Curriculum for Undergraduate Degree (B.Tech.) in Mechanical Engineering (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Eighth Semester

Course Name:	**Project-IV**		
Course Code:	PW-ME 881	**Category:**	Professional Core
Semester:	Eighth	**Credit:**	4
L-T-P:	0-0-10	**Pre-Requisites:**	All courses
Full Marks:	100		
Examination Scheme:	Semester Examination: 100 (Viva-voce)	Continuous Assessment: 00	Attendance: 00

Course Objectives:	
1	To develop the ability to conduct investigations of complex engineering problems using research knowledge, methods and other modern engineering tools.
2	To train the students in preparing project reports, to face review and viva voce examination.

Course Contents:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design and formulation of the problem is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester. The students in a group of 4 to 6 works on a topic are to be approved by the head of the department under the guidance of a faculty member. The students prepare a comprehensive project report after completing the work to the satisfaction of the supervisor to be submitted at the end of the semester. The progress of the project is evaluated by a committee may be constituted by the Head of the Department. The project work is evaluated based on oral presentation and the project report may jointly by external and internal examiners constituted by the Head of the Department.

Course Outcomes:

After completion of the course, students will be able to:

carry out some project works based on some design or fabrication or experimental problems in a group building up team spirit and would get sufficient exposure for the way to proceed to solve a practical or design problem.

Course Name:	**Comprehensive Viva-voce**		
Course Code:	PW-ME 882	**Category:**	Professional Core
Semester:	Eighth	**Credit:**	1.5
L-T-P:	0-0-0	**Pre-Requisites:**	All courses
Full Marks:	100		
Examination Scheme:	Semester Examination: 100 (Viva-voce)	Continuous Assessment: 00	Attendance: 00

Course Objectives:	
1	The objective of comprehensive viva-voce is to assess the overall knowledge, a student acquired in the relevant field of engineering over 4 years of study in the programme. In doing so, the main objective is to prepare the students to face interview both in the academic and the industrial sector.

Course Contents:
The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and all Faculty members of the department. The Comprehensive Viva-Voce is intended to assess the student's understanding of the courses he/ she studied during the 4 years B. Tech. programme.

Course Outcomes:
After completion of the course, students will be able to:
prepare for the interview in a better way by brushing up different course papers so that overall knowledge on Mechanical Engineering areas would be sharpened.

Course Name:	**Power Plant Engineering**		
Course Code:	A	**Category:**	Professional Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Thermodynamics and Heat Transfer
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To familiarize students with different aspects of power plant engineering, working of

	power plants based on different fuels and to expose the students to the principles of safety and environmental issues.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Analysis of Steam Cycles: Introduction to the course, Power plant layout and essential feature of Rankine cycle, Reheating and regeneration, Problems on Rankine Cycle, Combined cycle power generation, Binary vapour cycles.	3L
2	**Module 2:** Boilers: Definition, classification, fire tube and water tube boilers, mountings and accessories. Draft in boilers, performance of boiler – boilers efficiency, equivalent evaporation, Losses in boilers. Coal and combustion: Properties of coal, ultimate analysis and proximate analysis, combination calculation. Super heater, economizer and air-pre heater. Handling of coal and ash.	8L
3	**Module 3:** Fuel bed firing, PF firing and Fluidized bed boilers. Introduction to boiling and circulation in boilers. Power station boilers - Benson, Lamont. Supercritical boiler.	4L
4	**Module 4:** Steam turbine: i) parts and classification, ii) nozzles types, flow through nozzles and nozzle efficiency. Impulse turbine - velocity diagram, work done and blade efficiency.	6L
5	**Module 5:** Turbines: Pressure compounding and velocity compounding of steam turbine. Impulse reaction turbine - Velocity diagram, degree of reaction and Parsons turbine. Governing in Steam turbine.	6L
6	**Module 6:** Condensers: Direct Contact Condenser Surface Condensers, Effect of various parameters on condenser performance, Design of condensers, cooling towers and cooling ponds.	6L
7	**Module 7:** Power plant economics and other issues: Load duration curves, Power plant economics, estimation of tariff. Diesel and gas plants, Pollution and control, Greenhouse effect and control, Peak load plants.	3L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand functions of the various components of power plant.
2	Illustrate the working of nuclear, thermal and gas based power plants.
3	Evaluate the design layout and working of hydroelectric power plants.
4	Estimate the feasibility and its implications on power generating units.

