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SHIVAJI UNIVERSITY, KOLHAPUR

A Revised syllabus of

(B.E. Mechanical Engineering)

Structure (Semester III to VIII)

and

Syllabus of

Semester (III and IV)

To be introduced from Academic Year 2014-15

i.e. from June 2014 Onwards

(Subject to the modifications will be made from time to time)

SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of S.E. (MECHANICAL ENGINEERING) **Semester III**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2014-2015

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs	TP	TW	OE	POE	Total Mark
1	Engineering Mathematics - III	3	1	-	4	100	25	-	-	125
2	*Electrical Technology	3	-	2	4	100	25	-	-	125
3	Applied Thermodynamics	3	-	2	5	100	25	-	25	150
4	Metallurgy	3	-	2	5	100	25	25	-	150
5	Fluid Mechanics	3	-	2	5	100	25	-	25	150
6	Machine Drawing	--	--	2	2	-	25	-	-	25
7	Computer Graphics	--	--	2	2	-	25	-	-	25
8	*Computer Programming Using C++	-	--	2	1	-	25	-	-	25
9	Workshop Practice - III	-	-	2	2	-	25	-	-	25
Total		15	01	14	30	500	225	25	50	800

L: Lecture, T: Tutorial, P: Practical, TP: Theory Paper, TW: Term Work, OE: Oral Exam. , POE: Practical and Oral Exam.

*** Practical's to be conducted alternate weeks. For Electrical Technology And computer Programming C++ Term work assessment consist of 25 marks for each Electrical Technology And computer Programming C++ separately. And combined marks out of 50 obtained by each student should be forwarded to Shivaji University, Kolhapur**

HIVAJI UNIVERSITY, KOLHAPUR,

Structure of S.E. (MECHANICAL ENGINEERING) **Semester IV**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2014-2015

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Applied Numerical Methods	3	-	2	5	100	25	-	-	125
2	Analysis of Mechanical Elements	3	-	2	5	100	25	-	-	125
3	Fluid and Turbo Machinery	3	-	2	5	100	25	-	25	150
4	Theory of Machines – I @	3	-	2	5	100	25	-	-	125
5	Machine Tools and Processes	4	-	-	4	100	-	-	-	100
6	Testing and Measurement	-	-	2	2	-	25	25	-	50
7	Computer Aided Drafting	-	-	2	2	-	50	-	-	50
8	Workshop Practice - IV	-	-	2	2	-	25	-	50	75
Total		16	00	14	30	500	200	25	75	800

L: Lecture, T: Tutorial, P: Practical, TP: Theory Paper, TW: Term Work, OE: Oral Exam. , POE: Practical and Oral Exam.

@ Theory paper of 04 (four hour) Durations
Unless mentioned, theory paper examination duration 3 hours

SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of T.E. (MECHANICAL ENGINEERING) **Semester V**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2015-2016

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Control Engineering	3	-	2	5	100	25	-	-	125
2	Theory of Machine - II	3	-	2	5	100	25	25	-	150
3	Heat and Mass Transfer	3	-	2	5	100	25	-	25	150
4	Machine Design - I	3	1	-	4	100	25	-	-	125
5	Manufacturing Engineering @	3	-	2	5	100	25	-	-	125
6	CAD/CAM Laboratory	-	-	2	2	-	25	-	25	50
7	Professional Skill Development	1	-	-	1	-	25	-	-	25
8	Workshop Practice - V	-	-	2	2	-	25	-	-	25
9	Mini-Project- I	-	-	1	1	-	25	-	-	25
Total		16	01	13	30	500	225	25	50	800

L: Lecture, T: Tutorial, P: Practical, TP: Theory Paper, TW: Term Work, OE: Oral Exam. , POE: Practical and Oral Exam.

@ Theory paper of 04 (four hour) Durations

Unless mentioned, theory paper examination duration 3 hours

SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of T.E. (MECHANICAL ENGINEERING) **Semester VI**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2015-2016

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Industrial Management and Operation Research	3	1	-	4	100	25	-	-	125
2	Industrial Fluid Power	3	-	2	5	100	25	-	-	125
3	Metrology and Quality Control	3	-	2	5	100	25	25	-	150
4	Machine Design - II	3	1	-	4	100	25	25	-	150
5	Internal Combustion Engines	3	-	2	5	100	25	-	25	150
6	Computer Integrated Manufacturing Lab	-	-	2	2	-	25	-	-	25
7	Seminar	-	-	2	2	-	25	-	-	25
8	Workshop Practice -VI	-	-	2	2	-	25	-	-	25
9	Mini-Project- II	-	-	1	1	-	25	-	-	25
Total		15	02	13	30	500	225	50	25	800

L: Lecture, T: Tutorial, P: Practical, TP: Theory Paper, TW: Term Work, OE: Oral Exam. , POE: Practical and Oral Exam.

SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of B.E. (MECHANICAL ENGINEERING) **Semester VII**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2016-2017

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Refrigeration and Air Conditioning	3	-	2	5	100	25	-	25	150
2	Mechanical System Design	3	-	2	5	100	25	25	-	150
3	Finite Element Analysis	3	-	2	5	100	25	-	-	125
4	Elective I	3	-	2	5	100	25	-	-	125
5	Elective II	3	-	2	5	100	25	-	-	125
6	Industrial Training @	-	-	-	0	-	50	-	-	50
7	Project Phase -I	-	*1	2	2	-	50	25	-	75
Total		15	01	12	27	500	225	50	25	800

* The contact hours will be in the above proportion for faculty guiding more number of groups.

Sr. No.	Elective I	Elective II
1	Experimental Mechanics	Total Quality Management
2	Human and Professional Ethics	Industrial Product Design
3	Automobile Engineering	Advanced Forming Processes
4	Computational Fluid Dynamics	Design of Thermal Systems
5	Process Equipment Design	Smart Materials
6	Advanced Foundry Processes	Design for Sustainability
7	Introduction to Aircraft Systems	Flexible Manufacturing Systems

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@ Industrial training of minimum two (2) weeks should be done after T.E. (II) in summer vacation and it's assessment will be done in B.E. (I) based on report submitted Work load of the assessment can be assigned to the project seminar guide.

SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of B.E. (MECHANICAL ENGINEERING) **Semester VIII**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2016-2017

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Mechatronics	3	-	2	5	100	25	25	-	150
2	Energy and Power Engineering	3	-	2	5	100	25	-	-	125
3	Noise and Vibration	3	-	2	5	100	25	25	-	150
4	Elective III	3	-	2	5	100	25	-	-	125
5	Elective IV	3	-	2	5	100	25	-	-	125
6	Project Phase -II	-	*2	4	4	-	50	75	-	125
Total		15	02	14	29	500	175	125	00	800

* The contact hours will be in the above proportion for faculty guiding more number of groups.

Sr. No.	Elective III	Elective IV
1	Industrial Engineering	Industrial Automation and Robotics
2	Production Management	Cryogenics
3	Fracture Mechanics	Enterprise Resource Planning
4	Reliability Engineering	Micro Electro Mechanical Systems
5	Advanced I.C. Engine	Advanced Refrigeration
6	Machine Tool Design	Tribology
7	Design of Aircraft Systems	Precision Engineering

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SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
1. REFRIGERATION AND AIR CONDITIONING

Teaching Scheme:
Lectures: 3 Hrs. Per Week
Practical: 2 Hrs. Per Week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks
Practical and Oral Exam: 25 Marks

Course Objectives:
The course aims to:

1. Study basic refrigeration cycles and Psychrometry.
2. Performance Evaluation of Refrigeration and Air Conditioning Systems
3. Enable the students to analyze and solve refrigeration related problems by applying principles of mathematics, science and engineering

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Demonstrate an understanding of the need and importance of HVAC technology, the typical and some advanced and innovative schematic designs, and the goals of HVAC engineering and HVAC systems.
2. Demonstrate an understanding thermal comfort conditions with respect to temperature and humidity and human clothing and activities and its impact on human comfort, productivity, and health.
3. Demonstrate an understanding of psychrometrics and its application in HVAC engineering and design and will practice or observe psychrometric measurements.
4. Demonstrate an understanding of heat transfer in buildings with a given architectural design and its application to heating and cooling load estimation especially including thermal lag effects by conducting a detailed annual load analysis for a representative building and present the results of this analysis in a formal report possibly including recommendations for energy conservation.
5. Demonstrate an understanding of the engineering and operation of vapor compression and possibly heat-driven refrigeration systems and evaporative cooling systems and understand contemporary issues of ozone depletion and global warming potential with respect to refrigeration systems.

Unit 1
Application of Second Law of Thermodynamics **[03]**

A Refrigerating Machine – The Second Law Interpretation, Energy Ratios (EER), BEE star rating COP, Power Consumption of a Refrigerating Machine, Refrigeration Cycle, vapour as a Refrigerant in Reversed Carnot Cycle Limitations of Carnot Cycle with Gas as a Refrigerant, Reversed Brayton or Joule or Bell Coleman Cycle, Introduction to aero-plane air conditioning cycles (Only Theory)

Unit 2

Vapour Compression System [08]

Limitations of Reversed Carnot Cycle with vapour as a Refrigerant, Dry versus Wet Compression, Throttling versus Isentropic Expansion, Vapour Compression Cycle, Pressure Enthalpy Diagram and Calculations and effect of Operating Conditions, effect of Evaporator Pressure Effect of Condenser Pressure, effect of Suction Vapour Superheat, effect of Liquid Sub cooling, Using Liquid- Vapour Regenerative Heat Exchanger, Actual Vapour Compression Cycle.

Removal of flash gas, Flash intercooling, Multistage, Multi evaporator and cascade system, Choice of Intermediate Pressure , System Practices for Multistage Systems (Simple analytical treatment) , Introduction to cryogenic Engineering and applications, Claude Cycle, Linde Cycle

Unit 3

Refrigerants and Refrigeration Equipment [09]

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. Environmental Protection protocol and India's commitment. ASHRAE nomenclature.

Insulation, types and different applications, properties of ideal insulations.

Compressor, Condenser, Evaporator, Expansion devices, Types, selection. Component balancing, safety devices and refrigeration controls.

Applications of Refrigeration, Ice plant, Cold storage, Dairy plant

Unit 4

Psychrometry and Human Comfort [09]

Moist air as a working substance, Psychrometric properties of air, Use of Psychrometric tables and charts, Processes, Combinations and Calculations, ADP, Coil Condition lime, Sensible heat factor, Bypass factor, Air washer and it's applications.

Thermal exchange between human body and environment, factors affecting comfort, effective temperature comfort chart, ventilation requirements.

Unit 5

Heating and Cooling loading calculations [05]

Design of air conditioning systems, different Heat sources,- Adiabatic mixing of two air streams, sensible heat factor, RSHF, GSHF, ERSHF, Room apparatus dewpoint and coil apparatus dew point, Ventilation and infiltration, Inside andOutside Design condition.

Cooling Load estimation, Introduction to Unitary Products viz. Room/Split and Packaged Air Conditioners, Central air conditioning systems, Variable Refrigerant Flow systems, VAV control systems, Inverter Units.

