P D A College of Engineering

B.E. in Respective branch Name

Scheme of Teaching and Examinations 2022

Outcome Based Education(OBE) and Choice Based Credit System(CBCS)

VII SEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	IPCC	22ME71	Hydraulics and Pneumatics	TD- Respective Dept. PSB- Respective Dept.	3	0	2		03	50	50	100	4
2	IPCC	22ME72	Computer Integrated Manufacturing	TD- Respective Dept. PSB- Respective Dept.	3	0	2		03	50	50	100	4
3	PCC	22ME73	Energy Engineering	TD-Respective Dept. PSB- Respective Dept.	4	0	0		03	50	50	100	4
4	PEC	22ME74x	Advanced Foundry Technology/PM	TD-Respective Dept. PSB- Respective Dept.	3	0	0		03	50	50	100	3
5	OEC	22MEOE75x	Non Conventional Energy Sources/TQM	TD-Respective Dept. PSB- Respective Dept.	3	0	0		03	50	50	100	3
6	PROJ	22MEP76	Major Project Phase-II	TD-Respective Dept. PSB- Respective Dept.	0	0	12		03	50	50	100	6
										300	**300**	**600**	**24**

Professional Elective Course

22ME741	Advanced Foundry Technology	22ME743	Nano Technology
22ME742	Cryogenics	22ME744	Project Management

Open Elective Course

22MEOE751	Non Conventional Energy Sources	22MEOE753	Total Quality Management
22MEOE752	Rapid Prototyping and Modelling	22MEOE754	Vehicle Dynamics

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **PEC**: Professional Elective Course, **OEC**: Open Elective Course PR: Project Work, **L:**Lecture,**T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. **TD-** Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work

Note: VII and VIII semesters of IV years of the program swapping facility

Institutions can swap the VII and VIII Semester Schemes of Teaching and Examinations to accommodate research internships/industry internships after the VI semester

P D A College of Engineering

B.E. in Respective branch Name

Scheme of Teaching and Examinations 2022

Outcome Based Education(OBE) and Choice Based Credit System(CBCS)

VIII SEMESTER (Swappable VII and VIII SEMESTER)

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board(PSB)	Teaching Hours/Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self-Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PEC	22ME81X	**Professional Elective-IV (Online Courses) –NPTEL**	TD-Respective Dept. PSB- Respective Dept.	3	0	0		03	50	50	100	3
2	OEC	22MEOE82X	**Open Elective-III (Online Courses)**	TD-Respective Dept. PSB- Respective Dept.	3	0	0		03	50	50	100	3
3	INT	22MEINT83	**Internship(Industry/Research)(14-20weeks)**	TD-Respective Dept. PSB- Respective Dept.	0	0	12		03	100		100	10
										200	**100**	**300**	**16**

Professional Elective Courses (Online courses)

22ME811	Advanced Materials and Processes	22ME814	Automation in Manufacturing
22ME812	Industrial Safety and Fire safety Management	22ME815	Design of Mechatronics System
22ME813	Fundamentals of Artificial Intelligence	22ME816	Hydrogen Energy: Production, Storage, Transportation and Safety

Open Elective Courses(Online Courses)

22MEOE821	Engineering Aspects of Bio fuels and Biomass conversion Technologies	22MEOE824	Basic Apparel Industry and Entrepreneurship
22MEOE822	Artificial Intelligence and Machine Learning in Materials Engineering	22MEOE825	Ergonomics Research Techniques
22MEOE823	Cyber security, tools, techniques and counter measures	22MEOE826	Electro Chemical and Econmic Aspects of Hydrogen Energy

L:Lecture, **T**:Tutorial, **P**:Practical **S=SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation.**TD-**Teaching Department, **PSB**: Paper Setting department, **OEC**: Open Elective Course, **PEC**: Professional Elective Course. **PROJ**: Project work, **INT**: Industry Internship/Research Internship/Rural Internship.

