Title of the Course: INDUSTRIAL ENGINEERING	L	T	P	Cr
Course Code: UMCH0701	3	-	-	3

Course Pre-Requisite: knowledge of machines and processes used in manufacturing organizations.

Course Description:

Industrial engineering is one of the fastest growing areas of engineering. It looks at what makes organizations work best. An industrial engineer tries to find the right combination of human and natural resources, technology, equipment, information and finance to do the work best. This course is important to finding the answers for many important problems in manufacturing. Industrial engineers design and change how things are done to increase quality, safety and productivity.

Course Objectives:

The course aims to:

1. Introduce students to the concept of integration of various resources
2. Acquaint the students with tools and technique of industrial engineering.
3. Analyze and design new method of performing job.
4. Understand work measurement techniques

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	**Select** suitable layout for given application from different types of plant layout.	3	Applying
CO2	**Analyze** the existing method of performing job for new improved method.	4	Analyzing
CO3	**Estimate** standard time for job.	5	Evaluating
CO4	**Evaluate** the given job using suitable evaluation method	5	Evaluating

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3		3	2		3						3			
CO2	3	2	3	2		3	3	1	2		1				
CO3	3					3				2					
CO4	2					3			2	2	1				

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three Units)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three Units) covered after MSE.

Course Contents:	
Unit 1- Introduction to Industrial Engineering and Productivity	**7 Hrs.**
Introduction to Industrial Engineering – Definition, Scope, Responsibilities, Important contributors to I.E., Tools and techniques of industrial engineering. **Productivity:** factor productivity, total productivity; labour Productivity, measurement of Productivity, Productivity improvement techniques. Productivity improvement programme. **Merit Rating:** Job description, Job Analysis, Job evaluation and Merit rating.	
Unit 2- Method Study	**7 Hrs.**
Historical background, Role of work study in improving productivity, Steps, Tools and Techniques used in the Method Study, outline Process Chart, Flow process Chart, Symbols, Flow Diagrams, Two Handed Chart, String diagram, Multiple Activity Chart, 5W and 1 H.	
Unit 3- Motion Study and PPC	**6 Hrs.**
Motion Study: Principles of motion economy, Micro motion study, SIMO chart, MEMO motion study, Cycle graph, Chronocycle graph **Production Planning and Control**: Introduction: Types of production systems, Need and functions of PPC, Aggregate production planning, Capacity Planning.	
Unit 4- Work Measurement (Time Study)	**9 Hrs.**
Work Measurement **Time Study:** Aim & Objectives, Terminology & Tools, Use of stopwatch procedure in making Time Study. Time Study Forms, Performance rating, allowances and its types. Calculation of Standard Time. **Work Sampling:** Introduction to work sampling. Determinations of Standard time using work Sampling. **Synthetic & Standard data Methods:** Concepts, Introduction to PMTS, MTM1, WFS, and Basic Motion Time Study. MTM2 & Other second Generation Methods, MOST and other advanced work measurement techniques.	
Unit 5- Facility Design	**7 Hrs.**
Plant site selection, Factors influencing the selection, Optimum decision on choice of site and analysis, Types of plant layout, Advantages and disadvantages of layout, Principles and objectives of plant layout, Tools and techniques of layout planning, Material handling.	
Unit 6- Value Engineering	**4 Hrs.**
Value Analysis: Definition, Concept of approaches of value analysis and engineering, steps, Evaluation, and applications of value analysis.	

Textbooks:

1. M. Telsang, "Industrial Engineering and Production Management", S. Chand Publication, ISBN 81 219 1773 5.
2. O. P. Khanna, "Work Study", Dhanpat Rai Publications, New Delhi.
3. Banga & Sharma, "Industrial Organisation & Engg. Economics", Khanna Publishers, 2001, ISBN 81-7409-078-9
4. Chabra T. N., "Principles & Practices of Management", Dhanpat lal & compony
5. Mahajan M., "Industrial Engineering and Production Management" Dhanpat Rai and Sons Publishers, 2005, ISBN-81-7700-047-0

References:

1. H. B. Maynard and others, "Industrial Engineering Handbook", IVth edition McGraw Hill Publications, ISBN 0-07-041084-4.
2. "Introduction to Work Study", ILO Universal Pub. Co, B'bay,ISBN 81 85027 06

3. Ralph M. Barnes, "Motion and Time Study: Design and Measurement of Work" J. Wiley& Sons.
4. Koontz Harold and Weihrich Heinz, "Essentials of management", 7ed, Tata McGraw Hill publishing, 2008, ISBN 0-07-0623030-x.
5. Luthans f., "Organizational Behaviour", McGraw-Hill Company, 2008, ISBN 81-317-05021.
6. Cynthia L. Greene, "Entrepreneurship: Ideas in Action", Thomson, ISBN-981-243-257-1.

Journals:

1. Journal of Industrial Engineering International
2. Journal of Industrial Engineering and Management
3. Computers & Industrial Engineering

Unit wise Measurable students Learning Outcomes:

Unit 1	Introduction to Industrial Engineering and Productivity	- To acquaint the students with tools and technique of Industrial Engineering. - To interpret job evaluation and merit rating.
Unit 2	Method Study	- To analyze and design new method of performing job. - To understand work measurement techniques
Unit 3	Motion Study and Human Factor Engineering (Ergonomics)	- To understand principles of motion economy and Micro motion study. - To understand Man machine system
Unit 4	Work Measurement (Time Study)	- To measure and estimate standard time for job
Unit 5	Facility Design	-To make optimum decision on choice of site and analysis
Unit 6	Value Engineering	- To understand difference between value engineering and Value analysis - To make optimum decision related with substitutes.

Title of the Course: MECHATRONICS	L	T	P	Credit
Course Code: UMCH0702	3	----	--	3

Course Pre-Requisite: Knowledge of basic Electronics and Electrical Engineering

Course Description: Studying the mechatronics course is of importance due to the global demand and developments in Mechatronic systems, Industry 4.0 and automated manufacturing planning and controlling activities etc. The mechanical systems are becoming smart and for designing and developing such smart systems students of mechanical engineering must understand basic elements of smart systems such as sensors, signal conditioning devices, microcontrollers, microprocessors, digital logic and programs for automating the processes.

Course Objectives:

1. To provide graduates of mechanical engineering with fundamental knowledge in the field of mechatronics for advanced graduate studies in the area of Mechatronics, Manufacturing engineering, and related field.
2. To prepare graduates of mechanical engineering with comprehensive knowledge of Mechatronics to enable them to apply the relevant knowledge and technologies for the design and realization of innovative systems and products.
3. To introduce graduates of mechanical engineering with working principles and functioning of basic components, inputs, outputs and programming languages used in mechatronic systems.

Course Learning Outcomes:

CO	After the completion of the course, the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Explain the** construction, working principals and functions of input, processors and output components used in the mechatronics system.	II	Understanding
CO2	**Identify** suitable signal conditioning devices for the mechatronics system.	III	Application
CO3	**Solve** scenarios of automating the processes using the PLC programming approach.	VI	Creating

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	1	1	1								
CO2	1	1	1									
CO3	2	3	3	1	2	1						

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1: --- Introduction Introduction to Mechatronics, Mechatronics systems, Measurement systems, Multi-discipline scenario Transducers and Sensors: - Position Sensors: Limit switch, Photoelectric switches, Proximity sensors, Pneumatic limit valves and backpressure sensors, Pressure switches, resolvers, Incremental and absolute encoders, displacement sensors. Velocity sensors: Tachogenerator, Use of encoders, decoders, Types of inputs and outputs, Displacement: Potentiometer sensors, LVDT, Capacitive, smart sensors	**07Hrs.**
Unit 2: --- Signal Conditioning Signal conditioning process, Operational amplifier (inverting amplifier, Non-inverting amplifier, Summing, Integrating amplifier, Differtianting amplifier, Logarithmic amplifier), Protection, Filtering, Data acquisition, Multiplexer, Analog to Digital Converter (ADC), Digital to Analog Converter (DAC). Oscillators to generator sinusoidal, Square, Triangular and impulse Waveforms, 555 timer, Sample and hold, Demultiplexing. Interfacing input-output ports, Serial and parallel interfacing requirements, Buffers, Handshaking, Polling and interrupts.	**07Hrs.**
Unit 3: --- Digital Circuits, Microprocessor, and Microcontroller Digital logic, Number systems, Logic gates, Boolean algebra, Application of logic gates, Sequential logic, Flip flop, D flip flop, JK flip flop, Master slave flip flop. Microcontroller: Comparison between microprocessor and microcontroller, Organization of a microcontroller system, Architecture of MCS 51 /ATMEL /PIC controller, Pin diagram of 8051, Addressing modes, Instruction types and set, Selection and Applications of Microcontroller. Types of motors, Servo motors with drivers, feedback encoding devices. Applications of motors in Mechatronics.	**06Hrs.**
Unit 4: --- Programmable Logic Controllers (PLC) Introduction, Definition, PLC system and components of PLC Input-output module, PLC advantages and disadvantages. Ladder diagram and PLC programming fundamentals: Basic components and other symbols, Fundamentals of ladder diagram, Machine control terminology, Instruction list, Update – Solve ladder – Update, Physical components Vs. program components, Light control example, Internal relays, Disagreement circuit, Majority circuit, Oscillator, Holding (sealed or latches) contacts, Always ON always OFF contacts, Nesting of ladders.	**07Hrs.**
Unit 5: --- PLC Programming PLC Input instructions, Outputs, Coils, Indicators, Operational procedures, Contact and coil input output, Programming example, Fail safe circuits, Simple industrial applications. PLC Functions PLC timer functions – Introduction, Timer functions, Industrial applications, Industrial process Timing applications, PLC control functions – PLC counters and its industrial applications.	**07Hrs.**
Unit 6: --- Mechatronics Systems Traditional Vs Mechatronic Design, Case studies of Mechatronic systems designs, like piece counting system, Pick and place manipulator, Simple assembly task involving a few parts, Part loading/unloading system, Automatic tool and pallet changers etc. Fault finding and troubleshooting. Introduction to SCADA and MEMS. PLC applications in Industry 4.0 and IoT.	**06Hrs.**
Textbooks: 1. “Mechatronics”,W. Bolton, Pearson Education , 4th Edition,	

2. “Mechatronics”,Mahalik, TATA McGraw Hill, (2006) Reprint,
3. “Microprocessor 8085”, Gaokar Prentice Hall of India, 5th Edition.
4. “Introduction to PLC Programming” NIIT.
5. “Programmable Logical Controller”, Hackworth, Pearson Education, (2008).
6. “Programmable Logical Controller”, Reis Webb, Prentice Hall of India 5th Edition.
7. “MEMS and Microsystems”, HSU Tairan, TATA McGraw Hill Publication. 1st Edition.

References:

1. “Mechatronics”Appu Kuttam, Oxford Publications, 1st Edition.
2. “Automated Manufacturing Systems”,S. Brain Morris, Tata McGraw Hill.
3. “Mechatronics and Microprocessor”,Ramchandran , Willey India, (2009).
4. “Mechatronics: Integrated Mechanical Electronic System”, Ramchandran , Willey India,1st Edition.
5. “Programmable Logical Controller”,Gary Dunning Cengage Learning, 3rd Edition.
6. “Mechatronics Source Book”, N C Braga, Cengage Learning.
7. “SCADA”, Stuart A. Boyer, ISA Publication, 4th Edition.

Unit wise Measurable students Learning Outcomes:

1. The student will be able to explain the classification and working principles of Transducers & Sensors.
2. The student will be able to select signal conditioning devices based on knowledge of types of signals and basic information about sensors and transducers.
3.
   3.1. The students will be able to solve digital logic outputs based on knowledge of number system, logic gates, and flip-flops.
   3.2. The student will be able to explain different aspects of Microprocessor and Microcontroller, architecture, instructions, comparison, applications.
4. The student will be able to identify different components of PLC and can perform simple ladder diagram programming by knowing the rules of a drawing ladder diagram, inputs, outputs, timers, counters.
5. The student will be able to develop PLC programs for various simple applications.
6. The student will be aware of advances and different case studies in the field of mechatronics and automation.

Title of the Course: REFRIGERATION AND AIR CONDITIONING Course Code: UMCH0703	L	T	P	Credit
	3			3

Course Pre-Requisite: Applied Thermodynamics, Fluid Mechanics, Heat & Mass Transfer.

Course Description:

This subject enables the student to understand refrigeration cycles, their analysis and performance evaluation. Students will learn different refrigerants, their properties. The students will also learn components of refrigeration systems.

Course Objectives:

1. Study basic refrigeration cycles and Psychrometry
2. Performance Evaluation of Refrigeration and Air Conditioning Systems
3. Enable the students to analyze and solve refrigeration related problems by applying principles of mathematics, science and engineering.
4. To develop a professional approach to lifelong learning in the refrigeration/ air conditioning

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Apply knowledge of mathematics, science, and engineering for the needs in refrigeration and air conditioning .	3	Applying
CO2	Analyze different refrigeration and air conditioning systems with their applications.	4	Analyse
CO3	Evaluate refrigeration and air-conditioning systems under different conditions.	5	Evaluate

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2												2	2
CO3		2		3	3										

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: **Review of Thermodynamics:** Laws, General equations, Processes, Equations applied to processes. Applications of refrigeration. **Basic Refrigeration Cycles:** Carnot cycle, Reversed Carnot cycle, Simple Vapor compression cycle, effect of subcooling, suction vapor superheating, Liquid to suction vapor heat exchanger, Calculations and performance of above cycles, Actual vapor compression cycle, Bell Coleman - Reversed Bryton cycle, Air cycles for aircrafts (Descriptive Treatment). .	**7 Hrs.**
Unit 2. Multi pressure System and Refrigerants: **Multi pressure System:** Removal of flash gas, Flash inter-cooling, Water-cooling, Multistage, Multi-evaporator and Cascade System. **Refrigerants:** Classification, Desirable Properties like Thermodynamic, physical and chemical. Comparison among commonly used refrigerants, Selection of Refrigerants, Effect on Ozone depletion and global warming, Alternative Refrigerants. Secondary refrigerants.	**6 Hrs.**
Unit 3: Cryogenics and Vapor Absorption System: **Cryogenics:** Introduction to cryogenic engineering and application, liquefiers and cryocoolers. **Vapor Absorption System:** Aqua Ammonia system, Enthalpy-Concentration chart, analysis of system. Lithium Bromide -water vapor absorption system, Coefficient of Performance, Comparison with Vapor Compression cycle. (Descriptive treatment only).	**7 Hrs.**
Unit 4: Refrigeration Equipments: Types of Compressor, Condenser, Evaporator, Expansion devices, and selection, different controls and accessories, use of insulation, its types and applications.	**6Hrs.**
Unit 5: Psychrometry: Moist air as a working substance, Psychrometric properties of air, use of Psychrometric tables and charts, processes, combinations and calculations, ADP, Coil condition line, sensible heat factor, bypass factor, air washer and it's applications. Comfort: Thermal exchange between human body and environment, factors affecting comfort, effective temperature, comfort chart, ventilation requirements.	**7 Hrs.**
Unit 6: Heating and Cooling Load Calculation: Representation of actual air conditioning process by layouts and on Psychrometric charts, load analysis, RSHF, GSHF, ESHF, Enumeration and brief explanation of the factors forming the load on refrigeration and air conditioning systems, Energy requirements of different types of air conditioning systems, Energy conservation in air conditioning	**8Hrs.**
Textbooks: 1. C. P. Arora ,"Refrigeration and Air conditioning", Tata McGraw Hill Education Private Limited , third edition,2008	

2. Roy J. Dossat "Principles of Refrigeration", Pearson, fourth edition, 2007.
3. Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, New York, 1983.
4. Dr. S.N. Sapali "Refrigeration and Air-conditioning", PHI (Second Edition) 2016

References:

1. Wilbert F. Stoecker, Industrial refrigeration handbook, 1st edn., McGraw-Hill Professional Publishing,1998
2. Shan K. Wang, "Handbook of air conditioning and refrigeration" McGraw-Hill international edition, second edition.

Unit wise Measurable students Learning Outcomes:

Students should be able to:

1. Describe and recall basics of thermodynamics and study and analyze refrigeration cycles.
2. Carry out performance study of multistage VCC. Classify the refrigerants; explain the physical, chemical properties of refrigerants.
3. Study the applications of cryogenic systems. Analyze vapor absorption system.
4. Select different equipment used in refrigeration and become familiar with application of refrigeration.
5. Describe and recall basics of thermodynamics and air conditioning.
6. Calculate heating and cooling load for air conditioning systems.

Title of the Course: FINITE ELEMENT ANALYSIS Course Code: UMCH0721	L	T	P	Credit
	3	0		3

Course Pre-Requisite:

Engg. Mathematics, AM, AME, Machine Design, Fluid Mechanics.

Course Description:

This subject enables the student to understand the important concepts of FEA, its evolution and applications. Students will learn the mathematical formulation of FEA problems. The knowledge gained through this subject will be helpful in solving the real life problems.

