POOJYA DODDAPPA APPA COLLEGE OF ENGINEERING, KALABURAGI
Choice Based Credit System (CBCS)
Scheme of Teaching and Examination AY 2024 – 25- (Effective from the academic year 2021 – 22)

VII Semester

Sl. No.	Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical /Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1.	PEC	21ME71X	Professional Elective-II	Respective Department	3	0	0	0	03	50	50	100	3
2.	PEC	21ME72X	Professional Elective-III		3	0	0	0	03	50	50	100	3
3.	OEC	21ME73OEX	Open Elective-II		3	0	0	0	03	50	50	100	3
4.	OEC	21ME74OEX	Open Elective-III		3	0	0	0	03	50	50	100	3
5.	Project	21ME75	Project work		0	0	6	0	06	50	50	100	10
6.	AEC	21NPAE76	Ability Enhancement Course (Online) 8-weeks		2	0	0	0	02	--	--	--	2
				Total:	**14**	**0**	**6**	**0**		**250**	**250**	**500**	**24**

Professional Elective-II	**Professional Elective-III**
1. 21ME711 Computer Integrated Manufacturing	1. 21ME721 Energy Engineering
2. 21ME712 Mechatronics	2. 21ME722 Flexible Manufacturing Systems
3. 21ME713 Experimental Stress Analysis	3. 21ME723 Cryogenics
4. 21ME714 Quality Assurance and Reliability	4. 21ME724 Project Management
5. 21ME715 Alternate Fuels	5. 21ME725 Rapid Prototyping and Modelling
Open Elective-II	**Open Elective-III**
1. 21ME73OE1 Non-Conventional Energy Sources	1. 21ME74OE1 Total Quality Management
2. 21ME73OE2 Nano Technology	
Ability Enhancement Course (Online) 8-weeks	
1. Advanced Machining Processes	4. Advances in Welding and Joining Technologies
2. Power Plant Engineering	5. Energy Conversion Technologies (Biomass and Coal)
3. Laser Based Manufacturing	6. Design Practice - II

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VIII Semester

Sl. No.	Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1.	Seminar	21MES81	Technical Seminar	Respective Department	One contact hour /week for interaction between the faculty and students				----	50	---	50	1
2.	Internship	21MEI82	Research / Industry Internship		Two contact hours /week for interaction between the faculty and students.				03 Batchwise	50	50	100	15
									Total :	**100**	**50**	**150**	**16**

TECHNICAL SEMINAR (21MES81): The objective of the seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas. Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the programme of Specialization.

i) Carry out literature survey, systematically organize the content.
ii) Prepare the report with own sentences, avoiding a cut and paste act.
iii) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
iv) Present the seminar topic orally and/or through PowerPoint slides.
v) Answer the queries and involve in debate/discussion.
vi) Submit a typed report with a list of references.

The participants shall take part in the discussion to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Evaluation Procedure:

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question-and-answer session, and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three teachers from the department with the senior-most acting as the Chairman.

Marks distribution for CIE of the course:

Seminar Report:50 marks
Presentation skill:25 marks
Question and Answer: 25 marks.
No SEE component for Technical Seminar

21MEI82 Research Internship/ Industry Internship/Rural Internship

Research internship: A research internship is intended to offer the flavour of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural internship: A long-term goal, as proposed under the AICTE rural internship programme, shall be counted as rural internship activity. The student can take up Interdisciplinary Research Internship or Industry Internship. The faculty coordinator or mentor has to monitor the students' internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of internship.

Professional Elective-II

COMPUTER INTEGRATED MANUFACTURING(CIM)			
Subject Code	21ME711	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Course Objectives:

1. To impart knowledge of CIM and analysis.
2. To make students to understand the CNC Machine and its Tools, CNC part programming.
3. To expose students to Transfer mechanisms and automated flow lines.
4. To expose students to Material handling and storage systems.
5. To introduce the students to the concepts of computerized manufacturing planning and quality control

Modules	Teaching Hours
Module –I **COMPUTER INTEGRATED MANUFACTURING**: Introduction of CIM, CIM hardware and software, Role of the Elements of CIM system, Product development cycle, Sequential and concurrent engineering, Soft and hard prototyping. **FINITE ELEMENTAL MODELING AND ANALYSIS IN CIM:** Introduction ,General steps involved in FEM, Types of analysis, element and load types, simple numerical problems**.**	08 Hours
Module –II **COMPUTER NUMERICAL CONTROL:** Basic components of NC , Concepts of CNC , DNC, machining centers and their advantages. CNC tooling-turning tool geometry ,milling tooling system, tool presetting, work holding devices **CNC PROGRAMMING:** Steps involved in development of a part program, Manual part programming for turning, milling and drilling operations.	09 Hours
Module –III **HIGH VOLUME PRODUCTION SYSTEM:** Work part transport - continuous, Intermittent ,synchronous .Transfer mechanisms -linear-Walking beam, roller ,Chain drive, Rotary -Rack and pinion, ratchet and pawl, Geneva wheel. buffer storage, control functions. **ANALYSIS OF AUTOMATED FLOW LINE:** General terminology and analysis, Analysis of transfer line without storage, upper bound approach, lower bound approach, analysis of transfer lines with storage buffers and simple problems.	09 Hours
Module –IV **AUTOMATED MATERIAL HANDLING AND STORAGE:** Material handling functions, overview of metal handling equipment, Material handling analysis, Design of system, conveyor system, automated guided vehicle system, automated storage/ retrieval systems, carousel storage systems, Work in process storage .	08 Hours
Module –V **COMPUTERIZED MANUFACTURING PLANNING SYSTEM:** Computer-aided process planning: retrieval and generative type, material requirement planning, Capacity planning, Group technology: part family, parts classification and coding system. **COMPUTER AIDED QUALITY CONTROL:** Inspection methods, non-contact inspection methods, machine vision system, optical inspection method, coordinate measuring machine, computer aided testing.	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.

