Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

Course Contents (Syllabus) for

Final Year B. Tech.
(Mechanical Engineering)
Sem - VII to VIII

AY 2020-21

Professional Core (Theory) Courses

Title of the Course: Industrial Engineering, Course Code: 3ME401	L-3	T-1	P-0	Cr-4

Pre-Requisite Courses:

Textbooks:

1. Khanna O.P., *"Industrial Engineering and Management",* Dhanpat Rai Publications (P) ltd, New Delhi. Year 2003
2. Martand Telsang "*Industrial Engineering and Production Management*" S. Chand & Company Ltd., New Delhi Year 2003
3. Dinesh Seth, Subhash Rastogi*"Global management solutions demystified "*Cengage learning publications II edition,Year 2009

References:

1.Gavrial Salvendy " Hand book of Industrial engineering" John Wiley and sons,New York,2007
2. M. I. Khan "Industrial engineering" New age international(P) ltd, New Delhi,2004
3. International labour office, "Introduction to work study" Publisher International labour office,1969. Digitalized 2008

Course Objectives:

1. To make the students perform in industry for effective planning, controlling, and implementing projects.
2. To utilize the principles of science, technology and engineering for solving industry relevant problems.
3. To associate with growth of industrial economic sectors using analytical tools and effective computational approaches.
4. To develop managerial skills relevant to the industry.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain recent trends in industrial engineering.	II	Understanding
CO2	Illustrate the basic concepts of modern industrial engineering in manufacturing and service sector.	II	Applying
CO3	Examine various method study, work measurement and inventory management techniques.	IV	Analyzing

CO-PO mapping:-

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1					**M**				**L**				**H**	
CO2				**L**	**H**	**M**							**M**	**M**
CO3					**M**		**M**	**L**						**L**

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction of I.E., Productivity and PPC **8Hrs**

Definitions, functions and status of I.E. department in Manufacturing organization and Service sector, Productivity – concept and objectives, factors affecting, tools and techniques, Value analysis.
Production Planning and Control – Elements and functions of PPC, Sales forecasting and methods of Capacity requirement planning.

Module 2: Plant Layout and material handling **7Hrs**

Plant layout:-Site selection, principles and objectives, production types, tools and techniques used, maintenance, line balancing, layout planning.
Material handling:- Objective, elements, functions, principles, types of material handling equipments, unit load concept, Economics of material handling.

Module 3: Method study **6Hrs**

Definitions, objectives, various recording techniques, methods improvement techniques, principles of motion economy, Therbligs, micro-motion study, MOST.

Module 4: Work measurement **6 Hrs**

Definitions, objectives, activity and elements, performance rating, rating methods, allowances, group timing techniques, work sampling, PMTS.

Module 5: Inventory Control and Network Techniques **7 Hrs**

Different Models of Inventory Systems, MRP, Make or Buy decision. Network Techniques: CPM and PERT, Construction, Time cost trade off.

Module 6: Recent trends **6 Hrs**

5S, Kaizen, 6 sigma, Just in time, Toyota production system, Lean manufacturing, Management information system, Total productive maintenance, Poka-Yoke

Module wise Measurable Students Learning Outcomes:

Student should be able to:

1. Discuss the underlying concepts related to productivity, its importance, its measurement etc.
2. Explain various types of plant layouts, principles of a good plant layout and principle of line balancing, principles and methods of material handling.
3. Classify and use different method study techniques.
4. Identify and use different work measurement techniques.
5. Detect and solve simple inventory management and network analysis problems
6. Illustrate recent trends in industrial engineering.

Title of the Course: Refrigeration and Air Conditioning, Course Code : 3ME 402	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

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.

References:

1. Wilbert F. Stoecker, *Industrial refrigeration handbook*, 1st edn., McGraw-Hill Professional Publishing,1998
2. Wilbert F. Stoecker, Jerold W. Jones, "Refrigeration and Air Conditioning", McGraw-Hill Publishing , 2nd ed. ,2008
3. Shan K. Wang, "Handbook of air conditioning and refrigeration" McGraw-Hill international edition, second edition.

Course Objectives :

1. To enable the students to analyze and solve refrigeration related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques.
3. To practice effective communication skill to demonstrate refrigeration / air conditioning theories.
4. To develop skills in the analysis of refrigeration / air conditioning/cryogenics systems in research or design and industrial needs.
5. To develop a professional approach to lifelong learning in the refrigeration / air conditioning/cryogenics to include the awareness of social and environment issues.

Course Learning Outcomes:

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

CO-PO Mapping

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	**M**												**H**	
CO2	**M**	**M**										**H**	**M**	**M**
CO3	**M**			M								**H**		**M**

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
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 sub-cooling, 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**
Module 2 Multi pressure System and Refrigerants:	**Hrs.**
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**
Module 3 Cryogenics and Vapor Absorption System:	**Hrs.**
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**
Module 4 Refrigeration Equipments:	**Hrs.**
Types of Compressor, Condenser, Evaporator, Expansion devices, and selection, use of insulation, its types and applications.	**6**
Module 5 Psychrometry:	**Hrs.**
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**
Module 6 Heating and Cooling Load Calculation:	**Hrs.**

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.	**6**	

Module wise Measurable Students Learning Outcomes :

Students should be able to

1. Describe and recall basics of thermodynamics and study and analyze VCC.
2. Carry out performance study of multistage VCC. Classify the refrigerants; explain the physical, chemical properties of refrigerants.
3 Study the applications and 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.

Professional Core (Lab) Courses

Title of the Course: Refrigeration and Air Conditioning Lab, Course Code : 3ME 451	L	T	P	Cr
	0	0	2	1

Pre-Requisite Courses:

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.

References:

1. Wilbert F. Stoecker, *Industrial refrigeration handbook*, 1st edn., McGraw-Hill Professional Publishing,1998
2. Wilbert F. Stoecker, Jerold W. Jones, "Refrigeration and Air Conditioning", McGraw-Hill Publishing , 2nd ed. ,2008
3. Shan K. Wang, "Handbook of air conditioning and refrigeration" McGraw-Hill international edition, second edition.

Journal: Journal of Air conditioning and refrigeration- ISHRAE, ASHRAE

Course 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.
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 /cryogenics.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Performance the experiments in refrigeration and air-conditioning as per given objectives.	III	Applying.
CO2	Analyze different refrigeration, air conditioning and cryogenic systems with their applications.	IV	Analyzing.
CO3	Measure the performance of different systems under different conditions .	V	Evaluating

CO-PO Mapping :

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	M							M		H		M	H	
CO2	M	M			H							M	M	M
CO3	M									H	H	M		L

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

Following practical's be considered for ISE and ESE evaluation

Experiments

1 Trial on vapour compression refrigeration system.
2 Trial on Heat Pump.
3 Trial on ice plant.
4 Trial on Cascade system.
5 Trial on air conditioning system.

Demonstration / Study (any six)

1. Study and demonstration of refrigeration system for house hold refrigerator, water cooler, ice plant and cold storage.(Industrial visit is desirable)
2. Study and demonstration of controls in refrigeration.
3. Study and demonstration on window, split and central air conditioner.
4. Study of dehydration, charging, leak testing and testing of refrigeration system.
5. Study and demonstration of absorption system.
6. Study of method for star rating and EER for domestic appliances like house hold refrigerator.
7. Study/trial on Vortex tube /pulse tube refrigeration.
8. Study/ trial on multi-stage compression refrigeration system
9. Study/ trial on air washer.
10. Study/trial on multi-evaporator refrigeration system.

Title of the Course: Project I , Course Code : 3ME491	L	T	P	Cr
			4	4

Textbooks: - Suitable books based on the contents of the project selected.

References: - Suitable books based on the contents of the project selected and research papers from reputed national and international journals and conferences.

Course Objectives :

1. To help students to identify real life needs and discuss project requirements.
2. To give technical solutions through latest design & development tools.
3. To direct students to compare and analyze the IT platforms for efficient solutions.

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 software engineering and development skills.	II	Understanding
CO2	Demonstrate and implement appropriate software tools and prototypes for project execution.	III	Applying
CO3	Organize and manage the teamwork for effective execution of the task.	IV	Analyze

CO-PO Mapping :

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	H								H			H	H	
CO2			H						H		H		M	L
CO3		H						H						L

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Progress of the project	Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Progress of the project	Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Progress of the project	Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Progress of the project	Course faculty / Internal Examiner	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.
ISE are based on presentations, demos & seminar etc.
ESE: Assessment is based on 100% implementation, execution & validation

Course Contents

Project group should submit project report at the end of semester.

Project report should be prepared submitted along with soft copy (with code, PPT, PDF, Text report document & reference material).

Students should maintain a project log book containing weekly progress of the project.