Course Objectives:

1. Introduce students to Finite Element Analysis fundamentals.
2. Introduce students to steps involved in FEA, domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
3. To enable the students to formulate the design problems into FEA
4. Understand the practical (modeling and analysis) aspects of the FEA
5. Apply this theory and practical knowledge to solve 1-d, 2-d structural and thermal problems manually and with using computers.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Understand the mathematical modeling and FEA .	2	Understanding
CO2	Use of advanced software for solving the problems and interpreting the results	3	Applying
CO3	Develop solutions of some mechanical real time problems.	4	Develop
CO4	Estimate the deformation, stresses, strains and reactions	5	Estimate

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2												2	2
CO3		2		3	3										
CO4			3	2										2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks

ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Introduction : Introduction, Methods of solving engineering problems, past present and future of FEA, basic concept of FEA, Types of problems investigated and applications, steps in FEA, advantages of FEA, Stress analysis of stepped bar, 1D- thermal rod, Heat conduction through a wall. .	**6 Hrs.**
Unit 2: Discretization of the problem and interpolation models: Geometrical approximations, simplification through geometry, basic element shapes and behavior, choice of element type, size and number of elements, element and node numbering. Simplex complex and multiplex elements, linear interpolation polynomials for simplex elements, natural coordinate an axisymmetric element.	**8 Hrs.**
Unit 3: Finite element formulation for elasticity problems : Approximate analytical methods, Rayleigh Ritz method, Galerkin method, principle of minimum potential energy, one-dimensional elasticity, two- dimensional elasticity, axisymmetric elasticity, Plane stress and plane strain problems.	**6 Hrs.**
Unit 4: Finite element formulation for field problems : Variational formulation, thermal problems: one- dimensional, two-dimensional heat transfer, torsion problems, Fin problem, Analysis of Truss and beam.	**8 Hrs.**
Unit 5: Assembly and solution : Coordinate transformations, assembly of the element equations, incorporation of boundary conditions, solution of the equations. Model validity and accuracy, mesh design and refinement, element distortion, results processing, Model Checking.	**4 Hrs.**
Unit 6: Higher order element formulation and Advanced Applications : One dimensional quadratic and cubic elements, evaluation of element equations, isoparametric triangular and quadrilateral elements, features of commercial FE software's . Non-linear Static elasticity, Buckling, Modal, Transient Response, Harmonic Response, Shock Spectrum Analysis.	**8Hrs.**

Textbooks:

1. M. J. Fagan, Finite element analysis, Longman Scientific and Technical
2. D. L. Logan, A first course in finite element method, 4 ed. Cengage learning

3. J. N. Reddy, An introduction to the finite element method, 2 ed. McGraw Hill

References:

1. S. S. Rao, the finite element method in engineering, 4 ed. Elsevier Science & Technology Books, Dec2004.
2. T. A. Stolarski, Engineering analysis with ANSYS Software, Elsevier 2006
3. Erdogan Madenci, Ibrahim Guven, The Finite Element Method And Applications In Engineering Using Ansys, Springer 2017.
4. N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A.N. Thite, Practical Finite Element Analysis, Finite to Infinite Publication

Unit wise Measurable students Learning Outcomes:

1. Students will understand the preprocessing and post-processing, applications of FEA and formulation of 1D bar,.
2. . Students will understand Discrimination, Element selection and use of axi-symmetric elements
3. Students will Solve the problems on truss analysis
4. Students will able to solve the problems on Beam, torsion.
5. Students will understand the preparation of assembly matrix.
6. Students will understand the higher order elements

Title of the Course: NOISE AND VIBRATIONS	L	T	P	Credit
Course Code: UMCH0722	03	-		03

Course Pre-Requisite: Basics of Dynamics of Machines

Course Description: Many practical applications need investigation of Vibration such as design of machines, engines, turbines, structures, etc. Study of vibration is necessary to improve performance of system and to optimize the system. The subject contains - Free and forced vibrations of one-degree-of-freedom systems with and without viscous damping. Introduction to torsional vibration. Two degree of freedom systems, Multi degree vibrations. Numerical methods for multi degree vibration analysis. Introduction to Acoustics and Noise effects and measurement.

Course Objectives:

1. Overview of basic concepts of vibration analysis.
2. Study vibration analysis of multidgree of freedom systems
3. Acquaint with the principles of vibration measuring instruments.
4. Acquaint with Acoustic parameters and noise measurement.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain fundamentals of noise and vibration in mechanical systems.	2	Understanding
CO2	Solve numerical of natural frequency of mechanical system.	3	Applying
CO3	Analyze vibratory response of mechanical system.	4	Analyze
CO4	Estimate the parameters of Noise and Vibratory System.	5	Evaluate
CO5	Develop mathematical model to represent dynamic system.	5	Design

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2	2	2	2	1									1		
CO3	2	2	2	1									1		
CO4		2	2	1									2		
CO5		3	2	2									2		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10

MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:- Two Degrees of Freedom: a) Overview of analysis of Single Degree of Freedom systems (Free, forced, damped and undamped vibration) b) Free un damped vibrations – Principal modes and natural frequencies, Co-ordinate coupling and principal co-ordinates. c) Forced vibrations (Un damped) – Harmonic excitation, Vibration Dampers and absorbers, Dynamic vibration absorber – Tuned and Un tuned type, Two rotor system	08 **Hrs.**
Unit 2:- Introduction to Multi degrees of Freedom : Free vibrations of Multi DOF System-Flexibility and stiffness influence coefficient, Equation of motion , Rayleigh's method, Matrix Method, Matrix iteration method .	08 **Hrs.**
Unit 3: Continuous System: Mode shapes and natural frequencies,. Numerical methods in vibrations: Dunkerley's Method, Rayleigh, Rayleigh-Ritz, Stodola and Holzer's method.	08 **Hrs**
Unit 4:- Vibration Measurement and Applications - Instruments for measurement of displacement, velocity, acceleration and frequency of vibration, Sensors and Actuators, signal conditioners, Time and frequency domain plot, Spectral analyzers, Exciters, FFT analyzer, Condition Monitoring and Fault Diagnosis.	06**Hrs.**
Unit 5 – Basics of Noise : **a)** Basic definitions, human response to sound, Decibel scale, Relation among sound power, Sound intensity and sound pressure level, Octave Band Analysis, Noise- Effects, Rating and regulation Non auditory and Auditory effects of noise, Noise standards and limits, Ambient emission noise standards in INDIA, Hazardous noise explosion, Day night noise level.	05**Hrs.**
Unit 6 – Noise Measurement and control : Noise sources and control, Automotive noise control principles, Sound in enclosures, Sound energy absorption, Sound transmission through barriers, Noise measuring systems and instruments, psychoacoustic effects of sound.	05**Hrs.**

Textbooks:

1. "Mechanical Vibrations", Singiresu S.Rao , Pearson Education, ISBM –81-297-0179-0 - (2004).
2. "Mechanical Vibrations", G. K. Grover, Published by Nemchand and Brothers, Roorkee.
3. "Mechanical Vibrations", Dr. V. P. Singh, Published by S. Chand and Sons New Delhi.

4. “Noise and Vibration Control”, Leo L. Bernack, Tata Mc- Graw Hill Publication.
5. “Mechanical Vibration and Noise Engineering”,A. G. Ambekar, Prentice Hall of India.
6. “Fundamentals of Vibrations”, Balchandran Magrab ,Cengage Learning.
7. “Theory of Vibrations with Applications”, W. Thomson, Pearson Education,2nd Edition.
8. “Mechanical Vibration”,Dr Debabrata Nag, Wiley India Pvt. Ltd ,ISBN 978-81-265-3090-8.

References:

1. “Mechanical Vibration”,Austin Church, Wiely Eastern. 2nd Edition.
2. “Schaumm’s Outline series in Mechanical Vibration”, S. Graham Kelly, 6th Edition.
3. “Kinematics, Dynamics and Design of Machinery”,Waldron, Willey India, 2nd Edition.
4. “Mechanical Vibrations”, J.P. Den Hartog, Tata McGrawhill Book Company Inc., 4th Edition.
5. “Introduction to Dynamics and Control”, Leonard Meirovitch, J. Wiley, New York.
6. “Elements of Vibration Analysis” Leonard Meirovitch, Tata McGrmv-Hill, New York. 2nd Edition.
7. “Principles of Vibration”,Benson H. Tongue,Oxford University Press., 4th Edition.
8. “Vibrations and Noise for Engineers”, Kewal Pujara Dhanpat Rai and Sons, (1992).
9. “Mechanical vibration”, William J Palm III Wiley India Pvt. Ltd., ISBN 978-81-265-3168-4, 1st Edition.
10. “Fundamentals of vibrations”, Leonard Meirovitch, McGraw Hill International Edition.
11 “Principles of Vibration Control”, . Asok Kumar Mallik, Affiliated East-West Press.
12 “Mechanical Vibrations”, A.H. Church, John Wiley and Sons, Inc, New York, 1994.

Unit wise Measurable students Learning Outcomes:

1. **Identify types of vibratory system as Undamped, Damped, SDOF, MDOF**
2. **Model the vibratory system for analysis purpose.**
3. **Evaluate natural frequencies and mode shapes of SDOF systems.**
4. **Evaluate natural frequencies and mode shapes of MDOF systems.**
5. **Measure the vibration parameters of system using instrumrnts.**
6. **Understand the terms related to acoustic and measure the noise level.**

Title of the Course: AUTOMOBILE ENGINEERING Course Code: UMCH0723	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite: Basic Mechanical Engineering, I. C Engines.

Course Description: The aim of course is to understand the working of different automobile system. In this course the students will be familiar with advances in automobile. The focus of the course will be demonstration of working models of automobile systems and analyze automobile performance at different operating conditions.

Course Objectives:

1. To make students familiar with various basic systems of automobile.
2. To introduce the mathematical treatments required for vehicle performance.
3. To make students aware about latest trends in transportation towards a safe, pollution free and fully automatic vehicle.
4. To empower students to face the real life automotive usage with greater confidence.

Course Learning Objectives:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Understand basic concepts of automobile engineering.	II	Understanding
CO2	Learn the ability to understand deferent automobile systems and components.	II	Understanding
CO3	Identify, formulate and solve automobile engineering problems.	III	Applying
CO4	Function on automobile engineering laboratory teams.	III	Applying

CO-PO Mapping:

CO	PO1	PO	PO3	PO4	PO 5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2													2	
CO2		2											2		
CO3			2												
CO4				3											3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1:- **Introduction** Automobile history and development, Classification, vehicle layouts- engine location and drive arrangement, specifications of vehicles, Type of vehicle bodies, body parts and its advanced materials, Chassis types, constructional details, details of chassis material, Types of frames, sub-frames, frameless vehicles.	**5 Hrs.**
Unit 2:--- **Transmission System** Clutch – Function and requirements, Classification, Construction and working of Single-plate, Multi-plate, Diaphragm spring and centrifugal clutches, Fluid flywheel. Gear Box – Necessity, classification, construction of manual gear boxes like Sliding mesh, constant mesh, Synchromesh, Epicyclic gear train, Automatic transmission, CVT, Overdrive. Propeller shaft, Differential and final drive.	**8 Hrs.**
Unit 3:- **Steering and Braking Systems** Steering systems- function, principle of steering, Ackerman and Davis, steering geometry, center point steering, cornering force, slip angle, scrub radius, steering characteristic, Types of steering gearbox, power steering, collapsible steering. Braking system- Need, principle, types, Mechanical, hydraulic and pneumatic brakes, disc and drum types, air brakes, Anti-lock braking system, Brake adjustments, defects and causes.	**7 Hrs.**
Unit 4:--- **Suspension and Electrical system** Suspension system- Functions, Types of suspension linkages, types of spring - leaf, coil, air springs, telescopic shock absorber, hydro gas suspension, rubber suspension, self-levelling suspension (active suspension), Air suspension, Advances in suspension system. Electrical system-Automotive batteries, battery charging system, alternators, starter motor, Bendix drive,Modern automobile batteries,Advance ignition systems, lighting and electrical accessories, automobile air conditioning, panel board instruments.	**8 Hrs.**
Unit 5:--- **Vehicle Performance** Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Gradeability and draw bar pull, Traction and Tractive effort, Distribution of weight, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio. (Numerical treatment)	**7 Hrs.**
Unit 6:--- **Recent Trends in Automobiles** Construction & working of different types of sensors used in automobiles, Safety in Automobiles, Hybrid vehicles, Fuel Cell, Electrical vehicles, Autonomous Vehicles.	**5 Hrs.**
Textbooks: 1. Kripal Singh, *Automobile Engineering Vol II,* Standard Publishers Distributors, Tenth Edition , 2007 2. P S Gill, *Automobile Engineering II,* S K Kataria and Sons, Second Edition, 2012 3. R K Rajput, *Automobile Engineering*, Laxmi Publications, First Edition, 2007	

4. Automobile Engineering", G.B.S. Narang., Khanna Publication,3rd Edition.

References:

1. Newton, Steeds and Garrett, The Motor Vehicle, Butterworths International Edition, 11th Edition, 1989
2. Crouse and Anglin, Automotive Mechanics, McGrawhill Publication, Tenth Edition, 2007
3. William Crouse, "Automobile Engineering"

Unit wise Measurable students Learning Outcomes:
After completion of unit, students are able to

1. To select proper engine for given vehicular application
2. To discuss various types of transmission systems.
3. To relate concepts of Steering and Braking system.
4. To discuss concepts of suspension system and electrical system.
5. To analyse vehicle performance.
6. To comprehend recent trends in automobile development.

Title of the Course: ADVANCED FOUNDRY TECHNOLOGY Course Code: UMCH0724	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite:

Fundamental knowledge of materials and basic metal Casting processes

Course Description:

Casting is the process from which solid metal shapes (castings) are produced by filling voids in molds with liquid metal. The basic steps involved in making castings are patternmaking, molding, melting and pouring, shakeout and cleaning, heat treating, and inspection. Casting is a defect prone manufacturing process. Hence Casting simulation helps to visualize mold filling and casting solidification; to predict sand casting defects.

Course Learning Objectives:

CLO1: To Show knowledge in an advanced foundry by taking into account the fundamental of casting process.
CLO2: To explain special molding, core making and advanced casting techniques and modern equipment in casting operation
CLO3: To analyze manufacturing and management related problems in casting technology.
CLO4: To Perform optimization of gating system with the use of modern software.
CLO5: To Standardize the process with various productivity and quality control techniques in a casting industry

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	To Show knowledge in an advanced foundry by taking into account the fundamental of casting process.	II	Remembering
CO2	To Explain special molding, core making and advanced casting techniques and modern equipment's in casting operation	III	Understanding
CO3	To Model optimization of gating system with use of modern software.	III	Applying
CO4	To Analyze manufacturing and management related problems in casting technology.	IV	Analyzing
CO5	To Formulate the process with various productivity and quality control techniques in a casting industry	VI	Creating

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	2				2							3	1		
CO2	2			3		2						3			
CO3	2		2									3	1		
CO4	2					3						3			
CO5	2	2				2						3			

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/Moodle quiz/Topic seminar/Group Discussions, Industrial case study etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1 :Introduction and position of Indian foundry industry. — **4 Hrs.**

Comparison of casting technology with other metal processing technologies, merits and limitations, specifications of composition and purity of cast metals. Recent Trends and Scope In Foundry Industry: Position of foundry industry worldwide and in India, analysis of data in respect of supply and demand, recent trends in quality specifications like dimensional accuracy, surface finish and property requirements, specifications, properties and applications of modern cast alloys- SG iron. Al – alloys, Cu- alloys, Zn – alloys, Mg alloy

Unit 2. Design considerations in manufacturing of casting toolings, dies and sand conditioning: — **5 Hrs.**

Review of conventional method of casting and pattern design. pattern and die design considerations. Computer aided casting component design. Computer aided design and manufacturing of patterns and dies. 3D Scanning and rapid prototype design of dies in die casting and centrifugal casting.

Properties of shell sand, no-bake sand systems, CO_2 sand, cold box sand, their comparison, equipment for sand processing, developments in sand mullers and sand plants, sand reclamation - cost and environmental issues, types of reclamation methods,

Advanced Materials used – epoxy resins and heat treated Al alloys for patterns and dies - selection and applications.

Unit 3. **Casting methoding- design considerations:** — **6 Hrs.**

Elements and types of gating systems, gating ratio pressurized and non-pressurized gating, systems-applications, Risers – types and functions of risers, directional solidification – factor affecting and significance, use of exothermic sleeves, bricks, chills and their types, types and uses of filters, computer aided design for gating and risering systems**.** Use of simulation software for casting methoding and metal flow simulation

Unit 4. Advancement in molding and modern casting techniques: — **9 Hrs.**

High pressure molding technology, flaskless molding technology, magnetic molding, Core shooters used in shell core making and cold box process, Mold and core washes / coats – types, applications, selection and significance, Use of ceramic components and filters, their selection and significance,

Permanent Mold & Special Casting Techniques: Process parameters for Die casting- gravity, pressure and low pressure, Centrifugal casting, Vacuum casting, Thixocasting, Investment casting, Squeeze casting; Advantages, limitations and applications.

Coated Sands & Processing: shell sand, no-bake sand systems, CO2, sand, cold box sand, ,developments in sand mullers and sand plants, sand reclamation - cost and environmental issues,

types of reclamation methods.

Unit 5. Melting and Post processing of Castings: **8 Hrs.**

Recent advancement in melting practice, Melting technologies and furnaces used for steels, grey C.I., S.G. iron and compacted graphite iron, Al-Si alloys, Magnesium and Titanium based alloys; Inoculation, modification, de-oxidation, degassing, grain refinement treatments for various alloys, advanced methods for chemical analysis for metal compositions and temperature measurement, Use of ceramic materials in metal casting, Fettling and cleaning of castings,

Shot blasting, using pneumatic chippers and grinders. Salvaging. Casting defects and their classification. Casting rejection analysis, instrumentation, mechanization and automation, instrumentation,

Safety aspects in foundries, Environmental issues and regulations, Possible hazards in foundries, Safety measures, Safety devices, Foundry mechanization and automation, Automatic Ladle System, industrial safety.

