**First Year Departmental Subject**

**MEC-1201 Engineering Mechanics-1**

Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :4

**Concurrent Forces in a Plane:** Principles of statics- Equilibrium of concurrent forces in a plane- Method of projections- Equilibrium of three forces in a plane-Method of moments- Friction**.**

**Parallel forces in a plane:** Two parallel forces- General case of parallel forces in a plane-Centre of parallel forces and centre of gravity- Centroids of composite plane figures and curves- Distributed force in a plane.

**General Case of Forces in a Plane**: Composition of forces in a plane- Equilibrium of forces in a plane- Plane trusses, Funicular polygon, Maxwell diagrams, method of joints, method of sections- Plane frame- method of members, Distributed force in a plane- Flexible suspension cables.

**Force Systems in Space**: Concurrent forces in space; method of projections, method of moments; Couples in space- Parallel forces in space- Centre of parallel forces and centre of gravity- General case of forces in space

**Principal of virtual work:** Equilibrium of ideal systems – efficiency of simple machines – stable and unstable equilibrium.

**Text Book:**

1. **Engineering Mechanics by S.Timoshenko and D.HYoung** McGraw-Hill**.(4th edition)**

**References:**

1. Engineering Mechanics, Vol.1 & 2 by J.L. Meriems and L.G. Kraige.
2. Engineering Mechanics by Singer.
3. Engineering Mechanics by K.L. Kumar, Tata Mc-Graw Hill.

Engineering mechanics by Bhavikatti. New age international

**Second Year 1st Semester**

**ENG-2101Mathematics IV**

Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs.

 Credits :3

**SYLLABUS:**

**VECTOR CALCULUS-1:** Differentiation of vectors, curves in space, velocity and acceleration, relative velocity and relative acceleration, scalar and vector point functions, vector operator ∇ applied to scalar point functions- gradient, ∇ applied to vector point functions- divergence and curl. Physical interpretation of , ∇ applied twice to point functions, ∇ applied to products of two functions; Irrotational and Solenoidal fields.

**VECTOR CALCULUS-2:** Integration of vectors, line integral, circulation, work done, surface integral-flux, Green’s theorem in the plane, Stoke’s theorem, volume integral, Gauss Divergence theorem.

Introduction of orthogonal curvilinear coordinates, cylindrical and spherical polar coordinates

**INTRODUCTION OF PARTIAL DIFFERENTIAL EQUATIONS:** Formation of partial differential equations, solutions of partial differential equations- equations solvable by direct integration, linear equations of first order: Lagrange’s Linear equation, non-linear equations of first order, Charpit’s method.

Homogeneous linear equations with constant coefficients- rules for finding the complementary function, rules for finding the particular integral (working procedure), non- homogeneous linear equations.

**APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS:** Method of separation of variables, One dimensional wave equation-vibrations of a stretched string, one dimensional Heat equation, Two dimensional heat flow in steady state - solution of Laplace’s equation in Cartesian and polar coordinates (two dimensional).

**INTEGRAL TRANSFORMS:** Introduction, definition, Fourier integral, Sine and Cosine integrals, Complex form of Fourier integral, Fourier transform, Fourier Sine and Cosine transforms, Finite Fourier Sine and Cosine transforms, properties of Fourier transforms, Convolution theorem for Fourier transforms, Parseval’s identity for Fourier transforms, Fourier transforms of the derivatives of a function, simple applications to Boundary value problems.

**TEXT BOOKS:**

Scope and treatment as in “Higher Engineering Mathematics”, by Dr. B.S.Grewal, **43rd Edition**, Khanna Publishers.

**REFERENCE BOOKS:**

1. A text book of Engineering Mathematics by N.P. Bali and Dr. Manish Goyal, Lakshmi Publications.
2. Mathematical Methods of Science & Engineering aided with MATLAB by KantiB.Dutta, Cengage Learning India Pvt. Ltd.
3. Advanced Engineering Mathematics by Erwin Kreyszig.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw Hill Company.
5. Advanced Engineering Mathematics by H.K.Dass. S.Chand Company.
6. Higher Engineering Mathematics by Dr. M.K.Venkataraman.

**MEC-2102 Engineering Mechanics-2**

Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :4

**Basic concepts**: Kinematics- Kinetics- Newton laws of motion- Particle- Rigid body- Path of particle.

**Rectilinear Translation:** Kinematics of rectilinear motion Principles of dynamics- Differential equation of rectilinear motion- Motion of a particle acted upon by a constant force, Force as a function of time- Force proportional to displacement; free vibrations- D’Alembert’s principle- Momentum and impulse- Work and energy- Ideal systems: conservation of energy. **Curvilinear Translation:** Kinematics of curvilinear motion- Differential equations of curvilinear- Motion of a projectile- D’Alembert’s principle- Moment of momentum- work and energy in curvilinear motion.

**Rotation of rigid body about a fixed axis:** Kinematics of rotation- Equation of motion for a rigid body rotating about a fixed axis- Rotation under the action of a constant moment

**Torsional vibration-** The compound pendulum- General case of moment proportional to angle of rotation- D’Alembert’s principle in rotation.

**Plane Motion of a Rigid Body:** Kinematics of plane motion- Instantaneous center- Equations of plane motion- D’Alembert’s principle in plane motion- The principle of angular momentum in plane motion- Energy equation for plane motion.

**Text Book:**

1. Engineering Mechanics by S.Timoshenko and D.HYoung McGraw-Hill.

**References:**

1. Engineering Mechanics, Vol.1 & 2 by J.L. Meriems and L.G. Kraige.
2. Engineering Mechanics by Singer.
3. Engineering Mechanics by K.L. Kumar, Tata Mc-Graw Hill.
4. Engineering mechanics by Bhavikatti. New age international.

**MEC- 2103 INDUSTRIAL ELECTRONICS**

(Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Devices:** Semi-conductor diode, Zener diode - Transistor - Silicon control rectifier. Rectifiers, Amplifiers, Oscillators, Cathode ray oscilloscope.

**Industrial Applications:** Poly-phase rectifiers - Control circuits - Motor speed control voltage control, Time delay relay circuits - Photo electric circuits. Resistance welding, inducting heating - Dielectric heating.

**Servomechanism:** Open loop and closed loop systems (Elementary treatment only).

**Introduction to Digital Electronics:** Fundamentals of digital electronics, Number system and codes, Logic gates, Boolean algebra, Arithmetic-logic units, Flip-flops, Registers and counters, Memories: ROM, PROM, EPROM and RAM.

**Introduction to Microprocessors:** The Intel-8085 microprocessor; Architecture, Instruction set, Execution of instructions, Addressing structures, Timing and machine cycles of 8085 and programming I/O operations, Interrupts, Serial input and serial output, Programming the I/O ports, Programming the timer.

**Text Books:**

1. Industrial Electronics by Mithal (Khanna Publications).

2. Digital Computer Electronics - An Introduction to Micro Computer by Albert Paul Malvino, Tata McGraw-Hill Publishing Co. Ltd., New Delhi-2.

**References:**

1. Engineering Electronics by Ryder-McGraw Hill.

2. Micro Processors by Leventhal.

3. Industrial Electronics by Bhatacharya, Tata Mc-Graw Hill.

4. Industrial Electronics and Control by S.K. Bhatacharya and S. Chatarjee, 1995 Ed., Tata Mc-Graw Hill Pub. Co.Ltd.

**MEC- 2104 MECHANICS OF SOLIDS-1**

(Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**Simple Stresses:** Stress, Strain, Stress- Strain curve, Lateral strain, Relationship between elastic constants, Bars of varying cross-section, Compound bars, Temperature stresses in bars. Complex Stresses: Stresses on an inclined plane under different uniaxial and biaxial stress conditions, Principal planes and principal stresses, Mohr’s circle, Relation between elastic constants, Strain energy, Impact loading.

**Bending Moments and Shear Forces:** Beam - Types of loads, Types of supports, S.F. and B.M. diagrams for Cantilever, Simply supported and Over hanging beams.

**Center of Gravity and Moment of Inertia:**.Determination of Center of Gravity, Area and Mass Moment of Inertia of simple and composite sections, Area and Mass Product of Moment of Inertia

**Stresses in Beams**: Theory of bending, Flexural formula, Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Design of simple beam sections, Shear stresses in beams, Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T, angle sections..

**Deflections of Beams**: Relation between curvature, slope and deflection, double integration method, Macaulay’s method, Moment area method -application to simple cases including Cantilever, Simply supported and Over hanging beams.

**Torsional Stresses in Shafts and Springs**: Analysis of torsional stresses, Power transmitted, Combined bending and torsion, Closed and open coiled helical springs, Theories of Failure: Application to design of shafts

**Cylinders and Spherical Shells**: Stresses and strains in thin cylinders, Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders and Thin spherical shell.

**Text Books:**

1. Analysis of Structures, by Vazirani and Ratwani, Vol. 1, 1993 edition.
2. Mechanics of Materials by [James M. Gere](http://www.amazon.com/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&text=James+M.+Gere&search-alias=books&field-author=James+M.+Gere&sort=relevancerank) , [Stephen P. Timoshenko](http://www.amazon.com/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&text=Stephen+P.+Timoshenko&search-alias=books&field-author=Stephen+P.+Timoshenko&sort=relevancerank) , CBS Publishers
3. Solid Mechanics, by Popov

**Reference:**

1. Strength of Materials, by Timoshenko
2. Strength of Materials -By Jindal, Umesh Publications.
3. Analysis of structures by Vazirani and Ratwani.
4. Mechanics of Structures Vol-III, by S.B.Junnarkar.
5. Strength of Materials by Andrew Pytel and Ferdinond L. Singer Longman

**MEC- 2105 BASIC THERMODYNAMICS**

(Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Introduction:** Basic concepts; Thermodynamic systems; Micro & Macro systems; Homogeneous and heterogeneous systems; Concept of continuum; Pure substance; Thermodynamic equilibrium; State; Property; Path; Process; Reversible and irreversible cycles; Work; Heat; Point function; Path function; Heat transfer.

**Zeroth law of thermodynamics;** Concept of equality of temperatures- Joule’s experiments-First law of thermodynamics- Isolated systems and steady flow systems- Specific heats at constant volume and pressure - Enthalpy- First law applied to flow systems- Systems undergoing a cycle and change of state- First law applied to steady flow processes-Limitations of first law of thermodynamics.

**Perfect gas laws**- Equation of state- Universal gas constant, various non-flow processes-Properties of end states- Heat transfer and work transfer- Change in internal energy-throttling and free expansion- Flow processes- Deviations from perfect gas model-Vanderwall’s equation of state- Compressibility charts- Variable specific heats.

**Second law of thermodynamics**- Kelvin Plank statement and Clasius statement and their equivalence, Corollaries- Perpetual motion machines of first kind and second kind-Reversibility and irreversibility- Cause of irreversibility- Carnot cycle- Heat engines and heat pumps- Carnot efficiency- Clasius theorem- Clasius inequality- Concept of entropy-Principles of increase of entropy- Entropy and disorder.

**Availability and irreversibility**- Helmholtz function and Gibbs function- Availability in steady flow- Entropy equation for flow process- Maxwell’s equations- Tds relations- Heat capacities.

**Air standard cycles-**Air standard efficiency- Otto cycle-Diesel cycle- Dual cycle- Brayton cycle- Atkinson cycle- Stirling cycle- Erickson cycle

**Text Books:**

1. Engineering Thermodynamics, by P.K. Nag, Tata McGraw-Hill Publications Company.
2. Applied Thermodynamics-I by R. Yadav, Central Book House.
3. Engineering Thermodynamics by K. Ramakrishna, Anuradha agencies.

**References Books:**

1. Engineering Thermodynamics by Rathakrishnan, Prentice - Hall India.
2. Engineering Thermodynamics by Y.V.C. Rao.
3. Thermal Engineering by R.K. Rajput, S.Chand& Co.
4. Engineering Thermodynamics Work and Heat Transfer, by G.F.C Rogers and Y.R. Mayhew, ELBS publication
5. Engineering Thermodynamics by Zemansky.

**MEC- 2106 MANUFACTURING PROCESSES**

(Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Manufacturing concepts;** Product cycle; Job, batch and mass production; Primary and secondary manufacturing processes; Principle of metal casting; Terminology; Pattern; Types; Allowances; Materials; Core boxes; Selection; Testing and preparation of moulding sands; Moulding tools and equipment; Machine moulding; Core making; Sprue; Runner, gates and risers; Types and designing; Melting and pouring the metal; Shell mold casting; Investment casting; Permanent mould casting; Casting defects.

**Formability of metals**; Cold and hot working; Rolling; Types; Roll size; Stretch forming, metal spinning, embossing and coining; Peening; Sheet metal forming operations; Presses; Die design.

**Forging materials;** Forging processes; Forging techniques; Forging presses; Forging pressure distribution and forging force; Automation of forging; Swaging; Drawing; Extrusion; High energy rate forming.

**Weldability;** Welding metallurgy; Principles and processes of arc welding (SMAW, GTAW, GMAW, FCAW, PAW, SAW); Welding equipment; Weld positioners and fixtures; Oxyacetylene welding; Flame cutting; Brazing and soldering; Principle of resistance welding; Types of resistance welds; Seam welding; Projection welding; Resistance butt welding; Solid state welding; Weld inspection and testing.

**Text Book:**

1. Process and Materials of Manufacture (4th Edition) by Roy A. Lindberg, Prentice-Hall of India Private Limited.

**Reference Books:**

1. Manufacturing Engineering & Technology by Kalpak Jain, Addition Wesley Edition.
2. Materials and Processes in Manufacturing by De Margo, Black and Kohsen, Prentice Hall of India.
3. Principles of Metal Casting by Hein and Rosenthol, Tata Mc-Graw Hill India.
4. Manufacturing Technology-Foundary, Forming and Welding by P.N. Rao, Tata McGraw-Hill Publishing Company.

**MEC-2107 MACHINE DRAWING**

(Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs.

 Credits :1.5

**SYLLABUS:**

Screw threads and Screw Fastenings using standard Empirical formulae.