2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Automation, Production Systems and Computer-Integrated Manufacturing. Mikell P Groover 4th Edition,2015.
2. CAD / CAM Principles and Applications P N Rao Tata McGraw-Hill 3rd Edition, 2015.
3. CAD/CAM/CIM Dr. P. Radhakrishnan New Age International Publishers, New Delhi. 3rd edition

Reference Books:

1. CAD/CAM -Zimmers & Grover-PHL
2. CAD/CAM zeild-Mc-Graw Hill-2005.

E books and online course materials:

At the end of the course students will be able to:

CO	Course Outcomes
CO1	Evaluate the implementation of CIM in manufacturing and analysis.
CO2	Describe the concept of CNC and being able to develop part programs for simple jobs.
CO3	Analyse the various transfer techniques and investigate the automated flow lines.
CO4	Recognise different material handling and storage systems.
CO5	Learn modern manufacturing trends such as CAPP, GT, and CAQC.

MECHATRONICS

Subject Code	21ME712	Credits: 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

Course Objectives:

1. To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
2. To understand the evolution and development of Mechatronics as a discipline.
3. To substantiate the need for interdisciplinary study in technology education
4. To understand the applications of microprocessors in various systems and to know the functions of each element.
5. To demonstrate the integration philosophy in view of Mechatronics technology
6. To be able to work efficiently in multidisciplinary teams.

Modules	Teaching Hours
MODULE-I **Introduction:** Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine. **Transducers and sensors:** Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.	09 Hours
MODULE-II **Signal Conditioning:** Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods. **Electro Mechanical Drives:** Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.	08 Hours
MODULE-III **Microprocessor & Microcontrollers:** Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.	08 Hours

MODULE-IV **Programmable Logic Controller:** Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application. **Application of PLC control:** Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.	09 Hours
MODULE-V **Mechatronics in Computer Numerical Control (CNC) machines**: Design of modern CNC machines - Machine Elements: Different types of guide ways, Linear Motion guideways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. **Mechatronics Design process:** Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Mechatronics-Principles Concepts and Applications Nitaigour Premchand Mahalik ata McGraw Hill 1stEdition 2003
2. Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering, W.Bolton Pearson Education 1stEdition, 2005

Reference Books:

1. Mechatronics HMT Ltd Tata Mc Graw Hill 1st Edition, 2000 ISBN:978007 4636435
2. Mechatronics: Integrated Mechanical Electronic Systems K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram. Wiley India Pvt. Ltd. New Delhi,2008
3. Introduction to Mechatronics and Measurement Systems David G. Aldatore, Michael B. Histand McGraw-Hill Inc USA,2003
4. Mechatronics System Design Devdas Shetty, Richard A. Kolk Cengage publishers. second edition

At the end of the course students will be able to:

CO	Course Outcomes
CO1	Illustrate various components of Mechatronics systems.
CO2	Assess various control systems used in automation.
CO3	Design and conduct experiments to evaluate the performance of a mechatronics system or component with respect to specifications, as well as to analyse and interpret data.
CO4	Apply the principles of Mechatronics design to product design.
CO5	Function effectively as members of multidisciplinary teams.

EXPERIMENTAL STRESS ANALYSIS			
Subject Code	21ME713	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: Student should have the basic knowledge of physics and behavior of materials.

Course Objectives:

1. To use the method of electrical strain gauges to study and characterize the elastic behavior of solid bodies.
2. To measure displacement and perform stress strain analysis of mechanical systems using electrical resistance strain gauges.
3. To describe the photo elastic method to study and characterize the elastic behavior of solid bodies.
4. To determine stress strain behavior of solid bodies using methods of coating
5. To conduct stress strain analysis of solid bodies using the methods Holography

Modules	Teaching Hours
MODULE-I **Introduction:** Definition of terms, Calibration, Standards, Dimension and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause and types of experimental errors. General consideration in data analysis. **Electrical Resistance Strain Gages:** Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Whetstone's bridges, Constant current circuits.	08 Hours
MODULE-II **Strain Analysis Methods:** Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gauge, stress intensity factor. Force, **Torque and strain measurements:** Mass balance measurement, Elastic element for force measurements, torque measurement.	08 Hours
MODULE-III **Photoelasticity:** Nature of light, Wave theory of light - optical interference, Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinic's & Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photo elastic model materials. **Two-Dimensional Photoelasticity:** Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo elastic model materials, Materials for 2D photoelasticity.	08 Hours
MODULE-IV **Three-Dimensional Photo elasticity:** Stress freezing method, Scattered light photoelasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses. **Photo elastic (Birefringent) Coatings:** Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson's, Stress separation techniques: Oblique incidence.	10 Hours

MODULE-V	
Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications. **Moire Methods:** Moire fringes produced by mechanical interference. Geometrical approach, Displacement field approach to Moire fringe analysis, 0ut of plane displacement measurements, out of plane slope measurements. Applications and advantages.	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Experimental Stress Analysis, Dally and Riley, McGraw Hill.
2. Experimental Stress Analysis, Sadhu Singh, Khanna publisher.
3. Experimental stress Analysis, Srinath L.S TaTa Mc Graw Hill.

Reference Books:

1. Photoelasticity Vol I and Vol II, M.M.Frocht, John Wiley & sons.
2. Strain Gauge Primer, Perry and Lissner,
3. Photo Elastic Stress Analysis, Kuske, Albrecht & Robertson John Wiley & Sons.
4. Motion Measurement and Stress Analysis, Dave and Adams,
5. Holman, Experimental Methods for Engineers, Tata McGraw-Hill Companies, 7th Edition, New York, 2007.
6. B. C. Nakra and K. K. Chaudhry, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Companies, Inc, New York, 7th Edition, 2006.

E books and online course materials:

Course outcomes: On completion of the course, the student will have the ability to:

CO	Course Outcome (CO)
CO1	Impart basic knowledge of the elastic behavior of solid bodies
CO2	Ability to understand the stress and strain gauges.
CO3	Apply photo-elastic methods in whole field stress analysis of solids
CO4	Discuss experimental investigations by predictions by other methods.
CO5	Describe various coating techniques

QUALITY ASSURANCE AND RELIABILITY			
Subject Code	21ME714	Credits: 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:
Student should have knowledge of Industrial management, Statistics and probability, reliability.

