SGGS INSTITUTE OF ENGINEERING AND TECHNOLOGY, NANDED

(An Autonomous Institute Owned by Government of Maharashtra)

Final Year B. Tech. (Mechanical) Curriculum Structure

Academic year 2017-18 onwards

Semester VII						
Course Code	Course Title	Lectures (L)	Tutorials (T)	Practical (P)	Credits	
					Th.	Pr.
ME401	Automobile Engineering	03	01	02	04	01
ME402	Computer Aided Manufacturing	03	01	02	04	01
ME403	Operations Research and Management	03	01	02	04	01
ME407 to ME421	Elective-IV	03	01	--	04	--
	Elective-V	03	01	--	04	--
ME404	Internship*	--	--	--	--	02*
	Total	**15**	**05**	**06**	**20**	**03**
				Total credits	**23**	
Semester VIII						
Course Code	Course Title	Lectures (L)	Tutorials (T)	Practical (P)	Credits	
					Th.	Pr.
ME405	Project (Industrial/In-house)	**--**	**--**	24	--	12
ME406	Mini Project	**--**	**--**	8	--	4
	Total	--	--	32	--	16
				Total credits	**16**	
				Total	**39**	

Important Notes:

1. The student can do project in an industry or in-house for a complete semester. Along with the project, they should work on mini project (Energy Management).

2. *Credits earned for internship to be treated as over and above the minimum of total credits for acquiring B. Tech (Mechanical Engineering) Degree.

SGGS INSTITUTE OF ENGINEERING AND TECHNOLOGY, NANDED

(An Autonomous Institute Owned by Government of Maharashtra)

Final Year B. Tech. (Mechanical) Curriculum Structure
Academic year 2018-19 onwards

Semester VII						
Course Code	Course Title	Lectures (L)	Tutorials (T)	Practical (P)	Credits	
					Th.	Pr.
ME401	Automobile Engineering	03	01	02	04	01
ME402	Computer Aided Manufacturing	03	01	02	04	01
ME403	Operation Research and Management	03	01	02	04	01
ME407 to ME421	Elective-IV	03	01	--	04	--
	Elective-V	03	01	--	04	--
ME404	Internship*	--	--	--	--	02
	Total	**15**	**05**	**06**	**20**	**05**
				Total credits	**25**	
Semester VIII						
Course Code	Course Title	Lectures (L)	Tutorials (T)	Practical (P)	Credits	
					Th.	Pr.
ME405	Project (Industrial/In-house)	**--**	**--**	24	--	12
ME406	Mini Project	**--**	**--**	8	--	4
	Total	--	--	32	--	16
				Total credits	**16**	
				Total	**41**	

Important Notes:

1. The student can do project in an industry or in-house for a complete semester. Along with the project, they should work on mini project (Energy Management).

2. *Internship (at least 4 to 6 weeks) in the industry can be completed any time during non-academic period after second year but before the start of final year. However, it will be evaluated at the end of VII semester of the B. Tech Mechanical Engineering Program.

List of Electives for Final Year B. Tech Mechanical Engg.

Elective-IV and Elective-V (Choose any two from the following)

ME407: Power Plant Engineering

ME408: Renewable Energy

ME409: Pressure Vessel Design

ME410: Advanced Welding Techniques

ME411: Quality and Reliability Engineering

ME412: Tribology

ME413: Cryogenics

ME414: Plastics and composites

ME415: Robotics

ME416: Fracture Mechanics

ME417: Heating, Ventilation and Air Conditioning (HVAC)

ME418: Rapid Prototyping and Tooling

ME419: Shop Floor Automation

ME420: World Class Manufacturing

ME421: Elective offered by Industry

Open Elective(s): Offered by other departments in the Institute

Credits earned for open elective(s) to be treated as over and above the minimum of total credits for acquiring B. Tech (Mechanical Engineering) Degree.

ME401 - AUTOMOBILE ENGINEERING

(CREDITS: THEORY - 04, PRACTICAL - 01)

Course code: ME401 **Contact Hours/Week:** Th-03, Tu-01, Pr-02

Course Objectives:

- To familiarize with various types of automobile.
- To motivate students to learn the fundamentals of power transmission in automobile.
- To get familiar with steering, braking & suspension system which we commonly use.
- To implement the knowledge obtained in theory towards design and analysis of various automobile systems.

Evaluation Scheme:

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

Course Contents:

Introduction: Components of an automobile, vehicle specifications, classification of automobiles, layout with reference to power plant, chassis, construction and details (frames, sub-frames, frameless vehicles, vehicle dimensions), details of chassis & body materials. **(04Hrs)**

Clutches: Principle, types, their construction & working, fluid coupling. **(02Hrs)**

Transmission: Need transmission, types of transmission, different types of gear box, shift mechanisms, torque converter, and continuously variable transmission. **(04Hrs)**

Drive line: Propeller shaft, universal joint, slip joint, final drives, Hotchkiss and torque tube drives, rear axle types and construction, principle of differential, types of differential. **(04Hrs)**

Front Axle & Steering: Types of front axle, steering requirements, wheel alignment, steering geometry, steering mechanism, Turning radius, instantaneous centre, and wheel wobble, under-steer and over-steer, different types of steering gears, power steering. **(06Hrs)**

Braking & Suspension: Principle, braking requirements, types of brakes, drum brakes, disc brakes, hydraulic brakes, electric brakes, vacuum assisted brakes, Engine exhaust brakes, air brakes, Antilock Breaking System (ABS). Function and types of suspension springs (leaf & coil springs), Torsion bars, shock absorber, conventional and independent suspension, stabilizers, Air suspension. **(12 Hrs)**

Electrical System: Battery, Charging circuit, Alternator ,generator, current – voltage regulator – starting systems, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator. **(08Hrs)**

Wheels & Automotive materials: Types of wheels, tyre, desirable tyre properties, types of tyres, parameters affecting tyre life, various automotive materials, and natural materials smart materials, advances in automotive materials. **(08Hrs)**

Term Work:

Minimum ten experiments from the list given below should be conducted

1. Study of different automobile layouts.
2. Study and demonstration of working of single plate automobile clutch.
3. Study and demonstration of synchromesh gear box.
4. Study and demonstration of constant mesh gear box
5. Study and demonstration of car chassis with clutch , gear box and differential gear
6. Study and demonstration of working of hydraulic brake system.
7. Study and demonstration of working of air brake system.
8. Study and demonstration of working of vacuum assisted brake system.
9. Study and demonstration of hydraulic power steering.
10. Study and demonstration of electrical power steering.
11. Study of suspension system of a four wheeler.
12. Study and demonstration of Car wiring.

Practical Examination:
It shall consist of oral/practical examination based on above syllabus.

Text Books:

1. Dr. Kirpal Singh, "Automobile Engineering" (Vol. I & II), Standard Publishers, 2011.
2. G.B.S. Narang, "Automobile Engineering", Khanna publications, New Delhi, new edition, 2006.

Reference Books:

1. Newton & Steed, "Motor Vehicles", 13th ed., Butterworths London, 2001.
2. W. H. Crouse, "Automobile Mechanics", McGraw Hill publishing Co., 2004.
3. H. M. Sethi, "Automotive Technology", McGraw Hill. Education (India) Pvt. Limited, 2001.
4. Banga & Singh, "Automobile Engineering", Khanna Publishers, Delhi, 1993.

Course Outcomes:
Students will be able to:

- Classify different types of vehicles.
- Understand power transmission systems in automobiles.
- Understand various types of steering, braking & suspension systems.
- Get theoretical concepts assist in design and analysis of various automobile systems.