Professional Elective (Theory) Courses

Title of the Course: Dynamics of Machines, Course Code : 3ME411	L	T	P	Cr
	03	0	0	03

Pre-Requisite Courses:

Textbooks:

1. G. K. Grover, "Mechanical Vibration" Nemchand and Brothers, Roorkee, Third Edition, 2006
2. Dr. V. P. Singh, "Mechanical Vibrations", S. Chand and Sons New Delhi, Second Edition, 2004
3. J. S. Rao"Introductory Course On Theory And Practice Of Mechanical Vibrations", New Age International Publishers, Second Edition, 1999

References:

1. Austin Church ,"Mechanical Vibrations", Wiely Eastern. First Edition, 1963
2. Cyril M. Harris, Charles E. Crede, "Shock and vibration handbook", McGraw-Hill, 1976
3. S. S. Rao, "Mechanical Vibrations", Fourth Edition, 2006

Course Objectives:

1. To make students aware about causes and effects of the vibration on mechanical systems.
2. To discuss types of vibrations namely un-damped, damped, free and forced.
3. To elaborate the process of transmission of force and motion due to vibration.
4. To demostrate mechanical vibration measuring instruments

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain the basics of vibration, causes and basic elements and its measurement	II	Understanding
CO2	Apply numerical methods in finding natural frequency and corresponding mode shapes of systems	III	Applying
CO3	Analyze linear and torsional systems with single and two degree of freedom under free and forced vibrations, for their natural frequency and response to excitations	IV	Analyze
CO4	Evaluate shafts based on their critical speeds	V	Evaluate

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	**M**							**H**					**H**	
CO2			**L**									**M**	**M**	**M**
CO3		**L**		**M**								**H**		**L**

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

	Hrs
Module 1: Introduction: Importance and scope, Concepts and terms used, SHM, vector method of representing harmonic motions, Complex method of representing vibration, Fourier series and harmonic analysis, stiffness of springs in combinations.	7Hrs
Module 2: Single degree free and forced vibration: Damped and undamped (a) Undamped free vibrations, derivation of differential equation with solution, energy method, types of damping, free vibrations with viscous damping, logarithmic decrement, coulomb damping, and damping materials. (b) Forced Vibrations: Types of excitation, forced excitation, forced vibrations with constant harmonic excitation, steady state vibration, excitation due to unbalance in machines, support excitation, response due to above types of excitations, transmissibility, force transmissibility and motion transmissibility, vibration isolators, commercial isolation materials and shock mounts	8 Hrs
Module 3: Two degree free and forced vibration (a) Free un-damped vibrations – Principal modes and natural frequencies, co-ordinate coupling and principal co-ordinates. (b) Forced vibrations (Un damped) – Harmonic excitation, vibration, dampers and absorbers, dynamic vibration absorber – tuned and Un tuned type	7 Hrs
Module 4: Torsional Vibration Natural frequency of free torsional vibrations, effect of inertia of the constraint on torsional vibrations, free torsional vibrations of a single rotor system, two rotor system and three rotor system. Torsionally equivalent shaft, free torsional vibrations of a geared system.	6Hrs
Module 5: Vibration Measuring Instruments Instruments for measurement of displacement, velocity, acceleration and frequency of vibration, introduction of X – Yplotter, spectral analyzers, FFT analyzer. **Introduction to Numerical Methods in Vibration** Holzer method, Releigh's method, matrix iteration method, introduction to F. E. M., Analysis techniques used in vibration (Eigen value analysis)	6 Hrs
Module 6: Critical Speed of Shaft Critical speed of a light shaft having a single disc with and without damping, Critical speeds of a shaft having multiple discs, secondary critical speeds	6 Hrs

Module wise Measurable Students Learning Outcomes :

Students should be able to:

1. Explain basics of vibrations
2. Discuss Single degree free and forced vibration: Damped and undamped
3. Analyze Two degree free and forced vibration
4. Analyze Torsional Vibration
5. Apply Numerical Methods in Vibration, and demonstrate Vibration Measuring Instruments
6. Evaluate Critical Speed of Shaft

Title of the Course: Computational Fluid Dynamics, Course Code : 3ME412	L	T	P	Cr
	3	0	0	3

Pre-Requisite:

Textbooks:

1. Anderson, J.D., "*Introduction to Computational fluid Dynamics", McGrawHill Publication 2008*
2. Muralidhar K. and Sundararajan T., "*Computational Fluid Flow and Heat Transfer"*, Narosa Publishing House, 2nd edition, New Delhi 2011.
3. Hoffmann K.A *"Computational fluid Dynamics*" Publication of engineering education system, 2000.

References:

1. Suhas V. Patankar, *"Numerical heat transfer fluid flow",* Hemisphere Publishing Corporation, 1980.
2. H.K.Versteeg and W Malalasekera, "*Introduction to Computational Fluid Dynamics*" Longman group, 1998.
3. Fletcher C.A.J., *"Computational Techniques for Fluid Dynamics I,"* Fundamental and General Techniques, Springer-Verlag, 1987.

Course Objectives:

1. To familiarize the students about different prediction methods and role of CFD.
2. To prepare the students to derive different forms of governing equations used in CFD and their significance.
3. To analyze N-S equations and the different numerical techniques used in CFD.
4. To train the students to select the appropriate conditions to solve the problem with CFD.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Summarize the prediction methods and basic methodology of CFD.	II	Understanding
CO2	Derive various governing equations in different forms.	III	Applying
CO3	Analyze the different numerical techniques for solving fluid problems.	IV	Analyzing
CO4	Evaluate the operating parameters using numerical techniques.	V	Evaluate

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	**L**												**H**	
CO2			**L**									**H**	**M**	**M**
CO3		**L**												**L**

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Course Contents:

Module 1 Introduction:	**Hrs.**
Prediction method, experimental techniques, analytical methods, CFD application, typical problems/ Problem Solving with CFD – Methodology.	**7**
Module 2 Conservation laws and the model equations:	**Hrs.**
Governing equations of fluid flow and heat transfer, Equations of the state, Navier-Stokes equations for a Newtonian fluid, Conservative form of the governing equations of fluid flow, Differential and integral forms of the general transport equations, Classification of physical behavior.	**6**
Module 3 Exact solution of the Navier-Stokes equations and boundary conditions	**Hrs.**
Introduction, Transformation of the Governing Partial Differential Equations, Grid Generation Techniques. Boundary conditions: introduction, types of boundary conditions, Potential pitfalls and final remarks.	**7**
Module 4 Basic computational techniques:	**Hrs.**
Finite Difference Formulations**:** Introductory remarks, Taylor Series Expansions, Finite difference by Polynomials, Finite difference equations, Applications. Finite Volume Method: Introduction, Steady one-dimensional problem, the central discretization schemes, Properties of discretization schemes, Assessment of the central differencing scheme for convection-diffusion problems, 1-D examples, 2-D examples.	**6**
Module 5 Solution methods:	**Hrs.**
This chapter deals with basic numerical discretization approaches discussed in earlier chapter and mold them into various techniques that will allow the numerical solution of flow problems. Lax- Wendroff Technique McCormack's Technique, Crank-Nicolson Technique **,**Relaxation Technique, ADI Technique, Pressure correction Technique.	**7**
Module 6 Post processing:	**Hrs.**
Results are usually reviewed in one of two ways. Graphically and Alpha numerically. Graphically: Vector plots, Contours, Iso-surfaces, Flow lines, Animation. Alpha numerical techniques.	**6**

Module wise Measurable Students Learning Outcomes :

Students should be able to

1. Describe the basics of fluid mechanics, methods of prediction and applications of CFD

2. Derive various governing equations in different form and interpretation of these equations.
3. Solve the N-S equation for simple cases.
4. Understand the FDM and FVM methods; and apply the same to solve fluid problems.
5. Select the appropriate solution method, and analyze the same.
6. Choose the appropriate post processing method, carry out and compare the various results.

Title of the Course: Advanced Manufacturing Techniques, Course Code : 3ME413	L	T	P	Cr
	3	0	0	3

Pre-Requisites of Courses:

Textbooks:

1. B.L. Juneja, *"Fundamental of Metal Forming Processes",* New Age International Publisheres,2003.
2. AmitabhaGhosh, A.K. Mallik, *"Manufacturing Science"*, EWP Publisher.1999

Reference Books:

1. George E.Dieter, *"Mechanical Metallurgy",* McGraw Hill Int.,1997
2. S.Kalpakjian,S.R.Schmid, *"Manufacturing Engineering and Technology",* Prentice Hall,2009
3. Surendra Kumar, *"Principal of Metal Working",* PH learning Pvt.Ltd, 2008

Course Objectives:

1. To make the students aware of theory of plasticity, various forming processes and their applications.
2. To impart the knowledge of recent developments in metal forming processes to students.
3. Toprepare the student for the use of non–conventional machining processes.
4. To develop thestudent for practical knowledge in the field of sheet metal working processes.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Summarize basic mechanical forming operations	II	Understanding
CO2	Use the forming limit diagram and able to design die for given forming processes	III	Applying
CO3	Explain practical knowledge of different metal forming and non-conventional machining processes.	IV	Analyzing
CO4	Calculate the number of rolls required in rolling operation to achieve the required job sizes	V	Evaluating
CO5	Design the forging die as well as extrusion and drawing dies for given application	VI	Creating

CO-PO Mapping:

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1				**H**				**H**					**H**	
CO2	**H**			**M**								**M**	**M**	**M**
CO3			**H**					**M**						**L**
CO4	**M**		**H**	**M**									**L**	
CO5	**H**			**M**				**H**						**H**

Assessment:

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Course Contents:

Module 1:	**Hrs.**
Study of various Forming processes, their special features with respect to other manufacturing process. Metallurgical consideration, hot, cold and worm working. Recovery and Re-crystallization. Theory of Plasticity: Flow curve, Concepts of true stress and true strain, yield criteria and their comparison, plastic stress strain relationships. Parameters affecting the yield strength of materials	**6**
Module 2:	**Hrs.**
a. Rolling Classification of rolling processes, rolling mill types, condition for natural entry in rolling operation, number of passes in rolling, roll bite, elongation, reduction, rolling of sheets, plates, bars, sections and tubes, applications and defects in rolling. **b. Forging** Basic operations, types of forging, forging hammers/ presses, forging stages and force calculations, die design considerations, forging defects, applications.	**3+3 =6**
Module 3:	**Hrs.**
a. Extrusion Equipment and principles, types of extrusion, direct, indirect, impact, continuous, hydrostatic, tube extrusion, metal flow in extrusion, defects, factors affecting extrusion load **b. Drawing** Types of Drawing, Rod/wire drawing, equipment and principles of process, defects, Tube drawing, Seamless Pipe Manufacturing	**4+4 =8**
Module 4:	**Hrs.**
Introduction, press operations, types of dies, Nesting (strip layout) of sheet, Forces in blanking, Drawability of sheet metal, Deep drawing, Redrawing, Hydrostatic pressure forming, Tractrix dies, Forming limit diagrams (FLD). Die-less forming of sheet metal.	**6**
Module 5:	**Hrs.**
Mechanization, computerization in metal forming, High energy rate forming processes such as Explosive forming, Electro-hydraulic forming, Electromagnetic forming, Magnetic pulse forming etc. Metal forming in mashy state, forming by Laser beam / plasma arc, isothermal forging.	**7**
Module 6:	**Hrs.**
Importance and scope of various non-conventional machining processes like Electro-Chemical machining (ECM), Electro-Discharge machining (EDM), wire EDM, Abrasive Jet machining (AJM), Laser Beam Machining (LBM), Ultrasonic machining	**7**

Module wise Measurable Students Learning Outcomes :

Students should be able to

1. Understand the Concept and importance of cold working and hot working processes.
2. Calculate the number of rolls required in rolling operation to achieve the required job sizes.
3. Design the forging die for given application.
4. Fabricate the dies for extrusion and cold drawing.
5. Explain the forming limit diagram and able to design die for given forming process.
6. Summarize importance and principles of operation of various non-conventional forming processes.