Unit 6

Air Distribution System [06]

Re-circulated air, Ventilation air, Duct work, Use of friction loss and rectangular equivalent of round duct chart, duct system, principle of duct sizing, and air distribution it's norms, diffusers, dampers, layout, duct systems for theaters, auditorium, hospitals, assembly shop etc.,

Energy Conservations and Green Buildings, Freeze drying, Pharmaceutical and hospital air conditioning, textile, car air conditioning (plant layout, system components and design conditioning)

Term Work:

1. Study of various conventional and Nonconventional methods of refrigeration.
2. Study and demonstration of refrigeration system. (water cooler, refrigerators, chiller, ice plant and cold storage).
3. Study of Refrigeration tools.
4. Trial on Refrigeration Test Rig.
5. Trial on heat pump test rig.
6. Study and trial on vapour absorption system
7. Trial two stage cascade system.
8. Trial on ice plant test rig
9. Study and demonstration on air conditioning systems. (Unitary and central air conditioning / system)
10. Trial on window air conditioner or Air Conditioning Test Rig
11. Study or demonstration of dehydration, charging leak testing and testing of refrigeration system with trouble shooting.
12. Study and demonstration of controls and safety devices in refrigeration and air conditioning.
13. Visit to central air conditioning or cold storage or dairy plant to ice plant related with refrigeration and air conditioning system.
14. Market survey of various refrigeration and air conditioning systems which include the equipments with related specifications, manufacturers, cost and comparison with respect to tonnage, coat and presentation of report in the laboratory.

(Three trials and market survey report is compulsory/ Total 10 are compulsory)

Reference Books:

1. "Basic Refrigeration And Air Conditioning", P N Ananthanarayan Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, (1981).
2. "Principles of Refrigeration" Roy J. Dossat, Pearson Education, 4th Edition.
3. "Refrigeration and Air Conditioning",Stoker.
4. "Refrigeration and Air Conditioning", Arora Domkundwar, Pearson Education,3rd Edition.
5. "Refrigeration and Air Conditioning",V. K. Jain.

6. “Air Conditioning Principles and Systems”,Pita, Prentice Hall of India Publisher, 4th Edition.
7. “Air Conditioning Applications and Design”,W. P. Jones, Elsevier, 2nd Edition.
8. “Air Conditioning Engineering”,W. P. Jones,Elsevier,5th Edition .
9. “Thermal Environmental Engineering”, Tnerellaild Prentice Hall of India Publisher, 3rd Edition.

Text Book:

1. “Refrigeration and Air Conditioning”, C. P. Arora, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1981,2nd Edition.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
2. MECHANICAL SYSTEM DESIGN

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hrs/Week

Examination Scheme:
Theory Paper: 100 marks
Term Work: 25 marks
Oral Exam: 25 marks

Course Objectives:
The course aims to:

1. Study the concept of aesthetics, ergonomics and creativity considerations in product design.
2. Study design of various mechanical systems such as pressure vessel, brakes, clutches, machine tool gear box, I.C. Engine components etc.
3. Study the concepts of optimization of mechanical systems /elements.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Incorporate aesthetic, ergonomic and creativity considerations in industrial product design.
2. Design different systems such as Pressure vessel, Brakes, Clutches, Machine tool Gear box and I. C. Engine Components etc.
3. Optimize design of various components/systems in mechanical engineering
4. Use IS Codes, Design data books, Handbooks required for system design .

Unit 1
Aesthetic and Ergonomic Consideration in Design: [06]
Basic types of product forms, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry, Contrast etc. Morgon's colour code.Ergonomic considerations-Relation between man, machine and environmental factors.Design of displays and controls.Practical examples of products or equipments using ergonomics and aesthetic design principles.Creativity concept in designing.

Unit 2
Pressure Vessel Design: [07]
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 and nozzles in shell and covers. Types of pressure vessel support.

Unit 3
Design of Braking and Clutch System. [07]
A) Brakes: Design consideration in brakes, Band, Internal expanding shoe, External contracting shoe. Thermal consideration and rating of brakes.

B) Clutches: Design requirement of friction clutches, Selection criteria. Torque transmitting capacity of single plate, Multidisc clutch, Cone clutch and Centrifugal clutch.

Unit 4

Design of Gear boxes for machine tool applications [07]

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

Unit 5

Design of I. C. Engine Components [07]

Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, Design of cylinder liners, Design of piston and piston-pins, Piston rings, Design of connecting rod, Design of crank-shaft and crank-pin.

Unit 6

Optimum Design [06]

Objectives of optimum design- Johnsons Method of Optimum Design (MOD), Adequate and optimum design. Primary, Subsidiary and Limit equations- Optimum design with normal specifications of simple machine elements like tension bar, transmission shaft, helical spring. Introduction to optimum design with Langrange Multiplier.

Term Work:

1) A detail design report and A2 size sheet containing working drawing of detail and assembly of the following
   a) Design of Machine Tool Gear Box.(Three Stage, Twelve speed gear Box)
   b) Pressure vessel design/ Brake design or Clutch design.
2) Assignment based on
   a) Aesthetic and Ergonomic design consideration –case study
   b) Problems on Optimum design.
   c) Minimum four Problems on Design of IC Engine components. such as connecting rod, crank shaft, piston with piston rings and pins, cylinder and cylinder head.

Text Books:

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

Reference Books

1. "Handbook of Gear Design",Jitin Maitra,Tata Mc-Graw Hill Publication.
2. "Machine Design", Black P.H.and O.Eugene Adams, Tata Mc- Graw Hill Publication.

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

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
3. FINITE ELEMENT ANALYSIS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term work: 25 Marks

Course Objectives:
The course aims to:

1. Define the basic finite element formulation techniques.
2. Derive the finite element equations for 1d, 2d and 3d problems.
3. Formulate and solve basic problems in heat transfer, solid mechanics and fluid mechanics.
4. Develop the computer program based on finite element methods.
5. Use commercial software's to solve basic engineering problems in heat transfer, solid mechanics and fluid mechanics.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Elaborate the fundamental concepts, equations of equilibrium, Stress-strain relations and the principle of potential energy and approximations of differentials equations.
2. Develop the key concepts of finite element formulations by considering the 1D problem just as Shape function, element stiffness and boundary conditions.
3. Apply the finite element formulations for two dimensional plane stress and plane strain problems using constant strain triangle.
4. Demonstrate the modelling aspects of axisymmetric solids subjected to axisymmetric loading.
5. Understand the Galerkin formulation for steady state heat transfer, torsion and potential flow.

Unit 1 Fundamental Concepts **[07]**

Introduction, Past, present and future of FEA, stresses and Equilibrium, boundary conditions, strain-displacement relations, stress-strain relations, Temperature effects, Potential energy and equilibrium; the Rayleigh-Ritz method, Galerkins method, Saint-Venant'sprinciple, Von-Mises stress, Gauss elimination method.

Unit 2 One Dimensional Problem **[07]**

Introduction, Finite element modeling (element division, numbering scheme), coordinates and shape functions, the potential energy approach (element stiffness matrix, force terms), Galerkin approach (element stiffness matrix, force terms),Assembly of the global stiffness matrix and load vector, properties of K, the finite element equations; treatment

of boundary conditions (types of boundary conditions, elimination approach, penalty approach (Theoretical concept only), multipoint constraints, Quadratic shape functions.

Unit 3 Two-Dimensional Problems using Constant Strain Triangles [06]

Introduction, finite element modelling, Constant Strain Triangle (CST), Iso-parametric representation, potential-energy approach, element stiffness, force terms, Galerkin approach, stress calculations, Problem modelling and boundary conditions

Unit 4 Axisymmetric solids subjected to axisymmetric loading and Analysis of Trusses [08]

Introduction, Axisymmetric formulation, Finite element modelling, Triangular element, potential energy approach, body force term, rotating flywheel, pressure vessel, Galerkin approach, stress calculations.
Trusses:-Plane trusses, Local and Global coordinate systems, formulas for calculating L and M, element stiffness matrix, Stress Calculations, Assembly of global stiffness matrix.

Unit 5 Scalar Field Problems [05]

Introduction, steady state heat transfer, One dimensional heat conduction, One dimensional heat transfer in thin fins, Two dimensional steady state heat conduction, two dimensional fins.

Unit 6 Computer Implementation of the Finite Element Method: [07]

Pre-processing: Model definition – nodal coordinates element connectivity, material and element type and property definitions, type of analysis (static/modal), loading and boundary conditions. Meshing techniques- free and mapped meshing, Quality checks – aspect ratio, warp angle, skew, distortion, stretch, included angle, taper

Processing: Element level calculations, Equation assembly, Equation solver (sparse solvers, factorization, numerical/computational issues)

Post Processing: Strain and stress recovery (integration and nodal points), interpretation of results (results validation and data interpretation) and design modification

Term Work:

1. One assignment on past, present and future of FEA.
2. One assignment on Meshing – types of elements, choice of element, type of meshing – automatic, mapped, meshing in critical areas.
3. Finite Element Analysis of **Stepped bar** (Two or Three Steps only) using
a) Finite Element Approach (Theory)
b) Finite Element Software (ANSYS / ABACUS / NISA / NASTRANetc)
c) Computer Program using C or C++
Compare the results by above three methods in tabular form.

4. Use of any ONE Standard software packages like ANSYS, NISA, NASTRAN, HYPERWORKS
for solving following types of problems with snap shots of software (Any FIVE)

- Static Analysis of Truss
- Static Analysis of Beam
- Static Analysis of Plate with a circular hole
- Static Analysis of Wall Bracket
- Buckling Analysis of Column
- Analysis of 1D or 2D Fin

Text Books:

1. "Introduction to Finite Elements in Engineering", Chandrapatala, Belgundu, Prentice Hall of India, 3rd Edition.
2. "Finite Element Method with Application in Engineering" ,Y. M. Desai, T. I. Eldho, A. H. Shah, Pearson Education.
3. "Textbook of Finite Elements Analysis",P. Sheshu, Prentice-Hall of India Private Limited, New Delhi, 5th Edition.
4. "An Introduction to Finite Element Method",J. N. Reddy; Tata McGraw Hill International Editions, ISBN 0-07-112799-2, 2nd Edition.
5. "Finite Element Methods for Engineers",U.S. Dixit, Cengage Learning, 1st Edition.
6. "Finite Element Analysis – Theory and Practice", M.J. Fagan, Longman Scientific and Technical.

Reference Books:

1. "The Finite Element Method – Basic Concepts and Linear Applications" O. C, Zienkiewicz; Tata McGraw Hill International Editions; ISBN 0-07-084175-6.
2. "Practical Finite Element Analysis",N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A.N.Thite, Finite to Infinite Publication.
3. "Concepts of Finite Element Methods", Manicka Selvam, SCITECH publication.
4. "A First Course in the Finite Element Analysis" ,D.L.Logan, Cengage Learning.
5. "Finite Elements Analysis – Theory and Application with ANSYS", Sawed Moveni, Prentice-Hall of India, 2nd Edition.
6. "Applied Finite Elements Analysis", Larry J. Segerlind, BSP Books Pvt Ltd.

