SHRI GURU GOBIND SINGHJI INSTITUTE OF ENGINEERING TECHNOLOGY VISHNUPURI, NANDED – 431 606

T. Y. B. Tech. (Mechanical)

From the batch 2014-15

Sr No	Course Code	Course Name	Credits		Theory	Tutorial	Practical
			Th	Pr	(Number of Hours/Week)		
Odd Semester							
1	ME3511	Machine Design – I	3	1	3	--	2
2	ME3521	Dynamics of Machines	3	1	3	--	2
3	ME3531	Heat Transfer	3	1	3	--	2
4	ME3541	CAD/CAM	3	1	3	--	2
5	ME3551	Mechatronics-I	3	1	3	--	2
6	ME3561	Internal Combustion Engines	3	1	3	--	2
		Sub Total	**18**	**6**	**18**	**--**	**12**
Even Semester							
7	ME3611	Tool Design	3	1	3	--	2
8	ME3621	Machine Design – II	3	1	3	--	2
9	ME3631	Finite Element Analysis	3	1	3	--	2
10	ME3641	Mechatronics-II	3	1	3	--	2
11	ME3651	Quantitative Techniques	3	1	3	--	2
12	ME3661	Refrigeration & Air Conditioning	3	1	3	--	2
		Sub Total	**18**	**6**	**18**	**--**	**12**
		Total Credits Earned	**36 + 12 = 48**				

Note:

1. Evaluation of the theory subjects shall consist of midterm examination (30% marks) and end term examination (70% Marks) as per Academic Calendar of the Institute.
2. Evaluation of term work and practicals shall consist of weekly (continuous) evaluation (50% marks) and end term external evaluation (50% marks).
3. Continuous evaluation of the term work shall include presentation by a group / an individual on some recent / advanced topic of the concerned subject associated with a report submission.

ME 3511- MACHINE DESIGN-I

(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3511 **Contact Hours/Week:** Th. 03, Pr. 02

Course Objective:

- To understand design and drawing concepts of machine components.
- To understand the analysis the mechanical components for induced stress due to loading.
- To demonstrate knowledge on basic machine elements used in machine design.
- To design machine elements to withstand the loads and deformations for a given application.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

Introduction: Steps of design, Basic requirements of machine element, Design of machine elements, Design consideration for dynamic and static load, Selection of materials, Designation of material as per ISI, Various codes and standards.

Design against static load: Static Load, Modes of failure, Failure of ductile materials, Failure of brittle materials, Stress due to bending moment, Stress due to torsional moment, Eccentric axial loading, Design of machine parts subjected to combined direct and bending stress.

Design against fluctuating load: Definition, Stress concentration, Fluctuating stress, Fatigue failure, Endurance limit, S-N curve, Low cycle and High cycle fatigue.
Endurance Limit: Approximate estimation, Reversed stresses- Design for finite and infinite life, Cumulative damage in fatigue, Soderberg and Goodman lines, Modified Goodman diagrams, Gerber equation, Fatigue design under combined stresses.

Design of shafts, Keys & Couplings: Shaft design on strength basis, Shaft design on torsional rigidity basis. Keys: Definition, Types of keys and their design, Splines and their design. Couplings: Definition, Muff coupling, Rigid flange coupling, Bushed pin flexible coupling, Design for lateral rigidity, Castigliano's theorem, Area moment method, Critical speed of shaft.

Threaded, Riveted and Welded Joints: Introduction, Basic types of screw fastening, Bolt of uniform strength, Eccentrically loaded bolted joints in shear, Bolted joint under fluctuating load, Bolted joints with combined stresses. Riveted Joint: Methods of riveting, Types of rivet heads, Types of riveted joints, Strength of joint, Eccentric loaded riveted joint. Welded Joint: Introduction, Types, Stresses in Butt and fillet joints, Strength of welded joints, Eccentrically loaded joints.

Clutches: Type of clutches, Friction materials, Torque transmitting capacity, Single-disc, Multi-disc, Cone and Centrifugal clutches, Energy equation, Thermal considerations.

Brakes and Dynamometer: Introduction, Energy absorbed by brake, Heat to be dissipated during braking, Materials for brake lining, Types of brake, Shoe brake, Band brake, Band and block brake, Internal expanding brake. Dynamometer: Introduction, Types of dynamometers.

Term Work:

Full imperial size sheets with the design problems on

1. Cotter joint or Knuckle joint.
2. Design of screw and nut or Design of screw jack.
3. Rigid or Flexible flange coupling.
4. Threaded, Riveted and welded joint.
5. Clutch and Brake.

Practical Examination:

It shall consist of oral examination based on above syllabus.