Unit 6. Quality Control, Modernization , Mechanization and Productivity Improvement Techniques in Foundry: **8 Hrs.**

Quality specifications in respect of raw materials used in foundry sand, sand additives, furnace charging material, checklists maintained for raw materials, mould; Heat wise pouring reports, melting log sheets, test bars, calibration of testing equipments, chemical analysis, test reports, rejection report analysis, defect diagnosis, remedies, use of cause - effect or fish- bone diagrams, S.Q.C. in foundries, control charts ,Energy Auditing in foundries, optimization techniques, costing of castings; importance and implementation of TS, ISO and QS in foundries, KAIZEN, safety measures, pollution and its control (compliance to pollution control norms as specified by govt. authorities, Mechanization in Foundries: Conveying system, automated Pouring sand reclamation plants, foundry layout

Textbooks:

1. Manufacturing Technology: Foundry, Forming & Welding by P. N. Rao (TMH)
2. Metal Casting – Principles & Practice by T. V. Rama Rao (New Age International Pvt. Ltd.)
3. A Text Book on Foundry Technology by M. Lal, O. P. Khanna(Dhanpat Rai & Co.)
4. A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.)
5. Fundamentals of Metal Casting by P. C. Mukharjee (Oxford & IBH Publishing Co).
6. Principles of Foundry Technology by P. L. Jain (Tata McGraw Hill)
7. Foundry Practice by N. D. Titov (MIR)
8. Foundry Engineering by Taylor, Flemings, Wulff (Wiley Eastern Ltd.)
9. Principles of Metal Casting by Heine, Loper, Rosenthal

References:

1. Casting Technology And Casting Alloys by A.K.Chakrabarti, (PHL Learning Pvt Ltd.)
2. Iron and steel making by Ahindra Ghosh, Amit Chatterjee (PHL Learning Pvt Ltd.)
3. Complete Casting Handbook-Metal Casting Processes, Metallurgy, Techniques & Design by John Campbell (BH Publication
4. Casting simulation website www.efoundryiitb.ac.in
5. The FOSECO Foundry man's handbook 10th edition by Butter Worth-Heinemann (BH Publication)
6. ASM Handbook Volume 15 on casting

Unit wise Measurable students Learning Outcomes:

1. Graduates will be able to expain advancements and recent trends in foundry industry.
2. Graduates will be able to design casting tooling by using different materials as per casting operation and requirements
3. Graduates will be able to carry out method designing which plays important rle in gating system design and casting yield.
4. Graduates will be able to explain and relate advanced molding and casting techniques.
5. Graduates will be able to explain Recent advancement in melting practice and ladle technology
6. Graduates will be able to suggest a proper productivity improvement technique by using SQC tools.

Title of the Course: ADVANCED MANUFACTURING PROCESSES **Course Code: UMCH0725**	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-Requisite:

Fundamental knowledge of materials and basic traditional manufacturing processes

Course Description:

Advanced manufacturing is the use of innovative technology to improve products or processes, with the relevant technology being described as "advanced," "innovative," or "cutting edge." Advanced manufacturing industries "increasingly integrate new innovative technologies in both products and processes. The rate of technology adoption and the ability to use that technology to remain competitive and add value to define the advanced manufacturing sector.

Course Learning Objectives:

CLO1. Study and understand the various nonconventional and CNC machine tools and manufacturing processes carried out on these machines for different applications- outsight.
CLO2. Identification of basic knowledge about Composite material and Manufacturing Processes for composites material.
CLO3.Identification of basic knowledge about advanced machine tools and their overall idea of construction.
CLO4.To study various parts of the machine tools used in manufacturing machine shops only
CLO5.To study the constructional design aspect of various engineering machine tools only.
CLO6. To study the assembly (Fitment of parts- detailing) of various engineering machine tools only.
CLO7. To study assembly of various machine tools, actual fitments of components / assembly of conventional and present era machine tools.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	To relate positions of each components of the machine tool.	I	Remembering
CO2	To Compare the different components and their work contribution through different operations performed on the particular machine tool.	I	Remembering
CO3	To Compare various kinds of machine tools of previous and present era machine tools.	II	Understanding
CO4	To Utilize and design components/ shapes demanded by the present / advanced machine tools.	III	Applying

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PSO2**	**PSO3**
CO1	2	2			2							2	1		
CO2	2		2	2		2						2	1		
CO3	2		2		2							2			
CO4	2					2						2			

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/Moodle quiz/Topic seminar/Group Discussions, Industrial case study etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Review of Conventional Manufacturing Processes and role of Non traditional manufacturing processes- **4Hrs.**

forging, rolling, extrusion, wire drawing, sheet metal processes. Manufacturing automation, Modern materials and need for Nontraditional manufacturing processes. Single-action nontraditional machining , Hybrid machining Economics of nontraditional and automated manufacturing. Introduction to micromachining and MEMS. Introduction to coatings and tribology

Unit 2: Mechanical Non traditional manufacturing processes: **05Hrs.**

Study of Mechanical Non traditional manufacturing processes as Ultrasonic Machining , Water Jet Machining , Abrasive Jet Machining Abrasive Water Jet Machining ,Ice Jet Machining Magnetic Abrasive Finishing with reference to Introduction ,The machining system , Material removal process, Factors affecting material removal rate ,Dimensional accuracy surface quality and Applications

Unit 3: Chemical , Hybrid electrochemical Non traditional manufacturing processes: **06Hrs.**

Study of Chemical Non traditional manufacturing processes as Chemical Milling , Photochemical Milling , Micro-ECM, Electropolishing, and electrochemical Non traditional processes as Electrochemical Machining, Electrochemical Drilling, Shaped Tube Electrolytic Machining, Electrochemical Deburring ,Hybrid electrochemical processes as Electrochemical Grinding, Electrochemical Honing ,Electrochemical Superfinishing, Laser-Assisted ECM with reference to Introduction,Principles of electrolysis,Theory of ECM, ECM equipment, Basic working principles, Process characteristics, Process control, Applications, Advantages and disadvantages Environmental impacts

Unit4 : Thermal based Non traditional manufacturing processes: **9 Hrs.**

Study of Thermal based Non traditional manufacturing processes as Electro-discharge Machining , Laser Beam Machining , Electron Beam Machining , Plasma Beam Machining , Ion Beam Machining and Hybrid Thermal Processes as Electroerosion Dissolution Machining, Electro-discharge Grinding, Abrasive Electro-discharge Machining,EDM with Ultrasonic Assistance,Electrochemical Discharge Grinding, Brush Erosion-Dissolution Mechanical Machining with reference to Introduction, Basic equipment and removal mechanism , Machining systems, Material removal rate, Accuracy and surface effects, Applications

Unit 5: Material Addition Processes : **8Hrs.**

Material Addition type as Liquid-Based Techniques Stereolithography, Liquid thermal polymerization, Fused deposition modeling, Multijet modeling , Shape deposition manufacturing .
Powder-Based Processes as Selective laser sintering Laser engineered net shaping , Three-dimensional printing and
Solid-Based Techniques Solid foil polymerization ,Laminated object modeling with reference to Introduction, Basic equipment and applications

Unit6 : Rapid Prototyping and Electronic Fabrication: **8 Hrs.**

Product development cycle & importance of prototyping. Types of prototypes, principles and advantages and different types of generative manufacturing processes, Factors concerning to Rapid Prototyping consideration for adaptations, advantages, accuracy, economic considerations.

Electronic Fabrication Principles, salient features, advantages and applications of abrasive floor machining, magnetic abrasive finishing, wire EDM, electrochemical grinding, honing, lapping and super finishing. Principles, elements, process, advantages, applications and surface preparation etc. of physical vapor deposition, chemical vapor deposition, electro less coating and thermal metal spraying

Reference and Textbooks:

1. HMT Handbook – Production Technology (TMH)
2. Willer, "Non- traditional Machining Processes", SME publications.
3. G.F.Benidict, "Advanced Manufacturing Processes", Marcel Dekker Publisher
4. E. Paul DeGarmo, J. T. Black & Ronald A. Kohser, "Materials & Processes in Manufacturing", (PHI)
5. Non Conventional Machining", – P.K.Mishra (IIT, Kharagpur), NarosaPublishing House
6. S. Kalpaljian & Steven R. Schmidt, (Pearson Education) "Manufacturing Processe for Engineering Materials
7. H. El Hofy, Fundamentals of Machining Processes, Taylor and Francis, 2006
8. V. K. Jain, Advanced Machining processes, Allied publishers, New Delhi, 2008.
9. Rapid Manufacturing: An Industrial Revolution for the Digital Age – Editors N. Hopkinson, R.J.M. Hague and P.M. Dickens, (2006) John Wiley & Sons, Ltd., ISBN-10 0-470-01613-2
10. G. Benedict, Nontraditional manufacturing processes, Marcel Dekker, New York, 1st Edition, 1987.
11. D. T. Pham and S. S. Dimov, Rapid manufacturing, Springer-Verlag, 1st Edition, 2001.

Advanced Machining Processes Nontraditional and Hybrid Machining Processes Hassan El-Hofy

Unit wise Measurable students Learning Outcomes:

1. Graduates will be able to explain and relate advanced manufacturing techniques used for advanced material machining.
2. Graduates will be able to explain construction ,working , mechanisem of metal removal in Mechanical Non traditional manufacturing processes
3. Graduates will be able to explain construction ,working , mechanisem of metal removal in Chemical , Hybrid electrochemical Non traditional manufacturing processes
4. Graduates will be able to explain construction ,working , mechanisem of metal removal in Thermal based Non traditional manufacturing processes
5. Graduates will be able to explain construction ,working of Material Addition Processes used in prototyping
6. Graduates will be able to explain applications of advanced techniques as Rapid Prototyping and Electronic Fabrication

Title of the Course: PRODUCT LIFECYCLE MANAGEMENT	L	T	P	Credit
Course Code: UOEL0771	3	-	-	3

Course Pre-Requisite: This course requires the basic knowledge of the following:

1. Basics of Manufacturing Engineering
2. Basics of Design Engineering

Course Description:

This course covers the management of complex technical products during all phases of the product life cycle. It is a broad survey of all the tools needed by the technical product manager throughout the life cycle of a complex product. The course is taught with a systems approach and from the engineering manager's viewpoint. The product life cycle includes all aspects of managing products from launch to maturity.

Course Objectives:

1. To introduce the students to concept, need and components of PLM.
2. To explain product development process and methodologies.
3. To introduce product modelling and product data management technology.
4. To integrate PLM with other technologies.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain the concept, need, benefits and components of PLM.	II	Understanding
CO2	Distinguish product development processes and methodologies.	IV	Analysing
CO3	Illustrate concepts of product modeling	II	Understanding
CO4	Explain the PDM technology and integration of PLM with other applications	II	Understanding
CO5	Construct and manage product data using PLM/PDM technologies.	III	Applying

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2												2	2	
CO2	2	2											2	2	
CO3	2												2	2	
CO4	2												2	2	
CO5	2	2											2	2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Unit 1:--- Introduction to Product Life Cycle Management Product life cycle – Introduction, growth, maturity & decline, Product Lifecycle Management- Need, definition & Overview, Background for PLM-corporate challenges, Components/Elements of PLM, Emergence of PLM, Significance of PLM - life cycle problems to be resolved, product development problems to be resolved, Customer Involvement	**6 hrs**
Unit 2:--- Product Life Cycle Environment Product Data issues – Access, applications, Archiving, Availability, Change, Confidentiality. Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM	**6 hrs**
Unit 3:---Components of PLM Different phases of product life cycle and corresponding technologies, Product development processes and methodologies, Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration), Information authoring tools (e.g., MCAD, ECAD, and technical publishing), Core functions (e.g., data vaults, document and content management, workflow and program management), Functional applications. (e.g., configuration management) Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards, Vendors of PLM Systems and Components, Examples of PLM in use.	**8 hrs**
Unit 4:--- Product Development Process & Methodologies Integrated Product development, Product Development Process & Methodologies: Integrated Product development process – Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process, Conceive – Specification, Concept design: the activities of concept generation, Concept Selection: Overview of methodology, concept screening, and concept scoring, Design - Detailed design, Validation and analysis (simulation), Tool design, Realize - Plan manufacturing: Factors influencing material and process selection, approaches, tools and software used in selection, Manufacture, Build/Assemble, Test (quality check), Service - Sell and Deliver, Use, Maintain and Support, Dispose.	**8 hrs**

Unit 5:--- Product Development Approaches and Product Modelling Bottom-up design, Top-down design, Front-loading design workflow, Design in context, Modular design. Concurrent engineering, partnership with supplier, collaborative and Internet based design, work structuring and team deployment, Product and process systemization, problem, identification and solving methodologies, improving product development solutions Product Modelling - Definition of concepts – Fundamental issues - Role of Process chains and product models -Types of product models – model standardization efforts-types of process chains - Industrial demands.	**6hrs**
Unit 6:-- Product data management (PDM) technology Product Data Management – An Introduction to Concepts, Benefits and Terminology, CIM Data. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation. External drivers- scale, complexity, cycle times, globalization & regulation. Internal drivers - productivity, innovation, collaboration & quality. Board room drivers – income, revenues & costs **Integration of PLM system with other applications**: Different ways to integrate PLM system, transfer files, database integration, system roles, ERP, CAD, configurators	**6 hrs**

Textbooks:

1. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006.
2. Product Life Cycle Management - by Antti Saaksvuori, Anselmi Immonen, Springer, 1st Edition (2003)
3. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004. ISBN 1852338105

References books:

1. Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo, 1974.
2. Product Design & Development – by Kari Ulrich and Steven D. Eppinger, McGraw Hill International Edns, 1999.
   Effective Product Design and Development – by Stephen Rosenthol, Business One Orwin, Homewood, 1992 ISBN 1-55623-603-4.
4. Burden, Rodger PDM: Product Data Management, Resource Pub, 2003. ISBN 0970035225
5. Clement, Jerry; Coldrick, Andy; & Sari, John. Manufacturing Data Structures, John Wiley & Sons, 1992. ISBN 0471132691
6. Clements, Richard Barrett. Chapter 8 ("Design Control") and Chapter 9 ("Document Control") in Quality Manager's Complete Guide to ISO 9000, Prentice Hall, 1993. ISBN 013017534X
7. Crnkovic, Ivica; Asklund, Ulf; & Dahlqvist, Annita Persson. Implementing and Integrating Product Data Management and Software Configuration Management, Artech House Publishers, 2003. ISBN 1580534988
8. Garwood, Dave. Bills of Materials for a Lean Enterprise, Dogwood Publishing Co., 2004. ISBN 0962111848
9. Anti Saaksvuori, Anselmi Immonen, Product Lifecycle Management, Springer

Title of the Course: ENTERPRISE RESOURCE PLANNING	**L**	**T**	**P**	**Credit**
Course Code: UOEL0772	**3**	**0**	**0**	**3**

Course Pre-Requisite:

This course requires the basic knowledge of the following:

1. Basics of Industrial Management
2. Basics of Computer Software and Hardware.

Course Description:

In today's world managing the future means managing information. Almost all organizations are turning to some sort of ERP package as a solution to their information management problems.ERP packages if chosen correctly, implemented judiciously and used efficiently have the ability to raise productivity and profits of companies. Knowledge of ERP systems is therefore crucial for today's day to day working.

Course Objectives:

1. To elaborate basics, evolution and importance of ERP.
2. To explain ERP and related technologies.
3. To explain the students the business modules of ERP.
4. To explain the ERP Implementation process.
5. To explain the ERP market with the help of case studies.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive level**	**Descriptor**
CO1	**Explain the** organization structure of an ERP system.	II	Understanding
CO2	**Explain** ERP and related information technologies	II	Understanding
CO3	**Explain** the business modules of ERP and **select** the appropriate module depending on the volume of industry	III	Applying
CO4	**Explain the** implementation process of ERP package.	II	Understanding
CO5	**Explain** the ERP market and the career opportunities in ERP	II	Understanding

CO-PO-PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2														
CO2	2														
CO3	2	2											2	2	
CO4	2														
CO5	2								2	2		2	2	2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Introduction to ERP Introduction, Business Functions and Business Processes, Role of the Enterprise, Evolution, Reasons for the growth of ERP market, Advantages, Reasons for failure of ERP. Benefits of ERP-Reduction of lead time, On time shipment, Reduction in cycle time, Improved resource utilization, Better customer satisfaction, Input supplier performance, Increased flexibility.	6 **Hrs.**
Unit 2:--- ERP and Related Technologies Data warehousing, Data mining, OLAP, Business Process Reengineering (BPR), Management Information System (MIS), Supply Chain Management (SCM), Decision Support System (DSS), Executive Information System (EIS),Customer relationship Management (CRM), ERP and Security.	7 **Hrs.**
Unit 3:--- ERP Modules Introduction and study of Business modules like Finance, Mfg. and Production, HR, Plant Maintenance, Quality and Material Management, Sales and Distribution.	6 **Hrs.**
Unit 4:--- ERP Implementation Basics and Life cycle Challenges to successful ERP Implementation, Objectives of ERP Implementation, Different Phases of ERP Implementation:-Pre-evaluation Screening, Package evaluation, Project planning, Gap Analysis, Reengineering, Customization, Implementation Team Training, Testing, Going live, End User training, Post Implementation.	8 **Hrs.**
Unit 5:--- ERP Implementation Process ERP Deployment models, ERP Implementation Methodologies, Organization of the ERP Project Team, Success and Failure factors of the ERP Implementation.	7 **Hrs.**
Unit 6:--- ERP Market and Case Studies Brief account of ERP market, various ERP packages like SAP, BAAN, Oracle, QAD, Peoplesoft etc, Case studies based on implementation of ERP for various areas in manufacturing, Marketing and other businesses, ERP career.	6 **Hrs.**
Textbooks: 1. "Enterprise Resource Planning", Alexis Leon, Tata McGraw Hill Publication, ISBN 0-7-463712-6. 2. "Enterprise Resource Planning", Bret Wagner, Delmar Learning, International Edition, ISBN 10: 1439081085, ISBN–13: 978-1439081082. 3. "Enterprises Resource Planning", Venkateshswara, Scitech Publication. 4. "Entrepreneurship",Chris Boulton, Patric Turner, Willey India. 5. "Management Information System",S. Sadagopan, PHI, New Delhi, 2nd Edition.	
References: 1. "Modern ERP: Select Implement and Use", Marianne Bradford, Hand M Books, lulu.com, ISBN: 978-0-557-01291-6. 2. "Enterprises Resource Planning", E.F. Monk, B.J. Wagner, Cengage Learning. 3. "Enterprises Resource Planning", A. R Singla, Cengage Learning. 4. "Enterprises Resource Planning-Concepts and Practices", Vinod Kumar Garg and Venkitakrishnan N. K. , PHI, New Delhi.	

