B. Tech (Mechanical Engineering)

SEMESTER –VI

Sl No.	Course Code	Course Title	Hours Per Week			Total Credits
			Lecture	Tutorial	Practical	
1.	102601	Design of Machine Elements	3	0	0	3
2.	102602	Dynamics of Machinery	3	0	0	3
3.	102603	Manufacturing Technology	3	0	0	3
4.	102605	Automation in Manufacturing	3	0	0	3
5.	1026XX	Program Elective-I	3	0	0	3
6.	1026XX	Program Elective-II	3	0	0	3
7.	102611	Renewable Energy Systems (Open Elective-I)	3	0	0	3
8.	102601P	Design of Machine Elements Lab	0	0	2	1
9.	102602P	Dynamics of Machinery Lab	0	0	3	1.5
10.	102603P	Manufacturing Technology Lab	0	0	3	1.5
11.	102605P	Automation in Manufacturing Lab	0	0	2	1
TOTAL						26

List of Program Electives-I

	Course Code	Course Title	Lecture	Tutorial	Practical	Total Credits
1.	102606	Process Planning and Cost Estimation	3	0	0	3
2.	102608	Microprocessors in Automation	3	0	0	3
3.	102610	Power Plant Engineering	3	0	0	3

List of Program Electives-II

	Course Code	Course Title	Lecture	Tutorial	Practical	Total Credits
1.	102607	Mechatronics Systems	3	0	0	3
2.	102609	Composite Materials	3	0	0	3

SEMESTER – VI

Course Code- 102601 Design of Machine Elements 3 0 0 3

Unit-1.0: 8 hrs

Introduction to design: Steps in design process, design factors, practical considerations in design, selection of materials, strength of mechanical elements, impact load, shock load, fatigue loading, effects of surface, size, temperature and stress concentration, consideration of creep and thermal stress in design.

Unit-2.0: 8 hrs

Design of shafts: stresses in shafts, design of static loads, combined stresses, reversed bending and steady loads, design of shafts based on deflection and strength, critical speed of shafts. Analysis and design of sliding and rolling contact bearings.

Unit-3.0: 9 hrs

Riveted joint: Stresses in riveted joint, design of riveted joints with central and eccentric loads, boiler and tank joints, structural joints.

Bolt Joints: Stresses in bolt joint, design of bolt joints with central and eccentric loads.

Welded joints: types of welded joints, stresses, design of welded joints subjected to axial, torsional and bending loads, welds subjected to fluctuating loads.

Unit-4.0: 7 hrs

Design of Clutches: Friction clutches, uniform wear and uniform pressure assumptions, centrifugal clutches.

Brakes: Design of internal expansion elements, assumptions, design of external contraction elements, band type brakes.

Unit-5.0: 4 hrs

Design of transmission elements: spur, helical, bevel and worm gears.

Unit-6.0: 6 hrs

Springs: stresses in helical springs, deflection of helical compression and tension springs, springs subjected to fatigue loading, concentric and helical torsion spring, critical frequency of springs, leaf springs, and design of automotive leaf springs.

Text/ Reference:-

1. Mahadevan & Balaveera Reddy : Design Data Hand Book
2. Dr. Linghaigh & Prof. Narayana Iyengar, Vol.1 & 2 : Design Data Hand Book
3. P.S.G. Tech : Design Data Hand Book.
4. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
5. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
6. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
7. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
8. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

Course Code- 102602 Dynamics of Machinery 3 0 0 3

Unit 1.0- **4 hrs**

Force analysis of mechanism: Dynamics of plane motion of a rigid body, dynamically equivalent two mass system, correction torque, forced in mechanism and machines.

Unit 2.0- **6 hrs**

Turning moment diagram: Fluctuations of crankshaft speed and energy in a direct acting engine mechanism, flywheels.

Unit 3.0 – **8 hrs**

Cams: Classification of cams and followers, types of follower and retardation, cam profile and generation of concentric and offset radial cam profiles by graphical method. Cams with specified contours tangent cam with roller follower, circular arc cam with flat follower.

Unit 4.0- **8 hrs**

Analysis of gyroscopic motion : Principle of gyroscope, gyroscopic couple and gyroscopic reaction couple, Gyroscopic effects on the movement of ships, aeroplanes, two wheeled and four wheeled vehicles, gyrostabilizers.