Course Objectives:

1. To learn the fundamentals of Quality tools, techniques and quality production.
2. To have knowledge the quality and reliability tools and techniques to solving real world problems related to industry.
3. Learn to achieve reliability with cost related aspects.

Modules	Teaching Hours
MODULE-I **Basic Concepts of Quality:** Definition of Quality, Factors of quality, Quality of Design, Quality of conformance, Quality of performance. Objectives of quality control and its characteristics. **Statistical Quality Control and Cost of Quality:** Introduction to Statistical Quality control (SQC), types and its benefits. Cost of quality Categories, optimum cost of performance, Economics of quality design, specification of quality.	08 Hours
MODULE-II **Concepts in Probability:** Events, Sample space, Laws of probability (Addition law of probability, Multiplication law of probability and law of Conditional probability) Numerical. **Probability Distributions:** Discrete and Continuous Distributions, Binomial Distributions, Poisson Distributions, Normal Distributions, Weibull Distribution, Numerical.	09 Hours
MODULE-III **Statistical Aspects and Control Charts:** Statistical Tools in Quality control Control charts for Variable, Procedure, Interpretation and analysis using X-chats, R-Charts, Process capacity estimation, and Process improvement. Numerical **Control Charts for Attributes:** Practical limitation of the control charts for variables, Definition of fraction defective(p), Comparison of X and R charts with P-chart, control limits (3σ limits) on p Chart, Choice between p- chart and np-chart. Numerical.	09 Hours

MODULE-IV **Reliability:** Definition, basic elements and Achievements, Methods for improving Design Reliability and tests. **Failure Data Analysis:** Failure data, MTTF, MTBF, Bathtub curve, Mean life, life Testing, Introduction to failure Mode and effect Analysis. Numerical.	08 Hours
MODULE-V **System Reliability:** Probability of survival of series system and parallel redundant system. Numerical**.** **Maintainability and availability:** Maintainability Engineering, Designing for Maintainability, Maintainability Assurance, Availability, Equipment Availability, MTBF and MTTF trade-off, Numerical.	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Halpern, Seigmund (1978), The Assurances Sciences, Prentice Hall International,New Jersy, USA
2. M Mahajan. (2015) Statistical Quality Control.
3. Juran, I.M and Gryna, F. M (1982), Quality planning and Analysis Tata Mc Graw Hill Publishing Company Ltd, New Delhi, India

Reference Books:

1. Balachandra, Benjamin S (1986), Logistics Engineering and Management prentice Hall International, New Jersey, USA
2. Kraus, John W (1988), Maintainability and Reliability Hand Book of Reliability
3. Engineering and Management, Editors –Ireson.W.G. and Cooms. CF McGraw hill Books Company Inc. USA
4. Srinath KS (1985), Concepts in Reliability Engineering Affiliated East West Press Private Limited, New Delhi, India.

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

CO	Course Outcome (CO)
CO1	Knowledge of production processes and assurance Science of quality products
CO2	Implement Laws of probability and Probability Distributions
CO3	Interpret and represent the control charts according to the Specified specialization that meet the requirements.
CO4	Apply and analyze the appropriate technique of Reliability to understand the impact of applications in the industry.
CO5	Evaluate of system Reliability and illustrate Maintainability Engineering.

ALTERNATE FUELS			
Subject Code	21ME715	Credits: 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: Basic concept of Engineering Chemistry, Thermodynamics and Fluid mechanics.

Course Objectives:

1. To explain the importance of alternate fuels, their availability, properties and to delineate the types of them.
2. To analyze and apply the effects of use of alcohols on Performance and Emission in SI and CI engines.
3. To modify SI and CI engines which use CNG, LPG, H2, Biogas as fuels, to analyze Performance and Emission Characteristics of them.
4. To test the Performance and Emission parameters of Vegetable oils and Bio-diesels on CI engines.
5. To examine different energy sources available for hybrid engines and to explain with sketches ECS, Fuel cell and Batteries.

Modules	Teaching Hours
MODULE-I **Introduction:** Need for alternate fuel, availability and properties of alternate fuels, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, merits and demerits of various alternate fuels, introduction to alternate energy sources. Like EV, hybrid, fuel cell and solar energy.	**08 Hours**
MODULE-II **Alcohols:** DME, DEE and their blends and their effects on performance of SI and CI engines and Combustion and Emission characteristics related numerical problems.	**08 Hours**
MODULE-III **Natural Gas, LPG, Hydrogen and Biogas:** modification required in engines, Performance and Emission Characteristics of CNG, LPG in SI and CI engines, Hydrogen as fuel, its storage, handling, performance and safety.	**10 Hours**
MODULE-IV **Vegetable Oils:** Various vegetable oils for engines, esterification, performance in engines, performance and emission characteristics, biodiesel and its characteristics.	**08 Hours**
MODULE-V **New Generation Energy Sources (NGES):** Energy sources for hybrid engines, advantages and limitations, required system components and Electronic Control Systems (ECS), for use of NGES in engines, High energy and power density batteries, fuel cell.	**08 Hours**

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Alternative Fuels Guide Book, Richard L. Bechfold, SAE International Warren dale - 1997
2. Energy Today & Tomorrow, Maheswar Dayal, I & B Horsier India - 1982.

Reference Books:

1. Power Plant Engineering, Nagpal, Khanna Publishers - 1991.
2. Alcohols as motor fuels progress in technology, Series No.19, SAE Publication USE - 1980.

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Explain the importance of alternate fuels, their availability, properties and to delineate the types of them.
CO2	Analyze and apply the effects of use of alcohols on Performance and Emission in SI and CI engines.
CO3	Modify SI and CI engines which use CNG, LPG, H2, Biogas as fuels, to analyze Performance and Emission Characteristics of them.
CO4	Evaluate the Performance and Emission parameters of Vegetable oils and Bio-diesels on CI engines.
CO5	Examine different energy sources available for hybrid engines and to explain with sketches ECS, Fuel cell and Batteries.