Professional Elective/Open Elective Course: These are the ONLINE courses suggested by the respective Board of Studies

Online Professional Course: The students need to register (anywhere between VI to VIII Semesters) NPTEL Course of 12 weeks duration (3 Credits course) and should pass the examination. The NPTEL Courses relevant to the program and need to be identified by the department and same is to be informed to the students.

Online Open Elective Course: The students need to register (anywhere between VI to VIII Semesters) NPTEL Course of 12 weeks duration (3 Credits course) and should pass the examination. The NPTEL Courses that enables skill enhancements and job opportunities need to be suggested by the department and same is to be informed to the students.

HYDRAULICS AND PNEUMATICS		
Subject Code	**22ME71** I **Credits: 04**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory) + 2(Practical)**	**SEE: 50**
Total Number of Lecture Hours	**42**	**SEE Hours: 03**

PREREQUISITE: 1. Fundamental understanding of Physical laws like Pascal's law and others.
2. Knowledge of power transmission methods like electrical and mechanical and others.
3. Logic thinking capabilities.

COURSE OBJECTIVES:

1. The course elaborates principles of Hydraulic and Pneumatic devices.
2. Gives an overview of control systems associated with Hydraulic and Pneumatic applications.
3. Imparts know how analysis of Circuits for different typical Engineering applications.
4. The course gives an insight into the maintenance and troubleshooting aspects of FP Engineering.
5. Imports knowledge are logic control devise.

Modules	Teaching Hours
Module-I **INTRODUCTION:** Introduction hydraulics and pneumatics with basic block diagram with advantages, limitations and application, Pascal's law with power transmission and Power multiplication, continuity equation, Bernoulli's theorem, Frictional losses in fluid flow (Laminar & turbulent flow and Reynolds number). **HYDRAULIC PUMPS**: Introduction to pump, classification of pumps, construction and working principle of 1.Gearpumps:- (Internal pump, External pump, Lobe pump) 2. Vane pumps: - (Unbalanced vane pump and Balance vane pump) 3. Piston pumps: - (Axial piston pump, Bent Axis type axial pump).	8 hrs
Module-II **HYDRAULIC ACTUATORS & MOTORS:** Linear actuators:- Hydraulic cylinders (Single acting cylinder, Double acting cylinder and special cylinders, Double rod cylinder, Tandem cylinder and Telescopic cylinder) Lever Systems for loading Hydraulic cylinders. Rotary actuators:- Hydraulic motor (gear motor, vane motor and piston motor) **HYDRAULIC CONTROL ELEMENTS:** Classification of Hydraulic valves. I. Direction control valves :- Valve Representations and symbols, II. valve actuation mechanisms and symbols, Operation of check valves (Poppet type check valve, poppet valve with push button actuated, pilot operated check valve) and Sliding spool valve (3/2, 4/2, 4/3 spool valves) and Solenoid controlled valve. III.Pressure control valves: - Simple pressure Relief valve, compound pressure Relief valve and Pressure reducing valve. IV. Flow control valves: - Simple needle Valve, Needle valve with integral check valve and Pressure compensated flow control valve.	9 hrs

Module-III **ANALYSIS OF HYDRAULIC CIRCUITS:** analysis of typical hydraulic circuits. Regenerative circuits, Synchronization circuits, and Sequencing circuits, Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits. **HYDRAULIC SYSTEM ACCESSORIES AND MAINTENANCE:** Construction of Reservoirs, Construction of Hydraulic Accumulators:- (Dead weight, Spring loaded and gas loaded Accumulators) Maintenance of hydraulic system:- Causes of hydraulic system problem, safety considerations and environmental issues.	8 hrs
Module-IV **COMPRESSED AIR GENERATION AND PNEUMATIC ACTUATORS:** Air compressors, classification(piston type, Screw type, Diaphragm type compressors) stages ofair preparation and secondary air treatment Using FRL UNIT Pneumatic actuators:- Linear cylinders(single acting cylinder, Double acting cylinder,Rodless cylinder, Diaphragm cylinder),Seals in air cylinders, Rotary actuators:- Air motor (vane air motor ,Axial piston air motor) **PNEUMATIC CONTROL COMPONENTS:** Introduction and classification of control elements,Valves, types, constructional details, Symbolic representation, 3/2, 5/2spool valves, Non return Check valve, flow control valve, throttle valve.	9 hrs
Module-V **ANALYSIS OF PNEUMATIC CIRCUITS:** Direct and Indirect control of single and double acting cylinders, quick exhaust valve, Speed control ofcylinders using FCV(supply air and exhaust air throttling) **LOGIC CONTROLS:** Logic devices, use of logic gates, OR, AND, NANO, NOR in pneumaticapplications, practical examples involving the use of logic gates.	8 hrs