Title of the Course: Finite Element Method, Course Code : 3ME414	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. S. S. Rao, "*Finite Element Method in Engineering*", Elsevier Publication, 4th Edition, 2004
2. P. Seshu, "*Textbook of Finite Element Analysis",* 1st Edition. 2008.
3. M. J Fagan, "*Finite Element Analysis- Theory and Practice";* Longman Scientific & Technical, 1st Edition, 1992

References:

1. J. N. Reddy, "*An Introduction to Finite Element Method*", Tata McGraw Hill publication co. 2nd Edition, 1993

2. Logan D. L. "*A first course in Finite Element Method*", Cengage learning, 4th Edition, 2008.

3. O. C, Zienkiewicz *"The Finite Element Method – Basic Concepts and Linear Applications*", Tata McGraw Hill publication co., 5th Edition, 2000.

Course Objectives :

1. To explain the general steps in finite element method.
2. To solve various field problems using finite element method.
3. To apply variational formulation method to solve mechanical engineering problems.
4. To use modern software to simulate structural, thermal and fluid problems.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Explain the use of mathematical modeling and FEM.	II	Understanding
CO2	Use modern tools, software, and equipments to analyze and solve the problems and interpret the data	III	Applying
CO3	Analyze mechanical components, systems and projects required for industry by using FEM.	IV	Analyzing
CO4	Verify the analytical results of engineering problems using advanced tools.	V	Evaluating

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	**M**											**H**	**H**	
CO2			L	**M**				**M**					**M**	**M**
CO3		**M**						**M**				**M**		**L**
CO4				**M**		**M**						**M**		

Assessment:

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

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to FEM	**6 Hrs.**
Basic concepts of FEM – Historical background, relevance and scope for FEM – need for approximation, applications of FEM in various fields, advantages and limitations of FEM.	
Module 2:	**7 Hrs.**
Introduction Discretization, interpolation, shape function, formulation of element characteristics matrices, assembly and solution.	
Module 3	**7 Hrs.**
Introduction, Geometrical approximations, Simplification through symmetry, Basic element shapes and behaviour, Choice of element type, Size and number of elements, Element shape and distortion, Location of nodes, Node and element numbering.	
Module 4	**7 Hrs.**
Types of elements, order of element. Formulation of element characteristic matrices and vectors for elasticity problems : One dimensional elasticity – two dimensional elasticity, axi-symmetric elasticity. Formulation procedures, the variational formulation, the weighted residual method. Thermal problems, one dimensional heat transfer, two dimensional heat transfer, Torsional problems, Fluid flow problems.	
Module 5	**6 Hrs.**
Introduction, co- ordinate transformations, assembly of element equations, incorporation of the boundary conditions, solution of the equations, matrix operations, elimination method, penalty method	
Module 6	**7 Hrs.**
Model validity and accuracy, mesh design and refinement, element distortions, result processing, model checking.	

Module wise Measurable Students Learning Outcomes :

Student should be able to

1. Explain the use of mathematical modeling and FEM.
2. Apply the general steps of finite element method to solve engineering problems.
3. Use the discretization techniques to mesh the various geometries.
4. Solve the structural, thermal and fluid problems using variational formulation methods.
5. Describe the difference between various boundary conditions.
6. Interpret the finite element model and its simulation results.

Title of the Course: Cryogenics, Course Code : 3ME 415	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. Barron, R, "*Cryogenic Systems",* McGraw-Hill, 1966.
2. Thomas M. Flynn, Marcel Dekker. Inc "*Cryogenic Engineering*", Inc. New York, 1997.

References:

1. Marshall Sittig, D. Van Nostrand Co. "*Cryogenics - Research and Applications*", Inc. New York, 1963.
2. Klaus D. Timmerhaus, Thomas M. Flynn, "*Cryogenic Process Engineering",*Plenum Publishing Corporation,1989.

Course Objectives :

1. To make students aware about Cryogenics, its importance and applications
2. To explore the students to Cryogenic systems and their elements
3. To familiarize students with measurement systems for low temperature applications

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Summarize the applications and importance of Cryogenics	II	Understanding
CO2	Illustrate the various Cryogenic Systems	III	Applying
CO3	Explain the measurement systems for low temperature applications	IV	Analyze

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	H								H			H	H	
CO2			H						H		H		M	L
CO3		H						H						L

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Introduction to Cryogenic: History and development, cryogenic temperature scale. **Application Of Cryogenic Systems:** Super conductive devices, cryogenic space technology- cryogenics in biology and medicine.	**6**
Module 2	**Hrs.**
Material Properties: Low temperature properties of engineering materials- Mechanical properties, Thermal properties, electric and magnetic properties.	**7**
Module 3	**Hrs.**
Gas Liquefaction Systems: Introduction - production of low temperature, Liquefaction systems for freoen, hydrogen, helium and other gases. **Cryo-coolers:** Sterling, G-M and pluse tube cryocoolers.	**7**
Module 4	**Hrs.**
Gas Separation And Purification Systems: The Thermodynamically ideal separation systems properties of mixtures, principles of gas separation – Linde single column and double column system of air separation	**6**
Module 5	**Hrs.**
Measurement Systems For Low Temperatures: Temperature measurement – pressure measurement – flow rate measurement. Measurement and importance of vacuum in cryogenics.	**7**
Module 6	**Hrs.**
Cryogenic Fluid Storage and Transfer Systems: Cryogenic fluid storage vessels- Insulation– cryogenic fluid transfer systems.	**6**

Module wise Measurable Students Learning Outcomes :

Students should be able to

1. Describe basics of cryogenic systems and their applications
2. Explain importance of Cryogenics in material characterization
3. Discuss the gas liquification systems, and classify the Cryo-coolers
4. Depict the Gas Seperation and Purification systems
5. Articulate measurement systems for Low Temperature applications.
6. Summarize Cryogenic Fluid Storage and Transfer Systems.

Title of the Course: Computer Integrated Manufacturing and Robotics, Course Code : 3ME416	L 3	T 0	P 0	Cr 3

Pre-Requisite Courses:

Textbooks:

1.Groover M.P*, "Automation, Production Systems and Computer Integrated Manufacturing*", Prentice Hall International publication,2004.

2. Appu Kuttan K.K, "*Robotics*, I.K. International oublication,2007.

3.Groover M.P., Nagel R.N., Ordey N.G. "*Industrial Robotics- Technology, Programming and Applications,"* McGraw Hill International,2012.

References:

1. Richard M. Murrai, Zexiang Li, S Shankar Sasrty, "*Robotic Manipulation*," CRC Press, 2001

2. S.R. Deb, "*Robotics Technology and Flexible Automation*," Tata McGraw Hill, 2000

3. Urich Rembold, "*Computer Integrated Manufacturing Technology and System*," 1995

Course Objectives:

1. To expose the student to the various fundamentals of computer assisted manufacturing systems.
2. To make the students familiar with criteria for implementing systems associated with software and CAD/CAM database for design and manufacturing.
3. To explain students about Robotics and its allied interdisciplinary approach, component design, sensor technology, computer science and artificial intelligence.
4. To evolve prominent component of Automated Manufacturing Systems and controllers to perform a programmed tasks.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Determine the fundamental concepts of Automation and Product Development through CIM models	II	Understanding
CO2	Choose sensors, actuators and motion conversion devices in robot in logical way.	III	Applying
CO3	Defend the working of Robot software/ hardware in CIM environment	V	Evaluating
CO4	Design the modern information processing system and advanced robotics.	VI	Creating

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1			L										**H**	
CO2			H			M							**M**	**M**
CO3						H						**M**		**L**
CO4											**M**			

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 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:

Module 1: Computer Integrated Manufacturing:	**6 Hrs.**
- Introduction, definition, importance, components, automation and evolution of CIM. Advantages, limitations, scope and globalization view. - Product Development through CIM: Introduction, product development cycle, sequential engineering, concurrent engineering, comparison between SE and CE, implementation of CE, CE and IT, soft and hard prototyping, characteristics of CE, success of CE, applications of CE.	
Module 2: Automated Quality Control and CIM Implementation:	**7 Hrs.**
- In-process and post process methodologies, integrations of CNC machines, robot in CIM environment. - Communication, software/ Hardware: Availability of software, network topologies for LAN, network interface card and protocols, Network operating systems. - CIM models: Introduction, ESPRIT- CIM OSA model, the NIST- AMRF hierarchical model, the Siemens model, digital equipment corporation model, IBM concept of CIM.	
Module 3: Robotics in CIM:	**6 Hrs.**
Historical development, various terminologies, classification, degrees of freedom and degrees of motion, manipulation of robot components, joints and symbols, work volume, work envelope, accuracy and repeatability, configuration, Numerical examples.	
Module 4: Robot Programming and Modular Components:	**7 Hrs.**
Methods, languages, advantages and limitations of robot, requirements for robot in an Industries, specifications of robot, operational capabilities level of robot, modular robot components, wrist mechanism, Numerical examples.	
Module 5: Robot Sensors, Actuators and Motion Conversion:	**7 Hrs.**
-Internal and external sensors, force sensors, thermocouples, performance characteristics, standard test signals, controllers, PLC and robotics. -Robot actuators, micro grippers, motion conversion systems, harmonic drives, robot safety.	
Module 6: Advanced Robot Systems:	**6 Hrs.**
Heuristics decision for robot, Fuzzy logic for robot control, Artificial Neural Network for robotics, Biped Robot, Biomimetic robotics, calibration.	