ME402 - COMPUTER AIDED MANUFACTURING

(CREDITS: THEORY - 04, PRACTICAL - 01)

Course code: ME402 **Contact Hours:** Th-03, Tu-01, Pr-02

Course Objectives:

- To Introduce the students to the basic standard terminologies/conventions, hardware, applications, merits and demerits of general NC, CNC, DNC technology.
- To expose the students to Automatic/ Computer Assisted NC tool path programming using professional software tools used for complicated machining applications.
- To impart knowledge about the integration of interdisciplinary fields of computer aided design, computer aided manufacturing, automatic identification system, automatic storage & retrieval system, design and analysis of various automatic material handling systems as a whole.

Evaluation Scheme:

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

Course Contents:

Introduction of Automation: Introduction, basic elements of an automated system, advanced automation functions, levels of automation **(06Hrs)**

Numerical Control: Basic components of an NC system, classification, merits and demerits, applications, the cost of NC/CNC, dimensioning systems, axes designation, NC motion control, interpolation, part programming formats, manual part programming, NC words, macro statements, application of NC to machine tools and other applications, NC coding systems (ISO and EIA), computer assisted part programming, APT statements, programming, NC part programming using CAD/CAM, manual data input (MDI), engineering analysis of NC positioning systems, open loop and closed loop positioning systems, precision in NC positioning **(14Hrs)**

Computer Numerical Control (CNC) and DNC: Features of CNC, the machine control unit for CNC, CNC software, direct numerical control, distributed numerical control Group Technology and Cellular Manufacturing: Introduction to GT, benefits, part families, part classification and coding, product flow analysis, cellular manufacturing, adaptation consideration in GT, quantitative analysis in cellular manufacturing Flexible Manufacturing Systems - Introduction to FMS, components, applications, benefits, FMS layout, FMS planning and implementation issues, quantitative analysis of FMS. **(12Hrs)**

FMS Computer Integrated Manufacturing (CIM): CAD, CAD/CAM, CIM, evolution of CIM, CIM hardware and software, nature and role of the elements of CIM system, development of CIM, the IBM concept of CIM, the Siemens concept of CIM, the CIM concept of Digital equipment corporation, Esprit CIM – OSA model, the NIST – AMRF Hierarchical model **(08Hrs)**

Manufacturing support Systems: CAPP, benefits, types, forward and backward planning implementation considerations, process planning systems, CAQC, CMM, JIT principles, the meaning of JIT, MRP–I and MRP-II. **(08Hrs)**

Term Work:
It shall consist of at least 8 assignments based on above syllabus, 4 out of which will be on computer assisted and 4 will be on CNC machine.

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

Text Book:

1. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Education, New Delhi, 2002.

References Books:

2. P. Radhakrishnan & S. Subramanyan "CAD/CAM/CIM" Willey Eastern Limited New Delhi, 1994.
3. Hans B. Kief and J. Frederick Waters "CNC" Glencae Macmillan / McGraw Hill.
4. Steve Krar and Arthar Gill "CNC Technology and Programming", McGraw Hill Pub. Company, New Delhi.
5. Nicholas John M. "Competitive Manufacturing Management", McGraw Hill International.
6. P.N. Rao, N. K. Tewari et el "CAM" Tata Mc Graw Hill Pub, New Delhi.

Course Outcomes:

Students will be able to:

- Work individually and/or with an interdisciplinary team for the purpose of selection, design and use of NC technology for manufacturing applications.
- Generate manual/automated part programs for a given part to be machined on NC/CNC system.
- Demonstrate the technical reports for manufacturing automation as well as with regard to NC machining.
- Demonstrate the structure of modern day computer integrated manufacturing system and design to improve the existing manufacturing facility

ME403 - OPERATIONS RESEARCH AND MANAGEMENT

(CREDITS: THEORY- 04, PRACTICAL - 01)

Course code: ME403 **Contact Hours/Week:** Th-03, Tu-1, Pr-02

Course Objectives:

- To impart the operation research techniques.
- To familiarise with model formulation and applications those are used in solving business decision problems.
- To motivate for learning decision making techniques.

Evaluation Scheme:

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

Course Contents:

Unit I: Linear programming (10)

Definition of Operations Research: Scope & objectives, formulation of problem, graphical method, simplex methods for maximization and minimization problems. Degeneracy in L.P., duality in L. P.; Sensitivity analysis.

Unit II: Transportation and assignment problem (10)

Structure, industrial and business application Transportation problems- use of various methods for solving transportation problem, degeneracy and its solution, transshipment problem. Assignment problem solutions of various types of problems, travelling salesman Problem.

Unit III: Queuing theory (10)

Operating characteristics, Poisson single and multi channel queuing system M/M/1: ¥/ FCFS, MCSR. Games Theory: Introduction, two -person zero sum game, minimax and maximin principle, saddle point, methods for solving game problems with mixed strategies, Graphical and iterative methods.

Unit IV: Project Management (10)

Construction of networks, critical paths, forward and backward pass, floats and their significance, crashing for optimum duration and the cost, resource allocation and leveling, Time estimates, construction of networks, probability of completing projects by given date.

Term Work:

It shall consist of at least one assignments on each chapter based on above syllabus.

Practical Examination:

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

Text Book:

1. P. K. Gupta and D. S. Hira, "Operations Research, 3rd Edition", S. Chand and Company Ltd.

Reference Books:

1. R. Paneerselvam, "Operations Research", Prentice Hall of India (2002)
2. Ravindran, Philips, Soldberb, "Operations Research: Principles and Practices", 2nd Edition, John Wiley and Sons (2000).
3. H. S. Kasana and K. D. Kumar, "Introductory Operations Research: Theory and Applications", Springer International Edition (2003).
4. H. A Taha., "Operations Research An introduction", Prentice Hall Pvt. Ltd., ISBN 81-203-1222-8.

Course Outcomes:

Students will be:

- Able to do use of Linear programming techniques.
- Able to express and model problems as linear programs.
- Able to maintain a schedule and project plan.
- Apply the operations research techniques for real life problems.

ME407 - POWER PLANT ENGINEERING

(CREDITS: THEORY - 04)

Course code: ME407 **Contact Hours/Week:** Th-03, Tu-01

Course Objectives:

- To introduce the students to different types of power plants.
- To demonstrate constructional features and working of different power plants.
- To impart various factors affecting the site selection for a power plant.
- To introduce students with economic analysis for a power plant and to demonstrate its process.
- To comprehend pollution caused by power plants and different measures to control them.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction: Energy sources and their availability, types of power plant, review of basic thermodynamic cycles used in power plants, Factor affecting Selection of Site. **(02Hrs)**

Hydroelectric power plant: General arrangement of hydroelectric project and its operation, site selection, Storage and pond age, classification of hydro stations, selection of prime movers, operation of different components of hydro station, reservoirs Dam, spill ways, canals, penstock, water hammering effects, surge tank, draft tube, advantages of hydro station, Hydrograph, flow duration & mass curves, brief description of some important hydel installations in India. **(08Hrs)**

Thermal power plant: General layout of modern Thermal power plant, Working of Thermal power plant, Site Selection for Thermal power plant, thermodynamic cycles, Coal handling, storage, Preparation & Feeding, combustion and combustion equipment, Ash handling and dust collection, draught systems. **(06Hrs)**

Diesel engine power plant: Layout of Diesel Engine Power Plant, Type of Engines used for Diesel power plants, cooling & lubrication system for the diesel engines, filters, supercharging of Diesel engines, performance of diesel plant, advantages and limitations of diesel plant over thermal plant, Present Trends in Diesel research. **(04Hrs)**