Riveted joints, Keys, Cotter-joints, Pin-joints.

Shaft couplings: Box and split muff couplings, Flanged, Flexible, Universal and Oldham couplings,

shaft bearings, Brackets and Hangers, Pipe joints.

Orthogonal views and Sectional views of machine parts.

Assembly drawing of various engine components and machine tool components.

**Text Books:**

1. Machine Drawing, by N.D.Bhatt, Charotal Publishing House.
2. Engineering Drawing, by A.C.Parkinson, Wheeler Publishing.

**Reference:**

1. Machine Drawing by K.L Narayan, P. Kannaiah and K. Venkata Reddy, New Age.

**MEC- 2108 MECHANICS OF SOLIDS LAB**

(Effective from the batch admitted during 2019-2020- AICTE )

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs.

 Credits :1.5

**List of Experiments:**

1. To study the stress strain characteristics (tension and compression) of metals by using UTM.
2. To study the stress strain characteristics of metals by using HounsefieldTensometer.
3. Determination of compression strength of wood.
4. Determination of hardness using different hardness testing machines- Brinnels, Vickers and Rockwell’s.
5. Impact test by using Izod and Charpy methods.
6. Deflection test on beams using UTM.
7. Tension shear test on M.S. Rods.
8. To find stiffness and modulus of rigidity by conducting compression tests on springs.
9. Torsion tests on circular shafts.
10. Bulking of sand.
11. Punch shear test, hardness test and compression test by using Hounsefieldtensometer.
12. Sieve Analysis and determination of fineness number.

**SECOND YEAR-SECOND SEMESTER**

**MEC- 2201 MECHANICS OF SOLIDS-2**

(Effective from the batch admitted during 2019-2020-AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits : 3

**SYLLABUS**

**Fixed Beams**: Fixing moments for a fixed beam of uniform Moment of Inertia, Effect of sinking support, slope and deflection.

**Continuous beams:** Analysis of continuous beam, Reactions at the supports, Effect of sinking of supports.

**Energy Methods -**Castigliano's theorems I

**Columns and Struts**: Columns with one end free and the other fixed, Both ends fixed, One end fixed and other hinged, Limitation of Euler's formula, Column with initial curvature, Column carrying eccentric load, Laterally loaded columns with Central point load

 **Bending of Curved Bars:** Stresses in bars of circular, rectangular and trapezoidal sections.

**Stresses due to rotation**: Wheel rim, disc of uniform thickness, disc of uniform strength.

**Thick cylinders** subjected to internal and external pressure and compound cylinders.

**Text Books:**

1. Analysis of Structures, Vol. 1, 1993 edition, by Vazirani and Ratwani.

2. Chapter VI from Advanced Topics in Strength of Materials, by Prof. L.B.Shah and Dr.R.T.Shah.

**References:**

1. Strength of Materials, by Timoshenko.
2. Analysis of structures by Prof V.N.Vazirani &Dr MM Ratwani&Dr S.K.Duggal
3. Strength of Materials by Dr Sadhu Singh

**MEC- 2202 THEORY OF MACHINES**

(Effective from the batch admitted during 2019-2020-AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits : 3

**SYLLABUS**

**Mechanics of Metal Cutting**; Chip formation & Types; Machinability; Tool materials; Tool geometry and tool signature ASA&ISO systems; Tool wear and tool life; Cutting forces and power; Measurement of forces and temperatures; Metal cutting economics; Cutting fluids.

**Engine lathe**; Operations; Turret and capstan lathes; Turning center; Boring machine and operations; Shaper, planner and slotter; Types; Operations; Mechanisms.

**Drill geometry and cutting actions**; Special drills; Drill forces and power-drilling speeds & feeds; Torque & thrust calculation; Drilling machines; Features and operations; Milling process; Milling cutting geometry; Cutting speed, feed, time and power in milling; Types of milling machines; Machining center; Broaching; Types; Tools; Machines; Broach time.

**Principle; Operations**; Grinding wheel manufacturing and marking balancing; Truing and dressing of grinding wheel; Grinding wheel selection; Grinding force; Grinding machines.

**Abrasive belt machining**; Lapping, honing and super finishing; Electro polishing and buffing.

**Equipment;** Process; Characteristics; Advantages; Limitations; Applications of chemical milling; Photochemical milling; EDM-computer controlled-traveling wire; ECM; AJM; LBM; EBM; WJM.

**Text Book:**

1. Process and Materials of Manufacture (4th Edition) by Roy A. Lindberg, Prentice-Hall of India Private Limited.

**Reference Books:**

1. Fundamentals of Metal Machining and Machine Tools by Geoffrey Boothroyd, International Student Edition, McGraw-Hill Book Company.
2. Metal Cutting Principles by M.C. Shaw, MIT Press, Cambridge.
3. Advanced Methods of Machining by J. A. McGeough, Chapman & Hall Publishers.
4. Metal Cutting-Theory and Practice by Amitabha Bhattacharya, Central Book Publishers.
5. Production Engineering by P.C. Sharma, S. Chand and Company.

**MEC- 2203 METAL CUTTING & MACHINE TOOLS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits : 3

**SYLLABUS**

**Mechanics of Metal Cutting**; Chip formation & Types; Machinability; Tool materials; Tool geometry and tool signature ASA&ISO systems; Tool wear and tool life; Cutting forces and power; Measurement of forces and temperatures; Metal cutting economics; Cutting fluids.

**Engine lathe**; Operations; Turret and capstan lathes; Turning center; Boring machine and operations; Shaper, planner and slotter; Types; Operations; Mechanisms.

**Drill geometry and cutting actions**; Special drills; Drill forces and power-drilling speeds & feeds; Torque & thrust calculation; Drilling machines; Features and operations; Milling process; Milling cutting geometry; Cutting speed, feed, time and power in milling; Types of milling machines; Machining center; Broaching; Types; Tools; Machines; Broach time.

**Principle; Operations**; Grinding wheel manufacturing and marking balancing; Truing and dressing of grinding wheel; Grinding wheel selection; Grinding force; Grinding machines.

**Abrasive belt machining**; Lapping, honing and super finishing; Electro polishing and buffing.

**Equipment;** Process; Characteristics; Advantages; Limitations; Applications of chemical milling; Photochemical milling; EDM-computer controlled-traveling wire; ECM; AJM; LBM; EBM; WJM.

**Text Book:**

1. Process and Materials of Manufacture (4th Edition) by Roy A. Lindberg, Prentice-Hall of India Private Limited.

**Reference Books:**

1. Fundamentals of Metal Machining and Machine Tools by Geoffrey Boothroyd, International Student Edition, McGraw-Hill Book Company.
2. Metal Cutting Principles by M.C. Shaw, MIT Press, Cambridge.
3. Advanced Methods of Machining by J. A. McGeough, Chapman & Hall Publishers.
4. Metal Cutting-Theory and Practice by Amitabha Bhattacharya, Central Book Publishers.
5. Production Engineering by P.C. Sharma, S. Chand and Company.

**MEC- 2204 ELECTRICAL TECHNOLOGY**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits : 3

**SYLLABUS:**

**Magnetic Circuits:** Definitions of magnetic circuit, Reluctance, Magnetomotive force (m.m.f), Magnetic flux, Simple problems on magnetic circuits, Hysteresis loss.

**Electromagnetic Induction:** Faraday’s laws of Electromagnetic induction, Induced E.M.F., Dynamically induced E.M.F., Statically induced E.M.F., Self inductance, Mutual inductance.

**D.C. Generators:** D.C. generator principle, Construction of D.C. generator, E.M.F. equation of D.C. generator, Types of D.C. generators, Armature reaction, Losses in D.C. generator, Efficiency, Characteristics of D.C. generators, Applications of D.C. generator.

**D.C. Motors:** D.C. motor principle, Working of D.C. motors, Significance of back E.M.F., Torque equation of D.C. motors, Types of D.C. motors, Characteristics of D.C. motors, Speed control methods of D.C. motors, Applications of D.C. motor. Testing of D.C. machines: Losses and efficiency, Direct load test and Swinburne’s test.

**A.C. Circuits**: Introduction of steady state analysis of A.C. circuits, Single and balanced 3-phase circuits.

**Transformers:** Transformer principle, E.M.F. equation of transformer, Transformer on load, Equivalent circuit of transformer, Voltage regulation of transformer, Losses in a transformer, Calculation of efficiency and regulation by open circuit and short circuit tests.

**Three Phase Induction Motor**: Induction motor working principle, Construction of 3-phase induction motor, Principle of operation, Types of 3-phase induction motor, Torque equation of induction motor, Slip-torque characteristics, Starting torque, Torque under running condition, Maximum torque equation, Power stages of induction motor, Efficiency calculation of induction motor by direct loading.

**Alternator:** Alternator working principle, E.M.F. equation of alternator, Voltage regulation by sync, impedance method.

**Synchronous Motor**: Synchronous motor principle of operation, Construction. Methods of starting of synchronous motor.

**Electrical Measurements:** Principles of measurement of current, voltage, power and energy. Types of Ammeters, Voltmeters, Watt-meters, Energy meters, Electrical conductivity meter.Potentiometer, Megger.

**Text Book:**

1. Elements of Electrical Engineering and Electronics by V.K. Mehta, S. Chand & Co.

**Reference:** A First Course in Electrical Engineering by Kothari.

**MEC- 2205 METALLURGY AND MATERIAL SCIENCE**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :2

**Syllabus;**

Structure of crystalline solids: Atomic structure & bonding in solids- Crystal structures- calculations of radius, Crysrallography: Classification of Crystals-Bravi”s lattices-Miller Indices Coordination Number and Atomic Packing Factor for different cubic structures - Imperfection in solids, point defects, Linear defects, Planar defects and Volume defects- Concept of Slip & twinning.

Phase diagrams: Basic terms- phase rule- Lever rule & free energy of phase mixtures cooling curves- Phase diagram & phase transformation - construction of phase diagrams- binary phase diagrams - Brass, Bronze, Al-Cu and AlSi phase diagrams- Invariant reactions, eutectic, , peritectic, eutectoid, peritectoid, metatectic & monotectic reactions, Iron carbon phase diagram & microstructures of plain carbon steel & cast iron

Heat treatment: Heat treatment of steel- Annealing, and its types, normalizing, hardening, tempering, martemering, austempering - TTT diagrams, drawing of TTT diagram, TTT diagram for hypo-& hypereutectoid steels, effect of alloying elements, CCT diagram- Martensitic transformation, nature of martensitic transformation- Surface hardening processes like case hardening, carburizing, cyaniding, nitriding Induction hardening, hardenabilty, Jominy end-quench test, Age hardening of Al & Cu alloys Precipitation Hardening

Engineering Alloys: Properties, composition, microstructure and uses of low carbon, mild medium & high carbon steels. stainless steels, high speed steels, Hadfield steels, tool steels - Cast irons, gray CI, white CI, malleable CI, SC iron-The light alloys- Al & Mg & Titanium alloys- Copper & its alloys: brasses & bronzes- super alloys, Smart materials- Nano materials.

Composite Materials: Classification of composite materials, dispersion strengthened, particle reinforced and fiber reinforced composite laminates properties of matrix and reinforcement materials and structural applications of different types of composite materials.

Nano-Materials- Introduction and Applications.

Powder Metallurgy: Powder Metallurgy process, Preparation of powders, Characteristics of Metal powders, mixing , compacting, sintering, Applications of Powder Metallurgy. Forming and shaping of plastics-Extrusion and Injection moulding. Ferrous And Non –Ferrous Materials: Composition, properties and application of ferrous and Non ferrous metals and their alloys. Breif study of cast iron, steels, copper and aluminum

Text Books:

1. “Materials Science & Engineering- An Introduction”, William D.Callister Jr. Wiley India Pvt. Ltd. 6th Edition, 2006, New Delhi.

2. Physical Metallurgy, Principles & Practices”, V Raghavan.PHI 2nd Edition 2006, New Delhi.

References

1. Introduction to Physical Metallurgy by Sidney H Avner Tata McGraw-Hill Education 1997

2. Materials Science And Engineering: A First Course By V. Raghavan Phi 5th Edition 2011, New Delhi

**MEC- 2206 ENVIRONMENTAL SCIENCE**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits : 2

**Syllabus:**

**Introduction:** Definition, Score and importance, Measuring and defining environmental development: Indicators

**Ecosystems:** Introduction, Types, Characteristic features, Structure and functions of ecosystems, Forest, Grassland, Desert, Aquatic (lakes, rivers and estuaries).

**Environment and Natural Resource Management:** Land Resources: Land as a resource, Common property resources, land degradation, Solerosion and desertification, Effects of modern agriculture, fertilizer-pesticide problems, Forest Resources: Use and over-exploitation. Mining and dams - their effects on forest and tribal people. Water resources: Use und over-utilization of surface and ground water. Floods, Droughts, Water logging and salinity. Dams - benefits and costs, Conflicts over water, Energy Resources: Energy needs, Renewable and non-renewable energy sources, Use of alternate energy resources, Impact of energy use on environment.

**Bio-Diversity and its Conservation:** Value of bus-diversity - Consumptive and productive use, Social, Ethical, Aesthetic and option values, Bio-geographical classification of India - India as a mega diversity habitat. Threats to biodiversity - Hot-sports, habitat loss, poaching of wildlife, loss of species, seeds, etc., Conservation of biodiversity - in-situ and ex-situ conservation.

**Environmental Pollution - Local and Global Issues:** Causes, Effects and control measures of : Air pollution, Indoor air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Solid waste management, Compositing, Vermiculture, Urban and industrial wastes, Recycling and re-use, Nature of thermal pollution und nuclear hazards, Global warming, Acid ruin, Ozone depletion.

**Environmental Problems in India:** Drinking water, Sanitation und public health, Effect of activities of the quality of environment: Urbanization, Transportation, Industrialization, Green revolution, Water scarcity and ground water depletion, Controversies on major dams - Resettlement and rehabilitation of people problems and concerns, Rain water harvesting, Cloud seeding and watershed management.