Title of the Course: INDUSTRIAL MANAGEMENT & OPERATIONS RESEARCH [AUDIT COURSE] Course Code:UMCH0761	L	T	P	C
	3	-	-	0

Course Pre-Requisite: This course requires the basic knowledge of the following:

1. Basics of Mathematics.
2. Basic functional areas in Engineering

Course Description:-

The manufacturing Industry is now becoming conscious of the role of Industrial management and Operations Research and a good number of them have well trained OR teams. OR Techniques help in solving problems related to staffing, production planning, blending, product mix, maintenance, inspection, investment etc. Also, the need for motivating budding Engineers through Entrepreneurship development is also gaining importance.

Course Objectives:

1. To state the various functions of management.
2. To Know about the norms of industrial safety, business ethics, MIS, Industrial Safety and procedure to start small scale industries.
3. Apply the various models of operation research such as assignment model, transportation model, Linear programming model, Decision Theory Model, Network Model and Sequencing Model.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain the functions of Industrial Management areas like marketing, Materials, Costing.	**2**	Understand
CO2	Outline the skills necessary for Entrepreneurship development including safety in small scale industries	**2**	Understand
CO3	Demonstrate the applicability of LPP techniques such as Graphical method, Simplex , Transportation and Assignment to the Industrial problems	**2**	Understand
CO4	Apply OR techniques such as Project management, Sequencing Theory for Decision making in Manufacturing industry	3	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2														
CO2	2														
CO3	2														
CO4	2	2											2	2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one

EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ESE	100

ESE: Assessment is based on 100% course content.

Course Contents:

Unit 1:--- Functions of Management Definition of Management, Management environment. **I) Planning** – Need, Objectives, Strategy, Policies, Procedures, Steps in Planning, Decision making Forecasting. **II) Organizing** – Process of Organizing importance and principle of organizing, Departmentation, Organizational relationship, Authority, Responsibility, Delegation, Span of control. **III)Staffing** – Nature, Purpose, Scope, Human resource management, Policies, Recruitment procedure training and development, Appraisal methods. **IV)Leading** – Communication process, Barriers, Remedies, Motivation, Importance, Theories, Herzberg's theory, Maslow's theory, McGrager's theory, Leadership style. **V) Controlling** – Process, requirement for control Management, Accountability.	05 **Hrs.**
Unit 2:--- Marketing Management, Materials Management and Finance Management **I. Marketing Management**: Marketing Concepts –Objective –Types of markets – Market Segmentation, Market strategy – 4 AP's of market, Market Research, Salesmanship, Advertising. **II. Materials Management:** Definition, Scope, advantages of materials management, functions of materials management, Purchase Objectives, 5-R Principles of purchasing, Functions of Purchase department, Purchasing cycle, Purchase policy and procedure, Evaluation of Purchase Performance. **III. Finance Management**: Capital Structure, Fixed & working capital, Role of Securities and Exchange Board of India (SEBI), function of money market and capital Market, sources of finance. Introduction to capital budgeting, Techniques of capital budgeting.	06 **Hrs.**
Unit 3:--- Ethics, EDP, SSI, Industrial Safety, MIS, Inventory Control Models. I. Environmental factors influencing business, Business ethics and social responsibility of business, effect of globalization. II. Concept of an entrepreneur, Entrepreneurship development, Qualities required to become entrepreneurs III. Definition, Procedure to start Small Scale Industry. Assistance and incentives offered to SSI, Problems of SSI, Feasibility report writing. IV. Industrial Safety – Reasons for accidents, Prevention of accidents, Promotion of Safety V. Introduction to management information system, Introduction to ISO 9001 procedure VI. Inventory Control Models: Basic terminology, inventory associated costs, economic order quantity, E.O.Q. with price breaks.	07 **Hrs.**
Unit 4:--- Introduction to OR and Linear Programming Problems **Introduction:** History and development of OR, Applications, modeling in OR, OR models and their applications. **Linear Programming Problems**: Formulation of problem, Graphical solution, Simplex	08 **Hrs.**

procedure for maximization and minimization, Big M Method, Duality concept.	
Unit 5:--- Assignment Model and Transportation Model **Assignment Model**: Mathematical statement, Methods to solve balanced and unbalanced assignment problems, Maximization problems, Assignment with restrictions, Traveling salesman problem. **Transportation Model**: Mathematical formulation, methods to obtain initial basic feasible solution (IBFS), NWCR, Least Cost and VAM, Conditions for testing optimality, MODI method for testing optimality solution of balanced and unbalanced problems **Sequencing**: Sequencing of n jobs on two machines, n jobs on three machines.	06 **Hrs.**
Unit 6:--- Decision Theory, Network Model and Sequencing **Decision Theory**: Introduction, Pay off table, Opportunity loss or regret table, Decisions under uncertainty, Laplace criterion, Maximin or Minmax principle, Maximax or Minimin principle, Hurcuilicz principle, Decisions under risk–maximum likelihood criteria, Expectation principle, Expected opportunity loss or expected regret decision trees. **Network Model:** CPM – Construction of networks, critical path, Forward and backward path, Floats and their significance, PERT – Time estimates, Construction of networks, Probability of completing projects by given date, Crashing. **Dynamic programming**: Introduction – Bellman's Principle of optimality - Applications of dynamic programming- capital budgeting problem - Shortest Path problem – Minimum Spanning Tree.	08 **Hrs.**

Textbooks:

1. Operations Research, S. D. Sharma,
2. Operations Research, Hira Gupta, S. Chand & Co. Ltd., New Delhi.
3. Operations Research, Kanti Swarup,Man Mohan and P. K.Gupta, Sultan Chand & Sons,New Delhi.
4. "Industrial Management and Operation Research", Nandkumar Hukeri, Electrotech Publication.
5. "Industrial Engineering and Management", Vishwanath ,Scitech Publication,1st Edition.
6. "Optimization in Engineering", Biswal, Scitech Publication,2nd Edition.
7. "Operations Research", Manohar Mahajan Dhanapat Rai and Sons.
8. "Engineering Optimisation Methods and Application", A Ravindran ,K.M. Ragdell ,G.V. Rklaitis, Willey India Ltd

References:

1. Operations Research-An Introduction, H. Taha, Maxwell Macmillan,New York.
2. Principles Operations Research, Wrangler,Prantice-Hall of India,New Delhi.
3. "Essentials of Management", Koontz and H.Weinrich, Tata McGraw Hill Publication,12th Edition.
4. "Human Behaviour at Work Organizational Benhviour", Keith Davis, Tata McGraw Hill Publication, New Delhi,1st Edition.
5. "Business Management", J.P.Bose, S. Talukdar, New Central Agencies (P) Ltd.,
6. "Marketing Management", Philip Kotler, Prentice Hall of India, New Delhi, 8th Edition.
7. "Production and Operation Management", Tripathy, Scitech Publication, 2nd Edition.
8. "Engineering Management", Chithambaranathan, Scitech Publication.
9. "Introduction to Operation Research", Paneer-Selvam, Prentice Hall of India publication, 2nd Edition.

Title of the Course: Refrigeration and Air Conditioning Lab, Course Code: UMCH0731	L	T	P	Credit
	-	-	2	1

Course Pre-Requisite:
Applied Thermodynamics, Fluid Mechanics, Heat & Mass Transfer.

Course Description:
Students will be able to conduct trials on refrigeration and air conditioning systems. They will evaluate the performance of the systems.

Course Learning Objectives:

1. To enable the students to perform the experiment and analyze results based on principles of mathematics, science and engineering.
2. To prepare students to use modern tools and techniques in HVAC.
3. To train students with effective communication skill to demonstrate refrigeration/air conditioning theories.
4. To develop skills to fulfill industrial needs.
5. To develop a professional approach to lifelong learning in the refrigeration/ air conditioning.

Course Learning Outcomes:

CO	After the completion of the lab the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Perform the experiments in refrigeration and air-conditioning as per given objectives.	3	Applying
CO2	Analyze different refrigeration and air- conditioning systems with their applications.	4	Analyzing
CO3	Evaluate the performance of different systems under different condition	5	Evaluating

CO-PO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2												2		
CO2		2			3										1	1
CO3	2													2		

Assessments :
Teacher Assessment:
One component of In Semester Evaluation (ISE)

Assessment	Marks
ISE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

Experiment No. 1: **02Hrs**
Trial on vapour compression refrigeration system.
Aim and Objectives:
To demonstrate vapour compression cycle and to calculate theoretical and actual COP.
Outcomes:
The students will be able to understand the performance of vapour compression

refrigeration system	
Experiment No 2: Trial on Heat Pump tutor. **Aim and Objectives:** To study the Mechanical Heat Pump Testing Rig and calculate its Coefficient of Performance (COP). **Outcomes:** The students will be able to understand the performance of Heat pump.	**02 Hrs**
Experiment No 3: Trial on ice plant tutor. **Aim and Objectives:** To study the Ice Plant Testing Rig and calculate its Coefficient of Performance (COP) **Outcomes:** The students will be able to understand the performance of ice plant	**02 Hrs**
Experiment No 4: Trial on air conditioning Tutor **Aim and Objectives:** To study basic need of air conditioning, representation of different air conditioning processes on psychrometric chart and performance of refrigeration system. **Outcomes:** The students will be able to understand the performance of air conditioning system.	**02 Hrs**
Experiment No 5 : Trial on refrigeration tutor **Aim and Objectives:** To study the working of household refrigerator along with different auxiliary systems associated with household refrigerator and its wiring diagram and to evaluate the COP. **Outcomes:** The students will be able to understand the performance of domestic refrigerator.	**02 Hrs**
Experiment No 6 : Trial on Cascade refrigeration tutor. **Aim and Objectives:** To demonstrate cascade system and calculate the COP of system. . **Outcomes:** The students will be able to understand the performance of Cascade refrigeration system.	**02 Hrs**
Experiment No 7: Demonstration and study of accessories and controls used in refrigeration system. **Aim and Objectives:** To demonstration and study of accessories and controls used in refrigeration system **Outcomes:** The students will be able to understand accessories and controls used in refrigeration system	**02 Hrs**
Experiment No 8: Visit to Cold storage / Ice factory . **Aim and Objectives:** Visit to Cold storage / Ice factory to study the actual practices.	

Outcomes:

The students will be able to understand the actual practices followed in refrigeration systems.

Textbooks:

1. C. P. Arora ,"Refrigeration and Air conditioning", Tata McGraw Hill Education Private Limited , third edition,2008
2. Roy J. Dossat "Principles of Refrigeration", Pearson, fourth edition, 2007.
3. Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, New York, 1983.
4. Dr. S.N. Sapali "Refrigeration and Air-conditioning", PHI (Second Edition) 2016

References:

1. Wilbert F. Stoecker, Industrial refrigeration handbook, 1st edn., McGraw-Hill Professional Publishing,1998
2. Shan K. Wang, "Handbook of air conditioning and refrigeration" McGraw-Hill international edition, second edition.

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Experiment wise Measurable students Learning Outcomes: At the end of each experiment the students will be able to

1. The students will be able to understand the performance of vapour compression refrigeration system.
2. The students will be able to understand the performance of Heat pump.
3. The students will be able to understand the performance of ice plant
4. The students will be able to understand the performance of air conditioning system.
5. The students will be able to understand the performance of domestic refrigerator.
6. The students will be able to understand the performance of Cascade refrigeration system.
7. The students will be able to understand accessories and controls used in refrigeration system.
8. The students will be able to understand the actual practices followed in refrigeration systems.

Title of the Course:Mechatronics Lab	L	T	P	Credit
Course Code: UMCH0732	--	---	2	1

Course Pre-Requisite: Knowledge of basic Electronics and Electrical Engineering

Course Description: Studying the mechatronics course is of importance due to the global demand and developments in Mechatronic systems, Industry 4.0 and automated manufacturing planning and controlling activities etc. The mechanical systems are becoming smart and for designing and developing such smart systems students of mechanical engineering must understand basic elements of smart systems such as sensors, signal conditioning devices, microcontrollers, microprocessors, digital logic and programs for automating the processes.

Course Objectives:

1. To provide graduates of mechanical engineering with fundamental skills in the field of mechatronics for advanced graduate studies in the area of Mechatronics, Manufacturing engineering, and related field.
2. To stimulate students for developing simple mechatronics applications.
3. To introduce graduates of mechanical engineering with working principles and functioning of basic components, inputs, outputs and programming languages used in mechatronic systems.

Course Learning Outcomes:

CO	After the completion of the course, the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Experiment with** different input, processing and output components in the mechatronics system	III	Application
CO2	**Solve** scenarios of automating the processes using the PLC programming approach.	VI	Creating
CO3	**Develop** a small application of the Mechatronic system.	VI	Create

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3											
CO2	2	3	3	1	2	1						
CO3	2	3	3	1	2	1						

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	25
ESE	25

ISE are based on laboratory performance and journals.

ESE: Assessment is based on practical performance and oral examination (POE). Minimum 12 experiments to be performed and included in the journal. Students will perform any one experiment out of selected minimum 8 experiments from experiment number 1 to Experiment number 12 during POE exam and will be followed by oral exam.	
Course Contents:	
Experiment No.1: ---Trial on sensors (minimum four) and Selection of Actuators.	**2 Hrs.**
Experiment No. 2: --- To study of inverting and non inverting amplifier.	**2 Hrs.**
Experiment No. 3: --- To study of astable/monostable/bistable multivibrator using IC555.	**2 Hrs.**
Experiment No. 4: --- To study of basic logic gates.	**2 Hrs.**
Experiment No. 5: --- To study of universal logic gates.	**2 Hrs.**
Experiment No. 6: ---Addition and Subtraction of 8-bit numbers using microcontroller 8051.	**2 Hrs.**
Experiment No. 7: ---Interfacing and a controlling stepper motor with 8085 microprocessors.	**2 Hrs.**
Experiment No. 8: ---Demonstrating truth tables of logic gates using PLC ladder programming as well as digital output kits.	**2 Hrs.**
Experiment No. 9: ---PLC programming for demonstrating applications of combinational logic.	**2 Hrs.**
Experiment No. 10: ---Applications based on timers using PLC ladder programming.	**2 Hrs.**
Experiment No. 11: ---Applications based on counters using PLC ladder programming.	**2 Hrs.**
Experiment No. 12: ---Real-life application solving using PLC ladder programming.	**2 Hrs.**
Experiment No. 13: ---Fabrication of Simple Mechatronics working project by a group of 4/5 students usinghardware like sensors, signal conditioning, actuators, and suitable software.	
Experiment No. 14: ---Industrial visit to study Mechatronic system application and submission of visit report.	

Textbooks:

1. "Mechatronics",W. Bolton, Pearson Education , 4th Edition,
2. "Mechatronics",Mahalik, TATA McGraw Hill, (2006) Reprint,
3. "Microprocessor 8085", Gaokar Prentice Hall of India, 5th Edition ,
4. "Introduction to PLC Programming" NIIT.
5. "Programmable Logical Controller", Hackworth, Pearson Education, (2008).
6. "Programmable Logical Controller", Reis Webb, Prentice Hall of India 5th Edition.
7. "MEMS and Microsystems", HSU Tairan, TATA McGraw Hill Publication. 1st Edition.

References:

1. "Mechatronics"AppuKuttam, Oxford Publications, 1st Edition.
2. "Automated Manufacturing Systems",S. Brain Morris, Tata McGraw Hill.
3. "Mechatronics and Microprocessor",Ramchandran , Willey India, (2009).
4. "Mechatronics: Integrated Mechanical Electronic System", Ramchandran , Willey India,1st Edition.
5. "Programmable Logical Controller",Gary Dunning Cengage Learning, 3rd Edition.

6. “Mechatronics Source Book”, N C Braga, Cengage Learning.
7. “SCADA”, Stuart A. Boyer, ISA Publication, 4th Edition.

Experiment wise Measurable students Learning Outcomes:

1. The student will be able to select suitable sensors and actuators for the mechatronics system.
2. The student will be able to differentiate between inverting and non inverting amplifier and its applications.
3. The student will be able to demonstrate their knowledge of astable/ monostable/ bistable multivibrator using IC555.
4. The students will be able to demonstrate truth tables of basic logic gates using experimentation setup.
5. The students will be able to demonstrate truth tables of universal logic gates using experimentation setup.
6. The student will be able to perform addition and subtraction of two 8 bit numbers using assembly language programming of microcontroller 8051.
7. The student will be able to interface and control a stepper motor using 8085 microprocessors.
8. The students will be able to demonstrate their knowledge of digital logic and apply it to ladder programming.
9. The students will be able to perform ladder programming for given scenarios.
10. The students will be able to perform ladder programming for given scenarios.
11. The students will be able to perform ladder programming for given scenarios.
12. The students will be able to perform ladder programming for given scenarios.
13. The students will be able to develop simple mechatronics applications to solve real-life problems.
14. The students will be able to relate their fundamental knowledge of mechatronics in industrial applications.

Title of the Course: INDUSTRIAL ENGINEERING LAB	L	T	P	Credit
Course Code: UMCH0733	-	-	2	1

Course Pre-Requisite: knowledge of machines and processes used in manufacturing organizations.

Course Description:

Industrial engineering is one of the fastest growing areas of engineering. It looks at what makes organizations work best. An industrial engineer tries to find the right combination of human and natural resources, technology, equipment, information and finance to do the work best. This course is important to finding the answers to many important problems in manufacturing. Industrial engineers design and change how things are done to increase quality, safety and productivity.

Course Objectives:

The course aims to:

1. Introduce students to the concept of integration of various resources
2. Acquaint the students with tools and technique of industrial engineering.
3. Analyze and design new method of performing job.
4. Understand work measurement techniques

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Measure** different productivity indices along with total productivity.	1,3	Remembering
CO2	**Analyze** different tools & techniques to improve productivity.	3, 4	Analyzing
CO3	**Determine** element time using stop watch time study.	5	Evaluating
CO4	**Estimate** standard time for job.	5	Evaluating

CO-PO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3		3	2		3						3			
CO2	3	2	3	2		3	3	1	2		1				
CO3	2					2	3					1			
CO4		3		3				3		3		3			

Assessments :

Teacher Assessment:

In Semester Evaluation (ISE) based on experiments performed during the semester.