Gas Turbine Power Plant: Plant layout, method of improving the output and performance, fuel and fuel systems, method of testing open and closed cycle plants, operating characteristics, applications, advantage of combined working of different parts, effect of operating variable on thermal efficiency, regeneration, inter-cooling, reheating, performance of closed and semi closed cycle gas turbine plant. **(06Hrs)**

Nuclear Power Plant: Principle of release of nuclear energy fusion & fission reaction, nuclear fuels used in reactors, multiplication and thermal utilization factors, elements of nuclear reactor, moderators, control rods, fuel rods, coolants, brief description of reactor PWR, BWR, sodium

graphite reactor, fast breeder reactor, Homogenous reactor and gas cooled reactors, radiation hazard, shielding, radioactive waste disposal, classification of nuclear power plants, waste disposal. **(08Hrs)**

Choice of power site for power station: Load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, and demand factor, effect of variable load on power plant, selection of the number and size of units **(04Hrs)**

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. **(02Hrs)**

Air pollution Caused by Power Generation and Its Control: Effect of Air pollution, Green House Effect, Acid Precipitation, Human Health, Basic types of Systems for Air Quality Control, Fuel-Gas Desulfurization (FGD) system. The Wet –Gas Desulfurization system, the dry –Gas Desulfurization system, Single Alkali Scrubbing, NO removal, thermal pollution. Pollution from Nuclear power Plant, Radioactivity release, radioactive waste, high efficiency engines and turbines technology with near zero emission. **(08Hrs)**

Term Work:

It shall consist of at least 8 assignments based on above syllabus.

Text Book:

1. Domkundwar and Arora “Power Plant Engineering”, Dhanpat Rai and Sons, New Delhi.
2. E.I. Wakil, “Power Plant Engineering”, Publications, New Delhi.

Reference Books:

1. P. K. Nag, “Power Plant Engineering”, Tata McGraw Hill, New Delhi.
2. R. K. Rajput,“Power Plant Engineering”, Laxmi Publications, New Delhi.
3. R. Yadav - Steam and Gas turbines, central publishing house, Allahabad.

Course Outcomes:

- Student demonstrates working and constriction of various power plants.
- Students exhibit knowledge of systems of waste disposals from power plant.
- Student exhibit techniques of power generation and storage systems.
- Student will be able to calculate the economy of power plant.

ME 408 - RENEWABLE ENERGY

(CREDITS: THEORY - 04)

Course code: ME408 **Contact Hours /Week:** Th-03,Tu-01

Course Objectives:

- To study energy generation, different energy sources and their utilization and impact on environment
- To gain knowledge of solar radiation and its applications
- To understand the wind energy and its nature
- To analyze the performance of solar collectors and wind turbines
- To learn fuel cell and its efficiency

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Energy Resources and Utilization: Conservation and forms of energy, energy reserves in India, nuclear power, hydroelectric power potential, India's power scene, renewable energy sources, energy parameters, cogeneration, rational energy use of energy, energy efficiency and conservation, new technologies, distributed energy systems and dispersed generation. **(06Hrs)**

Environmental aspects of electric energy generation: Atmospheric pollution, hydrocarbons, particulates, thermal pollution, hydroelectric projects, operational phase of hydro power projects, operational safety in nuclear power plants, disposal of nuclear waste, global environmental awareness, impact of renewable energy generation on environment, GHG emissions from various energy sources, cost of electricity production from different energy sources, electromagnetic radiation from high voltage overhead lines, energy options for Indian economy. **(06Hrs)**

Solar radiation and measurement : Solar constant, spectral distribution of extraterrestrial radiation, terrestrial solar radiation, solar radiation geometry, computation of COSθ, sunrise, sunset, day length, LAT, Empirical equation of for estimating the availability of solar radiation, solar radiation measurement and Solar radiation data for India. **(04Hrs)**

Solar collector and applications: Solar Thermal energy collectors, design parameters, analysis, performance, laws of thermal radiation, radiation heat transfer between real bodies, radiation optics, transmitivity, heat losses and coefficient, Solar Thermal energy storage. Solar thermal energy conservation systems - Solar water heating, solar distillation, thermodynamic cycles and power plants, solar ponds, solar pumping system, solar cooker, solar passive technologies, solar furnace, solar green house . **(06Hrs)**

Solar photovoltaic systems : Photovoltaic effect, solar photovoltaic system, materials for solar cells, characteristics, efficiency, applications PV system, plastic solar cell with nanotechnology, peltier cooling, solar photovoltaic in India, JNNSM. **(04Hrs)**

Wind energy : Classification, types of rotors, terminology, operation of wind turbines, wind energy extraction, wind characteristics, wind speed, energy estimation, power density duration curve, density function, field data analysis, direction and wind speed, variation of wind speed, wind scale, energy pattern factor in wind power studies, land for wind energy, design of wind turbine rotor, regulating system, wind power generation curve, horizontal axis wind turbine generator, modes of wind power generation, advantages and disadvantages. wind energy farms. **(06Hrs)**

Ocean Energy : Tidal Energy, Tidal characteristics, Tidal Energy estimation, Development of a tidal power scheme, Yearly power generation from Tidal Plants, Economics of Tidal Power, Wave energy-characteristics-energy and power from the waves, wave energy conversion devices

Geothermal energy: Structure of earth's interior, sites, field, gradient, resources, power generation, geothermal resources in India, utilization, global status of electricity generation from geothermal resources, advantages of geothermal energy. **(06Hrs)**

Fuel Cells: Principle of operation of an acidic Fuel Cell, Technical parameter, Fuel Processor, methanol fuel cell, fuel cell types, Advantages of fuel cell power plants, fuel cell battery powered bus system, comparison between acidic and alkaline hydrogen-oxygen fuel cells, state of art fuel cells, energy output of a fuel cell, efficiency and EMF of a fuel cell, Gibbs-Helmholtz equation, hydrogen fuel cell analysis with thermodynamic potentials, comparison of electrolysis and the fuel cell process, operating characteristics of fuel cells, thermal efficiency, future potential. **(06Hrs)**

Hybrid Energy Systems: Need for hybrid systems, types, electric and hybrid electric vehicles, hydrogen powered electric vehicle. **(04Hrs)**

Term Work: It shall consist of assignments and case presentation based on the syllabus.

Text Books:

1. D.P.Kothari, K.C.Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", Prentice Hall of India, New Delhi, 2009.

Reference Books:

1. Chetan Singh Solanki, "Renewable Energy Technologies", Prentice Hall of India, New Delhi, 2009
2. G. D. Rai, "Non- conventional Energy Sources", Khanna publishers, New Delhi, 2011.
3. Malti Goel, "Energy Souces and Global Warming", allied publishers Pvt Ltd. New Delhi, 2005.
4. S.P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", TMH, New Delhi, 2008.

Course outcomes: On successful completion of the course, students able to:

- Interpret energy reserves of India and potential of different energy sources.
- Measure the solar radiation parameters and performance of different solar collectors.
- Calculate different parameters of wind turbine rotor.
- Implicit the importance and applications of geothermal and ocean energy.
- Demonstrate knowledge in field of fuel cell and potential for power generation.