**Economy and Environment:** The economy and environment interaction, Economics of development, Preservation and conservation, Sustainability: Theory and practice, Limits to growth, Equitable use of resources for sustainable lifestyles, Environmental impact assessment.

Text Book:

1. Kaushik – Kaushik, Anubha

Reference:

1. Deswal & Deswal, Raja Gopal, Dharmaraj Publishers.

**MEC- 2207 PRODUCTION DRAWING**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs. Credits :1.5

**SYLLABUS:**

**Introduction to Production drawing**, Component drawing, Assembly drawing, Machine shop drawing, Pattern-shop drawing, Sheet metal drawing. Limits, Tolerances and Fits- Indication of surface roughness, preparation of process sheets.

**Production drawings** of Spur, Bevel and Helical gears, swivel bracket, main spindle, crank, revolving centre, jigs and fixtures.

**Drawing of Dies**. Sheet metal dies. Forging dies, stock strip layouts in sheet metal work, process layout for forge and press operations.

**Cutting tool layout**.Single point, multi point cutting tools for conventional and CNC machine tools.

**Text Book:**

 1. A Text Book on Production Drawing by K.L.Narayana, P.Kannaiah and K.Venkata Reddy, New age international.

**References:**

1. Manufacturing technology Foundry, Forming and Welding by P.N.Rao, Tata McGraw Hill Publishing Company Ltd, New Delhi.

2. Production Technologies, HMT.

**MEC- 2208 ELECTRICAL TECHNOLOGY LAB**

(Effective from the batch admitted during 2010-2020- AICTE)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs.

 Credits : 1.5

**LIST OF EXPERIMENTS:**

1. Study and Calibration of wattmeter and energy meter.
2. Measurement of armature resistance, field resistance and filament resistance.
3. Verification of KCL and KVL.
4. Superposition theorem.
5. Parameters of a choke coil.
6. O.C. and S.C. tests on transformer.
7. Load test on D.C. shunt machine.
8. O.C. test on D.C. separately excited machine.
9. Swinburnes test.

10. 3 phase induction motor (No load and rotor block tests) load tests.

11. Alternator regulation by Syn. Impedance method.

**THIRD YEAR-FIRST SEMESTER**

**MEC- 3101 DYNAMICS OF MACHINERY**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits : 3

**SYLLABUS:**

**Gyroscopic Couple and Precessional Motion**: Precessional and angular motion- gyroscopic couple- effect of gyroscopic couple on an aero plane and on a naval ship, stability of a four wheel vehicle moving in a curved path, stability of a two-wheel vehicle taking a turn.

**Cams:** Classification of followers and cams- Definitions- Motions of the follower- Uniform velocity- Simple harmonic motion- Uniform acceleration and retardation- Displacement- Velocity and acceleration diagrams. Construction of cam profiles- Cam with knife edged follower and roller follower- Cams with specified contours- Tangent cam with roller follower- Circular arc cam with flat faced follower.

**Toothed gearing**: Classification of toothed wheels, technical terms, conditions for constant velocity ratio of toothed wheels- Law of gearing- Velocity of sliding of teeth, forms of teeth- Length of contact, arc of contact, interference in involute gears, minimum number of teeth required on pinion to avoid interference- Methods of avoiding interference- Helical gears, Spiral gears- Efficiency of spiral gears.

**Gear Trains**: Types of gear trains- Simple, compound, reverted and epicyclic gear trains- Velocity ratio of epicyclic gear train- Tabular method- Algebraic method- Torques and tooth loads in epicyclic gear trains.

**Balancing of Rotating and Reciprocating Masses**: Balancing of a single rotating mass in the same plane and by two masses in different planes, balancing of several masses revolving in the same plane- Balancing of several masses revolving in different planes- Primary and secondary unbalanced forces of reciprocating masses, Partial balancing of unbalanced primary forces in a reciprocating engine, Partial balancing of locomotives- Effect of partial balancing of reciprocating parts of two cylinder locomotives- Variation of tractive force, Swaying couple and hammer blow- Balancing of primary and secondary forces in multi cylinder in-line engines- Direct and reverse cranks- Balancing of V- Engines.

**Vibrations:** Definitions- Types of vibrations- Natural frequencies of free longitudinal vibrations of systems having single degree of freedom- Equilibrium method- Energy method and Rayleghy's method. Frequency of damped vibration and forced vibration with damping- Magnification factor or dynamic magnifier.

**Transverse and Torsional Vibrations**: Natural frequency of free transverse vibrations due to point load and uniformly distributed load acting over a simply supported shaft- Transverse vibrations for a shaft subjected to number of point loads- Energy method- Dunkerley's method, Critical speed of a shaft. Natural frequency of free torsional vibrations- Free torsional vibrations of single rotor system, two rotor system, three rotor system and gear system.

**Text Book:**

1. Theory of Machines by R.S.Khurmi&J.K.Gupta.

**Reference books:**

1. Theory of Machines by Thomas Bevan.
2. Theory of Machines by S.S. Rattan.

**MEC- 3102 APPLIED THERMODYNAMICS-I**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Properties of Pure Substance**: Definition of pure substance, phase change of a pure substance, p-T (Pressure-Temperature) diagram for a pure substance, p-V-T(Pressure-Volume-Temperature) surface, phase change terminology and definitions, property Diagrams in common use, Formation of steam, Important terms relating to steam formation, Thermodynamic properties of steam and steam tables, External work done during evaporation, Internal latent heat, Internal energy of steam, Entropy of water, Entropy of evaporation, Entropy of wet steam, Entropy of superheated steam, Enthalpy-Entropy (h-s) charts for Mollier diagram, Determination of dryness fraction-Tank or bucket calorimeter, throttling calorimeter, separating and throttling calorimeter.

**Gases and Vapour Mixtures and Vapor Power Cycles** : Introduction, Daltons law and Gibbs-Dalton law, Volumetric Analysis of gas mixtures, Apparent molecular weight and gas constant, specific heats of gas mixture, Adaibatic mixing of perfect gases, Gas and vapour mixtures.Vapor power cycle- Rankine cycle- Reheat cycle- Regenerative cycle- Thermodynamic variables effecting efficiency and output of Rankine and Regenerative cycles- Improvements of efficiency, Binary vapor power cycle.**Steam Nozzles**: Type of nozzles- Flow through nozzles- Condition for maximum discharge- Nozzle efficiency- Super saturated flow in nozzles- Relationship between area velocity and pressure in nozzle flow- Steam injectors.

**Steam Turbines:** Classification of steam turbines- Impulse turbine and reaction turbine- Compounding in turbines- Velocity diagrams in impulse and reaction turbines- Degree of reaction- Condition for maximum efficiency of reaction turbines- Effect of friction on turbines constructional features governing of turbines.

**Condensers:** Classification of condenser- Jet, Evaporative and surface condensers- Vacuum and its measurement- Vacuum efficiency- Sources of air leakage in condensers- Condenser efficiency- Daltons law of partial pressures- Determination of mass of cooling water- Air pumps.

**Refrigeration:** Bell Colemen cycle, Vapor compression cycle- effect of suction and condensing temperature on cycle performance, Properties of common refrigerants, Vapor absorption system, Electrolux refrigerator. Principles of psychrometry and Air conditioning - Psychrometric terms, psychrometric process, air conditioning systems.

**Text Books:**

1. A Treatise on Heat Engineering by Vasandhani and Kumar.

2. Applied Thermodynamics-II by R. Yadav.

3. Fundamentals of Engineering Thermodynamics by E. Radhakrishna, PHI.

**References:**

1. Thermal Engineering, by R. K. Rajput.

2. Fluid Flow Machines, by M.S. GovindaRao, Tata McGraw Hill publishing company Ltd.

3. Refrigeration and Air-conditioning, by C.P.Arora and Domokundwar.

4. Thermal Science and Engineering by D.S. Kumar, S.K. Kataria and Sons

5. Refrigeration and Air-conditioning, by AhamadulAmeen, PHI.

**MEC-3103 FLUID MECHANICS**

(Effective from the batch admitted during 2019-2020 -AICTE)

Periods/week : 4 Th. Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits:3

**Properties of fluids**- Introduction-Viscosity- Pressure and its measurement , Absolute, Gauge, Atmospheric and Vacuum pressure – Manometers, Simple manometers, Differential manometers. Hydrostatic forces on surfaces - Total Pressure and Pressure Centre - Vertical, Horizontal, inclined and Curved plane surfaces submerged in liquid- Buoyancy and Floatation.

**Fluid Kinematics & Fluid Dynamics**: Types of fluid flow - Continuity equation - Velocity potential function and Stream Function - Types of Motion, Linear Translation, Linear deformation, Angular deformation, Rotation, Vorticity and circulation-Vortex flow, forced and Free Vortex – Equation of Motion- Euler's equation - Bernoulli's equation and its applications- Venturimeter, Orifice Meter, Pitot tube-Momentum Equation-Momentum of momentum Equation- Free Liquid Jet- Flow net analysis.

**Viscous Flow**: Couette flow- Plane Couette flow, Favourable pressure gradient and adverse pressure gradient-Power absorbed in Viscous Flow- Flow through pipes- Hagen Poiseulle flow- Fannigs friction factor- Darcy's Weisbach friction factor- Loss of head due to friction in pipes, Minor Losses and Major losses - Flow through branched pipes- Power transmission through pipes-Two dimensional viscous flow: Navier -Stokes equations and solutions- Order of magnitude analysis- Boundary layer equations.

**Laminar Boundary Layer:** Definition**-** Laminar Boundary Layer-Laminar Sub layer- Boundary Layer thickness-Displacement thickness, Momentum thickness and Energy thickness-Momentum integral equation- Flow over a flat plate.

**Turbulent Boundary Layer**: Laminar- Turbulent transition- Momentum equations and Renold's stresses- Fully developed turbulent flow through a pipe- Turbulent boundary layer on a flat plate- Laminar sub-layer- Boundary layer separation and control.

**Dimensional and Modeling Analysis**: Fundamental and derived dimensions- Dimensionless groups- Rayleigh method- Buckingham π-theorem- Model Analysis - Types of similarity- Geometric, Kinematic and Dynamic similarities- Dimensionless numbers- Modal Laws- Hydraulic diameter.

**Compressible Fluid Flow**: Thermodynamic relations- Continuity, Momentum and Energy equations- Velocity of sound in a compressible fluid- Mach number and its significance- Limits of incompressibility- Pressure field due to a moving source of disturbance- Propagation of pressure waves in a compressible fluids- Stagnation properties- Stagnation pressure, Temperature and density- Area velocity relationship for compressible flow- Flow of compressible fluid through nozzles- Condition for maximum discharge through nozzles- Variation of mass flow with pressure ratio- Compressible flow through a venturimeter- Pitot static tube in a compressible flow.

**Text Book:**

1. Fluid Mechanics and Hydraulic Machines, by R. K. Bansal, Laxmi publications.

2. Fluid Mechanics, by A.K. Mohanty, Prentice Hall of India Pvt.Ltd.

**References:**

**1.** Fluid Mechanics andFluid Power Engineering by Dr. D.S. Kumar, S.K. Kataria &Sons.

2. Foundations of Fluid Mechanics, by Yuan, Prentice Hall of India.

3. Fluid Mechanics and its Applications, by S. K.Gupta and A.K.Gupta, Tata McGraw Hill, New Delhi.

4. Fluid Mechanics and Hydraulic Machines by R. K. Rajput, S.Chand & Co.

5. Fluid Mechanics by Kothandaraman and Rudramoorthy.

**MEC- 3104 OPERATIONS RESEARCH**

(Effective from the batch admitted during 20159-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Development:** Definition, Characteristics and phase of Scientific Method, Types of models. General methods for solving operations research models.

**Allocation:** Introduction to linear programming formulation, graphical solution, Simplex method, Artificial variable technique, Duality theory and Dual simplex method.

**Transportation Problem:** Formulation optimal solution. Unbalanced transportation problems, Degeneracy. Assignment problem, Formulation optimal solution, Variations i.e., Non-square (m\*n) matrix restrictions.

**Sequencing**: Introduction, Terminology, notations and assumptions, problems with n-jobs and two machines, optimal sequence algorithm, problems with n-jobs and three machines, problems with n-jobs and m-machines, graphic solutions. Travelling salesman problem.

**Waiting lines**: Single channel Poisson arrivals, Exponential service times, Unrestricted queue with infinite population and finite population models; Single channel Poisson arrivals, Exponential service times with infinite population and restricted queue.

**Replacement**: Introduction, Replacement of items that deteriorate with time - value of money unchanging and changing, Replacement of items that fail completely.

**Theory of games**: Introduction, Two-person zero-sum games, The Maximum -Minimax principle, Games without saddle points - Mixed Strategies, 2xn and mx2 Games - Graphical solutions, Dominance property, Use of L.P. to games, Algebraic solutions to rectangular games.

**Inventory**: Introduction, inventory costs, Independent demand systems: Deterministic models - Fixed order size systems - Economic order quantity (EOQ) - Single items, back ordering, Quantity discounts (all units quantity discounts), Batch - type production systems: Economic production quantity - Single items, Economic production quantity multiple items. Fixed order interval systems: Economic order interval (EOI) - Single items, Economic order interval (EOI) - Multiple items.

**Network Analysis**: Network definitions, Minimum spanning tree algorithm, Shortest root problem, Maximum flow model. Elements of project scheduling by CPM and PERT.

**Text Books:**

1. Operation Research, by TAHA (PHI)

2. Operations Research Methods and Problems, by M.Sasiene, A.Yespal and L.Friedman.(John Wiely)

3. Operation Research by S.D.Sharma.(KedarnadhRamnadh& Co.,)

4. Operation Research by R.Pannerselvam, (PHI)

**OEC- 3105 MANAGERIAL ECONOMICS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs.

 Credits :3

**Significance of Economics and Managerial Economics:**

**Economics:** Definitions of Economics- Wealth, Welfare and Scarcity definition Classification of Economics- Micro and Micro Economics

**Managerial Economics:** Definition, Nature and Scope of Managerial Economics, Differences between Economics and Managerial Economics, Main areas of Managerial Economics, Managerial Economics with other disciplines

**Demand Analysis :** **Demand -** Definition, Meaning, Nature and types of demand, Demand function, Law of demand - Assumptions and limitations. Exceptional demand curve.

