Course Code	**HSM_ME701**				
Category	**Humanities and Social Sciences including Management course**				
Course Title	**Industrial Engineering-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	**Industrial Engineering-I**				

Objectives:

This course covers selected topics in the vast field of Industrial Engineering which is primarily concerned to meet with the challenges for contemporary professional practice; be able to adapt and solve the increasingly complex problems faced by industry; embrace innovation through intellectual diversity and creative problem solving; and continue to develop holistically as a learner to become leaders of tomorrow.

M. No:	Topic	No. of Hrs
Module 1.	Introduction to facility location problems, factors affecting the plant location, break even analysis and their application, subjective, qualitative and semi-quantitative techniques of facility location, single facility location problem, minimax location problem, gravity problem and their applications.	08
Module 2.	Line balancing, introduction to facility layout and their objectives, classification of layouts, with advantages and disadvantages of each, layout design procedures (*CRAFT, CORELAP, ALDEP*), material handling systems, make or buy decisions, planning and control of batch production, characteristics of batch production, determination of batch size, minimum cost batch size, maximum profit batch size, sequencing and scheduling for batch production.	10
Module 3.	Inspection and quality control**,** concept and definition of quality, concepts of inspection and quality control, objectives of inspection, function of inspection and their types, concept of statistical quality control (*SQC*), process variation, sampling inspection, concepts and types of control charts, acceptance sampling, application of control charts.	12
Module 4	Materials management and inventory control, integrated materials management and their components, functions and objectives of material management, introduction and concepts of inventory management, purchase model with instantaneous replenishment and without shortage, manufacturing model without shortages, purchase model with shortages, manufacturing model with shortages, probabilistic inventory concepts with lead time, selective inventory management- *ABC , FSN, VED* analysis.	12
Total number of Hours		**42**

Course Outcomes:

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

- ***Understand*** the concept of organization structure **(L1)**
- ***Analyse*** & ***design*** facility location and layout using various techniques and softwares **(L4, L6)**.
- ***Demonstrate*** the ability to use the methods of statistical quality control and process control for effective designing of Industrial Quality Monitoring Systems **(L3)**.
- ***Demonstrate*** the ability to ***apply*** the techniques of material management and inventory control for effective designing and systematic implementation of various MM methods and inventory systems in manufacturing set-up **(L3)**

S.No:	Text Books	Author	Publisher
1.	Production and Operations Management	Everett, E.A., Ronald J.E	Prentice Hall of India
	References		
1.	Plant Layout & Material Handling.	Apple, J.M,	John Wiley & Sons, New York.
2.	Industrial Engineering Hand Book.	Maynard	McGraw Hill, New York
3.	Statistical Quality Control	Grant, E.L; Leavenworth R.S	Tata Mcgraw Hill

Course Code	**HSM_ME701L**				
Category	**Humanities and Social Sciences including Management course**				
Course Title	**Industrial Engineering-II lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	0	**0**	**2**	**1**	
Pre requisites	-				

M. No:	**Topic**
Module 1.	Study the layout in an organization and draw existing and proposed layouts in WITNESS software.
Module 2.	Develop a simulation model in *WITNESS* software and get results in Gantt chart format.
Module 3.	Study any process sheet with corresponding factory elements and use *WITNESS* simulation software to find out existing operational bottlenecks & carry possible line balancing to achieve proposed outcome.
Module 4.	To measure the variable characteristics (diameter of pins, with micrometer) and prepare a frequency histogram. Calculate values of $\bar{X}$ and sigma.
Module 5.	To conduct Process capability study of a machine tool and to specify the tolerances for a job.
Module 6.	To verify the theorem "the standard deviation of the sum of any number of independent variables is the square root of the sum of the squares of the *S.D*s of the independent variable. Determine statistically, the permissible tolerance of mating components, when the tolerance of the assembly is given (using statistical analysis software).
Module 7	To draw a control chart for percent defectives after inspecting a sample and sorting out the defective units.