Website References:

1. University of Alberta Tutorials from Website.
2. NPTEL Videos Lectures Series.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
4. EXPERIMENTAL MECHANICS (ELECTIVE I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course Objectives:

The course aims to :

1. Introduce the concept of elementary elasticity and experimental stress analysis
2. Prepare mechanical engineering students for advanced graduate studies in various experimental stress analysis techniques like photo elasticity, strain gauge
3. Supply qualified personnel to meet the requirement of specialist in experimental stress analysis

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Analyze photo elastic technique to stress analysis
2. Explain the concept of strain gages and its applications
3. Elaborate the concept of coating methods.
4. Apply the knowledge of Moiré fringe method of stress analysis.

Unit 1 Principles of Experimental Approach- **[03]**

Introduction to Experimental Mechanics, advantages scope of Experimental Mechanics in design, various experimental methods of stress analysis and their relative merits and demerits

Unit 2 Two Dimensional Photoelasticity- **[11]**

- optics related to photoelasticity, temporary and permanent double refraction, principle of photoelasticity, method of photoelastic stress analysis
- stress optics law, material fringe value in terms of stress and strain, significance of material fringe value
- polariscope, its scope in photoelasticity, various configurations of polariscope
- effect of stressed model in plane and circular polariscope, isoclinics, isochrometics, their significance in photoelastic stress analysis, fringe order, use of white light in photoelasticity
- fractional fringe measurement methods- color matching techniques, compensation methods like babinet soleil compensation method and Tardy's method (Derivation)

Unit 3 Analysis of Photoelastic Data – **[06]**

Determination of direction of principal stress at a given point, determination of exact fringe order N and difference of principal stresses at a given point, shear difference method, oblique incidence method and electrical analogy method.

Photoelastic Materials - Criteria for selection, common photoelastic materials and their properties, Photoelastic sheet casting and model making, calibration of photoelastic material, calibration methods using circular disc

Unit 4 Strain Measurement Using Strain Gauges– **[07]**

Concept, meaning of strain gauge, desirable properties of strain gauges, types of strain gauges, comparison of various strain gauges Strain measurement using electrical resistance strain gauge –Introduction, principle, types, construction, materials used in construction, sensitivity, gauge factor, cross sensitivity, semiconductor strain gauge, comparison with electrical resistance strain gauge, advantages and limitations Selection and mounting of strain gauge, criteria for selection, mounting of gauge and checking its installation

Unit 5 Strain Gauge Circuitry – **[07]**

Wheatstone bridge circuit, its role in measurement of resistance change, condition for bridge balance, different configurations of Wheatstone bridge, output voltage of Wheatstone bridge, relationship between output voltage and strain, commercial strain indicators, potentiometer circuit. Introduction to strain gauge rosettes, two, three and four element rosettes, different configurations of rosettes and their comparison, determination of magnitudes and direction of principal stresses when principal stress directions are specified and not specified. Transducer applications of strain gauge

Unit 6 Coating Method and Moire Fringe– **[06]**

Brittle coating, Introduction, interpretation of crack pattern data, crack detection techniques, selection of brittle coating, advantages, Birefringent coating:- Limitations and applications, Introduction to Birefringent coating, use of reflection polariscope, merits and demerits

Introduction to Moiré fringe method of stress analysis – Mechanism of fringe formation, approaches to moiré fringe analysis, advantages, limitations and applications

Term Work:

Any Eight out of the following list

1. Bonding of strain gauge and checking its installation.
2. Determination of gauge factor for one arm sensitive and two arm sensitive configuration.
3. Determination of gauge factor for four arm sensitive and four arm sensitive two linear and two lateral configuration.
4. Transducer applications of strain gauge- determination of unknown weight using load cell.
5. Transducer applications of strain gauge – determination of unknown torque using torque transducer.
6. Study of photoelastic stress analysis – use of diffused light transmission polariscope.
7. Determination of fractional fringe order using Tardy's method.
8. Calibration of photoelastic materials - determination of material fringe value.
9. Separation of stresses using oblique incidence method.
10. Study of Moiré Fringe Technique.
11. Study of Brittle Coating Method.
12. Study of Photoelastic materials.

Text Books:

1. "Experimental Stress Analysis", Dr. Sadhu Singh; Khanna Publishers, 5th Edition.
2. "Experimental Stress Analysis", U.C. Jindal, Pearson Publications, 1st Edition.
3. "Experimental Stress Analysis", Abdul Muben; Dhanpat Rai and Co., 1st Edition.
4. "Experimental Stress Analysis", Vazirani, Khanna Publications.
5. "Stress Analysis and Experimental Techniques an Introduction",J. Srinivas, Narosa Publications.

Reference Books:

1. "Experimental Stress Analysis",J.W. Dally and W.F.Riley, Tata McGraw Hill Book Company, 3rd Edition.
2. "Principles of Experimental Stress Analysis", by American Society for Metals ,6th Edition.
3. "Experimental Stress Analysis", L.S.Srinath., Tata McGraw Hill.
4. "Experimental Stress Analysis", Dove and Adams Merrill, 1st Edition.
5. "The Strain Gauge Primer", Perry Listner McGraw Hill Book Company 2nd Edition.
6. "Moiré Fringes", Theocoris., Pergamon Press limited.
7. "Experimental Stress Analysis Principles and Method", by Holister G.S., Cambridge Engineering Services.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) Semester VII
4. HUMAN VALUES AND PROFESSIONAL ETHICS (ELECTIVE –I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term work: 25 Marks

Course Objectives:

The objective of the course is an exploration of human values which go into making a good human being, a good human society and a good life. The context is the work life and the personal life of modern Indian professionals. The movement to identify and romote the values shared by societies around the world is relatively new. It is only in recent years as globalization extended its reach to even remote corners of the earth that he need to refocus and build upon what we as a human society have in common, has become apparent. Increased contact between peoples and nations enhances awareness of our kinship and the shared code of ethics and conduct that underlies all civilization. It s he Human values that we must now promote to create a common vision and means for moving forward toward a more peaceful and sustainable world.

The course also aims to have students appreciate the vastness of the Universe and the wonder of its parts, and the philosophical significance of this for improving the quality of human life through value clarification.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Understand the role of cognitive and moral values in world views, by discussing and writing about the ethical implications of modern scientific and technological results
2. Recognize the difference between matters of fact and matters of value, while understanding the important ways in which facts influence value assessments and how value judgments shape our vision of "the facts"
3. Understand ethical methodologies and competency in ethical deliberation on rationally applying these methodologies to contemporary ethical questions related to scientific progress and technological power
4. Understand why ethics plays an important role in science and technology

Unit 1 Human Values **[08]**

The value-crisis in the contemporary Indian Society-The Indian system of values-Values in the Indian constitution-Aesthetic values: perception and enjoyment of beauty-Relative and absolute values-Morals- Values and Ethics – Integrity-Service – Work Ethic –Service Learning – Civic Virtue – Respect for Others –Respect for the Environment-Quest for Living Peacefully and happily–Attitude of Nonviolence-Innate dignity for human life – Bring out the best in oneself - caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality

Unit 2 Engineering Ethics **[06]**

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of

Professional Roles - theories about right action- Self-interest - customs and religion - uses of ethical theories.

Unit 3 Engineering as Social Experimentation [06]

Engineering as experimentation - engineers as responsible experimenters - Research Ethics - codes of ethics - a balanced outlook on law - the challenger case study

Unit 4 Safety [05]

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - The Government Regulator's Approach to Risk- the three mile island, Chernobyl and Bhopal case studies. Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime -.

Unit 5 Responsibilities and Rights [05]

Engineers responsibility, Professional rights - Employee rights - Intellectual Property Rights (IPR) - Discrimination

Unit 6 Global Issues [10]

Multinational corporations - Business Ethics -Environmental ethics –Role in Technological Development- computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -Honesty-moral leadership-sample codes of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE), India,etc.

Term Work:

The term work should be carried out with the methodology of Lecturess, group discussions (based on case studies), movies, field visits, essays and student self investigation sessions.

1. TEN modules based on the topics mentioned above and Including –

- Group Discussions based on Case Studies with Report/Essays .
- Undergoing the Art of Living's ***YES+ / Happiness Programme*** on the Awareness of Human Values conducted by Vyakti Vikas Kendra ,Bangalore in assistance with ***INTERNATIONAL ASSOCIATION OF HUMAN VALUES. (IAHV).***
- Visits (with report writing) to Public Institutes like Municipal Corporation,ZP, Co-op organizations, social clubs like charitable trusts, Waste Water/Air Pollution Control Plant, Slum Areas etc.
- Conduction of Health and Hygiene Awareness Camp for Society.
- Study of economic status of the society –Survey data collection, analysis and any suggestions.
- Study of impacts of technology on society.

Text Books:

1. "Professional Ethics and Human Values", M.P. Raghavan,Scitech Publications (India) Pvt Ltd.
2. "Human Values and Professional Ethics", Jayashri and Suresh B S ,S Chand .

3. “Ethics in Engineering”, Mike Martin and Roland Schinzinger, , Tata McGraw-Hill, New York, (1996).
4. “Engineering Ethics(Including Human Values)”,Govindarajan M, Natarajan S, Senthil Kumar V. S, Prentice Hall of India, New Delhi.
5. “A Textbook on Professional Ethics and Human Values”, Naagarazan, R.S. ,New Age Publishers .
6. “Professional Ethics and Human Values”,A Alavudeen,R Kalil Rahman M Jayakumaran ,Laxmi Publisher .
7. “Understanding Human Values :Individual and Societal”,Milton Rokeach ,Free Press Publication .
8. “Human Values” A N Tripathy, New Age International .
9. “A Foundation Course in Value Education”,R R Gaur,R Sangal,(2009).
10. “Science and humanism”, P L Dhar and R R Gaur, Commonwealth Publishers.
11. “Wisdom for The New Millennium”,H.H .Sri Sri Ravishankarji, founder ,Art of Living, Vyakti Vikas Kendra, Bangalore.
12. “The Monk Who Sold his Ferrari”,Robin Sharma, Jaico Publishing House .
13. “Mega Living”,Robin Sharma, Jaico Publishing House .
14. “The Story of Phillosophy”, W,Durant .
15. “The first and the Last Freedom”, Osho.
16. “Commentaries on living”, J Krishnamurti.
17. “The Rebirth of Buddha”, Ryuho Okawab Paperback –,Happy Science; 2nd (Revised) Edition., (2009).
18. “Speeches and writings of Swami Vivekananda; A Comprehensive Collection”,G. A. Natesan and Co., Madras.