**Elasticity of demand** - Definition, Measurement of elasticity, Types of Elasticity ( Price, Income, Cross and Advertisement), Practical importance of price elasticity of demand, role of income elasticity in business decisions, Factors governing Price Elasticity of demand. **Demand Forecasting -** Need for Demand forecasting, Factors governing demand forecasting, Methods of demand forecasting: Survey methods- Experts' opinion survey method and consumers Survey methods.

**Utility Analysis:** Utility- Meaning, Types of Economic Utilities, Cardinal and Ordinal Utility, Total Utility, Marginal Utility, The law of Diminishing Marginal Utility and its Limitations**.**

**Theory of Production and Cost analysis:**

**Production -** Meaning, Production function and its assumptions, use of production function in decision making; Law of Variable Proportions: three stages of the law.

**Cost analysis -** Nature of cost, Classification of costs - Fixed vs. Variable costs, Marginal cost, Controllable vs. Non - Controllable costs, Opportunity cost, Incremental vs. Sunk costs, Explicit vs. Implicit costs, Replacement costs, Historical costs, Urgent vs. Postponable costs, Escapable vs. unavoidable costs, Economies and Diseconomies of scale.

**Market Structures** : Definition of Market, Classification of markets; Salient features or conditions of different markets - Perfect Competition, Monopoly, Duopoly , Oligopoly, Importance of kinked demand curve ;Monopolistic Competition

**Pricing Analysis** : Pricing - Significance: Different Pricing methods- Cost plus pricing, Target pricing, Marginal cost pricing, Going -rate pricing, Average cost pricing, Peak load pricing , Pricing of joint Products, Pricing over the life cycle of a Product, Skimming pricing Penetration pricing, Mark- up and Mark- down pricing of retailers.

**Business cycles, Inflation and Deflation:**

**Business cycles** - Definition , Characteristics , Phases, Causes and Consequences; Measures to solve problems arising from Business cycles

**Inflation -**Meaning, Types, Demand- pull and Cost push inflation, Effects of Inflation, Anti- inflationary measures.

**Deflation-** Meaning, Effects of Deflation, Control of Deflation, Choice between Inflation and Deflation.

**Text Books:**

1. Sankaran,S., **Managerial Economics,** Marghan Publications, 2015, Chennai.

2. Aryasri, A.R., **Managerial Economics and Financial Analysis,** MC Graw Hill

 Education, New Delhi,2015.

**Reference Books:**

1. Dwivedi, D.N., **Managerial Economics,** Vikhas Publishing House Pvt. Ltd. 6th

 Edition, New Delhi,2004.

2)Dewett, K.K., **Modern Economic Theory**, S.Chand & Company Ltd., New Delhi, 2005

**ELECTIVE-1 MEC- 3106A FINITE ELEMENT ANALYSIS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Fundamental Concepts**: Introduction, Historical background, Outline of presentation, General procedure for FEA, Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain problems, Temperature effects, Potential energy and equilibrium. The Rayleigh-Ritz method, Hamilton's principle.Galerkin's method, Saint Venant's principle.

**One-dimensional Problems**: Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach.The Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

**Two-dimensional Problems** Using Constant Strain Triangles: Introduction, Finite element modeling, Constant strain triangle, In plane and Bending, problem modeling and boundary conditions.

**Axisymmetric Solids Subjected to Axisymmetric Loading**: Introduction, Axisymmetric formulation, Finite element modeling, Triangular element, Problem modeling and boundary conditions.

**Two-dimensional Isoparametric Elements and Numerical Integration**: Introduction, The four-node quadrilateral, Numerical integration, requirements, h-refinement and p-refinement, Higher-order elements, Convergence

**Beams and Frames:** Introduction, Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports, Plane frames.

**Text Book:**

 1. Introduction to Finite Elements in Engineering, by Tirupathi R. Chandrupatla, Ashok D.Belegundu (chapters 1 to 8 only).

**References:**

1. Introduction to Finite Element Method, by S.S.Rao

2. Finite Element Method, by O.C. Zienkiewicz.

3. Concepts and Applications of Finite Element Analysis, by Robert D. Cook.

4. Introduction to Finite Element Method, by J.N.Reddy.

**ELECTIVE-1 MEC- 3106B WORK STUDY**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS**

**Introduction to work study:** Scientific management – Productivity - Advantages of work study to management, Supervisors and workers.

**Method Study**: Introduction - Process charts, Critical Examination, Identification of key activities on process charts, Diagrams and Templates, Therbligs, Micro motion analysis, Memo motion study. Developing new method - Job survey report writing.

**Principles of Motion Economy:** Related to human body, work place, equipment.

**Work Measurement**: Work measurement techniques – Rating - Measuring the job – Allowances - Standard time - Synthetic data - Analytical estimating – PMTS ,Work factor, MTM, Activity sampling, Its applications.

**Job Evaluation,** Techniques of job evaluation - Merit rating - Incentive plans.

**Ergonomics:** Basics of Ergonomics**,** Anthropometry.

**Text Books:**

1. Introduction to Work Study - International LabourOrganisation.

2. Elements of Work Study and Ergonomics by Dalela et al, Standard Publications.

**References:**

1. Motion and Time Study, by Barnes, John Wiely.

**ELECTIVE-1 ME 3106C ADVANCED FOUNDRY AND WELDING TECHNOLOGY**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Moulding:** Development of metal castings- Materials for moulding- Foundry sand control- Different types of cores- Core making processes- Materials for core making- Moulding and core making machines. Recent developments in core mould making- Cold set process- Investment process- Shell moulding- Hot box method- Shaw process. Vacuum moulding- moulding for mass production.

**Melting and Solidification**: Furnaces used in foundry for melting ferrous and nonferrous metals- principals of operation of cupola and charge calculations. Family of cast irons- Production of malleable and S.G. Irons- Methods of alloying and inoculants and their effects on the structure and properties of cast iron. Principles of Solidification: Nucleation- Crystal growth- Morphology and structure of cast metals and alloys- Pure metals- Single phase alloys and eutectics. Solidification in sand and chill moulds.

**Foundry Mechanization**: Layout for ferrous and nonferrous foundries- Description of equipment used for mechanization- Sand conditioners- Conveyors- Cranes- Equipment for handling moulds, Cores and molten metal- Knock out of moulds- Fettling equipment.

**Special Welding Processes**: Resistance welding processes- Spot, Seam, Projection, Flash butt welding - Machine cycle for resistance welding- Parameters in resistance welding- Electrodes for resistance welding – Solid State Welding: Cold welding – Forge welding - Ultrasonic welding Diffusion welding – Radiation welding: Laser Beam Welding, Electron Beam Welding – Automatic welding systems.

**Weldability of Metals**: Factors influencing weldability of metals- Welding of Cast steels, Carbon steels, Stainless steels and Cast iron. Weldability of Cu and its alloys, Al and its alloys- Ti and its alloys- Mg and its alloys- Temperature changes in welding and their effects on mechanical properties. Absorption of gases by welds and their effects- Residual stresses and distortion- Heat treatment of welded parts.

**Welding Joints, Weld Symbols and Joint Design principles:** Types of joints – types of welds – Variants of joints and weld types - Welding symbols – principles of weld joint design and evolving of good weld designs.

**Text Books:**

1. Foundry Technology, by Jain P.L.

2. Welding Engineering and Technology, by R.S. Parmar.

**References:**

1. Foundry Engineering, by Agarwal.

2. Foundry Engineering, by Taylor F. & Others.

3. Principles of Metal Castings, by Heine & Others.

4. Modern Welding Technology, by H.B. Cary.

5. Welding Technology, by Koenisburger.

6. Welding Metallurgy, S.Kou, 2ndedition, John Wiley and Sons, New York, NY (2003).

**MEC -3107 MANUFACTURING TECHNOLOGY LAB-I**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs. Credits : 1.5

**LIST OF EXPERIMENTS:**

Use of basic tools and operations of the following trades.

|  |  |  |
| --- | --- | --- |
| S. No. | Trade | No. of exercises |
| 1. | Foundry | 3 |
| 2. | Welding | 2 |
| 3. | Lathe Step and taper turningThread cuttingOffset turning | 111 |
| 4. | Milling | 1 (Spur gear) |
| 5. | Shaper | 1 |

1. Cylindrical grinding, Surface grinding, Planing, Slotting and Capstan lathe (only demonstration in one class for the entire batch of students).

7. Dissembling and assembling of \*

i. Machine Tool (Lathe)

ii. I.C. engine

iii. Pump

iv. Gear box

\* Not for examination.

**MEC-3108 FUELS & MECHANICS LAB – I**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs.

 Credits :1.5

**List of Experiments:**

1. Study and valve timing diagrams for four-stroke and study & PTD of two-stroke engines.
2. Determination of volumetric efficiency of the given air compressor by (i) plate orifice method and (ii) tank capacity method.
3. Calibration of the given pressure gauge.
4. a) Determination of flash and fire points and

 b) Canradsons carbon residue test.

1. Determination of calorific value of flues (solid, liquid and gaseous) by Bomb calorimeter/Gas calorimeter.
2. Determination of the kinematic and absolute viscosity of the given sample oils.
3. Determination of inertia of the given flywheel and connecting rod.
4. Determination of modulus of rigidity of the given wire with torsion pendulum.
5. Study of boilers, various mountings and accessories.
6. Assembling of the given two-stroke petrol engine. (Instead of engine, any mechanical unit can be given for this experiment.)

**Third Year 2nd Semester**

**MEC- 3201 MEASUREMENTS & CNC**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

Automatic screw lathes, Multi spindle automatic lathes, Turret lathes, Numerical control, NC operation, Coordinate system, Data input devices, Data storage, Programme editing, Machining centres, Turning centres, Vertical turning centres, Milling centres, Advantages of NC, Computers & NC, CNC, DNC, CNC part programming: Designation of co-ordinate axes for CNC machines, Functions of machine control units, Tape format, Manual part programming and computer assisted part programming (using APT language). Exercises involving simple contours and positioning.

ISO system of limits, Fits and Tolerances, Interchangeability, Plain limit gauges, Measurement of screw threads, major diameters, Minor diameters and effective diameter, Pitch, Limit gauges for internal and external threads, Measurement of spur gears, pitch, profile, lead, backlash, tooth thickness.

Tool maker's microscope, Straightness measurement, Slip gauges, Twisted strip mechanical comparator, Optical lever comparator, Optical projector, Electric comparator, Pneumatic comparator, Squareness testing, Optical bevel protractor, Sine bar, Angle gauges, Precision level, Autocollimeter, Angle dekkor, Optical dividing heads and rotary tables, Flatness measurement, Roundness measurement. Co-ordinate measuring machines.

Surface texture: Parameters, sampling length, Specification, Stylus instruments for surface roughness measurement. Acceptance tests on machine tools: Lathe, Milling machine, Radial drill, Laser equipment.

Text Books:

1. Process & Materials of Manufacture, R.A.Lindberg, 4th edition, Prentice-Hall of India, New Delhi.

2. A Text Book of Engineering Metrology, I.C.Gupta, Dhanpat Rai & Sons, Delhi.

3. CNC and Computer Aided Manufacturing, T.K.Kundra, P.N.Rao & N.K.Tewari, Tata McGraw-Hill Publishing Company Ltd, Delhi.

References:

1. A.S.T.M.E., Hand book of Industrial Metrology, Prentice-Hall of India, New Delhi.
2. A.S.T.M.E., Hand book of Manufacturing Engineering.
3. Manufacturing Processes & Materials for Engineers, L.E.Doyle & others, Prentice-Hall of India, New Delhi.

**MEC- 3202 CAD/CAM**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**COMPUTER AIDED DESIGN**

**Fundamentals of CAD** - Introduction - The design process - Application of computers for design - Operating systems - Hardware in CAD: The design work station - I/O Devices - CAD system configuration - Creating database for manufacturing - Benefits of CAD.

**Interactive Computer Graphics** - Graphic display devices- Graphics system- Graphics standards - Graphical user interface- Transformation systems- 2D and 3D transformations - Linear transformation- windowing – clipping - Geometric Modeling - Modeling Techniques - Wire frame Modeling - Surface Modeling - 3 D Solid Modeling.

**Introduction to Finite Element Analysis** – Steps of FEM for solving physical problem, CAD techniques to finite element data preparation- Automatic mesh generation- Presentation of results - CAD applications of FEM.

**COMPUTER AIDED MANUFACTURING**

**Group technology**: Merits & demerits, Organization, Classification and Coding systems, Cellular manufacturing.

**Computer aided process planning**: Introduction to process planning, Methods of process planning, Computer aided process planning, CAPP systems

**Computer aided material handling:** Robots: Structure and operation of Robots, robot sensors and applications. Automatic conveyor systems.Automated guided vehicles.

**Computer aided inspection and quality control**: Quality assurance and quality control. Contact and Non-contact inspection -Coordinate measuring machine.

**FMS & CIM**S: Building blocks of Flexible Manufacturing Systems (FMS), Machining systems of FMS, Tool management systems, Advantages of FMS, Computer integrated manufacturing systems (CIMS).

**Text Books:**

1. CAD/CAM- Computer Aided Design & Manufacturing, by M.D.Groover&E.W.Zimmer.

2. Computer Aided Design and Manufacturing, by Dr.Sadhu Singh, Khanna Publishers.

**References:**

1. Computer Aided Design in Mechanical Engineering, by V.Rama Murthy.

2. Elements of Computer Aided Design & Manufacturing, by Y.C.Pao.

3. Computer Aided Kinetics for Machine Design, by D.L.Ryan.

4. Computer Aided Design and Manufacturing, by C.B.Besant&C.W.K.Lui.

5. Computer-Aided Analysis & Design by S. Ghosal, Prentice Hall of India.

6. CAD/CAM/CIM by Radhakrishna, New age international.

7. Computer Integrated Design and Manufacturing, by David D.Bedworth, Mark R.Henderson& Philip M.Wolfe, McGraw-Hill Book Company, Singapore.