Learning Resources:	
1	P.K. Nag, Power Plant Engineering, McGraw Hill, 2017.
2	Domkundwar, Arora and Domkundwar, Power Plant Engineering, Dhanpat Rai & Sons, New Delhi, 2016.
3	M.M. Ei-Wakil, Power Plant Technology, McGraw Hill Com., 1985.
4	P.C. Sharma, Power Plant Engineering, S.K. Kataria & Sons, New Delhi, 2010.

Course Name:	**Energy Conservation and Management**		
Course Code:	B	**Category:**	Professional Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Thermodynamics, Heat Transfer and Basic Electrical Engineering
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To understand the energy data from industries and carry out energy audit for energy savings.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Introduction to energy & power scenario of world, National Energy consumption data, environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.	9L
2	**Module 2:** Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors;	9L

	Illumination- Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.	
3	**Module 3:** Thermal systems, Boilers, Furnaces and Thermic Fluid heaters efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.	9L
4	**Module 4:** Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration& Air Conditioning systems, Cooling Towers, DG sets. Energy Economics: discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.	9L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand principles of energy management and its influence on environment.
2	Comprehend methods of energy production for improved utilization.
3	Improve the performance of thermal systems using of energy management principles
4	Analyse the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems.
5	Prepare energy audit report of energy consumption for industries.

Learning Resources:	
1	L.C. Witte, P.S. Schmidt and D.R. Brown, Industrial Energy Management and Utilization, Hemisphere Publication, Washington, 1988.
2	P.W. Callaghn, Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
3	B.K. De, Energy Management Audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
4	W.R. Murphy and G. McKay, Energy Management, Butterworths Publication, London, 1987.

Course Name:	**Cryogenics**		
Course Code:	C	**Category:**	Professional Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Thermodynamics, Heat Transfer
Full Marks:	100		
Examination	Semester Examination:	Continuous	Attendance: 05

Scheme:	70	Assessment: 25	

Course Objectives:	
1	To provide the knowledge of evolution of low temperature science, properties of materials at low temperature and to familiarize with various gas liquefaction and refrigeration systems.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Introduction: Definition and engineering applications of cryogenics, Properties of solids for cryogenic systems.	5L
2	**Module 2:** Low Temperature Properties: Properties of engineering materials (Mechanical properties, Thermal properties, Electric and Magnetic properties), Properties of Cryogenic fluids.	3L
3	**Module 3:** Refrigeration and Liquefaction: Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual-pressure cycle, Simon helium liquefier, classical cascade cycle, mixed refrigerant cascade cycle.	6L
4	**Module 4:** Ultra-low-temperature refrigerators: Definition and fundamentals regarding ultra-low temperature refrigerators, Equipment associated with low-temperature systems, various advantages and disadvantages.	7L
5	**Module 5:** Storage and Handling of Cryogenic Refrigerants: Storage and transfer systems, Insulation, Various types of insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation, and so on.	7L
6	**Module 6:** Cryogenic Instrumentation: Pressure, flow-rate, liquid-level and temperature measurements. Types of heat exchangers used in cryogenic systems (only description with figure). Cryo pumping applications.	6L
7	**Module 7:** Broad applications of cryogenic refrigerants in various engineering systems.	2L
Total		**36L**

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

1	Understand principles of cryogenic systems.
2	Understand air and helium liquefaction processes.
3	Be able to classify cascade refrigeration systems.
4	Understand principles of ultra-low temperature systems and their applications.
5	Be able to evaluate storage systems used in cryogenic applications.

Learning Resources:	
1	M. Mukhopadhyay, Fundamentals of Cryogenic Engineering, Prentice Hall of India, 2010.
2	T. Flynn, Cryogenic Engineering, Revised and Expanded, CRC, 2004.
3	Arora and Domukundwar, Refrigeration and Air-conditioning, Dhanpat Rai & Co., 2018.
4	A.R. Jha, Cryogenic Technology and Applications, Butterworth-Heinemann, 2005.