Reference Books:

1. “Engineering Ethics”, Charles D. Fleddermann, Pearson Education / Prentice Hall of India , New Jersey, (Indian Reprint now available).(2004)
2. “Engineering Ethics –Concepts and Cases” Charles E Harris, Michael S. Protchard and Michael J Rabins, , Wadsworth Thompson Leatning, United States, (Indian Reprint now available), (2000).
3. “Ethics and the Conduct of Business”,John R Boatright, Pearson Education, New Delhi, (2003).
4. “Fundamentals of Ethics for Scientists and Engineers”, Edmund G Seebauer and Robert L Barry, Oxford University Press, Oxford.
5. “Business Ethics – An Indian Perspective”, Prof. (Col) P S Bajaj and Dr. Raj Agrawal, Biztantra, New Delhi, (2004).
6. “Science and the Human Prospect”, Ronald C. Pine Brave New World by Aldous Huxley.
7. “Society ,Environment and Engineering”, H R Mukhi , Birla Publications, New Delhi.
8. “Society, Environment and Engineering”, R Agor, Satya Prakashan,New Delhi.

Relevant CDs ,Movies ,Documentaries and Websites

- www.onlineethics.org, www.storystuff.com, www.iahv.org , www.5h.org , www.artofliving.org , www.ijhvpe.com,
- Al Gore,An Inconvinient Truth, Paramount Classics USA.
- Charlie Chaplin, Modern Times,United Artits ,USA.
- IIT Delhi, ModernTechnology-The Untold Story.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) Semester VII
4. AUTOMOBILE ENGINEERING (ELECTIVE –I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term work: 25 Marks

Course Objectives:
The course aims to:

1. Describe importance and basic knowledge of automobile engineering.
2. Classify various automobile layouts and bodies.
3. Demonstrate automobile systems, wheels and tyres and automobile electrical and electronic systems for understanding construction and working principle.
4. Enable students to analyze and solve problems on automobile system by focus and critical thinking.
5. Demonstrate use of modern trends, techniques and skill to fulfill industrial needs by arranging industrial visit.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Explain components of automobile.
2. Distinguish various types of automobile lay outs as per drive given to wheels.
3. Identify types of automobile bodies and materials used for the same.
4. Demonstrate various automobile systems like clutch, gearbox final drive, brake, steering suspension wheels and Tyres, and its construction and working.
5. Demonstrate various electrical and electronic systems like lighting, starting charging electronic controlled management system and its construction and working principle, sensors used in automobile
6. Solve the problems related with various resistances for the automobile, engine power calculation.
7. Explain modern trends, techniques used in industries.

Unit 1 Introduction [06]
Automobile history and development, Classification, vehicle layouts- engine location and drive arrangement, safety regulations, specifications of vehicles, Type of vehicle bodies, body parts and its advanced materials, Chassis types, constructional details, Types of Frames, sub frames, frameless vehicles, details of chassis material, Vehicle life development cycle overview.

Unit 2 Transmission System [06]
Clutch – Function and requirements, Classification, Construction and working of Single-plate, Multi-plate, Diaphragm spring and centrifugal clutches, Fluid flywheel.

Gear Box – Necessity, classification, construction of manual gear boxes like Sliding mesh, constant mesh, Synchromesh, Epicyclic gear train, Automatic transmission, Torque convertor, Electronic transmission control, Overdrive. Propeller shaft, Differential and final drive.

Unit 3 Steering and Suspension Systems [08]

Live and dead axles, live axle arrangement.

Steering systems, function, principle of steering, Ackerman and Davis, steering geometry, center point steering, cornering force, slip angle, scrub radius, steering characteristic, steering gearbox, power steering, collapsible steering.

Suspension system- Functions, Sprung and unsprung mass, Types of suspension linkages, types of spring - leaf, coil, air springs, telescopic shock absorber, hydro gas suspension, rubber suspension, interconnected suspension, self-leveling suspension (active suspension) Advances in suspension system, Air suspension

Unit 4 Brakes, Wheels and Tyres [07]

Brakes: Need, principle, types, Mechanical, hydraulic and pneumatic brakes disc and drum types, air brakes, servo and power braking, ABS, their relative merits, details of components, brake adjustments, defects and causes.

Wheels and Tyres: Wheel construction, alloy wheel, Types, tyre construction, tread design, specification, factors affecting tyre performance, tyre wear and its causes, wheel balancing.

Unit 5 Electrical and Electronic Systems [07]

Automotive batteries - lead acid batteries, Advances in batteries ,battery charging system, alternators, principle and operation of cutout and regulators, starter motor, Bendix drive, solenoid drive, magneto coil and solid stage ignition systems, lighting and electrical accessories, automobile air conditioning, panel board instruments. Electronic Controlled Management (ECM) Systems, Automobile wiring. Sensors used in automobile.

Unit 6 Performance of Automobiles [06]

Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Gradability and draw bar pull, Traction and Tractive effort, Distribution of weight, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio. (Numerical)

Term Work:

Minimum eight experiments from Group A and all experiments from Group B are to be performed.

Group A.

1. Study and demonstration of four wheeler chassis layout and vehicle body parts and its materials.
2. Study and Demonstration of working of single plate automobile clutch and clutch plate lining materials.
3. Study and demonstration of synchromesh gearbox. (necessity, interlocking mechanism, gear shifting mechanism (Troubleshooting)
4. Study and demonstration of final drive and differential. (Types of final drive gear, Troubleshooting)
5. Study and demonstration of front wheel steering geometry and steering mechanism. (Troubleshooting)
6. Study and demonstration of suspension system of a four-wheeler. (Any one suspension system from conventional or independent, troubleshooting)
7. Study and demonstration of working Hydraulic braking system. (Air bleeding of hydraulic brake, Troubleshooting)
8. Study and demonstration of Lead acid Battery. (Troubleshooting)
9. Study and demonstration of electrical charging system. (Troubleshooting)
10. Study and demonstration of electrical starting system.(Troubleshooting)
11. Study and demonstration of
    a) D. C. Electric Horn b) Electric Fuel Gauge c) Flasher Unit. d) Wiper Circuit
12. Study of automobile air conditioning system.

Group B.

1 Experiment on wheel balancing and front wheel alignment.

2 Visit to servicing station for study of vehicle maintenance, repairs and report.

OR

2. Visit to Automobile manufacturing industry.

Text Books:

1. "Automobile Engineering",Dr. Kirpal Singh (Vol. I and II) Standard Publishers, New Delhi.
2. "Automobile Mechanics",N K Giri.
3. "Automobile Engineering", G.B.S. Narang., Khanna Publication ,3rd Edition.
4. "Automotive Technology", H.M. Sethi. Tata McGraw-Hill Education, (2001).
5. "Automobile Engineering", Banga and Singh.
6. "Automotive Mechanics", Joseph Heitner, Affiliated Eastern Law House, 2nd Edition .,(1967).
7. "Motor Vehicle Technology and Practical Work",Dolan. J.A., ELBS, (1978).
8. "Automobile Electrical Equipment", P.L.Kohali ,Technical Education Series, 1st Edition.
9. "Automobile Engineering", R.B.Gupta, Satya Prakasan, 9th Edition.
10. "Automotive Excellence Volume 1 and 2", Gelncoe, Tata McGraw-Hill Publication.

Reference Books:

1. "Motor Vehicles",Newton and Steed
2. "Motor Manuals (Vol I to VII)", A.W. Judge., Chapman and Hall Publication.
3. "Automobile Mechanics",W.H. Crouse.,Tata McGraw Hill Publishing Co.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) Semester VII
4. COMPUTATIONAL FLUID DYNAMICS (ELECTIVE –I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term work: 25 Marks

Course Objectives:
The course aims to:

1. Provide Fundamental fluid dynamic principles and their applications.
2. Carry out research in the area of Computational Fluid Dynamics.
3. Provide students with the necessary skills to use commercial Computational Fluid Dynamics packages
4. Introduce the student to widely used techniques in the numerical solution of fluid equations, issues that arise in the solution of such equations, and modern trends in CFD.

Course Outcomes:
Upon successful completion of this course, the student will be able to:
1. Understand of the basic theory of Computational Fluid Dynamics, including discretisation, accuracy and stability.
2. Capable of writing a simple solver and using a sophisticated commercial CFD package.
3. Develop programming skills to solve some specific CFD problems.
4. Ability to assess fluid mechanics problems commonly encountered in industrial and environmental settings, construct and apply computational models, determine critical control parameters and relate them to desired outcomes and write reports.

Unit 1 Introduction to Computational Fluid Dynamics and Principles of Conservation [08]
Computational Fluid Dynamics: What, When, and Why? CFD Applications, Numerical vs. Analytical vs. Experimental, Modeling vs. Experimentation, typical problems, Problem Solving with CFD — Methodology, The Governing Equations of Fluid Dynamics and Heat transfer, Models of the flow- Control Volume, Fluid Element, Substantial Derivative, Divergence of Velocity, Continuity Equation Different Models and their Equivalence, Integral versus Differential Form of the Equations, The Momentum Equation, The Energy Equation, Summary Equations for Viscous Flow (the Navier-Stokes Equations) Equations for Inviscid Flow (the Euler Equations) Forms of the Governing Equations Particularly Suited for CFD

Unit 2 Basic of Discretization and Grid Generation [06]
Basic aspects of discretization - Discretization techniques Finite difference - Finite volume and Finite element method Comparison of discretization by the three methods, Transformation of non-uniform grids to uniform grids - General transformation of the equations -Form of the governing equations suitable for CFD - Compressed grids - Boundary fitted co-ordinate systems Elliptic grid generation - Adaptive grids - Modern developments in grid generation.

Unit 3 Finite Difference Method [06]
Finite Difference Formulations: Introductory remarks, Taylor Series Expansions,. Finite difference equations, Central Forward, Backward Numerical error, Explicit, Implicit, Semi-

implicit(Crank- Nicholson method), Solution methods Direct, Iterative, Thomas algorithm, Gauss- Jacobi, Gauss- seidal method, Alternate Directional Implicit, Applications. 1-D examples, 2-D examples.

Unit 4 Finite Volume Method [08]

i. For Diffusion

Introduction, FVM for 1D steady state Diffusion, FVM for 2 D Diffusion

ii. For Convection Diffusion

Introduction, Steady 1-D Convection and Diffusion, Central Differencing, Upwind Differencing, Hybrid Differencing, Power Law Scheme, QUICK scheme.

Unit 5 Introduction to Solution Algorithms for Pressure Velocity Coupling in Steady Flows and Turbulence and Multiphase Modeling (Introductory Treatment) [06]

Introduction, staggered grid, introduction to SIMPLE, SIMLEC, SIMPLER, PISO algorithms, Modeling of multiphase problems, Level set methods, VOF method. Coupled LS+VOF.

Unit 6 Introduction to Turbulence and its Modeling [06]

What is turbulence?; Transition from laminar to turbulent flow; Effect of turbulence on time averaged Navier -Stokes equations; Characteristics of simple turbulent flows; Introduction to Turbulent Models like Mixing length Model, k-epsilon model, Reynolds stress equation models, Algebraic stress equation models; Some recent Advances, introduction to LES, DNS.

Term Work:

1. Simulate and solve two problems, each 2-d and 3-d steady and unsteady flows using any commercial CFD package like Ansys-FLUENT, STAR CCM, FLUIDYNE, Ansys-CFX etc.
2. Write codes using C, C++, SciLab for at least one each, 1-d and 2-d steady flows and do the post processing to verify with analytical results.