Assessment	Marks
ISE	25

Course Contents:

Experiment No. 1:-- Productivity Measurement **Aim and Objectives:** To understand and find out different productivity indices **Outcomes:** Student will be able to measure the productivity. **Theoretical Background:** Concept of productivity and its indices **Experimentation:** Numerical calculation for productivity and its indices **Results and Discussions:** To analyze and find the effect of different productivity indices on total productivity **Conclusion:** Students will be able to understand the factors which are helpful to increase productivity.	**02 Hrs.**

Experiment No. 2:-- Method study **Aim and Objectives:** To conduct method study to analyze present method and suggest best method. **Outcomes:** Student will be able to analyze the method. **Theoretical Background:** Steps to conduct Method study & different symbols used for Method Study. **Experimentation:** Draw the flow process chart **Results and Discussions:** Analyze flow process chart critically to eliminate unnecessary elements. **Conclusion:** Students will be able to decide the best method of doing the job.	**02 Hrs.**
Experiment No. 3:-- Multiple activity chart **Aim and Objectives:** To draw multiple activity chart for one process and calculate efficiency. **Outcomes:** Student will be able to find the idle time and working time. **Theoretical Background:** Concept of multiple activity chart and different terminology associated with it. **Experimentation:** Draw multiple activity chart. **Results and Discussions:** Analyze the chart critically and obtain the efficiency. **Conclusion:** Students will be able to understand the utilization of available resources.	**02 Hrs.**
Experiment No. 4:-- Two handed process chart **Aim and Objectives:** To draw Two handed process chart and to eliminate or reduce the unwanted motion to minimum and to arrange the best of motions in a possible sequence. **Outcomes:** Student will be able to find unwanted motions. **Theoretical Background:** Knowledge about recording symbols. **Experimentation:** A two hand process chart for nut and bolt assembly. **Results and Discussions:** Analyze the chart critically and arrange the best of motions in a possible sequence. **Conclusion:** Students will be able to arrange the best of operators motions in a possible sequence.	**02 Hrs.**
Experiment No. 5:-- Stop watch time study for an operation **Aim and Objectives:** To observe elements of an activity critically and differentiate into idle, missing and working elements. **Outcomes:** Student will be able to find idle, missing and working time. **Theoretical Background:** Knowledge to operate stop watch and use of time study sheet. **Experimentation:** Skill to identify different elements and record in appropriate column. **Results and Discussions:** Analyze the sheet critically and focus on idle and missing elements.	**02 Hrs.**

Conclusion: Students will be able to increase working time by reducing missing and idle time.	
Experiment No. 6:-- Work sampling **Aim and Objectives:** To establish time standards for an operation. **Outcomes:** Student will be able to find standard time using work sampling technique. **Theoretical Background:** Knowledge about work sampling. **Experimentation:** numerical establishment of standard time for an operation. **Results and Discussions:** Discussion on an estimation of the percentage utilization of machine. **Conclusion:** Students will be able to decide standard time using work sampling.	**02 Hrs.**

Textbooks:

1. M. Telsang, "Industrial Engineering and Production Management", S. Chand Publication, ISBN 81 219 1773 5.
2. O. P. Khanna, "Work Study", Dhanpat Rai Publications, New Delhi.
3. Banga & Sharma, "Industrial Organisation & Engg. Economics", Khanna Publishers, 2001, ISBN 81-7409-078-9
4. Chabra T. N., "Principles & Practices of Management", Dhanpat lal & compony Mahajan M., "Industrial Engineering and Production Management" Dhanpat Rai and Sons Publishers, 2005, ISBN-81-7700-047-0

References:

1. H. B. Maynard and others, "Industrial Engineering Handbook", IVth edition McGraw Hill Publications, ISBN 0-07-041084-4.
2. "Introduction to Work Study", ILO Universal Pub. Co, B'bay,ISBN 81 85027 06
3. Ralph M. Barnes, "Motion and Time Study: Design and Measurement of Work" J. Wiley& Sons.
4. Koontz Harold and Weihrich Heinz, "Essentials of management", 7ed, Tata McGraw Hill publishing, 2008, ISBN 0-07-0623030-x.
5. Luthans f., "Organizational Behaviour", McGraw-Hill Company, 2008, ISBN 81-317-05021.

Experiment wise Measurable students Learning Outcomes:

Expt. 1	Productivity Measurement	- To acquaint the students with different techniques of productivity measurement.
Expt 2	Method study	- To analyze and design new method of performing job.
Expt 3	Multiple activity chart	- To eliminate/ reduce unwanted motion and to arrange the best of motions in a possible sequence.
Expt 4	Two handed process chart	- To understand principles of motion economy and Micro motion study. - To understand Man machine system
Expt 5	Stop watch time study for an operation	-To make optimum decision on nonproductive elements and eliminate the same.
Expt 6	Work sampling	- To measure and estimate standard time for job

Title of the Course: Finite Element Analysis Lab Course Code:UMCH0734	L	T	P	Credit
	-	-	2	1

Course Pre-Requisite: Engg. Mathematics, AM, AME, Machine Design, Fluid Mechanics.

Course Description:
The course aims at solving the structural and thermal problems by FEA by hand calculations as well as by using Software.

Course Learning Objectives:
CLO1: To provide the students the methodology of solving FEA problems by using hand calculations
CLO2:To train students in using the FEA software for solving FEA problems

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	understand structural and thermal problems by hand calculations as well as by using softwares.	II	Understanding
CO2	Analyze structural and thermal problems using FEA software	IV	Analyzing

CO-PO Mapping:

CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2												2		
CO2		2			3										1	1

Assessments :
Teacher Assessment:
One component of In Semester Evaluation (ISE)

Assessment	Marks
ISE	25

ISE are based on practical performed/ Quiz/ Mini-Projectassigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

Assignment No. 1: Assignment on past, present and future of FEA, steps involved in FEA . **Aim and Objectives:** To understand evolution of FEA & methodology of solving numerical. **Outcomes:** The students will be able to understand the methodology of solving FEA problems.	**02Hrs**
Experiment No. 2: One dimensional structural problems to be solved by hand calculations. **Aim and Objectives:**To understand solving of 1D Structural problems **Outcomes:** The students will be able to solve 1D Thermal problems	**02 Hrs**
Experiment No. 3: One dimensional structural problems to be solved by hand calculations.	**02 Hrs**

Aim and Objectives: To understand solving of 1D Thermal problems **Outcomes:**The students will be able to solve 1D Thermal problems	
Experiment No. 4: Analysis of truss problems to be solved by hand calculations. **Aim and Objectives:**To understand solving of truss problems by hand calculations. **Outcomes:**The students will be able to solve truss problems by hand calculations.	**02 Hrs**
Experiment No. 5: Torsion problems to be solved by hand calculations. **Aim and Objectives:**To understand solving of Torsion problems by hand calculations **Outcomes:**The students will be able to solve Torsion Torsion problems by hand calculations	**02 Hrs**
Experiment No. 6: Beam problems to be solved by hand calculations. **Aim and Objectives:** To understand solving of Beam problems to be solved by hand calculations **Outcomes:** The students will be able to solve Beam problems to be solved by hand calculations	**02 Hrs**
Experiment No. 7: Solution of all above problems by using FEA software and comparing results**.** **Aim and Objectives:** To understand solving of structural and thermal problems by using software. **Outcomes:** The students will be able to solve structural and thermal problems by using software.	**02 Hrs**
Experiment No.8: Modal Analysis of Mechanical element by using software. **Aim and Objectives:** To understand solving of Modal Analysis of Mechanical element by using software. **Outcomes:** The students will be able to solve Modal Analysis of Mechanical element by using software.	**02 Hrs**
Experiment No.9: Plane Stress and plane Strain problems by hand calculations and using software. **Aim and Objectives:** To understand solving of Plane Stress and plane Strain problems **Outcomes:** The students will be able to solve Plane Stress and plane Strain problems which will enhance software skill.	

Textbooks:

1. M. J. Fagan, Finite element analysis, Longman Scientific andTechnical
2. D. L. Logan, A first course in finite element method, 4 ed. Cengagelearning
3. J. N. Reddy, An introduction to the finite element method, 2 ed. McGrawHill

References:

1. S. S. Rao, the finite element method in engineering, 4 ed. Elsevier Science & Technology Books, Dec2004.
2. T. A. Stolarski, Engineering analysis with ANSYS Software, Elsevier 2006
3. Erdogan Madenci, Ibrahim Guven, The Finite Element Method And Applications In Engineering Using Ansys, Springer 2017.
4. N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A.N. Thite, Practical Finite Element Analysis, Finite to Infinite Publication

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Experiment wise Measurable students Learning Outcomes: At the end of each experiment the students will be able to

1. understand methodology of solving FEA problems
2. estimate the variables of One dimensional structural problems
3. estimate the variables of One dimensional thermal problems
4. estimate the variables of truss problems
5. estimate the variables of Torsion problems
6. estimate the variables of Beam problems
7. solve problems by using software
8. solve Modal analysis problem.
9. Solve Plane Stress and plane Strain problems

Title of the Course: NOISE AND VIBRATIONS LAB	L	T	P	Credit
Course Code: UMCH0735	--	-	2	1

Course Pre-Requisite: Basics of Dynamics of Machines

Course Description: Many practical applications need investigation of Vibration such as design of machines, engines, turbines, structures, etc. Study of vibration is necessary to improve performance of system and to optimize the system. The subject contains - Free and forced vibrations of one-degree-of-freedom systems with and without viscous damping. Introduction to torsional vibration. Two degree of freedom systems, Multi degree vibrations. Numerical methods for multi degree vibration analysis. Introduction to Acoustics and Noise effects and measurement.

Course Objectives:

1. Overview of basic concepts of vibration analysis.
2. Study vibration analysis of multi degree of freedom systems
3. Acquaint with the principles of vibration measuring instruments.
4. Acquaint with Acoustic parameters and noise measurement.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain fundamentals of noise and vibration in mechanical systems.	2	Understanding
CO2	Solve numerical of natural frequency of mechanical system.	3	Applying
CO3	Analyze vibratory response of mechanical system.	4	Analyze
CO4	Estimate the parameters of Noise and Vibratory System.	5	Evaluate
CO5	Develop mathematical model to represent dynamic system.	5	Design

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2	2	2	2	1									1		
CO3	2	2	2	1									1		
CO4		2	2	1									2		
CO5		3	2	2									2		

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one component of End Semester Examination (ESE) having 50% weightage each.

Assessment	Marks
ISE 1	25
ESE (OE)	25

ISE is based on performance of experiments and timely submission of journal, internal oral.
ESE: Assessment is based oral/practical exam.

Course Contents:

Experiment No. 1:- Experiment on Equivalent spring mass system.	02**Hrs.**
Experiment No. 2: - Experiment on torsional vibration of two rotor without damping	
Experiment No. 3:--- Experiment on free vibration of a coupled pendulum and/or double pendulum	02 **Hrs.**
Experiment No. 4:--- Use of different types of exciters for vibration analysis.	02 **Hrs.**
Experiment No. 5:--- Measurement of vibration parameters using vibration measuring instrument.	02**Hrs.**
Experiment No. 6:--- Assignment on MDOF systems. (minimum Six Problems covering all methods)	02**Hrs.**
Experiment No7:--- Case Studies of Condition Monitoring (Minimum Two)	02**Hrs.**
Experiment No. 8: --- Measurement of Noise by Noise measurement instrument	02**Hrs.**
Experiment No. 9: -- Introduction to FFT Analyser	02**Hrs.**
Experiment No. 10: Vibration analysis using MATLAB/CAE (Minimum 4 problems)	02**Hrs.**

Textbooks:

1. "Mechanical Vibrations", Singiresu S.Rao , Pearson Education, ISBM –81-297-0179-0 - (2004).
2. "Mechanical Vibrations", G. K. Grover, Published by Nemchand and Brothers, Roorkee.
3. "Mechanical Vibrations", Dr. V. P. Singh, Published by S. Chand and Sons New Delhi.
4. "Noise and Vibration Control", Leo L. Bernack, Tata Mc- Graw Hill Publication.
5. "Mechanical Vibration and Noise Engineering",A. G. Ambekar, Prentice Hall of India.
6. "Fundamentals of Vibrations", Balchandran Magrab ,Cengage Learning.
7. "Theory of Vibrations with Applications", W. Thomson, Pearson Education,2nd Edition.
8. "Mechanical Vibration",Dr Debabrata Nag, Wiley India Pvt. Ltd ,ISBN 978-81-265-3090-8.

References:

1. "Mechanical Vibration",Austin Church, Wiely Eastern. 2nd Edition.
2. "Schaumm's Outline series in Mechanical Vibration", S. Graham Kelly, 6th Edition.
3. "Kinematics, Dynamics and Design of Machinery",Waldron, Willey India, 2nd Edition.
4. "Mechanical Vibrations", J.P. Den Hartog, Tata McGrawhill Book Company Inc., 4th Edition.
5. "Introduction to Dynamics and Control", Leonard Meirovitch, J. Wiley, New York.
6. "Elements of Vibration Analysis" Leonard Meirovitch, Tata McGrmv-Hill, New York. 2nd Edition.
7. "Principles of Vibration",Benson H. Tongue,Oxford University Press., 4th Edition.
8. "Vibrations and Noise for Engineers", Kewal Pujara Dhanpat Rai and Sons, (1992).
9. "Mechanical vibration", William J Palm III Wiley India Pvt. Ltd., ISBN 978-81-265-3168-4, 1st Edition.
10. "Fundamentals of vibrations", Leonard Meirovitch, McGraw Hill International Edition.
11 "Principles of Vibration Control", . Asok Kumar Mallik, Affiliated East-West Press.
12 "Mechanical Vibrations", A.H. Church, John Wiley and Sons, Inc, New York, 1994.

Unit wise Measurable students Learning Outcomes:

1. **Identify types of vibratory system as Undamped, Damped, SDOF, MDOF**
2. **Model the vibratory system for analysis purpose.**
3. **Evaluate natural frequencies and mode shapes of SDOF systems.**
4. **Evaluate natural frequencies and mode shapes of MDOF systems.**
5. **Measure the vibration parameters of system using instrumrnts.**
6. **Understand the terms related to acoustic and measure the noise level.**

Title of the Course: AUTOMOBILE ENGINEERING LAB	**L**	**T**	**P**	**Credit**
Course Code: UMCH0736	**0**	**0**	2	1

Course Pre-Requisite: Basic Mechanical Engineering, I. C Engines.

Course Description: This course deals with demonstration of different systems of automobiles and conduct at experiments for understanding of working of different automobile systems. In this course the student will be given hands on training for automobile maintenance through industrial visit.

Course Objectives:

1. To make students familiar with various basic systems of automobile.
2. To introduce the mathematical treatments required for vehicle performance.
3. To make students aware about latest trends in transportation towards a safe, pollution free and fully automatic vehicle.
4. To empower students to face the real life automotive usage with greater confidence.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	
CO1	Understand basic concepts of automobile engineering.	II	**CO1**
CO2	Learn the ability to understand deferent automobile systems and components.	II	**CO2**
CO3	Identify automobile troubleshooting and remedies.	III	**CO3**
CO4	Function on automobile engineering laboratory teams.	III	**CO4**

CO-PO Mapping:

CO	**PO1**	**PO**	**PO3**	**PO4**	**PO 5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2													2	
CO2		2											2		
CO3			2												
CO4				3											3

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	25
ESE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

Course Contents:

Experiment No. 1:--- Study and demonstration of four wheeler chassis layout and vehicle body parts and its materials.	**2 Hrs.**

Experiment No. 2:--- Study and Demonstration of working of single plate automobile clutch and clutch plate lining materials.	**2 Hrs.**
Experiment No. 3:--- Study and demonstration of synchromesh gearbox.	**2 Hrs.**
Experiment No. 4:--- Study and demonstration of final drive and differential.	**2 Hrs.**
Experiment No. 5:--- Study and demonstration of front wheel steering geometry and steering mechanism.	**2 Hrs.**
Experiment No. 6:--- Study and demonstration of suspension system of a four-wheeler.	**2 Hrs.**
Experiment No. 7:--- Study and demonstration of working Hydraulic braking system.	**2 Hrs.**
Experiment No. 8:--- Study and demonstration of electrical systems of automobile.	**2 Hrs.**
Experiment No. 9:-- Experiment on wheel balancing and wheel alignment.	**2 Hrs.**
Experiment No. 10:-- Visit to servicing station for study of vehicle maintenance, repairs and report.	**2 Hrs.**

Textbooks:

1. Kripal Singh, Automobile Engineering Vol II, Standard Publishers Distributors, Tenth Edition , 2007
2. P S Gill, Automobile Engineering II, S K Kataria and Sons, Second Edition, 2012
3. R K Rajput, Automobile Engineering, Laxmi Publications, First Edition, 2007
4. Automobile Engineering", G.B.S. Narang., Khanna Publication, 3rd Edition.

References:

1. Newton, Steeds and Garrett, The Motor Vehicle, Butterworths International Edition, 11th Edition, 1989
2. Crouse and Anglin, Automotive Mechanics, McGrawhill Publication, Tenth Edition, 2007
3. William Crouse, "Automobile Engineering"

Experiment wise Measurable students Learning Outcomes:

1. Identify different components of Automobile.
2. Demonstrate and explain different types of clutch.
3. Explain different components and types transmission system.
4. Demonstrate differential used in automobile.
5. Explain and demonstrate different steering system and steering geometry.
6. Constriction and demonstration of suspension system of a four-wheeler.
7. Demonstration of working of hydraulic braking system.
8. Identify various electrical systems used in automobile.
9. Understand wheel balancing and wheel alignment procedure.
10. Understand the preventive and breakdown maintenance of automobile.