Course Name:	**Tribology**		
Course Code:	D	**Category:**	Professional Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Fluid Mechanics and Design of Machine Elements
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To provide students with the fundamental knowledge in the field of Industrial tribology.
2	To provide basic concepts in the design of automotive lubrication system.
3	To provide knowledge of friction and wear mechanism in automotive system.

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	**Module 1:** Introduction to Tribology: Introduction to Tribology, Tribology in design, Tribology in industry, economic aspects of Tribology, lubrication, basic modes of lubrication, lubricants, properties of lubricants-physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion. Types of sliding contact bearings, comparison of	6L

	sliding and rolling contact bearings.	
2	**Module 2:** Friction and Wear: Friction: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear.	6L
3	**Module 3:** Hydrodynamic lubrication: Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, two-dimensional Reynold's equation, infinitely long journal bearing, infinitely short journal bearing, finite bearing. Hydrodynamic thrust bearing: Introduction, flat plate thrust bearing, pressure equation, load, centre of pressure, friction in tilting pad thrust bearing.	6L
4	**Module 4:** Hydrostatic Lubrication: Hydrostatic lubrication: Basic concept, advantages and limitations, viscous flow through rectangular slot, load carrying capacity and flow requirement of hydrostatic step bearing, energy losses, optimum design of step bearing. Compensators and their actions. Squeeze film lubrication: Introduction, circular and rectangular plates approaching a plane.	6L
5	**Module 5:** Elastohydrodynamic Lubrication and Gas Lubrication: Elastohydrodynamic Lubrication: Principle and application, pressure viscosity term in Reynolds equation, Hertz theory. Ertel- Grubin Equation. Gas lubrication: Introduction, merits and demerits, applications. Lubrication in metal working: Rolling, forging, drawing and extrusion. Bearing materials, bearing constructions, oil seals, shields and gaskets.	6L
6	**Module 6:** Surface Engineering: Introduction to surface engineering, concept and scope of surface engineering, manufacturing of surface layers, solid surface geometrical, mechanical and physic chemical concepts, superficial -layer, development of concept, structure of superficial layer, general characteristics of superficial layer, obtained by machining, strengthening and weakening of superficial layer.	6L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Apply knowledge of tribology for industrial component design.
2	Apply design concepts practically for automotive lubrication systems.

Learning Resources:	
1	A. Cameron, Basic Lubrication Theory, Wiley Eastern Ltd., 1976.
2	S. Wen and P. Huang, Principles of Tribology, 2nd Edition, Wiley, 2012.
3	B. C. Majumdar, Introduction to Tribology and Bearings, S. Chand and Company Ltd., New Delhi, 2008.
4	D. D. Fuller, Theory and Practice of Lubrication for Engineers, John Wiley and Sons, 1984.
5	B. Bhushan and B.K. Gupta, Handbook of Tribology: Materials, Coatings and Surface Treatments, McGraw-Hill, 1991.

Course Name:	**Materials Testing**		
Course Code:	E	**Category:**	Professional Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Materials Engineering and Design of Machine Elements
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	The subject exposes students to the basics parameter for selection of materials and different classes of materials, and various destructive and non-destructive testing methods of materials and its industrial applications.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Engineering Materials: Introduction – classification of engineering materials – selection of materials for engineering purposes –selection of materials and shape classification metal and alloys, polymers, ceramics and glasses, composites, natural materials, non-metallic materials- smart materials; physical, metrical properties of metals.	5L