Reference Books:

1. Joseph E.Shigley and Charles R.Mischke, "Mechanical Engineering Design," Tata McGraw Hill Publication, 6th Edition,2005
2. V.B.Bhandari, "Design of Machine Element," Tata McGraw Hill Publications, 4th Edition, 1997
3. C.S Sharma & Kamlesh Purohit, "Design of Machine Elements," Prentice Hall of India publications, New-Delhi, Eastern Economy 3rd Edition, 2003.
4. Spott's M.F. and Shoup T.E. – "Design of Machine elements," Prentice Hall International.
5. Black P.H. and O. Eugene Adams, "Machine Design," McGraw Hill Book Co. Ltd.

Design Data Book:

1. Design Data Book for Mechanical Engineers, K.Mahadevanan & K.Balaveera Reddy, CBS Publishers & Distributor Delhi, 4th Edition 2008
2. Design Data Book – B.D.Shiwalkar, Central Techno Publication Nagpur, 2nd Edition 2007

ME3521 – DYNAMICS OF MACHINES

(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3521 **Contact Hours/Week:** Th.03, Pr.02

Course Objective:

- To expands the student's background in kinematic synthesis and analysis.
- To understand the concepts of balancing.
- To understand the concepts of gear train and vibrations.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

Static force analysis: Constraint and applied forces, Static equilibrium, Equilibrium of two and three force members, Equilibrium of four forces and torque, Force convention and free body diagrams, Principle of virtual work, Static force analysis considering friction.

Dynamic Force Analysis: D-Alembert's Principle, Dynamic analysis of Four link mechanism and slider-crank mechanism, Velocity & acceleration of piston and connecting rod, Engine force analysis, Inertia of connecting rod, Inertia force in reciprocating engines (Graphical method).

Turning Moment: Turning moment diagram for reciprocating engines, Speed fluctuation, Power smoothening by flywheels.

Balancing: Static balancing, Dynamic balancing, Balancing of several masses in different planes, Force balancing of linkages, Balancing of reciprocating mass, Balancing of locomotives, Effect of partial balancing in locomotives, Balancing of inline engines, Balancing of V engines, Balancing of radial engines, Balancing machines, Field balancing.

Gear Trains: Types of Gear trains- simple, Compound, Reverted, Epicyclic gear train, Tabular method for finding the speeds of elements in epicyclic gear train, Differential gear box.

Vibration: Definitions, Types of vibration, Basic features of vibrating system, Degree of freedom, Free longitudinal vibration, Displacement, Velocity and Acceleration, Inertia effect of the mass of spring, Damped vibration, Logarithmic decrement, Forced vibration, Forced damped vibration, Dynamic magnifier, Transmissibility, Vibration isolation, Transverse vibration, Whirling of shaft & critical speeds, Free torsional vibration, Single rotor systems, Inertia effect of mass of shaft, Multifilar system, Two rotor system, Three rotor system, Geared systems.

Term Work:

1. Full imperial size sheets/Assignments on Static, Dynamic force analysis and balancing.
2. Assignment on each unit.

List of Experiments: (Any eight)

1. To find out the oscillations of simple pendulum with universal vibration apparatus.
2. To find out the oscillations of Compound pendulum with universal vibration apparatus.
3. To find out the radius of gyration of bi-filler suspension with universal vibration apparatus.
4. To find out undamped torsional vibration of single rotor system with universal vibration apparatus.
5. To find out the frequency of damped torsional vibration of single rotor system with universal vibration apparatus.
6. To measure the frequency of torsional vibrations of single rotor system with universal vibration apparatus.
7. To study force damped vibration of a spring mass system and simple supported beam with universal vibration apparatus.
8. To verify the static and dynamic balancing for different planes and masses by balancing apparatus.
9. Study the gear train models.
10. To find out the natural frequency of under-damped & un-damped system.
11. To study the whirling of shaft.
12. To study cantilever vibration.

Practical Examination:

It shall consist of oral examination based on above syllabus.

Reference Books:

1. S. S. Rattan, “Theory of Machines,” Tata McGraw Hill Publishing Co Ltd., New Delhi 2nd Edition, 2005.
2. P.L. Ballaney, “Theory of Machines & Mechanism,” Khanna Publishers, New Delhi, 21st Edition, 2005.
3. Thomas Bevan, “The Theory of Machines,” CBS Publishers and Distributors, New Delhi, 1st Edition, Reprint 2005.
4. J. E. Shigley, J. J. Uicker, “Theory of Machines & Mechanism,” McGraw Hill Publication– New Delhi, 2nd Edition.