Professional Elective-III

ENERGY ENGINEERING			
Subject Code	21ME721	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite : The Energy Engineering major interweaves the fundamentals of classical and modern physics, chemistry, and mathematics with energy engineering applications.

Course Objectives:

1. To Define and understand steam power plant machinery and process.
2. To Understand the functioning of boiler accessories, natural, forced and balanced draft systems.
3. To Understand the diesel engine power plant, accessories and layout.
4. To Define and understand the cogeneration, hydroelectric, gas turbine power plants, accessories and Layouts.
5. To Define and understand nuclear power plant fundamentals, nuclear fuels-use and disposal of nuclear waste.
6. To Understand and analyze the power plant economics as well as performance.

Modules	Teaching Hours
Module –I **Steam Power Plant:** Layout of steam power plant, different types of fuels used for steam generation, Equipment of burning (overfeed and underfeed stokers), Burners (long flame, turbulent flame, tangential, cyclone burners),unit system and bin system. Pulverised fuel furnaces (No numericals). **Coal, Ash Handling and Different Types of Boilers:** Coal and Ash handling, Generation of steam using forced circulation, high and supercritical pressures, A brief account of LaMount, Benson, Velox, and Loeffer steam generators (No numericals).	08 Hours
Module –II **Chimneys:** Types of chimneys (Natural, forced, induced and balanced draft) Calculations involving height of chimney to produce a given draft (Numerical). **Accessories for the Steam Generator Cooling Towers and Ponds:** Air Pre-heaters Study of different types of cooling towers and ponds. Accessories for the Steam Generator such as super-heaters, de-super heater, Re heaters, Economizers (No numericals).	08 Hours
Module –III **Diesel Engine Power Plant:** Layout of a diesel power plant. Method of starting diesel engines, cooling and lubrication system for the diesel engine. Filters, centrifuges, Oil heaters, Intake and exhaust system. Advantages and disadvantages of the diesel power plant. (No numericals) **Nuclear Power Plant:** Principles of release of nuclear energy fusion & fission reactions. Nuclear fuels used in the reactors. Radiation hazards, Shieldings, Radio active waste disposal, Nuclear reactors and its types (PWR, BWR, HGR,GCR, LMCR, Fast Breeder reactor) Site selection criteria area. (No numericals).	08 Hours

Module –IV **Hydro-Electric Plants:** Storage and pondage, flow duration and mass curves, hydrographs, Low, medium and high head plants, pumped storage plants, Penstock, water hammer, surge tanks, gates and valves, power house, general layout. A brief description of some of the important Hydel Installations in India (Numerical). **Gas Turbine Power Plant:** Advantages & Disadvantages of the gas turbine plant, Open & closed cycle turbine plants with the accessories. Multi stage expansion and multi stage compression Different methods of improving efficiency (Reheat regeneration and inter cooling) (No numericals)	09 Hours
Module –V **Choice of Site for Power Station:** Load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, Effect of variable load on power plant, selection of the number and size of units (Numerical). **Economic Analysis of Power Plant:** Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants, tariffs for electrical energy (Numerical).	09 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Power plant Engineering, P.K Nag, Tata Mc Graw Hill.
2. Power Plant Engineering, Er.R K Rajput Laxmi Publications (P) Ltd. New Delhi.
3. Power Plant Engineering, G.R.Nagpal, Khanna Publishers, 2006

Reference Books:

1.Power plant Engineering, F.T Morse, Van Nostrand.
2. Power Plant Engineering, Dhomakundawar, Dhanpath Rai sons. 2003
3. Power Plant Technology, M.M.Wakil, Tata Mc Graw Hill Publishers, 2nd Edition

At the end of the course students will be able to:

CO	Course Outcomes
CO1	Identify and choose the various components needed for a steam power plant.
CO2	Interpret the various accessories and auxiliaries for steam power plants.
CO3	Choose the diesel engine and nuclear power plant fundamentals required for the geographical area.
CO4	Analyze power plant layout for a hydroelectric and gas turbine power plant.
CO5	Predict the usage of base load and peak load plant and analyze, Interpret the power plant economics and recommend solutions.

FLEXIBLE MANUFACTURING SYSTEMS			
Subject Code	21ME722	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

Course Objectives:

1. To impart knowledge of FMS
2. To make students to understand the Numerical control Machining centers.
3. To expose students to Industrial robotics and Tool management.
4. To expose students to FMS hardware and software systems.
5. To introduce the students to the concepts of JIT in Production system.

Modules	Teaching Hours
MODULE-I **INTRODUCTION** :- Definition, Basic components of FMS , Levels of manufacturing flexibility, Different types of FMS , FMS Layout configurations, Objectives of FMS , Advantages and disadvantages of FMS.FMS Planning and Design Issues and operational issues.	08 Hours
MODULE-II **MANUFACTURING CELL**: - Introduction, classification of cell, Unattended machining, Differences between FMC AND FMS. **MACHINING CENTERS**: - Introduction to machining centers, classification, numerical control machining centers, NC Turning center. Deburring, types of Automated Deburring, wash stations, classification of wash stations.	09 Hours
MODULE-III **INDUSTRIAL ROBOTICS**: - Robot anatomy, Robot control systems, sensors in robotics, industrial robot applications. **CUTTING TOOLS AND TOOL MANAGEMENT**: - Introduction to cutting tools, control of cutting tools, Role of Tool management in FMS, Tool monitoring and fault detection.	09 Hours
MODULE-IV **FMS SYSTEM HARDWARE AND SOFTWARE STRUCTURE**: - General structure and requirements, Introduction to PLC, components of PLC and PLC programming. FMS installation and implementation, acceptance testing.	08 Hours
MODULE-V **JIT AND KANBAN SYSTEM**: - Lean production system, Introduction to Just-in-Time (JIT) Production system, Goals of JIT, Benefits of JIT, Principal Objectives of JIT, Error Prevention, Introduction to Kanban system, types of Kanban.	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Shivanand H.K., Benal MM, Koti V, "Flexible Manufacturing System", New age international (P)Limited, New Delhi, 2006

Reference Books:

1. Mikell P. Groover "Automation, Production Systems and Computer Integrated Manufacturing",
2. PHI, 2008.
3. Kalpakjin, "Manufacturing Engineering and Technology ", AddisonWesley Publishing Co., 1995.

