Bachelor of Technology

(B Tech)

7th Semester

Detailed Syllabus of

2022-2026 Batch

Department of

Mechanical Engineering

NIST Institute of Science and Technology,

Pallur Hills, Berhampur, 761008, Odisha

SEVENTH SEMESTER					
Theory					
Sl. No.	Category	Subject Code	Subject Name	L-T-P	Credit
1	PCC	22ME7PC01T	Refrigeration and Air-Conditioning	3-0-0	3
2	PCC	22ME7PC02T	Mechanical Measurement, Metrology and Reliability	3-0-0	3
3	PEC	22ME7PE01T/ 22ME7PE02T/ 22ME7PE03T/ 22ME7PE04T	Fatigue Creep and Fracture/ Design of Machine Components/ Experimental Stress Analysis/ Hydraulic and Pneumatic Devices	3-0-0	3
4	PEC	22ME7PE05T/ 22ME7PE06T/22 ME7PE07T/ 22ME7PE08T	Power Plant Engineering/ Computational Fluid Dynamics/ Product Design and Production Tooling/ Process Planning and Cost Estimation	3-0-0	3
5	OEC	**Open Elective – 3 (for Non-ME Students)**			
		22ME7OE01T/ 22ME7OE02T	Robotics (Introduction to Kinematics and Dynamics)/ Numerical Method for Engineers	3-0-0	3
		Open Elective – 3 (for ME Students)			
Total Credit (Theory)					15
Practical					
1	PCC	22ME7PC01L	Refrigeration and Air Conditioning	0-0-2	1
2	PCC	22ME7PC02L	Mechanical Measurement, Metrology and Reliability	0-0-2	1
3	PSI	22CM7PS01L	Minor Project	0-0-6	3
4	PSI	22CM7PS02L	Summer Internship/ Training/ MOOC Certified	0-0-2	1

5	HSMC	22CM6HS01L	Entrepreneurship Project	0-0-4	2
Total Credit (Practical)					8
Total Semester Credit					23

Course Code: 22ME7PC01T	Course Name: Refrigeration and Air-Conditioning	L-T-P: 3- 0- 0	Credit: 3

Course Objectives:

1 Students can understand the principles of refrigeration and air conditioning.
2 Students can to calculate the cooling load for different applications.
3 Students can select the right equipment for a particular application.
4 Students can design and implement refrigeration and air conditioning systems using standards.
5 Students can understand Energy Conservation and Management by using different types of refrigeration system like VARS
6 Student have gain knowledge about various refrigerant and its designation

Syllabus

Module – I **[10 Hours]**

Air Refrigeration System: Introduction, unit of refrigeration, coefficient of performance, reversed Carnot cycle, Temperature limitations, maximum COP, Bell Coleman air cycle, simple air cycle system for air-craft with problems.

Vapour Compression System: Analysis of theoretical vapour compression cycle, representation of cycle on T-s and p-h diagram, Simple saturation cycle, sub-cooled cycle and super-heated cycle, Effect of suction and discharge pressure on performance, actual vapour compression cycle, problem illustration and solution.

Module – II **[8 Hours]**

Multi-stage compression and Multi-evaporator systems: Different arrangements of compressors and inter-cooling, multistage compression with inter-cooling, multi evaporator system, dual compression system, simple problems

Vapour Absorption System: Ammonia absorption system, lithium-bromide-water vapour absorption system

Module – III **[8 Hours]**

Classification of refrigerants and its designation: halocarbon compounds, hydrocarbons, inorganic compounds, azeotropes, properties of refrigerants, comparison of common refrigerants, uses of important refrigerants, alternative refrigerants, a discussion on ozone layer depletion and global warming.

Module – IV **[8 Hours]**

Psychometrics: Properties of air-vapour mixture, law of water vapour-air mixture, enthalpy of moisture, psychometric chart, simple heating and cooling, humidification, dehumidification, mixture of air streams.

Module – V **[6 Hours]**

Requirements of comfort air conditioning: Oxygen supply, heat removal, moisture removal, air motion, purity of air, thermodynamics of human body, comfort and comfort chart, effective temperature, factors governing optimum effective temperature

Air Conditioning System: Process in air conditioning, summer air conditioning, winter air conditioning and year round air conditioning, cooling load calculations.

Text Books

1. Refrigeration and Air conditioning, R. C. Arora , PHI Publication, 3rd edition, 2010.
2. Refrigeration and Air conditioning, C. P. Arora, Tata McGraw Hill, 3rd edition, 2017.

Reference Books

1. A Course in Refrigeration and Air- Conditioning, S.C. Arora and S. Domkundwar, Dhanpat Rai & Sons, 7th edition, 2018.
2. Refrigeration and Air conditioning Data book, Manohar Prasad, New Age International Pvt Ltd; 2nd edition, 2001.
3. Refrigeration and Air conditioning, P. L. Ballney, Khanna Publishers.
4. Refrigeration and air conditioning, W. Stoecker and J.W. Jones, McGraw-Hill, Inc. 2nd edition, 1958.

5. Refrigeration and air conditioning, G. H. Hundy, A. R. Trott, T.C. Welch, Butterworth-Heinemann, 4th edition, 2008.

Online Resources

1 Online course on "Refrigeration and air-conditioning" by Prof. Ravi Kumar, IIT Roorkee, https://nptel.ac.in/courses/112107208

Course Outcomes:

1 Understand the principles and applications of refrigeration systems.

2 Understand vapor compression refrigeration system and identify methods for performance improvement.

3 Study the working principles of air, vapor absorption, thermoelectric and steam-jet refrigeration systems.

4 Analyze air-conditioning processes using the principles of psychometric

5 Evaluate cooling and heating loads in an air-conditioning system.

Course Code:	Course Name:	L-T-P	Credit
22ME7PC01L	Refrigeration and Air-Conditioning Laboratory	0- 0- 2	1

Course Objectives:

1. To know about actual vapor compression and vapor absorption refrigeration system
2. To know about air conditioning system
3. To study of psychometric analysis of air conditioning system
4. Understand the working of heat pump
5. Able to analysis the performance of cooling tower

Syllabus

1. Find COP of vapor compression system
2. Find COP of Ice Plant test rig
3. Find COP of duct type Air Conditioning
4. Psychometric evaluation of duct type Air Conditioning
5. Study of window type air conditioning
6. Find COP of heat pump
7. Study of vapor absorption refrigeration system
8. Performance of cooling tower test rig

Course Outcomes:

At the end of the course, the student will be able to:

1 Basic knowledge vapor compression and vapor absorption refrigeration system

2 Get knowledge on air conditioning system

3 Evaluate the psychometric properties analysis of air conditioning system

4 Gain knowledge about heat pump and its performance

5 Evaluate the performance of cooling tower

Course Code:	Course Name:	L-T-P	Credit
22ME7PC02T	Mechanical Measurement, Metrology and Reliability	3- 0- 0	3

Course Objectives:

1. To develop the knowledge of basics of Measurements, Metrology and Measuring devices in students
2. To develop competence in sensors, transducers and terminating devises with associated parameters
3. To understand the concepts of various measurement systems & standards with regards to realistic applications.
4. The application of principle of metrology and measurements in industries.
5. To develop basic principles of reliability

Syllabus

Module – I **[6 Hours]**

Principles of Measurement and Instrumentation: Principle of measurement, error, measurement, measurand, methods of measurement, classification of measuring instruments and measuring systems, static performance parameters, impedance loading and matching, selection and spec of instrument, dynamic response, compensation.