Module wise Measurable Students Learning Outcomes: Students should be able to
1. Explain advanced manufacturing systems
2. Introduce the idea of implementation of CIM
3. Use of robot in CIM environment
4. Apply the robot Programming and other related modular components
5. Observe anatomy parameters of robot
6. Describe new trends in robotics

Title of the Course: Mechanical System Design , Course Code : 3ME417	L	T	P	Cr
	3	1	0	3

Pre-Requisite Courses:

Textbooks:

1 V.B.Bhandari , "Design of Machine Element", Tata Mc- Graw Hill Publication , 4th Edition, 2001
2 Shigley and C.R.Miscke , "Mechanical Engineering Design", Tata Mc- Graw Hill Publication, 2001
3 M.F.Spotts , "Mechanical design analysis", Prentice Hall publication, 1964
4 Black P.H.and O.Eugene Adams , "Machine Design", Tata Mc- Graw Hill Publication, 3rd Edition, 1993
5. W.H.Mayall , "Industrial Design for Engineers", Illife, 1967

References:

1. M.V.Joshi, " Process Equipment Design" , Macmillal Publication, 1976
2. Robert L.Norton , "Machine Design", Tata Mc- Graw Hill Publication, 2001
3. Anurag Dixit , "Mechanical System Design" , SCITECH publication, 2005
4. PercyH.Hill *"The Science of Engineering Design",* Holt McDougal,1970.

Course Objectives :

1. To prepare the students to succeed as designer in industry/technical profession.
2. To Provide students with a sound foundation in mechanical system design required to solve the problems in industry.
3. To train the students for safe and efficient design of structural parts of the mechanical system.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain the theory of pressure vessels and gear box design.	II	Understanding
CO2	Use Johnson's method of optimum design to design mechanical components.	III	Applying
CO3	Estimate the tolerances and reliability of mechanical components and systems.	V	Evaluating
CO4	Design the products as per the needs of society considering aesthetics and ergonomics concept.	VI	Creating

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	**H**		**M**									**H**	**H**	
CO2			**M**					**M**				**M**	**M**	**M**
CO3		**M**	**L**	**L**										**L**
	H		**M**									**H**		

Assessment:

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

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1:	**6 Hrs.**
Thin and thick cylinders; failure criteria of vessels; Lame's equation; Clavarino's and Birnie's equation; Autofrettage and compound cylinders; Types of pressure vessels- Horizontal and vertical; Classification of pressure vessel as per IS2825, 1969.Introdduction to design of pressure vessels as per IS Codes. Shell and end closures. Effect of opening & nozzles in shell & covers. Types of pressure vessel support .	
Module 2:	**7 Hrs.**
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- Compound ray diagram	
Module 3 :	**7 Hrs.**
System Approach to Design; Mathematical model; Lumped system; Dynamic response of lumped & distributed system; Modeling of masses, Elasticity, Inertia, Damping and friction.	
Module 4:	**7 Hrs.**
Introduction to optimum design for mechanical elements, adequate and optimum design, Johnson's method of optimum design- simple problems in optimum design like axially loaded members, shafts subjected to torsional and bending moments, helical spring, levers. Optimum design with in Lagrange multipliers	
Module 5:	**6 Hrs.**
(a) Statistics in design, probability, random variables- sample and populations, Normal distribution, Sampling distribution, Confidence intervals, population combinations (Introductory treatment, no questions to be asked in examinations on 5(a) (b) Design for natural tolerances, Statistical analysis of tolerances. Introductions to reliability and its applications for selections of factor of safety, study of process capability for design.	
Module 6:	**7 Hrs.**
Approach to industrial product based on idea generation and innovations to meet the creative process involved in idea marketing, designers, mind-criticism, design process, creation needs of the developing society. Design and development process of industrial products, various steps such as Ergonomics and aesthetic requirements of product design, quality and maintainability consideration in product design, Use of modeling technique, prototype designs, conceptual design	

Module wise Measurable Students Learning Outcomes : Student should be able to

1. Explain the theory of pressure vessels design.
2. Discuss the theory of gear box design.
3. Demonstrate the approach in system design
4. Use Johnson's method of optimum design to design mechanical components.

5. Estmate the tolerances and reliability of mechanical components and systems.
6. Design the products as per the needs of society considering aesthetics and ergonomics concept.

Title of the Course: Product Lifecycle Management, Course Code : 3ME418	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. Stark John, Product Lifecycle Management - 21st Century Paradigm for Product Realization, Springer, 2005.
2. Hoffer J, Prescott M, McFadden F, Modern Database Management, Prentice Hall, 2007.

References:

1. Ramakrishnan R and Gehrke J, Database Management Systems, McGraw-Hill Publisher, 2002.
2. Kusiak A, Concurrent Engineering: Automation, Tools, and Techniques, John Wiley & Sons, 1993.
3. Magrab E, Gupta S, McClusky P, Sandborn P, Integrated Product and Process Design and Development: The Product Realization Process, CRC Press, 2010.

Course Objectives :

1. To provide the knowledge of different information systems used in an engineering enterprises
2. To impart the recent knowledge in the broader field of product development and various lifecycle aspects involved
3. To provide exposure to application of software tools for addressing problems in product design and development.

Course Learning Outcomes:

CO	**Upon completion of this course the student will be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain various phases in product life cycle and its considerations in product development	II	Understanding
CO2	Discuss PLM backend technologies and its implementation	II	Understanding
CO3	Apply DFX principles for product development	III	Applying
CO4	Compare functionalities of various commercial PLM systems	IV	Analyzing

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	**M**					**H**			**H**			**l**	**H**	
CO2	**M**			**H**				**H**					**M**	
CO3			M		M									**L**
CO4	**M**					**H**			**H**			M		**M**

Assessment:

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

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

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MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction	**6 Hrs.**
Globalization and international business, Global competitiveness and manufacturing excellence, Operating environment, Business challenges, Emergence of information Age, Data and information management, Role of information systems.	
Module 2 PLM evolution	**7 Hrs.**
Pre-PLM era, Sequential engineering, Concurrent engineering, Integrated product process development (IPPD),DFX, Design for manufacturability, Design for assembly, Design for disassembly, Design for environment	
Module 3Product Lifecycle Management	**6 Hrs.**
PLM Need, PLM overview, PLM system architecture, PLM functionalities, PLM systems and its benchmarking	
Module 4 Pillars of PLM systems	**7 Hrs.**
Computer aided design (CAD), Product data management (PDM), Enterprise resource planning (ERP), Supply chain management (SCM), Customer relationship management (CRM), Knowledge management (KM)	
Module 5 PLM and Database Management System	**6 Hrs.**
Database modeling (relational, object-oriented models, web models), Database systems (i.e., databases and rule management), Data warehousing, Databases and WWW, XML databases, Information retrieval, Distributed databases, Heterogeneous databases and data integration	
Module 6 PLM implementation	**7 Hrs.**
PLM implementation, Challenges, Data Interoperability, Business Process Reengineering, PLM implementation case studies.	

Module wise Measurable Students Learning Outcomes :

Student should be able to:

1. Summarize current trends in global product development and related practices
2. Illustrate the principles of DFX for product development
3. Explain various functionalities in PLM systems
4. Compare various commercial PLM systems
5. Associate the role of database management systems in PLM
6. Describe various issues related to PLM implementation

Title of the Course: Precision Engineering, **Course Code** : 3ME419	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. Murty, R. L, "*Precision Engineering in Manufacturing",* New Age International Publishers,ed.- 1st ,2009.
2. Venkatesh, V.C. and Izman, S. *"Precision Engineering",* (TMH),2007.
3. G. Henzold,*"Geometric Dimensioning and Tolerancing for Design, Manufacturing and Inspection",* Butterworth Heinemann – Elsevier Ltd., 2006.