Course outcomes:

On completion of the course, the student will have the ability to:

CO	Course Outcome (CO)
CO1	Discuss the role of FMS in manufacturing systems.
CO2	Describe the concept of NC machining centers and Automated Deburring operations.
CO3	Role of Industrial robotics in manufacturing systems and tool management.
CO4	Recognize various FMS Hardware and software systems.
CO5	Understand the importance JIT methods in Manufacturing systems.

CRYOGENIC			
Subject Code	21ME723	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

Course Objectives:

1. To understand cryogenic system and gas liquefaction system
2. To analyze gas cycle cryogenic refrigeration system
3. To Comprehend gas separation and gas purification system
4. To have detailed knowledge of vacuum technology, insulation, storage of cryogenic liquids
5. To study applications of cryogenics and to embark on cryogenic fluid

Modules	Teaching Hours
MODULE-I **Introduction to Cryogenic Systems:** Cryogenic propellants and its applications, liquid hydrogen, liquid nitrogen, and liquid Helium. The thermodynamically Ideal system Production of low temperatures – Joule Thompson Effect, Adiabatic expansion. **Gas Liquefaction Systems:** Liquefaction systems for Air Simple Linde –Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System. Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of liquefaction systems.	08 Hours
MODULE-II **Gas Cycle Cryogenic Refrigeration Systems:** Classification of Cryo coolers, Stirling cycle Cryo – refrigerators, Ideal cycle – working principle. Schmidt's analysis of Stirling cycle, Various configurations of Stirling cycle refrigerators, Integral piston Stirlingcryo-cooler, Free displacer split type StirlingCryo coolers, Gifford McmahonCryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators.	08 Hours
MODULE-III **Gas Separation and Gas Purification Systems:** Thermodynamic ideal separation system, Properties of mixtures, Principles of gas separation, Linde single column air separation. Linde double column air separation, Argon and Neon separation systems. **Ultra Low Temperature Cryo – Refrigerators:** Magneto Caloric Refrigerator 3He-4He Dilution refrigerator. Pomeranchuk cooling. Measurement systems for low temperatures, Temperature measurement at low temperatures, Resistance thermometers, Thermocouples, Thermistors, Gas Thermometry. Liquid level sensors.	08 Hours

MODULE-IV **Vacuum Technology :** Vacuum Technology: Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level. Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Composite insulation	08 Hours
MODULE-V **Cryogenic Fluid Storage And Transfer Systems**: Design of cryogenic fluid storage vessels, Inner vessel, Outer Insulation, Suspension system, Fill and drain lines. Cryogenic fluid transfer, External pressurization, Self pressurization, Transfer pump. **Application of Cryogenic Systems:** Cryogenic application for food preservation – Instant Quick Freezing techniques Super conductive devices, Cryogenic applications for space technology. Application of cryogenic systems, super conducting devices, space technology, cryogenic in biology and medicine.	10 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Cryogenic Systems – R.F. Barron
2. Cryogenic Engineering – R.B. Scott – D.VanNostrand Company, 1959

Reference Books:

1. Cryogenic Process Engineering – K.D. Timmerhaus and T.M. Flynn, Plenum Press, New York,1989
2. High Vacuum Technology – A. Guthree – New Age International Publication
3. Experimental Techniques in Low Temperature Physics – G.K. White – Osford University Press,

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

CO	Course Outcome (CO)
CO1	To be able to understand the cryogenic system.
CO2	To have complete knowledge of cryogenic refrigeration system
CO3	To be able to design gas separation and gas purification system
CO4	To able to solve the problem in , insulation, storage of cryogenic liquids
CO5	To be able to apply cryogenic in various areas and to be able take up research in cryogenics

PROJECT MANAGEMENT			
Subject Code	21ME724	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisites of the course:
Student should have knowledge of Operations Management and Basic knowledge of accounting

Course Objectives:

1. To make them understand the concepts of Project Management for planning to execution of projects.
2. To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
3. Make them capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.

MODULES	Teaching Hours
MODULE-I **CONCEPTS OF PROJECT MANAGEMENT:** concepts of project, categories of project, phase of project life cycle, role and responsibilities of project leaders, tool and techniques for project management. **PROJECT PLANNING:** feasibility report phased planning, project planning steps, objectives and the goals of the project.	08 Hours
MODULE-II **ESTIMATING**: preparation of cost estimation, evaluation of the project profitability, financial analysis. **PROJECT ORGANIZING:** project organization and types, accountability in project organization.	07 Hours
MODULE-III **STAFFING THE PROJECT TEAM:** skills /abilities required for project manager, authorities and responsibilities of project manager, tendering and selection of contractors. **PROJECT SCHEDULING:** project implementation scheduling, effective time management, and different scheduling and resources allocation methods, Machine loading and sequencing: Johnson's rule	08 Hours
MODULE-IV **TOOLS AND TECHNIQUES OF PROJECTS MANAGEMENT:** bar chart (Gantt chart), bar chart for combined activates, logic diagrams and networks, project evaluation and review techniques (PERT), planning computerizes project management. **CO-ORDINATION AND CONTROL:** Project Direction communication in a project, MIS project co-ordination, project controls requirement for project or role of MIS in project controls, performance controls, schedule control, cost controls,	09 Hours

MODULE-V	
PERFORMANCE MEASURES & NETWORK ANALYSIS: Performance Indicators, Network analysis and network diagram, Computation of project completion time (Forward pass and backward pass), CPM, Computation of float, Difference between PERT and CPM, Probabilistic time estimates, probability of project completion by a target date.	10 Hours

Question paper pattern:

Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
Five full questions are to be answered choosing at least one from each MODULE.
Each question should not have more than 4 sub divisions.

