding Joint	6

Assessment:

Term Work:

1. All the jobs mentioned above
2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work with complete workshop book 40 marks
Attendance 10 marks

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned						
		Theory	Pract	Theory	Pract	Total				
MEC401	Applied Mathematics IV**	04	--	04	--	04				
MEC402	Fluid Mechanics*	04	--	04	--	04				
MEC403	Industrial Electronics*	03	--	03	--	03				
MEC404	Production Process II*	04	--	04	--	04				
MEC405	Kinematics of Machinery*	04	--	04	--	04				
MEL401	Data Base and Information Retrieval*	--	2 ^s +2	--	02	02				
MEL402	Fluid Mechanics*	--	02	--	01	01				
MEL403	Industrial Electronics*	--	02	--	01	01				
MEL404	Kinematics of Machinery*	--	02	--	01	01				
MEL405	Machine Shop Practice II*	--	04	--	02	02				
Total		19	14	19	07	26				
Course Code	Course Name	Examination Scheme								
		Theory					Exam Duration (Hrs)	Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam					
		Test1	Test 2	Avg						
MEC401	Applied Mathematics IV**	20	20	20	80	03	--	--	100	
MEC402	Fluid Mechanics*	20	20	20	80	03	--	--	100	
MEC403	Industrial Electronics*	20	20	20	80	03	--	--	100	
MEC404	Production Process II*	20	20	20	80	03	--	--	100	
MEC405	Kinematics of Machinery*	20	20	20	80	03	--	--	100	
MEL401	Data Base and Information Retrieval*	--	--	--	--	--	50	50	100	
MEL402	Fluid Mechanics*	--	--	--	--	--	25	25	50	
MEL403	Industrial Electronics*	--	--	--	--	--	25	25	50	
MEL404	Kinematics of Machinery*	--	--	--	--	--	25	--	25	
MEL405	Machine Shop Practice II*	--	--	--	--	--	50	50	100	
Total				100	400		175	150	825	

* Common with Automobile Engineering

** Common with Automobile Engineering, Production Engineering and Civil Engineering

\$ Theory for entire class to be conducted

Course Code	Course Name	Credits
MEC401	Applied Mathematics IV**	04

Objectives:

- 1 To inculcate an ability to relate engineering problems to mathematical context
- 2 To provide a solid foundation in mathematical fundamentals required to solve engineering problem
- 3 To study the basic principles of Vector analyses, complex integration, probability, test of hypothesis and correlation between data.
- 4 To prepare students for competitive exams

Outcomes: Learner will be able to...

- 1 Solve the system of linear equations using matrix algebra with its specific rules
- 2 Demonstrate basics of vector calculus
- 3 Apply the concept of probability distribution and sampling theory to engineering problems
- 4 Apply principles of vector calculus to the analysis of engineering problems
- 5 Identify, formulate and solve engineering problems
- 6 Illustrate basic theory of correlations and regression

Module	Details	Hrs
1	Matrices: 1.1 Brief revision of vectors over a real field, inner product, norm of a vector 1.2 Eigen values and Eigen vectors: Characteristic polynomial, characteristic equation, characteristic roots and characteristic vectors of a square matrix, properties of characteristic roots and vectors of different types of matrices such as orthogonal matrix, Hermitian matrix, Skew-Hermitian matrix, Cayley Hamilton theorem (without proof) . Similarity of matrices. Functions of a square matrix	08
2	Matrices: 2.1 Minimal polynomial and Derogatory matrix 2.2 Quadratic forms: Linear transformations of a quadratic form, congruence of a square matrix, reduction to Canonical form under congruent transformations, orthogonal transformations, determining the nature of a quadratic form, Applications of Eigen Values and Eigen Vectors Vector calculus 2.3 Brief revision of Scalar and vector point functions. Gradient of a scalar function, Divergence and curl of a vector function 2.4 Line integrals, circulation of a vector, condition for independence of the path in the line integral	09
3	Vector calculus: 3.1 Green's theorem(without proof) for plane regions and properties of line integrals, Stokes theorem (without proof), Gauss divergence theorem (without proof) related identities and deductions.(No verification problems on Stoke's Theorem and Gauss Divergence Theorem) Linear Programming problems 3.2 Types of solutions to linear programming problems, standard form of L.P.P. Simplex method to solve L.P.P	09
4	Linear Programming problems Probability Distributions: 4.1 Big M method (Penalty method) to solve L.P.P, Duality, Dual simplex method and Revised simplex method to solve L.P.P. Probability Distributions 4.2 Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expected value, Variance. 4.3 Probability Distributions: Binomial, Poisson and Normal Distributions	09