8. Computer Aided Manufacturing, by P.N.Rao, N.K.Tewari&T.K.Kundra, Tata McGraw-Hill publishing company Ltd, NewtDelhi.

**MEC 3203 APPLIED THERMODYNAMICS-II**

(Effective from the batch admitted during 2015-2016- CBCS)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**I.C. engines:** classification-comparison of two stroke and four stroke engines- comparison of S.I. and C.I. engines**-**Air cycles-Otto, Diesel, Dual, Stirling, Ericson and Atkinson cycles and their analysis-Valve timing and port timing diagrams- Efficiencies- air standard efficiency,indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, volumetric efficiency and relative efficiency-Testing and performances of I.C. engines-Basic principles of carburetion and fuel injection.

**Combustion in I.C. Engines:** S.I. engines- Normal combustion and abnormal combustion- Importance of flame speed and effect of engine variables-types of abnormal combustion pre-ignition and knock, Fuel requirements and fuel rating, anti-knock additions- Combustion chamber requirements and Types of combustion chamber- Design principles of combustion chambers-C.I. engines- Stages of combustion- Delay period and its importance- effect of engine variables, diesel knock, suction compression and combustion induced turbulence, open and divided combustion chambers.

**Reciprocating and Rotary Compressors:** Reciprocating compressors-effect of clearance in compressors, volumetric efficiency-single stage and multi stage compressors-effect of inter cooling in multi stage compressors-Vane type blower-centrifugal compressor- Adiabatic efficiency- Diffuser- Axial flow compressors- Velocity diagrams, degree of reaction, performance characteristics.

**Gas Turbines**: Simple gas turbine plant- Ideal cycle, closed cycle and open cycle for gas turbines-Efficiency, work ratio and optimum pressure ratio for simple gas turbine cycle- Parameters of performance- Actual cycle, regeneration, Inter-cooling and reheating, closed and semi-closed cycle-Jet propulsion and Rockets.

**Nuclear power plants:** Classification of reactors-Thermal utilization-Fuels, Fuel moderator and coolant, Control and safety rods, Special properties of structural materials required, Induced radio-activity-Gas cooled reactors, Radiation hazards and shielding-Radio active waste disposal.

**Direct Energy Conversions and non conventional energy sources:** Solar Energy- Introduction, Solar radiation, Solar collectors, Energy storage-Wind Energy- Wind mills-Thermo Electric- MHD.

**Text Books:**

1. A Treatise on Heat Engineering by Vasandhani and Kumar.

2. Applied Thermodynamics-II by R. Yadav.

**References:**

1. Thermal Engineering, by R.K.Rajput.

2. I.C. Engines, by Mathur and Nehata.

3. Gas Turbines, by Cohen and Rogers.

4. Fluid Flow Machines, by M.S. GovindaRao, Tata McGraw Hill publishing company Ltd.

5. I.C. Engines by V. Ganesan.

6. Power Plant Engineering, P.K.Nag

7. Non ConventionalEnergy Sources, G.D.Rai

8. Internal Combustion Engines by R.K. Mohanty, Standard Book House

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**ELECTIVE-II MEC- 3204A AUTOMOBILE ENGINEERING**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Introduction:** Definition of automobile, Automobile Layout, Chassis and Transmission: Introduction to Drive Train: Clutch, Gearbox, Hook’s Joint, Propeller /Drive Shaft, Slip Joint, Final Drive and Differential, Front and Rear Axles, Wheels and Tires, Control systems: Introduction to Steering, and Brakes. Electrical system: Introduction to Starting System, Ignition, dynamo/alternator, cut-out and wiring. Automobile Body: Parts and Stream lining, Automobile types: Front, Rear and Four wheel drive and Automotive materials.

**Engine (Power Plant):** Multi cylinder engine parts, Classification: ‘In-line’ and ‘V’ type, Multi-Valve Engines, VCR Engines, Super Charging/Turbo charging, Air filters, Fuel Systems: Petrol Engines: Carbureted and MPFI, Ignition Systems: Conventional and Electronic, Diesel Engines: Conventional, CRDI, and Duel Fuel engines., Performance, Combustion and Exhaust Emissions, Air pollution and their control: EGR and Catalytic Converters, EURO/Bharat Stage Norms: I, II, III, IV and V., Manifolds and Mufflers, Engine Cooling and Lubrication.

**Clutch:** Necessity, Clutch Assembly: Construction and Working Principle, Types: Single and Multiple Plates, Free-Play, Fluid coupling/Torque converter, Clutch Troubles and Remedies.

**Gearbox:** Necessity of Transmission and Transaxle, Construction and Working Principle, Selector Mechanism, Types: Sliding mesh, Constant mesh, Synchromesh, and Epicyclical. Three, Four and Five- Speed Gearbox, Overdrive, Automatic Gearbox, Gearbox Troubles and Remedies.

**Drive shaft and Final Drive:** Drive Shaft: Constructional Features: Universal/Hooks Joints, Slip Joint, and Working Principle., Types of Propeller shafts, Final drive and Differential: Necessity, Constructional Features and Working Principle., Front/Rear Axles: Constructional Features and Types of Rear Axle Floating, Wheels: Disc and Drum type, Tires: Tire Construction, Tube and Tubeless Tires, Radial Tires, Tire specification, Tire rotation and Tire Maintenance.

**Suspension System and Vehicle Control**: Coil and Leaf Springs, Shock absorbers, Wheel alignment: Kingpin angle, Caster, Camber, Toe-in, and Toe-out., Necessity of vehicle control, Steering Mechanism and its Elements: Steering gear box and its types, Steering gear ratio, Constant Velocity Joints and linkages. Power Steering, Brake system: Necessity, Parking and Power Brakes, Parts and Working Principle of Mechanical, Air and. Hydraulic Brakes: Mater and Wheel cylinder, Properties of Brake Fluids, Brake Diagnostics and Service: Brake Bleeding, Anti-lock Braking System, Automobile Accessories and Tips for Safe Driving.

**Electrical and Electronic Systems:** Basics of Electrical/Electronic Systems: Battery, Starting system, Charging System, Lighting and Signaling System, A/C Electrical System, Electronic Engine Management system, Automotive Embedded Systems: Vehicle Security System and Working Principle of Computer Sensors: Temperature, Flow, Cam, knock, and Oxygen, and ECU/ ECM.

**Trouble shooting and Maintenance:** Engine and Vehicle Troubles: Diagnostic Information: Symptom descriptions and their Causes and Remedies, Periodic, Preventive and Break down Maintenance: Engine tuning, Fuel and Air filters, Lubricants, Maintenance of Battery and Electrical/Electronic System, and Tires. The Motor Vehicle Act (India).

**Introduction to Electric and Hybrid vehicles**: Performance and emission characteristics of electric and hybrid vehicles

**Text Books:**

1. Automotive Mechanics (10/e) - William H. Crouse and Donald L. Anglin, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-059054-0

2. Automobile Engineering – KK Jain/ RB Asthana, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-044529-X

3. Internal Combustion Engines and Air Pollution- E.F. Obert, Harper & Row International Publishers Inc., ISBN: 0-06-350561-4

**Reference Books**:

1. Automotive Mechanics – S. Srinivasan, Tata McGraw-Hill Publishing company Limited, ISBN: 0-07-044941-6

2. Internal Combustion Engines – Heywood, John, B. McGraw-Hill Publications Limited.

3. Automotive Engines- S Srinivasan, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-040265-5

**ELECTIVE-II MEC- 3204B MECHANICAL VIBRATIONS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:Single degree freedom systems** -Introduction - Single degree freedom systems - free and forced vibrations - Damping classification and damped systems .

**Two degree freedom systems** - Free, forced damped and undamped motions - Use of influence coefficients, Matrix methods and Lagrange's equations - Phenomenon of beat - Dynamic absorbers – Applications.

**Transient (Shock) vibrations** as applied to single and two degree freedom systems - Use of mathematics and graphical techniques in the analysis (superposition integral, Laplace transformations, phase plane techniques).

**Multi degree freedom systems** - Free and forced motions in longitudinal, torsional and lateral modes - damped and undamped, critical speeds of rotors. Continuous systems - free and forced vibrations of string, bars and beams - Principle of orthogonality Classical and energy methods by Rayleigh, Ritz and Gelerkin.

**References:**

1. Mechanical Vibrations by A.H. Church.

2. Vibration Problems in Engineering by Timoshenko and Young.

3. Mechanical Vibrations by Den Hartog.

 **ELECTIVE-II MEC- 3204C RELIABILITY ENGINEERING**

(Effective from the batch admitted during 2015-2016- CBCS)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Introduction:** Concepts of quality and reliability, a brief history, terms, definitions, reliability function, MTTF, Hazard rate function, bath tub curve, conditional reliability.

**Constant failure rate models:** Exponential reliability, failure modes, failure modes with exponential distribution, applications, two parameter exponential distribution, Poisson process.

**Time dependent failure models:**Weibull distribution, burn-in screening for Weibull, three parameter Weibull distribution, Normal and Lognormal distributions

**Reliability of systems:** Series, parallel configurations, combined systems, k-out-of-n systems, complex configurations, common failure modes, minimal cuts and minimal paths.

**State dependent systems:** Markov analysis, load sharing, standby systems, degraded systems

**Physical reliability models:** Static models- random stress and random strength, dynamic models- periodic models, random loads.

**Design for reliability:** Reliability specification, Lifecycle costs, reliability allocation, design methods, failure analysis, FTA.

**Reliability testing:** Life testing, burn-in testing, acceptance testing-binomial acceptance testing.

**Reliability growth testing:** Reliability growth process, idealized growth curve, Duane growth model.

**Text Book:**

1. Introduction to Reliability and Maintenance engineering by Charles E Ebeling, Tata McGrawhill, India.

**References:**

1. Introduction to Reliability Engineering by E.E. Lewis, John Wiley& Sons, NewYork

2. Reliability based design by S.S.Rao, McGraw-Hill, New York

**MEC- 3205 PRODUCTION PLANNING AND CONTROL**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Introduction :** Definition – Objectives of production Planning and Control – Functions of production planning and control – Types of production – Organization of production planning and control department.

**Forecasting** : Importance – Types of forecasting– Forecasting techniques – qualitative methods and quantitative methods.

**Inventory management** : Functions of inventories – relevant inventory costs – EOQ model – Inventory control systems – ABC analysis – VED analysis

Material Requirement Planning, Bill of material, MRP II, Master Production Scheduling.

**Aggregate planning**,: Chase planning, Expediting, controlling aspects.

**Routing** : Definition – Routing procedure –Route sheets –– Factors affecting routing, procedure – Difference with loading

**Scheduling:** Policies – Types of scheduling- Forward and Backward Scheduling – Gantt Charts – Flow shop Scheduling – n jobs and 2 machines, n jobs and 3 machines – Job shop Scheduling – 2 jobs and n machines – Line of Balance.

**Dispatching** : Activities of dispatcher – Dispatching procedure – follow up – priority rules for dispatching jobs.

Applications of computer in production planning and control.

**Text Books:**

1. Elements of Production Planning and Control / Samuel Eilon.

2. Modern Production/ operation managements / Baffa&RakeshSarin

**References:**

1. Operations Management – S.N. Chary.

2. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.

4. Production Control A Quantitative Approach / John E. Biegel.

5. Operations Management / Joseph Monks.

**MEC- 3206 DESIGN OF MACHINE ELEMENTS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Introduction to Mechanical engineering design**: traditional design methods, different design models, Problem formulation, Design considerations, engineering materials and processes and their selection, BIS designation of steels, Mechanical properties, Load determination, manufacturing considerations in design.

**Design against static loads:** Modes of failure, Factory of safety, Axial, bending and torsional stresses, Stress concentration factors. Static failure theories.

**Fluctuations and fatigue stresses**, Soderberg, Goodman and modified Goodman diagrams, fatigue failure, design consideration in fatigue

**Threaded and welded joints**: forms of threads, basic types of screw fastenings, ISO metric screw threads, eccentrically loaded bolted joints, Torque requirement for bolt tightening, Fluctuations loads on bolted joints, fasteners, Joints with combined stresses. Power screws, Force analysis. Collar friction, Differential and compound screws design. Types and strength of weld joints subjected to bending and fluctuating loads, cotter and knuckle joints, welded joints, different types welded joints and their design aspects, welding inspection

**Shafts, keys and couplings**: shafts design on strength basis, torsional rigidity basis, Design of hollow shafts, flexible shafts, ASME codes for shafts, Keys and cotter design, Flat, square keys, Splines, Rigid and flange couplings, Flexible couplings

**Spring Design**: classification and spring materials, Spring end formation, Design of helical compression springs, helical extension springs, torsion springs, laminated springs, Protective coatings, Equalized stress in spring leaves. Multi - leaf springs. Surge in springs, Nipping and shot peening.

**Text Books:**

1. Design of Machine Elements by V.B.Bhandari, TMH Publishing Co. Ltd., New Delhi

**References:**

1. Machine Design by Jain, Khanna Publications.

2. Machine Design by Pandya and Shaw, Charotar publications

3. Machine design , an integrated approach by R.L.Norton, 2nd edition, Pearson Education

**MEC- 3207 ENGINES & MECHANISMS LAB**

((Effective from the batch admitted during 2015-2016- CBCS)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs. Credits : 1.5

1. Load test and smoke test on I.C. Engines.

2. Morse test on multi-cylinder engine.

3. Heat balance sheet on I.C. Engines.

4. Study of multi-cylinder engines and determination of its firing order.

5. Calculations of efficiencies of the given air compressor.

6. Determination of pressure distribution around the given (1) cylinder and (2) airfoil specimens kept in a uniform flow wind-tunnel.