Unit 5.0 – **7 hrs**

Effects of inertia of reciprocating masses on engine frame: Unbalanced primary and secondary forces and couples, balancing of primary and secondary forces, partial balancing of locomotives, balancing of multicylinder in line and radial engines, direct and reverse cranks methods for balancing of radial engines.

Unit 6.0- **9 hrs**

Mechanical vibrations : Basic concepts degree of freedom, types of damping and viscous damping; natural free, damped free and damped forced vibrations of a single degree of freedom spring mass system, reciprocating and rotating unbalance, vibration isolation and transmissibility, whirling of shaft, elementary treatment of two degree of freedom systems torsional vibrations of single rotor and two rotor systems, transverse vibration of simply supported beam energy method, Rayleigh's and Dankerley method.

Text/ Reference:-

1. Theory of Machines / S.S Ratan/ Mc. Graw Hill Publ.
2. Mechanism and machine theory by Ashok G. Ambedkar, PHI Publications.
3. Mechanism and Machine Theory / JS Rao and RV Dukkipati / New Age.
4. Theory of Machines / Shiegly / MGH
5. Theory of Machines / Thomas Bevan / CBS Publishers
6. Theory of machines / Khurmi / S.Chand.

Course Code- 102603 Manufacturing Technology 3 0 0 3

Unit- 1.0: 7 hrs
Tooling for conventional and non-conventional machining processes: Mould and die design,

Unit- 2.0: 7 hrs
Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools –configuration, design of die and punch; principles of forging die design.

Unit- 3.0: 7 hrs
Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry.

Unit- 4.0: 7 hrs
Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as microscale machining, Inspection and workpiece quality.

Unit-5.0: 5 hrs
Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.

Unit- 6.0: 9 hrs
Unconventional Machining Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters. Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, Dielectric, power and control circuits, wire EDM;
Electro-chemical machining (ECM), etchant & maskant, process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining.

Text/ Reference:-

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)-PearsonIndia, 2014.
2. Taha H. A., Operations Research, 6th Edition, Prentice Hall of India, 2003.
3. Shenoy G.V. and Shrivastava U.K., Operations Research for Management, Wiley Eastern, 1994.

Course Code- 102605 Automation in Manufacturing 3 0 0 3

Unit- 1.0: 5 hrs

Introduction: Why automation, Current trends, CAD, CAM, CIM, Rigid automation: Part handling, Machine tools.

Unit- 2.0: 7 hrs

Flexible automation: Computer control of Machine tools and Machining centres, NC and NC part programming, CNC-Adaptive Control, Automated Material Handling. Assembly, Flexible fixturing.

Unit- 3.0: 6 hrs

Computer Aided Design: Fundamentals of CAD-Hardware in CAD-Computer Graphics software and Data Base, Geometric modelling for downstream applications and analysis methods.

Unit- 4.0: 7 hrs

Computer Aided Manufacturing: CNC Technology, PLC, Micro-controllers, CNC Adaptive control.

Unit-5.0: 8 hrs

Low cost automation: Mechanical & Electromechanical systems, Pneumatic and Hydraulics, Illustrative examples and case studies.

Unit- 6.0: 9 hrs

Introduction to Modeling and Simulation: Product design, process route modelling, Optimization techniques, Case studies & Industrial applications.

Text/ Reference:-

1. M. P. Groover, Automation, Production Systems and Computer-integrated Manufacturing, Prentice Hall, 2018.
2. S. Kalpakjian and S. R. Schmid, Manufacturing – Engineering and Technology, Pearson.
3. Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill, 2005.
4. Ibrahim Zeid, CAD/CAM: Theory & Practice, 2nd edition.
5. CAD/CAM Principles and Applications, P.N. Rao, Tata McGraw Hill, 2010.

B.Tech (Mechanical Engineering) **Semester-VI**

Program Elective- I

Course Code- 102606 Process Planning and Cost Estimation 3 0 0 3

Unit-1.0 **8 hrs**

Introduction of Process Planning- methods of process planning, drawing interpretation.

Unit-2.0- **5 hrs**

Material evaluation, steps in process selection, production equipment and tooling selection.