5	Sampling theory: 5.1. Sampling theory: Sampling distribution. Test of Hypothesis. Level of significance, critical region. One tailed and two tailed tests. Interval Estimation of population parameters. Large and small samples 5.3. Test of significance for Large samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two samples. 5.4. Student's t-distribution and its properties. Test of significance of small samples: Test for significance of the difference between sample mean and population means, Test for significance of the difference between the means of two Samples, paired t-test	09
6	Sampling theory and ANOVA 6.1. Chi-square test, Test for the Goodness of fit, Association of attributes and Yate's correction 6.2. Analysis of Variance(F-Test): One way classification, Two-way classification(short-cut method)	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References:

1. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
2. Higher Engineering Mathematics, B. S. Grewal, Khanna Publication
3. Advanced Engineering Mathematics, H. K. Dass, S. Chand & co
4. Vector Analysis by Murray R. Spiegel, Schaum Series
5. Operations Research, S.D. Sharma, S. Chand & CO.
6. Fundamentals of Mathematical Statistics, S C Gupta & V K Kapoor, S. Chand & Co
7. Elements of Applied mathematics, P N & J N Wartikar, Pune Vidyarthi Gruha Prakashan
8. Advanced Engineering Mathematics, E Kreyszing, Wiley Eastern Limited
9. Operations Research, Kantiswearup, Manmohan, P K Gupta, S. Chand & CO

Course Code	Course Name	Credits
MEC402	Fluid Mechanics*	04

Objectives:

1. To study fluid statics and fluid dynamics
2. To study application of mass, momentum and energy equations in fluid flow.
3. To learn various flow measurement techniques.

Outcomes: Learner will be able to...

1. Define properties of fluids and classification of fluids
2. Evaluate hydrostatic forces on various surfaces and predict stability of floating bodies
3. Formulate and solve equations of the control volume for fluid flow systems
4. Apply Bernoulli's equation to various flow measuring devices
5. Calculate resistance to flow of incompressible fluids through closed conduits and over surfaces
6. Apply fundamentals of compressible fluid flows to relevant systems

Module	Detailed Contents	Hrs
1	1.1 Fluid Definition and properties, Newton's law of viscosity concept of continuum, Classification of fluids 1.2 Fluid Statics: Definition of body and surface forces, Pascal's law, Basic hydrostatic equation, Forces on surfaces due to hydrostatic pressure, Buoyancy and Archimedes' principle	06
2	2 Fluid Kinematics: 2.1 Eulerian and Lagrangian approach to solutions; Velocity and acceleration in an Eulerian flow field; Definition of streamlines, path lines and streak lines; Definition of steady/unsteady, uniform/non-uniform, one-two and three dimensional flows; Definition of control volume and control surface, Understanding of differential and integral methods of analysis 2.2 Definition and equations for stream function, velocity potential function in rectangular and cylindrical co-ordinates, rotational and irrotational flows; Definition and equations for source, sink, irrotational vortex, circulation	06
3	3 Fluid Dynamics: 3.1 Integral equations for the control volume: Reynold's Transport theorem, equations for conservation of mass, energy and momentum, Bernoulli's equation and its application in flow measurement, pitot tube, venture, orifice and nozzle meters. 3.2 Differential equations for the control volume: Mass conservation in 2 and 3 dimension in rectangular, Euler's equations in 2,3 dimensions and subsequent derivation of Bernoulli's equation; Navier-Stokes equations (without proof) in rectangular Cartesian co-ordinates; Exact solutions of Navier-Stokes Equations to viscous laminar flow between two parallel planes (Couette flow and plane Poiseuille flow)	12
4	4 Real fluid flows: 4.1 Definition of Reynold's number, Laminar flow through a pipe (Hagen-Poiseuille flow), velocity profile and head loss; Turbulent flows and theories of turbulence-Statistical theory, Eddy viscosity theory and Prandtl mixing length theory; velocity profiles for turbulent flows-universal velocity profile, $1/7^{th}$ power law; Velocity profiles for smooth and rough pipes 4.2 Darcy's equation for head loss in pipe (no derivation), Moody's diagram, pipes in series and parallel, major and minor losses in pipes	08
5	5 Boundary Layer Flows: 5.1 Concept of boundary layer and definition of boundary layer thickness, displacement, momentum and energy thickness; Growth of boundary layer,	08