7. Study of automobile mechanisms.

8. Verification of laws of balancing.

9. a) Determination of ratios of angular speeds of shafts connected by Hooke's joint.

 b) Determination of the ratio of times and ram velocities of Withworth quick return motion mechanism.

10. To draw curves of slider displacement and crank angle and linear velocities w.r.t. time for a slider crank mechanism and compare with theoretical values.

11. To determine the relation of gyroscopic couple and compare with the theoretical values.

12. To draw the crank angle vs. pressure diagram for an I.C. engine using pressure transducer and cathode ray oscilloscope.

**MEC- 3208 MANUFACTURING TECHNOLOGY LAB-II**

(Effective from the batch admitted during 2015-2016- CBCS)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs. Credits :1.5

**LIST OF EXPERIMENTS:**

1. Experiments on Lathe to establish the following curves

 a) Depth of cut Vs Cutting force.

 b) Feed Vs Cutting force.

 c) Cutting speed Vs Cutting force.

2. Grinding of single point cutting tool as per given specifications (to check the tool angles).

3. Study of chip formations on shaping machine (with lead sample).

4. Torque measurement on drilling/milling machine.

5. Effect of speed and feed on surface roughness.

6. Measurement of cutting tool temperature in turning.

7. Sieve analysis to evaluate G.F.No.

8. Moisture and clay content test.

9. Green compression and shear test.

10. Shatter Index & Hardness Testing

**FOURTH YEAR FIRST SEMESTER**

**MEC- 4101 MACHINE DESIGN**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

Classification of gears.Standard tooth systems. Spur, Helical, Bevel and Worm gears. Terminology of each. Tooth failure. Face width an beam strength. Lewis equation. Design for dynamic and wear loads. Force analysis of Bevel and Worm gears. Thermal design considerations of worm gears.

Engine parts: I.C. engine design. Design of cylinders and heads.Design of pistons.Design of cross-head, connecting rods and crank shafts.

Friction clutches. Torque capacity multi-plate clutches. Design considerations. Energy considerations and Temperature rise friction materials. Centrifugal clutches. Brakes.Energy equations. Band and block brakes. Internal expanding shoe brakes, self locking, brake design.

Sliding contact bearings.Lubrication modes.Temperature effect on viscosity.Journal bearing design.Bearing modulus.McKee equations.Heating of bearings. Collar and thrust bearings. Roller and ball bearings.Static and dynamic load capacity.Equivalent bearing load.Load-life relationships. Load factor. Selection of bearings from manufacturers catalogue.

Design of crane hooks, Wire rope construction and classification. Stresses in wire ropes. Design for service like lifts and winches. Chain drives, Nomenclature: Brief outline and simple applications of composite materials.

**Text books:**

1. Design of Machine Elements by V.B. Bhandari, TMH publishing Co. Ltd., New Delhi.

**References:**

1. Machine Design by R.K. Jain, Khanna publications.

2. Mechanical Engineering Design by Joseph E. Shingley.

**ELECTIVE- III: MEC-4102A. TOTAL QUALITY MANAGEMENT**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Concepts of TQM:** Philosophy of TQM, Customer focus, Organization, Top management commitment, Team work, Quality philosophies of Deming, Crossby and Muller.

**TQM process**: QC tools, Problem solving methodologies, New management tools, Work habits, Quality circles, Bench marking, Strategic quality planning.

**TQM systems**: Quality policy deployment, Quality function deployment, Standardization, Designing for quality, Manufacturing for quality.

**Quality system**: Need for ISO 9000 system, Advantages, Clauses of ISO 9000, Implementation of ISO 9000, Quality costs, Quality auditing, Case studies.

**Implementation of TQM**: Steps, KAIZEN, 5S, JIT, POKAYOKE, Taguchi methods, Case studies.

**References:**

1. Total Quality Management by Rose, J.E., Kogan Page Ltd., 1993.

2. The Essence of Total Quality Management by John Bank, PHI, 1993.

3. Beyond Total Quality Management by Greg Bounds, Lyle Yorks et al, McGraw Hill, 1994.

4. The Asian Productivity Organization by Takashi Osada, 1991.

5.KAIZEN by Masaki Imami, McGraw Hill, 1986.

**ELECTIVE-III MEC- 4102B OPTIMIZATION DESIGN**

(Effective from the batch admitted during 2015-2016- CBCS)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

Introduction to Optimization: Engineering applications of optimization- Statement of an optimization problem- Classification of optimization problem- Optimization techniques.

Classical Optimization Techniques: Single variable optimization- Multivariable optimization with equality constraints- Multivariable optimization with inequality constraints.

Nonlinear Programming: One-Dimensional Minimization: Unimodal function- Elimination methods- Unrestricted search- Exhaustive search- Dichotomous search- Fibonacci method- Golden section method- Interpolation

methods- Quadratic interpolation method- Cubic interpolation method- direct root method.

Nonlinear Programming: Unconstrained Optimization Techniques: Direct search methods- Random search methods- Univariate method- Pattern search method- Rosenbrock's method of rotating coordinates- The simplex method- Descent methods- Gradient of function- Steepest descent method- Conjugate gradient method (Fletcher-Reeves method)- Quasi-Newton methods- Variable metric method (Davidon- Fletcher-Powell method).

Nonlinear Programming: Constrained Optimization Techniques: Characteristics of a constrained problem- Direct method- The complex method- Cutting plane method- Methods of feasible directions- Indirect methods- Transformation techniques- Basic approach in the penalty function method- Interior penalty function method- Convex programming problem- Exterior penalty function method.

Geometric programming (G.P): Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions.Solution of a constrained geometric programming problem (G.P.P). Complimentary geometric programming(C.G.P)

Dynamic programming(D.P): Multistage decision processes. Concepts of sub optimisation, computational procedure in dynamic programming calculus method and tabular methods.Linear programming as a case of D.P., Continuous D.P.

Integer programming(I.P): Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem.Integer non linear programming.

**Text Book:**

1. Optimization Theory and Applications, by S.S.Rao, Wiley Eastern Limited, New Delhi.

**References:**

1. Optimization of Design of Machine Elements, by R.C.Johnson.

2. Computer Aided Analysis and Design of Machine Elements, by RaoV.Dukkipati, M.AnandaRao and R.B.Bhat.

3. Engineering optimization methods and applications, by G.V.Reklaits, A.Ravindarn and K.M.Ragsdell, by Publications John Wiley and Sons.

**ELECTIVE-III MEC- 4102C TOOL DESIGN**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Locating and Clamping Devices:** Principles of Jigs and Fixtures design-Locating principles-Locating elements-Standard parts-Clamping devices-Mechanical actuation-Pneumatic & hydraulic actuation-Analysis of clamping forces-Tolerance and error analysis.

**Jigs & Fixtures:** Drill bushes-Different types of Jigs-Plate latch, channel, box, post, angle plate, angular post, turnover, pot jigs- Automatic drill jigs-Rack & Pinion Operated, Air operated Jigs Components.

General principles of lathe, milling and broaching fixtures-Grinding, Drilling and shaping fixtures, Assembly, Inspection and Welding fixtures-Modular fixtures.Design and development of Jigs and fixtures for simple components.

**Press Tools:** Press working terminology-Presses and Press accessories-Computation of capacities and tonnage requirements-Design and development of various types of cutting, forming and drawing dies.

**Tool Design for Numerically Controlled Machine Tools:** Fixture Design for Numerically Controlled Machine Tools, Cutting Tools for Numerical Control, Tool-holding Methods for Numerical Control

**Design of Limit Gauges:** Elements, types and application of limit gauges, Gauge materials, their selection, Taylor’s principles of gauge design, Types and methods to provide gauge tolerances. Design steps and design of plug & ring / snap gauge for given dimension and application.

**Text Books:**

1. Donaldson. C, Tool Design, Tata McGraw-Hill, 1986
2. “ASTME Handbook of Fixture Design ".Prentice Hall of India Pvt. Ltd.
3. Basu, Mukherjee, Mishra, Fundamentals of Tool Engg. Design, Oxford & IBH Publishing, N. Delhi

**References:**

1. A. K. Goroshkin, " Jigs and Fixtures Handbook ", Mir Publishers, Moscow, 1983.
2. “Die Design Handbook ", IvanaSuchy, McGraw Hill Book Co., 2005.
3. Production technology, HMT,Tata McGraw Hill.
4. P. Eugene Ostergaard, “Basic Die Making” - McGraw Hill Book, 1963.
5. Principle of Machine Tool. Sen& Bhattacharya,New Central Book Agencies, 1975.
6. Production tooling equipments,S. N. Parsons,Macmillan, 1966.

**ELECTIVE-IV MEC- 4103A INSTRUMENTATION AND CONTROL SYSTEMS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

Instrumentations: Concepts of measurements, static performance, characteristics accuracy of measurement and its analysis. Instrumentation, for measurement: Force, torque, strain. pressure, flow, temperature and vibration.

Optical Methods of Measurement: Introduction, Laser beam as a light pointer, length/displacement measurement, temperature sensors, seismographic measurement.

Introduction to fiber optics, fiber types, properties of optical fibres and a fibre optic sensor configuration.

Introduction: Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graph: Impulse response and Transfer functions of linear systems, Block diagrams.

Mathematical Modeling of Physical Systems: Equations of electrical networks, Modeling of mechanical system elements, Equations of mechanical systems. State-variable Analysis of Linear Dynamic Systems: Matrix representation of state equations, State transition matrix, State transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Characteristic equation, eigen values and eigen vectors.

Time-Domain Analysis of Control Systems: Typical test signals for the time response of control systems, Time- domain performance of control systems- The steady- state error, Time-domain performance of control systems- Stability of control systems- stability, Characteristic equation and the state transition matrix, Methods of determining stability of linear control systems, Routh- Hurwitz criterion.

Frequency-domain Analysis of Control Systems: Introduction, Nyquist stability criterion, Application of the Nyquist criterion, Stability of multi loop systems, Stability of linear control systems with time delays.

**Text Books:**

1. Automatic Control Systems, by Benjamin C. Kuo.

2. Mechanical Measurements, by R.S.Sirohi, H.G. Radha Krishna, Wiley Eastern, New Delhi.

**References:**

1. Experimental Methods for Engineers, by J.P.Holman, McGraw-Hill.

2. Instrumentation for Engineering Measurements, by R.H. Cerni and L.E.Foster, J.Wiley& Sons, New York.

**ELECTIVE-IV MEC- 4103B SUPPLY CHAIN MANAGEMENT**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

Role of supply chain management in Economy and Organization- Introduction to SCM, Evolution, Key concepts, Decisions and Importance of SCM.

Supply chain strategy and Performance Measures- Competetive supply chain strategies, CRM strategy, Supplier relationship strategy- Performance Measures (Financial, Productivity, Quality and cycle time).

Supply chain drives- Introduction, Facilities, Inventory, Transportation and Information.

Supply chain design- Network design and operation models.

Sourcing and Transportation- Role of sourcing, Supplier selection and contracts, Procurement process, Role of Transportation, Design options for transportation network.

Planning and Managing Inventories-Introduction, cycle/safety/seasonal stock, Inventory for short life cycle products, Multi echelon inventory.

Information Technology in SCM- Role of IT, E-business and future trends.

Supply chain innovations- Introduction, Supply chain integration, Restructuring, Agile supply chains.

**References:**

1. Supply chain management text and cases: Janat Shah, Pearson Education, 2009.
2. Supply chain management strategy, planning and operation, Sunil Chopra, Peter Meindl, PHI.
3. Supply chain management: Chopra, Pearson Education, 2009.
4. Business logistics/ Supply chain management, 5/e: Ballou, Pearson Education.

**ELECTIVE-IV MEC- 4103C CONDITION MONITORING**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**Introduction:** Failures – System, Types of failures, Causes of failures, Maintenance Schemes – objectives – types and economic benefits, break down, preventive, predictive and Reliability monitoring.

**Vibration Monitoring:** Basic vibration theory, vibration measurement and analysis, machine vibration; Rotational machine faults and vibration characteristics. Applications of vibration monitoring to rotating machines. Vibration monitoring in practice - overall vibration monitoring and experience based spectrum analysis to detect machine condition and faults in bearings and gears. Current diagnostic techniques/tools commercially available, Commonly witnessed machinery faults diagnosed by vibration analysis.

**Thermal Monitoring:** Introduction to thermal monitoring; thermal monitoring techniques, application of thermal monitoring to manufacturing processes. Thermal imaging camera, and its application as a condition monitoring tool.

**Lubricant analysis/monitoring:** Introduction to tribology - lubricant types and their properties. Introduction to wear debris monitoring; collecting and quantifying wear debris; wear debris and oil analysis in practice.,SOAP, Ferrography and other spectrometric analysis techniques for wear rate evaluation and interpretation.

**Sensors for condition monitoring:** Accelerometers, strain gauges, eddy current probes and LVDT for measurement of displacement, velocity and acceleration. Lock in amplifier for signal conditioning. Thermocouples, thermistors, resistance thermometers and junction semiconductor devices for temperature measurement.Radiation pyrometers for temperature measurement, Thermal imaging devices.

**Data acquisition and Analysis for condition monitoring:** Fourier analysis and FFT, Sampling, Shannon's theorem, Analogue to digital conversion. Static characteristics of signals including mean, standard deviation, skewness and kurtosis, probability density function, power spectral density and autocorrelation.