Unit-3.0 **8 hrs**

Process planning activities- process parameter calculation for various production processes, selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies.

Unit-4.0 **8 hrs**

Introduction to cost estimation- importance of costing and estimation, method of costing, elements of cost estimation, types of estimates, estimating procedure, estimation of labor cost, material cost, allocation of overhead charges, calculation of depreciation cost.

Unit-5.0 **6 hrs**

Machining time estimation- importance of machine time calculation, machining time for different lathe operations, drilling and boring time calculation, Machining time calculation for Milling, Shaping. Planning and Grinding.

Unit-6.0 **7 hrs**

Production costs- different production processes for different jobs, estimation of forging cost, estimation of welding cost, estimation of foundry cost, estimation of machining cost.

Text/ Reference:-

1. Peter Scalon, Process Planning, Design/ Manufacture Interface, Elsevier Sci. & Tech. 2002.
2. Ostwaal P.F. and Munez J., Manufacturing Processes and Systems, 9th ed., John Wiley 1998.
3. Chitale A.V. and Gupta R.C., Product Design and Manufacturing, 2nd ed., Prentice Hall 2002.

B.Tech (Mechanical Engineering) **Semester-VI**

Course Code- 102610 Power Plant Engineering 3 0 0 3

Unit-1.0: 7 hrs

Power plants – types and classification based on energy sources.

Unit-2.0: 7 hrs

Basic Rankine cycle and its modifications; Layout of modern coal power plant; Super critical boilers, FBC boilers; Turbines, condensers, steam and heating rates; Subsystems of thermal power plants; Fuel and ash handling; Draught system; Feed water treatment; Binary cycles and cogeneration systems.

Unit-3.0: 7 hrs

Brayton cycle analysis and optimization; Components of gas turbine power plants; Combined cycle power plants; Integrated Gasifier based Combined Cycle (IGCC) systems.

Unit-4.0: 7 hrs

Basics of nuclear energy conversion; Layout and subsystems of nuclear power plants; Boiling Water Reactor (BWR); Pressurized Water Reactor (PWR); CANDU Reactor; Pressurized Heavy Water Reactor (PHWR); Fast Breeder Reactors (FBR); Gas cooled and liquid metal cooled reactors; Safety measures for nuclear power plants.

Unit-5.0: 7 hrs

Hydroelectric power plants, hydrological cycle, Rainfall & run-off measurement & plotting of various curves for estimating stream flow, site selection, classification, comparison with other types of power plant, typical layout and components, Principles of wind, tidal, solar photo-voltaic, solar thermal, geothermal, biogas and fuel cell power systems.

Unit-6.0: 7 hrs

Economic and environmental issues; Power tariffs; Load distribution parameters; Load curve; Capital and operating cost of different power plants; Pollution control technologies including waste disposal options for coal and nuclear plants.

Text/ Reference:-

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.
4. Power Plant Engineering, 5th Edition, Laxmi Publications (P) Ltd.

B.Tech (Mechanical Engineering) **Semester-VI**

Course Code- 102608 Microprocessors in Automation 3 0 0 3

Unit-1.0 **6 hrs**

Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers.

Unit-2.0 **6 hrs**

Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals.

Unit-3.0 **6 hrs**

Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing.

Unit-4.0 **9 hrs**

Assembly Language Programming: Addressing modfes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt stucture, Multiple Interrupt requests and their handling, Programmable interrupt controller; Interfacing pheripherals: Programmable peripheral interface (8255).

Unit-5.0 **8 hrs**

Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control, Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features,

Unit-6.0 **7 hrs**

Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z-Transform, Digital Filters, Implementation of Digital Algorithm.

Text/ Reference:-

1. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited.
2. Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata Mc Graw-Hill Publishing Company Ltd.
3. Mictoprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
4. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
5. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall.

B.Tech (Mechanical Engineering) **Semester-VI**

Program Elective-II

Course Code- 102607 Mechatronics Systems 3 0 0 3

Unit 1.0- **8 hrs**

Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronics approach, Integrated Product Design, Modeling, Analysis and Simulation, Man- Machine Interface;

Unit 2.0- **8 hrs**

Sensors and transducers: classification, Development in Trransducer technology, Opto-electronics Shaft encoders, CD Sensors, Vision System, etc.