ME3531-HEAT TRANSFER

(CREDITS THEORY: 03, PRACTICAL:01)

Course code: ME3531 **Contact Hours:** Th. 03, Pr.02

Course Objective:

- To understanding the basic phenomenon of heat transfer.
- To understand modes of heat transfer in detail.
- To understanding the concepts of heat transferring devices like heat exchangers.
- To understand analytical / logical skills required for modeling various heat transfer phenomenon.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

Introduction: Steady and unsteady heat transfer, Different modes & laws of heat transfer, Thermal conductance, Thermal resistance, Thermal conductivity, Electrical analogy, Thermal diffusivity

Conduction: General three dimensional heat conduction equation in Cartesian coordinates, General three dimensional heat conduction equation in cylindrical & spherical coordinates (no derivation), Steady state one dimensional heat conduction without heat generation & temperature distribution in the: plane wall, composite wall, sphere and composite cylinder, Thermal contact resistance , Critical radius of insulation and its importance, Introduction to unsteady state heat conduction system with negligible internal resistance.

Extended surfaces: Types and Applications of fins, Heat transfer from a fin of uniform cross section area, Different end conditions to solve fin problems, Efficiency & Effectiveness of fins, errors in the measurement of temperature in a thermo-well.

Convection: Hydrodynamic & thermal boundary layer, Local & average heat transfer coefficient, Effect of various parameters on heat transfer coefficient, Free & force convection, physical significance of the dimensionless numbers related to free & forced convection, Empirical relations for free convection heat transfer over horizontal, vertical plate & cylinder.

Radiation: Fundamental concepts, Basic laws of radiation: Planks law, Kirchoffs law, Stefan Blotzman Law, Weins displacement law and Lambert's cosine law, Emissivity, Radiosity, Radiation heat exchange between two black bodies , Shape factor for simple geometries, Radiation heat exchange between two infinitely parallel plates & cylinders, Radiation shields, Heat transfer with radiation shields.

Heat Exchangers: Heat exchangers classification, Overall Heat transfer coefficient, heat exchanger analysis- use of log mean temperature difference (LMTD) for parallel & counter flow heat

exchangers, Special case of condensers & evaporators and heat exchangers where heat capacities of fluids are same, The effectiveness-NTU method for parallel and counter flow heat exchangers.

List of Experiments:

Any eight experiments and assignments on the above topics.

1. Determination of thermal conductivity of metal rod.
2. Determination of thermal conductivity of insulating powder.
3. Determination of thermal conductivity of composite wall.
4. Determination of heat transfer coefficient in natural convection.
5. Determination of heat transfer coefficient in forced convection.
6. Determination of emissivity of a test surface.
7. Determination of Stefan Boltzmann constant.
8. Study of performance of parallel & counter flow heat exchanger.
9. Determination of critical thickness of insulation.
10. Heat transfer from pin fin apparatus**.**

Practical Examination:

It shall consist of oral examination based on above syllabus.

Reference Books:

1. J. P. Holman, “Heat transfer” McGraw Hill Book Company 1989, New York.
2. Yunus A. Cengel, “Heat & Mass Transfer: A practical Approach” TATA McGraw Hill Education 2007.
3. Dr. S. P. Sukhatme, “A Textbook on Heat Transfer” Universities Press 2005.
4. Dr. D. S. Kumar, “Heat and Mass Transfer”, S.K.Kataria & Sons publishers 2013
5. R.C. Sachdeva, “Fundamentals of Engineering Heat and Mass Transfer” New Age International 2012.
6. R. Yadav, “Heat and Mass Transfer” Central Publishing House 1992

ME 3541-CAD/CAM

(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3541 **Contact Hours /Week:** Th.03, Pr.02

Course Objective:

- To understand use of computers in design process.
- To understand the facilities in different CAD Software.
- To understand theory of solid modeling techniques.
- To understand NC/CNC and Part Programming basics.
- To understand the basics of computer integrated manufacturing.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

COMPUTER AIDED DESIGN:

Fundamentals of CAD: Introduction, The design Process, Application of computers for Design, benefits of Computer-Aided Design and hardware in CAD.

Computer Graphics: The Software Configuration of a Graphics System, Functions of a Graphics Package, Constructing the Geometry, Graphics Primitives, Co-ordinate Systems used in Graphics and Windowing, View Ports, 2-D Transformations, Homogeneous Transformations, Combination Transformations, 3-Dimensional Transformations, Salient Features of Solid Modeling, Wireframe modeling. Solid modelling techniques- Half space, Octree, sweep, Constructive solid Geometry, B-rep, Feature Based Modelling, and Parametric modelling. Surface modelling. Introduction to Curves and Surfaces, Data exchange standards.

COMPUTER AIDED MANUFACTURING:

Numerical Control: Fundamentals of NC Technology, Computer Numerical Control, Distributed Numerical control, Applications of NC, Engineering Analysis of NC Positioning Systems, NC Part Programming, APT programming.

Material Handling Systems: Introduction to Material Handling, Equipment, analysis of Material Transport systems, Storage system: Performance and Location strategies, Conventional Storage Methods and Equipment, Automatic Storage and Retrieval System

Cellular Manufacturing: Part Families, Parts Classification and Coding, Production flow analysis, Cellular Manufacturing, Application of Group technology.