Title of the Course: ADVANCED FOUNDRY TECHNOLOGY LAB **Course Code: UMCH0737**	**L**	**T**	**P**	**Credit**
		-	**2**	**1**

Course Pre-Requisite:

Fundamental knowledge of materials and basic metal Casting processes

Course Description:

Casting is the process from which solid metal shapes (castings) are produced by filling voids in molds with liquid metal. The basic steps involved in making castings are patternmaking, molding, melting and pouring, shakeout and cleaning, heat treating, and inspection. Casting is a defect prone manufacturing process. Hence Casting simulation helps to visualize mold filling and casting solidification; to predict sand casting defects.

Course Learning Objectives:

CLO1: To utilize knowledge in an advanced foundry by taking into account the fundamental of casting process.
CLO2: To design casting tooling by using knowledge of CAD and CAM
CLO3: To analyze manufacturing and management related problems in casting technology.
CLO4: To Perform optimization of gating system with the use of modern software.
CLO5: To carry out casting rejection analysis by using SQC tools

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	To Rephrase knowledge in an advanced foundry by taking into account the fundamental of casting process.	II	Understanding
CO2	To analyze manufacturing and management related problems in casting technology.	V	Analyzing
CO3	To design casting tooling by using knowledge of CAD and CAM	VI	Creating
CO4	To Formulate optimization of gating system with the use of modern	VI	Creating
CO5	To Discuss and carry out casting rejection analysis by using SQC tools	VI	Creating

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2				2							3	1		
CO2	2			3								3	1		
CO3	2		2									3	1		
CO4	2	2				3						3			
CO5	2	2										3			

Assessments :

Teacher Assessment:
One components of In Semester Evaluation (ISE1) and one End Semester Examination (ESE) having 25 marks each

Assessment	Marks (Mini. marks for Passing = 10)
ISE 1	25
ESE (O.E)	25

ISE 1 are based on unit assignment and lab experiment.
ESE: Assessment is based on external Oral examination based on 100% course content.

Course Contents:

1. To Design of pattern and core for given casting (2 Hrs)
2. To Design of gating and risering system for given casting (4 Hrs)
3. To carry out Casting simulation of designed gating system using online tools (4 Hrs)
4. To Design of basic die for die casting process. (4 Hrs)
5. To carry out Casting rejection analysis based on industrial data. (4 Hrs)
6. To Study of TS/ISO/QS norms for Foundry Industry (4 Hrs)
7. To Visit report to Ferrous and non ferrous foundry. (2 Hrs)

Textbooks:

1. Manufacturing Technology: Foundry, Forming & Welding by P. N. Rao (TMH)
2. Metal Casting – Principles & Practice by T. V. Rama Rao (New Age International Pvt. Ltd.)
3. A Text Book on Foundry Technology by M. Lal, O. P. Khanna(Dhanpat Rai & Co.)
4. A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.)
5. Fundamentals of Metal Casting by P. C. Mukharjee (Oxford & IBH Publishing Co).
6. Principles of Foundry Technology by P. L. Jain (Tata McGraw Hill)
7. Foundry Practice by N. D. Titov (MIR)
8. Foundry Engineering by Taylor, Flemings, Wulff (Wiley Eastern Ltd.)
9. Principles of Metal Casting by Heine, Loper, Rosenthal

References:

1. Casting Technology And Casting Alloys by A.K.Chakrabarti, (PHL Learning Pvt Ltd.)
2. Iron and steel making by Ahindra Ghosh, Amit Chatterjee (PHL Learning Pvt Ltd.)
3. Complete Casting Handbook-Metal Casting Processes, Metallurgy, Techniques & Design by John Campbell (BH Publication
4. Casting simulation website www.efoundryiitb.ac.in
5. The FOSECO Foundry man's handbook 10th edition by Butter Worth-Heinemann (BH Publication)
6. ASM Handbook Volume 15 on casting

Title of the Course: ADVANCED MANUFACTURING PROCESSES LAB **Course Code: UMCH0738**	**L**	**T**	**P**	**Credit**
		-	**2**	**1**

Course Pre-Requisite:

Fundamental knowledge of materials and basic traditional manufacturing processes

Course Description:

Advanced manufacturing is the use of innovative technology to improve products or processes, with the relevant technology being described as "advanced," "innovative," or "cutting edge." Advanced manufacturing industries "increasingly integrate new innovative technologies in both products and processes. The rate of technology adoption and the ability to use that technology to remain competitive and add value to define the advanced manufacturing sector.

Course Learning Objectives:

CLO 1: Study and understand the various nonconventional and CNC machine tools and manufacturing processes carried out on these machines for different applications- outsight.
CLO 2: Identification of basic knowledge about Composite material and Manufacturing Processes for composites material.
CLO 3: Identification of basic knowledge about advanced machine tools and their overall idea of construction.
CLO 4: To study various parts of the machine tools used in manufacturing machine shops only
CLO 5: To study the constructional design aspect of various engineering machine tools only.
CLO 6: To study assembly of various machine tools, actual fitments of components / assembly of conventional and present era machine tools.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	To demonstrate a 3D Printing machining technique.	II	Understanding
CO2	To Identify study variables in a Mechanical Non traditional machining processes	III	Applying
CO3	To Identify basics about Composite material and Manufacturing Processes for given material.	IV	Analyzing
CO4	To Select process parameters in a given Non traditional machining process and analyze it.	VI	Applying

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	2		2		2							2	1		
CO2	2			3								2	1		
CO3	2		2								2	2			
CO4	2	2				3						2			

Assessments :

Teacher Assessment:

One components of In Semester Evaluation (ISE1) and one End Semester Examination (ESE) having 25

marks each

Assessment	Marks (Mini. marks for Passing = 10)
ISE 1	25
ESE (O.E)	25

ISE 1 are based on unit assignment and lab experiment.
ESE: Assessment is based on external Oral examination based on on 100% course content.

Course Contents:

1. To carry out Prototyping of one industrial component by using 3D Printing (4 Hrs)
2. To carry out Case study on any one Non conventional manufacturing technique. (2 Hrs)
3. Assignment based on Thermal based Non traditional manufacturing processes (2 Hrs)
4. Assignment based on Material Addition Processes (2 Hrs)
5. Assignment based on Mechanical Non traditional manufacturing processes: (2 Hrs)
6. To Visit to Non conventional manufacturing plant and report writing (2 Hrs)
7. To Visit to conventional manufacturing plant and report writing. (2 Hrs)
8. To undergo a virtual lab assignment available online. (4 Hrs)

Reference and Textbooks:

1. HMT Handbook – Production Technology (TMH)
2. Willer, "Non- traditional Machining Processes", SME publications.
3. G.F.Benidict, "Advanced Manufacturing Processes", Marcel Dekker Publisher
4. E. Paul DeGarmo, J. T. Black & Ronald A. Kohser, "Materials & Processes in Manufacturing", (PHI)
5. Non Conventional Machining", – P.K.Mishra (IIT, Kharagpur), NarosaPublishing House
6. S. Kalpaljian & Steven R. Schmidt, (Pearson Education) "Manufacturing Processe for Engineering Materials
7. H. El Hofy, Fundamentals of Machining Processes, Taylor and Francis, 2006
8. V. K. Jain, Advanced Machining processes, Allied publishers, New Delhi, 2008.
9. Rapid Manufacturing: An Industrial Revolution for the Digital Age – Editors N. Hopkinson, R.J.M. Hague and P.M. Dickens, (2006) John Wiley & Sons, Ltd., ISBN-10 0-470-01613-2
10. G. Benedict, Nontraditional manufacturing processes, Marcel Dekker, New York, 1st Edition, 1987.
11. D. T. Pham and S. S. Dimov, Rapid manufacturing, Springer-Verlag, 1st Edition, 2001.

Advanced Machining Processes Nontraditional and Hybrid Machining Processes Hassan El-Hofy

Title of the Course: Project Phase-I and Seminar Course Code:UMCH0751	L	T	P	Credit
		-	2	1

Course Pre-Requisite:
Knowledge up to pre-final year Mechanical Engineering Program.

Course Description:
It covers problem identification, Activity planning for the time frame and division of project responsibility to each student, literature survey, designing methodology, synopsis preparation and data collection.

Course Objectives:
The student should be able implement their ideas/real time industrial problem/ current application of their engineering branch which they have studied in the curriculum. The dependent study of the state of the art topics in a broad area of his/her specialization. Also through this process student will learn to plan and carry work as per plan.
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Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Identify the need or problem faced by industry or society that can be solved using knowledge and skills acquired during the program	I	Find
CO2	Survey the literature available about the problem chosen to assess various methods to solve it.	IV	Survey
CO3	Formulate the problem to identify the best methodology	II	Identify
CO4	Organize and demonstrate the entire process in the prescribed format.	VI	Organize

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2								2		2				
CO2		2		3				2	2						
CO3		2				3			2			2	2	2	2
CO4	2							2	3	2					

Assessments :

Teacher Assessment:
One In Semester Evaluation (ISE) and (ESE) having 66% weights for ISE and 33% weight for ESE.

Assessment	Marks
ISE	50
ESE	25

ISE is based on presentation/report etc.
As a part of ISE, students are expected to do the literature survey and problem definition, in the area student wishes to do the project. The In-Semester Exam (ISE) will be carried tentatively after one and half month of commencement of VII-Semester. Also give s seminar

related with project topic.
ESE(O.E):
As a part of ESE, students are expected to get their synopsis approved by respective guide and undergo the oral examination (Power point presentation) along with submission of a hard copy of phase I report.

Course Contents:

The students in a group of not more than FOUR will work under the guidance of the faculty member on the project work undertaken by them. The work started in Semester VII will be continued in the Semester VIII and the final submission of the report will be at the end of the Semester VIII.

The project work may consist of-

1. A comprehensive and up-to-date survey of literature related to study of a phenomenon or product.
2. Problem Identification
3. Methodology / Design Documents
4. A synopsis of the selected project work (two to three pages typed on A4 size sheets) will be submitted and assessed by the Project Guide and one more faculty member appointed by the Department / concerned responsible official of the sponsoring industry/Co-guide.
5. Data collection

Activity planning for the time frame and division of project responsibility to each student. An interim report of the work **co**mpleted in Semester VII in the form of workbook /project diary and other relevant documents shall be submitted for the term work. The term work shall be assessed by the Guide and one more faculty member appointed by the Head of the Department. The assessment shall be based on a presentation of the work completed and submission of interim report.

Seminar :

A student has to give a seminar on topic relevant with Project area. This Seminar will cover a comprehensive review of research undergoing in the field of related with the area of project topic. Also it will cover information about recent trend is the field of project.

The oral examination shall be based on the work planned and actually completed in Semester-VII

Title of the Course: ENERGY AND POWER ENGINEERING Course Code:UMCH0801	L 3	T	P	Credit 3

Course Pre-Requisite: Basic Physics, Engineering Thermodynamics, Fluid and Turbomachinery. I.C. Engines

Course Description: The course will cover following topics
Solar , wind ,biomass ,tidal energy and prospective , efficient use of primary energy sources, different power plants, Energy management .

Course Objectives:

1. Demonstrate need of different energy sources and their importance
2. Classify equipment's/systems utilized in power plants like solar collectors, nuclear reactor
3. Analyze the utilization of solar, wind energy etc
4. Explain the working of pollution control devices used in Power plants

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain need of different energy sources and their importance	II	Understanding
CO2	Classify different power plants.	II	Understanding
CO3	Identify different power generation methods by renewable energy sources .	III	Applying
CO4	Analyze performance parameters of Power plants.	IV	Analyzing

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2	3												2		
CO3		3					2								
CO4			3											2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:- Resources and development of power in India- NTPC, NHPC and their role in Power development in India, Power generation in Private sector, Indian Electricity Grid Code, Present Power position in India and world. Different types of power plants – Thermal, Hydro, IC Engine, Gas Turbine, Nuclear and their characteristics, Comparison of Power plants with respect to various parameters, Combined Cycle, Pumped storage, Compressed Air storage power plants and their characteristics, Combined cycle, MHD - steam plant.	6 Hrs
Unit 2:--Economics of Power Plant- Load Curves and Load duration curves (Numerical treatments), Performance and operational characteristics of power plants, Peak load, Intermediate	7Hrs

load and Base load plants and their characteristics, Input output characteristics of power plants, Economic division of between Base load plant and peak load plants, Tariff methods, Cost of electric Energy, Fixed and operating cost	
Unit 3:-- Environmental aspects and Energy Management- Different pollutants due to power plants and their effects on ecology, pollution monitoring instruments, control over different types of air and water pollution. Pollution measuring and control devices, Safety & Maintenance in Power Plants: Operation and Maintenance procedures of Power plants, Operator training, Safety during selection of power plant equipment, Energy management and marketing, Energy audit .	**6Hrs**
Unit 4:---Solar Energy - Solar potential and site selection, Solar radiation spectrum, Solar radiation geometry (Numerical on angle of incidence only), Solar radiation data, Solar Collectors(Flat plate, evacuated tube, Cylindrical parabolic, Concentrating paraboloid), Thermal Energy storage (Introduction and types) Operating Principle of Photovoltaic cell concepts. Photo-cell materials, Cell module array, Series and parallel connections, Maximum power point tracking, Design of standalone system with battery and AC or DC load (Descriptive Treatment)	**8 Hrs.**
Unit 5:--- Wind Energy- Wind parameters and wind data, Betz model, Power from wind, Site selection, Wind energy conversion systems and their classification, Construction and working of typical wind mill, Application of wind energy. Electrical Power Generation Subsystem. Operational issues.	**6Hrs.**
Unit 6:--- Other Renewable Energy Sources- **Biomass:** as a source of energy, Classification of biomass, Biomass conversion processes, Biogas plant and its components, Types of biogas plants. **Geothermal Energy**: Resources, types of wells, methods of harnessing the energy, potential in India. **Ocean Energy**: Ocean Thermal Energy Conversion, Principles utilization, setting of Ocean Thermal Energy Conversion plants, Comparison with normal thermal power cycles. **Tidal and wave energy**: Potential and conversion techniques, mini-hydel power plants, and their economics.	**7 Hrs.**

Textbooks:

1. Solar Energy, Sukhatme, 3rd Edition, Tata McGraw-Hill Education, 2008
2. Fundamentals of Renewable Energy Resources, G. N.Tiwari and M. K. Ghosal, Narosa Publishing House, 2007
3. A Text Book of Power Plant Engineering, R. K. Rajput, Laxmi Publications, New Delhi.
4) A Course in Power Plant Engineering, S.C. Arora and S. Domkundwar, Dhanpat Rai, 1988

References:

1] . Renewable Energy Resources, John Twidell & Anthony D. Weir, 2nd Edition, Taylor & Francis, 2006
2] Thermal Energy, Mahesh Rathore, Tata McGraw-Hill Education, 2010
3) Power Plant Engineering, P.K.Nag, 2nd Edition, Tata McGraw-Hill Education, 2002
4) Power Plant Technology, M. M. ElWakil, McGraw-Hill, 1984
5) An Introduction to Power Plant Technology, G.D. Rai, 3rd Edition, Khanna publications, 1996 5. Power plant Engg, C. Elanchezhian, I K International Publishing House, 2007

Unit wise Measurable students Learning Outcomes:

1 Acquire the knowledge of renewable sources of energy and utilization
2 To inculcate knowledge in students about Construction and working of typical wind mill, Introduction to OTEC
3 To provide the knowledge about present power scenario in India.
4 Acquire knowledge about present power position of India.
5 study different power plants
6 Study different pollution control devices

Title of the Course: DESIGN OF MECHANICAL SYSTEMS	L	T	P	Credit
Course Code: UMCH0802	03	-	-	03

Course Pre-Requisite: Basics of applied mechanics, Kinematics of machines, Design of Machine elements.

Course Description:

Design of Mechanical Systems is offered as Professional Elective III at the 8th semester of Mechanical Engineering undergraduate programme; consists of six units. The first unit focuses on Automobile transmission systems and Second unit deals with design of speed box for machine tools. Third unit focuses on design of cranes and forth unit deals with I.C.Engine component design. Fifth unit consists of Design of conveyor systems whereas Sixth unit consists of method to obtain optimum design.

This course intends to build the competency in the students to identify change in design as whole compared to component design, Analyze the problem and implement solutions to enhance the efficiency of Systems in terms of cost, Strength, Rigidity, reliability, etc

Course Objectives:

1. Select clutch and brake on the basis of Functional requirements of Automobile transmission systems.
2. Elaborate the significance of stepped regulation in Design of machine tool speed box and Design gear box
3. Identify various design parameters of Crane.
4. Design I.C.Engine components.
5. List different material handling systems and Design of conveyor system.
6. Classify different design parameters and evaluate optimum design**.**
7.