2	**Module 2:** Material Properties: Mechanical properties - fatigue strength - fracture Toughness - Thermal Properties - Magnetic Properties - Fabrication Properties - electrical, optical properties - Environmental Properties, Corrosion properties - shape and size - Material Cost and Availability– failure analysis.	3L
3	**Module 3:** Materials Selection Charts and Testing: Ashby material selection charts- Testing of Metallic Materials - Selection of Materials for Biomedical Applications – Medical Products - Materials in Electronic Packaging - Advanced Materials in Sports Equipment - Materials Selection for Wear Resistance - Advanced Materials in Telecommunications - Using Composites - Manufacture and Assembly with Plastics, fiber and Diamond Films	6L
4	**Module 4:** Mechanical Testing: Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.	6L
5	**Module 5:** Non Destructive Testing: Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.	6L
6	**Module 6:** Material Characterization Testing: Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.	6L
7	**Module 7:** Other Testing: Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermomechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.	4L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	To understand importance of engineering materials.
2	To choose materials for engineering applications.
3	To identify the material properties.
4	To identify suitable testing technique to inspect industrial component.
5	To use different techniques and know its applications and limitations.

Learning Resources:	
1	L. Gladius, Selection of Engineering Materials, Prentice Hall Inc. New Jersey, USA, 1995.
2	J.A. Charles and F.A.A. Crane, Selection and Use of Engineering Materials, 3rd Edition, Butterworths, London, UK, 1996.
3	M.F. Ashby, Materials Selection in Mechanical Design, 3rd Edition, Elsevier, 2005.
4	B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non-Destructive Testing, Narosa Publishing House, 2009.

Course Name:	**Micro Machining**		
Course Code:	F	**Category:**	Professional Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Materials Engineering and Design of Machine Elements
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To give awareness of different techniques used in micro and nano-machining/manufacturing.
2	To give in-depth idea of the conventional techniques used in micro-machining/manufacturing.
3	To introduce Non-conventional micro-nano manufacturing and finishing approaches
4	To introduce Micro and Nanofabrication Techniques and other processing routes in Micro and nano machining/manufacturing

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Introduction: Introduction, Basic elements of molecular dynamics modelling, Design and requirements for state-of-the-art MD cutting process simulations, Capabilities of MD for nanoscale material removal process analysis, Advances and recent developments in material removal process simulation, Summary. Ductile Mode Cutting of Brittle Materials The mechanism of ductile mode cutting of brittle materials, the chip formation in cutting of brittle materials, machined surfaces in relation to chip formation mode Diamond Tools in Micromachining Diamond technology, preparation of substrate, modified HFCVD process, Nucleation and diamond growth, deposition on complex substrates, Diamond micromachining.	6L
2	**Module 2:** Conventional Processes: Micro-turning, Micro-drilling and Micro-milling Introduction, Micro-turning, Micro-drilling, Micro-milling, Product quality in micromachining Micro-grinding and Ultra-precision Processes Introduction, Micro and nano-grinding, Nano-grinding tools.	6L
3	**Module 3:** Non-Conventional Processes: Laser Micromachining Introduction, Fundamentals of lasers, Laser microfabrication, Laser nanofabrication. Evaluation of Subsurface Damage in Nano and Micromachining Destructive evaluation technologies, Non-destructive evaluation technologies	6L
4	**Module 4:** Micro and Nano Finishing Processes: Need for Nano finishing, Magnetic abrasive Finishing, Magnetorheological Finish, Elastic Emission Finishing, Magnetic Float Polishing, Ion Beam finishing.	6L
5	**Module 5:** Micro Joining Challenges, Micro Resistance welding, Ultrasonic welding, Micro TIG, Applications.	6L
6	**Module 6:** Applications of Nano and Micromachining in Industry Typical machining methods, Applications in optical manufacturing, Semiconductor and electronics related applications.	6L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	To understand importance of engineering materials.
2	To choose materials for engineering applications.
3	To identify the material properties.
4	To identify suitable testing technique to inspect industrial component.
5	To use different techniques and know its applications and limitations.

Learning Resources:	
1	L. Gladius, Selection of Engineering Materials, Prentice Hall Inc. New Jersey, USA, 1995.
2	J.A. Charles and F.A.A. Crane, Selection and Use of Engineering Materials, 3rd Edition, Butterworths, London, UK, 1996.
3	M.F. Ashby, Materials Selection in Mechanical Design, 3rd Edition, Elsevier, 2005.
4	B. Raj, T. Jayakumar and M. Thavasimuthu, Practical Non-Destructive Testing, Narosa Publishing House, 2009.