Flexible Manufacturing Systems: Introduction, FMS components, Applications and Benefits.

Term Work:

A. It will consist of assignment(s) based on Software Documentation, tutorials, manuals of any high CAD / CADD software.

B. It will consist of a simple job on CNC Lathe or Milling.

Practical Examination:

The practical examination consists of an oral/practical based on the syllabus prescribed.

Reference Books:

1. Groover M.P. and Zimmers E. W., "CAD/CAM: Computer Aided Design and Manufacturing," Prentice Hall International, New Delhi, 1992.
2. P. Radhakrishnan, S. Subramanayan and V.Raju, "CAD/CAM/CIM," New Age International (P) Ltd., New Delhi.
3. Chris McMahon and Jimmie Browne, "CAD/CAM – Principle Practice and Manufacturing Management," Addision Wesley England, Second Edition, 2000.
4. Ibrahim Zeid, "CAD/CAM theory and Practice," Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1992.
5. Rogers, D.F. and Adams, A., "Mathematical Elements for Computer Graphics," McGraw Hill Inc, NY, 1989
6. Groover M.P. "Automation Production Systems, and Computer Integrated Manufacturing," PHI.
7. B.S. Pabla, M. Adithan, "CNC Machines," New Age International Ltd. New Delhi.
8. P.N. Rao, N.K. Tewari, T.K. Kundra, "Computer Aided Manufacturing," Tata McGraw Hill Publishing Co. Ltd.

ME3551-MECHATRONICS-I

(CREDITS THEORY: 03, PRACTICAL:01)

Course code: ME3551 **Contact Hours/Week:** Th. 03, Pr.02

Course Objective:

- To understand fundamental principles of Mechatronics System.
- To reinforce analytical skills already learned, and use these skills to in analyzing and designing Mechatronics systems.
- To understand and solve control problems.
- To understand and appreciate the data and signal transfer among various sub-systems.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course content:

Introduction: What is Mechatronics?; A Measurement System with its constituent elements; Open and Closed Loop Systems; Sequential Controllers; Micro-processor Based Controllers; The Mechatronics Approach.

System Modeling: Introduction, System Modeling and Analogies, Transfer Functions for first and Second Order System, Simple Mechanical, Thermal, Pressure and Fluid systems, Block Diagram & Signal Flow Graphs.

Signal Conditioning: Signal conditioning, Operational amplifier, Protection of Components, Filtering, Signal Manipulation, Sampling and Quantizing, Analog to Digital and Digital to Analog Converters, Multiplexers, Digital logic, Number system, Logic gates, Boolean algebra, Karnaugh graph, Application of logic gates, Sequential logic.

Pneumatic and Hydraulic Actuation System: Actuation systems, pneumatic and hydraulic system, Direction control valves, pressure control valves, Cylinders, Process control valves, Rotary actuators.

Electrical Actuation System: Electrical system, Mechanical Switches, Solid-state Switches, solenoids, D.C motors, A.C motors, Steeper motors.

Controllers: Analog Controllers like Two Position (ON/OFF). Proportional (P), Integral (I), Derivative (D), PI, PD and PID, Hydraulic, Pneumatic and Electronic controllers.

Data Presentation Systems: Display, Display Presentation elements, Magnetic recording, Displays, Data acquisition and Data acquisition System, measurement system, Testing and Calibration, Problem.

Term Work:
It shall consist of at least six assignments / practicals based on the above syllabus.

Practical / Oral Examination:
It shall consist of oral based on the above syllabus and term work.

Reference Books:

1. Mechatronics: "Electronic control system in Mechanical and Electrical Engineering," W. Bolton, Pearson Education Asia.
2. D.G. Alciatore and M.B.Histand "Introduction to Mechatronics and Measurement System," Tata Mc Graw Hill.
3. Kastuhiko Ogatta, "Modern Control Engineering" [Phi]
4. Sudhir Gupta, "Elements of Control system," Prentice Hall.

ME3561 – INTERNAL COMBUSTION ENGINES

(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3561 **Contact Hours/Week:** Th.03, Pr.02

Course objective:

- To understand the basic types of internal combustion engines.
- To understand the performance of internal combustion engines.
- To understand the fundamental thermo chemistry as applied to fuels.
- To understand the various operational processes from intake to exhaust.
- To understand cooling and lubrication systems in internal combustion engines.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

Introduction: Classification of I.C. engines, Analysis of Engine Cycles, Analysis of fuel-air cycle and actual cycles.

Carburetion:
Theoryof carburetion, simple carburetor, calculation of Air-Fuel ratio for simple carburetor with and without compressibility of air, petrol injection system, LUCAS petrol injection system, aircraft carbur ettor.