	laminar and turbulent boundary layers, laminar sub-layer; Von Karman Momentum Integral equation for boundary layers (without proof), analysis of laminar and turbulent boundary layers, drag, boundary layer separation and methods to control it, streamlined and bluff bodies 5.2 Aerofoil theory: Definition of aerofoil, lift and drag, stalling of aerofoils, induced drag	
6	6 Compressible Fluid flow: 6.1 Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Application of continuity, momentum and energy equations for steady state conditions; steady flow through nozzle, isentropic flow through ducts of varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio 6.2 Normal shocks, basic equations of normal shock, change of properties across normal shock	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Reference Books:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, McGraw Hill Education, 3rd Edition
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press
3. Introduction to Fluid Mechanics by Fox and McDonald
4. Fluid Mechanics by R K Bansal
5. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9th Edition
6. Fluid Mechanics by K. L. Kumar
7. Introduction to Fluid Mechanics by James A. Fay
8. Fluid Mechanics by B. M. Massey
9. Mechanics of Fluids by Irving Shames
10. Fluid Mechanics and Hydraulics, S. K. Ukarande, Ane Books Pvt.Ltd

Course Code	Course Name	Credits
MEC 403	Industrial Electronics*	3

Objectives

- 1 To study power electronic switches and circuits and their applications
- 2 To familiarise Op amp and digital circuits and their applications
- 3 To acquaint with basics of microprocessor and microcontroller
- 4 To study structure, working and characteristics of different types of industrial electric motors and their selection for a particular application

Outcomes: Learner will be able to...

- 1 Illustrate construction, working principles and applications of power electronic switches
- 2 Identify rectifiers and inverters for dc and ac motor speed control
- 3 Develop circuits using OPAMP and timer IC555
- 4 Identify digital circuits for industrial applications
- 5 Illustrate the knowledge of basic functioning of microcontroller
- 6 Analyse speed-torque characteristics of electrical machines for speed control