Question paper pattern:

Total of Ten Questions with Two questions from each Module to be set covering the entire syllabus.Five full questions are to be answered selecting at least one full question from each Module.

Each question should not have more than 4 sub divisions.

Text books:

1) Anthony Esposito," Fluid Power with applications", Pearson Education.
2) Andrew parr, Hydraulics and Pneumatics, A technician and engineers guide, Butterwortb, Heinemann

Reference Books:

1) SR Mujumdar, oil hydraulic systems, principles and maintenance, McGraw Hill Education
2) Joji P, Pneumatic Controls, Wiley India Pvt. Ltd.
3) Pippenger J J , and R.M. Koff, Fluid Power Control systems, New York: McGraw Hill.

Course outcomes:

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

CO#	Course Outcome (CO)
CO1	Describe the hydraulic and pneumatic system with Basic governing law for fluid Power and Differenttype of pump.
CO2	Illustrate the hydraulic actuators and control elements of hydraulic system.
CO3	Analysis of the hydraulic circuits and Accessories in hydraulic system.
CO4	Describe the compressed air generation, pneumatic actuators and pneumatic control components.

CO5	Analysis of the pneumatic circuits and logic controls.

PREREQUISITE:
1. The student should know the fundamentals hydraulics and pneumatics systems.
2. Should aware of power transmission methods like electrical and mechanical.
3. Should have profound knowledge of safety.

COURSE OBJECTIVES:
1) To describe the performance and operating characteristics of hydraulics and pneumatics systems.
2) To explain the different types and complete knowledge of control elements.
3) To explain the parts and complete knowledge of actuators & motors.
4) To build a manual operated hydraulics and pneumatics circuits.
5) To build an Electro- hydraulics and Electro- pneumatics circuits.

HYDRAULICS AND PNEUMATICS LAB

Modules

Module-I

Analysis of hydraulic circuits :
1) To Analysis the working of double acting cylinder in hydraulic system.
   Electro hydraulics
2) To Analysis the flow control by METER-IN circuits, using 4/2 in hydraulic system.
3) To Analysis the flow control by METER-OUT circuits, using 4/2 in hydraulic system.
4) To Analysis the application of 4/3 (Tandem and closed centre) directional control valve.

Analysis of pneumatic circuits :
1) To Analysis the controlling of pneumatic cylinders by DIRECT control of single and double acting cylinder.
2) To Analysis the controlling of pneumatic cylinders by INDIRECT control of single and double acting cylinder.
3) To Analysis the speed control of pneumatic cylinders by supply air and exhaust air throttling of double acting cylinder.
4) To Analysis the application of 4/3 (Tandem and closed centre) directional control valve.
   Electro pneumatics
5) To Analysis the control of single acting cylinder with 3/2 single solenoid valve.
6) To Analysis the control of double acting cylinder with 4/2 double solenoid valve.