Text Books:-

1. "Computational Fluid Mechanics the Basics with Applications",Anderson J. D. Jr,Tata McGraw Hill Education Pvt. Ltd.
2. "An Introduction to Computational Fluid Dynamics the Finite Volume Method" H. K.Versteeg and W. Malalasekera, Pearson Publication.
3. "Numerical Heat Transfer Fluid Flow",Suhas V. Patankar ,Taylor and Francis.
4. "Introduction to Computational Fluid Dynamics", Pradip Niyogi, S. K. Chakrabarthy, M. K. Laha , Pearson Publication.

Reference Books:-

1. "Computational Fluid Dynamics: A Practical Approach",Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, Butterworth – Heinemann.
2. "Computational Fluid Dynamics", T. J. Chung, Cambridge University Press.
3. "Introduction to Computational Fluid Dynamics",Anil W. Date, Cambridge University Press.
4. "Convective Heat and Mass Transfer",S. Mostafa Ghiaasiaan, Cambridge University Press.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) Semester VII
4. PROCESS EQUIPMENT DESIGN (ELECTIVE –I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

1. Acquaint several design codes used in the design process.
2. Study design of process equipment such as pressure vessel, storage tank, heat exchanger etc.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Illustrate understanding of process design parameters.
2. Design and develop pressure vessels.
3. Demonstrate capabilities developed for designing storage tank, agitators.

Unit 1 Process Design Parameters **[06]**

Basic concepts in process design, block diagrams for flow of processes, material flow balance. Importance of codes and standards and their applications. Pand ID, Process Data Sheet, PFD and other documents used for designing. Review of Design pressures, temperatures, design stresses, factor of safety, minimum shell thickness and corrosion allowance, weld joints efficiency, design loading, stress concentration and thermal stresses, failure criteria. Selection of material for process equipment's using ASME Codes.

Unit 2 Design of Pressure Vessels **[08]**

Types of pressure vessels, selection of various parameters for their design Pressure vessel subjected to Internal Pressure: Complete design as per ASME code of Cylindrical and spherical shells.
Design of various end closures such as: Flat, Hemispherical, Torrispherical, Elliptical and Conical.
Design of openings: nozzles and manholes. Design of Flanged joints; Gasket selection and design
Design of supports for process vessels.
Pressure vessel subjected to External Pressure: Design of shell, heads, nozzles, flanged joints and stiffening rings.

Unit 3 Design of Tall Vessels and Large Storage Tanks **[06]**

Determination of equivalent stress under combined loadings including seismic and wind loads application of it to vertical equipment like distillation column.
Design of Storage Tanks **:**
Study of various types of storage vessels and applications. Atmospheric vessels,

vessels for storing volatile and non-volatile liquids. Various types of roofs used in storage vessels. Manholes, nozzles and mounting design. Design of Rectangular tanks.

Unit 4 Vessel Supports **[06]**

Introduction and classification of supports. Design of skirt support considering stresses due to dead weight, wind load, seismic load and periodic vibration. Design of base plate, skirt bearing plate, anchor bolts. Design of Lug and bracket support.

Unit 5 **Unit 5 : Process Piping Design** **[06]**

Flow diagrams and pipe work symbols, design of layout of water, steam and compressed air pipes work, pipe fitting, linings and flanged connections. Types of valves used on pipe line. Fabrication of pipe lines, expansion joints and pipe supports.

Unit 6 Heat Exchangers **[08]**

Heat exchangers: Design of vessels, Design of Shell and Tube Heat Exchanger, Study and design of various types of jackets like plain half coil, channel, limpet coil.

Agitator

Study of various types of agitators and their applications. Baffling, Power requirement of agitation. General design of agitator including blades, shaft, blade assembly.

Term Work:

Following assignments comprise the laboratory practice:-

1) Design of Pressure vessels and large tanks.
2) Design of Heat exchangers used in industries.
3) Design and development of equipment useful to process industries such as sugar, cement, chemical industries.
4) Preparing flow diagrams of processes, piping layout, etc.
5) Report based on visit to industries such as sugar, cement, chemical industries.

Text Books:

1) “Process Equipment Design”, Dr. M.V. Joshi, Mc-Millan Publication.
2) “Process Equipment Design”, Browell and Young, Wiley India.
3) “Chemical Equipment Design”,B.C. Bhattacharya.

Reference Books:

1) “Plant Design and Economics”,Max and Timasulaus Kalus , Tata McGraw Hill.
2) “Industrial Instrumentation Servicing Hand Book”,Cannel Grady, Tata McGraw Hill.
3) “Handbook of Instrumentation and Control”, KellenHeward, Tata McGraw Hill.
4) “Chemical Engineering Handbook”,Perry John, Tata McGraw Hill.
5) “Industrial Pipe Work”, D.N.W. Kentish, Tata McGraw Hill.
6) “Chemical Engineering”, J.M. Coulson, Richardson, Sinnott, Maxwell, McMillan. Publication.
7) “Pressure Vessel Design Hand Book,” H. Bedna.
8) “Dryden’s Outlines of Chemical Technology” Roa M. Gopala, Sitting M., East West Press Pvt. Ltd., New Delhi.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) Semester VII
4. ADVANCED FOUNDRY PROCESSES (ELECTIVE –I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

1. Acquaint students with the basic concepts of foundry processes
2. Impart knowledge of ferrous and non ferrous metal processing
3. Study casting design process
4. Analyze casting process

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Understand basic casting design procedure.
2. Understand fundamental knowledge of Ferrous and Non Ferrous Metal.
3. Design of castings for different application.
4. Understand need of castability.

Unit 1 Metal Casting –Overview and Solidification [07]
Introduction to types of casting processes, Review of various processes, Solidification of Casting: Concept of solidification of metals. Homogenous and heterogeneous nucleation.Growth mechanism, Solidification of pure metals and alloys, Mechanism of columnar and dendritic growth, Coring or Segregation, Solidification time and Chvorinov's rule, Concept of progressive and directional solidifications.

Unit 2 Principles of Gating and Risering [07]
Principles of Gating and Risering: Purpose of the gating system. Components of the gating System and its functions, Design of the gating System, Different types of gates, Gating ratio and its functions, Definition and functions of the riser, Types of risers and their application. Design of the riser - its shape, Size and location, Use of insulating material and exothermic compounds in risers.

Unit 3 Design of Casting [06]
Design of Casting: Factors to be considered in casting design. Designconsideration in pattern making, moulding techniques and core making and assembly. Cooling stresses and hot spots in castingand modification in casting geometry to overcome them, Casting Quality Control: Casting defects and factors responsible for them.Different inspection and testing methods to evaluate the casting, Quality control activities in a foundry,Salvaging methods of defective casting.

Unit 4 Melting Practices for Different Alloys [07]
Melting Practices and Furnaces for Ferrous and Non- ferrous Alloys: Melting practices of Al-alloys, Mg - alloys, Cu - based alloys and Zn- based alloys and SG Iron; Degassing process and

methods in Al – alloys, modification treatment in Al- alloys, use of covering fluxes to avoid oxidation; Desulphurization, spherodisation treatment, inoculation practice, de-oxidation and alloy additions; Principle of working of thermocouples, spectrometers, and C.E. meters – applications; use of pyrometers for temperature measurement and control, energy saving in melting practices, Vacuum casting, Rheo casting.

Unit 5 Foundry Mechanization and Modernization [06]

Foundry Mechanization and Modernization: Introduction to modernization. Mechanization of foundry and its advantages.Mechanization of sand plant, moulding and core making mechanization in melting, pouring and shakeout units.Material handling equipments and conveyor systems. Brief sketches and description of layouts of job. Captive and mechanized foundries.

Unit 6 Quality Control in Foundries [07]

Quality Control in Foundries: Quality specifications in respect of raw materials used in foundry sand, sand additives, furnace charging material, alloys; Q.C. checklists maintained for raw materials, Q.C. checklists for mould – core properties; Heat wise pouring reports, details of melting log sheets, test bars, calibration records of testing equipments (U.T.M., Sand testing equipments); Results of chemical analysis, mechanical properties, test reports, rejection report analysis, defect diagnosis, remedies, use of cause - effect or fish- bone diagrams, Application of S.Q.C. in foundries, control charts

Term Work:

1. Sand moulding laboratory report preparation
2. Design of pattern layout for a given component
3. Design of gating system for a given component (ferrous / non ferrous)
4. Design of risering system for a given component (ferrous / non ferrous)
5. Die design for pressure die casting / centrifugal casting
6. Design of a foundry layout for a given case
7. Study of any one type of melting furnace
8. Study of TS/ISO / QS norms for foundry industry
9. Industrial visit to a modern foundry and its report

(Use of computer in designs is essential)

Text Books:

1) "Metal casting: computer aided design and analysis",B .Ravi, Prentice Hall of India.
2) "Principles of Metal Castings",Heine, Loper and Rosenthal ,Tata McGraw hill Publication.
3) "Principles of Foundry Technology",P.L. Jain, Tata McGraw hill Publication.
4) "Foundry Technology" Beelely, P.R., Butterworth.
5) "Text Book of Foundry Technology" Lal, M. Khanna, P.O , Dhanpat Rai and Sons.
6) "Manufacturing Processes and Systems" Phillip F Ostwald, J. Munoz, Wiley Student Edition , ISBN 89-81-26518944.

Reference Books :

1. “Indian Institution of Foundrymen”, Foundry Journal.
2. “Advanced Pattern Making”,Cox I.I.,The Technical Press, London.
3. “ASM Handbook”,Vol. 15 Castings, Tata McGraw hill Publication.
4. “Metal Castings – Principles and Practice” T.V. RamanaRao. New Age Publishers.
5. “AFS and Control Hand Book”,AFS.
6. “Mechanization of Foundry Shops – Machine Construction”,P.N. Aeksenov , MIR
7. “Fundamentals of Metal Casting Technology”,P.C. Mukherjee Oxford, IBH.
8. “Foundry Engineering”,Taylor, Fleming and Wulff , John Wiley.
9. “The Foseco Foundryman's Handbook”, Foseco, CBS Publishers and Distributors.
10. “The New Metallurgy of Cast Metals Castings”, Campbell, CBS Publishers and Distributors.

Shivaji University Kolhapur
B.E. (Mechanical Engineering) Semester VII
4. INTRODUCTION TO AIRCRAFT SYSTEMS (ELECTIVE –I)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term work: 25 Marks

Course Objectives:
The course aims to:

1. Introduction to the Aircraft History, Industry
2. Analyze effect of Wind over Aerofoil, Aircraft
3. Analyze. Assess and Judge stability of Aircraft.
4. Understand the Basics of Aircraft Systems and Systems Engineering approach.
5. Industry Practices on Design of Aircraft Systems: Mechanical, Electrical.
6. Understand the applicability of Design aspects in Aircraft Design.
7. Relate the theoretical knowledge with the design of Aircraft Structures.