Combustion in SI Engines: Ignition limits, stages of combustion, engine variables affecting combustion stages, normal and abnormal combustion, pre-ignition, detonation, effect of detonation, control of detonation, combustion chamber design principles, requirements, various types of combustion chambers and their comparison.

Fuel injection system: Requirements, heat release pattern, types of injection systems namely common rail, individual pump distributor and unit injection systems, types of nozzles.

Combustion in CI Engines: Stages of combustion, variables affecting stages of combustion, delay period, knocking, its effects and control. Combustion chambers used in C.I. engines, requirements and type's viz. open swirl M-combustion chamber.

Testing performance of Engines: Performance parameters, methods for measurement of B.P, I.P. and F.P., performance of S.I. and C.I. engines, heat balance sheet.

Selection criteria of Engines: Type of service, type of fuel to be used general service requirements, diesel v/s petrol engine, two stroke v/s four stroke engine, air cooled v/s water cooled, supercharged v/s un-supercharged engine, number of cylinders and cylinder arrangements.

Supercharging:
Introduction, necessity of supercharging, thermodynamic cycles with supercharging, supercharging of S.I. and C.I. engines, advantages and limitations of supercharging, Methods of supercharging, turbocharging.

Engine Friction and Lubrication: Total engine friction, effect of engine variables on friction, Lubrication requirements, theory of lubrication, types of lubrication, splash lubrication system, petroil lubrication system, forced feed lubrication system.

Cooling System: Air cooling and water cooling – forced cooling systems, comparison of air and water cooling system.

I.C. Engine Emissions: Emissions from S.I. and C. I. engines, pollutant s and their effects, methods for controlling emissions, current techniques of emission control.

Term Work:
Term work shall consist of record of any eight experiments from the following.

1. Trial on diesel engine with variation of load.
2. Trial on diesel engine with variation in speed for torque speed characteristics.
3. Trial on petrol engine with variation of load.
4. Trial on petrol engine with variation in speed for torque speed characteristics.
5. Study of ignition system and variation of timing of spark and adjustment of contact breaker gap and spark plug gap.
6. Dismantling and assembling of fuel pumps and injectors for single and multi cylinder engines any one.
7. Dismantling and assembling of any one automotive carburettor.
8. Actual valve timing diagram for high and low speed engines.
9. Analysis of exhaust emission from S.I. engine.

Practical Examination:
The practical examination consists of an oral based on the syllabus prescribed above.

Reference Books:

1. J. B. Heywood, “Internal Combustion Engine Fundamentals”, McGraw Hill Book Co, 1988.
2. V. Ganesan, “Internal Combustion Engines”, Tata McGraw Hill Book Co, 2005
3. Mathur, Sharma, “Internal combustion engines”, Dhanpat Rai publications, 2005
4. Gill P W., J H. Smith, “Fundamentals of Internal Combustion Engines”, Oxford and IBH Publishing Company, 1972
5. Lester Clyde Lichty, “ Internal Combustion Engines”, McGraw-Hill book company, inc., 1939

ME3611 – TOOL DESIGN

(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3611 **Contact Hours/Week:** Th.03, Pr.02

Course objective:

- To understand Tool design methodologies for different elements of machines and their models.
- To designing skills and enhance thinking and analytical power of students to understand jig, fixtures/Press tools from design point of view for different machining operations.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

JIG and FIXTURE:

Locating and Clamping Devices: Degrees of freedom, 3-2-1 method of location, choosing a locating surfaces, redundant locaters, fool proofing, locating methods and devices, clamping methods, power clamping: pneumatic, hydraulic, hydro–pneumatic, vacuum, magnetic and non-conventional clamps.

Jig / Fixture Design Considerations: Design principles of Jig/Fixture and their parts, fastening elements, construction elements, and process planning for Jig/Fixture manufacturing.

JIG Design: Drill bush types, fixed, plain, headed renewable, slip, threaded and special, design principles for drill bush, drill bush materials, jig feet, Types of jigs, templates, plate, angle-plate, leaf, turnover, box, multi-station and indexing jigs.

Fixture Design: Cutter setting and mounting devices, milling fixture design, single piece, sting, progressive, index and rotary milling, design of lathe, boring and broaching fixtures.

DIE DESIGN:

Blanking and Piercing Die Design: Introduction, Die cutting operations, Power press types, General press information, Cutting action in Punch and Die Operations, Die clearance, Types of Die construction, Die design fundamentals, Pilots, Strippers and Pressure pads, Press Work Material, Strip layout. Design problems.

Design of Bending, Forming and Drawing Dies: Introduction, Bending dies, Forming dies, Drawing Operations, variables that affect metal flow during Drawing, Determining Blank size, Drawing force, Single and Double action draw dies. Design problems.