COMPUTER INTEGRATED MANUFACTURING(CIM)

Subject Code	**22ME72** **I Credits: 04**	**CIE: 50**
Number of Lecture Hours/Week	**3 (Theory) + 2(Practical)**	**SEE: 50**
Total Number of Lecture Hours	**42**	**SEE Hours: 03**

PREREQUISITE:

1. Fundamental knowledge of Design and Manufacturing processes
4. Familiarity with CAD/CAM software tools for product design and development
5. Basic programming and logical reasoning skills

COURSE OBJECTIVES:

6. To understand the concept key components (hardware and software) of CIM systems and their integration in modern manufacturing environments.
7. To develop knowledge of Finite Element Modeling (FEM), CNC machines, and part programming techniques for turning, milling, and drilling operations.
8. To analyze and model automated production systems, including material handling, storage systems, inspection and flow lines for high-volume manufacturing.
9. To study computerized planning and quality control systems, including CAPP, MRP, Group Technology, and modern inspection methods.

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.	8 hrs
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.	9 hrs
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.	9 hrs

Module-IV **AUTOMATED MATERIAL HANDLING AND STORAGE:** Material handling functions, overview of material 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 . **Automated Inspection Systems**: Overview of Automated Identification Methods, Bar Code Technology and RFID, Other Automatic Identification and Data Capture (AIDC) Technologies.	8 hrs
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.	8 hrs

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.

Course outcomes:

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

CO#	Course Outcome (CO)
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 ,storage systems and inspection system.
CO5	Learn modern manufacturing trends such as CAPP, GT, and CAQC.

CIM LAB

PREREQUISITE: Manufacturing Processes, CAD/CAM, Machine Tools

COURSE OBJECTIVES:

1. To explore the fundamental concepts of CNC simulation and learn to use CAM software for designing and generating CNC codes for simple components.
2. To develop proficiency in using G-codes and M-codes on CNC simulator software for turning and milling operations.
3. To understand and practice writing G-code and M-code programs for CNC turning and milling operations to produce specified components.

Modules

Module-I

CNC Simulation: (Individual execution)

1. Introduction to G-codes and M-codes for milling operations.
2. Simulation of milling operations involving linear and circular interpolation**.**
3. Introduction to G-codes and M-codes for turning operations.
4. Simulation of turning operations such a**s** facing, step turning, taper turning, chamfering, and filleting**.**

Module-II

CNC Machine Programming & Job Production :(Group execution)

1. Writing and executing CNC programs using G-codes and M-codes for CNC turning**.**
2. Feeding the program into the CNC turning machine, setting tool offsets, and producing the job.
3. Writing and executing CNC programs using G-codes and M-codes for CNC milling**.**
4. Feeding the program into the CNC milling machine, setting up the job, and producing the component.

Professional core course (PCC)

ENERGY ENGINEERING			
Subject Code	22ME73	Credits: 04	CIE:50
Number of Lecture Hours/Week	4 (Theory)		SEE:50
Total Number of Lecture Hours	52		SEEHours: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. Pulverized fuel furnaces (No numerical). **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 numerical).	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 numerical).	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 numerical) **Nuclear Power Plant:** Principles of release of nuclear energy fusion & fission reactions. Nuclear fuels used in the reactors. Radiation hazards, Shielding, Radioactive waste disposal, Nuclear reactors and its types (PWR,BWR,HGR,GCR,LMCR,Fast Breeder reactor)Site selection criteria area. (No numerical).	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, powerhouse, 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 numerical)	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 McGraw 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. PowerPlantTechnology,M.M.Wakil,TataMcGrawHillPublishers,2ndEdition

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	Choosethedieselengineandnuclearpowerplantfundamentalsrequiredforthegeographical 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.

Professional Elective course

ADVANCED FOUNDRY TECHNOLOGY

Subject Code	22ME741	Credits	03	CIE:50
Number of Lecture Hours/Week	3(Theory)			SEE:50
Total Number of Lecture Hours	42			SEE Hours:03

Prerequisite: Manufacturing process and materials science knowledge, basic Foundry practices of metal casting.