ME409 - PRESSURE VESSEL DESIGN

(CREDITS: THEORY - 04)

Course code: ME409 **Contact Hours /Week:** Th-03,Tu-01

Course Objectives:

- To acquire basic understanding of design parameters for pressure vessel design.
- To make aware of different type of stresses to be considered in designing a pressure vessel.
- To inculcate use ASME codes for designing pressure vessels.
- To analyze different piping systems for stresses using flow diagrams, layouts.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Stresses in vessels: General theory of membrane stresses in vessel under internal pressure and its application to shells (cylindrical, conical and spherical) and end closures. Bending of circular plates and determination of stresses in simply supported and clamped circular plate; Thermal stresses; Stress concentration in plate having circular hole due to bi-axial loading, excessive elastic deformation, plastic instability, brittle, rupture and creep. Theory of reinforced opening and reinforcement limits **(08Hrs)**

Design of Vessels using Codes: Introduction to ASME cods for pressure vessel design, Pressure vessel and related components' design using ASME codes; Supports for short vertical vessels, stress concentration at a variable thickness transition section in a cylindrical vessel; Design of nozzles. **(06Hrs)**

Supports for vertical & horizontal vessels: Design of base plate and support lugs. Types of anchor bolt, its material and allowable stresses. Design of saddle supports. **(06Hrs)**

Design Considerations: Buckling phenomenon, Elastic Buckling of circular ring and cylinders under external pressure, collapse of thick walled cylinders or tubes under external pressure, Effect of supports on Elastic Buckling of Cylinders, Design of circumferential stiffeners, Buckling under combined External pressure and axial loading. Fatigue, shock, high pressure, high temperature, irradiation, corrosion, and other hostile environments, high strength, lightweight pressure vessels, vessels resistant to external high pressures found in undersea exploration, offshore drilling, and mineral mining. **(10Hrs)**

Piping Analysis: Flow diagram, piping layout and piping stress analysis; Flexibility factor and stress intensification factor; Design of piping system as per B31.1 piping code. Piping components: bends, tees, bellows and valves. Types of piping supports and their behavior; Introduction to piping Codes and Standards. **(08Hrs)**

Storage Vessel: Storage of fluids, Storage of non-volatile fluid, Storage of volatile liquids, storage of gases, Design of rectangular tanks, design of tanks, nozzles and mountings, large capacity storage tanks. **(06Hrs)**

Process Hazards and Safety Measures in Equipment Design: Introduction, Hazards in process

industries, Analysis of Hazards, Safety Measures in equipment design, Pressure relief device. **(04Hrs)**

Text Book:

1 V.V. Mahajani "Joshi's Process Equipment Design" Paperback – 2014.
2 M.V. Joshi, V.V. Mahajaini "Process Equipment Design", Macmillan India Ltd.

Reference Books:

1. Henry H. Bedner, "Pressure Vessels", Design Hand Book, CBS publishers, 2007.
2. John F. Harvey, "Pressure Vessel Design", CBS publishers, 2007.
3. ASME Code for Pressure Vessel Design.

Course Outcomes:

- Student demonstrates basics of pressure vessel design and important parameters to design.
- Ability to design internal pressure vessels and external pressure vessels.
- Ability to design special vessels (e.g. tall vessels) and various parts of vessels (e.g. heads).
- Student shows ability to understand standard codes and use them to design process equipments.
- Student shows ability to identify pitfalls in system and related control measures.

ME410 - ADVANCED WELDING TECHNIQUES

(CREDITS: THEORY - 04)

Course code: ME410 **Contact Hours /Week:** Th-03, Tu-01

Course Objectives:

- To inculcate the need of advanced welding techniques.
- To describe and demonstrate EBW,LBW,USW,AHW techniques
- To demonstrate the working principles of underwater welding.
- To make aware destructive and nondestructive testing methods for testing welded joints.
- To apply different techniques of testing the welded joints to test simple welded joints.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction: Classification of welding processes, weld design, applications and need of advanced welding processes. **(08Hrs)**

Electron beam welding: Principle, working, key holing, power source requirements, variables that control EBW, applications. **(08Hrs)**

LASER welding: Principle, parallelism and intensity, focusing, quantum theory, population inversion, types of lasing materials, working and applications. **(08Hrs)**

Ultrasonic welding: Principle, working, ultrasonic welding and energy flow, and applications. **(08Hrs)**

Atomic hydrogen welding: Atomic hydrogen welding system, Principle, working, atomic hydrogen flame, atomic hydrogen arc column, limitations and applications. **(08Hrs)**

Under water welding: Principle, working, types, limitations and applications. **(04Hrs)**

Testing of welding: Destructive and non-destructive testing methods for welds **(04Hrs)**

Text Books:

1. Welding Technology - O. P. Khanna

Reference Books:

1. Welding Technology - R. Little - TMH Pub.
2. Welding Manufacturing Process - Dr. Y.V. Deshmukh, P.K. Roy.
3. Manufacturing Technology-Foundry, Forming and welding by P. N. Rao, Tata McGraw Hill, 2006 .

Course Outcomes:

- Student knows the principles of various welding processes and their application and need of advanced welding processes.
- Student demonstrates how different welding power sources work.
- Relate Generation and control of laser beam for welding, its working and applications.
- Student can explain the principle, working, key holing, power source requirements, variables that control EBW, applications.

- Understands Principle, working, energy flow, and applications of Ultrasonic welding, atomic hydrogen welding system, and under water welding.
- Student show ability to analyze destructive and non-destructive testing methods for welds.

ME411 - QUALITY & RELIABILITY ENGINEERING

(CREDITS: THEORY - 04)

Course code: ME411 **Contact Hours /Week:** Th-03, Tu-1

Course Objectives:

- To acquaint with basic concept of quality Control.
- To aware of various quality control tools and techniques.
- To inculcate the scientific basis of process capability analysis
- To impart the fundamentals of Acceptance Sampling, its use and economics.
- To impart the fundamentals of Reliability Engineering.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction: Quality, components of quality control viz; quality of design, quality of conformance, quality assurance, statistical process control, role of Q. C. in industries. **(04Hrs)**

Basic Probability Concepts: The histogram, Box-and-whisker plot, numerical indices for summarizing data (mean, median, standard deviation, etc) probability distribution (Normal, Exponential, poisson, Binomial) concept, nature and applicability. **(06Hrs)**

Statistical Tools for Analyzing Data: Scope of data analysis, statistical inference, sampling variation and sampling distribution, statistical estimation: confidence limits, importance of confidence limits in planning test programs, sample size determination for given accuracy. Hypothesis testing and drawing conclusion, type I and Type II errors, determination of sample size required for testing of hypothesis. Simple numerical based on above. **(08Hrs)**

Control Charts: Control Chart Point of View, System of Chance Causes, Patterns of Variations, Interpretation of Lack of Statistical Control, Interpretation of Patterns of Variation on X & R Charts, Shewart'sNormal Bowl, Estimation of Control Limits. Control Charts for Variables, X & R, 6 Charts, O C curve for control charts, Control Charts for Attributes: p, c, np, u-Charts. **(10Hrs)**

Process Capability Analysis: Objectives Of Analysis, Estimation Of Process Capability, Process Capability Indices, Viz: Cp, Cpk, Cpm, and Their Interpretation. **(04Hrs)**

Acceptance Sampling: Concept and importance of sampling, economics of sampling inspection, symbols and terms used in relation to sampling plans. Lot-by-lot acceptance using single sampling plan, OC curves, sampling risk, AQL, LTPD, alpha and beta risk, construction of OC curve for given sampling plan, estimating alpha and beta risks for a given plan. Effect of lot size, sample size, acceptance number, producer's and customer's risk.Indexing of acceptance sampling plans by using a single point on OC curve.Average outgoing and the AOQL. Double sampling plans, analysis of double sampling plans, minimizing average total inspection. Use of ANSI/ASQC Z 1.4 standards for attribute sampling plans switching procedure for normal and tightened inspections. Calculation of average

sample numbers in double sampling plans. Use of Dodge - Romig sampling plans. Construction of OC curves. Estimation of average inspection, sampling risks, etc. for single and double sampling plans selected for the standard plan. **(10Hrs)**

Reliability Engineering: Introduction, Bathtub curve, causes of failure, concepts/definitions of reliability availability, maintainability, Computation of component reliability: failure rate, hazard rate, MTBF, MTTF etc. Reliability of series and parallel systems, redundancy, product/component design analysis using FMECA and fault tree analysis. **(06Hrs)**

Text Book:

1. Fundamentals of Quality Control and Improvement – Amitava Mitra Pearson Education Inc.

References Books:

1. Statistical Quality Control - E.L.Grant, R.S. Leavenworth. - Tata McGraw Hill.
2. Quality Planning and Analysis - J.M. Juran, Frank M. Gryna - Tata McGraw Hill.
3. Assurance Science - Walter A Shewart.
4. Introduction to Reliability in Design - Charles O. Smith - McGraw Hill Ltd.
5. Mechanical Reliability – L.S.Srinath.