Module	Detailed Contents	Hrs.
1	Semiconductor Devices: Diodes: Principles V-I characteristics and Application of: rectifier diode, zener diode, LED, photodiode, SCR V-I characteristics, UJT triggering circuit, turning-off of a SCR (preliminary discussion), basics of Gate Turn-off thyristor (GTO). Structure and V-I characteristics of Triac (modes of operation not needed) and Diac, Applications of Triac-Diac circuit. Characteristics and principle of Power BJT, power MOSFET, IGBT, comparison of devices, MOSFET/IGBT Gate driver circuit Comparison of SCR, Triac, Power BJT, power MOSFET, IGBT	08
2	Phase controlled rectifiers and Bridge inverters: Full wave controlled rectifier using SCR's(semi controlled, fully controlled) with R load only, Derivation of output voltage Block diagram of closed loop speed control of DC motors, Necessity of inner current control loop Basic principle of single phase and three phase bridge inverters , block diagrams including rectifier and inverter for speed control of AC motors (frequency control only)	07
3	Operational amplifiers and 555 Timer: Operational amplifier circuits, Ideal OPAMP behaviour, common OPAMP ICs; Basic OPAMP circuits- Inverting amplifier, Non-inverting amplifier, Voltage follower (Buffer), Instrumentation Amplifier, Active first order filter: Low pass and high pass filter; Power Op Amps, Optical Isolation amplifier; 555 timer-Operating modes: monostable, astable multivibrator	04
4	Digital logic and logic families: Digital signals, combinational and sequential logic circuits, clock signals, Boolean algebra and logic gates. Integrated circuits and logic families: Logic Levels, Noise Immunity, Fan Out, Propagation Delay, TTL logic family CMOS Logic family, comparison with TTL family Flip flops: Set Reset(SR),Trigger(T), clocked F/Fs; Registers, decoders and encoders, Multiplexer and Demultiplexer, applications	04
5	Microprocessor and Microcontrollers: Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller	08

	MSP430 architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output) Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor, Piezoelectric Actuator Drive	
6	Motors: Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor Basics of BLDC motor, Linear Actuator motor, Servo Motor Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor.	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

Reference Books:

1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics, Vedam Subramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall
6. Industrial Electronics and Control by S K Bhattacharya, S Chatterjee, TTTI Chandigarh
7. Modern Digital Electronic, Jain R P, Tata McGraw Hill, 1984
8. Digital principal and Application, Malvino and Leach, Tata McGraw Hill, 1991
9. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM
10. MSP430 Microcontroller Basics, John H. Davies, Newnes; 1 edition 2008

Course Code	Course Name	Credits
MEC404	Production Process II*	04

Objectives

1. To study sheet metal forming as well as mechanical behavior of stress system in metal forming processes.
2. To Acquaint to basic principles of design of jigs and fixtures
3. To give exposure to Non-traditional machining operations.
4. To acquaint with fundamentals of metal cutting and tool engineering

Outcomes: Learner will be able to...

1. Demonstrate understanding of metal cutting principles and mechanism
2. Identify cutting tool geometry of single point and multipoint cutting tool
3. Demonstrate various concepts of sheet metal forming operations
4. Demonstrate concepts and use of jigs and fixtures
5. Illustrate various non-traditional machining techniques
6. Illustrate concepts and applications of additive manufacturing

Module	Details	Hrs
1	Metal Cutting: 1.1 Features of machining processes, concept of speed and cutting, mechanism of chip formation, concept of shear plane, chip reduction coefficient force analysis, Merchant's circle of cutting forces, expression for shear plane angle and coefficient of friction in terms of cutting forces and tool angles, Merchant's theory-original and modified, effect of various parameters on cutting forces 1.2 Different types of dynamometers and their operations, Tool life definition, mechanism of tool wear and measurement, preliminary and ultimate feature, factors influencing tool life such as speed, feed, depth of cut, tool material, cutting fluids etc., Machinability, factors affecting surface finish	16
2.	Tool Engineering: 2.1 Cutting Tool geometry and definition of principles tool angles of single point cutting tools, Types of milling cutters and their geometry, Geometry of drill, broach 2.2 Specification & Selection of grinding wheel, dressing & truing and balancing of grinding wheels	06
3.	Sheet Metal Forming: 3.1 Sheet metal operations, Classification of presses, Types of Dies:, compound, combination, progressive, bending, forming and drawing dies, scrap strip layout, centre of pressure, selection of die sets, stock guides, strippers	06
4.	Jigs and Fixtures: 4.1 Elements of Jigs and fixtures, principles of location, types of locating and clamping elements, Drill bushes-their types and applications indexing devices, auxiliary elements, Types of jigs, Milling fixture and turning fixture	06
5.	Non-traditional Machining: 5.1 Ultrasonic Machining (USM), Abrasive Jet Machining (AJM), Water Jet Machining, Electrochemical Machining (ECM), Chemical Machining (CHM), Electrical Discharge Machining (EDM), Plasma Arc Machining (PAM), Laser Beam Machining (LBM), Electron Beam Machining (EBM)	06