Unit 3.0- **6 hrs**

Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor nad Stepper motor, Drive Circuits, open nad closed loop control; Embedded Systems: Hardware Structure, Software Design nad Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems;

Unit 4.0- **6 hrs**

Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Statics and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.

Unit 5.0 – **8 hrs**

Micromechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro- joining etc.

Unit 6.0- **8 hrs**

Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology

Text/ Reference:-

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Peason Education
3. A Text book of Mechatronics, R.K. Rajput, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control System in Mechanical and Electrical Engineering, William Bolton, Prentice Hall

B.Tech (Mechanical Engineering) **Semester-VI**

Course Code- 102609 Composite Materials 3 0 0 3

Unit-1.0: 7 hrs

Definition and applications of composite materials, Fibers-glass, carbon, ceramic and aramid fibers; Matrices-polymer, graphite, ceramic and metal matrices; characteristics of fibers and matrices.

Unit-2.0: 7 hrs

Lamina assumptions, macroscopic viewpoint, generalized Hookes law, reduction of homogenous orthotropic lamina, isotropic limit case, orthotropic stiffness matrix, commercial material properties, rule of mixtures, transformation matrix, transformed stiffness.

Unit-3.0: 7 hrs

Manufacturing of composite materials, bag moulding, compression, pultrusion, filament welding, other manufacturing processes.

Unit-4.0: 7 hrs

Basic assumptions of laminated anisotropic plates, symmetric laminates, angle ply plates, cross ply laminates, laminate structural moduli, evaluation of lamina properties, determination of lamina stresses, maximum stress and strain criterias, Von Mises yield criterion for isotropic materials.

Unit-5.0: 7 hrs

Generalized Hill's criterion for anisotropic materials, Tsai-Hill's criterion for composites, prediction of laminate failure, thermal analysis of composite laminates.

Unit-6.0: 7 hrs

Analysis of laminated plates-equilibrium equations of motion, energy formulation, static bending analysis, buckling analysis, free vibrations, natural frequencies.

Text/ Reference:-

1. Gibson R.F. Principles of Composite Material Mechanics, 2nd edition, McGraw Hill.
2. Hyer M.W. Stress Analysis of Fiber-Reinforced Composite Materials, McGraw Hill, 1998.

B.Tech (Mechanical Engineering) **Semester-VI**

Course Code- 102611 Renewable Energy Systems **3 0 0 3**

Unit 1.0- **8 hrs**

Principles of Renewable Energy: Introduction, Energy and sustainable development, Fundamentals, Scientific Principles of renewable energy, Technicle implications, Social implications, Problems.

Unit 2.0- **8 hrs**

Solar radiation: Introduction, Exatra- terrestrial solar radiation, Components of radiation, Geometry of collector and the solar beam, Effects of the Earth's atmosphere Measurements of solar radiation, Estimation of solar radiation, Solar wate heating: Introduction, Calculation of heat balance: general remarks, Uncovered solar water heaters- progressive analysis, Improved solar water heaters, Prograssive analysis, Improved solar water heaters, Evacuated collectors, Buildings and other solar thermal applications. Air heaters, Crop driers, Space cooling, Water desalination, Solar ponds, Solar concentrators, Solar thermal electric power systems, Problems.

Unit 3.0- **6 hrs**

Photovoltaic generation: Introduction, The silicon p-n Junction, Photon absorption at the Junction, solar radiation absorption, Maximizing cell efficiency, Solar cell construction, Applications, Problems,

Unit 4.0- **6 hrs**

Hydro- power: Introduction, Principles, Assessing the resource for small installations, An inpulse turbine Reaction trubines, Hydroelectric systems. the hydraulic ram pump, Problems.

Unit 5.0 – **8 hrs**

Power from the wind: Introduction, Turbine types and tems, Linear momentum and basic theory, Dynamics matching, Blade element theory, Contents Characteristics of the wind, Power extraction by a turbine, Electricity generations, Mechanical power, Problems.

Unit 6.0- **8 hrs**

Biomass and Biofuels: Introduction, Biofuel classification, Biomass production for energy faming, Direct combustion for heat, Pyrolysis (destructive distillation), Further thermochemical processes, Alcoholic fermentation, Anaerobic digestion for biogas, Wastes and residues, Vegetable oils and biodiesel, Problems.