Text books:

1. Chaudhary S.; Project Management, Tata Mc Graw Hill
2. Prasanna Chandra; Projects- Planning, Analysis, Selection, Financing, Implementation and Review', I Edition, Tata Mc Graw Hill, 8th Edition 2015.

Reference Books:

1. Kerzner H.; Project Management, II Edition, CBS Publishers
2. Meredith Jack R., Mantel Samuel J.; Project Management, IV Edition, John Wiley & Sons
3. Gopalakrishnan P., Ramamurthy V.E; Textbook of Project Management, MacMillan Publishers
4. Maylor Harvey, Project Management, MacMillan Publishers
5. Matheen A. Prof., Comprehensive Project Management, Laxmi Publications (P) Ltd.
6. Project Management,Gopalan, Wiley India
7. A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Ed, Project Management Institute PA, USA
8. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Course outcomes: On completion of the course, the student will have the ability to

COs	**Course Outcomes**
CO1	Describe and identify the projects of different categories, phases of product life cycle, tools and techniques for project management.
CO2	Organize the staff and prepare project teams and define the goals of the project and understand the concepts of project planning and estimation.
CO3	Schedule the project, identify the performance indicators and measure the performance of a project.
CO4	Coordinate and control the project activities.
CO5	Write work break down structure for a project and develop a schedule based on it.

RAPID PROTOTYPING AND MODELLING			
Subject Code	21ME725	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

Course Objectives:

1.Understand technology used in rapid prototyping and tooling.
2.Recognized importance of rapid prototyping in advance manufacturing process.
3.Acquire knowledge, techniques and skills to select relevant rapid prototyping and tooling process.
4.Comprehend the potential of rapid prototyping and tooling in different industrial sectors.
5.Illustrated 3D printing technology for Rapid prototyping and Modeling

Modules	Teaching Hours
MODULE-I **Introduction:** Evolution, basic principle, concept, procedure and need of rapid prototyping and tooling, Classification of rapid prototyping and tooling processes (Additive/Subtractive/Deformative), Classifications of materials used for Rapid prototyping and tooling, Industrial applications of rapid prototyping and tooling, Most commonly used processes for rapid prototyping.	08 Hours
MODULE-II **Processes used for rapid prototyping and modeling:** Stereolithography Apparatus (SLA), Fused Deposition Modeling (FDM), Selective Deposition Lamination (SDL), Laminated Object Manufacturing (LOM), Ultrasonic Consolidation, Laser Engineered Net Shaping (LENS), Electron Beam Free Form Fabrication (EBFFF), Selective Laser Sintering (SLS), Electron Beam Melting (EBM). Convectional Tooling vs Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect rapid tooling methods.	10 Hours
MODULE-III **CAD for rapid prototyping and modeling:** Preparation of 3D-CAD model in STL format, Reverse engineering, Reconstruction of 3D CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and generation of codes for tool path.	08 Hours
MODULE-IV **Constructions of manipulator systems for rapid prototyping and modeling:** Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors, Energy delivery systems, Material delivery systems.	08 Hours
MODULE-V **Post processing in rapid prototyping and modeling:** Support material removal, Surface texture improvement, Accuracy improvement, Aesthetic improvement, Property enhancements using non-thermal and thermal techniques. 3D printing: Introduction, process parameters involved, advantages and Disadvantages.	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. 1.Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
3. 3. Ian Gibson, "Software Solutions for Rapid Prototyping", Professional Engineering Publishing Limited, UK, 2002.

Reference Books:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A toolbox for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

E books and online course materials:

Course outcomes:

On completion of the course, the student will have the ability to:

CO	Course Outcome (CO)
CO1	Explain rapid prototyping and tooling for manufacturing complex geometries.
CO2	Identify and solve problems related to rapid prototyping and modeling.
CO3	Select suitable process and materials for rapid prototyping and modeling
CO4	Distinguish technique of CAD and reverse engineering for geometric transformation in rapid prototyping and modeling.
CO5	Determine part orientation, apply suitable slicing algorithm and generate tool path for minimum build time.

Open Elective-II

NON-CONVENTIONAL ENERGY SOURCES			
Subject Code	21ME73OE1	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: Should have knowledge of energy sources and their utilization.

Course Objectives:

1. Understand energy scenario, energy sources and their utilization.
2. Learn about energy conversion methods and their analysis.
3. Study the principles of renewable energy conversion systems.
4. Understand the concept of green energy and zero energy.

Modules	Teaching Hours
MODULE-I **Introduction:** Energy Source, India's production and reserves of commercial energy sources, need for non-conventional energy sources, energy alternatives, solar, thermal, photovoltaic, water power, wind, bio-mass, ocean temperature difference, tidal and waves, geothermal, tarsands and oil shale, nuclear (Brief description); advantages and disadvantages, comparison (Qualitative and Quantitative). **Solar Radiation:** Extra – Terrestrial radiation, spectral distribution of extra terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. Measurement of solar radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working.	09 Hours
MODULE-II **Photovoltaic Conversion:** Description, principle of working and characteristics, applications. **Solar Thermal Conversion:** Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, power generation, and refrigeration. Distillation solar pond, principle of working, operational problems.	09 Hours
MODULE-III **Wind Energy** Properties of wing, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills, elementary design principles; coefficient of performance of a wind mill rotor, aerodynamic considerations of wind mill design. **Tidal Power:** Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidel energy, limitations.	08 Hours