Course Code	**PEC1_ME702**				
Category	**Professional Elective Courses**				
Course Title	**Power Plant Engineering**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	**Basic Engineering Thermodynamics**				

Objectives:

To provide an overview of power plants and the associated energy conversion issues.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Coal based thermal power plants, layout of modern coal power plants, super critical boilers, *FBC* boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment.	07
Module 2.	Gas turbine and combined cycle power plants, components of gas turbine power plants, combined cycle power plants, integrated gasifier based combined cycle (*IGCC*) systems.	06
Module 3.	Basics of nuclear energy conversion, layout and subsystems of nuclear power plants, boiling water reactor (*BWR*), pressurized water reactor (PWR), *CANDU* reactor, pressurized heavy water reactor (*PHWR*), fast breeder reactors (*FBR*), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.	07
Module 4.	Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar *PV* and solar thermal, geothermal, biogas and fuel cell power systems.	05
Module 5.	Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.	05
Total number of Hours		**42**

Course Outcomes:

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

- ***Understand*** the principles of operation for different power plants and their economics **(L2).**
- ***Analyze*** economics of power plants and list factors affecting the power plants **(L4).**
- ***Determine*** performance of power plants based on load variations **(L5).**

S.No:	**Text Books Recommended**	**Author**	**Publisher**
1.	Power Plant Engineering	Nag P.K	Tata McGraw Hill
	References		
1.	Power Plant Engineering	Elliot T.C., Chen K and Swanekamp R.C	Tata McGraw Hill
2.	Power Plant Engineering	El Wakil M.M	Tata McGraw Hill
3.	Modern Power Plant Engineering	Joel W Roy E	Prentice-Hall Ltd.

Course Code	**PEC2_ME702**				
Category	**Professional Elective Courses**				
Course Title	**Energy Systems and Management**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	-				

Objectives:

To study the various energy systems and the status for energy sources and technologies, their environmental interactions and the relevant global energy policies.

M. No:	Topic	No. of Hrs
Module 1.	Introduction to thermodynamics, fluid flow and heat transfer.	05
Module 2.	Heat transfer media- water, steam, thermal fluids, air-water vapour mixtures heat transfer equipment- heat exchangers.	05
Module 3.	Steam plant energy storage systems- thermal energy storage methods, energy saving, thermal energy storage systems.	06
Module 4.	Energy conversion systems- furnaces, turbines.	05
Module 5.	Heat recovery systems- incinerators, regenerators and boilers.	05
Module 6.	Energy management- principles of energy management, energy demand estimation, organising and managing energy management programs.	06
Module 7.	Energy pricing energy audit- purpose, methodology with respect to process industries, characteristic method employed in certain energy intensive industries.	05
Module 8.	Economic analysis: scope, characterization of an investment project.	05
	Total number of Hours	**42**

Course Outcomes:

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

- ***Understand*** principles of energy management and its influence on the environment **(L2).**.
- ***Comprehend*** methods of energy production for improved utilization **(L2)** .
- ***Improve*** the performance of thermal systems using energy management principles **(L6).**
- ***Analyse*** the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems **(L4).**
- ***Evaluate*** energy projects on the basis of economic and financial criteria **(L5).**

S. No:	Text Books	Author	Publisher
1.	Energy Management Hand book.	Turner, W. C., Doty, S. and Truner, W. C.,	7th edition, Fairmont Press, 2009
	References		
2.	Energy Management audit & Conservation	De, B. K.,	Vrinda Publication, 2nd Edition, 2010.
3.	Energy Management	Murphy, W. R.,	Elsevier, 2007.
4.	Energy Management Principles,	Smith, C. B.,	Pergamon Press, 2007.

Course Code	**PCC_ME703**				
Category	**Professional Core Courses**				
Course Title	**Heating Ventilation and Air Conditioning**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	3	**1**	**0**	**4**	
Pre requisites	**Basic Engineering Thermodynamics**				

Objectives:

To apply the principles of Thermodynamics to analyze different types of refrigeration and air conditioning systems and to understand the functionality of the major components