Text/ Reference:-

1. Renewable Energy Resources by John Twidell and Tony Weir, Taylors and Francis Publication
2. Solar Energy by G N Tiwari, Narosa Publication
3. Green Power: The Eco- Friendly Energy Engineering by Nikolai V.Khartchenko, Tbi Publication
4. Duffie J.A. & Beckman W.A., Solar engineering of thermal processes, Wiley-international Publication
5. Solar Energy principal of thermal collector and storage by SP Sukhatme and JK Nayak, TMH Publication
6. Renewable Energy Resources by G N Tiwari and M K Ghosal, Narosa Publication
7. Bansal Keemann, Meliss, Renewable energy sources and conversion technology, Tata Mc Graw Hill
8. Kothari D.P., Renewable energy resources nad emerging technologies, Prentice hall of India Pvt. Ltd.

B.Tech (Mechanical Engineering) **Semester-VI**

Course Code-102601P **Design of Machine Elements Lab** **0 0 2 1**
Perform all Experiments

1. To study the design procedure of Knuckle & Cotter joint.
2. Design of shafts subjected to torsion, bending moment and combined bending and torsion.
3. Design of flat and square key
4. Design and drawing of riveted joints
5. Design and drawing of screw jack
6. Journal Bearing Test Rig.

B.Tech (Mechanical Engineering) **Semester-VI**

Course Code- 102602P Dynamics of Machinery Lab 0 0 3 1.5

Perform any 10 Experiments

List of Experiments:

1. To study various types of Links, Pairs, Chain and Mechanism
2. To study inversion of Four Bar Mechanism
3. To study velocity diagram for Slider Crank Mechanism.
4. To study various kinds of belts drives.
5. To study and find coefficient of friction between belt and pulley.
6. To study various types of Cam and Follower arrangement.
7. To plot follower displacement Vs cam rotation graph for various cam follower arrangement.
8. To study Different types of Gears.
9. To study Different types of Gear Trains.
10. To Perform Experiment on Watt, Porter, Proell and Hartnell Governors and prepare Performance Characteristic Curves also analyze Stability & Sensitivity
11. To study gyroscopic effects through models.
12. To determine gyroscopic couple on Motorized Gyroscope.
13. To perform the experiment of Balancing of rotating parts and find the unbalanced couple and forces.
14. To study Dynamically Equivalent System.
15. Determine the moment of inertial of connecting rod by compound pendulum method and trifler suspension pendulum.
16. To study the various types of dynamometers.
17. To find out critical speed experimentally and to compare the Whirling Speed of a shaft with theoretical values.

B.Tech (Mechanical Engineering) **Semester-VI**

Course Code- 102603P **Manufacturing Technology Lab** **0 0 3 1.5**

Perform all Experiments

List of Experiments:

1. Measurement of angle using Sine Center / Sine bar / bevel protractor
2. Measurement of alignment using Autocollimator / Roller set
3. Measurement of cutting tool forces using
   a. Lathe tool Dynamometer
   b. Drill tool Dynamometer.
4. Measurement of Screw Threads Parameters using Two wire or Three-wire method.
5. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
6. Measurement of gear tooth profile using gear tooth Vernier/Gear tooth micrometer
7. Calibration of Micrometer using slip gauges
8. Measurement using Optical Flats.

B.Tech (Mechanical Engineering) **Semester-VI**

Course Code- 102605P **Automation in Manufacturing Lab** **0 0 2 1**

Perform any 10 Experiments

List of Experiments:

1. Case study on automated system of any industry.
2. Practice programming on manual part program.
3. Practice Programming on APT.
4. Demonstration on robot.
5. Performance on robot.
6. Demonstration on CNC lathe.
7. Performance on CNC lathe.
8. Performance and simulation with CNC lathe software.
9. Demonstration on CNC milling.
10. Performance on CNC milling.
11. Performance and simulation with CNC milling software.
12. Case study on Computer aided process planning.
13. Case study on part coding and group technology.
14. Case study on Computer aided quality control.
15. Case study on flexible manufacturing system.