Course Outcomes:

After completion of this course a student should be able to:

- Interpret the basic principles of probability theory, standard distributions.
- Interpret the statistical process control, rules for identifying process out of control.
- Understand and solve numerical on confidence interval, test of hypothesis
- Design a sampling plan, construct its OC curve, and estimate ATI, AOQ and other indices.

ME412 - TRIBOLOGY

(CREDITS: THEORY - 04)

Course code: ME412 **Contact Hours /Week:** Th-03,Tu-01

Course Objectives:

- To impart various theories of friction and wear and will be able to apply them to various practical situations.
- To make acquaint various surface measurement techniques and effect of surface texture on tribological behaviour of a surface.
- To demonstrate the process of selecting materials and lubricants to suggest a tribological solution to a particular situation.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction to Tribology: Introduction to tribology, tribology in design and industry, tribological properties of bearing materials, lubrication, basic modes of lubrication, properties of lubricants - physical and chemical, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, disposal of scrap oil, oil emulsion. **(08Hrs)**

Friction and Wear: Friction: Introduction, laws of friction, kinds of friction, causes of friction, friction measurement, theories of friction, effect of surface preparation. Wear: Types of wear, various factors affecting wear, measurement of wear, wear between solids and liquids, theories of wear. **(08Hrs)**

Hydrodynamic lubrication: Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, two-dimensional Reynold,,s equation, infinitely long journal bearing, infinitely short journal bearing, finite bearing. **(08Hrs)**

Hydrodynamic thrust bearing: Introduction, flat plate thrust bearing, pressure equation, friction in tilting pad thrust bearing. **(04Hrs)**

Hydrostatic lubrication: Basic concept, viscous flow through rectangular slot, load carrying capacity and flow requirement of hydrostatic step bearing, energy losses, optimum design of step bearing. Compensators and their actions. **(06Hrs)**

Squeeze film lubrication: Introduction, circular and rectangular plates approaching a plane. **(02Hrs)**

Elastohydrodynamic Lubrication: Principle and application, pressure - viscosity term in Reynolds equation, Hertz theory, Ertel-Grubin Equation. **(02Hrs)**

Gas lubrication: Introduction, merits and demerits, applications. **(02Hrs)**

Surface Engineering: Introduction, concept and scope of surface engineering, manufacturing of surface layers, solid surface-geometrical, mechanical and physico chemical concepts, superficial-layer, structure of superficial layer, general characteristics of superficial layer, obtained by machining, strengthening and weakening of superficial layer. Surface Engineering for Wear and Corrosion resistance: Diffusion, coating, electro and electro-less plating, hot deep coating, metal spraying, cladded

coating, crystallizing coating, selection of coating for wear and corrosion resistance, potential properties and parameters of coating. **(08Hrs)**

Term Work: It shall consist of at least six assignment based on above syllabus.

Text Books:

1. S. K. Basu, B. B. Ahuja, S. N. Sengupta , Fundamentals of Tribology. EEE, PHI Pvt. Publications Ltd.

Reference Books:

1. Cameron, "Basic Lubrication Theory", Ellis Horwood Ltd, 1981.
2. Principles in Tribology, Edited by J. Halling, 1975.
3. Tribology – B.C. Majumdar, Tata McGraw Hill Co Ltd.
4. Standard Hand Book of Lubrication Engg., O'Conner and Royle, McGraw Hills.

Course Outcomes: Student will to;

- Apply different theories of friction and wear in concerned areas.
- Predict tribological behaviour of the materials.
- Shows basic knowledge of selecting materials and lubricants to solve the problems aroused due to friction and wear in industries.
- Acquires the knowledge of surface engineering and its applications.

ME413 - CRYOGENICS

(CREDITS: THEORY - 04)

Course code: ME413 **Contact Hours /Week:** Th-03, Tu-01

Course Objectives:

- To impart the basic concepts of Cryogenics.
- To acquaint students methods of production of low temperature.
- To make familiar with the various applications of low temperature production

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction: Concept of Cryogenics, Historical background, Present areas involving cryogenics. **(02Hrs)**

Low Temperature Properties Of Engineering Materials: Mechanical properties, Thermal properties, Electric and magnetic properties, Properties of cryogenic fluids. **(06Hrs)**

Gas Liquefaction Systems: Introduction, Production of low temperature. Liquefaction systems for gases other than Neon, Hydrogen and helium, Liquefaction systems for Neon, Hydrogen and helium. **(08Hrs)**

Cryogenic Refrigeration System: Ideal refrigeration system, Refrigerators for temperature above 2K, Refrigerators for temperatures below 2K. **(08Hrs)**

Measurement Systems For Low Temperatures: Temperature measurement - Metallic resistance thermometers, Semiconductor resistance thermometers, thermocouples, Constant volume gas thermometer, Flow rate measurement - Orifice meters, venturi meters, fluid quality measurement, Liquid level measurement - Hydrostatic gauges, electric resistance gauges, capacitance liquid level probes, thermodynamic liquid level gauge. **(08Hrs)**

Cryogenic Fluid Storage And Transfer Systems: Cryogenic fluid storage vessel, Insulations, Cryogenic fluid transfer systems. **(08Hrs)**

Introduction To Vacuum Technology: Importance of vacuum technology in Cryogenics, Components of vacuum systems, Mechanical vacuum pumps, diffusion pumps, ion pumps, cryo pumping, baffle sand cold traps, vacuum gauges and valves. **(08Hrs)**

Text Book:

1. A. Bose and P. Sengupta, “Cryogenics: Applications and Progress”, Tata McGraw Hill Publications.

Reference Books:

1. Randall F Barron, “Cryogenic systems” Second Edition, Oxford University Press.
2. K. D. Timmerhaus and T. M. Flynn, “Cryogenic process engineering”, Plenum Press.
3. G. G. Haselden, “Cryogenic Fundamentals”, Academic Press.
4. J. G. Weisend II, Taylor and Fancis, “Handbook of cryogenic Engineering Editor”

Course Outcomes: students will be able to;

- Explains the working principles of three basic methods to achieve low temperature by using cryogenic technologies.
- Apply the basics of thermal and refrigeration science for cryogenics.
- Show knowledge about measurement equipment and basic skills for cryogenics.
- Provide design experiences for practical cryogenic systems requiring significant consideration of thermodynamics cycles.