Course Objectives:

1. To promote understanding of foundry practice and metal casting as one of the important manufacturing processes.
2. Tostudythevarioustechniquesusedinfoundryindustriesandtheirapplications.
3. Understand the standard foundry practices for casting of ferrous and non-ferrous alloys elaborated according to specialization.
4. Anoverviewofthedesigningofmolds,castingdefects,inspectionandtestingof Casting sand modernization of foundries

Modules	Teaching Hours
MODULE-I **Introduction of foundry:** History, Types of Manufacturing process, principles of foundry, Types of foundries, Different sections of foundry and its layout. Foundry materials: Types of raw materials. **Introduction and Technology of Pattern making:** Definition, pattern materials, types of patterns, pattern allowances.	08Hours
MODULE-II **Technology of Mould making:** Mould materials, sand preparation, Properties of moulding materials, steps involved in sand mould making, Core and core prints. Greensandmoulding,drysandmoulding,shellmoulding,Sodiumsilicatemolding, no-bake moulding, Plaster moulding, Vacuum sealed moulding (V process).	08Hours
MODULE-III **Melting and Pouring:** Introduction, Melting furnaces-open hearth furnace, acidic and basic hearth furnaces. **Metal Pouring:** Pouring temperatures, pouring equipment, pouring ladles, Gates, Risers, Chvorinov's rule, risers feeding distance, sprues and their characteristics. **Solidification of castings:** Concept of solidification of metal, solidification of pure metals-nucleation, heterogeneous-nucleation, solidification rate, time and Chvorinov's rule-Progressive, directional solidification and control of solidification to obtain sound castings.	09Hours
MODULE-IV **Special casting Techniques:** Introduction-Special casting techniques-Permanent mould casting,, pressure die casting, centrifugal casting, Squeeze casting, comparison with sand casting, advantages, disadvantages and applications. **Inspection and testing:** Non-destructive testing, visualtesting, liquid penetrate, ultrasonic testing.	08Hours

MODULE-V	
Fettling technique: Introduction of shake out, modern developments, Fettling or cleaning, and finishing of castings, removal of cores, cleaning casting surfaces, blast cleaning, removal of gates, risers, fins and other unwanted projections from castings. **Casting Defects:** causes and remedial measures, porosity, Shrinkage cavity, inclusions, hot tears, rat tail, sand fusion, mis-run, cold shut, Fins.	09Hours

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.

Textbooks:

1. O.P.Khanna,*"ATextBookofFoundryTechnology"*,DhanpatRai&Sons,15th Edition,2011.
2. P.N.Rao,*"ManufacturingTechnology",*TMH,5th Edition,2013.

Reference Books:

1. Richard.W.HeineandRosenthal,*"PrinciplesofMetalCastings"*,TMH,2nd Edition,2001.
2. R.K.Jain,*"ProductionTechnology",*KhannaPublishers,17th Edition,2011.

Ebooks and online course materials:

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

CO	Course Outcomes
CO1	Detect the material to prepare pattern sand moulds
CO2	Explainsandpreparation,reclamation,controltestsandvarioustypesofmoulding
CO3	Design gating systems and calculate solidification time.
CO4	Selectmeltingfurnacesandladles,non-destructivemethodsusedincastings
CO5	Identify defects, salvage and heat treatment of castings

CRYOGENICS				
Subject Code	22ME742	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.				08Hours
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.				08Hours
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.				08Hours

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	08Hours
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 pumps. **Application of Cryogenic Systems:** Cryogenic application for food preservation – Instant Quick Freezing techniques Super conductive devices, Cryogenic applications for space technology. Application of cryognic systems, super conducting devices, space technology, cryogenic in biology and medicine.	10Hours

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.

Textbooks:

1. Cryogenic Systems–R.F. Barron
2. CryogenicEngineering–R.B.Scott–D.VanNostrandCompany,1959

Reference Books:

1. Cryogenic Process Engineering –K.D.TimmerhausandT.M.Flynn,PlenumPress,NewYork,1989
2. High Vacuum Technology–A.Guthree–New Age International Publication
3. ExperimentalTechniquesinLowTemperaturePhysics–G.K.White–OsfordUniversityPress,

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 be 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

NANO TECHNOLOGY				
Subject Code	22ME743	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 nano scale science, types of materials, and their engineering applications and hazards.				