M. No:	Topic	No. of Hrs
Module 1.	Introduction to air conditioning, psychometric properties and their definitions, psychrometric chart, different psychrometric processes, applications of *AC* systems, sensible heat factor (*SHF*), by pass factor, grand sensible heat factor (*GSHF*), apparatus dew point (*ADP*), concept of enthalpy potential, thermal analysis of human body, effective temperature and comfort chart, human comfort.	8
Module 2.	Review of vapour compression cycle, effect of superheating, subcooling, condenser pressure and evaporator pressure on *CoP*, presentation of cycle on *P-h* and *T-s* chart, absorption refrigeration systems and their components.	8
Module 3.	Classification of refrigerants, *CFC, HFC, HCFC,* azeotropic, zeotropic, natural refrigerant, secondary refrigerant, antifreeze solution, desired properties of refrigerants and applications, properties and uses of commonly used refrigerant, greenhouse effect, global warming.	4
Module 4.	Ventilation- introduction, purpose of ventilation, natural ventilation, mechanical ventilation, tunnels ventilation, mine ventilation, natural ventilation, and mechanical ventilation.	4
Module 5.	Air conditioning system- introduction, unitary system, central air conditioning system, direct expansion system, all water system, all air system, air water system.	4
Module 6.	Load calculation- solar radiation, heat gain through glass- calculation of solar heat gain through ordinary glass tables, shading devices, fabric heat gain, overall heat transfer coefficient through walls and roofs, infiltration- stack effect, wind effect, infiltration load, internal heat loads, system heat gains, break-up of ventilation and effective sensible heat factor, cooling and heating load estimation, psychrometric calculation for cooling, evaporative cooling, building requirements and energy conservation in air conditioning buildings.	12
Module 7.	Air distribution- room air distribution- types of supply air outlets, mechanism of flow through outlets, selection and location of outlets, distribution patterns of outlets, materials for ducts and its specification, friction loss in ducts- grills, diffusers, registers, rectangular equivalent of circular duct. air duct designs, duct construction, duct design procedures, equal friction method, static regain method, velocity reduction method.	8
Module 8.	Air conditioning apparatus- fans and blowers, types of fans, fan characteristic, centrifugal fans, axial fans, fan arrangements, suction line, discharge line (hot-gas line), liquid line, location and arrangement of piping, basic elements of the control system	6
Total number of Hours		**52**

Course Outcomes:

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

- ***Understand*** basic concepts of HVAC and various HVAC systems **(L2).**
- ***Understand*** the basics of psychometry and utilize the principles of psychometric in the design of air conditioning equipment **(L2).**
- ***Apply*** the concepts of psychrometry to design HVAC systems for different applications **(L6).**

- ***Understand*** the ventilation and basics of duct design **(L2)**.
- ***Model, analyse*** and ***design*** different refrigeration as well as air conditioning processes and components **(L4, L6).**
- ***Evaluate*** applications and design calculations of HVAC & R systems **(L5).**
- ***Apply*** the basic laws for thermodynamic analysis of different processes involved in HVAC systems **(L6).**

S.No:	Text Books Recommended	Author	Publisher
1.	Refrigeration and Air Conditioning	Arora.C.P	Tata McGraw Hill
	References		
1.	Refrigeration and Air conditioning	Stockers W.F and Jones J.W.	McGraw Hill international edition
2.	Basics of refrigeration and Air Conditioning	Ananthanarayana	Tata McGraw Hill

Course Code	**PCC_ME703L**				
Category	**Professional Core Courses**				
Course Title	**Heating Ventilation and Air Conditioning Lab**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	0	**0**	**2**	**1**	
Pre requisites	**Basic Engineering Thermodynamics**				

Objectives:

To have a good understanding of the working principles of refrigeration and air-conditioning systems.

S.No:	Topic
Module 1.	Test on domestic refrigerator for evaluation of energy efficiency ratio (*EER).*
Module 2.	Test on vapour compression test-rig.
Module 3.	Test on air-conditioning test-rig.
Module 4.	Visit to vapour-absorption refrigeration plant.
Module 5.	Estimation of cooling load of simple air-conditioning system (Case Study).
Module 6.	Case study on cold storage.
Module 7.	Visit to any air conditioning plant.
Module 8.	Thermal analysis of refrigeration cycle using suitable software.
Module 9.	Installation and servicing of split air conditioner.

Course Outcomes:

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

Apply Refrigeration cycles and Conduct test on refrigeration and air conditioning test units to study their performance **(L3).**

Understand and ***Draw*** performance curves of these machines/systems **(L2).**

Analyse and ***calculate*** the results obtained from the tests **(L4)**.

Evaluate conclusions based on the results of the experiments **(L5).**

Course Code	**PCC_ME704**				
Category	**Professional Core Course**				
Course Title	**Design of Machine Elements-II**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites					

Objectives:

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice through a strong background in mechanics of materials.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Couplings, rigid couplings, muff couplings, flange couplings and flexible couplings	08
Module 2.	Design of sliding bearings, bearing materials, fluid viscosity, hydrodynamic lubrication, Petroff's equation, Raimondi and Boyd chart, heat dissipation, rolling element bearings- types, catalogue information (Timken and *SKF* bearings), bearing life, radial and thrust load.	09
Module 3.	Rope drive, belt drive and chain drive.	05
Module 4.	Gear design- spur, helical and worm gears, gear tooth profile, gear geometry, module, contact ratio, gear train, gear tooth bending strength, gear tooth surface fatigue analysis, gear material.	13
Module 5.	Clutches and brakes- single and multi-plate clutch, constant wear and constant pressure theories for plate clutches, materials, shoe drum brakes, internal and external shoe brakes	07
Total number of Hours		**42**