Module – II **[6 Hours]**

Transducers and Strain Measurement: Analog digital transducer comparison, transducer element list, electrical transducer: sliding contact, variable-inductance transducer elements, differential transducer, variable reluctance transducer, capacitive transducer, piezo-electric effect, photo electric transducer.

Strain Measurement: Electrical resistance strain gauge, metallic resistance strain gauge.

Module – III **[9 Hours]**

Pressure and Flow Measurement: Pressure measurement transducer, Elastic diaphragm, strain gauge pressure cell, high pressure measurement, low pressure measurement, dynamic characteristics of pressure measuring system.

Flow characteristics of obstruction flow meter, orifice meter, venturimeter, pitot tube variable area meter, turbine flow meter bi-metals precision thermometer, thermocouple, pyrometer, calibration.

Module – IV **[9 Hours]**

Fundamentals of Metrology and Measurement Standards: Principles of measurement, line, end standards, comparison, optical standard, calibration, find unknown length, accuracy and precision. Random error and systematic error, measurement of surface roughness. limits, fit & gauges, straightness, flatness and circularity.

Module – V **[8 Hours]**

Quality and Reliability Engineering: Quality, reliability, bath-tub curve, system reliability for multi-component system, reliability improvement, MTBF, MTTR, maintainability and availability, availability of single repairable system using markov model. life tests, acceptance sampling plan based on life test.

Text Books

1 Engineering Metrology& amp Measurement, N. V. Raghavendra and L. Krishnamurthy, OXFORD University Press, 2013
2 Instrumentation Measurement and Analysis, B. C. Nakra and K. K. Chaudhry, Tata McGraw Hill, 4th edition, 2016
3 Engineering Metrology, R. K. Jain, Khanna Publisher, Delhi, 21st edition, 1984
4 Reliability Engg. And Terotechnology, A. K. Gupta, Macmillan India, 1st edition, 2015

Reference Books

1 Metrology & Measurement, A. K. Bewoor and V. A. Kulkarni, Mc Graw hill, 2017
2 Mechanical Measurements, T. G. Beckwith and N. Lewis Buck, Oxford and IBH Publishing Co., 2020
3 A text book of Engineering Metrology I.C. Gupta, Dhanpat Rai & amp, sons, Delhi, 2018.

Online Resources

1. Online course on "Mechanical Measurements and Metrology, IIT Madras" by Prof. S.P. Venkateshan, Prof. Shunmugam, IIT, Madras, https://nptel.ac.in/courses/112106138

Course Outcomes:

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

1 Define and explain measurement systems. He will be able to define various terminologies associated with Mechanical Measurements.

2 Explain various measuring techniques for Pressure, Strain and Temperature with neat sketches.

3 Describe laws of thermocouples and pyrometer construction.

4 Understand and describe the basic standards of measurements and application of slip gauge, limit gauges.

5 Understand the concept of different types of dimensional tolerances and fits.

Course Code:	Course Name:	L-T-P	Credit
22ME7PC02L	Mechanical Measurement, Metrology and Reliability Laboratory	0- 0- 2	1

Course Objectives:

1. Understand the working of LVDT, load cell and rotameter.
2. Understand the working of thermocouples ,bourdon gauge .
3. Determine surface roughness and strain gauge.
4. Understand straightness and flatness.
5. Understand the working o damping coefficient.

Syllabus

1. Calibration of LVDT
2. Calibration of load cell using electrical resistance strain gauge
3. Calibration of a Rotameter for fluid flow measurement
4. Calibration of thermo couples
5. Calibration of Bourden Tube Pressure Gauge and measurement of pressure using manometer
6. Strain measurement using resistant strain gauge
7. Measurement of straightness and flatness
8. Measurement of roughness of the surface
9. Experiment on slip gauges and sine bar.
10. Determination of damping coefficient of vibration absorbing materials using vibration measuring equipment.

Course Outcomes:

At the end of the course, the student will be able to:

1 Evaluate the calibration process of LVDT, load cell, rotameter.

2 Evaluate the calibration process of thermocouples, Bourdon gauge.

3 Determine surface roughness, straightness and flatness of materials.

4 Calculate the length and angles using slip gauges and sine bar.

5 Determine damping coefficient.

Course Code:	Course Name:	L-T-P	Credit
22ME7PE01T	Fatigue Creep And Fracture	3- 0- 0	3

Course Objectives:

The main objective of the course is to

1. Provide the basic knowledge on the mechanics of elastic and plastic deformation.
2. Understand basic techniques used to predict and control fatigue.
3. Provide a thorough introduction to the principles of fracture mechanics.
4. Creep, Fracture and fatigue failure as applied to metals
5. Learn about basic mechanisms behind creep.

Syllabus

Module – I **[10 hours]**

Fatigue Design: Cyclic stress and stress reversals, fatigue and progressive fracture, Endurance limit, cantilever and beam type of fatigue tests, axial fatigue tests, influence of mean stress on fatigue: Gerber, Goodman and Soderberg's criteria, effect of compressive cyclic stress on fatigue, fatigue design formula for axial, bending, torsional and combined loading, fatigue controlling factors: effect of frequency, temperature, size, form, stress concentration factors, notch, sensitivity & surface conditions, residual stresses.

Module – II **[8 hours]**

Fatigue strength: Improvement of fatigue strength by chemical/metallurgical processes such as nitriding, flame hardening, case carburising. Fatigue strength enhancement by mechanical work: cold rolling, peening, shot peening.

Module – III **[8 hours]**

Fracture Mechanics: Ductile and brittle fracture, theoretical cohesive strength of metals, Griffith Theory of brittle fracture, Oruron's modification to Griffith Theory.

Module – IV **[8 hours]**

Modes of fracture: Mode I, II and III, fatigue creek growth behaviour of metals, linear elastic fracture mechanics (LEFM), stress intensity factor(SIF), stress field near the crack tip, critical SIF and fracture toughness, experimental determination of fracture toughness (K_{IC}), crack opening displacement (COD) gauges and standard ASTM tests, strain energy release rates (SERR), elasto-plastic fracture mechanics (EPFM), plastic zone size an its evaluation, J-integral method.

Module – V **[9 hours]**

Creep analysis: Definition, constant stress and constant, strain creep tests, uniaxial creep tests, Baily's power law, creep relaxation: strain hardening and time hardening creep relaxation, introduction to creep bending and deflection of simple problems.