Course Outcomes:
. Upon successful completion of this course, the student will be able to:

1. Develop a systems engineering plan for a realistic project.
2. Judge the applicability of any proposed process, strategy, or methodology for systems engineering using the fundamental concepts from disciplines such as probability, economics, and cognitive science.
3. Understand system engineers' role and responsibilities. Understand the role of organizations.
4. Apply systems engineering tools (e.g., requirements development and management, robust design, Design Structure Matrix) to realistic problems.
5. Recognize the value and limitations of modeling and simulation.
6. Formulate an effective plan for gathering and using data.
7. Know how to proactively design for and manage system lifecycle targets.

Unit 1 Introduction to Aircraft and Principles of Flight [07]
Evolution and History of Flight, Aircraft definition, Aircraft classification, Basic components of an Aircraft, Aircraft control surfaces-movements, Aircraft axis systems, Types of Aircraft's – Lighter than air/ Heavier than air Aircraft.
Principles of Flight: Forces on Aircraft, Properties of atmosphere, Bernoulli's Principle and equation, Airflow over wing, Pressure distribution over wing section, Types of Drag, Basics of Lift and Drag.

Unit 2 Aircraft Stability and Control [04]
Lateral, Longitudinal, Directional stability and controls of aircraft, Factors affecting lateral, longitudinal and directional stability. Why different Aircraft's have different designs- Conventional Aircraft, Un- Conventional Aircraft

Unit 3 Aircraft Systems [09]

(A) Mechanical

Mechanical Systems: Environmental control systems (ECS), Pneumatic systems, Hydraulic systems, Fuel systems, Landing gear systems, Engine Control Systems, Ice and rain protection systems, Cabin Pressurization and Air Conditioning Systems, Steering and Brakes Systems, Auxiliary Power Unit.

(B) Electrical and Electronics

Electrical systems: Avionics, Flight control Systems, Autopilot and Flight Management Systems, Navigation Systems, Communication, Information systems, Radar System, Emergency Systems.

Unit 4 Systems Engineering [06]

Introduction to Systems Engineering- An approach, Need for Systems Engineering, Scope of Systems Engineering activities, Systems Engineering-Process, Tools used for Systems Engineering process, Systems Integration, Systems Interaction. Role and Responsibilities of a Systems Engineer, Understand the role of organizations

Unit 5 Aircraft Systems Design [07]

Introduction to Aircraft Systems design, Development Process, Key elements of design process, System requirements, Fault Tree Analysis (FTA), Dependency Diagram, Failure Modes and Effects Analysis (FMEA), Reliability- Analytical methods, Development verification and validation, reliability, system attributes

Unit 6 Aircraft Systems Development Process [07]

Introduction to Development Process, Product Life Cycle (PLC), Concept Phase, Definition Phase, Design Phase, Build Phase, Test Phase, Operate Phase, Disposal Phase, Development Program, Design and Development verification and validation, Reliability, System attributes.

Term Work:

1. Eight assignments based on above topics.
2. Two reports on Industrial Exposure or visit.

Practical Exposure

With an intent to get some exposure on Aerospace and related industries, the colleges can arrange

- Industry Visits to some of the Industries in Aerospace like HAL(Hindustan Aeronautics Limited),NAL (National Aerospace Limited),ISRO (Indian Space Research Organization) and Students need to submit a report on the learning from the visits

  (OR)
- Visits to Aerospace Museums

  (OR)
- Building miniature Models of Aircraft /Gliders etc as Hands on Exercises conducted as competitions.

Text Books:

1. “Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration”,Ian Moir, Allan Seabridge , 3rd Edition.
2. “Flight without Formulae”, A.C. Kermode, Pearson Education,10th Edition.
3. “Mechanics of Flight”, A.C .Kermode, Pearson Education,5th Edition.
4. “Fundamentals of Flight”, Shevell, Pearson Education, 2nd Edition.

Reference Books:

1. “Introduction to Flight”,Dave Anderson.
2. “Aircraft Maintenance and Repair” Frank Delp, Michael J. Kroes and William A. Watkins, Glencoe and McGraw-Hill, 6th Edition, (1993).

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) Semester VII
5. TOTAL QUALITY MANAGEMENT (ELECTIVE –II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

1. Know the concept of total quality and role of quality assurance.
2. Understand planning and controlling techniques for quality
3. Know the reliability approach for quality
4. Realize benefits of taguchi's quality philosophy
5. Understand the key issues and some popular approaches to TQM implementation
6. Understand the current trends in TQM

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Understand importance of assuring quality in the service or manufacturing sector and explain Quality assurance system
2. Identify and solve the quality related problems in manufacturing or service sector at various stages by using various TQM tools and techniques,
3. Calculate reliability of system
4. Understand vendor rating and select suitable vendor
5. Interpret various quality attributes and discuss the various quality approaches.
6. Comment on quality using Taguchi Philosophy.

Unit 1 Quality Assurance System: [06]
Concept of total quality, role and objectives of Q.A. Q.A. cycle, process approach to Q.A. (input-process-output), Information feedback, Significance of feedback and field complaints analysis in Q.A., Significance of internal customer approach, Defect prevention programs for Q.A**.**

Unit 2 Planning and Controlling Techniques for Quality [07]
Planning for quality – The dimensions of Quality(quality of Design, conformance, performance and service) Specifications for quality dimensions, Quality planning activities for new products, Advanced Product Quality Planning (APQP), Planning through trial lots, Quality planning with vendors, Vendor control procedures, Vendor-rating.

Controlling techniques for quality –Seven statistical tools, Process capability analysis, Problem solving new management tools, Six sigma- Concept, Need, Implementation, DPMO, Gradations.

Unit 3 Robust and Reliable Product Approach for Quality [07]
Product and system reliability: Basic concepts, Prediction and evaluation of parallel, Series and combined system reliability, Reliability tests (life testing, burn-in test, accelerated life testing),

FMEA; and FTA, Taguchi's quality Philosophy, System design, Parameter design, Tolerance design, Orthogonal arrays, S/N ration, Loss functions.

Unit 4 Principles and Approaches to TQM: [06]

Basic concepts: definition of TQM, TQM and traditional management approach, Principles, characteristics, and benefits of TQM.

Approaches to TQM: Deming's approach, Juran's triology, Crosby and quality improvement, Ishikawa's CWQC, Feignbaum's theory of TQC, Schonberger's action agenda for manufacturing excellence.

Unit 5 The Essentials of TQM: [07]

Customer Focus,- Customer perception of quality, Quality policy deployment, Quality function deployment, Voice of customer, Customer satisfaction, Kano's model of satisfaction, Customer retention.

TQM Leadership- Role and commitment and accountability of leadership, Quality policy and objectives, Organizational structure for TQM, Role of HR in TQM, Training for TQM, Developing quality culture.

Tools and Techniques for TQM: 5-S campaign, TEI, quality circles, QFD, poka-yoke, KAIZEN

Unit 6 Current Trends in TQM: [07]

TQM in service sector: Definition and meaning and service, problems in defining service quality, attributes of service quality, SERVQUAL model, Implementing TQM in service industries, Measurement system for service quality.

Quality Management Systems:

ISO 9001:2008 Series Standards – Clauses, contents, interpretation and implementation, audit

Sector Specific Standards – AS 9100, ISO/ TS 16949, TL9000,

Q**uality Awards:** National and International quality awards, Criteria and case studies.

Term Work:

- Five assignments based on the syllabus
- Four case studies through industrial visits on
    1. Tools and techniques of TQM
    2. TQM implementation in manufacturing sector
    3. TQM implementation in Service Sector
    4. ISO 9001-2008 implantation

  (Presentation is preferable for case studies)

Text Books:

1. "Practical Reliability Engineering",Patrick D.T. O'connor, , Wiley India, (ISBN 978-81-265-1642-1), 4th Edition.
2. "Total Quality Management – Text and cases",Jankiraman and Gopal, Prentice Hall India Publication. (ISBN 978-81-203-2995-9).
3. "Total Quality Management" Dr. Suri and Dr. Sharma, Wiley Publication, (ISBN 978-93-5004-317-2).
4. "Total Quality Management",Dr. Rajaram, Wiley Publication, (ISBN 978-81-7722-63-2).

Reference Books:

1. "Total Quality Management",Dale H. Besterfiled,et.al. ,Pearson Education, Asia (ISBN 978-81-317-3227-4).
2. "Total Quality Management",Dr. Poornima Charantimath Pearson Education, Asia (ISBN 978-81-317-3262-5) ,2nd Edition.
3. "Fundamentals of Quality Control and Improvement", Amitava Mitra Pearson Education ,Asia.
4. "Handbook of Total Quality Management"Dr. R.P.Mohanti ,R.R. Lakhe Jaico Publishing House , (ISBN 81-7224-833-44).
5. "Total Quality Management in Service Sector",Dr. R.P. Mohanti Jaico ,Publishing House.
6. "Quality Planning and Analysis",Juran J.M and Gryna.
7. "Inspection, Quality Control and Reliability",Sharma S.C., Khanna Publishers (ISBN 81-7409-022-3).
8. "Global Management Solutions Demystified", Dinesh Seth, Subhash C. Rastogi, Ceneage Education (Former ThomsonAsia Pvt.Ltd.) (ISBN 981-265-142-X).
9. "Total Quality Control", Feigenban, Tata McGraw Hill Book Company, New York.
10. "Managing Quality",Barrie G Dale,Wiley India Pvt .Ltd. (ISBN 978-81-265-2246-0), 5th Edition.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester –VII**
5. INDUSTRIAL PRODUCT DESIGN (Elective –II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	Theory Paper: 100 Marks
Practical: 2 Hrs/week	Term Work: 25 Marks

Course Objectives:

The course aims to:

1. Study the various parameters in product design and development like
    - Finding Customer Needs
    - Doing Market Research in various parameters for product
    - Product Specifications criteria
    - Product Architecture and Prototyping
    - Cost and Value Engineering
    - Design for Manufacturing and Assembly
    - Standards in Ergonomics and Industrial Safety
2. Practice exposure to Case Studies and CAD Software with a product case.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Find the Customer Needs for a Quality Product through Market Research in product development process, Concept Generation, Selection and Testing.
2. Describe basics of Product Architecture, Prototyping and Cost and Value Engineering. Select the Standard Ergonomics and Industry Safety parameters in Product Design.

Unit 1 **Introduction** **[06]**

Challenges of product development, Identify customer needs, Successful product development, Quality aspect of product design, Market Research, Survey.

Unit 2 **Product Development Process and Planning** **[07]**

Innovation and Creativity in Product Design, Product Planning Processes, Product specifications: Process of setting specifications. (Concept Generation–Selection–Testing).

Unit 3 **Product Architecture** **[07]**

Product Architecture: Implication of architecture, Establishing the architecture, Related system level design issue, Product Data Management, Use of Computerized Data Management and `Process, Industrial Design : Overview.

Unit 4 **Design for Manufacturing and Assembly** **[07]**

Tolerance, Design of Gauges, Design for Environment, Prototyping, Engineering Materials, Concurrent Engineering, Product Costing, Value engineering.