6.	Additive Manufacturing: 6.1 Historical Development , Fundamentals of Rapid Prototyping, Advantages of Rapid Prototyping ,Additive Manufacturing (AM) Definition, Applications of AM parts, The Generic AM process, Why use the term Additive Manufacturing, The Benefits of AM, Distinction Between AM and CNC Machining, Other Related Technologies: Reverse Engineering, CAE, Haptic based CAD, Classifications of AM / RP System: Liquid polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems 6.2 New AM Classification Schemes as per ASTM F42 and ISO TC 261: Vat photo polymerization, Powder bed fusion, Material extrusion, Material jetting, Binder jetting, Sheet lamination and Directed energy deposition 6.3 Vat Photo Polymerization based AM / RP Systems: Principle of operation, Process, materials advantages, disadvantages, and applications of 3D Systems' stereo lithography (SLA), CMET'S Solid Object Ultraviolet-Laser Printer (SOUP).	08
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Assessment:

Internal Assessment for 20 marks:

Consisting Two Compulsory Class Tests

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References

1. Tool Design by Donaldson
2. Machining Process by H.L. Juneja
3. Production Technology - HMT
4. Manufacturing, Engineering and Technology SI by Serope Kalpakjian, Steven R Schmid, Prentice Hall
5. Fundamentals of Tool Design by ASTME
6. Metal cutting Theory & Cutting Tool Designing by V. Arshinov, G Alekseev
7. Principle of Metal cutting by Sen & Bhattacharya
8. Manufacturing science by Ghosh and Mallick
9. Production Engg by P.C.Sharma
10. Additive Manufacturing Technologies, Ian Gibson, D.W. Rosen, and B. Stucker, , 2nd Edition, Springer 2015

Course Code	Course Name	Credits
MEC405	Kinematics of Machinery*	04

Objectives:

1. To acquaint with basic concept of kinematics and kinetics of machine elements
2. To familiarise with various basic mechanisms and inversions
3. To study basics of power transmission

Outcomes: Learner will be able to...

1. Define various components of mechanisms
2. Develop mechanisms to provide specific motion
3. Draw velocity and acceleration diagrams of various mechanisms
4. Draw Cam profile for the specific follower motion
5. Analyse forces in various gears
6. Select appropriate power transmission for specific application

Module	Details	Hrs.
1	1.1 Kinetics of Rigid Bodies: Mass M.I. about centroidal axis and about any other axis, Radius of Gyration, D'Alembert's Principle of bodies under rotational motion about a fixed axis and plane motion, Application of motion of bars, cylinders and spheres only Kinetics of Rigid bodies: Work and Energy Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work Energy Principle and Conservation of energy 1.2 Basic Kinematics: Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grübler's criterion & its limitations Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions	10
2	2.1 Special Mechanisms: Straight line generating mechanisms: Introduction to Exact straight line generating mechanisms - Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms- Watt's, Grasshopper mechanism, Tchebicheff's mechanisms Offset slider crank mechanisms - Pantograph, Hook-joint (single and double). Steering Gear Mechanism - Ackerman, Davis steering gears	06
3	3.1 Velocity Analysis of Mechanisms (mechanisms up to 6 links): Velocity analysis by instantaneous center of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach) Analysis extended to find rubbing velocities at joints, mechanical advantage (Graphical approach) Velocity analysis of low degree complexity mechanism (Graphical approach), Auxiliary point method 3.2 Velocity and Acceleration Analysis of Mechanism: Velocity and Acceleration- analysis by relative method (mechanism up to 6 link) including pairs involving Coriolis acceleration (Graphical Approach)	10
4	4.1 Cam Mechanism: Cam and its Classification, Followers and its Classification, Motion analysis and plotting of displacement - time, velocity-time, acceleration-time, jerk-time graphs for uniform velocity, UARM, SHM, and Cycloid motions (combined motions during one stroke excluded), Motion analysis of simple cams - R-R cam, D-R-R and D-R-D-R Cam operating radial translating follower, Pressure angle	06