Text Books

1 Instrumentation Measurement and Analysis, B. C. Nakra and K. K. Chaudhry, Tata McGraw Hill, 4th edition, 2016
2 Mechanical Metallurgy, George E. Dieter, McGraw Hill Education, 3rd edition, 2017
3 Mechanical Behaviour of Engg. Materials, Joseph Marin, Prentice Hall of India, 2nd edition, 2017
4 Metal Fatigue in Engg. ,Stephens, R.I. and Fuchs, H.O., John Wiley & Sons, 2nd edition, 2000
5 Creep of Engg. Materials, Finnie, I. and Heller, W.R., McGraw Hill Book Co., 2nd edition, 1995

Reference Books

1. Advanced Mechanics of Materials, L.S. Srinath, Tata Mc Graw Hill Ltd., 3rd edition, 2017
2. Mechanical Behaviour of Materials, Norman E, Dowling, Prentice Hall, 4thedition, 2012
3. Stress Concentration Design Factors, Peterson, R.E., John Wiley & Sons, 4thedition, 2020

Online Resources

1. Video course on "Experimental Stress Analysis" by Prof. Indrani Sen, Kharagpur available on NPTEL at Kharagpur available on NPTEL at https://archive.nptel.ac.in/courses/113/105/113105106/

Course Outcomes:

1. Have a solid foundation in the theory, concept, principle of fatigue, creep and fracture mechanics.
2. Enhance product performance through fatigue design and analysis.
3. Fracture mechanics to quantitatively estimate failure criteria for metals.
4. Recognize different mode of fractures and analyze.
5. Understand creep deformation and failure in materials.

Course Code:	Course Name:	L-T-P	Credit
22ME7PE02T	Design of Machine Components	3- 0- 0	3

Course Objectives:

1. Enable students to attain the basic knowledge required understanding, analyzing, designing of pressure vessels and levers.
2. Design machine elements like belt drive, power screw, clutch and brake.
3. Understand the basic design concept of flywheel and different type of gears.
4. Analyze the stresses and strains induced in I.C. engine components.
5. Introduce the concepts of Mathematical Modeling of Engineering Problems using Finite element analysis.

Syllabus

Module – I **[8 Hours]**

Design of pressure vessels: Thin pressure vessels: cylindrical and spherical vessels, design of end closures, thick cylindrical shells.

Design of lever: Classification, design of levers, cranked lever, lever of safety-valve.

Module – II **[8 Hours]**

Design of belt drive and power screw: Design of belt drive and pulley, power screw design with square thread such as screw jack.

Module – III **[8 Hours]**

Design of clutch and brake: Friction clutch, cone clutch and centrifugal clutch, block brake, band brake, internal expanding shoe brake.

Module – IV **[8 Hours]**

Design of gears and Flywheel: Design of spur, helical, bevel and worm gears, design of flywheel.

Module – V **[9 hours]**

Design of internal combustion engine components: design of cylinder, piston, connecting rod, crank shaft.

Text Books

1 Design of Machine Elements , V. B. Bhandari, TMH, 3rd edition, 2010

2 Mechanical Engineering Design, Joseph E. Shigley, McGraw-Hill Publications, 8th edition, 2005

Reference Books

1. Design of Machine Members, Alex Valance V.I Doughtie, McGraw-Hill, 3rd edition, 1951
2. Fundamentals of Machine Design, Rechard M. Phelan, TMH, 3rd edition, 1970
3. Machine Design, V. L. Maleev and J. B. Hartman, Scranton: International Textbook Co., 3rd editon, 1954
4. Machine Design, Robert L. Norton, Pearson, 5th edition, 2014
5. Machine Design, Paul Howard Black & O. Eugene Adams, Mc Graw-Hill, 3rd edition, 1968

Online Resources

1. Web course on "Machine Design - II" by Prof. M.M. Mayuram and Prof. K. Gopinath, IIT Madras available on NPTEL at Madras available on NPTEL at https://archive.nptel.ac.in/courses/112/106/112106137/

Course Outcomes:

At the end of the course, a student will be able to

1. learn a skill to design pressure vessels, levers, power screw and brake for various applications.
2. inculcate an ability to design belt drives and selection of belt.
3. understand and apply principles of gear design to spur gears and industrial spur gear boxes.
4. become proficient in Design of flywheel and various I.C. engine components.
5. implement numerical methods to solve mechanical problems.

Course Code:	Course Name:	L-T-P	Credit
22ME7PE03T	Experimental Stress Analysis	3- 0- 0	3

Course Objectives:

1 This course facilitates the student to implement the theoretical concepts of stress and strain in their measurement procedures.
2 Distinguish the principles of photo elasticity in two dimensional stress analyses
3 Recognize the various techniques available to measure the stress and Strains using different sources.
4 To know the concepts and uses of strain gauges and mounting approaches.
5 Understand the concepts of strain analysis.

Syllabus

Module – I **[8 Hours]**

Elementary elasticity: Stress at a point, principal stresses in 2-D and 3-D stress systems, strain and stress strain relations, principal strains, plane stress and plane strain problems.

Module – II **[8 Hours]**

Theory of photo elasticity: Photo elasticity methods: light and optics as related to photo-elasticity, polarization of light, plane and circularly polarized light, plane polariscopes. The stress-optic law, effects of a stressed model in plane and circular polariscopes, dark field and light field arrangements.

Module – III **[8 Hours]**

Photoelestic model materials for two-dimensional applications, calibration methods, analysis techniques, isochromatic and isoclinic fringe patterns, compensation techniques, stress separation techniques, scaling model to prototype stresses, birefringent coatings and scattered light in photoelasticity, reflection polariscope.

Module – IV **[8 Hours]**

Strain measurement methods and related instrumentation: Electrical resistance strain gauges, Gage

construction, gage factor, selection, temperature compensation, semiconductor strain gauges, strain gage circuits, Wheatstone and potentiometer bridge circuits

Module – V **[8 Hours]**

Strain analysis: Rosette analysis, recording instruments, dynamic strain measurements, brittle coating methods, behavior of stress coats and its application, grid Technique of displacement/strain analysis.

Text Books

1. Experimental Stress Analysis, James W. Dally and William F. Riley, McGraw Hill Education, 3rd edition, New York, 1991
2. Experimental stress Analysis and Motion Measurements, R. C. Dove and P. H. Adams, Prentice Hall of India (P) Ltd, New Delhi, 1968

Reference Books

1 Theory of Elasticity, S. P. Timoshenko, and J. N. Goodier, McGraw-Hill Book Co., New York, 1951

2 Photoelasticity, M. M. Frocht, John Wiley and Sons, Inc., New York, 1948. (vol. I & II).

Online Resources

1. Video course on "Experimental Stress Analysis" by Prof. K. Ramesh, IIT Madras available on NPTEL at Madras available on NPTEL at https://archive.nptel.ac.in/courses/112/106/112106068/

Course Outcomes:

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

1. analyze stresses in components subjected to various loading.
2. apply concepts of theory of elasticity and plasticity.
3. familiar with birefringent coatings and scattered light in photoelasticity, reflection polariscope.
4. describe the mechanical, optical, pneumatic and electrical strain gauges for strain measurement.
5. acquire the knowledge on brittle coatings and grid techniques

Course Code:	Course Name:	L-T-P	Credit
22ME7PE04T	Hydraulic and Pneumatic Devices	3- 0- 0	3

Course Objectives:

The objective of the course is to enable students to:

1. provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.
2. provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
3. develop a measurable degree of competence in the design, construction and operation of fluid power circuits.
4. understand various hydraulics circuit, pumps, actuators, flow controllers
5. gain knowledge about the pneumatic circuits and systems.