Modules	Teaching Hours
MODULE-I **INTRODUCTION TO NANO SCIENCE AND NANO TECHNOLOGY:** 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 nano scale materials and their devices.	08Hours
MODULE-II **CLASSIFICATION OF NANO STRUCTURES:** Zerodimensional,one-dimensionalandtwo dimensional nanostructure materials - classification of solids: conductor, semiconductors, insulator, types of semiconductor, doping, diodes, current flow in semiconductors, ceramics and nano composites, quantum size effect(QSE) in 1D, 2D, 3D nano materials, quantum dots, nano wires, nano tubes, nano sheets, top down and bottom up approach.	08Hours
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.	08Hours
MODULE-IV **INTRODUCTION TO NANOMATERIALS AND DEVICES:** Types of nano materials: 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 nano materials 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 nano materials And their application.	10Hours
MODULE-V **INTRODUCTION TO NANOTOXICOLOGY:** Nano materials pollution – Nano materials in Environment - Toxicology of Airborne – Effect of Nano materials in the environment. Safety and pollution Control techniques-handling, storage, packaging, transportation And disposal.	08Hours

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.

Textbooks:

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 Nanotechnology – Basic Science&EmergingTechnologies:2002by MichaelWilson,KamaliKannangara,GeoffSmith,Michelle Simmons, and Burkhard Raguse.
3. Nanoparticles technology: Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, First edition 2007, ISBN: 978-0-444-53122-3.

Reference Books:

1. VladimirP.Torchilin(2006)Nano particulates as Drug Carriers, Imperial College Press.
2. M.RezaMozafari(2007)Nano materials and Nano systems for Biomedical Applications.
3. K.W.Kolasinski," Surface Science: Foundations of Catalysis and Nano science",Wiley,2002.
4. Biomimetics: lessons from nature–an overview by Bharath bhushan
5. Biomimetics—using nature to inspire human innovation Yoseph Bar-Cohen.

Ebooks 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 nano science and nanotechnology
	CO2	Classify nano-structures;
	CO3	Develops mart materials
	CO4	Analyse biomaterials
	CO5	Explain nano toxicology

PROJECT MANAGEMENT			
Subject Code	22ME744	Credits: 03	CIE:50
Number of Lecture Hours/Week	3 (Theory)		SEE:50
Total Number of Lecture Hours	42		SEEHours: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. **PROJECTPLANNING:** 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. **PROJECTORGANIZING:** 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 (Forwardpass 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.

Textbooks:

1. ChaudharyS.;ProjectManagement,TataMcGrawHill
2. PrasannaChandra;Projects-Planning,Analysis,Selection,Financing,ImplementationandReview', I Edition, Tata Mc Graw Hill, 8th Edition 2015.

Reference Books:

1. KerznerH.;Project Management, II Edition, CBS Publishers
2. MeredithJackR.,MantelSamuelJ.;ProjectManagement,IVEdition,JohnWiley&Sons
3. GopalakrishnanP.,RamamurthyV.E;TextbookofProjectManagement,MacMillanPublishers
4. Maylor Harvey, Project Management, MacMillan Publishers
5. MatheenA.Prof., Comprehensive Project Management, Laxmi Publications(P) Ltd.
6. Project Management, Gopalan, Wiley India
7. A Guide to the Project Management Body of Knowledge (PMBOKGuide), 5thEd, 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

CO_S	Course Outcomes
CO1	Describe and identify the projects of different categories, phases of product lifecycle, 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	Co ordinate and control the project activities.
CO5	Write work break down structure for a project and develop a schedule based on it.