MODULE-IV **Ocean Thermal Energy Conversion:** Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC. **Geothermal Energy Conversion :** Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.	08 Hours
MODULE-V **Energy From Bio Mass:** Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of bio-gas, problems involved with bio-gas production, application of bio-gas, application of bio-gas in engines, advantages. **Hydrogen Energy:** Properties of Hydrogen with respect to its utilization as a renewable from of energy, source of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, thermo chemical production and bio-chemical production. Storage and Transportation Methods: Gaseous, cryogenic and metal hydrides, application of hydrogen, domestic and industrial safe burning of hydrogen.	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. G.D Rai K, "Non conventional energy sources", Khanna publishers.2004, ISBN:9788174090737
2. Subhas P.Sukhatme, J K Nayak, "Solar energy", Tata Mc Graw Hill,India 3rd Edition. 2009, ISBN: 9780070142961

Reference Books:

1. N.K.Bansal, Manfred Kleeman and Mechael Meliss, "Renewable energy sources and conversion technology", Tata Mcgraw Hill, 2001. ISBN:9780074600238
2. John W.Twidell, Tony Weir, "Renewable energy resources" , Routledge, 4th edition, 2014, ISBN:9780415633581
3. Solar Power Engineering: P K Nag TMH.2003

Course outcomes:

On completion of the course, the student will have the ability to:

CO	Course Outcome (CO)
CO1	Students will be able to study concepts of various renewable energy systems
CO2	Identify renewable energy sources and their utilization
CO3	Discuss the basic concepts of solar radiation and analyze the working of solar PV and thermal systems.
CO4	Explain principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas.
CO5	Implement the concepts and applications of fuel cells, thermoelectric convertor and MHD generator methods of energy storage for specific applications.

NANOTECHNOLOGY			
Subject Code	21ME73OE2	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: Material science.	
Course Objectives: In this course students will learn about the basics of nanoscale science, types of materials, and their engineering applications and hazards.	
Modules	**Teaching Hours**
MODULE-I **INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY:** History, background and interdisciplinary nature of nano-science and nanotechnology, challenges of Rechard Feynman, scientific revolutions. Nano-size effect on surface to volume ratio. Atomic structure, Bohr atomic model, molecules and phases. Introduction to classical physics and quantum mechanics and importance of nanoscale materials and their devices.	08 Hours
MODULE-II **CLASSIFICATION OF NANOSTRUCTURES :** Zero dimensional, one-dimensional and two dimensional nanostructure materials - classification of solids: conductor, semiconductors, insulator, types of semiconductor, doping, diodes, current flow in semiconductors, ceramics and nanocomposites, quantum size effect(QSE) in 1D, 2D, 3D nanomaterials, quantum dots, nanowires, nanotubes, nanosheets, top down and bottom up approach.	08 Hours
MODULE-III **BIOMIMETICS AND BIOMATERIALS:** **Biomimetics**: Introduction, Industrial significance, Lessons from nature and applications, overview of various objects from nature and their selected functions, Lotus effect, Velcro effect, biologically inspired mechanisms, Biologically inspired structures and tools, biological materials. **Biomaterials:** Introduction, Classification of Biomaterials, Biomaterials as implant in human body, characterization of biomaterials.	08 Hours
MODULE-IV **INTRODUCTION TO NANOMATERIALS AND DEVICES:** Types of nanomaterials: Metal nanoparticles eg Au, Ag, Cu, Pt and their application as FETs. Metal oxide nanoparticles TiO2, ZnO, SnO2 and their application in solar cells, MEMS based gas sensors, Semiconducting Cadmium and Selenide quantum dots bio imaging, Carbon based nanomaterials and their applications in FETs, MOSFETS, sensors and actuators , Silicon based nanostructures and their application in single electron electronics used as tips for AFM and Field emission microscopy, magnetic and ceramics nanomaterials and their application.	10 Hours
MODULE-V **INTRODUCTION TO NANOTOXICOLOGY:** Nanomaterials pollution – Nanomaterials in Environment - Toxicology of Airborne – Effect of Nanomaterials in the environment. Safety and pollution Control techniques-handling, storage, packaging, transportation and disposal.	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Edward L. Wolf, "Nanophysics and Nanotechnology - An Introduction to Modern Concepts in Nanoscience" Second Edition, John Wiley & Sons, 2006.
2. Foundations of Nanoscale Science and Technology,Shareefraza J. Ukkund, Prasad Puthiyillam, LAP-Lambert Academic Publishing, Mauritius, 2018. ISBN: 978-613-958649-3
3. Nanotechnology – Basic Science & Emerging Technologies: 2002 by Michael Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, and Burkhard Raguse.
4. Nanoparticles technology: Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, First edition 2007, ISBN: 978-0-444-53122-3.

Reference Books:

1. Vladimir P. Torchilin (2006) Nanoparticulates as Drug Carriers, Imperial College Press.
2. M. Reza Mozafari (2007) Nanomaterials and Nanosystems for Biomedical Applications.
3. K.W. Kolasinski, "Surface Science: Foundations of Catalysis and Nanoscience", Wiley, 2002.
4. Biomimetics: lessons from nature – an overview by Bharath bhushan
5. Biomimetics—using nature to inspire human innovation Yoseph Bar-Cohen.

E books and online course materials:

Course outcomes: On completion of the course, the student will have the ability to:

CO	Course Outcome (CO)
CO1	Describe fundamentals of nanoscience and nanotechnology
CO2	Classify nano-structures;
CO3	Develop smart materials
CO4	Analyse biomaterials
CO5	Explain nanotoxicology

Open Elective-III

TOTAL QUALITY MANAGEMENT			
Subject Code	21ME74OE1	Credits : 03	CIE: 50
Number of Lecture Hours/Week	3 (Theory)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

Student should have knowledge of production process, utilization of men, machine, materials.

Course Objectives:

1. The aim of course to provides the knowledge of TQM, Benefits of TQM, and Contribution of Gurus.
2. Students learn role and characteristics of leaders.
3. Selectively choose Tools & Techniques of TQM.
4. To study product acceptance plan and supply.
5. To study the concept of supply chain management and Experimental design.