Syllabus

Module – I **[8 Hours]**

Fluid power principles and hydraulic: Introduction to fluid power, advantages and applications, fluid power systems, types of fluids, properties of fluids and selection, basics of hydraulics, Pascal's law, principles of flow, friction loss, work, power and torque problems, sources of hydraulic power: pumping theory, pump classification, construction, working, design, advantages, disadvantages, performance, selection criteria of linear and rotary, fixed and variable displacement pumps, problems.

Module – II **[8 Hours]**

Hydraulic actuators and control components: Hydraulic actuators: cylinders, types and construction, application, hydraulic cushioning, hydraulic motors; control components: direction, flow and pressure control valves, types, construction and operation, servo and proportional valves, applications, accessories: reservoirs, pressure switches, application, fluid power ANSI symbols, problems.

Module – III **[8 hours]**

hydraulic circuits and systems: Accumulators, intensifiers, industrial hydraulic circuits, regenerative, pump unloading, double-pump, pressure intensifier, air-over oil, sequence, reciprocation, synchronization, fail-safe, speed control, hydrostatic transmission, electro hydraulic circuits, mechanical hydraulic servo systems.

Module – IV **[8 Hours]**

Pneumatic and electro pneumatic: Properties of air, perfect gas laws, compressor, filters, regulator, lubricator, muffler, air control valves, quick exhaust valves, pneumatic actuators, design of pneumatic circuit, cascade method, electro pneumatic system, elements, ladder diagram, problems, introduction to fluidics and pneumatic logic circuits.

Module – V **[8 Hours]**

Trouble shooting and applications: Installation, selection, maintenance, trouble shooting and remedies in hydraulic and pneumatic systems, design of hydraulic circuits for drilling, planning, shaping, surface grinding, press and forklift applications, design of pneumatic circuits for pick, place applications, tool handling in CNC machine tools, low cost automation, hydraulic and pneumatic power packs.

Text Books:

1. Pneumatic Systems - Principles and Maintenance, S. R. Majumdar, Tata McGraw Hill, 16th edition reprint, 2007.
2. Fluid Power with Applications, Anthony Esposito, PHI / Pearson Education, 7th edition, 2008.

Reference Books

1. Hydraulic and Pneumatic controls, Shanmuga K. Sundaram, S. Chand & Co, 1st edition 2006.
2. Oil Hydraulics Systems- Principles and Maintenance, S. R. Majumdar, Tata McGraw Hill, 1st edition, 2017.
3. Power Hydraulics, J. Micheal, Pinches and J. G. Ashby, Prentice Hall, 1st edition 1989.
4. Basic Fluid Power, Dudley, A Pease and John E. Pippenger, Prentice Hall, 1st edition, 1987

Online Resources

1. Web course on “Fundamentals of Industrial Oil Hydraulics and Pneumatics” by Prof. R.N. Maiti, IIT Kharagpur, available on NPTEL athttps://nptel.ac.in/courses/112105046.
2. Video course on “Fundamentals of Industrial Oil Hydraulics and Pneumatics” by Prof. R.N. Maiti, IIT Kharagpur, available on NPTEL at https://nptel.ac.in/courses/112105047.
3. Video course on “Hydraulics and Pneumatics” by Prof. Somasekhar, IIT madras, available on NPTEL at https://swayam.gov.in/nd1_noc21_me51/

Course Outcomes:

At the end of the course, the student will be able to:

1. Explain the Fluid power and operation of different types of pumps
2. Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
3. Explain the different types of Hydraulic circuits and systems
4. Explain the working of different pneumatic circuits and systems
5. Summarize the various trouble shooting methods and applications of hydraulic and pneumatic

Course Code:	Course Name:	L-T-P	Credit
22ME7PE05T	POWER PLANT ENGINEERING	3- 0- 0	3

Course Objectives:

1 Students can understand the principles of power generation.
2 Students can know about steam generation and steam generating equipment
3 Students can get knowledge about flow through nozzle
4 Students can gain knowledge about types of steam turbine and its controlling mechanism
5 Student able know about nuclear power plant and effect of nuclear power plant and the nuclear disposal.

Syllabus

Module – I **[8 hours]**

Introduction: Different sources (conventional and non-conventional) of energy and the principle of power generation only, types of power plant and description, site selection of power plant, overall view of a steam power plant.

Module – II **[8 hours]**

Steam generator: Fossil fuel steam generators, classification, circulation in water tube boilers, modern high pressure water tube boilers (both sub critical and super critical), boiler mounting and accessories, boiler performance calculations.

Draught system: Air supply systems (natural and mechanical draught Systems), pulverized coal burning systems and basics of fluidized bed combustion

Module – III **[8 hours]**

Flow through nozzles: Types of nozzles and their area of application & related calculation, critical pressure & chocked flow, super saturated flow, effect of friction and nozzle efficiency

Turbines: Turbine types, variation of pressure and velocity in different types of turbines, simple impulse turbines, flow through turbine blades and velocity diagram, pressure-compounded impulse turbines and velocity compounded impulse turbines. turbine power and related calculations.

Module – IV **[8 hours]**

Steam condenser & circulating water systems: Types, surface condenser, performance calculation, air removal methods, vacuum & vacuum efficiency, cooling towers (types, principle of operation and performance).

Module – V **[8 hours]**

Nuclear power plant: Introduction, nuclear fuels, nuclear fission, reactor components, & materials and classification, boiling water reactor (BWR), pressurized water reactor (PWR), CANDU reactor, gas cooled reactors, liquid metal fast breeder reactor, heavy water reactors, waste disposal and safety of nuclear power plant

Economics of power plant: Basic definitions, cost of electrical energy(fixed cost and operating cost), types of tariff, types of loads(typical load curves), economic load sharing

Text Books

1. Power Plant Engineering, P. K. Nag, TMH, 4th edition, 2017.
2. Power Plant Engineering, Arora and Domkundwar, Dhanpat Rai publications, 6th edition, 2013.

Reference Books

1. Power Plant Engineering, R. K. Rajput, Laxmi Publications, 4th edition, 2016.
2. Power plant technology, E. I. Wakil, TMH, 2nd edition, 1988.
3. Power Plant Engineering, A. K. Raja, New Age International; 1st edition, 2006.

Online Recourses:

1. Online course on “Power Plant Engineering” by Prof. Ravi Kumar, IIT Roorkee, available on NPTEL athttps://swayam.gov.in/nd1_noc20_me10/

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand functions of the components of power plant.
2. Understand the working of thermal based power plants.
3. Gaining knowledge of design for nozzle, condenser, boiler, draught system.
4. Evaluate the design layout and working of Nuclear electric power plants.
5. Evaluate economic feasibility and its implications on power generating units.