Forging Dies: Types of forging dies, advantages and limitations; forging equipment and machines,

press forging, drop forging, open die forging, close forging, dogging defects. Forging design, factors- draft, fillet, corner radius, parting line, shrinkage, die wear, mismatch, and tolerances, forging operations stock size determination, forging die design.

Term Work:

It shall consist of **one full imperial sheet each** on:

1. Jig design and
2. Fixture design
3. Cutting die design
4. Shaping die design

Journal based on above syllabus for:

1. Jig design
2. Fixture design
3. Design of a cutting die (punching, blanking, compound, and progressive), bending die, and drawing die
4. Press tool Design and / or 3D Modeling, assembling and drawing assignment using computer.

Practical Examination:

The practical examination consists of an oral based on the syllabus prescribed above.

Reference Books:

1. Kempster "Introduction to Jig and Tool Design": M.H.A. English language book society.
2. Joshi P.H, "Jigs and Fixtures," Tata McGraw Hill, New Delhi.
3. Sharma P.C. "Production Engineering," S. Chand and co. Ltd. New Delhi 7th edition 1982.
4. Donaldson, Lecain, Good "Tool Design Tata McGraw" Hill co. Ltd 3rd Edition 1976).
5. Pollack Herman W "Tool Design" D.B. Tarapurwall son's and co. pvt. Ltd. Mumbai 1983.

ME3621 – MACHINE DESIGN-II

(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3621 **Contact Hours /Week:** Th. 03, Pr.02

Course Objective:

- To understand the basics of springs and different types of springs.
- To understand design of motion transmission system.
- To understand safety and reliability concepts in the design of machine elements..

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

Springs: Introduction, Types of springs, Terminology of helical spring, Stress and defection equations, Material for helical spring, Design of helical springs, Wahl's correction factor, Design against fluctuating load, Optimum design, Surging, Helical torsion spring, Leaf spring.

Belt, Ropes & Chain Drives: Introduction, Type of belts, Types of flat belt drives, Tension ratio in belts, Length of belt, Power transmitted by belt, Maximum power condition, Rope drive, Stresses in wire rope, Chain drives, Power transmitted by chain.

Sliding contact bearings: Introduction, Classification of bearing, Modes of Lubrication, Viscosity, Bearing materials, Petroff's eq^{n}, McKee's investigation, Hydrostatic step bearing, Sommerfeld number, Heat generated in journal bearing, Raimondi and boyd method, Bearing design, Thrust bearing.

Rolling contact bearings: Types of rolling contact Bearings, Static and dynamic load carrying capacities, Stribeck's equation, Equivalent bearing load, Load-life relationship, Selection of bearing from manufacture's catalogue, Design for cyclic loads and speeds.

Spur Gears: Introduction, Gear terminology, Gear tooth failure, Selection of gear material, Gear blank design, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear tooth, Estimation of Dynamic and Static tooth load, Wear strength (Buckingham's) equation, Design of spur gear.

Helical, Worm and Bevel Gear: Helical Gears: Terminology, Tooth proportions, Force analysis, Strength analysis and Effective load on gear tooth. Bevel Gears: Terminology, Force analysis, Strength analysis and Effective load on gear tooth. Worm Gear: Terminology, Tooth proportions, Force analysis, Strength analysis.

Tem Work:

Assignments consisting of Theoretical questions and Full imperial size sheets with the design problems.

Practical Examination:

It shall consist of oral examination based on above syllabus.

Reference Books:

1. Joseph E.Shigley and Charles R.Mischke, "Mechanical Engineering Design," Tata McGraw Hill Publication, 6th Edition,2005
2. V.B.Bhandari, "Design of Machine Element," Tata McGraw Hill Publications, 4th Edition, 1997
3. C.S Sharma & Kamlesh Purohit, "Design of Machine Elements," Prentice Hall of India publications, New-Delhi, Eastern Economy 3rd Edition, 2003.
4. Spott's M.F. and Shoup T.E. – "Design of Machine elements," Prentice Hall International.
5. Black P.H. and O. Eugene Adams, "Machine Design," McGraw Hill Book Co. Ltd.

Design Data Book:

1. Design Data Book for Mechanical Engineers, K.Mahadevanan & K.Balaveera Reddy, CBS Publishers & Distributor Delhi, 4th Edition 2008
2. Design Data Book – B.D.Shiwalkar, Central Techno Publication Nagpur, 2nd Edition

ME3631 – FINITE ELEMENT ANALYSIS
(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3631 **Contact Hours/Week:** Th.03, Pr.02

Course objective:

- To understand basics of Finite Elements Analysis.
- To understand and use the commercial finite element packages effectively through hands on practice in the laboratory.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

Introductory Concepts: Historical Background, Introduction to FEM. General FEM procedure. Applications of FEM in various fields. Advantages and disadvantages of FEM. stresses & equilibrium boundary conditions, strain displacement relations, stress – strain relations, temperature, effects, variational approach solution techniques.