Modules	Teaching Hours
MODULE-I **Overview of Total Quality Management:** Introduction, Definition, Basic Approach, Contribution Of quality Gurus. Quality circle TQM frame work , Historical review, benefits of TQM, TQM organization. **Leadership:** characteristics of quality leaders, 14 Principles of Demings Philisopy, role of TQM Leaders, continuous processes improvement, Juran,s Triology, quality costs, 6- sigma.	08 Hours
MODULE-II **Tools and techniques of TQM:** Basic tools of TQM, Bench marking definition, types of benchmarking, processes of bench marking, advantages and pitfalls of benchmarking quality management systems .ISO-9000 series of standards, implementation and documentation of ISO_9000. Introduction of QFD and QFD process, TQM exemplatory organisation. Design of Failure Mode and Effect analysis [FMEA], process of FMEA.	10 Hours
MODULE-III **Product acceptance control:** Design of single sampling, double sampling and multiple sampling plan. Military STD 105, OC curve, AQL, LTPD, AOQL, Problems.(Intensive coverage with numerical problems). **Dodge-Roming System:** Introduction, Single sampling lot tolerance, Double sampling lot tolerance tables, Philips Standard sampling system, MIL-STD-105D (ABC standard), Sampling plan for normal inspection, Criteria normal to tightened inspection and re-qualification for normal Inspection. Problems.	10 Hours

MODULE-IV **Quality Circles:** Introduction, origin**,** Definition, Concept, Philosophical Basis of quality circles, Theory X, Theory Y, Characteristics, scope organization structure, Process of operation of quality circle, (for Knowledge of 7 basic problem solving tools or techniques)**.**	07 Hours
MODULE-V **Experimental Design:** Introduction, Design Matrix, Design matrix for two level(lower and Upper) or three level (Middle), Basics statistics, One factor design, two factor designs, t-test, F-test, Analysis of variance(Note: $F_{model} > F_{table}$ hence the model is adequate from table $F_{14,6,0.05} = 4.07$) orthogonal design Thaguchi's philosophy of quality engineering, loss function, simple problem. (Basic conceptual treatment).	08 Hours

Question paper pattern:

1. Total of Ten Questions with two from each MODULE to be set covering the entire syllabus.
2. Five full questions are to be answered choosing at least one from each MODULE.
3. Each question should not have more than 4 sub divisions.

Text books:

1. Total quality Management Dale H Berster field(etal) Pears education , Third edition Indian Reprint - 2004
2. TQM by K. Shridhar Bhat,pearson Education III, Edn I 2004,Himalya publishing
3. Statistical quality Control by Grant Levenworth (2000).

Reference Books:

1. Stastical quality control by Douglos C Mantego third editon Pearson Education -2006
2. A new American TQM for revolution in management:Sho- shiba, Alan Graham and,
3. David walder Productivity press Oregon-1990
4. Organizational excellence through TQM H Lal, New Age Publishers
5. Quality control and Total quality management-PL Jain TMH Publications company Ltd - 2001 New Delhi
6. Cocran WG, Cox GM, 'Experiment Design' 2nd edition, John Wiley & Sons, Inc.India 2000
7. Box GEP, Hunter JS, Statistics for experimenters, John Wiley & Sons Inc. USA 1978.

Course outcomes: On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Able to apply the knowledge of TQM and contribution of TQM gurus and strong fundamental role of quality leaders and characteristics of ethical and societal principles in the industry.
CO2	Identify and implement the tools and techniques like QFD, QFD process and FMEA, synthesis information in bench marking for continuous improvement.
CO3	Design solutions of acceptance sampling plan solving problems of AOQL and percent defective..
CO4	Function effectively individual and team work to supply chain management activities coordination and communication is very important.
CO5	Demonstrate the knowledge of design of experiments, Taguchi array method for research and consistent development and improvement.

PROJECT WORK			
Subject Code	21ME75	Credits : 10	CIE: 50
Number of Lecture Hours/Week	6 (Practical)		SEE: 50
Total Number of Lecture Hours	52		SEE Hours: 03

Course Objectives:

The students should be able to apply acquired knowledge of courses studied in engineering to identify, formulate, analyze, evaluate and provide solution to a technical problem in the field of mechanical engineering

Modules	Teaching Hours
SCHEME OF EVALUATION **Assessment** / **Marks** CIE I Evaluation (7th week) — 25 CIE II Evaluation (12th week) — 25 SEE — 50 **Total** — 100	52 Hours

Course outcomes:
On completion of the course, the student will have the ability to:

CO #	Course Outcome (CO)
CO1	Identify a problem from the available literature and societal needs.
CO2	Apply principles of mechanical engineering in designing and conducting experiments, date acquisition and interpretation towards meaningful analysis of identified problem.
CO3	Use their analytical, teamwork and leadership skills in designing and development of products and find solution
CO4	Apply advanced tools / techniques for solving the problem.
CO5	Prepare a detailed quality project report and present the work.

Ability Enhancement Course (Online) 8 weeks				
Subject Code	21XXL76	Credits	02	CIE: ---
				SEE: ---

B.E VIII SEM

TECHNICAL SEMINAR (21MES81): The objective of the seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas. Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the programme of Specialization.

i) Carry out literature survey, systematically organize the content.
ii) Prepare the report with own sentences, avoiding a cut and paste act.
iii) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
iv) Present the seminar topic orally and/or through PowerPoint slides.
v) Answer the queries and involve in debate/discussion.
vi) Submit a typed report with a list of references.

The participants shall take part in the discussion to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Evaluation Procedure:

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question-and-answer session, and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three teachers from the department with the senior-most acting as the Chairman.

Marks distribution for CIE of the course:

Seminar Report:50 marks
Presentation skill:25 marks
Question and Answer: 25 marks.
No SEE component for Technical Seminar

21MEI82 Research Internship/ Industry Internship/Rural Internship

Research internship: A research internship is intended to offer the flavour of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research.

Industry internship: Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints.

Rural internship: A long-term goal, as proposed under the AICTE rural internship programme, shall be counted as rural internship activity. The student can take up Interdisciplinary Research Internship or Industry Internship. The faculty coordinator or mentor has to monitor the students' internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of internship.