Course Code:	Course Name:	L-T-P	Credit
22ME7PE06T	Computational Fluid Dynamics	3- 0- 0	3

Course Objectives:

1. Equip students with the knowledge base essential for application of computational fluid dynamics to engineering flow problems
2. Provide the essential numerical background for solving the partial differential equations governing the fluid flow
3. To know the solution methods for Inviscid Burger's equation.
4. Understand the numerical technique for convection- diffusion problems
5. Develop students' skills of using a commercial software package

Syllabus

Module – I **[8 hours]**

Basics of computational fluid dynamics (CFD): Introduction to one dimensional (1-D) computation: finite difference methods (FDM)-finite element method (FEM)-finite volume method (FVM). Solution of discretised equations, the tri-diagonal matrix algorithm (Thomas algorithm for 1-D case) the finite volume method for diffusion problems, finite volume method for 1-D steady state diffusion, worked examples: 1-D steady state diffusion

Module – II **[8 hours]**

Inviscid Burger's equation: Burger's equation, numerical and Analytical solution of 1-D Burger's equation, Stability and convergence analysis.

Module – III **[8 hours]**

Convection-diffusion problems: Introduction, steady one dimensional convection and diffusion, the central difference scheme, assessment of the central difference scheme for convection-diffusion problems, the upwind difference scheme, assessment of the upwind difference scheme, the hybrid difference

scheme, assessment of the hybrid difference scheme, the power-law scheme, higher order difference schemes for convection-diffusion problems, quadratic upwind difference scheme: the quick scheme.

Module – IV **[8 hours]**

Unsteady Flows: Introduction, 1-D unsteady heat conduction, Explicit scheme, Crank-Nicolson scheme, the fully implicit scheme, illustrative examples

Module – V **[8 hours]**

Implicit method for 2D problems: Discretisation of transient convection-diffusion equation, worked example of transient convection-diffusion using QUICK scheme.

Text Books

1. An Introduction to Computational Fluid Dynamics-The Finite Volume Method, Longman Scientific & Technical.Versteeg, H. K., Malalasekera W, PHI; 2nd Edition, 2007.
2. Numerical Heat Transfer & Fluid Flow, Suhas V. Patenkar, CRC Press, 1st edition, 1980.

Reference Books

1. Computational Fluid Flow and Heat Transfer, by Muralidhar, K. and Sundararajan, T., Norosa Publishing House, N. Delhi, Alpha Science International Ltd; 2nd Edition, 2003
2. Computational Fluid Mechanics and Heat Transfer, by Anderson, D. A. Jr, McGraw-Hill, CRC Press; 3rd edition, 2012.
3. Computational Methods for Fluid Dynamics, by Ferziger J. H. and Peric M., Springer, 2002.

Online Recourses:

1. Video course on“Computational Fluid Dynamics” by Prof. K. M. Singh, IIT Roorkee, available on NPTEL at https://nptel.ac.in/courses/112107080.
2. Video course on “Computational Fluid Dynamics” by Prof. Sreenivas Jayanti, IIT Madras, available on NPTEL at https://nptel.ac.in/courses/112105045

Course Outcomes:

At the end of the course, the student will be able to:

1 Develop mathematical models for flow phenomena.

2. Analyze mathematical and computational methods for fluid flow and heat transfer simulations.
3. Solve computational problems related to fluid flows and heat transfer.
4. Evaluate the grid sensitivity and analyze the accuracy of a numerical solution.
5. Evaluate flow parameters in internal and external flows.

Course Code:	Course Name:	L-T-P	Credit
22ME7PE07T	Product Design and Production Tooling	3- 0- 0	3

Course Objectives:

1 To enable students the fundamentals of work holding devices.
2 To enable the students to design tools, dies, jigs and fixtures.
3 To enable students to analyze and optimize an existing jig and fixture.
4 To expose students to design of dies for press work and forging.
5 To enable the students to design gating parts and other cutting tool.

Syllabus

Module – I **[8 Hours]**

Introduction on product design: Product Design: Product design considerations, product planning, product development, value analysis, product specification. Role of computers in product design.

Module – II **[8 Hours]**

Jigs and fixture: Types of load, modes of failure, factor of safety concepts, theories of failure, concept and mitigation of stress concentration, fatigue failure and curve, endurance limit and factors affecting it, notch sensitivity, Goodman, Gerber and Soderberg criteria.

Module– III **[8 Hours]**

Design of forging : Forging design allowances, die design for drop forging, design of flash and gutter, upset forging die design.

Module– IV **[8 Hours]**

Design of sheet metal working dies: Sheet metal working: Design consideration for shearing, blanking, piercing, deep drawing operation, die design for sheet metal operations, progressive and compound die, strippers, stops, strip layout.

Module – V **[8 Hours]**

Design of gating parts and machining tools: Design of gating parts, design of single point cutting tool, broach and form tool.

Text Books

1 Product Design & Manufacturing, A K Chitale, R C Gupta, Eastern Economy edition, PHI, 6th edition,2018.

2 Product Design & Development, Karl T Ulrich, Steven D Eppinger, Anita Goyal, Mc Graw Hill, 5th edition,2011.

3 A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co, 8th edition, 1999.

Reference Books

1 Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford & IBH Publishing co, 2011.

2 Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill, 1st edition 2010.

3 Jigs & Fixture Design, Edwrd G. Hoffman, Cengae Learning, 5th edition,2004.

Online Resources

1 Video course on , “Product Design and Manufacturing” by Dr. Janakarajan Ramkumar , Professor of Mechanical Engineering Department, and Design Program, at Indian Institute of Technology, Kanpur on NPTEL at (NPTEL-noc19 me-23)

Course Outcomes:

At the end of the course, the student will be able to:

1 Identify the importance of work holding device.

2 Design jigs and fixtures.

3 Calculate the required specifications of a press for required operations.

4 Design forging dies for required operations.

5 Design gating parts and cutting tool.

Course Code:	Course Name:	L-T-P	Credit
22ME7PE08T	Process Planning and Cost Estimation	3- 0- 0	3

Course Objectives:

1 Process planning concepts to make cost estimation for various products.
2 Selection of Jigs and fixtures for various production processes.
3 Estimation of production cost of forging, welding, foundry and machining.
4 Costing and estimation of labor, material and overhead cost.
5 Estimation of time for different machining processes.

Syllabus

Module – I **[6 hours]**

Introduction to process planning: Introduction, methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection.

Module – II **[8 hours]**

Process planning activities: Process parameters calculation for various production processes-Selection jigs and fixtures, selection of quality assurance methods, set of documents for process planning, economics of process planning- case studies

Module – III **[10 hours]**

Production cost estimation: Estimation of different types of jobs, estimation of forging shop, estimation of welding shop, and estimation of foundry shop.

Module – IV **[10 hours]**

Introduction to cost estimation: Importance of costing and estimation, methods of costing, elements of cost estimation, types of estimates, estimating procedure, estimation labor cost, material cost, allocation of over head charges, calculation of depreciation cost

Module – V **[8 hours]**

Machining time calculation: Estimation of machining time, importance of machine time calculation, calculation of machining time for different lathe operations, drilling and boring, machining time calculation for milling, shaping and planning , machining time calculation for grinding.