Open Elective course

NON-CONVENTIONAL ENERGY SOURCES			
Subject Code	22ME73OE751	Credits:03	CIE:50
Number of Lecture Hours/Week	3 (Theory)		SEE:50
Total Number of Lecture Hours	42		SEEHours: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:** EnergySource,India'sproductionandreservesofcommercialenergysources,needfornon-conventional energy sources, energy alternatives, solar, thermal, photovoltaic, water power, wind, bio-mass, ocean temperature difference, tidal and waves, geothermal, tar-sands and oil shale, nuclear (Brief description); advantages and disadvantages, comparison (Qualitative and Quantitative). **Solar Radiation:** Extra–Terrestrial radiation, spectral distribution of extraterrestrial 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 pyrhelio-meter, 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) 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** Propertiesofwing,availabilityofwindenergyinIndia,windvelocityandpowerfromwind; 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 tidal 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. TotalofTenQuestionswithtwofromeachMODULEtobesetcoveringtheentire syllabus.
2. FivefullquestionsaretobeansweredchoosingatleastonefromeachMODULE.
3. Eachquestionshouldnothavemorethan4sub divisions.

Text books:

1. G.DRaiK,—Nonconventionalenergysources‖,Khannapublishers.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 Kleemanand Mechael Meliss,—Renewable energy sources and conversion technology‖, Tata Mcgraw Hill, 2001. ISBN:9780074600238
2. JohnW.Twidell,TonyWeir,—Renewableenergyresources‖,Routledge,4thedition,2014, ISBN:9780415633581
3. SolarPowerEngineering:PKNagTMH.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, bio gas.
CO5	Implement the concepts and applications of fuel cells, thermo electric converter and MHD generator methods of energy storage for specific applications.

Open Elective **RAPID PROTOTYPING AND MODELLING**				
Subject Code	22MEOE752	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.				08Hours
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.				10Hours
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.				08Hours
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.				08Hours
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.3Dprinting:Introduction, process parameters involved, advantages and Disadvantages.				08Hours

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.

Textbooks:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. GebhardtA.,"Rapidprototyping",HanserGardenerPublications,2003.
3. IanGibson,"SoftwareSolutionsforRapidPrototyping",ProfessionalEngineeringPublishingLimited, 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. KamraniA.K.andNasrE.A.,"RapidPrototyping:Theoryandpractice",Springer,2006.
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

Ebooks 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 Course

TOTAL QUALITY MANAGEMENT

Subject Code	22MEOE753	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, TQM frame work, Historical review, benefits of TQM, TQM organization.	08Hours
MODULE-II **Tools and techniques of TQM:** Basic tools of TQM, Benchmarking 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.	09Hours
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**: Single sampling lot tolerance, Double sampling lot tolerance tables. **Preventive techniques**: Design of Failure Mode and Effect analysis[FMEA],process of FMEA.	10Hours
MODULE-IV **Quality Circles:** Introduction, origin**,** Definition, Concept, Philosophical Basis of quality circles, TheoryX, TheoryY, Characteristics, scope, organization structure, Process of operation of quality circle,(for Knowledge of 7 basicproblem solving tools ortechniques)**.**	07Hours

MODULE-V	
Experimental Design: Introduction, Design Matrix, Design matrix for two level(lowerandUpper)orthreelevel(Middle),Basicsstatistics,Onefactordesign, two factor designs, t-test, F-test, Analysis of variance (Note: $F_{model}>F_{table}$ hence the model is adequate from table $F_{14,6,0.05} = 4.07$) **Team Development:** Synergy, Team building, types of teams, characteristics of successful teams, team member's roles, effective team meetings, common team problems.	08Hours

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.

Textbooks:

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, EdnI2004,Himalya publishing
3. Statistical quality Control by Grant Levenworth (2000).
4. Statistical quality Control by M. Mahajan (2015)

Reference Books:

1. Statical 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, David walder Productivity press Oregon-1990
3. Organizational excellence through TQMH Lal, New Age Publishers
4. Quality control and Total quality management- P L Jain TMH Publications company Ltd - 2001 New Delhi
5. Cocran WG, Cox GM, 'Experiment Design' 2nd edition, John Wiley & Sons, Inc.India2000

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

Course Code	CO #	Course Outcome(CO)
	CO1	Able to apply the knowledge of TQM and contribution of TQM gurus and strong
	CO2	Identify and implement the tools and techniques like QFD, QFD process.
	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 co ordination and communication is very important.
	CO5	Demonstrate the knowledge of design of experiments, consistent development and improvement.