Course Outcomes:

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

- ***Design*** of Sliding contact bearing in industrial applications **(L6).**
- ***Understand*** and ***apply*** principles of gear design to spur gears, Helical and Bevel Gear **(L2).**
- ***Design*** belt drives and selection of belt, rope and chain drives **(L6)**.
- ***Analyze*** the pressure distribution and design journal bearings **(L4).**

S.No:	**Text Books**	**Author**	**Publisher**
	Design of Machine Elements	V.B. Bhandari	Tata McGraw Hill, New Delhi
	References		
	Machine Elements in Mechanical Design	Robert L. Mott	Pearson Education
	Mechanical Engineering Design	Shigley, Budynas, Nisbett	McGraw Hill, New York
	Machine design	Robert L. Norton	Pearson Education

Course Code	**OEC1_ME705**				
Category	**Open Elective Course**				
Course Title	**Automatic Control**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	**Laplace Transforms**				

Objectives:

To Develop mathematical models of dynamic systems in differential equation form and transfer function form. To use solution methods for dynamic systems and to analyze different systems in time and frequency domains. To study transient response and block diagram models.

M. No:	**Topic**	**No. of Hrs**
Module 1.	Introduction to control systems, examples of control systems, closed-loop control versus open-loop control.	02
Module 2.	Mathematical modelling of control systems, inertial and non-inertial frames of reference, transfer functions, block diagrams, signal flow graphs.	06
Module 3.	Transient and steady-state response analyses first-order systems, second-order systems, higher-order systems, performance characteristics of control systems.	07
Module 4.	Basic control actions, effects of proportional,derivative and integral contour actions on system performance, steady-state errors in unity-feedback control systems.	09
Module 5.	Stability, asymptotic stability, bounded input bounded output (*BIBO*) stability, Routh's stability criterion.	06
Module 6.	Control systems analysis and design by root-locus method.	06
Module 7	Control systems analysis and design by frequency-response method.	08
	Total number of Hours	**42**

Course Outcomes:

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

- ***Understand*** the principles of machine dynamics **(L2).**
- ***Derive*** mathematical models for mechanical, electrical and thermal systems **(L3)**.
- ***Use*** different solution methods for dynamic models **(L3).**
- ***Understand*** the feedback control theory **(L2)**.
- **Model, analyse, design** and simulate automatic control systems in the time domain and frequency domain **(L4, L6)**.
- ***Apply*** methods of block diagram, root locus, Bode plot and feedback control theory to ***analyse*** and design automatic control systems **(L6, L4).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Modern control Engineering	Ogata. K	Prentice Hall,2020
	References		
1.	Automatic Control	Raven.H	McGraw Hill, 1998

Course Code	**OEC2-ME705**				
Category	**Open Elective Course**				
Course Title	**Introduction to Project Management**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester- 7 (Seven)**
	2	**1**	**0**	**3**	
Pre requisites	**Basic Probability & Statistics, Basic Operations Research**				

Objectives:

To understand the general and advanced concepts of Project Management for managing projects under costs and time constraints

S.No:	**Topic**	**No. of Hrs**
Module 1.	Project management- concepts and definitions, project management cycle, stages and methods of project management, project management for a process.	08
Module 2.	Risk management in projects- project risk management,project management and decision analysis, decision tree analysis, application of utility theory in project management, work breakdown structure.	12
Module 3.	Project scheduling and control- concept, aspects and applications of *CPM* and *PERT*, project life cycle, scheduling and crashing of jobs, resource levelling and resource constraint.	10
Module 4.	Introduction to *GERT* and earned value management- earned value management and its key components, graphical evaluation and review technique.	09
Total number of Hours		**42**

Course Outcomes:

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

- ***Analyze*** the different stages of the project **(L4).**
- ***Determine*** the different methods of project management **(L5).**
- ***Understand*** the ways to perform network analysis using *PERT* and *CPM* **(L2)**.
- ***Determine*** the ways to minimize the duration of crashing activities **(L5).**

S.No:	**Text Books**	**Author**	**Publisher**
1.	Project Management Core Textbook	S J Mantel, Jr., J R Meredith, S M Shafer	John Wiley
	References		
1.	Project Management: The Managerial Process	C F Gray, E W Larson	Tata McGraw Hill