5	5.1 Belts, Chains and Brakes: Belts: Introduction, types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission Chains: types of chains, chordal action, variation in velocity ratio, length of chain Brakes: Introduction, types and working principles, Introduction to braking of vehicles	06
6	6.1 Gears and Gear Trains: Gears- Introduction, types, Law of gearing, Construction of Involute and Cycloid gear tooth profile, Details of gear terminology, involutes and cycloidal tooth profile, Interference in involutes gears, Critical numbers of teeth for interference free motion Methods to control interference in involutes gears, Static force analysis in gears - spur, helical, bevel, worm & worm wheel Gear Trains: Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination	10

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions, each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved.**

References:

1. Theory of Mechanisms and Machines by Amitabh Ghosh and A. Kumar Mallik
2. Theory of Machines and Mechanism by Uicker Jr, Garden Pennock & J.F. Shigley, OXFORD University Press
3. Theory of Machines by P L Ballaney
4. Theory of Machines by S S Ratan
5. Kinematics of Machines by R T Hinckle, Prentice Hall Inc
6. Kinematics by V M Fairs, McGraw Hill
7. Mechanism Design: Analysis and Synthesis Vol I by A. Erdman and G N Sander, Prentice Hall
8. Kinematics and Dynamics of Planer mechanisms by Jeremy Hirsihham, McGraw Hill
9. Theory of Machines by W. G. Green, Bluckie & Sons Ltd

Course Code	Course Name	Credits
MEL401	Data Base and Information Retrieval*	02

Objective:

1. To acquaint with data modelling/database design using the entity-relationship
2. To study use of Structured Query Language (SQL) and learn SQL syntax
3. To familiarise Graphical User Interface techniques to retrieve information from database
4. To study needs of database processing and controlling the consequences of concurrent data access

Outcomes: Learner will be able to...

1. Identify data models and schemes in DBMS
2. Demonstrate the features of database management systems and Relational database
3. Use SQL- the standard language of relational databases
4. Demonstrate understanding of functional dependencies and design of the database
5. Design graphical user Interface for specific application
6. Create visual software entities

Module	Detailed Contents	Hrs.
01	Introduction to Database Concept: What is a database?, Characteristics of database, Example of database, File system V/s Database system, What is DBMS?, Users of database system, Advantage of using an enterprise database, Concerns when using an enterprise database, Data independence, DBMS systems architecture, Database administrator	02
02	Entity-Relationship Data Model: Introduction, Benefits of Data Modelling, Types of Models, Phases of Database Modelling, The Entity-Relationship (ER) Model, Generalisation, Specialization and Aggregation, Extended Entity-Relationship (EER) Model	04
03	Rational Model and Algebra: Introduction, Mapping the ER and EER Model to the relational Model, Data Manipulation, Data Integrity, Advantages of Relational Model, Relational Algebra, Relational Algebra Queries, Relational Calculus	04
04	Structured Query Language (SQL): Overview of SQL, Data definition commands, set operations, aggregate functions, null values, Data manipulation commands, Data control commands, Views- using virtual tables in SQL, Nested and complex queries	04
05	Introduction to Transactions Management and Co-currency: Transaction concept, transaction states, ACID properties, Implementation of atomicity and durability, Concurrent Executions, Serializability, Recoverability, Co-currency Control: Lock-based, Timestamp-based, Validation-based protocols, Deadlock handling, Recovery system, Failure classification, Storage structure, Recovery and atomicity, Log based recovery, Shadow paging	04
06	Graphical User Interface: Murphy's law of GUI design, Features of GUI, Icons and graphics, Identifying visual cues, clear communication, colour selection, GUI standard, planning GUI Design Work Visual Programming: Sharing Data and Code: Working with projects, introduction to basic language, Using inbuilt controls and ActiveX controls, creating and using classes, introduction to collections, using and creating ActiveX components, dynamics data exchange, Object linking and embedding, Creating visual software entities: Working with text, graphics, working with files, file management, serial communication, multimedia control interfaces	06