ME414 - PLASTICS AND COMPOSITES

(CREDITS: THEORY 04)

Course code: ME414 **Contact Hours/Week:** Th-03, Tu- 01

Course Objectives:

- To impart sound knowledge in types of plastics, their structure, properties and applications
- To provide information about composites, its manufacture, applications
- To gain an understanding and in-depth knowledge of the various Reinforcements and Matrix Materials
- To provide knowledge of design of composite for a particular application

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction to Plastics: Structure and mechanical properties of plastics, Types; Thermosetting and Thermoplastics, Properties, Applications, Advantages and Disadvantages. **(02Hrs)**

Introduction to Composites: History of composite materials, Classification of composite materials, Properties of composites compared to other materials, Principles of composite reinforcement, Effect of fibrous reinforcement on composite strength, Application of composites in aerospace, automotive industry, marine industry, civil engineering applications, Electrical industry. **(06Hrs)**

Reinforcements and Matrix Materials: Glass, Boron, Carbon, Organic, Ceramic and Metallic Fibers, Manufacturing processes of fibers, Characteristic features of fibers, Surface treatment for glass fibers, Coupling agents, Particulate and flake reinforcement. **(06Hrs)**

Matrix Materials: Polymers, Metals and Ceramics, Composition manufacture. **(04Hrs)**

Processing of Composites:

Polymer Matrix Composites: Processing of thermoplastic: Injection moulding, Compression moulding, Glassmat-thermoplastic (GMT), **Processing of thermosetting;** Filament winding, Pultrusion, Unidirectional Prepreg autoclave processing, Resin transfer moulding, Sheet moulding compound (SMC). **(08Hrs)**

Metal Matrix Composite: Solid State Fabrication Techniques, Diffusion Bonding, Powder Metallurgy Techniques, Plasma Spray, Chemical and Physical Vapor Deposition of Matrix on fibers, Liquid State Fabrication Methods, Infiltration, Squeeze Casting, Rheo Casting, Compo casting. **(08Hrs)**

Ceramic Matrix Composites: Processing and structure of glass, Glass-ceramics, Processing of ceramic matrix composites, Alumina matrix composites, Carbon-carbon composites. **(06Hrs)**

Mechanical properties and mechanical testing of composites: Rule of mixtures, Responses of polymer composites to different mechanical loading conditions, Principles and features of different mechanical test methods. **(08Hrs)**

Term Work:

Assignments based on the each topic in above syllabus.

Text Books:

1. B. T. Astrom, "Manufacturing of polymer Composites", Chapman and Hall, London (1995).
2. Polymer Engineering Composites. Ed. M. O. W. Richardson, Applied Science Publishers, London.

References Books:

1. T. G. Gutowski, "Advanced Composites manufacturing", John Wiley and Sons, New York (1997).
2. P. K. Mallick," Fiber reinforced plastics", Marckel Dekkar Inc,1998.
3. Composite Material Science and Engineering, Krishan K. Chawla Springer.
4. Handbook of composites, G. Lubin, Van Nostrand, New York, 1982
5. Composite Materials handbook, Mein Schwartz McGraw Hill Book Company, 1984.
6. Mechanics of composite materials, Autar K. Kaw CRC Press New York.

Course Outcomes:

After completion of this course a student should be able to:

- Evaluate the properties of composite laminate.
- Fabricate PMC, MMC and CMC.
- Select an appropriate processing method for variety of composite and products.

ME415 - ROBOTICS

(CREDITS: THEORY - 04)

Course code: ME415 **Contact Hours /Week:** Th-03, Tu-01

Course Objectives:

- To demonstrate Basics of robotics (Links, Actuators, Sensors etc).
- To impart Statistics & Kinematics of robots.
- To demonstrate Desired motion of robot.
- To demonstrate Control system necessary for accurate operation of the robot.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction: Specifications of Robots- Classifications of robots – Work envelope - Flexible automation versus Robotic technology – Applications of Robots ROBOT KINEMATICS AND DYNAMICS Positions, Orientations and frames, Mappings: Changing descriptions from frame to frame, Operators: Translations, Rotations and Transformations - Transformation Arithmetic - D-H Representation - Forward and inverse Kinematics of Six Degree of Freedom Robot Arm – Robot Arm dynamics **(08Hrs)**

Robot Drives And Power Transmission Systems: Robot drive mechanisms, hydraulic – electric – servomotor- stepper motor - pneumatic drives, Mechanical transmission method - Gear transmission, Belt drives, cables, Roller chains, Link - Rod systems - Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws **(08Hrs)**

Kinematics And Kinematics Of Robot: Kinematics of serial robots: Direct and inverse kinematics problems, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Inverse kinematics solution for the general 6R serial manipulator. Kinematics of parallel robots: Degrees-of-freedom of parallel mechanisms and manipulators, Active and passive joints, Constraint and loop-closure equations, Direct kinematics problem, Mobility of parallel manipulators, Closed-from and numerical solution, Inverse kinematics of parallel manipulators **(08Hrs)**

Manipulators: Statics of robot manipulators: Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial and parallel manipulators, Loss and gain of degree of freedom, Statics of serial and parallel manipulators, Singularity analysis and statics. Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators **(08Hrs)**

Robot End Effectors: Classification of End effectors – Tools as end effectors. Drive system for grippers-Mechanical-adhesive-vacuum-magnetic-grippers. Hooks scoops. Gripper force analysis and gripper design. Active and passive grippers. **(04Hrs)**

Artificial Intelligence And Image Processing: Linear Kalman Filter: Algorithm, Application Artificial Intelligence: Introduction, Need and Application, Problem solving through forward and backward search. Image Processing: Introduction, Need, Image acquisition, Masking, Sampling. **(04Hrs)**

Text Book:

1. Asfahl, Robots and Manufacturing Automation, Wiley, India, 2012.

Reference Books:

1. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication,2015.
2. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009.
3. Mathia, Robotics for Electronics Manufacturing, Cambridge Uni. Press, India.
4. A Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2013.
5. R K Mittal & I J Nagrath, Robotics and Control, McGraw Hill Publication, 2015.
6. K Astrom & T Hagglund, PID Controllers: Theory, Design and Tuning, 2nd Edition, The Instrumentation, Systems, and Automation Society, 1995.

Course Outcomes: Student will be able to;

- Understands the complete design procedure of the robot.
- Select correct mechanism for operation of the robot.
- Select necessary actuators, sensors, control for satisfactory performance of the robot.

ME416 - FRACTURE MECHANICS

(CREDITS: THEORY - 04)

Course code: ME416 **Contact Hours /Week:** Th-03, Tu-01

Course Objectives:

- To pass on knowledge of fracture mechanics
- To percolate knowledge of using fracture mechanics in the actual design
- To pass on knowledge of using materials with existing cracks and know the behavior of existing cracks.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction: Significance of fracture mechanics – Linear elastic fracture mechanics (LEFM)-Griffith energy balance approach - Irwin's modification to the Griffith theory - instability and R curve-Stress analysis of cracks- fracture toughness - modes I, II & III - mixed mode problems- expressions for stresses and strains in the crack tip region - finite specimen width - superposition of stress intensity factors (SIF) – SIF of centre cracked plate, single edge notched plate, and embedded elliptical cracks R-curve concept-thickness effect. **(12Hrs)**

Crack tip plasticity: Irwin plastic zone size - Dugdale approach - shape of plastic zone - state of stress in the crack tip region - influence of stress state on fracture behavior- LEFM testing: Plane strain and plane stress fracture toughness testing -determination of R-curves. **(10Hrs)**

Elastic plastic fracture mechanics (EPFM): Development of EPFM - J-integral – Definition-Path independence-Application to engineering problems-crack opening displacement (COD) approach - COD design curve - relation between J and COD - tearing modulus concept - standard JIc test and COD test 26. **(10Hrs)**

Fatigue crack growth: Mechanisms of fracture and crack growth- Description of fatigue crack growth using stress intensity factor - effects of stress ratio - crack closure - prediction of fatigue crack growth under constant amplitude and variable amplitude loading - Fatigue Crack Initiation- Time-to-failure (TTF) tests - crack growth rate testing - practical significance of sustained load fracture testing- Basic aspects of Dynamic Crack Growth-Basic Principles of Crack Arrest -Fracture Mechanics Analysis of fast fracture and Crack Arrest. **(16Hrs)**

Text Books:

1. Prashant Kumar, Elements of Fracture Mechanics, Wheeler Publishing.

Reference Books:

1. M. Janssen, J. Zuidema and R. J. H. Wanhill., Fracture Mechanics, Taylor & Francis.
2. Broek D., Elementary Engineering Fracture Mechanics, Sijthoff & Noordhoff International Publishers.
3. T.L. Anderson , Fracture Mechanics Fundamentals and Applications , CRC PRESS.