Text Books

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

Reference Books

1 Process, Planning and cost estimation, R. Kesavan,New Age International, 2004
2 Process, Planning and Cost Estimation, R. Panneerselvam PHI learning private limited, 2nd edition, 2016.
3 Operations Management, R.S Russell and B.W. Tailor, 4th edition, PHI, 2003.

Web Resources:

1 Video course on, “Process planning and cost estimation” by R.David, Assistant Professor, Rohini College of Engineering & Technology, Tamilnadu, available on https://youtu.be/VTYZf9EnsUU

Course Outcomes:

At the end of the course, the student will be able to:

1 Select the process, equipment and tools for various industrial products.
2 Select right jigs and fixtures for a particular production method.
3 Explain the concept of cost estimation.
4 Determine costing and estimation of labor, material and overhead cost.
5 Calculate the machining time for various machining operations.

Open Elective – 3 (for Non-ME Students)

Course Code:	Course Name:	L-T-P	Credit
22ME7OE01T	Robotics	3- 0- 0	3

Course Objectives:

1 To develop the student's knowledge in various robot structures and their workspace.
2 Accure knowledge to perform kinematics analysis of robot systems.
3 To provide knowledge on the various robotic systems with the help of mathematical models.
4 Understand the various flexures, actuators and sensor systems.
5 To provide the student with some knowledge and analysis skills associated with trajectory planning.

Syllabus

Module – I **[8 Hours]**

Fundamentals of Robotics: Evolution of robots and robotics, Definition of industrial robot, Laws of Robotics, Classification, Robot Anatomy, Work volume and work envelope, Human arm characteristics, Design and control issues, Manipulation and control, Resolution; accuracy and repeatability, Robot configuration, Economic and social issues, Present and future application.

Module – II **[8 Hours]**

Mathematical modeling of a robot: Mapping between frames, Description of objects in space, Transformation of vectors.

Direct Kinematic model: Mechanical Structure and notations, Description of links and joints, Kinematic modeling of the manipulator, Denavit-Hartenberg Notation, Kinematic relationship between adjacent links, Manipulator Transformation matrix.

Module – III **[8 Hours]**

Inverse Kinematics: Manipulator workspace, Solvable of inverse kinematic model, Manipulator Jacobian, Jacobian inverse, Jacobian singularity, Static analysis.

Dynamic modeling: Lagrangian mechanics, 2D- Dynamic model, Lagrange-Euler formulation, Newton-Euler formulation.

Module – IV **[8 Hours]**

Robot Sensors: Internal and external sensors, force sensors, Thermocouples, Performance characteristic of a robot.

Robot Actuators: Hydraulic and pneumatic actuators, Electrical actuators, Brushless permanent magnet DC motor, Servomotor, Stepper motor, Micro actuator, Micro gripper, Micro motor, Drive selection.

Module – V **[8 Hours]**

Trajectory Planning: Definition and planning tasks, Joint space planning, Cartesian space planning.

Applications of Robotics: Capabilities of robots, Material handling, Machine loading and unloading, Robot assembly, Inspection, spot and continuous arc welding & spray painting , Obstacle avoidance.

Text Books

1 Robotics and Control, R. K. Mittal and I. J. Nagrath, Tata McGraw-Hill, 2005
2 Introduction to Robotics: Mechanics and control, John J. Craig, PHI, 3rd edition, 2004
3 Robotics Technology and Flexible Automation, S. R. Deb and S. Deb, TMH, 2nd edition, 2017

Reference Books

1. Introduction to Robotics, S. K. Saha, Tata McGraw Hill, 1st edition, 2008
2. Robotics: Control, Sensing, Vision and Intelligence, K.S.Fu, R.C.Gonzalez and C.S.G.Lee, McGraw Hill, 2008
3. Industrial Robotics Technology, programming and application, M. P. Groover, TMH, 2nd edition, 2017

Online Resources

1. Video course on “Robotics” by Prof. Dilip Kumar Pratihar, IIT Kharagpur available on NPTEL at Kanpur available on NPTEL at https://onlinecourses.nptel.ac.in/noc21_me76/preview

2. Video course on “Introduction to Robotics” by Prof. Asokan T, Prof. Balaraman Ravindran, Prof. Krishna Vasudevan , IIT Madras available on NPTEL at Kanpur available on NPTEL at https://onlinecourses.nptel.ac.in/noc20_de11/preview

Course Outcomes:

1. Differentiate the various types of Industrial Robots, their architecture and robot kinematics.
2. Describe the characteristics of a robotic system from its dynamic model.
3. Specify the characteristics of various actuators and sensor systems
4. Analyze the various path planning techniques by briefing about the robot’s environment
5. Analyze the applications of robots in various industrial application.

Course Code:	Course Name:	L-T-P:	Credit:
22ME7OE02T	Numerical Method for Engineers	3:0:0	3

Course Objectives:

The objective of the course is to enable students to:

1. solve the nonlinear equations and finding the roots of the equation.
2. realize the power of interpolation, numerical differentiation and integration
3. solve ordinary differential equations, stability and convergence of numerical methods,
4. solve elliptic partial differential equations with numerical methods
5. solve hyperbolic partial differential equations with numerical methods

Syllabus

Module – I **[8 Hours]**

Nonlinear equations: Approximation of numbers, significant figures, accuracy and precision, error definition, round off errors, error propagation, system of non-linear equations: interval halving false-position method, fixed point iteration, newton-raphson method, secant method, convergence and error analysis,

Module – II **[8 Hours]**

Interpolation, Numerical Differentiation and Integration: Introduction,Newton's divided difference interpolating polynomial, Lagrange interpolating polynomial, spline interpolation, trapezoidal rule, Simpson's rule, Newton-Cotes algorithm for equations, Romberg integration, Gauss quadrature

Module – III **[8 Hours]**

Ordinary differential equation: Introduction, Taylor series method, finite difference grids and finite difference approximations, finite difference equations, consistency, order, stability and convergence, the modified differential equations, stability analysis

Module – IV **[8 Hours]**

Elliptic Partial difference equations: Introduction, finite difference approximations, consistency, order and convergence, finite difference solutions of Laplace equations and Poisson equation,

Module – V **[8 Hours]**

Hyperbolic Partial Differential Equations: Introduction, The method of characteristics, the forward-time centered space method, Lax method, upwind methods, the leapfrog method

Text Books

1. Numerical methods for Engineers, S. C. Chapra and R. P. Canale, McGraw-Hill Higher Education, 5th edition, 2005.
2. Numerical analysis, K.E. Atkinson, John Wiley & Sons, 2nd edition, 2011.
3. Numerical Methods for Engineers and Scientists, Joe D. Hoffmann, CRC Press; 2nd edition, 2001.

Reference Books

1. Numerical Method for Scientific and Engineering Computation, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age International Publishers, 7th edition, 2019.
2. Introductory Methods for Numerical Analysis, S. S. Sastry, PHI learning private limited, 4th edition, 2012.