References:

1. Dornfeld, David and Lee, Dae-Eun, - *"Precision Manufacturing"*, (Springer Science + Business Media, LLC), ISBN: 978-0-387-32467-8, 2008
2. Meadows, James D., *"Geometric Dimensioning and Tolerancing"*, Marcel Dekker Inc., 1995.
3. Drake, Paul J. Jr., *"Dimensioning and Tolerancing Handbook"*, (McGraw Hill), ISBN:0-07-018131-4, 1999

Course Objectives:

1. To develop an interest in precision engineering and precision components.
2. To make the students familiar with fundamentals of precision machining.
3. To acquire the knowledge of recent developments in precision machining.
4. To gain knowledge of selection of optimum process parameters in precision engineering.
5. To make aware of measurement techniques used in precision components.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Summarize different machining processes for precision components	II	Understanding
CO2	Interpret appropriate geometrical features and tolerances for precision components	III	Applying
CO3	Identify various process parameters for defect free precision components	IV	Analyzing

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	M											M	H	M
CO2			M	M								H	M	
CO3		M	L									H		L

Assessment:

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

Assessment	Marks
ISE 1	10
MSE	30

ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Precision Engineering	**6 Hrs.**
Definition, difference in precision and accuracy, need for high precision, Classes of achievable machining accuracy – normal, precision, high precision and ultra precision machining; Concept of accuracy – part accuracy, errors of form, errors in flat surface and errors in relative location of surfaces, machining accuracies and the processes. Applications of Precision Manufacturing: Semiconductor device manufacturing- process steps, Micro electro mechanical devices – applications, Future of precision manufacturing.	
Module 2: Geometrical Dimensioning and Tolerancing	**7 Hrs.**
Geometrical tolerances, tolerance zones – form, location and orientation of tolerance zones, Datum and precedence – primary, secondary and tertiary, Positional tolerances – zones, form; Combination of dimensional coordinate tolerancing and positional tolerancing, Defining substitute elements (best fit elements) from measured coordinates; Maximum Material Requirements and Minimum (Least) Material Requirements, their applications; Accumulation of tolerances (tolerance stacking)	
Module 3: Machine Tools and Accuracy	**7 Hrs.**
General concept of accuracy of machine tool, spindle rotation accuracy, displacement accuracy, the philosophy of precision machine design, sources of error on a machine tool, factors affecting workpiece accuracy from the point of view of machine design, accuracy of CNC machines – errors due to input interpolation and servo system; Thermal errors- Sources and transmission of thermal errors in precision machining, error avoidance and compensation, environment control of precision machinery- machine enclosures, room and factory enclosures.	
Module 4: Tool Materials for Precision Machining	**6 Hrs.**
Classes of tool materials and their properties, coated carbides- laminated, CVD and PVD coated carbides, Cermets, Ceramics - hot pressed, Silicon Nitride and whisker reinforced ceramics, Diamonds – crystallographic planes, natural and synthetic diamonds, polycrystalline diamonds, diamond coated tools, Cubic boron nitrides (CBN), coated CBNs, Tool and work material compatibility	
Module 5: Processing and Accuracy	**7 Hrs.**
Dimensional wear of cutting tools and its influence on accuracy, clamping and setting errors, errors due to location; Surface roughness and microfinishing processes – Terminology, influence of machining parameters on surface roughness, Honing, lapping and super finishing, Process capability – mean, variance, skewness, process capability metrics, Cp, Cpk, Methods for improving accuracy and Surface finish.	
Module 6: Precision Machining Processes	**7 Hrs.**
Classification of material removal processes in terms of the energy source used and the tool- workpiece reaction, influence of machining parameters, work material and tool	

	geometry, Diamond turning and milling machines, tool design and alignment, Fixed abrasive processes - Basic mechanics of rinding,finish grinding, precision cylindrical, internal and surface grinding bondless diamond grinding wheels, jig grinding, electrolytic in-process dressing, Ultra-precision grinding, nano-grinding; Loose abrasive processes polishing, modes of material removal.		

Module wise Measurable Students Learning Outcomes :

Students should be able to

1. Understand the precision engineering, its classification, application, advantages and limitations.
2. Know the importance of geometrical dimensioning and tolerances in precision engineering.
3. Describe the role of machine tools and accuracy in precision engineering.
4. Distinguish the tool materials used in precision engineering, CVD and PVD processes.
5. Explain the role of processing in precision engineering, errors in precision engineering and methods for improving surface finish and accuracy.
6. Narrate the precision machining processes their capabilities and applications.

Title of the Course: Thermal systems Course code: 3ME420	L	T	P	Cr
	3	**0**	**0**	**3**

Textbooks:

1. EL-Wakil, *"Power plant Technology"*, M.M., McGraw Hill, 1st Edition, 2017
2. P.K. Nag , *"Power Plant Engineering"*, Tata McGraw Hill, 4th Edition 2017
3. Domkundwar, Arora, *"Power plant Technology"*, Dhanpat Rai and Co. sixth edition 2013

References:

1. Weisman, J., and Eckert, L., *"Modem Power Plant Engineering"*, Prentice Hall, 1st edition, 1999
2. Kam W. Li and A. Paul Priddy, *"Power Plant System Design"*, John Wiley, 1st edition, 2018
3. Ibrahim Dincer, Marc A. Rosen, " *Thermal Energy Storage: Systems and Applications*" , Wiley Publication 2nd Edition 2010.

Course Objectives :

1. To introduce the students about working of thermal systems.
2. To familiarize about failure theories and economics of thermal systems.
3. To judge the performance and economics of thermal systems.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		Level	Descriptor
CO1	Interpret the working of various thermal systems.	II	Understanding
CO2	Apply the fundamental laws of thermodynamics to thermal systems.	III	Applying
CO3	Analyze the performance of various thermal systems.	IV	Analyzing

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO-1**	**PSO-2**
CO1	**H**	**M**											**L**	
CO2	**H**	**M**	L										**L**	
CO3	**H**	**M**	H		M	L							**L**	

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 etc.

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

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module-1 - High Pressure Boilers Introduction , Advantages of High Pressure Boilers, LaMont Boiler , Benson Boiler, Loeffler Boiler , Supercharged Boilers , Waste Heat Boilers , Corrosion in Boilers and its Prevention , Causes of Boiler Tube Failures and Prevention	**Hrs. 8**
Module-2 Fluidized Bed Combustion (Fbc) Introduction , Principle of FBC , Types of FBC , FBC for low grade fuels , Corrosion of FBC system ,Control of FBC system , Starting of Fluid-Bed Firing system. Erosion and Corrosion and its prevention in FBC Boilers , Advantages of Fluidized Bed Systems	**Hrs. 6**
Module -3 Combined Cycle Technology Introduction, Arrangement of Combined Cycles , Combined Cycle with Gas Production from coal , Combined cycles using PFBC system. Optimum design of Gas Turbine Unit for Combined cycle plant , Advantages of Combined Cycle , Performance of Combined Cycle , Economics of Combined Cycle	**Hrs. 5**
Module-4 Cogeneration Concepts, Types of Co generating Systems , Performance Evaluation of Co generating System	**Hrs. 6**
Module-5 Waste Heat Recovery System Introduction, Sources of Waste Heat and their Grading, Thermodynamic Cycles for Waste Heat Recovery. Heat Recovery Forms and Methods, Other Uses of Heat , Heat Pump Systems , Different Wastes for Power Generation .	**Hrs. 7**
Module-6 Thermal Storage System Introduction, need of thermal storage, methods, design and analysis of thermal storage systems.	**Hrs. 6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1.Understand the high pressure boiler and its components.
2.Distinguish the different FBC.
3.Apply the laws of thermodynamics to various thermal systems.
4.Interpret the need of cogeneration and its performance.
5.Understand the various techniques of waste heat recovery.
6. Understand the significance of thermal storage system.

Professional Elective (Lab) Courses

Title of the Course: Dynamics of Machines Lab, Course Code: 3ME452	L	T	P	Cr
	0	0	2	1

Pre-Requisite Courses:

Textbooks:

1. G. K. Grover, "Mechanical Vibration" Nemchand and Brothers, Roorkee, Third Edition, 2006
2. Dr. V. P. Singh, "Mechanical Vibrations", S. Chand and Sons New Delhi, Second Edition, 2004
3. J. S. Rao"Introductory Course On Theory And Practice Of Mechanical Vibrations", New Age International Publishers, Second Edition, 1999

References:

1. Austin Church ,"Mechanical Vibrations", Wiely Eastern. First Edition, 1963
2. Cyril M. Harris, Charles E. Crede, "Shock and vibration handbook", McGraw-Hill, 1976
3. S. S. Rao, "Mechanical Vibrations", Fourth Edition, 2006

Course Objectives:

1. To be aware about causes and effects of the vibration on mechanical systems.
2. To demonstrate mechanical vibration measuring instruments
3. To analyze types of vibrations namely un-damped, damped, free and forced vibrations.
4. To determine the transmission of force and motion due to vibration.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Demonstrate the concept of vibration, causes and basic elements and its measurement	II	Understanding
CO2	Determine natural frequency and corresponding mode shapes of systems	III	Applying
CO3	Measure force and motion transmissibility of given system	IV	Analyze

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	**M**							**1**					**H**	
CO2			**H**								**M**		**M**	**M**
CO3		**H**		**M**							**L**			**L**

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

Any ten experiments/lab sessions from the list given below

1. Determination of stiffness of spring from static deflection
2. Determination of natural frequency of single degree of freedom spring mass system
3. Determination of natural frequency of two degree of freedom spring mass system
4. Determination of natural frequency of double pendulum system
5. Measurement of torsional vibrations
6. Plot response curve of system under forced vibration
7. Determining damping coefficient of a viscous damper
8. Determine damping effect on a system under forced vibration with viscous damping
9. Determine optimal frequency for dynamic vibration absorber
10. Determine critical speed of shaft
11. Measure various parameters of vibrations
12. Diagnose fault in a system based on FFT
13. Determine mode shapes of a thin plate
14. Study of numerical methods of natural frequency determination

Title of the Course: Computational Fluid Dynamics Lab, Course Code: 3ME453	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: The subject requires the student should know basic of fluid mechanics, partial differential equations, numerical methods, heat transfer.

Textbooks:

1. Anderson, J.D., "*Introduction to Computational fluid Dynamics", McGrawHill Publication 2008*
2. Muralidhar K. and Sundararajan T., "*Computational Fluid Flow and Heat Transfer"*, Narosa Publishing House, 2nd edition, New Delhi 2011.
3. Hoffmann K.A, *" Computational fluid Dynamics*" Publication of engineering education system, 2000

References:

1. Suhas V. Patankar*"Numerical heat transfer fluid flow",* Hemisphere Publishing Corporation, 1980.
2. H.K.Versteeg and W Malalasekera, "Introduction to Computational Fluid Dynamics" Longman group, 1998.
3. Fletcher, C.A.J., *"Computational Techniques for Fluid Dynamics 1,"* Fundamental and General Techniques, Springer-Verlag, 1987.