Course Learning Outcomes:

After successful completion of this course, Students will able to

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Identify various design parameters of mechanical Systems	3	Applying
CO2	Select various mechanical components on basis of functional requirements of system.	3	Applying
CO3	Apply analytical formulae to various mechanical systems to calculate design parameters.	3	Applying
CO4	Analyze static and dynamic behavior of mechanical systems.	5	Analyzing

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2	3		2										1		
CO3	3		3	2									1		
CO4	3		3	2									2		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---Design of Automobile transmission Systems Design consideration in brakes, Band, Internal expanding shoe, External contracting shoe. Thermal consideration and rating of brakes. Design requirement of friction clutches, Selection criteria. Torque transmitting capacity of single plate, Multidisc clutch, Cone clutch and Centrifugal clutch.	06 **Hrs.**
Unit 2:--- Design of Speed Drives for machine tool applications Determination of variable speed range- Graphical representation of speeds- Structure diagram Deviation diagram- Ray diagram- Selection of optimum ray diagram- Difference between number of teeth of successive gears in a change gear box- Analysis of twelve speed gear box.	07 **Hrs.**
Unit 3:--- Design of Cranes Classification, Criteria for selection, Types of cranes and their Layouts, Hoisting Mechanism, Traveling Mechanism – Trolley and Bridge, Design of Bridge Girder: Box type, Truss type, Design of Jib crane.	07 **Hrs.**
Unit 4:--- Design of I. C. Engine Components Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, Design of cylinder liners, Design of piston and piston-pins, Piston rings, Design of connecting rod.	08**Hrs.**
Unit 5:--- Design of Conveyor Systems Classification, Merits and Demerits. Design of Belt Conveyor: Belt, Roller Assembly, Drum & Drum Shaft, Bearings, Motor selection, Take-up arrangements.	06**Hrs.**
Unit 6:--- Optimum Design Objectives of optimum design- Johnsons Method of Optimum Design (MOD), Adequate and optimum design. Primary, Subsidiary and Limit equations- Optimum design with normal specifications of simple machine elements like tension bar, transmission shaft, helical spring. Introduction to optimum design with Langrange Multiplier.	06**Hrs.**

Textbooks:

1. “Design of machine element”, V.B.Bhandari, Tata Mc- Graw Hill Publication, 3rd Edition.
2. “Mechanical Engineering Design”, Shigley and C.R.Miscke, Tata Mc- Graw Hill Publication.
3. “Mechanical Design Analysis”, M.F.Spotts, Prentice Hall Publication.
4. “Design of Machine Tools”, S.k. Basu and D.K. Pal Oxford and IBH Publication, 6th Edition.
5. “Machine Tools Design”,N.K. Mehta, Tata Mc- Graw Hill Publication, 5th Edition.
6. “Design Data Book”,P.S.Gill (PSG) 3rd Edition. 7. I.S.:2825 Code for Unfired Pressure Vessels.

References:

1. “Handbook of Gear Design”,Jitin Maitra,Tata Mc-Graw Hill Publication.
2. “Machine Design”, Black P.H.and O.Eugene Adams, Tata Mc- Graw Hill Publication.
3. “Mechanical Design Synthesis with Optimisation Applications”,Johnson R.C.,VonNostrand-Reynold Publicaion.
4. “Engineering Design”,Dieter G.E., Tata Mc- Graw Hill Publication, 4th Edition.
5. “Mechanical System Design”,S.P.Patil, Jaico Publication House,New Delhi,2nd Edition.
6. “Product Design and Process Engineering”,Benjamin W. Niebel , Alan B. Draper, Tata Mc- Graw Hill Publication.
7. “Design of Pressure Vessel”, Harve, CBS Publishers and Distributors Van Nostrand Reinhold.
8. “Engineering Optimization Theories and Practice”, S.S.Rao, New Age Publication, 3rd Edition.
9. “Process Equipment Design”, M.V.Joshi , Macmillal Publication, 3rd Edition.
10. “Machine Design”, Robert L.Norton, Tata Mc- Graw Hill Publication.
11. “Machine Design”, P. Kannaiah, Scitech Publication, 2nd Edition.
12. “Fundamentals of Machine Component Design”,Junvinall Wiley India, 5th Edition.
13. “Mechanical System Design”, Anurag Dixit,SCITECH publication.
14. “Principles of Machine Tool”, Sen. Bhattacharya, New Central Book Agency.

Unit wise Measurable students Learning Outcomes:

After successful completion of this course, Students will able to

1. Select clutch and brake on the basis of Functional requirements of Automobile transmission systems.
2. Elaborate the significance of stepped regulation in Design of machine tool speed box and Design gear box
3. Identify various design parameters of Crane.
4. Design I.C.Engine components.
5. List different material handling systems and Design of conveyor system.
6. Classify different design parameters and evaluate optimum design.

Title of the Course: COSTING & FINANCE MANAGEMENT	**L**	**T**	**P**	**Credit**
Course Code: UMCH0803	**3**	**0**	**0**	**3**

Course Pre-Requisite:

This course requires the basic knowledge of the following:

1. Basics of Mechanical Engineering.
2. Basics of Mathematics.

Course Description:

Engineering management relies on the knowledge of engineering economics to be able to evaluate projects from a financial perspective. Optimizing financial performance of a project is a key responsibility of an engineer in the decision making process. This course is designed to present Engineering students the major concepts and techniques of costing that are needed in the decision making process. The emphasis of this course is on the analytical analysis of cost calculation of component.

Course Objectives:

1. To acquire knowledge of Costing to be able to evaluate component/product from a financial perspective.
2. To apply analytical formulae to determine the cost of a component.
3. To present engineering students the major concepts and techniques of costing and cost control analysis that are needed in the decision making process
4. To emphasizes the strong correlation between engineering design and manufacturing of products/systems and the economic issues they involve.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	**Explain** elements of cost, demand and supply.	2	Understanding
CO2	**Explain** the elements of Finance Management and Cost Control	2	Understanding
CO3	**Explain** the concept of Overheads and **make use of** Cost Accounting methods.	3	Applying
CO4	**Estimate** the Depreciation cost and Purchasing procedure	5	Evaluate
CO5	**Estimate** the Cost of a component based on the type of manufacturing process.	5	Evaluate

CO-PO-PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2														
CO2	3														
CO3	2	3											2	2	
CO4			2										2	2	
CO5			2										2	2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

Course Contents:

Unit 1:---Introduction Flow in an Economy, Law of Supply and Demand, Types Of Efficiency , Definition and scope of Concept of cost, cost unit, cost center, classification of cost, Definition of costing, Cost-price-profit equation, desirable conditions for a costing system. Cost Estimating: Definition, purpose and functions of Cost Estimation, role of Estimator, estimating procedures, Break Even Analysis.	**6 Hrs.**
Unit 2:---Depreciation Elements of Cost, Depreciation Causes of depreciation of assets. Calculation of depreciation values using different methods of depreciation. Review of purchasing procedure, recording of stock and consumption of material by LIFO, FIFO, Weighted average method. (Numerical Treatment expected)	**7 Hrs.**
Unit 3:---Estimation of Fabrication, Foundry, Forging and Machining Cost Constitutes, direct cost, indirect cost, Estimation Process for each Operation Process of breaking down product drawing in to simpler elements or shapes, estimating the volume, weight and cost. Operation time calculation for turning, knurling, facing, drilling, boring, reaming, threading, milling, tapping, shaping, cutting, various grinding operations, planning etc. Machine Hour Rate Calculation. (Numerical Treatment expected)	**7 Hrs.**
Unit 4:--- Overheads and Cost Accounting Methods of Overhead Allocation, apportionment, absorption of overheads.(Numerical) Cost Accounting Methods: Job costing, Batch costing, Unit costing, Process costing, Contract costing, Activity based costing. (numerical)	7 **Hrs.**
Unit 5:--- Finance Management Objectives of Finance Management, Finance Functions, Internal and External, Short, medium and long term finance , Sources of funds for business organization, Concepts of wants, scarcity, choice, opportunity cost, demand and supply curves, price determination. Minimum Attractive Rate of Returns, Internal Rate of Returns (IRR) Taxation: Introduction to Direct and Indirect tax, GST – concepts and general principles.	7 **Hrs.**
Unit 6:--- Cost Control and Cost Reduction Budgetary control, Budget objectives, classification of budgeting, standard cost, Variance analysis, marginal cost, value analysis and value engineering, Zero Base Budgeting. Time value of money. The cash flow diagram.	**6 Hrs.**
Textbooks: 1. Mechanical Estimating and Costing By B.P. Sinha. Tata McGraw Hill Publishing Co. Ltd. N. Delhi 2. Mechanical Estimating and Costing T.R. Banga and S.C.Sharma, Khanna Publishers, Delhi-6	
References: 1. Principles & Practice of Cost Accounting – N. K. Prasad (Book Syndicate Pvt. Ltd.) 2. Costing Simplified: Wheldom Series – Brown & Owier (ELBS) 3. Cost Accounting: B. Jawaharlal (TMH) 4. Cost Accounting: R.R. Gupta.	

5. Cost Accounting, 13/e - B. K. Bhar, (Academic Publishers, Kolkata) 6. Cost Accounting: Jain, Narang (Kalyani Publishers) 7. A Text Book of Estimating and Costing Mechanical – J.S. Charaya & G. S. Narang (Satya Prakashan) 8. Mechanical Estimation and Costing – TTTI, Chennai (TMH) 9. Theory & Problems of Management & Cost Accounting – M.Y. Khan, P. K. Jain (TMH) 10. Financial Management- I.M.Pande, Vikas Publishing House Pvt Ltd.	

Title of the Course: MARKETING MANAGEMENT	L	T	P	C
Course Code: UMCH0804	3	-	-	3

Course Pre-Requisite:

This course requires the basic knowledge of the following:

1. Manufacturing processes
2. Industrial management
3. Operation research

Course Description:

Course provides fundamental knowledge of basic concepts of marketing, its commercial and technical application and marketing management.

Course Objectives:

1. To make students have an understanding of the fundamental concepts of marketing & the environment in which marketing system operates.
2. To analyze the motives influencing buying behavior & describe major bases for segment marketing, target marketing, and market positioning.
3. Identify a Conceptual framework, covering basic elements of the marketing mix.
4. To make students aware of marketing channels, promotional policies and advertising strategies.
5. To understand functioning of marketing organization.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Define** the concept of marketing and consumer behavior.	1	Remembering
CO2	**Explain** the functioning of marketing organization	2	Understanding
CO3	**Illustrate** market segmentation, targeting and positioning.	2	Understanding
CO4	**Evaluate** marketing mix elements.	5	Evaluate
CO5	**Choose** marketing channels and promotional tools	5	Evaluate

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1 1	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2	3												2		
CO3	3												2		
CO4									3					2	
CO5									3	3	3			3	

Assessments :Teacher Assessment

Assessment is purely on End Semester Examination based on 100% course content.

Assessment	Marks
ESE	100

Course Contents:

Unit 1:--- Introduction 8 **Hrs.**

Definitions and types of markets, Concept and Basics of Marketing, Journey from sales to marketing, , Old Concept or Product oriented Concept, New or Modern or Customer- oriented Concept, marketing in 21st century, Challenges & Ethics.

Marketing tools and strategies, Micro and Macro marketing environment, Concept of societal marketing, Introduction to Services marketing, Impact of Multi National Corporations, privatization etc. Ecommerce/ On line marketing.

Unit 2:--- Consumer Behavior-Meaning and definition of Consumer behavior, Characteristics, Importance, Buying Decision process and the Factors Influencing Consumer Behaviour, Psychological factors, social factors, cultural factors and personal factors, Consumer Purchase Decision, Buying Roles, Buying Motives **Marketing Planning:** Meaning and importance, sales forecasting, methods of sales forecasting, marketing budget and marketing organization, data banks utilization (3)	6 **Hrs.**
Unit 3:--- Market Segmentation, Targeting & Positioning (STP) **Market Segmentation**: Meaning, benefits of segmentation, bases for market segmentation, market coverage strategies adopted for segmenting the market, aggregation strategy, single segment strategy and multiple segment strategy. **Targeting** - Bases for identifying target Customer target Marketing strategies, **Positioning** - Meaning, Product Differentiation Strategies, Tasks involved in Positioning. Branding - Concept of Branding, Types, Brand Equity, Branding strategies.	8 **Hrs.**
Unit 4:--- Marketing Mix: Part I Introduction to marketing Mix elements - product, place, promotion and price **Product [Goods and Services]:** Concept of product, classification of consumer goods, convenience goods, shopping goods and specialty goods, product life cycle, product mix, product decisions to be made such as brand policy decisions, product modification decisions, product elimination decisions, new product development decisions and product mix decisions, procedure for new product development. **Place:** Channels of distribution, meaning, types of channels, selecting the type of a channel, channel management, physical distribution wholesaling and retailing, Importance of Electronic channels.	7 **Hrs.**
Unit 5:--- Marketing Mix: Part II **Promotion:** An introduction to promotion-mix elements, advertising, personal selling, sales promotion and publicity **Pricing:** Meaning and importance of price, pricing objectives, procedure for setting the base price, price modification and price negotiation .	7 **Hrs.**
Unit 6:--- Marketing Organization, Selection of marketing staff, Specialized Training, Role of a salesman, Routine management, Salaries and incentives, Marketing intelligence, Marketing performance.	4 **Hrs.**
Textbooks: 1. Philip Kotler, "Principles of Marketing", Prentice – Hall. 2. Philip Kotler, "Marketing Management", Prentice – Hall 3. Tapan Panda, "Marketing Management: Text and Cases", Excel Books. 4. Philip Kotler, Abraham Koshy , Kevin Lane Keller, Mithileswar Jha "Marketing Management: A South Asian Perspective".	
References: 1.J.C.Gandhi, " Principles of Marketing and Salesmanship" 2. Rajagopal, "Marketing Management Text & Cases", Vikas Publishing House, ISBN 81-259-0773-4 1. 3. Ramswamy V. S., Namakumari S., "Marketing Management", Mac Million Publishers India Ltd. 5.Indian Journal of Marketing 6. Journal of Marketing – American Marketing Research. 7. Journal of Marketing Research – American Marketing Research.	

Title of the Course: TOTAL QUALITY MANAGEMENT **Course Code: UMCH0805**	**L**	**T**	**P**	**C**
	3	**-**	**-**	**3**

Course pre-requisite: knowledge of industrial management, Quality Control and Statistics

Course Description: Course describes about the basics of quality management and deals with the basics aspects of quality while interfacing with industry**.**

Course Objectives:

To enhance the ability to control, monitor and implement the quality system in the organization

Course Learning Outcomes:

CO	**After the completion of the course the student should be**	Bloom's Cognitive level	Descriptor
CO1	Able to describe quality.	2	Demonstrate
CO2	Able to explain statistical tools and techniques	3	Explain
CO3	Able to Discuss advance management tools	2	Discuss
CO4	Able to Have Hands on skill in problem solving and controlling and improvement of quality based on industrial case studies.	4	Evaluating

CO-PO Mapping:

	PO												**PSO**	
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	2													
CO2		3												
CO3						2		2						
CO4			1		3		2			2				

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1:-- **Basic concepts and Quality Gurus-** Definition of TQM; Concept of total quality, role and objectives of Q.A.; Gurus of TQM, TQM Framework; Definition of quality; historical review, benefits of TQM; Costs of quality: prevention, appraisal & failure costs .	**6Hrs.**
Unit 2:--- **Planning for quality-** Need for quality policies & objectives with examples, Leadership concepts, Importance of Top Management commitment, quality council and strategic planning; **Quality improvement-** Juran's trilogy, management of controllable defects, operator controllable defects, sporadic and chronic problems of quality; Bench Marking: Introduction, definition and its significance.	**8 Hrs.**
Unit 3:-- **Customer relation and satisfaction:-** Origin of consumerism - Product knowledge, definition and types of customers, their importance, Customer perception and quality expectations; Quality feedback and redressal; Definition and principles of reliability, reliability and product life cycle (boat curve/bath tub curve), trade-off between reliability, maintainability and availability	**6Hrs.**
Unit 4:--- **Vendor Relations :** Treating Vendor(Supplier) as a partner; Principle and elements of Partnering; Selection of supplier, Performance measurement & rating of supplier; Push-Pull view of supply chain and Cycle view of supply chain management.	**5 Hrs.**
Unit 5:-- **Quality / Productivity Improvement Tools-** Seven statistical tools, Process capability analysis; Acceptance sampling; PDCA cycle; Importance of Six-sigma, DMAIC approach, SIPOC Process and Sample Calculation of sigma level. Productivity improvement techniques -5S, POKAYOKE, Kaizen.	**7 Hrs.**
Unit 6:-- **Quality Systems-** Quality standards; ISO9001:2000 Quality Management System Standard; ISO/TS 16949:2002 for Automobile Industry; Internal audit, surveillance audit, maintaining of certification; Approach to world class manufacturing (Toyota production system, Lean manufacturing, Zero defect supply concept), Quality Function Deployment (QFD), Failure Mode Effect Analysis (FMEA), Introduction to Design of experiments	**8Hrs.**

Textbooks :

1. *"Total Quality Management",* Dale H. Besterfiled, , Pearson Education Asia
2. *"Total Quality Management – Text and cases",* Jankiraman and Gopal, Prentice Hall India Publication
3. *"Total Quality Management",* Dr. Rajaram, Wiley Publication,
4. *"Practical Reliability Engineering",* Patrick D.T. O'connor, , Wiley India

5. "*Masaki Imami"*, KAIZEN, McGraw Hill, 1986.
6. *"Quality Without Tears",* Phil Crosby, McGraw Hill
7. "*Six Sigma for Business Excellence"*, Hemant Urdhwareshe , Pearson

Reference Books :

1.Quality planning and analysis, J M Juran, FM Gryana, TMH
2. *Total Quality Management*, D. H. BesterField et al. prentice hall.
3. *Quality is free*, Philip B Crossbly, Mentor/ new American library.
4. *What is Total Quality Control? The Japanese way*, Ishikawa k, PH.
5. *Total Quality Control*, Armand V Feigenbaum.
6. *TQM in new product manufacturing*, HG Menon; TMH.
7. *Managing for total quality*, N. Logothetis / prentice hall
8. *Statistical Process Control*, John S. Oakland, Butterworth-Heinemann.
9. *The essence of total quality management*, John Bank, Prentice Hall, 1993.
10. *Beyond Total Quality Management*, Greg Bounds and Lyle Yorks, McGraw Hill, 1994.
.

Unit wise Measurable students Learning Outcomes:

1) To define quality and explain the evolution of quality
2) To select and explain tools and techniques for problem solving.
3) To select and explain customer involvement,
4) To select and explain vendor/supplier involvement
5) To choose and demonstrate the statistical process control.
6) To describe a quality system.

Title of the Course: CRYOGENICS	L	T	P	C
Course Code: UMCH0806	3	-	-	3

Course Pre-Requisite: Fundamentals of thermodynamics, Heat and Mass Transfer, Fundamentals of Refrigeration and Air Conditioning

Course Description: The course deals with Liquefaction of Cryogenic Gases, Cryogenic Refrigeration Systems, Gas Separation and Purification etc,. The knowledge of these processes is necessary in all types of Cryogenic devices used various applications.

Course Learning Objectives:

CLO1: To enable the students to analyze and solve cryogenics related problems by applying principles of mathematics, science and engineering.