**Electrical Condition Monitoring:** Overview of electrical plant and how the interaction of inherent stresses causes degradation of plant Components and affects equipment operation; Electrical contact methods for assessing electrical plant condition; Acoustic measurement of electrical plant condition; RF/UHF assessment of electrical plant condition; Chemical methods of assessing electrical plant condition

**References**

1. Rao J. S., Vibration Condition Monitoring, Narosa Publishing House, 2/e 2000.
2. Isermann R., Fault Diagnosis Application, Springer-Verlag Berlin, 2011.
3. Allan Davis, Hand book of Condition Monitoring, Chapman and Hall, 2000.
4. Choudary K K., Instrumentation, Measurement and Analysis, Tata McGraw Hill.
5. Collacott, R. A., Mechanical Faults Diagnosis, Chapman and Hall, London, 1990
6. Collacot R.A.- Mechanical fault diagnosis and condition monitoring
7. Hunt, T.M., (1993), Handbook of wear debris analysis and particle detection in liquids, Elsevier applied science, London and New York
8. Rao, B. (1996), Handbook of condition monitoring, Elsevier advanced technology, Oxford.
9. A Davis – Handbook of condition monitoring.
10. P Girdhar – Machinery vibration analysis and predictive maintenance
11. R G Eisenmann et-al – Machinery malfunction diagnosis and correction
12. John S Mitchell – Machinery analysis and monitoring
13. Mechanical Vibrations Practice with Basic Theory by V. Ramamurti, Narosa Publishing House.
14. Machinery Condition Monitoring: Principles and Practices *by* A. R. Mohanty (ISBN: 9781466593046, CRC Press, 2014)
15. NPTEL II Video Lectures: Machinery Condition Monitoring and Signal Processing *by* A R MOHANTY (NPTEL, 2013)

**MEC- 4104 REFRIGERATION & AIR-CONDITIONING**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Principles of Refrigeration**: Refrigeration and II law of thermodynamics- Methods of Refrigeration- Unit of Refrigeration- Applications of Refrigeration. Air cycle Refrigeration: Reversal Carnot cycle- Bell Colman cycle- Selection of Refrigeration systems for air crafts- Boot strap system- Regenerative cycle- Reduced ambient type- Comparisons of different systems.

**Vapour Compression Refrigeration**: Wet versus Dry compression- Effect of evaporator pressures and temperatures. Simple vapour compression Refrigeration cycle and its analysis. Advantages and disadvantages of vapour compression Refrigeration system over Air compression Refrigeration system- Methods of improving C.O.P.- Multi compression system- Multiple evaporators expansion valves- Flash inter cooler- Defrosting- Hot gas defrosting.

**Classification of Refrigerants**: Nomenclature- Properties- Secondary refrigerants- Selection of refrigerants- **Condensers-** Air cooled, Water cooled and evaporative type- Evaporators- Once through, flooded, shell and tube Baudelot cooler- **Expansion devices**- Capillary expansion device, Thermostatic expansion device.

**Absorption Refrigeration System**: Basic absorption system- Aqua ammonia absorption system- Li-Br absorption refrigeration system- Electrolux refrigeration- C.O.P. of absorption refrigeration system- Comparison of vapour compression and vapour absorption system. Steam jet refrigeration system and analysis- Advantages and limitation- Ejector compression system.

**Psychrometry:**Psychrometric properties and relations- Psy chart- Psy processes- Human comfort and comfort chart- Effective temperature and factors governing effective temperature. **Air conditioning**: Summer, Winter and year round air conditioning- Different types of Air conditioning load - By pass factor, RSHP, GSHF- Fresh air quantity- Cooling coils and Dehumidity- Air washers.

**Text Books:**

1. Refrigeration and Air conditioning, by C.P.Arora.

2. Refrigeration and Air conditioning, by P.L.Bellany.

**References:**

1. Refrigeration and Air conditioning, by Jordan R.C. and Priester G.B.

2. Principles of Refrigeration, by Dossat.

3. Refrigeration and Air-conditioning, by W.P.Stoecky.

**MEC- 4105 HEAT AND MASS TRANSFER**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

Introduction: Basic modes of heat transfer- Rate equations- Generalized heat conduction equation in Cartesian, Cylindrical and Spherical coordinate systems.

Steady state heat conduction solution for plain and composite slabs, cylinders and spheres- Critical thickness of insulation- Heat conduction through fins of uniform and variable cross section- Fin effectiveness and efficiency.

Unsteady steady state heat conduction- Transient heat conduction- Lumped system analysis, and use of Heisler charts.

Convection: Continuity, momentum and energy equations- Dimensional analysis- Boundary layer theory concepts- Free, and Forced convection- Approximate solution of the boundary layer equations- Laminar and turbulent heat transfer correlation- Momentum equation and velocity profiles in turbulent boundary layers- Application of dimensional analysis to free and forced convection problems- Empirical correlation.

Radiation: Black body radiation- radiation field, Kirchoff's laws- shape factor- Stefan Boltzman equation- Heat radiation through absorbing media- Radiant heat exchange, parallel and perpendicular surfaces- Radiation shields.

Heat Exchangers: Types of heat exchangers- Parallel flow- Counter flow- Cross flow heat exchangers- Overall heat transfer coefficient- LMTD and NTU methods- Fouling in heat exchangers- Heat exchangers with phase change.

Boiling: Different regimes of boiling- Nucleate, Transition and Film boiling. Condensation: Laminar film condensation- Nusselt's theory- Condensation on vertical flat plate and horizontal tubes- Dropwise condensation.

Mass Transfer: Conservation laws and constitutive equations- Isothermal equimass, Equimolal diffusion- Fick's law of diffusion- diffusion of gases, Liquids- Mass transfer coefficient.

**Text Books:**

1. Heat Transfer, by J.P.Holman, Int. Student edition, McGraw Hill book company.

2. Analysis of Heat transfer, by Eckert and Drake, Int.Student edition, McGraw Hill Kogakusha Ltd.

**References:**

1. Heat and Mass Transfer by R.K. Rajput, S. Chand & Co.

2. Heat and mass transfer by Sachjdeva.

3. Heat and mass transfer by Kothandaramanna, New Age International

**MEC-4106 MINI-PROJECT-Credits-2**

**MEC- 4107 METROLOGY AND MECHATRONICS LAB**

(Effective from the batch admitted during 2019-2020-AICTE)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs. Credits :1.5

**METROLOGY LAB. EXPERIMENTS - (Any Five)**

1. Calibration of the following instruments: (using slip gauges)

 i. Calibration of Micrometer. ii. Calibration of Mechanical Comparator.

 iii. Calibration of Vernier Caliper. iv. Calibration of Dial Gauge.

2. Measurement of taper angle using

 i. Bevel Protractor ii. Dial Gauge iii. Sine-Bar iv. Auto-Collimator.

3. Alignment tests:

 i. Parallelism of the spindle ii. Circularity & Concentricity of the spindle

 iii. Trueness of running of the spindle.

4. Gear parameters Measurement

 i. diameter, pitch/module ii. Pitch circle diameter iii. Pressure angle iv. Tooth thickness.

5. Check the flatness of a surface plate.

 i. Using spirit level ii. Using Auto-collimator

6. Using light wave interference:

 i. Study of flatness of slip gauges ii. To find the height of a slip gauge.

7. Tool Maker's Microscope:

 i. Establish the thread details ii. To find the cutting tool angles.

8. Miscellaneous:

 i. To find the diameter of a cylindrical piece ii. Taper angle of a V-block

 iii. Central distance of two holes of a specimen.

**MECHATRONICS LAB. EXPERIMENTS - (Any Five)**

I. Training on Programmable Logic Controller (any ONE of the Following)

 i) Lift Control Using Ladder Logic Programme

 ii) Traffic Signal Control using Ladder Logic Programme

II. Training on Programmable Logic Controller - Sensor Training Kit

1. Proximity Switch
2. Photo Electric Switch
3. Limit Switch

III. Training on Sensor and Transducer (any ONE of the Following)

 i). Linear position or Force applications

 a. LVDT (Linear variable differential transformer)

 b. The strain gauge Transducer

 ii). Rotational Speed or Position Measurement (The inductive Transducer)

 iii). Linear or Rotational Motion

1. D.C. Solenoid
2. D.C. Relay

IV. Training on Automation Studios

 i). Punch Machine operation

 ii). Hydraulic Cylinder operation

V. Training on Material Handling

VI. Training on any Controller Package

VII. Training on Servo Fundamental Trainer.

**MEC- 4108 INDUSTRIAL ENGINEERING LAB**

(Effective from the batch admitted during 2015-2016- CBCS)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs. Credits :1.5

**LIST OF EXPERIMENTS:**

1. To measure the skill and dexterity in the movement of Wrist and Fingers using pin board.

2. To measure the Heart beat using Stethoscope.

3. To show that the sample means from a normal universe follow a normal distribution.

4. To draw the control chart for fraction defective for a given lot of marble balls.

5. To determine the cycle time using PMTS.

6. To draw two handed process charts for

 i. Bolt, Washer and nut assembly

 ii. Assembly of electric tester.

7. To study the changes in heart rate for different subjects using Tread mill.

8. To draw Multiple Activity chart using an electric toaster.

9. To determine the percentage utilization using work sampling.

10. To study the process capability of a given process.

11. To measure the Heart rate during working and recovery periods of the subjects under different loads, using Bicycle ergometer.

12. To draw flow process charts on activities in Workshop/ Laboratory/Office.

13. To determine the time required to perform motion sequence using work factor system.

14. To draw SIMO charts for

 i. Ball point pen assembly

 ii. Electric plug assembly.

15. To conduct time study of the bulb holder assembly operation of the existing method.

16. To collect the anthropometrics data using `Anthropolometer'.

**FOURTH YEAR SECOND SEMESTER**

**ELECTIVE-5 MEC-4201A ROBOTICS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Introduction:** Background- Historical development-Robot Arm kinematics and Dynamics- Manipulator Trajectory Planning and Motion Control-Robot Sensing- Robot Programming Language- Machine Intelligence.

**Robot Arm kinematics:** Introduction – The Direct Kinematics Problem-The Inverse Kinematics Solution.

**Robot Arm Dynamics:** Introduction – Lagrange-Euler Formulation- Newton-Euler Formation - Generalized D’Alemberts Equations of Motion.

**Planning of Manipulator Trajectories:** Introduction-General Considerations on Trajectory Planning- Joint Interpolated Trajectories- Planning of Manipulator Cartesian Path Trajectories.

**Control of Robot Manipulators:** Introduction – Control of the Puma Robot arm- Computed Torque Technique- Near Minimum Time Control- Variable Structure Control- Nonlinear Decoupled Feedback Control- Resolved Motion Control- Adaptive Control.

**Sensing:** Introduction-Range Sensing-Proximity Sensing- Touch Sensors- Force and Torque Sensing.

**Low-Level Vision:** Introduction –Image acquisition- Illumination Techniques- Imaging Geometry- Some Basic Relationship Between Pixels – Preprocessing.

**Robot Programming Languages:** Introduction- Characteristics of Robot Level Languages- Characteristics of Task Level Languages.

**Text Book:**

1. Robotics By K.S. Fu, R.C. Gonzalez and C.S.G Le, McGraw- Hill International Editions1987.

**Reference Books**:

1. Industrial Robotics By M.P.Groover,Mitchell Weiss, Roger N. Nagel and N.G.Odrey, McGraw- Hill International Editions1986.

2. Robot Analysis- The Mechanics of Serial and Parallel Manipulators By Lung-Wen

 Tsai, Jhon Wiley and Sons,Inc

**ELECTIVE-5 MEC- 4201B MECHATRONICS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Mechatronics system design**: Introduction to Mechatronics: What is mechatronics, integrated design issues in mechatronics, Mechatronics key elements, the mechatronics design process, advanced approaches in mechatronics.

**Modeling and simulation of physical systems**: Simulation and block diagrams, Analogies and impedance diagrams, Electrical systems, Mechanical translational systems, Mechanical rotational systems, electromechanical coupling, Fluid systems.

**Sensors and transducers**: An introduction to sensors and transducers, Sensors for motion and position measurement, Force, torque and tactile sensors, Flow sensors, Temperature-sensing devices. Actuating devices: Direct current motor, Permanent magnet stepper motor, Fluid power actuation.

**Signals, systems and controls**: Introduction to signals, systems and controls, System representation, Linearization of nonlinear systems, Time delays.

**Real time interfacing**: Introduction, Elements of a data acquisition and control system, Overview of the I/O process, Installation of the I/O card and software.

**Advanced applications in mechatronics**: Sensors for condition monitoring, Mechatronic control in automated manufacturing, Artificial intelligence in mechatronics, Microsensors in mechatronics.

**Text Book:**

1. Mechatronics System Design by DevdasShetty and Richard A. Kolk, P.W.S. Publishing Company, 2001.

**References:**

1. Mechatronics by W. Bolton, Pearson Education, Asia, II-Edition, 2001

2.Introduction to Mechatronics and Measurement Systems by David G. Alciatore and Michael B. Histand, Tata McGraw Hill Company Ltd.

**ELECTIVE-5 MEC- 4201C POWER PLANT ENGINEERING**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 4 Th Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Steam Power Plants:** General Layout, Power plant cycles, Fuels-handling, storing, preparation andsupply. Various Stokers. Draft systems, chimney including calculations. Boilers: Construction and Heating surfaces. Mountings and accessories. High pressure and high duty forced circulation boilers land modern trends in Boiler design. Flue chambers and dampers. Steam piping–fittings–logging. Boiler performance, Flue gas testing and indicators (mechanical, electrical and chemical).

**Internal Combustion Power Plants:** Types of engines for power generation, Super charging,Exhaust heating fuel tanks and oil supply systems. Air supply for starting, Lubricating oils and systems of lubrication, Modern trends and design in diesel engines, Performance of engines, Care of diesel plants. Gas Turbine and other Propelled Power Plants: Introduction – Gas turbine plant– Classification and comparison of different types of gas turbine power plants – Components and different arrangements of the gas turbine plants – Indian gas turbine power plants–Governing system of gas turbine plant–Marine, Aero and Rocket Propulsion power plants.

**Hydro Electric Plants:** Hydrology, Hydrometric survey rainfall, Catchment, Reservoir, Run-off flowand fall, Storage and pondage, Losses due to percolation, Evaporation and transpiration. Mass– duration and flood discharge. Frequency studies and gauging. Different types of plants. Selection of site. Low, medium and high head plants and pumped storage plants. General layout of the plant – Head works, Spillways, Canals, Tunnels, Governing, Lubrication, Penstock, Anchorages and relief valves, different types of surge tanks, intakes, Gates and Valves.