Course Objectives:

1. To introduce students about the prediction methods and methodology of CFD simulation.
2. To prepare the students to use tools for geometry creation, meshing, boundary conditions and numerical techniques.
3. To inculcate the students for interpretation of CFD results.
4. To develop skills in the analysis of fluid systems for lifelong learning.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Interpret the different prediction methods and explain the Methodology of CFD simulation.	II	Understanding
CO2	Select the grids, boundary conditions, solver / numerical technique, post processing techniques etc.	III	Applying
CO3	Analyze the fluid problems using CFD technique.	IV	Analyzing
CO4	Measure the performance parameters mechanical systems through CFD simulation.	V	Evaluate

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1			M										H	
CO2			H		L							M	M	M
CO3		H									L			L
CO4				H				M						

Lab Assessment:
There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents: (Any ten out of the following list)

1. Methodology to simulate the problem with CFD.
2. Different types of grids and grid generation techniques.
3. Applying FDM and FVM solve the simple problem in thermal engineering.
4. Simulation of flow through pipes: Parallel flow, Series Flow etc.
5. Simulation of flow through orifice.
6. Simulation of flow through venture.
7. Flow around Cylinder/Sphere/ Aerofoil.
8. Simulation of flow through duct.
9. Simulation of natural convection heat transfer.
10. Simulation of forced convection heat transfer problem.
11. Simulation radiation heat transfer problem.
12. Simulation of flow and heat transfer through porous media.
13. Simulation of Parallel flow heat exchanger.
14. Simulation of Counter flow heat exchanger.
15. Simulation of phase change phenomenon.
16. Simulation of flow in Turbomachines.
17. Simulation of unsteady state heat transfer problem.

Title of the Course: Advanced Manufacturing Techniques Lab, Course Code: 3ME454	L	T	P	Cr
	0	0	2	1

Pre-Requisite Courses:

Textbooks:

1. B.L. Juneja, *"Fundamental of Metal Forming Processes",* New Age International Publisheres,2003
2. AmitabhaGhosh,A.K. Mallik,*"Manufacturing Science"*, EWP Publisher,1999
3.Surendra Kumar,*"Principal of Metal Working",* PH learning Pvt.Ltd., 2008

References:

1.Johnson W. & Mellor P.B.,D.VanNostrand, *"Plasticity for Mechanical Engineers",*1992
2.Black and Kosher*"Materials and Processes in Manufacturing"*,PHI Publisher,2001
3. Pearson C., *"Extrusions of Metals",*., Willy Eastern Ltd., New York.2007
4.E.CLarke*"Rolling of Strips,Sheet& Plate",* , Chapman and Hall,1957

Course Objectives :

1. To make the students familiar practical knowledge of forming processes.
2. To demonstrate the experiment on the theory of plasticity using UTM.
3. To prepare the students for calculations of the no. of passes / stages and forces required in forming processes.
4. To demonstrate carry out experimentson the non –conventional machining processes.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Demonstrate the practices for advanced machining processes and forming operations	III	Applying
CO2	Estimate press capacity and forcesand die-design for forging, extrusion etc.	IV	Analyzing
CO3	Calculate the number of passes required in rolling and wire drawing operation to achieve the required job sizes.	V	Evaluating

CO-PO Mapping :

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	**H**					**L**		**M**					**H**	
CO2		**M**		**L**								**L**	**M**	**M**
CO3		**H**		**M**								**M**		**L**

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities,	Lab Course Faculty	During Week 10 to Week 14	25

	attendance, journal		Submission at the end of Week 14	
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

Any six experiments from **1 to 7**following list**, Industrial visits are compulsory**:

1. Study and demonstration and tensile on Universal Testing Machine.
2. Exercise on Rolling: Number of passes and force calculation for various sections like I section, round, square bar etc.
3. Exercise on Forging: Number of passes, force calculation etc. for various components such as connecting rod, cam shaft etc.
4. Exercise on Extrusion process.
5. Designing layout for multi pass wire drawing.
6. Exercise on Press working: press capacity calculation, force calculation.
7. Demonstration and hands on experiments on EDM machine.
8. Industrial visit to rolling mill, wire drawing and extrusion industry.
9. Industrial visit for studying the sheet metal forming processes.
10. Industrial visit for studying conventional and the non-conventional machining/forming processes in Industrial estates.

Title of the Course: **Finite Element Method Lab, Course Code: 3ME455**	L	T	P	Cr
	0	0	2	1

Pre-Requisite Courses:

Textbooks:

1. S. S. Rao, "*Finite Element Method in Engineering*", Elsevier Publication, 4th Edition, 2004
2. P. Seshu, "*Textbook of Finite Element Analysis",* 1st Edition, PHI publication, 2008.
3. M. J Fagan, "*Finite Element Analysis- Theory and Practice";* Longman Scientific & Technical, 1st Edition, 1992

References:

1. J. N. Reddy, "*An Introduction to Finite Element Method*", Tata McGraw Hill publication co. 2nd Edition, 1993
2. Logan D. L. "*A first course in Finite Element Method*", Cengage learning, 4th Edition, 2008.
3. O. C, Zienkiewicz *"The Finite Element Method – Basic Concepts and Linear Applications*", Tata McGraw Hill publication co., 4th Edition.

Course Objectives :

1. To explain the finite element method, its fundamentals and general steps.
2. To describe the underlying theory, assumptions and modeling issues in FEM.
3. To provide hands on experience using finite element software to model, analyze and design systems of mechanical engineering.
4. To provide hands on experience using finite element software to simulate structural, fluid and thermal problems.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Execute the structural, thermal and dynamic analysis using FEM software.	III	Applying
CO2	Categorize the mathematical methods and finite element procedures for engineering applications.	IV	Analyzing
CO3	Select the procedures for structural, thermal and fluid analysis of 1D, 2D and 3D problems.	V	Evaluating

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1		**M**		**H**				H					**H**	
CO2		**M**		**M**				**M**					**M**	**M**
CO3		**M**	**M**									**L**		**L**

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities,	Lab Course Faculty	During Week 1 to Week 4	25

	attendance, journal		Submission at the end of Week 5	
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.
The experimental lab shall have typically 8-10 experiments.

Course Contents:

Term work shall consist of minimum ten based on the topics given below.
The students are expected to solve the problems by using any FEM software.

1. Analysis of stepped bar
2. Thermal analysis of composite wall
3. Torsional analysis of shaft
4. Analysis of truss
5. Problems on shape functions
6. Structural 2D analysis
7. Structural 3D analysis
8. Modal Analysis
9. Thermal 2D analysis
10. Thermal 3D analysis
11. Geometrical nonlinear analysis
12. Contact nonlinear analysis
13. Material nonlinear analysis
14. Industrial Visit to Software Company.

Title of the Course: Cryogenics Lab, Course Code: 3ME456	L	T	P	Cr
	0	0	2	1

Pre-Requisite Courses:

Textbooks:

1. Barron, R, "*Cryogenic Systems",* McGraw-Hill, 1966.
2. Thomas M. Flynn, Marcel Dekker. Inc "*Cryogenic Engineering*", Inc. New York, 1997.

References:

1. Marshall Sittig, D. Van Nostrand Co. "*Cryogenics - Research and Applications*", Inc. New York, 1963.
2. Klaus D. Timmerhaus, Thomas M. Flynn, "*Cryogenic Process Engineering",* Plenum Publishing Corporation,1989.

Course Objectives :

(1) To demonstrate the importance of Cryogenics through laboratory experimentation
(2) To describe the working of Cryogenic systems through Hands-On
(3) To prepare the students to use the tools, techniques and skills to fulfill the needs related to low temperature applications
(3) To Expose the students for real-life cases in Cryogenics.

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	Handle the cryogenic systems	III	Applying
CO2	Inspect the performance of Cryogenic Systems	IV	Analyzing
CO3	Justify the applications of cryogenics for machining, material characterization, and others	V	Evaluate

CO-PO Mapping :

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1			M			H			H					
CO2	H	M				H		H					H	M
CO3	H		M									H	H	L

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

1. Measurement of various mechanical properties at Cryogenic Temperature 2. Study / Trial on Cryo-cooler 3. Study of Cryogenic Insulators 4. Measurement of Thermal Conductivity of Cryogenic Insulators 5. Trial on Cascade Tutor 6. Demonstration of Cryogenic Storage systems 7. Demonstration of Liquifaction Systems 8. Study of Cryogenic 9. Study of Cryogenic Transportation System 10. Visit to Industry / Cryogenic Research Lab	

Title of the Course: CIM and Robotics Lab, Course Code: 3ME457	L	T	P	Cr
	0	0	2	1

Pre-Requisite Courses:

Textbooks:

1. Groover M.P., "*Automation, Production Systems and Computer Integrated Manufacturing,"*, Prentice Hall International, 2004
2. Groover M.P., Nagel R.N., Ordey N.G., "*Industrial Robotics- Technology, Programming and Applications*", McGraw Hill International, 1999
3. R.K. Mittal, I.J. Nagrath, "*Robotics and Control*,", Tata McGraw Hill, 1997
4. Pradeep Chaturvedi, N.K. Tewari, P.V. Rao, G.S. Yadav, "*Modern Trends in Manufacturing Technology,"*, IE India, New Delhi, 2002

References:

1. Richard M. Murrai, Zexiang Li, S Shankar Sasrty, "*Robotic Manipulation*," CRC Press, 2001
2. S.R. Deb, "*Robotics Technology and Flexible Automation*," Tata McGraw Hill, 2000
3. Urich Rembold, "*Computer Integrated Manufacturing Technology and System*," 1995

Course Objectives :

1. To deliver the knowledge of advance concepts and implementation of Industrial Automation and Robot programming.

2.To provide the basic understanding of Hydraulic and Pneumatic systems, SCADA and DCS systems and Robotics systems use in modern industries.

3. To acquire knowledge of various power systems in industries, Industrial distribution systems, buses, protocols, Electrical controls of motors etc.