Assessment:

Term Work:

Assign minimum two case studies for each student. On their case studies following exercises to be performed

1. Problem Definition and draw ER/EER diagram
2. Design Relational Model
3. Perform DDL operation
4. Perform DML and DCL operations
5. Design Forms using Visual programming
6. Retrieve the information through GUI.

Distribution of Term work Marks

Laboratory work	40 Marks
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Attendance	10 Marks
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End Semester Practical/Oral Examination:

1. Practical examination of 2 hours duration followed by viva to be conducted by Pair of Internal and External Examiner based on contents
2. Evaluation of practical examination to be done by examiner based on the printout of students work
3. Distribution of marks

Practical examination:	40 marks
Viva based on practical examination	10marks
4. Students work along with evaluation report to be preserved till the next examination

Reference Books:

1. Database Management Systems, G K Gupta, McGraw – Hill
2. Database System Concepts, Korth, Silberchatz, Sudarshan, 6thEdition, McGraw – Hill
3. GUI Design for dummies, IDG books
4. Visual Basic 2005, How to program, Deitel and Deitel, 3rdEdition, Pearson Education
5. SQL and PL/SQL for Oracle 10g, Black Book, Dr P S Deshpande, Dreamtech Press
6. Introduction to Database Management, Mark L Gillenson, Paulraj Ponniah, Wiley
7. Oracle for Professional, Sharaman Shah, SPD.
8. Database Management Systems, Raghu Ramkrishnan and Johannes Gehrke, TMH
9. Fundamentals of Database Management System, Mark L Gillenson, Wiley India

Course Code	Course/Subject Name	Credits
MEL402	Fluid Mechanics*	1

Objectives:

1. To study measurement as well as calibration principles
2. To practically verify the concepts learnt in theory course

Outcomes: Learner will be able to...

1. Calibrate different gauges
2. Measure hydrostatic forces
3. Verify the Archimedes Principle
4. Calibrate Venturimeter, Orificemeter and Pitot tube
5. Verify the Bernoulli's Principle
6. Read manometers and maintain them.

(a) List of Experiments: Any 6 experiments to be performed.

Expt no	Experiment	Hrs
1	Calibration of Pressure Gauges	2
2	Measurement of Hydrostatic Pressures	2
3	Verification of Archimedes' Principle	2
4	Calibration of Venturimeter/ Orificemeter/Nozzlemeter/ Pitot tube	2
5	Determine the friction factor for Pipes	2
6	Determination of major and minor losses in Pipe systems	2
7	Verification of Bernoulli's Equation	2
8	Experiment on Laminar flow in pipes	2
9	Calculation of Lift and Drag over an aerofoil	2
10	Determine the pressure profile over an aerofoil	2

- (b) Mini Project: A mini project along with a brief report in which a group of students (maximum 4) will design/ fabricate/ assemble a unit or software based simulation to demonstrate any principle in Fluid Mechanics.

Assessment:

Term work Mark distribution will be as follows:

Laboratory work	15 marks
Mini Project	05 marks
Attendance	05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Viva	10 marks
2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
3. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL403	Industrial Electronics*	01

Objectives

1. To study operational characteristics of various electrical and electronics components
2. To study microcontroller based applications and its programming

Outcomes: Learner will be able to...

1. Demonstrate characteristics of various electrical and electronics components
2. Develop simple applications built around these components
3. Identify use of different basic gates
4. Identify and use digital circuits for industrial applications
5. Built and demonstrate basic parameter measurement using microcontroller
6. Test and Analyse speed-torque characteristics of electrical machines for speed control.