Course Name:	**Maintenance Engineering**		
Course Code:	F	**Category:**	Professional Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Manufacturing Processes
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To provide knowledge on different aspects of repair and maintenance practised in industry.
2	To make students familiar with different repair and maintenance strategies used in industry.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Introduction: Definitions of repair and maintenance; Importance of maintenance; Different maintenance systems- breakdown, preventive, planned; predictive maintenance through condition monitoring; Maintainability, failure pattern, availability of equipment/ systems,	5L

	design for maintainability.	
2	**Module 2:** Total Productive Maintenance (TPM): definition, objective & methodology; Implementation of TPM; Lean maintenance; Overall equipment effectiveness (OEE).	3L
3	**Module 3:** Organizational structures for maintenance: Objective; Maintenance functions and activities; Organizational requirements; Types of maintenance organizations, Manpower planning; Engineering stores & inventory management.	4L
4	**Module 4:** Economic Aspect of Maintenance: Life cycle costing; Maintenance cost & its impact; Maintenance budget; Cost control; Maintenance audit-Procedure, tools, planning, reports.	4L
5	**Module 5:** Function and use of Maintenance Equipment, Instruments & Tools: Facilities like NDT, painting, coating and cladding, Gas cutting and welding, crack detection, vibration monitor, balancing equipment, compressor, basic machine tools, lubricators and lubricants, chain pulley block, Tools like different types of wrenches, torque wrench, pipe wrench, plier, screw driver, dimension measuring instruments, feeler gauge, scraper, fitting shop tools, spirit level, hand grinder & drill, screw jack, etc.	6L
6	**Module 6:** Lubrication: Purpose & importance; Type of lubricants, Properties of lubricants; Types of lubrication and their typical applications, lubrication devices, centralized lubrication system; Gasket, packing and seals.	4L
7	**Module 7:** Repair & Maintenance Procedures: Repair of cracks, threads, worn shafts, keyways, bush bearing, damaged gear tooth. Assembly and dismantling of antifriction bearing; Maintenance of bearing, clutches, coupling, brakes, Alignment of shafts, belt and chain drives, gear drives, centrifugal pump, pipe and pipe fittings, electrical wiring, isolators and main switches, small induction motors; Steps for installation of a machine	10L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Know different types of repair and maintenance procedures practised in industry.

2	Understand different repair and maintenance strategies used in industry.
3	Understand the organizational structure of an industry for maintenance management and the

Learning Resources:	
1	R.C. Mishra and K. Pathak, Maintenance Engineering and Management, PHI, 2012.
2	J S.K. Srivastava, Maintenance Engineering and Management, S. Chand & Company Ltd., New Delhi, 1998.
3	K. Venkataraman, Maintenance Engineering and Management, PHI, 2007.
4	K. Mobley, Maintenance Engineering Handbook, McGraw Hill, Eighth Edition, 2014.

Course Name:	**Total Quality Management**		
Course Code:	A	**Category:**	Open Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Engineering Knowledge
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To express knowledge about various aspects of quality and total quality management.
2	To understand different tools of TQM and related standards.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Introduction: Need for quality, Definition of Quality, Evolution of quality, Product quality and Service quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs - Analysis, Techniques for Quality Costs, and Basic concepts of Total Quality Management. Quality Council, Quality Statements, Strategic quality planning, Barriers to TQM Implementation, Benefits of TQM, Contributions of Deming, Juran and Crosby.	6L
2	**Module 2:** TQM Principles: Customer satisfaction- Customer Perception of Quality, Customer Complaints, Service Quality. Customer Retention;	6L

	Employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal; Continuous process improvement; PDCA cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection.	
3	**Module 3:** TQM Tools and Techniques: Benchmarking- Reasons to Benchmark, Benchmarking Process; Quality Function Deployment (QFD); Taguchi Quality Loss Function; Seven traditional tools of quality; New management tools; Process capability; Six sigma concepts, methodology; TPM- concepts, improvement needs, performance measures; FMEA- Stages of FMEA.	18L
4	**Module 4:** Quality Systems: Need for ISO 9000 and Other Quality Systems, ISO 9001:2015 Quality System- Elements, Documentation; Quality Auditing, QS 9000, ISO 14000- Concept, Requirements and Benefits; TQM implementation in manufacturing and service sectors	6L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand quality management philosophies, techniques, and frameworks
2	Apply tools and techniques of TQM in manufacturing and service sectors.
3	Understand the implications of quality management standards and systems