FEA Procedure : Step wise procedure of Finite element method, variational techniques for derivation of finite element equations, assembly procedure, solution methods

FEM of One Dimensional Problem: Introduction, finite element modeling, shape functions, variational approach, weighted residual approach, Assembly of finite element equations, Higher-order element, Boundary conditions, Temperature effects.

FEA of Two Dimensional Problems: Introduction, FE modeling, formulation of constant strain triangular element, problem modeling & boundary conditions.

Preprocessor and Post Processors: Introduction, Mesh Generation, post processing, requirements of a preprocessor and post processor, preprocessor and post processors in analysis softwares. Introduction to FEA Software.

Term Work:
The term work shall consist of the following assignments, using analysis softwares.

1. Assignment on mesh generation for different geometries.
2. Assignment on static structural analysis.
3. Assignment on steady state thermal analysis
4. Assignment on thermo-structural analysis

Practical Examination:

The practical examination consists of an oral based on the syllabus prescribed above.

Reference Books:

1. S.S.Rao, "Introduction to Finite Element Method in Engineering", Butterworth Heinmann Publication.
2. Nitin S. Gokhale, "Practical Finite Element Analysis" Finite to Infinite
3. Bathe K.J. "Finite Element Procedures by using ANSYS & other software manuals", Prentice Hall of India, New Delhi.
4. P. Seshu "Textbook of Finite Element Analysis" Prentice Hall of India, New Delhi
5. Reddy J. N. "Finite Element Method" Mc-GRAW-HILL

ME3641-MECHATRONICS-II

(CREDITS THEORY: 03, PRACTICAL:01)

Course code: ME3641 **Contact Hours/Week:** Th. 03, Pr.02

Course Objective:

- To understand the procedure of Digital Control systems.
- To understand the working of embedded controllers.
- To understand the working of advance control systems like PLC.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course content:

Dynamic Responses of system: Modelling dynamic systems, First and second order systems, Performance measures for second order systems, system identification.

Frequency Responses: Sinusoidal input, Phasors, Frequency response, Bode plots, Performance specification, Stability.

Introduction to Digital Controllers: Digital controllers, Control system performance, Controller tuning, Velocity control, Adaptive control.

Microprocessors: Control, Microprocessor system, Microcontrollers, Applications, Programming.

Assembly and High Level Language: Languages, Instruction sets, Assembly language programs, Need of HLL, program structure, Branches and loops, Arrays, Pointers, Program development, Examples of programs.

Input / Output system: Interfacing, IO/OP addressing, peripheral interface adapters, Serial communication interface, Examples of interfacing.
Programmable Logic Controllers: Programmable Logic Controllers, Basic structure, IO/OP Processing, Programming, Mnemonics, Timers, internal, relays, counters, Shift registers, Master and jump controls, Data handling, Analogue IO/OP, Selection of a PLC.

Communication System:
Digital communication, centralized, hierarchical and distributed control, Networks, Protocols, Open system interconnection communication model, Communication interfaces.

Term Work:
It shall consist of at least ten assignments / practicals based on the above syllabus.

Practical / Oral Examination:

It shall consist of oral based on the above syllabus and term work.

Reference Books:

1. W. Bolton, "Mechatronics: Electronic control system in Mechanical and Electrical Engineering," Pearson Education Asia.
2. D.G. Alciatore and M.B.Histand "Introduction to Mechatronics and Measurement System," Tata Mc Graw Hill.
3. "Mechatronics (HMT)" Tata Mc Graw Hill.
4. Sudhir Gupta, "Elements of Control system," Prentice Hall.
5. Kastuhiko Ogatta, "Modern Control Engineering" [Phi]

ME3651 – QUANTITATIVE TECHNIQUES
(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3651 **Contact Hours/Week:** Th.03, Pr.02

Course objective:

- To understand the meaning of quantitative techniques.
- To have effective decisions–making; model formulation and applications those are used in solving business decision problems.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70Marks	Practical Examination : 50%

Course Content:

Numerical Methods:

Root finding- Bisection method, false- position method, Newton-Raphson method, the Secant method and multiple roots.

Regression - Linear regression, polynomial regression, multiple linear regressions.

Interpolation- Newton's Divided-Difference interpolating polynomials, Lagrange Interpolating polynomials

One dimensional search*:* - Golden-Section search, Quadratic Interpolation and Newton's method.

Multi dimensional Search-Direct Methods: Evolutionary Optimization, Simplex Method. Gradient Method: Cauchy's steepest Decent Method.

Linear Programming (LP): Model Formulation for various types of LP problems, Canonical and Standard form, Graphical, Simplex and Dual Simplex methods for solving general LP problems, Concept of Duality, Assignment, Transportation and Travelling Salesman problem.