Online Resources

1 Video course on “Numerical methods of ordinary and partial differential equation” by Dr. G. P. Raja Sekhar, IIT Kharagpur available on NPTEL athttps://nptel.ac.in/courses/111105038

Course Outcomes:

At the end of the course, the student will be able to:

1. Find the root of the nonlinear equations
2. Get experience of using interpolation, numerical differentiation and integration
3. Solve ordinary differential equations numerically and know order, stability and convergence of numerical methods
4. Solve the Laplace and Poisson equations by finite difference approximations.
5. Solve the hyperbolic differential equations by using simple solvers.

Bachelor of Technology

(B Tech)

8th Semester

Detailed Syllabus of

2022-2026 Batch

Department of

Mechanical Engineering

NIST Institute of Science and Technology,

Pallur Hills, Berhampur, 761008, Odisha

Eighth Semester					
Theory					
Sl. No.	**Category**	**Subject Code**	**Subject Name**	**L-T-P**	**Credit**
OEC Courses offered from Department of Mechanical Engineering to other Department students					
1	OEC	**Open Elective-5/ MOOC Certification**			
		22ME8OE01T	Solar Energy for Engineers/	3-0-0	3
		22ME8OE02T	Supply Chain Management		
2	OEC	**Open Elective-6/MOOC Certification**		3-0-0	3
		22ME8OE03T	Heating, Ventilation and Air Conditioning (HVAC)/		
		22ME8OE04T	Fluid Power and Control		
Total Credit (Theory)					6
1	PSI	22CM8PS01L	Major Project/Internship	0-0-12	6
2	PSI	22CM8PS02L	Comprehensive Viva-Voce	0-0-4	2
Total Semester Credit					**14**

Open Elective Course [OEC] offered by ME Department to other Department students

Course Code: 22ME8OE01T	Course Name: Solar Energy for Engineers	L-T-P: 3- 0- 0	Credit: 3

Course Objectives:

The objective of the course is to enable students to:

6 Understand the theory involved in solar energy and its propagation.

7 Develop the knowledge to collect the solar energy and its conversion into thermal energy.

8 Understand the working photovoltaic cells.

9 Recognize the necessity of storing the solar energy.

10 Know the application of solar energy.

Syllabus

Module – I **[8 Hours]**

Solar Radiation and Its Interaction with Earth: Concepts and Measurements: Energy scenario, physics of propagation of solar radiation from the sun to the earth. Sun-earth geometry, extra-terrestrial and terrestrial radiation, solar energy measuring instruments, estimation of solar radiation under different climatic conditions, concept of time, equation of time, solar time, standard time, role of atmosphere on solar radiation, air mass, terrestrial spectrum, prediction of solar radiation

Module – II **[8 Hours]**

Solar Collectors: Fundamentals of solar collectors, Flat plate collector: thermal analysis, collector efficiency factor, heat removal factor, Concentrating collectors: Cylindrical parabolic collector, compound parabolic collector, paraboloid dish collector, central receiver tower.

Module – III **[8 Hours]**

Photovoltaic Cells: Fundamentals of solar photovoltaic cells, P-N junction diode, IV characteristic curve for P-N junction diodes, principles and performance analysis, modules, arrays, different types of solar cells, series and parallel connections, theoretical maximum power generation from photovoltaic cells.

Module – IV **[8 Hours]**

Solar Energy Storage: Necessity of storage for solar energy, thermal energy storage (sensible, latent and thermo chemical), solar pond, performance analysis of solar pond.

Module – V **[8 Hours]**

Applications of Solar Energy: Solar refrigeration, solar air-condition, passive architecture, solar distillation, solar dryers, solar-green houses and solar air heaters.

Text Books:

1. Solar Energy-Principles of Thermal Energy Collection & Storage, S .P. Sukhatame, Mc-Graw Hill Publishers, 4th edition, 2017, New Delhi.

Reference Books:

1. Solar Energy Utilization, G. D. Rai, Khanna Publishers, 2nd edition, 1995, New Delhi.
2. Solar Photovoltaics-Fundamental, Technologies and Applications, C. S. Solanki, PHI Learning Private Limited, 3rd edition, 2015, New Delhi.

Online Resources

1. Video course on "Solar Energy Engineering and Technology" by Prof. Pankaj Kalita, Center for Energy, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/115103123
2. Video course on "Elements of Solar Energy Conversion" by Prof. Jishnu Bhattacharya, Department of Mechanical Engineering, IIT Kanpur available on NPTEL at https://nptel.ac.in/courses/112104300

Course Outcomes:

1. Understand the basics of solar radiation and its propagation from the Sun to the Earth.
2. Demonstrate the working of solar collectors.
3. Discuss the performance of Photo Voltaic Cells.
4. Explain the different modes of storing the solar energy.
5. Implement the solar energy refrigeration and distillation.

Course Code:	Course Name:	L-T-P:	Credit:
22ME8OE02T	Supply Chain Management	3- 0- 0	3

Course Objectives:

1. To provide an insight on the fundamentals of supply chain networks, tools and techniques.
2. Recognizing supply chain integration to support products in various product life cycles.
3. Balancing logistics, manufacturing and inventory policies with demand and customer satisfaction.
4. Leveraging organizational capabilities and resources across supply chain business processes.
5. Designing lean but agile supply chains that integrate green initiatives.

Syllabus

Module – I **[8 Hours]**

Introduction to Supply Chain Management: Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

Module – II **[8 Hours]**

Distribution and Network Design: Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice- Role of network Design in Supply Chain – Framework for network Decisions.

Module – III **[8 Hours]**

Transportation in Supply Chain: Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.

Module – IV **[8 hours]**

Sourcing and Supply Chain Coordination: Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull

whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

Module – V **[8 Hours]**

IT and E-Business in Supply Chain: The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.

Text Books:

1. Supply Chain Management, Strategy, Planning, and Operation, Sunil Chopra, Peter Meindl, Pearson, 5th edition, 2010.
2. Modeling the Supply Chain , Jeremy F.Shapiro, Wadsworth Publishing Co Inc, 2nd edition, 2006.

Reference Books

1. Quantitative models in Operations and Supply Chain Management, G. S. Srinivasan, " Prentice Hall India Learning Private Limited, 2010
2. Logistics, David J. Bloomberg,Pearson, 2001
3. Handbook of Supply Chain Management, Peter Robert Boyce, Auerbach Publications; 2nd edition, 2006.

Online Resources

1. Video course on "Operations and Supply Chain Management" by Prof. G. Srinivasan, IIT Madras, available on NPTEL at https://nptel.ac.in/courses/110106045.

Course Outcomes:

1. The student would understand the framework and scope of supply chain networks and functions.
2. Understand the tactics to manage the interactions of the business functions.
3. Gain insights on demand management function and its integration with supply chain.

4. Strategize on the enterprise knowledge and resources across the supply chain activities.
5. Describe the usage of information technologies in supply chain management.