Learning Resources:	
1	D.H. Besterfield, C. Besterfield, G.H. Besterfield, M. Besterfield, H. Urdhwareshe and R. Urdhwareshe, Total Quality Management, Pearson Education, 2018.
2	A. Mitra, Fundamentals of Quality Control and Improvement, Wiley Student Edition, 2008.
3	S. Ramasamy, Total Quality Management, McGraw Hill Publishing Co., New Delhi, 2011.
4	J.R. Evans and W.M. Lindsay, The Management and Control of Quality, Cengage Learning, 1999.

Course Name:	**Entrepreneurship Development**		
Course Code:	B	**Category:**	Open Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Engineering Knowledge
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills.
2	To understand how to run a business efficiently and effectively.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Entrepreneurship: Types of Entrepreneurs– Difference between Entrepreneur and Intrapreneur, Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.	7L
2	**Module 2:** Motivation: Major Motives Influencing an Entrepreneur– Achievement Motivation Training, Self-Rating, Business Games, Thematic Apperception Test– Stress Management, Entrepreneurship Development Programs– Need, Objectives.	7L
3	**Module 3:** Business: Small Enterprises– Definition, Classification– Characteristics, Ownership Structures– Project Formulation– Steps involved in setting up a Business– identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment– Preparation of Preliminary Project Reports– Project Appraisal– Sources of Information– Classification of Needs and Agencies.	8L
4	**Module 4:** Financing And Accounting: Need– Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Taxation– Income Tax, Excise Duty– Sales Tax.	7L
5	**Module 5:** Support to Entrepreneurs: Sickness in small Business– Concept, Magnitude, Causes and Consequences, Corrective Measures– Business Incubators– Government Policy for Small Scale Enterprises– Growth Strategies in small industry– Expansion, Diversification, Joint Venture, Merger and Sub Contracting.	7L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand quality management philosophies, techniques, and frameworks
2	Apply tools and techniques of TQM in manufacturing and service sectors.
3	Understand the implications of quality management standards and systems

Learning Resources:	
1	Gain knowledge and skills needed to run a business successfully.
2	Interpret key regulations and legal aspects of entrepreneurship in India.
3	Understand the concept of business plan and ownerships.

Course Name:	**Automation and Control**		
Course Code:	C	**Category:**	Open Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Electronics Engineering, Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To know about various types of control systems used in different industries.
2	To learn about mathematical representation and analysis of control systems.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Introduction to control system: Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servo mechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function. Mathematical modeling of dynamic systems: Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram	6L

	representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. Control system components: Potentiometer, Synchros, Resolvers, Position encoders..	
2	**Module 2:** Time domain analysis: Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh Hurwitz criteria and applications. Error Analysis: Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.	8L
3	**Module 3:** State variable Analysis: State variable model of Linear Time invariant system, properties of the State transition matrix, State transition equation, Definition of transfer function & Characteristic equation, definition of controllability and observability.	8L
4	**Module 4:** Stability Analysis using root locus: Importance of Root locus techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros. Frequency domain analysis of linear system: Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin. Determination of margins in Bode plot. Nichols chart. M circle and M-Contours in Nichols chart.	10L
5	**Module 5:** Control System performance measure: Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.	4L
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	know about the various types of control systems.
2	learn about modeling control systems.

Learning Resources:

1	K. Ogata, Modern Control Engineering, 4th Edition, Pearson Education, 2010.
2	I.J. Nagrath and M. Gopal, Control System Engineering, New Age International, 2009.
3	D. Roy Choudhury, Control System Engineering, PHI, 2005.
4	B.C. Kuo and F. Golnaraghi, Automatic Control Systems, 8th Edition, PHI, 2014.
5	M.N. Bandyopadhyay, Control Engineering Theory & Practice, PHI, 2002.