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	Demonstrate how CIM knowledge is useful in engineering and consumer products in day-to-day life.	III	Applying
CO2	Estimate continuous-time control using software for the manipulation, transmission, and recording of data.	IV	Analyzing
CO3	Decide suitable actuators and sensors and integrate them with embedded control systems.	V	Evaluating
CO4	Design static and dynamic logic systems used for combinational, synchronous and asynchronous sequential logics.	VI	Creating

CO-PO Mapping :

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1						M						M	H	
CO2		M											M	M
CO3				H								L		L
CO4			H						H					

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.

IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

1. Various features of Gripper system in Robot 2. Various Robot programming parameters 3. Robot programme for simple pick and place 4. Robot programming for complex pick and place 5. Robot programming for simple palletization 6. Robot programming for complex palletization 7. Robot programming for comparison of two or more jobs 8. Study, designing system and demonstration of robot anatomy 9. Study, designing system and demonstration of various drive systems used in robotics 10. Study, designing system and demonstration of various sensors used in robot 11. Study, designing system and demonstration of various mechanisms, ball screws etc. used in robot	

Open Electives Courses

Title of the Course: Automobile Engineering, Course Code:1OE429	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

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

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

Course Objectives :

1. To make students familiar with various basic systems of a modern automobile.
2. To introduce the mathematical treatments required for vehicle performance and for some of important systems such as steering system and brake system.
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	Bloom's Cognitive Descriptor
CO1	Comprehend about various automotive systems and recent trends in automobile design, development, manufacturing and assembly.	II	Understanding
CO2	Relate concepts of vehicle dynamics with daily experiences.	III	Applying
CO3	Analyze acceleration, barking and steering performance of a vehicle in different driving conditions.	IV	Analyzing
CO4	Compare automobile systems based on their construction, working and performance.	V	Evaluating

CO-PO Mapping :

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1		M	L								L		H	
CO2	H	H		L									M	M
CO3		H		M								L		L
CO4		M		L	L									

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction, classification and Automotive power plants	**6 Hrs.**
Introduction, Broad classification of Automobiles. Major components and their functions. Types of vehicle layouts, Types of bodies. Requirements of automotive power plants, Comparison and suitability considerations. Electric and Hybrid vehicles- Layout, advantages and limitations.	
Module 2 Vehicle Performance	**7 Hrs.**
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.	
Module 3 Transmission System	**7 Hrs.**
Automobile clutch requirements, Types & functions, Single plate, Multi plate, Centrifugal and Fluid clutches. Requirements of gear box, Types of gearboxes, construction and Working Principle of operation of automatic transmission, Torque converter, Epicyclic gear train, Construction and working of Propeller shaft, Universal joint, Final drive, Differential, Rear axles.	
Module 4 Suspension and Steering System	**7 Hrs.**
Suspension requirements, Sprung and Un sprung mass, Types of automotive suspension systems. Conventional and Independent, Shock absorber, Types of springs, Hotch- kiss and Torque tube drive, Reaction members-Radius rods, Stabilizer bar, Air suspension system. Function of steering, Steering system layout, Automotive steering mechanism, Types of steering gear boxes, Condition for true rolling, Steering geometry-Camber, Caster, King pin inclination, Toe-in and Toe-out, Wheel alignment, Slip angle, Under steer & over steer conditions, Introduction of power steering,	
Module 5 Braking and Electrical System	**7 Hrs.**
Function of automotive brake system, Types of braking mechanism, internal expanding & Disc brake, Mechanical, Hydraulic & Air brake system, Servo and power brakes, Calculation of braking force required, stopping distance and dynamic weight transfer Automotive batteries, Automotive lighting system, Starting system, Charging system, Voltage and current regulator, Electric horn, Dash board gauges, Wiper & side indicator circuit, Engine electronic control modules, Safety devices.	
Module 6 Recent trends in Automotive Development	**6 Hrs.**
NVH and crashworthiness of vehicles, Emission norms and control, automotive electronics, Automotive manufacturing and assembly, material and vendor management, Testing and certification of vehicles	

Module wise Measurable Students Learning Outcomes :

Students should be able to

1. To select proper engine for given vehicular application
2. To analyze vehicle performance

3. To discuss various types of transmission systems
4. To relate concepts of vehicle dynamics with daily experiences
5. To calculate braking performance of the vehicle in different conditions
6. To comprehend recent trends in automobile development

Title of the Course: Energy Modeling and Management, Course Code: 1OE430	L	T	P	Cr
	3	**0**	**0**	**3**

Pre-Requisite Courses:

Textbooks:

1. Ari Rabl, "*Active solar collectors and their applications*", Oxford university press, First edition, 1985.
2. Bureau of Energy Efficiency " *General aspects of energy management*" Ministry of power govt of India, 2007
3. J K Nayak "*Hand book on Energy conscious buildings*", Solar energy centre, First edition, May 2006

References:

1. Solar Energy by S P Sukahtme, Mcgraw hill education , third edition2005
2. John Twiddle, Renewable Energy reources, Taylor and Francis, Second edition2005.
3. W F Stocker "*Design of thermal system*" McGraw Hill, 1981

Course Objectives :

1. To describe performance assessment in various devices.
2. To explain different types of co-generation systems.
3. To teach principal components and types of industrial heat recovery systems.
4. To explain parameters to check performance of solar and wind energy systems.
5. To narrate energy conservation opportunities in buildings and model the energy systems.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Recognize the energy conservation opportunities in co-generation and waste heat management	I	Remember
CO2	Distinguish the heat and comfort conditions in various structures	II	Understand
CO3	Estimate solar and wind energy available	IV	Analyzing

CO-PO Mapping :

Civil

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1					**M**				**L**				**H**	
CO2							**L**		**L**				**M**	**M**
CO3					**L**		**L**		**L**					**L**

Electronics

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1						M				L			H	
CO2				L		L				L			M	M
CO3				L		L				L				L

Electrical

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1								L		L			H	
CO2				L						L			M	M
CO3				1				L		L				L

Computer Science

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1				L	L								H	
CO2				L	L								M	M
CO3				L										L

Information Technology

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1				L				L					H	
CO2				L									M	M
CO3				L				L						L

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Performance assessment of equipments and utility systems:	**Hrs.**
Conservation of energy and resources, carbon foot prints, Kyoto protocol, Steam distribution systems, steam traps. Simple HVAC system, COP, Energy efficiency ratio, power ton, Energy consumption and performance assessment of mechanical devices such as water pumps, fans, blowers, compressors.	**5**
Module 2 Waste Heat recovery and Insulation:	**Hrs.**
Commercial devices recuperators, regenerators, heat pipe and its Applications. Economizer shell and tube heat exchanger. Effect on efficiency due to heat recovery devices. Types of insulation material, High medium and low temperature insulators, cost of insulation, cost of heat leakage, and Economic thickness of insulation.	**7**

Module 3 Co-generation:	**Hrs.**
Need of co-generation, Co-generation for steam turbine, gas turbine and IC Engine. Use of low-grade energy with the help co-generation, Topping and bottoming cycles in Co-generation. Heat power ratio, Power output, Overall Efficiency (Numerical) Load patterns, performance assessment, Case study, Analysis of co-generation systems.	**7**
Module 4 Simulation of solar systems:	**Hrs.**
Solar energy incident on tilted plane. Types of active collectors. Steady state performance analysis of solar flat plate collector, Optical efficiency, Over all heat transfer coefficient, Collector heat removal factor, Collector efficiency, Transient analysis, Steady state performance analysis of concentrating collector programming using software,	**7**
Module 5 Conservation of energy in buildings and Wind Energy Conversion Systems:	**Hrs.**
Embodied energy of building material, Solar energy incident of building, Human comfort conditions and energy balance. Energy conservation opportunities in buildings. Wind speed and Weibull distribution function. Wind m/c coupled to pump. Constant speed and constant torque machines, Optimum blade theory. Numerical.	**6**
Module 6 Modeling and analysis	**Hrs.**
Constrained and unconstrained optimization of energy systems, Simulation wind station for annual energy output. Modeling for solar geometry using software, Modeling for solar FPC with storage. Simulation for estimating wind power. Economic comparison of investment in solar, biomass and wind energy based on Life cycle savings, internal rate of return and payback period.	**7**

Module wise Measurable Students Learning Outcomes :

Student should be able to

1. Summarize about energy sources, supply and demand.
2. Explain of different co-generation
3. Estimate performance of different solar devices
4. Recognize of different wind m/c and its energy output
5. Explain the Energy conservation opportunities
6. Understand the economics of and energy modeling

Title of the Course: Aerospace Engineering, Course Code: 1OE431	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

(1) ShevellR.S., "Fundamentals of flights," Pearson education, 2004

(2) Houghton E. L. and Carruthers, N. B,"Aerodynamics for Engineering Students," Edward Arnold Publisher, 1989

(3) Howard D Curtis, "Fundamentals of Aircraft Structural Analysis," WCB-McGraw Hill, 1997.

Reference Books:

(1) Anderson J.D., "Introduction to Flight," McGraw Hill, 1995

(2) McKinley J.L. and R.D. Bent, "Aircraft Power Plants," McGraw Hill, 1993.

(3) George M. Siouris, "Missile Guidance and Control Systems," Springer-Verlag, New York, 2000.