Unit 5 **Aesthetics :** **[08]**

Aesthetic Considerations, Visual Effects of Form and Color in Product Design.

Ergonomics :

Ergonomics and product design and automated systems, Anthropomorphic data and its applications in ergonomic design, Limitations of Anthropomorphic data, General approach to the Man-Machine Relationship - Workstation Design and environment (working position and posture).

Control and Displays:

Configurations and sizes of various controls and displays, Design of controls in automobiles, machine tools etc., Design of instruments and controls.

Unit 6 **Industrial Safety:** **[05]**

An approach to Industrial Design - Elements of Design Structure for Industrial Design in engineering applications in manufacturing systems.

Personal protective Equipment and Environment Control Prevention and specific safety measures for manufacturing and processing industry and chemical industry.

Term Work:

1. Case Study on any **TWO** (by a group, a group of Min.02 and Max. 04 students to be presented in front of all students) covering following points,
    a. Product Development Process / Planning.
    b. Product Architecture.
    c. Design for Manufacturing.
    d. Design for Assembly.
    e. Aesthetic and Ergonomic considerations in Product Design.
    f. Industrial Safety in Machine and Equipment Handling.
    g. Health Safety in Product Design.
    h. Environmental Safety and ISO 14000 Systems.

2. Development of any Product using high end CAD software considering following points.

a) Need of Customer, Methodology of Market Survey.
b) Invention / Innovation of a product with modifications required.
c) Aesthetics (Form and Color) and Ergonomics consideration in design.
d) Preparation of various Views of the product.
e) Design for Assembly Procedures .
f) Product and Maintenance Manual.
g) Product Database Management .

A report should be prepared with details, drawing sheet, Bill of Material, Assembly – Disassembly Procedure, Maintenance Manual and Cost Estimation (if required)

3. Presentation of the product designed.

Text Books:

1. "Product Design and Development",Karl T. Ulrich, Steven G. Eppinger; Irwin Tata McGraw Hill, 3rd Edition.

2. "Product Design and Manufacturing",A.C. Chitale and R.C. Gupta, Prentice Hall of India, 3rd Edition.

3. "Product Design",Otto and Wood, Pearson education.
4. "Human Factor Engineering", L P Singh , Galgotia Publication Pvt.Ltd, 1st Edition.

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Reference Books:

1. "New Product Development", Tim Jones, Butterworth, Heinemann, Oxford, (1997).
2. "Assembly Automation and Product Design",Geoffrey Boothroyd, Marcel Dekker, CRC Press.
3. "Industrial Product Design",C W Flureshem.
4. "Industrial Design for Engineers",Mayall W.H, London, Hiffee books Ltd.
5. "Introduction to Ergonomics",R.C. Bridger, Tata McGraw Hill Publication.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
5. ADVANCED FORMING PROCESSES (ELECTIVE-II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course objectives:
The course aims to:

1. Understand the fundamentals of various traditional, nontraditional and advanced metal forming processes
2. Study different types of traditional, nontraditional and advanced metal working processes, their advantages, limitations and applications
3. Understand how the processes are carried out in industry

Course Outcomes:
Upon successful completion of this course, the student will be able to:
1. Solve for strain rates, temperatures and metallurgical states in forming problems using constitutive relations
2. Develop process maps for metal forming processes using plasticity principles
3. Estimate formability limits for bulk metals and sheets
4. Evaluate high energy rate deformation process parameters.

Unit 1 Introduction and Fundamentals of Forming Processes: [05]
Importance of manufacturing technology, Classification of manufacturing processes, Selection of materials and manufacturing processes. Study of various forming processes their significance and comparison of various manufacturing processes on different criteria. Need for near net shape manufacturing.
Theory of elasticity, Simple Stress and Strains- Elastic stresses and strains, Plastic stresses and strains, Poisson's ratio, True stress and True strain, Empirical relations for the stress strain curve, Idealized stress strain curve. Two and three dimensional stresses and strains- Principal stresses and strains, Mean (Hydrostatic) stress and stress deviators, Principal strains, Equilibrium in Cartesian, cylindrical and spherical coordinates

Unit 2 Theory of Plasticity [07]
Theory of dislocations, Slip line field theory, Slab method and lower and upper bond methods for load , their significance in investigating and modeling of metal working operations. Plastic work.Yield criteria- Tresca and Von mises yield criteria, General plastic stress-strain relations (Theory of plasticity).
Effect of Temperature on plastic deformation, Cold forming- and effect of annealing on cold formed materials- recovery, Recrystallization and grain growth, warm forming and hot forming. Effect of strain rate on plastic deformation and super plasticity.Effect of friction and lubrication in metal forming. Classification of forming processes on various criteria

Unit 3 Bulk Forming of Metallic Materials [08]

Forging Processes: Introduction to types of forging and forging equipments, Modeling of forging process, Calculation of forging loads in closed die forging, Effect of forging variables on properties, forging die design, Design principles, Pre form design considerations and die materials, Forging Defects.

Rolling Process: Introduction to types of rolling and rolling mills, Forces and geometrical relationships in rolling, Simplified analyses of rolling load , Variables, Torque and power, Roll pass design, Rolling mill control, Theories of cold rolling, hot rolling, transverse rolling, Rolling of bars and shapes. Rolling defects

Extrusion: Classification and applications, Extrusion equipment. Hot and cold extrusion, hydrostatic extrusion. Patterns of metal deformation in extrusion, Analyses of extrusion process, Extrusion Defects.,

Rod, Wire and Tube Drawing: Classification of drawing processes. Rod Drawing, Wire Drawing, Tube Drawing. The Drawing Die.Modeling of Drawing Process.

Unit 4 Sheet Metal Forming Processes: Introduction and Classification [07]

Shearing Processes: Classification and applications, Open Contour Shearing, Closed Contour Shearing. Shearing mechanism.

Bending Processes: Applications, Bending Parameters, Spring back in Bending, Residual stresses in bending. Bending equipment, Press Brake, Roll Bending Machines and Contour Roll forming.

Stretch Forming: Applications, Stretch forming machines and accessories.

Deep Drawing: Applications. Deformation zones in deep drawing, Blank holding pressure. Ironing. Deep Drawing force. Limiting Drawing Ratio.Effect of Anisotropy.Redrawing.

Unit 5 High Velocity Forming and High Energy Rate Forming [06]

Introduction and Classification.Characteristics of HVF and HERF Processes.

High Velocity Forming Machines: Pneumatic (Compressed air) Hammer, Compressed Gas Forming Hammer, Gas Combustion High Speed Hammers,

High Energy Rate Forming Processes: Explosive Forming, Principles and Types of Explosives. Classification of Explosive Forming Methods, Process variables, Failure of Formed products , Advantages and limitations,

Electro Magnetic Forming: Principles of the process, Basic Methods of Electromagnetic Forming, Pressure required in EMF, Advantages and Limitations of EMF. Safety Considerations.

Electro Hydraulic Forming: Principles of the Process, Energy requirements, Process variables, Advantages and Limitations, Future of HVF and HERF.

Unit 6 Recent Trends in Forming: **[07]**

Thixo- forging, isothermal forging, super plastic forming technology, forming of super conductors, forming of ceramics and glasses, Forming of plastics and composite materials-Extrusion, Form moulding, Thermo forming, Cold forming and Solid phase forming, Design and economic considerations.

Rubber Pad Forming (Flexible – Die Forming) **and Hydro forming** (Fluid forming Processes).

Spinning: Conventional spinning, Flow Turning (Shear spinning), Tube spinning,

Super Plastic Forming of Sheets: Blow Forming and Vacuum Forming, Thermo forming Methods, Super Plastic Forming/ Diffusion Bonding Process. Sheet Metal Formability, Testing of Formability, Forming Limit Diagrams.

Term Work:

1. One exercises each on i. Rolling ii. Forging iii. Extrusion, iv. Wire and deep drawing forming processes
2. Four exercises on High velocity and high energy rate forming
3. Industrial visits to observe bulk metal, sheet metal and High velocity and high energy rate forming processes

Text Books:

1. "Modern Manufacturing", Mikell Groover, Wiley publication.
2. "Mechanical Metallurgy", George E. Dieter, Tata McGraw Hill Education (India) Pvt. Ltd. 3rd Edition, (ISBN 978-1-25-906479-1), (2013).
3. "Manufacturing Technology – Materials, Processes and Equipments", Helmi A. Youssef, Hassan A. El- Hofy, Mahmoud H. Ahmad, CRC Press, Taylor and Francis Group, ISBN 978-1-4398-1085-9.
4. "Production Technology",R.K. Jain, Khanna Publishers (ISBN :81-7409-099-1)
5. "Manufacturing Processes and Systems",Phillip F Ostwald, J. Munoz, Wiley Student Edition, ISBN 978-81-26518944.

Reference Books:

1. "Metal Forming Handbook" Schuler, Springer-Verlag, Berlin Heidelberg New York ISBN 3-540-61185-1 (2008).
2. "Forging Design and Practice",R. Sharan, S.N. Prasad Chand, (1982).
3. "Forging Equipment, Material and Processes",J. Altan, F. W. Boulger- Metals Cewramic Information Centre Columbus ,(1973).
4. "Roll Forming Handbook", Geotge T. Halmos ,(CRC Press, Taylor and Francis)- ISBN 0-8247-9563-6, (2006).
5. "Metal Forming Fundamentals and Applications",Altan T, American Society of Metals, Metal Park, (1983).
6. "ASM Hand Book", Forming and Forging, Vol. 14, 9th Edition, (1998).
7. "Manufacturing Engineering and Technology", Serope Kalpakjain, Steven R. Schmid, Pearson Education Asia, 4thEdition (ISBN 978-81-7758-170-6).
8. "Fundamentals of Metal Forming Processes", B.L. Juneja New Age International Publishers, (ISBN 978-81-224-3089-9). 2nd Edition.
9. "Roll Forming Handbook", Geotge T. Halmos CRC Press, Taylor and Francis(ISBN :0-8247-9563-6) ,(2006).

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) Semester -VII
5. DESIGN OF THERMAL SYSTEMS (Elective-II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ week	Theory Paper:100 Marks
Practical: 2 Hrs/week	Term Work: 25 Marks

Course objectives:
The course aims to:

1. Learn thermal system design methodology
2. Understand real life situations and be able to decide an approach for problem solving.
3. Design simple thermal systems with advanced tools where in integration of more than one component is required.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Understand the thermal system design methodology
2. Decide an approach to solve real life thermal system design problems.
3. Design simple thermal systems with advanced computer aided systems
4. Gain confidence in problem solving.

Unit 1Introduction to Thermal System Design [06]
Classification of design, Optimal and nearly optimal design, Methodology of design, Aspects of thermal system design, Assessment concept and creation, Component modelling

Unit 2 Design of Refrigeration System [07]
Design of basic components of refrigeration system, Design of refrigeration systems: vapour compression system- Household refrigerator, Ice plant, Vapour absorption systems using waste heat and solar energy.