List of Experiment: Minimum six from 1-9 and four from 10-15, in all minimum ten experiments need to be performed

Sr No	Detailed Contents
1	MOSFET / IGBT as a switch
2	V-I characteristics of SCR
3	Triggering circuit of SCR (UJT)
4	Full wave Rectifier using SCR
5	Single phase Bridge inverter with rectifier load
6	OPAMP as integrator
7	555 timer as astable multivibrator
8	Implementing study of gates and Logic Operations like, NOT, AND, OR
9	Realization of basic gates using universal gates
10	Light dimmer circuit using Diac-Triac
11	Speed control of DC motor
12	Speed control of induction motor
13	Simple programs using microcontroller
14	Simple microcontroller based application like Temp Measurement/ Speed Measurement using Proximity Sensor/ Piezoelectric Actuator Drive
15	Microcontroller based speed control for Induction Motor

Learners (in a group) may be encouraged for Project Based Learning. Appropriate Weightage may be given in term work assessment

Assessment:

Distribution of marks for term work

Laboratory work	20 Marks
Attendance	05 Marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Distribution of marks for practical/viva examination shall be as follows:

Practical performance	15 marks
Viva	10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination
4. Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
MEL 404	Kinematics of Machinery*	01

Objectives:

1. To familiarise with various mechanisms and inversions
2. To acquaint with basics of power transmission systems

Outcomes: Learner will be able to...

1. Draw velocity diagram by instantaneous center method
2. Draw velocity and acceleration diagrams for four bar mechanism by relative method.
3. Draw velocity and acceleration diagrams for Slider crank mechanism by relative method
4. Draw Cam profile for the specific follower motion
5. Plot displacement-time, velocity-time, acceleration-time cam profiles
6. Develop and build mechanisms to provide specific motion

Term Work: (Comprises a and b)

a) List of Experiments

Sr No	Details	Lab Session
1	Analysis of velocity of mechanisms by Instantaneous Center of Rotation – 3 to 5 problems	2 Hrs
2	Analysis of velocity of mechanism by Relative method – 3 to 5 problems	4 Hrs
3	Analysis of Velocity & Acceleration of mechanism by Relative method – 3 to 5 problems	4 Hrs
4	Motion analysis and plotting of displacement–time, velocity-time and acceleration-time, jerk-time and layout of cam profiles - 2 to 3 problems	4 Hrs
5	Mini project on design and fabrication of any one mechanism for a group of maximum 4 students	6 Hrs

b) Assignments: Minimum two problems on each of the following topics:

- i) Brakes
- ii) Chains and belts
- iii) Gear and gear trains

Distribution of marks for Term Work shall be as follows:

Laboratory work	:	15marks.
Assignments	:	05 Marks
Attendance	:	05 marks.

Course Code	Course/Subject Name	Credits
MEL405	Machine Shop Practice – II*	2

Objectives:

1. To familiarise with basic machining processes.
2. To Acquaint to various machining operations and machine protocols

Outcomes: Learner should be able to

1. Operate lathe machine,
2. Perform shaping operations
3. Perform finishing operations on grinding machine
4. Perform milling operations.
5. Perform precision turning
6. Perform drilling and threading operations.

Module	Details	Hrs
1	One composite job consisting minimum four parts employing operations on lathe like precision turning screw cutting, boring etc. This job shall involve use of shaping, milling and grinding operations	48

Term Work:

1. Composite job mentioned above
2. Complete Work-Shop Book giving details of drawing of the job and time sheet

The distribution of marks for Term work shall be as follows:

Job Work with complete workshop book 40 marks
Attendance 10 marks

End Semester Practical Examination:

Pair of Internal and External Examiner should conduct practical/viva based on contents.

Practical examination will be held for 4 hours.

Job shall consist of minimum four operations such as precision turning, boring, screw cutting, drilling, milling, shaping, grinding etc.