Course outcomes:

- Students shows basic knowledge about fracture mechanics.

- Student will be able to Predict the life of the components under fatigue loading.
- At the end of the course students will know about how to restrict the propagation of crack

ME417 - HEATING VENTILATION AND AIR CONDIOTIONING

(CREDITS: THEORY - 04)

Course code: ME417 **Contact Hours /Week:** Th-03,Tu-01

Course Objective:

- To motivate the students for knowing basics of Heating Ventilation and Air-Conditioning system design.
- To familiarize with Building's HVAC system.
- To impart the skillS of knowing load estimation on HVAC systems.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course content:

UNIT I
Introduction: Overview of Industry and Scope of HVAC, applications of HAVC, definitions and terminology. (4HRS)
UNIT II
Duct and Air-Distribution Systems
Duct:
Duct Systems- General Aspects, Duct Size, Shape, Material and Construction, Pressure in Ducts, Continuity and Bernoulli's equation for ducts, Pressure Losses in Ducts-Pressure loss due to friction in ducts, Equivalent diameter of a circular duct for rectangular duct, Friction chart for circular ducts, Dynamic losses in ducts- Pressure loss due to enlargement in area and static regain, pressure loss due to contraction in area, pressure loss at suction and discharge of duct, pressure loss due to obstruction in a duct, Duct design-general aspects, Determination of duct size, Leakage of air and maintenance of ducts,

Air Distribution Systems:
Definitions, Principles of Air-distribution, Air-handling System, Room air-distribution- Requirements of good room air-distribution, Draft, Types of supply air outlets, Arrangement of ducts, Types of air-distribution systems. (16HRS)

UNIT III
Load Estimation:
Introduction, Cooling-load Estimate, Heating-load Estimate, Solar Radiation, Solar heat gain through Glass, Heat through Building Structures (Thermal Barrier), Infiltration, Internal Heat gains- Heat load of occupants, Electric load, Product load, Process load, System Heat Gains, Different factors to be considered in load Estimation Sheet for Comfort Application, Design of Cold Storage. (12HRS)

UNIT IV

Air conditioning systems:

Central system, Zoned system, Unitary system, Air-conditioning Equipment, Air-conditioning Components, Air-conditioning Controls, Noise and Noise Control. (8HRS)

UNIT V

Air conditioning Applications:

Typical air conditioning systems such as automobile, air plane, ships, railway coach air-conditioning. All the Year-round Air-conditioner, Year-round Absorption Air-conditioner, Air-conditioning of Theatres. (08HRS)

Text Books:

1. Refrigeration and Air Conditioning, Arora, C.P., Tata-McGraw- Hill, New Delhi, 2003.
2. Refrigeration and Air-Conditioning by R.K. Rajput, S. Chand Publications.

Reference Books:

1. ASHRAE Handbook - Fundamentals, American Society of Heating, Refrigerating and Air - Conditioning Engineers Inc., Atlanta, USA, 2009.

Course Outcomes: Students will be able;

- Apply the concepts of psychometrics and thermodynamics to heating and cooling analysis.
- Use basic concepts from heat transfer to determine heat gained or lost from a building.
- Design air-handling systems using concepts from fluid dynamics.
- Apply good engineering principles to meet the requirements for air quality control and comfort conditions.

ME418 - RAPID PROTOTYPING AND TOOLING

(CREDITS: THEORY - 04)

Course code: ME418 **Contact Hours /Week:** Th-03, Tu-01

Course Objectives:

- To familiarize with fundamentals of rapid prototyping
- To acquaint students process of making of suitable CAD model for Rapid prototyping
- To pass on various file formats and their techniques usable for rapid prototyping.
- To impart the process of manufacturing and tools required Prototypes.
- To make aware of use of rapid prototyping in reverse engineering

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course contents:

Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP. **(06Hrs)**

CAD Modeling & Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements, Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation. **(06Hrs)**

Rapid Prototyping Systems:

Photopolymerization:

Stereolithography (SL), SL resin curing process, SL scan patterns, Microstereolithography, Applications of Photopolymerization Processes. **(04Hrs)**

Powder Bed Fusion: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes. **(04Hrs)**

Extrusion Based Rapid Prototyping System: Fused Deposition Modeling (FDM), Principles, Plotting and Path Control, applications of extrusion based processes. **(03Hrs)**

3D Printing: 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes. **(04Hrs)**

Sheet Lamination: Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. **(04Hrs)**

Beam Deposition: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks. **(04Hrs)**

Reverse Engineering: Basic concept, Digitization techniques, Model Reconstruction, Data Processing for Rapid Prototyping, Reverse Engineering (RE) Methodologies and Techniques, Selection of RE

systems, RE software, RE hardware, RE in product development. **(04Hrs)**

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods. **(03Hrs)**

Errors in RP process: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS. **(03Hrs)**

Rapid Tooling Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP. **(03Hrs)**

Text Books:

1. Rapid Prototyping - A Brief Introduction by Amitabha Ghosh, East West Publishers.

Reference Books:

1. M Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific Publishers.
2. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
3. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons.
4. D.T. Pham & S. S. Dimove: Rapid Manufacturing: The Technologies and application of of Rapid prototyping and Rapid tooling, Springer.

Course Outcomes: Students will;

- Show knowledge Basics Rapid Prototyping processes
- Apply and use techniques for processing of CAD models for rapid prototyping.
- Demonstrate areas of application of rapid prototyping
- Map relevance of rapid prototyping in reverse engineering

ME419 - SHOP FLOOR AUTOMATION

(CREDITS: THEORY - 04)

Course code: ME419 **Contact Hours /Week:** Th-03, Tu-01

Course Objectives:

- To demonstrate techniques to increase Productivity and quality of products and reduce the cost of production lines.
- To make aware of the basics of cell manufacturing.
- To impart the concept of control systems, automation and assembly line.
- To Familiarize with various work handling systems used in industries.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction to Automation: Basic element of an automated system, Advanced automation functions, Levels of automation. **(04Hrs)**

Introduction to manufacturing systems: Components of manufacturing system, classification scheme for manufacturing systems, overview of the classification scheme. **(06Hrs)**

Single station manufacturing cells: Single station manned cells, single station automated cells, applications of single station cells, analysis of single station systems. **(06Hrs)**

Assembly lines: Fundamentals of manual assembly lines, Fundamentals of automated production lines, Applications of automated production lines, Analysis of transfer lines, Fundamentals of automated assembly systems. **(08Hrs)**

Control Technologies in Automation: Industrial Control Systems, process industries verses discrete-manufacturing industries, continuous versus discrete Control. Computer based control process and its forms. Open and closed loop control system. Control system components. Introduction to sensor technology, various sensors, transducers, signal processing. Programming of microprocessors using 8085 instructions. Programmable logic controllers. **(12Hrs)**

Automated Work Piece Handling: Working principles and techniques, job orienting and feeding devices. Transfer mechanisms, automated feed cut of components, performance analysis. Types of automated handling systems including AGV and its various guiding technologies, applications. **(12Hrs)**

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

Text Books:

1. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education Pte. Ltd, Delhi.