VEHICLE DYNAMICS				
Subject Code	22MEOE754	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 develop the basic knowledge of the students in automotive field in the areas of vehicle vibrations. 2. To develop the skills of the students in stability of vehicles and their effects, related With longitudinal, vertical & lateral dynamics.				
Modules				**Teaching Hours**
MODULE-I **CONCEPTOFVIBRATION:** Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification Factor, Transmissibility, Vibration Absorber, Vibration Measuring Instruments, Torsional Vibration, Critical Speed.				08Hours
MODULE-II **TIREDYNAMICS:** Tire Forces and Moments, Tire Structure, Longitudinal and Lateral Force at Various Slip Angles, Rolling Resistance, Tractive and Cornering Property of Tire. Performance of Tire on Wet Surface. Ride Property of Tires. Magic Formulae Tire Model, Estimation Of Tire Road Friction. Teston Various Road Surfaces. Tire Vibration.				08Hours
MODULE-III **VERTICALDYNAMICS:** Human Response to Vibration, Sources of Vibration. Design and Analysis of Passive, Semi-Active and Active Suspension Using Quarter Car, Half Car and Full Car Model. Influence of Suspension Stiffness, Suspension Damping, and Tire Stiffness. ControlLawforLQR,H-Infinite,SkyhookDamping.AirSuspensionSystemandTheir Properties.				08Hours
MODULE-IV **LONGITUDINALDYNAMICS:** Aerodynamic Forces and Moments. Equation of Motion. Resistance, Rolling Resistance, Load Distribution for Three Wheeler and Four Wheeler. Calculation of Maximum Acceleration, Reaction Forces for Different Drives. Braking and Driving Torque. Prediction of Vehicle Performance.				08Hours
MODULE-V **LATERALDYNAMICS:** Steady State Handling Characteristics. Steady State Response to Steering Input. Testing of Handling Characteristics. Transient Response Characteristics, Direction Control Of Vehicles Roll Center, Roll Axis, Vehicle Under Side Forces. Stability of Vehicle Running on Slope, Banked Road and During Turn, Effect of Suspension on Cornering, Latest Trends in Vehicle Dynamic Testing Like Four Poster, Multi Axis Simulator, etc.				10Hours

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.

Textbooks:

1. Singiresu S.Rao, "Mechanical Vibrations", 5th Edition, Prentice Hall, 2010
2. Wong.J.Y., "Theory of Ground Vehicles", 3rd Edition, Wiley-Inter science, 2001
3. Rajesh Rajamani, "Vehicle Dynamics and Control", 1st edition, Springer, 2005
4. Thomas D.Gillespie, "Fundamentals of Vehicle Dynamics", Society of Automotive Engineers Inc,1992

Reference Books:

1. Dean Karnopp, "Vehicle Stability",1st edition, Marcel Dekker,2004
2. Nakhaie Jazar.G., "Vehicle Dynamics: Theory and Application", 1st edition, Springer, 2008
3. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited 2004 3. Hans B Pacejka, "Tire and Vehicle Dynamics", 2nd edition, SAE International, 2005
4. John C. Dixon, "Tires, Suspension, and Handling",2nd edition, Society of Automotive Engineers Inc, 1996 6. Jan Zuijdijk, 'Vehicle dynamics and damping", Author House, 2009

Ebooks and online course materials:

Course outcomes:

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

	CO	Course Outcome(CO)
	CO1	Understand the basics of vibration, when the vehicle is at dynamic condition
	CO2	Understand the tyre dynamics with respect to force & moments.
	CO3	Derive the effective cornering stiffness when considering the elastic elements in the wheel suspension and be able to analyze effect on the dynamic characteristics of the vehicle
	CO4	Understand the aerodynamic forces & moments, load distribution in the various vehicles.
	CO5	Test the effective steering geometry, vehicle handling & directional control of vehicle