Project Management: Projects and their description, work break down structure, network diagram and Fulkerson's rule, CPM, PERT, crashing, resource leveling and scheduling.

Term Work:
It shall consist of at least 10 assignments based on above syllabus, 6 out of which will be computer assisted.

Practical Examination:

The practical examination consists of an oral based on the syllabus prescribed above.

Reference Books:

1. Chapra, Canale, "Numerical Methods for Engineers", McGraw-Hill Int.
2. Shastry, "Introductory Methods of Numerical Analysis", Prentice Hall of India Delhi.
3. P. K. Gupta and D. S. Hira, "Operations Research, 3rd Edition", S. Chand and Company Ltd.
4. R. Paneerselvam, "Operations Research", Prentice Hall of India (2002)
5. Ravindran, Philips, Soldberb, "Operations Research: Principles and Practices", 2nd Edition, John Wiley and Sons (2000)
6. H. S. Kasana and K. D. Kumar, "Introductory Operations Research: Theory and Applications", Springer International Edition (2003)
7. Turgut Ozan, "Applied Mathematical Programming for Engineering and Production Management", Prentice Hall (1986)

ME3661 – REFRIGERATION & AIR CONDITIONING
(CREDITS THEORY: 03, PRACTICAL: 01)

Course code: ME3661 **Contact Hours/Week:** Th.03, Pr.02

Course objective:

- To understand the principles of refrigeration and air conditioning.
- To calculate the cooling load for different applications.
- To select the right equipment for a particular application.
- To understand and implement refrigeration and air conditioning systems using standards.

Evaluation Scheme:

Theory	Practical
Mid Term: 30 Marks	Continuous Evaluation : 50%
End Term: 70 Marks	Practical Examination : 50%

Course Content:

Introduction & Air refrigeration cycles: Refrigeration, Applications of refrigeration, elements of refrigeration system, unit of refrigeration, Co-efficient of performance (COP), Air refrigerator working on a reversed Carnot cycle, Air refrigerator working on a reversed Brayton cycle (Bell-Coleman cycle).

Refrigerants: what is refrigerant, classification of refrigerants, Designation of refrigeration, desirable properties of ideal refrigerant, properties and applications of commonly used refrigerants, Leak detection.

Vapour Compression Cycle: Introduction**,** simple vapour compression system, functions of parts of a simple vapour compression system, pressure enthalpy (p-h) chart, simple VCC on p-h chart, factors affecting the performance of a simple vapour compression system, actual vapour compression cycle, mathematical analysis of vapour compression refrigeration, methods of improving vapour compression cycle, refrigeration controls like hand expansion valve, automatic expansion valve, capillary tube etc, introduction to vapour compression refrigeration system with multiple evaporators and compressors.

Vapour Absorption Refrigeration: simple vapour absorption system, practical vapour absorption system, properties of ideal absorbent, advantages of vapour absorption refrigeration system over vapour compression refrigeration system, comparison between VAS and VCS, Lithium Bromide absorption refrigeration system.

Psychrometry: Definitions, psychrometric relations, different psychrometers, psychrometric charts, Psychometric process such as mixing of air streams, sensible heating, sensible cooling, cooling and dehumidification, heating and dehumidification, cooling and humidification, heating and

humidification. Bypass factor sensible hear factor.

Air conditioning: Introduction, factors affecting human comfort, Air conditioning cycle, classification of Air-conditioning systems, ice system of air conditioning, selection of system, Room sensible heat factor, Grand sensible heat factor, Mobile air conditioning, applications of Air conditioning.

Term Work:

Term work shall consist of any eight experiments from the following.

1. Experiment on of vapour compression refrigeration system
2. Experiment on air conditioner.
3. Experiment on ice refrigeration system
4. Demonstration of different compressors used in refrigeration.
5. Demonstration of household refrigeration.
6. Study of different controls used in refrigeration system such as thermostat, solenoid valve.
7. Study of different controls such as H.P. & L.P. control OLP, relays.
8. Study of psychrometer used in determination of D.B.T. W.B.T study of humidistat.
9. Charging refrigerant in refrigeration system or finding refrigeration capacity of refrigerating unit.
10. Study of cold storage plant.
11. A report on Visit to air-conditioned / air-cooled premises
12. Visit to ice factory.

Practical Examination:

The practical examination consists of an oral based on the syllabus prescribed above.

Reference Books:

1. C. P. Arora, “Refrigeration & Air-conditioning”-Tata McGraw Hill.
2. R. K Rajput, “Refrigeration & Air-conditioning” S.K.Kataria & Sons publication.
3. S. Domkundwar, S. C. Arora , “A course in Refrigeration & Air-conditioning”.
4. R. J. Dossat, “Principles of refrigeration,” Willey Eastern Publication.
5. W. F. Stoker and J. W. Jones, “Refrigeration and air-conditioning,” Tata McGraw Hill Publication.