Reference Books:

1. M.P. Groover and Zimmer, "CAD/CAM", PHI. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing" Pearson Education, New Delhi. ISBN: 0132393212
2. N. Viswanandham, Y. Narhari "Performance Modeling of Automated Manufacturing Systems"

Prentice-Hall. ISBN: 0136588247.

Course Outcomes:

Students will,

- Know basics of production lines and its real life application.
- Shows ability to solve various manufacturing and assembly lines problems.
- Apply concepts of automation and control systems for manufacturing.
- Capable of selecting and analyzing proper work handling systems required for manufacturing.

ME420 – WORLD CLASS MANUFACTURING

(CREDITS: THEORY - 04)

Course code: ME420 **Contact Hours /Week:** Th-03,Tu-01

Course Objectives:

- To acquaint the basic concept of manufacturing excellence.
- To Impart and understand various manufacturing philosophies.
- To develop an ability to understand Total Quality Management (TQM) Philosophy.
- To develop an ability to understand various maintenance philosophy's.
- To Impart Various Lean Principles used in Manufacturing.
- To understand the hurdles in implementation of WCM philosophy.

Evaluation Scheme:

Theory	Mid Term: 30 Marks	End Term: 70Marks

Course Contents:

Introduction to World Class Manufacturing:

Manufacturing excellence and competition frame work of WCM- Hall's, Schonberger's Gunn's, Maskell. WCM and Indian manufacturing scenario.

Total Quality Management:

Quality definition, Contribution of various quality guru, Customer satisfaction, Continuous improvement, Supplier partnership, performance measures of Quality.

Tools and Techniques of TQM:

Matrix diagram, process decision program chart, Management tool- Force field analysis, affinity diagram, Pareto diagram, Histogram, Process flow diagram, why- why analysis, Cause and effect diagram, Benchmarking, Quality function deployment (QFD), ISO 9000,

JIT Philosophy:

Just in time, Push-Pull Production, seven waste, Basic element of JIT, KANBAN, PoKa YoKe, 5 S Theory, Implementation of JIT, Value engineering, Six Sigma.

Total Productive Maintenance:

Introduction of maintenance, Zero breakdowns – Zero Defects and TPM, five pillars of TPM, Learning and implementing TPM, Development Autonomous Group, Training pertaining to TPM, Calculation relation with availability of machine.

Business Process Reengineering:

Service Management, Introduction to concurrent engineering, Introduction to ERP and Supply chain management.

Reference Books:

1. WCM- A strategic Perspective by B. S. Sahay, K. B. C. Saxena, Macmillan Publication.
2. Industrial Engineering and Production Management by Mart and Telsang. S. Chand Publication.
3. Total Quality Management by K.C. Arora. S. K. Kataria and Sons Publication.
4. Total Quality Management by Barsterfield, Pearson Publication.

Course Outcomes:

After completion of this course a student should be able to;

- Demonstrates the various manufacturing Philosophies.
- Apply and demonstrates Just in time and Quality management philosophies.
- Apply and demonstrates the maintenance philosophies.
- Demonstrates various JIT and West elimination Technologies

ME405 - PROJECT

(CREDITS: PRACTICAL - 12)

Course code: ME405 **Contact Hours/Week:** Pr-04

Course Objectives:

This course is progression of courses studied by students focusing on enhancing the abilities and skill in conducting project based on their interested area. It provides students with technical writing and presentation skills.

At the end of the course student should be able to:

- Get interface with industry culture and environment.
- Manage and execute project plan in solving technical/research problems.
- Analyse project results using appropriate techniques or tools.
- Preset and defend project outcomes effectively.
- Team work: it required to work as team during project work.
- Think creatively, critically, innovatively, analytically and ability to apply the understanding and knowledge to the new and real life problems.

Evaluation Scheme:

Sr. No.	Component	Weightage (%)
1	Mid Term Presentation (Including Abstract +Part Implementation)	30
2	End Term Presentation cum oral examination/demonstration of the project work (Including submission of hard bound project Report)	70

1. The students doing project in industry have to maintain a project diary, in which continuous (at least weekly) improvement of work should be noted and should be duly signed by supervisor (industry person).
2. The students who are doing in-house project (non industrial) should also maintain project diary and have to report improvements in work to the guide/supervisor in institute 04 hours weekly at least.
3. Projects have to be performed in groups (Max 4-5 student in a group) and individual's roll/participation/ work will be evaluated through project diary and presentations.
4. Project Report writing should be done only as per given guidelines.

Course Contents:

The project work may consist of an extensive work, study or analysis of field/industrial problems with appropriate solutions or remedies. It includes like:

1. Fabrication of model, machine, prototype on the basis of innovative ideas.
2. Modeling and/or simulation of a system and improvements in the system.
3. Design of experiments, experimental setups, fabrication of test equipment, experimentation an Statistical analysis, comparison with the existing data.
4. Renovation of machines, testing equipments.

5. Extensive analysis of some problems solved with the help of suitable software.
6. Design, modeling, analysis and so on as deemed fit.

Term Work: It shall consist of abstract and progress report submission during Midterm presentation and final hard bound report submission at the time of End term submission.

Practical Examination: It shall consist of oral examination/demonstration of project in presence of guide/supervisors and external examiners or panel of the same.

Course Outcomes:

At the end of course students will able to

1. Design, analyse and manufacture the machines/testing rigs/experimental setup
2. Customize/develop software in the relevant area.
3. Solve the problems of industry through project work.
4. Learn presentation skills and documentation.

ME406 - MINI PROJECT

(CREDITS: PRACTICAL - 04)

Course code: ME406 **Contact Hours/Week:** Pr-01

Course Objectives:

- To motivate the students for applying engineering knowledge for benefits of society through Energy Management, Waste Elimination, Pollution Control and Environmental awareness.
- To develop an ability to design and conduct experiments, as well as to analyze and interpret data
- To develop an ability to function on multidisciplinary teams.
- To develop an ability to identify, formulate, and solve engineering problems

Evaluation Scheme:

Sr. No.	Component	Weightage (%)
1	Mid Term Presentation (Including Abstract)	30
2	End Term Presentation cum oral examination/demonstration of the mini project work (Including submission of spiral bound project report)	70

Note:

1. The students doing project in industry have to maintain a project diary, in which continuous (at least weekly) improvement of work should be noted and should be duly signed by supervisor (industry person).
2. The students doing in-house project (non industrial) should also maintain project diary and report improvement in work to the allotted guide/supervisor in institute 02 hours weekly at least.
3. Mini Projects have to be performed in groups (Max 4-5 student in a group) and individual's roll/participation/ work will be evaluated through project diary and presentations.
4. Report writing should be done only as per given guidelines.

Course Contents:

This course will considered as mini project and student has to carry out the all activities similar to the project course and the project may include extensive study, analysis, modeling and fabrication of various systems for;

- Energy Management
- Pollution Control Systems
- Waste Management
- Efficiency in Motor drive Systems
- Efficiency in Boilers and Steam Systems
- Efficiency in Pumping Systems
- Environmental crisis and Control Measures
- Waste Heat Recovery

- Climate, Clean Development Mechanism, Carbon Credits
- House Keeping
- Any Other related Topic.

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Term Work:

It shall consist of abstract submission during Midterm presentation and final spiral bound report submission at the time of End term submission.

Practical Examination: It shall consist of oral examination/demonstration of mini project in presence of guide/supervisors and external examiners or panel of the same.

Course Outcomes:

At the end of course students will able to

1. Design, analyse, manufacture the machines/component/ represent methodology to save energy.
2. Shows ability to design and conduct experiments, as well as to analyze and interpret data
3. Shows Techniques to Eliminate West, Pollution Control.
4. Function on multidisciplinary teams
5. Understand professional and ethical responsibility
4. Learn presentation skills and documentation.