Course Code:	Course Name:	L-T-P:	Credit:
22ME8OE03T	Heating, Ventilation and Air Conditioning (HVAC)	3- 0- 0	3

Course Objectives:

1. Describe types, working principles, construction and performance of refrigeration systems.
2. Know about the chilled water system and its components
3. Explain the thermal comfort requirement and indoor air quality
4. To know about troubles and problem in air conditioning system
5. To know about various application of HVAC system

Syllabus

Module – I **[8 Hours]**

Thermodynamics: The study of heat, pressure and vacuum, calibrations of meters and instruments, types of refrigeration systems, the refrigeration cycle, refrigerants and their properties, plotting the refrigeration cycle, piping and tubing, soldering and brazing, refrigerant leak testing, refrigerant system evacuation, refrigerant system charging,

Electrical safety, basic electricity, alternating current fundamentals, electrical measuring and test instruments, electrical components, electric motors, electrical diagrams, control systems, communicating control systems

Air conditioning and refrigeration: Introduction to heating, ventilation, intro to air conditioning, and refrigeration, professional ethics of HVAC technician, safety practices, hand and power tools.

Module – II **[8 Hours]**

Chilled water system: definition of STHE & explain, study about chilled water systems, components of chilled water system, types & application of chillers, open loop & closed loop system- chilled water pipe sizing, types of valves & its connection, primary and secondary pump system, hydraulic calculation for

pump selection, expansion tank sizing, air separator, pump cavitations, pump curves, NPSH calculation for pumps.

Module – III **[8 Hours]**

Psychometrics comfort and fundamentals: Psychometrics & airflow- air filters, ventilation and dehumidification, residential load calculations, green buildings and systems, indoor air quality (iaq), duct installation, duct designzone control systems, testing and balancing air systems, heat pump system fundamentals, air source heat pumps applications, geothermal heat pumps, heat pump installation, troubleshooting heat pump systems

Module – IV **[8 Hours]**

Trouble shooting and applications: Advanced trouble shooting, troubleshooting air-conditioning systems, troubleshooting refrigeration systems, all other troubleshooting, refrigerant management and the epa, refrigerant leak testing

Module – V **[8 Hours]**

HVAC applications: Chilled water systems, cooling towers, commercial refrigeration systems, supermarket equipment, ice machines, refrigerant management and the epa, refrigerant system evacuation

Text Books:

1. Refrigeration and Air conditioning, R.C. Arora , PHI Publication, 3rd edition, 2010.
2. Refrigeration and Air conditioning, C.P. Arora, Tata McGraw Hill, 3rd edition, 2017.

Reference Books:

1. A Course in Refrigeration and Air- Conditioning, S.C. Arora and S. Domkundwar, Dhanpat Rai & Sons, 7th edition, 2018.
2. Refrigeration and air conditioning, W. Stoecker and J.W. Jones, McGraw-Hill, Inc., 2nd edition, 1958.
3. Refrigeration and air conditioning, G. H. Hundy, A. R. Trott, T.C. Welch, Butterworth-Heinemann, Fourth edition, 2008.

4. ASHRAE Handbook - Fundamentals, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Atlanta, USA, 2009
5. HVAC system Design , Roger W. Haines and C. Lewis Wilson - 4th edition, 2003.
6. Indoor Air Quality & Control , A. L Hines, T. K. Gosh, S.K. Loyalka and R.C.Warder, Jr., PTR Prentice Hall, 1993.
7 Indoor Air Pollution – Characterization, Prediction, and Control, Richard A. Wadden, and Peter A. Scheff, John Wiley & Sons, 1st edition, 1983.

Online Resources

1 Video course on "Refrigeration and air-conditioning" by Prof. Ravi Kumar, IIT Roorkee, available on NPTEL at https://nptel.ac.in/courses/112107208.

Course Outcomes:

1. Explain about Refrigeration systems and its performance.
2. Gain knowledge about chilled water system and its components.
3. Describe the thermal comfort requirement and indoor air quality.
4. Explain troubles and problem in Air conditioning system.
5. Know about various application of HVAC system.

Course Code:	Course Name:	L-T-P	Credit
22ME8OE04T	Fluid Power and Control	**3- 0- 0**	**3**

Course Objectives:

The objective of the course is to enable students to:

1 provide student with knowledge on the application of fluid power in process, construction and manufacturing Industries.

2 provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.

3 develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

4 understand various hydraulics circuit, pumps, actuators, flow controllers

5 gain knowledge about the pneumatic circuits and systems.

Syllabus

Module – I **[8 Hours]**

Fluid power principles and hydraulic: Introduction to fluid power, advantages and applications, fluid power systems, types of fluids, properties of fluids and selection, basics of hydraulics, pascal's law, principles of flow, friction loss, work, power and torque problems, sources of hydraulic power: pumping theory, pump classification, construction, working, design, advantages, disadvantages, performance, selection criteria of linear and rotary, fixed and variable displacement pumps, problems.

Module – II **[8 Hours]**

Hydraulic actuators and control components: Hydraulic actuators: cylinders, types and construction, application, hydraulic cushioning, hydraulic motors, control components: direction control, flow control and pressure control valves, types, construction and operation, servo and proportional valves, applications, accessories: reservoirs, pressure switches, application, fluid power ANSI symbols, problems.

Module – III **[8 hours]**

Hydraulic circuits and systems: Accumulators, intensifiers, industrial hydraulic circuits, regenerative, pump unloading, double-pump, pressure intensifier, air-over oil, sequence, reciprocation, synchronization, fail-safe, speed control, hydrostatic transmission, electro hydraulic circuits, mechanical hydraulic servo systems.

Module – IV **[8 Hours]**

Pneumatic and electro pneumatic: Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

Module – V **[8 Hours]**

Trouble shooting and applications: Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

Test Books:

1 Pneumatic Systems - Principles and Maintenance, S. R. Majumdar, Tata McGraw Hill, 16th edition reprint, 2007.

2 Fluid Power with Applications, Anthony Esposito, PHI / Pearson Education, 7th edition, 2008.

Reference Books

1 Hydraulic and Pneumatic controls, Shanmuga K. Sundaram, S. Chand & Co, 1st edition 2006.

2 Oil Hydraulics Systems- Principles and Maintenance, S. R. Majumdar, Tata McGraw Hill, 1st edition, 2017.

3 Power Hydraulics, J. Micheal, Pinches and J. G. Ashby, Prentice Hall, 1st edition 1989.

4 Basic Fluid Power, Dudley, A Pease and John E. Pippenger, Prentice Hall, 1st edition, 1987

Online Resources

1. Video course on "Fundamentals of Industrial Oil Hydraulics and Pneumatics" by Prof. R.N. Maiti, IIT Kharagpur, available on NPTEL athttps://nptel.ac.in/courses/112105046.
2. Video course on "Fundamentals of Industrial Oil Hydraulics and Pneumatics" by Prof. R.N. Maiti, IIT Kharagpur, available on NPTEL at https://nptel.ac.in/courses/112105047.
3. Video course on "Hydraulics and Pneumatics" by Prof. Somasekhar, IIT madras, available on NPTEL athttps://swayam.gov.in/d1_noc21n_me51/

Course Outcomes:

1. Explain the Fluid power and operation of different types of pumps
2. Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
3. Explain the different types of Hydraulic circuits and systems
4. Explain the working of different pneumatic circuits and systems
5. Summarize the various trouble shooting methods and applications of hydraulic and pneumatic.