CLO2: To Prepare students to use modern tools, techniques and skills to fulfill industrial needs related to low temperature systems.

CLO3: To Develop skills in the analysis of cryogenics systems in research or design.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain the different Cryogenic systems.	II	Understanding
CO2	Identify the Cryogenic systems to suit the application	III	Applying
CO3	Decide various ideas related to design/research in different Cryogenic systems.	V	Evaluating

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2												3	2
CO3		2		3										1	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: **Introduction:** Industrial applications, Recent development, Properties of cryogenic Fluids, Applications of cryogenics in different areas such as Space, Medical, Manufacturing processes, Mechanical Design Behavior of Structural Materials at Cryogenic Temperature: Mechanical properties, Thermal properties, Thermoelectric properties.	**06 Hrs.**
Unit 2: **Liquefaction of Cryogenic Gases:** Ideal cycle, System performance parameters, Joule Thomson effect, Adiabatic expansion, Liquefaction systems; Simple Linde-Hampson system, Precooled Linde-Hampson system, Cascade system, Claude system, Comparison of above systems.	**07 Hrs.**

Unit 3: **Liquefaction Systems for Neon, Hydrogen, Helium and Heat Exchanger:** Precooled LindeHampson system forneon and hydrogen, Claude system for hydrogen, Helium refrigerated hydrogen liquefaction system, Heat exchanger used in liquefaction systems	**10 Hrs.**
Unit 4: **Cryogenic Refrigeration Systems:** Ideal refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvay refrigerator, Gifford-McMohan refrigerator, Pulse tube refrigerator	**06 Hrs.**
Unit 5: **Gas Separation and Purification:** Thermodynamic Ideal refrigeration system, Temperature composition diagram, Principles of Gas separation,Principles ofRectifiers column, Separation column design; Plate calculation, Types of rectification columns, Single column and double column air separation systems, Cryogenic air separation plants, Linde single Column separation system, Gas Purification methods	**06 Hrs.**
Unit 6: **Insulation:** Cryogenic fluid storage,Vacuum insulation, Fibrous materials, Solid foams, Gas filled power, Comparison, Critical thickness. Vacuum Technology: Importance, Pump down time, Flow regimes, Components of vacuum systems, Mechanical Vacuum pumps, and Ion pumps	**05 Hrs.**

Textbooks:

1. "Cryogenic Systems", Barron F. Randall, Oxford University Press, New York.
2. "Cryogenic Engineering", Thomas M. Flynn, Marcel Dekkcr. Inc, New York.
3. "Cryogenic Process Engineering",Klaus D. Timmerhaus, Thomas M. Flynn, Plenum Publishing Corporation (1989).
4. "Applied Cryogenic Engineering",Vance, R. W, and Duke, Isted, W. M., John Wiley (1962).
5. "Introduction to Cryogenics" B. S. Gawali, Mahalaxmi Publication.

Reference books:

1."Experimental Techniques in low Temperature Physics", Guy, K White, Claredon Press, Oxford, (1987).
2. "Cryogenic Research and Applications", Marshall Sitting and Stephen Kidd, D. Van Nostrand, Inc USA, (1963).
3. "Cryo-Cooler: Fundamentals Part-I", G. Walker, Plenum Press, New York.
4. "Cryo-Cooler: Fundamentals Part-II", G. Walker, Plenum Press New York.

Unit wise Measurable students Learning Outcomes:

1. Graduates will be able to explain recent development and Properties of cryogenic Fluids,
2. Graduates will be able to explain and compare various Liquefaction techniques of Cryogenic Gases.
3. Graduates will be able to explain Liquefaction Systems for Neon, Hydrogen, Helium and Heat Exchanger.
4. Graduates will be able to explain different Cryogenic Refrigeration Systems.
5. Graduates will be able to explain various Gas Separation and Purification techniques.
6. Graduates will be able to explain types of Insulation used in cryogenic systems and importance of vacuum technology

Title of the Course: DESIGN OF THERMAL SYSTEMS Course Code: UMCH0807	L	T	P	C
	3			3

Course Pre-Requisite: Applied Thermodynamics, Fluid Mechanics, Heat & Mass Transfer, Refrigeration and Air-conditioning.

Course Description:

This subject enables the student to understand the different components, accessories and controls used in refrigeration systems. The students will be able to understand mathematical formulation of components as well as a whole thermal system. The students will be able to estimate the heat load calculations for refrigeration applications and will be able select or design appropriate components.

Course Objectives:

1. Learn thermal system design methodology.
2. Learn mathematical formulation of components as well as a whole thermal system
3. Learn estimation of heat load calculations for refrigeration applications.
4. Design simple thermal systems .

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Apply knowledge of mathematics, science, and engineering for mathematical formulation of components as well as a whole thermal system.	3	Applying
CO2	Analyze the heat load calculations for refrigeration applications	4	Analyze
CO3	Design the thermal systems.	5	Design

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	2												2	2
CO3		2		3	3										

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Introduction to Thermal System Design:	6Hrs.
Thermal systems used in practice, Classification of design, Optimal and nearly optimal design, Methodology of design, Aspects of thermal system design, Assessment concept	

and creation, mathematical formulation component level and system level by first law of thermodynamics [energy balance basis].	
Unit 2. Design of Refrigeration System: Types of components used in VCRC, controls, accessories, their functions, salient features, applications, heat load calculations and design of basic components of refrigeration systems, Design of refrigeration systems - Household refrigerator, Ice plant, Cold storage, refrigerated vehicle, Vapour absorption systems.	**9 Hrs.**
Unit 3: Design Analysis of Air Conditioning System: Design of Air conditioning systems: Design considerations, Load calculations, Single unit room air-conditioner, Central air conditioning plant, Industrial drying systems, Component selection.	**5 Hrs.**
Unit 4: Design of Solar System Design of solar assisted water heating systems, applications of solar energy, types of solar collectors, Preliminary specifications, Concepts development, Component design.	**6Hrs.**
Unit 5: Heat Exchanger Networking & Advanced Cooling Systems: Design of advanced heat exchanger networks, Design of electronic miniature cooling systems, Utilization of Nano- Fluids for cooling systems, Design of waste heat recovery systems.	**6 Hrs.**
Unit 6: Exergy Analysis: Concept of exergy, Physical exergy and Chemical exergy, Exergy analysis for control region, Exergy concepts for closed systems, Exergy efficiency, Grassmann diagram .	**8Hrs.**

Textbooks:

1. "Thermal Design & optimization", Adrian Bejan, George Tsatsaronis, Michael Moran, JOHN WILEY & SONS INC .
2. "The Exergy Method of Thermal Plant Analysis", T. J. Kotas, British Library Cataloguing in Publication Data.
3. "Exergy, Energy, Environment and Sustainable Development ", Ibrahim Dincer, Marc A. Rosen
4. "Handbook of Process Heat Transfer", Hewitt

References:

1. "HVAC System Design Handbook" ASHRAE.
2. "Design and Optimisation of Thermal Systems", Yogesh Jalurkar, CRC Press.
3. "Design and Simulation of Thermal Systems", N.V. Suryanarayana, Oner Arici, Tata Mc Graw Hill Inc.
4. "Thermal System Design",Stoecker, Tata McGrew Hill Publication, 3rd Edition.

Unit wise Measurable students Learning Outcomes:

Students should be able to:

Title of the Course: Industry 4.0	L	T	P	Credit
Course Code: UMCH0808	3	---	---	---

Course Pre-Requisite: None

Course Description: The fourth industrial revolution is about to change the way industries are performing. The key technologies will disrupt the way day to day industrial activities are performed. Specifically the practices in designing the products and processes are targeted in this course. The said course will introduce students to concepts and terminologies the fourth industrial revolution so that students will be having competitive advantages in the industrial environment.

Course Objectives:

1. To provide graduates of mechanical- design engineering with fundamental knowledge in the fourth revolution terminologies and technologies.
2. To introduce graduates of mechanical- design engineering with digital twin based approach in designing the products and processes.
3. To create awareness amongst mechanical- design of benefits, limitations and implications of industry 4.0.

Course Learning Outcomes:

CO	After the completion of the course, the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Summarize** the evolution and different terminologies in industry 4.0.	II	Understanding
CO2	**Explain** key components and applications of industry 4.0.	II	Understanding
CO3	**Illustrate** mechanical design engineering approaches with respect to industry 4.0	II	Understanding

CO-PO Mapping:

CO	1	2	3	4	5	6	7	8	9	10	11	12
CO1	3	2										
CO2	3	2										
CO3	3	2										

Assessments:

Teacher Assessment:

The assessment will be based on end semester theory exam (ESE) on entire syllabus.

Assessment	Marks
ESE	100

Course Contents:

Unit 1: Introduction and Evolution of INDUSTRY 4.0: Flow line, TPS, job shop and cell for industry 2.0, FMS and Seru for Industry 3.0, Comparisons of Seru with the TPS and Cells, Potential manufacturing for Industry 4.0, Smart manufacturing for Industry 4.0, An example of a smart manufacturing system for Industry 4.0, Time line of Industry 1.0–4.0, Demand dimensions for Industry 4.0, Modular design for vehicles.	**7 Hrs**
Unit 2: Fundamentals of Comuter Integrated Technologies: Database Management Systems (DBMS), design requirements, criterion, comparison of DBMS with Conventional file handelling, types of DBMS models, scope of DBMS in Industry 4.0. **Communication in CIMS:** Requirements of shop floor communications, Networking Concept, Network Topology, Access methods, media, protocols in communications, role of computer communication in industry 4.0.	**07**

Unit 3: Key Components of I4.0: Big Data, Cloud Manufacturing, Internet of Things, Autonomous Robots, Simulation, Horizontal and Vertical Systems Integration, Cyber Security, Additive Manufacturing, Augmented Reality The Smart Factory of the I4.0: . Cyber-Physical Systems, Internet of Services, Steps to implement industry 4.0 in manufacturing industry.	**05 Hrs.**
Unit 4: Internet of Things: Introduction , Physical design of IoT, Logical design of IoT, IoT Enabling Technologies,IoT Level and deployment Template, Open Source IoT Platforms for Developers. **IO Links and Industry 4.0:** Development of information pyramid, The cyber physical production systems, Connections between IO Link and Industry 4.0.	**07 Hrs.**
Unit 5: Smart Machines: Concept, sensors and transducers used in smart machines, Selection of parameters on the manufacturing machines to be monitored for monitoring-machine health, quality of output of the machine, machine data collections, storing, retrieving and analyzing, time intervals for these measurements, applications, benefits.	**06 Hrs.**
Unit 6: Other Applications and Case Studies Industry 4.0: Current Status of industry 4.0 implementation and impact of implementation, Design prerequisites for Industry 4.0, Smart machines, Machine learning, Benefits of Industry 4.0, Limitations of Industry 4.0, Xiaomi case, The Digital Twin – a sheet metal assembly example, Concept of SmartCorrect, GE Digital Twin, A digital twin for the city of Newcastle, Digital Twin in automobile.	**06 Hrs.**

Textbooks:

1. Industry 4.0: Managing The Digital Transformation by Alp Ustundag, Springer Publication
2. Industry 4.0: Industrial Revolution of the 21st Century, by Elena G. Popkova, Yulia V. Ragulina, Aleksei V. Bogoviz
3. Augustine, P. (2019). The industry use cases for the Digital Twin idea. In *Advances in Computers* (1st ed.). https://doi.org/10.1016/bs.adcom.2019.10.008

References:

1. Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress)
2. "Industrial Internet of Things: Cybermanufacturing Systems"by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer)
3. Yin, Y., Stecke, K. E., & Li, D. (2018). The evolution of production systems from Industry 2.0 through Industry 4.0. *International Journal of Production Research*, *56*(1–2), 848–861. https://doi.org/10.1080/00207543.2017.1403664
4. Albers, A., Stürmlinger, T., Mandel, C., Wang, J., Frutos, M. B. de, & Behrendt, M. (2019). Identification of potentials in the context of Design for Industry 4.0 and modelling of interdependencies between product and production processes. *Procedia CIRP*, *84*, 100–105. https://doi.org/10.1016/j.procir.2019.04.298
5. Alcácer, V., & Cruz-Machado, V. (2019). Scanning the Industry 4.0: A Literature Review on Technologies for Manufacturing Systems. *Engineering Science and Technology, an International Journal*, *22*(3), 899–919. https://doi.org/10.1016/j.jestch.2019.01.006
6. Wagner, R., Schleich, B., Haefner, B., Kuhnle, A., Wartzack, S., & Lanza, G. (2019). Challenges and Potentials of Digital Twins and Industry 4.0 in Product Design and Production for High Performance Products. *Procedia CIRP*, *84*, 88–93. https://doi.org/10.1016/j.procir.2019.04.219
7. Söderberg, R., Wärmefjord, K., Carlson, J. S., & Lindkvist, L. (2017). Toward a Digital Twin for real-time geometry assurance in individualized production. *CIRP Annals - Manufacturing Technology*, *66*(1), 137–140. https://doi.org/10.1016/j.cirp.2017.04.038
8. Fatorachian, H., & Kazemi, H. (2018). A critical investigation of Industry 4.0 in manufacturing: theoretical operationalisation framework. *Production Planning and Control*,

29(8), 633–644. https://doi.org/10.1080/09537287.2018.1424960
9. Gianessi, P., Abdellaoui, E., Gianessi, P., Abdellaoui, E., & Gianessi, P. (2019). *ScienceDirect Process to to Design Industry*. 1390–1395. https://doi.org/10.1016/j.ifacol.2019.11.390
10. Mabkhot, M. M., Al-Ahmari, A. M., Salah, B., & Alkhalefah, H. (2018). Requirements of the smart factory system: A survey and perspective. *Machines*, *6*(2). https://doi.org/10.3390/MACHINES6020023
11. Romeo, L., Loncarski, J., Paolanti, M., Bocchini, G., Mancini, A., & Frontoni, E. (2020). Machine learning-based design support system for the prediction of heterogeneous machine parameters in industry 4.0. *Expert Systems with Applications*, *140*. https://doi.org/10.1016/j.eswa.2019.112869
12. Mariani, M., & Borghi, M. (2019). Industry 4.0: A bibliometric review of its managerial intellectual structure and potential evolution in the service industries. *Technological Forecasting and Social Change*, *149*(September), 119752. https://doi.org/10.1016/j.techfore.2019.119752
13. Pacchini, A. P. T., Lucato, W. C., Facchini, F., & Mummolo, G. (2019). The degree of readiness for the implementation of Industry 4.0. *Computers in Industry*, *113*, 103125. https://doi.org/10.1016/j.compind.2019.103125
14. Szozda, N. (2017). *LogForum*. *13*(4), 401–414.

Unit wise Measurable students Learning Outcomes:

1. The student will be able to summarize industrial revolutions 1.0-4.0.
2. The student will be able to explain key components and technologies used in industry 4.0 and smart manufacturing.
3. The students will able to relate present design practices in the context of industry 4.0.
4. The student will be able to illustrate digital twin concepts that can be used in product and process designs.
5. The student will be able to explain implications of the industry 4.0.
6. The student will be able to explain applications and case studies in industry 4.0.

Title of the Course: PROJECT PHASE-II/ INTERNSHIP **Course Code:UMCH0851**	**L**	**T**	**P**	**Credit**
		-	**12**	**6**

Course Pre-Requisite:
Domain knowledge from Mechanical Engineering

Course Description:
Major Project Phase-II covers problem data analysis, design calculations, manufacturing/ simulation, results and discussion and documentation of project report.
Under Internship, every student will undergo minimum 8 week and maximum 16 week training in an Industry. Each student will identify a problem from selected industry and try to find out a feasible solution of the same and document its report.

Course Objectives:

1. Practical implementation of theoretical knowledge gained during study.
2. Implement ideas/real time industrial problem/ current application.
3. Evaluate better solution for selected problem using state of the art topics in a broad area of his/her specialization.
4. Internship helps students to build confidence in handling and finding feasible solution of a real time industrial problem.

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Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Find a need or problem faced by manufacturing industry or by general population that can be solved using knowledge and skills acquired during the program	I	**Find**
CO2	Survey the literature available about the problem chosen to assess various methods to solve it.	IV	**Survey**
CO3	Create a prototype solution using the methodology / numerical or simulation model for performance assessment of the solution under the variety of working conditions	VI	**Create**
CO4	Compile and document the entire process of project work using prescribed format.	VI	**Compile**

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1			2	3	3		2		3		2	2	3	3	3
CO2			2	3	3		2		3		2	2	3	3	3
CO3	2							2	3	2					
CO4									3	2					

Assessments :

Teacher Assessment:

In Semester Evaluation (ISE-I and ISE-II) and End Semester Examination (ESE) having 50% weights each

Assessment	Marks
ISE –I	75
ISE-II	75
ESE(O.E.)	150

ISE-I : Students are expected to undergo the internship and present their progress in front of the committee members. Along with this, it is also expected to give the project phase-I presentation in front of committee.

ISE-II : Progress presentation

a) Project Phase-II
b) Internship

ESE(O.E) :

a) Submission of dissertation and internship report
b) Viva-voce of project phase-II and internship

Course Contents:

A) Major Project Phase-II

The work started in Semester VII will be continued in the Semester VIII and the final submission of the report will be at the end of the Semester VIII.

The project work may consist of-

1. Design of equipment /idea
2. Manufacturing / simulation and testing.
3. Critical Analysis of any design or process for optimizing it.
4. Experimental verification of principles used in applications
5. Project report preparation

The report of the work completed in Semester VIII in the form of workbook /project diary and other relevant documents shall be submitted for the term work. The term work shall be assessed by the Guide and one more faculty member appointed by the Head of the Department. The assessment shall be based on a presentation of the work completed and submission of final report.

B) Internship

Under Internship, every student should undergo minimum 8 week to maximum 16 week training in the industry. Each student should identify a problem from selected industry and try to find out a feasible solution of the same and document its report

The oral examination shall be based on the final reports of project and internship