**Nuclear Power Plants:** Classification of reactors, Thermal utilization, Fuels, Fuel moderator andcoolant, Control and safety rods, Special properties of structural materials required, Induced radio-activity, Gas cooled reactors, Radiation hazards and shielding, Radioactive waste disposal.

**Direct Energy Conversion:** Solar Energy–Introduction, Solar radiation, Solar collectors, Energystorage. Wind Energy–Wind mills. Thermo Electric–MHD and other non conventional energy sources. Power Plant Economics: Capacity factor, Load actor, Diversity factor, Peak load consideration, Factors governing capacity of plants. Cost of power plant, Cost of erection. Operating& maintenance expenses, Cost of production, distribution of power & determination of rates.

**Text Books**:

1. Power Station Engineering and Economy by Benhaedt G.A.Skrotzki, William A. Vopat, MGH Book , Inc.
2. Heat Engineering, I.T. Shvets et al, MIR Pub Moscow.
3. A Course in Power Plant Engineering, S.C.Arora&S.Domdundwar.

**References:**

1. Solar Power Engineering by B.S. Magal, TMGHPub Co..
2. Solar Energy by S.P. Sukhatme, T MGH pub. Co.
3. Modern Power Plant Engineering by Joel Weisman, Roy Eckart, PHI.
4. A textbook of Power Plant Engineering by P.C. Sharma,S.K. Kataria&Sons, ND.
5. Fundamentals of Nuclear Power Engineering by D.K. Singhai, Khanna Pub.
6. **ELECTIVE-5 MEC- 4201D INDUSTRIAL TRIBOLOGY**
7. (Effective from the batch admitted during 2019-2020- AICTE)
8. Periods/week : 4 Th Ses. : 30 Exam : 70
9. Examination (Theory): 3hrs. Credits :3

**Tribology:** Introduction to tribology, bearings, historical background, economic considerations.

**Friction:** Introduction, causes of friction, laws of friction, sources of sliding friction, adhesion, ploughing, energy dissipation mechanisms, friction characteristics of metals, and non metals, friction of ceramic materials, rolling friction, source of rolling friction, stick slip motion, measurement of friction.

**Wear:** Types of wear, various factors affecting wear, simple theory of sliding wear, mechanism of sliding wear of metals, abrasive wear, materials of adhesive and abrasive wear situation, corrosive wear, surface fatigue wear situations, brittle fracture wear, wear of ceramics, wear measurement.

**Lubricants and Lubrication Types:** Importance of lubrication, Types and properties of lubricants, viscosity, viscometry, effect of pressure temperature on viscosity, testing methods, hydro dynamic lubrication, elasto-hydro dynamic lubrication, boundary lubrication, solid lubrication, hydrostatic lubrication.

**Film Lubrication Theory:** Fluid film in simple shear, viscous flow between very close parallel plates, shear stress variation, Reynolds equation for film lubrication, high speed unloaded journal bearings, loaded journal bearings, reaction torque on the bearings, virtual coefficient of friction, the somerfield diagram. (15)

**Surface Engineering and Materials for Bearings:** Surface modifications, transformation hardening, surface fusion, thermo chemical processes, surface coatings, plating and anodizing, fusion processes, vapour phase processes, materials for rolling element bearings, materials for fluid film bearings, materials for marginally lubricated and dry bearings. (15)

**TEXT BOOKS:**

1. “Principles of Tribology” by Halling j., McMillan Press Ltd.

2. “Friction and Wear of Engineering Materials” by ,I.M. Hutchings, Edwar Arnold, London ,1992.

3. “Friction and Lubrication” E.P. Bowden and Tabor., Heinemann Educational Books Ltd.,1974.

**REFERENCE BOOKS**

1. Tribology Hand Book”, by Neale M.J., Butterworths

2. “Introduction to Tribology of Bearings”, B.C. Majumdar, H. Wheeler and Company Pvt. Ltd.

**MEC- 4202 STATISTICAL QUALITY CONTROL**

(Effective from the batch admitted during 2015-2016- CBCS)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

Introduction to quality, definitions, Taguchi’s loss function, examples of off-line and on-line quality control techniques, quality costs, Deming’s philosophy, introduction to six sigma concept.

Shewart’s normal bowl, control charts for variables, ‾X , R and sigma control charts, theory of runs, ARL and ATS, Type-I and Type-II errors

Control charts for attributes, p-chart, standardized p –chart, np-chart, c-chart, u-chart, demerit control chart.

Process capability analysis: using frequency distribution and control charts. Process capability ratios, Cp and C pkProcess capability ratios for nominal the batter type, smaller the better type and larger the better type product specifications.

Sampling palns: single, double, multiple and sequential sampling plans, rectifying inspection, AOQ, AOQL, and ATI. Use of Dodge Romig Tables, Design of single and sequential sampling plans.

**Text Books:**

1. Introduction to statistical quality control by E.L. Grant
2. Introduction to statistical quality control by D.C. Montgomery

**OEC-4203 INDUSTRIAL MANAGEMENT & ENTREPRENEURSHIP**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Basic Concepts of Management :**

**Management :-** Definition, Nature and Importance ; Functions of the Management; Levels of Management; F.W Taylor's Scientific Management; Henry Fayol's Principles of Management;

**Forms of Business Organizations:** Introduction, **Types of Business organizations:**  **Private Sector**- Individual Ownership , Partnership, Joint stock companies and Co-Operative organizations**; Public sector**- Departmental Organizations, Public Corporations and Government Companies; The Joint sector Management.

**Production and operations Management:** Plant location- Factors to be considered in the selection of Plant location; Break - even analysis- Significance and managerial applications; Importance of Production Planning and Control and its Functions; Human Resource Management and Functions of Human Resource Manager (in brief); Functions of Marketing; Methods of Raising Finance.

**Entrepreneurship :** Definition, Characteristics and Skills , Types of Entrepreneurs, Entrepreneur vs. Professional Managers, , Growth of Entrepreneurs, Nature and Importance of Entrepreneurs, Women Entrepreneurs, Problems of Entrepreneurship.

**Entrepreneurial Development and Project Management:** Institutions in aid of Entrepreneurship Development, Idea generation: Sources and Techniques;, Stages in Project formulation ; Steps for starting a small enterprise - Incentives for Small Scale Industries by Government.

**Text Books:**

(1 ) Sharma,S.C, and Banga, T.R., **Industrial Organization & Engineering Economics**, Khanna

 Publishers, Delhi, 2000.

(2) Vasant Desai , **The Dynamics of Entrepreneurial Development and Management (Planning**

 **for future Sustainable growth),** HImalayan Publishing House, 2018.

**Reference Books:**

 (1) Aryasri , A.R., **Management Science,** McGraw HIll Education (India Private Limited , New

 Delhi 2014.

(2) Sheela, P. , and Jagadeswara Rao, K., **Entrepreneurship**, Shree Publishing House, Guntur,

 Andhra Pradesh, 2017.

**MEC- 4204 HYDRAULIC MACHINERY AND SYSTEMS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

Impact of Jet and Jet propulsion; Impact of jet vane on stationary surfaces-Impact of jet on hinged surfaces-A moving curved vane high tangential entry of water-Radial flow ove the vanes-Jet propulsion.

Hydraulic Turbines: Classification- Pelton wheel-Reaction turbines-Inward and outward radial flow reaction turbines- Francis turbine –Axial flow reaction turbine-Kaplan turbine-Draft tube-Types-Theory-and efficiency of draft tube.

Specific Speed: Determination-Significance –Unit quantities-Unit speed –Unit discharge and Unit power-Characteristic curves of Hydraulic turbines-Constant heat curves-Constant speed curves and Iso-efficiency curves-Governing of turbines.

Centrifugal Pumps : Main parts-Efficiency- Minimum speed for starting-Multi-stage centrifugal Pumps-Specific speed of a Centrifugal Pump-Priming of a Centrifugal Pump.

Characteristics Curves-Main, Operational and constant efficiency curves-Cavitation-Effects-Cavitation in Hydraulic machines.

Reciprocating Pumps : Main pats-Classification-Velocity and acceleration variation in suction and delivery pipes due to piston acceleration-Effect of variation of velocity on friction in suction and delivery pipes-Effect of acceleration in suction and delivery pipes on indicator diagram-Effect of Friction-Maximum speed of Reciprocating Pump-Air vessels.

Hydraulic Press-Hydraulic accumulator-Differential hydraulic accumulator-Hydraulic intensifier-Hydraulic Ram- Hydraulic lift- Hydraulic Crane –Fluid Coupling- Hydraulic Torque converter, Servo systems- Open and Closed loop systems-Hydraulic and Pneumatic systems-Fluid power components-Fluidics- Efficiency of a Fluidic device- Proportional or analog devices- Vortex diode, Vortex triode , Counting , Fluidic systems-Digital devices

Text Books : Fluid Mechanics and Hydraulic Machinery by R .K .Bansal, Laxmi publications

**MEC- 4205 INDUSTRIAL ENGINEERING & METHODS**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Th+ 1 Tut Ses. : 30 Exam : 70

Examination (Theory): 3hrs. Credits :3

**SYLLABUS:**

**Introduction to personnel management-** Functions, Motivation, Theories of motivation, Hawthrone studies, Discipline in industry, Promotion, Transfer, lay off and discharge, Labour turnover.

**Industrial relations**- Trade unions, Industrial disputes, Strikes, Lock-out, Picketing, Gherao, Settlement of industrial disputes, Collective bargaining, Industrial dispute act 1947 and factories act 1948.

**Production Planning and Control:** Types of productions, Production cycle, Product design and development, Process planning, Forecasting, Loading, Scheduling, Dispatching, Routing, Progress, Control, Simple problems.

**Plant Layout**: Economics of plant location, Rural Vs Suburban sites, Types of layouts, Types of building, Travel chart technique, Assembly line balancing simple problems.

**Materials Handling**- Principles, Concept of unit load, Containerization, Pelletization, Selection of material handling equipment, Applications of belt conveyors, Cranes, Forklift trucks in industry.

**Plant Maintenance:** Objectives and types.

**Work Study**: Concept of productivity, Method Study **-** Basic steps in method study, Process charts, Diagrams, Models and Templates, Principles of motion economy, Micro motion study, Therbligs, SIMO chart. Work Measurement - Stop watch procedure of time study, Performance rating, allowances, Work sampling, Simple problems.

**Materials Management:** Introduction, Purchasing, Objectives of purchasing department, Buying techniques, Purchase procedure, Stores and material control, Receipt and issue of materials, Store records. Inventory Control, EOQ model(Simple problems).

**Quality Control** - Control charts of variables and attributes (Use of formulae only). Single and Double sampling plans.

**Text Book:**

1. Industrial Engineering Management, by Dr. O. P .Khanna.

**References:**

1. Principles of Management by Koontz &Donnel.

2. Production and Operations Management by Everette Adam & Ronald Ebert.

3. Operations Management by John McClain & Joseph Thames.

4. Industrial Engineering and Production Management by Telsay, S. Chand & Co.

**MEC-4206 PROJECT-Credits-2**

**MEC- 4207 HEAT AND MASS TRANSFER LAB**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs. Credits :1.5

**LIST OF EXPERIMENTS:**

1. Study of conduction phenomena in the composite slab system.

2. Determination of emmissivity, time constant, FouriesBiot module and study of variation of temperature with respect to time on a circular disc.

3. Study of heat transfer by forced convection through a horizontal test section.

4. Study of heat transfer by forced convection through a vertical test section.

5. Determination of free convective heat transfer coefficient from a horizontal cylinder in air.

6. Determination of thermal conductivity of brass employing it as a fin.

7. Tests on natural convection and pool boiling.

8. Study of forced convection with turbulence promoters.

9. Study of condensation on fin.

10. Tests on film condensation.

11. Determination of COP of a vapour compression refrigeration system.

12. Study of vapour compression air conditioning system.

**MEC- 4208 FMM LAB**

(Effective from the batch admitted during 2019-2020- AICTE)

Periods/week : 3 Pr. Ses. : 50 Exam : 50

Examination (Practical): 3hrs. Credits: 1.5

List of Experiments:

1. Calibration of flow meters,

 a. Venturi meter

 b. Orifice meter

 c. Nozzle meter

2. Determination of coefficient of discharge for

 a. small orifice

 b. cylindrical mouth piece

3. Finding coefficient of discharge for

 a. rectangular notch

 b. triangular notch

 c. trapezoidal notch

4. To draw the performance characteristics of C.F. pump.

5. To find the specific speed of

 a. Pelton turbine

 b. Francis turbine

6. To draw the characteristic curves for reciprocating pump.

7. To draw the pressure distribution and finding coefficient of drag for

 a. a bluff body

 b. an Aero foil

8. To draw the characteristic curves for the hydraulic ram.

**MEC- 4209 CAD/CAM LAB**

(Effective from the batch admitted during 2019-2020- CBCS)

Periods/week : 3 Lab Ses. : 50 Exam : 50

Examination (Theory): 3hrs. Credits :1.5

**COMPUTER AIDED DESIGN LAB**

**CAD experiments:**

1. Initiating the graphics package; Setting the paper size, space; setting the limits, units; use of snap and grid commands.

2. Drawing of primitives (line, arc, circle, ellipse, triangle etc.)

**3.**  3D GEOMETRIC MODELING:Creation of 3D Models,Wire Frame, Surface, Solid modeling Techniques Using CAD Packages – CSG, B-Rep Approaches in Solid Modeling Feature Based Modeling Technique – Assembly – Detailing Exposure to Industrial Components – Application of GD&T

4. Drawing a flange.

5. Drawing a Bushing assembly.

6. Dimensioning the drawing and adding text.

7. Setting the layers and application of the layers.

8. Isometric and orthographic projections.

9. Viewing in Three dimensions.

10. Removal of hidden lines - Shading and rendering.

**CAM experiments:**

1. Preparation of manual part programming for CNC turning/Milling.

2. Part programming preparation through AutoCAD.

3. APT part programming for 2D - contour.

4. Machining of one job on CNC machine tool.

5. Robot programming through Teaching Box method.

6. Robot programming through computer.