Course Objectives:

1. To provide concepts related to aircraft engine, structure and flight dynamics.
2. To deliver knowledge about design and manufacturing of aero vehicles.
3. To make the students aware of Economics, flight and maintenance management in Aerospace Industry
4. To develop skills in the analysis of aero-vehicles for lifelong learning.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Tell basics of aircraft, rockets and missiles, their construction and functions.	I	Remembering
CO2	Describe aerodynamics, flight dynamics, optimization of performance of multi-stage rockets and separation dynamics of rockets and missiles.	II	Understanding
CO3	Execute the thermal and production systems to decide the various parameters and processes related aero vehicles	III	Apply
CO4	Analyze the design and manufacturing of aero vehicles	IV	Analyze

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1				M									H	
CO2			H									L	M	M
CO3			M					L						L

3

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]

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

ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Early flying vehicles, Components of an airplane and their functions, Aero-electronics, Aero thermodynamics, Aero fluid mechanics, Aero-manufacturing technologies	**7**
Module 2	**Hrs.**
Aircraft engine and instrumentation systems, Flight dynamics, Aircraft structures, Aerodynamics, Air breathing propulsion	**6**
Module 3	**Hrs.**
Vibrations and Elements of aero-elasticity, Automatic control systems, Spacecraft technology, Aero-foil theory, Wing theory, Aircraft lighting	**7**
Module 4	**Hrs.**
Theory of plates and shells, Fatigue and fracture mechanics, Aircraft materials, Selection of materials for aircraft and rockets	**6**
Module 5	**Hrs.**
Helicopter aerodynamics, Rocket and missile technology, Combustion engineering, Cryogenics, Communication and navigation systems	**7**
Module 6	**Hrs.**
Economics and Principles of management, Airframe maintenance and repair, Air transportation and Aircraft maintenance management, Modern aerospace Industry	**6**

Module wise Measurable Students Learning Outcomes :

Students should be able to

1. Explain the basic concepts of Aerospace mechanisms.
2. Summarize the basics of aircraft structures, systems and instruments.
3. Understand the design, performance and testing aspects.
4. Focus on design principles, performance, materials selection and testing of rockets and missiles.
5. Explain the combustion and propulsion systems in rocket.
6. Manage economics of aerospace Industries.

EVEN Semester

Credit System and Evaluation Scheme

Professional Core (Theory) Courses

Title of the Course: Engineering Management, and Ethics 3IC 401	L	T	P	Cr
	4	0	0	4

Textbooks:

1. Management: Theory and Practice; A.I.T.B.S. Publishers, Delhi. - N.C. Jain, Saakhshi
2. Principles and Practice of Management - L.M. Prasad
3. Principles of Management; Himalaya Publishing House - T. Ramasamy
4. Modern micro economic theory – H.L. Ahuja, S.Chand.
5. Engineering economics – Sullivan, Wicks, Koelling – Pearsons.

References:

1. Principles of Management; P.C. Tripathi and P.N. Reddy, Tata McGraw Hills Pub. Company Ltd.,
2. Business Management; - J. C. Sinha, V. N. Mugata, S. Chand & Co., New Delhi
3. Principles of Management - Koontz and O'Donnell
4. Management: A Functional Approach - Joseph M. Putti
5. Stonier & Hague – A text book of economic theory, Pearson
6. Industrial organization and engineering economics – Banga and Sharma

Course Objectives :

1. To provide insight into management, economics and ethics.
2. To manage effectively business operations and project management teams.
3. To meet the challenges for contemporary professional practice; be able to adapt and solve the increasingly complex management problems faced by industry.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Perceive and describe key management theories and approaches, economics terminologies and organizational / business ethics.	**2**	**Understanding**
CO2	Grasp the market scenario and apply the principles of financial, production and Human Resource management.	**3**	**Apply**
CO3	Examine various cost factors for different alternatives in project situations and make optimal economic decisions.	**4**	**Analyzing**

CO-PO Mapping: Common to all branches**.**

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 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:

Module 1: Basics of Management	**Hrs.**
Management: Definition, objectives, Nature & importance of management, management approaches, principles of management, managerial roles & skills, Recent trends & challenges of management in Global scenario. Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory, X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs	**7**
Module 2: Principles of Management	**Hrs.**
Planning: Meaning, Importance, Planning process; Types of Plans - Objectives, Strategy, Policy, Procedure, Method, Plan vs. Programme, Decision making, types of decision, Decision-Making steps Forecasting methods **Organizing:** Definition, Nature & purpose, Principles, Process, Types and structure of organization **Staffing:** Nature & purpose, recruitment policies and selection procedure, Induction/orientation, carrier development, carrier stages & performance appraisal **Directing and Co-ordination:** Directing: Concept and importance, creativity & innovation, Elements of Directing - Supervision, Motivation (Theories), Leadership (styles & theories), Communication (Barriers to effective communication) Co-ordination: Concept and Importance, Limitations; Types- Internal and External; Co-ordination- the Essence of Management **Controlling:** Concept and importance, Limitations, process of controlling, Requirements of good control system, Types of control, Techniques of Control, Relationship between Planning and Controlling; Change Management	**12**
Module 3: Introduction to Functional areas as Marketing Management	**Hrs.**
Financial Management: Scope, Sources of finance, capital types, financial statements, balance sheets, Profit & Loss A/C **Production Management:** Objectives, Site selection & factors affecting site selection , plant layout (objectives, principles, merit & demerit of each type) **Human Resource Management:** Introduction, Importance, Functions of H.R.M, Job	**7**

evaluation & different types of evaluation methods, Recruitment Process- Selection, Training and Development- Methods, Performance Appraisal, Functions of Personnel Manager	
Module 4: Introduction to Engineering Economics	**Hrs.**
Introduction to Economics: Definition , Nature of economic problem, Scope, Difference between Microeconomics & Macroeconomics, Meaning of demand & supply, elasticity of demand, demand forecasting methods, market equilibrium, practical importance & applications of the concept of elasticity of demand, Economic evaluation of project by: (i) Present worth method (ii) Future worth method (iii) I.R.R. Method **Theory of production:** factors of production (meaning & characteristics of Land, Labour, Capital, Entrepreneur & organizations), law of variable proportion, return to scale, Internal and External economics and diseconomies of scale. **Cost -** Meaning, short & long run cost, fixed cost, variable cost, direct and indirect costs, total cost, average cost, marginal cost, concept of cash flow & revenue, break-even analysis **Theories of demand** – Law of demand & supply, Cardinal Utility, indifference curve, Consumer equilibrium, consumer surplus, Revealed preference approach	**14**
Module 5: Market Structure	**Hrs.**
Market : Definition, types of market their characteristics, (Perfect competition, Monopoly, Oligopoly, Monopolistic competition), Role of demand & supply in price determination imperfect competition **National Income** – Definition, concept of national income, Methods of calculation, Meaning of GNP, GDP, GNI, NNP, NDP, NNI, Green GDP, PCI, Types, Causes and effects of Inflation, measures to control.	**6**
Module 6: Ethics in Business/ Professional ethics	**Hrs.**
Business Ethics: Need, Concept and elements, importance, characteristics & principles of business ethics, advantages of managing ethics in workplace, Ethics in business, Role of ethics in organizational culture, Challenges of business ethics and corporate leadership, Ethical principles in business – Indian perspective	**6**

Professional Core (Lab) Courses

Title of the Course: Project II , Course Code : 3ME492	L	T	P	Cr
			20	**10**

Textbooks: - Suitable books based on the contents of the project selected.

References: - Suitable books based on the contents of the project selected and research papers from reputed national and international journals and conferences.

Course Objectives :

1. To help students to identify real life needs and discuss project requirements.
2. To give technical solutions through latest design & development tools.
3. To direct students to compare and analyze the IT platforms for efficient solutions.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Integrate project at each stage of the software development life cycle	IV	Analyzing
CO2	Recommend project plans that address real-world challenges. Develop successful software projects that support program's strategic goals and satisfies the customer needs	V	Evaluating
CO3	Integrate project at each stage of the software development life cycle	VI	Creating

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**
CO1	H								H			H	H	
CO2			H						H		H		M	L
CO3		H						H						L

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.
IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Progress of the project	Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Progress of the project	Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Progress of the project	Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Progress of the project	Course faculty / Examiner	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.
Project activities and performance shall include literature review. Problem statement, presentation / drawings / modelling / programming / simulation and other activities, suitable for the nature and the requirements of the project.

ISE are based on presentations, demos & seminar etc.
ESE: Assessment is based on 100% implementation, execution & validation.

Course Contents

Project group should submit workable project at the end of second semester.
Project report should be prepared submitted along with soft copy (with code, PPT, PDF, Text report document & reference material).
Students should maintain a project log book containing weekly progress of the project.

Title of the Course: Skill Based Learning Course Code:3ME493	L	T	P	Cr
	0	**0**	**0**	**1**

Textbooks: Not applicable.

Reference books: Not applicable.

Course Objectives :

In this course the student performance in co-curricular and extra-curricular activities over four years will be considered.

The institute, state, national and international level activities are like technical events, Sports, Cultural, Social, and Students Club etc. These activities help the students to develop leadership skills, team integrity, coordination skills, Time management, Communications skills, Interviewing skills etc. These activities help the students to know his or her intelligence. The evaluation will be done by the mentor who is mentoring the student during graduation period.

Course Learning Outcomes:

CO	After the completion of the course the student should be able	Bloom's Cognitive	
		Level	Descriptor
CO1	Notice an improvement in his understanding and presentation skills.	II	Understanding
CO2	Understand and value the importance of working in a diversified team.	II	Understanding
CO3	Demonstrate the soft skills like presentation skills, technical report writing etc.	III	Demonstrating

CO-PO Mapping :

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO-1**	**PSO-2**
CO1								L					**L**	**L**
CO2									M					**M**
CO3							L						**M**	

Assessments :

Event	Details	1st prize	2nd Prize	3rd Prize	Participation
Technical events, Sports, Cultural, Social,	National	30	25	20	15
	State	25	20	15	10
	Inter college	10	08	06	04
Students Club	President, Vice President, Treasurer, Secretary	10			
	Member/volunteer	05			

The proctor faculty will be mentoring a given student batch for the duration of four years. The students shall submit proof of their achievements in various extra and co-curricular activities from First year to Final year. The faculty will evaluate the students' performance at the end of 8th semester, based on the rubrics provided by department from time to time.