Unit 3 Heat Transfer and Design Analysis of Air Conditioning System [07]
Design of Air conditioning systems: Design considerations, Load calculations, Single unit room air conditioners, Central air conditioning plant, Industrial drying systems, Component selection and Computer Aided Piping Design.

Unit 4 Design of Solar System [07]
Design of solar assisted water heating systems, Preliminary specifications, Concepts development, Detailed design for feasibility study, Component design

Unit 5 Design of Advanced Cooling Systems [06]
Design of advanced heat exchanger networks, Design of electronic miniature cooling systems, Utilization of Nano- Fluids for cooling systems

Unit 6 Design and Economic Analysis of Waste Heat Recovery Systems [07]

Design of waste heat recovery systems, Design specifications, Concept development, Detailed specifications and component design, Thermo Economic Evaluation and additional costing considerations

Term Work:

Any six assignments to be completed

1. Design of water chilling plant
2. Design of cold storage plant
3. Design and optimization of fins
4. Design of waste heat recovery system for diesel power plant
5. Design of dehumidification plant used for industrial drying.
6. Design of gas turbine system
7. Design of shell and tube heat exchangers

***(Designing of any one basic component with CAE software like ANSYS, HYPERWORKS)**

Text Books:

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

Reference Books:

1. "Essentials of Thermal System Design", C. Balaji, CRC Press.
2. "Design of Fluid Thermal Systems", Janna W.S., Cengage Learning, 4th Edition.
3. Online Tutorials and ANSYS User Guide.

Shivaji University Kolhapur

B.E. (Mechanical Engineering) Semester – VII

5. SMART MATERIALS (Elective – II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term Work: 25 Marks

Course Objectives:

The course aims to:

1. Study Smart materials and their types
2. Study HBLS and LBHS based smart materials, actuators and sensors.
3. Study use of actuators and sensors in forming a smart system and its applications.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Classify smart materials and explain their functions.
2. Explain the smart materials and their uses
3. Use of different sensors and actuators
4. Should suggest suitable material for actuators

Unit 1 Overview of Smart Materials [06]

Introduction, Components of smart systems – Sensors, actuators, Transducers, MEMS, Introduction to piezoelectric materials, Magnetostrictive smart materials, Active smart polymers, Shape memory alloys

Unit 2 Types of Smart Materials [06]

Introduction to HBLS (high bandwidth low strain) generating smart materials- Piezoelectric and magnetostrictive materials, LBHS (low bandwidth high strain) generating smart materials- Shape memory alloys and electro-active polymers.

Unit 3 Actuators Based on Smart Materials [08]

HBLS based actuators- Piezoelectric actuators- Induced strain actuation model, Unimorph and bimorph actuators, Actuators embedded in composite laminate. Magnetostrictive actuators - Mini actuators, Thermal instabilities, Magnetorstrictive composites, MEMS based actuators. LBHS based actuators: Shape memory alloy based actuators, Electro-active polymer.

Unit 4 Sensors Based on Smart Materials [06]

Sensors based on HBLS smart materials- Piezoelectric sensors, Magnetostrictive sensors, MEMS sensors, Sensors based on LBHS smart materials- Shape memory alloy based encoders, EAP based sensors.

Unit 5 Integration of Smart Sensors and Actuators [08]

Case studies to advanced smart materials - Active fiber composites, Energy harvesting Actuators, energy Scavenging sensors, Self healing smart materials

Unit 6 Applications of Smart Material [06]

Structural applications of smart materials, Structural acoustic control, and vibration control applications. Aerospace and transportation applications

Term work:
Any eight assignments based on above syllabus

Text Books:

1. "Smart Materials and Structures", Gandhi, Thompson and Gandhi, Chapmann and Hall London.
2. "Smart Structures and Materials", Bryan Culshaw, ARtech House, (1996).

Reference Books:

1. "Smart Material Systems and MEMS", Vardhan, Vinoy, Gopalkrishanan, Willey India Edition.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
5. DESIGN FOR SUSTAINABILITY (Elective – II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

1. Enable student to design products and equipment for sustainability
2. Use appropriate methodology to analyze and improve product design in terms of sustainability issues.
3. Know contextual factors impacting the engineering discipline.
4. Apply systematic engineering synthesis and design processes.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Explain the role of sustainability in the design process
2. Describe principles of materials selection based on sustainable principles
3. Apply a systematic approach to system redesign in terms of energy efficiency, water efficiency and transport efficiency
4. Give examples of engineering innovation
5. Explain principles of disposal and recycling

Unit 1 **[06]**

Introduction- Definition, Relevance of Sustainable product design, Strategies for design, Impact of sustainable design

Unit 2 **[08]**
Sustainable design through economic aspects: Energy Conservation Water Conservation Materials Conservation

Unit 3
Life Cycle Design: Pre-Building Phase, Building Phase, Post-Building Phase [**06]**

Unit 4
Human Design: Preservation for Natural Conditions Urban Design and Site Planning. Design for Human Comfort [**08]**

Unit 5
Application of sustainable design principles for HVAC products [**06]**

Unit 6
Redesigning and benchmarking for sustainable design [**06]**

Term Work:
Minimum Six assignments based on above syllabus. Preferably the assignment should be Case study.

Text Books:-

1. "Design for Sustainability: A practical approach for developing economics", M.R.M. Cruland J.C. Diehi,Delf , University of Technology, USA.
2. "Introduction to Sustainability", Jong Jin Kim; National Polution Prevention center for higher education.
3. "Design for Sustainability a Practical Approach", Tracy Bhamra; Gower Publication.

Reference Books:

1. "Integral Sustainable Design: Transformative Perspectives", Mark Dekay Earth Scan an imprint of Tailor and Francis Group.
2. "Sustainable Energy Systems and Applications", Ibrahim Dincer; CalinZamfirescu Springer Publications.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
5. FLEXIBLE MANUFACTURING SYSTEM (ELECTIVE II)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper : 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

1. Study fundamental concepts of flexible manufacturing systems
2. Familiarize students to various components of Fms.
3. Impart knowledge of flexible assembly systems.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Understand meaning of flexible manufacturing system
2. Explain the concept of group technology, and how it relates to cellular manufacturing.
3. Explore primary capabilities of flexibility in the FMS.
4. Know about different types of FMS with components.

Unit 1 Introduction and Control Structure of FMS [07]
Flexible and rigid manufacturing, F.M. Cell and F.M. System concept, Types and components of FMS, Tests of flexibility, Group Technology and FMS, unmanned factories, Economic and Social aspects of FMS.
Architecture of typical FMS, Automated work piece flow, Control system architecture – Factory level, Cell level; Hierarchical control system for FMS, Transmission medium, Signaling, Network topology, Factory networks, Protocols – ISO OSI reference model, Manufacturing Automation Protocol; Communication interfaces, Structure and functions of manufacturing cell, Distributed Numerical Control (DNC), FMS Diagnostics, conceptual DBMS, relevance of DBMS in FMS

Unit 2 Production Planning and Control in FMS [06]
Activities in modern PPC system, Process planning, Computer aided process planning systems-Retrieval and generative, Material requirement planning, and shop floor control, Scheduling algorithms, Heuristic approach and optimized production technology approach to scheduling , Automated scheduling systems, Inventory control in FMS, MRP-II or ERP

Unit 3 Tooling and Fixturing in FMS [07]
Modern cutting tools and tool materials, Tool holders, Modular tooling, Tool monitoring, Presetting and offsets, Wear and radius compensation, Tool magazines, Automatic tool changers, Robotized tool assembly, Tool management system
Part holding on Pallets, Standard fixtures, Pallet changers, Pallet pool, Flexible fixturing – Principles and methodologies, Modular fixturing system: Tslot based, Dowel pin based, Fixturing components, Computer aided fixture design – Locating and clamping, Use of GT in fixture design, Fixture database

Unit 4 Group Technology and Material Handling in FMS [08]

GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part machine group analysis, Methods for cell formation, Cellular vs. FMSproduction.Quantitative analysis in cellular manufacturing using rene order clustering system and hollien method.

Material Handling in FMS: Functions of an integrated material handling system in FMS, Flexibilities in material handling, Industrial robots for load / unload applications, Robotic cell layouts and FMS layouts, Automatically Guided Vehicles (AGVs) – Types, Features, Guidance technologies and applications; Automated warehousing - AS/RS, storage and retrieval machines in AS/RS.

Unit 5 Automated Inspection Systems [06]

Online offline infection, Automated inspection techniques, Contact non contact inspection, Application of m/c vision system in inspection, CMM, Study of inspection and post inspection software, FIS (Flexible Inspection System)

Unit 6 Flexible Assembly Systems [06]

Basic Concepts, Classification, Planning and Scheduling in FAS, Loading and scheduling in F.A. cells. Lean and Agile Manufacturing: Definition and principles of lean manufacturing, Benefits, Methodologies for transferring to lean manufacturing, Definition, Principles of agility, Market forces and agility, Reorganizing the production system for agility, Managing relationships for agility; Comparison of mass, Lean and agile manufacturing

Term Work:

Minimum eight assignments based on the following.

1. Develop a form code using any classification system for 3 parts.
2. Application of rank order clustering algorithm to identify logical part families and machines groups.
3. Exercise on any scheduling algorithm.
4. Exercise on flexible fixturing.
5. Simulation of FMS shop, using Simulation software package (like ARENA, OpenCIM/ OpenFMS or equivalent) using various modules like Arrive, Server, Depart, Simulate modules, Creating models of FMS shops and simulating the performance to obtain output results.
6. Exercises on assessment of performance of batch production systems for the following measures.
   a) Manufacturing lead time, b) Work - in – process, c) Machine utilization

Text Books:

1. "Flexible Manufacturing Systems in Practice Applications, Design And Simulation", Joseph Talavage et. al: , Taylor and Francies Publisher: US.
2. "Computer Integrated Design and Manufacturing", Bedworth el.al, Tata McGraw-Hill,(1991).
3. "Performance Modeling of Automated Manufacturing Systems",N. Viswanadham, Y. Narhari,Prentice Hall Publication, (1992).

4. “Automation, Production Systems and Computer Integrated Manufacturing”,Groover, Pearson Education.
5. “CAD/CAM”, P.N. Rao, Tewari NK, Kundra TK, Tata McGraw Hill Publications
6. “FMS”, H K Shivanand, New Age International Publication.
7. “Handbook of CIMS”, Teicholds and Orre, Tata McGraw Hill Publications.

Reference Books:

1. “The Design and Operation of FMS”, Ranky, Dr. Paul, (1984).
2. “Automation, Production Systems and Computer Integrated Manufacturing”, Groover, Mikell P, ,Pearson Education or Prentice Hall India, 2nd Edition, (2002).
3. “Performance Modeling of Automated Manufacturing System”,Viswanadhan, N. and Narahari, Y., Prentice Hall of India, (1998).
4. “Operations Scheduling with Applications in Manufacturing and Services”,Pinedo, Michael and Chao, Xiuly, Tata McGraw Hill International Editions (with 2 Floppy Disks of LEKIN Scheduling Software),(1999).
5. “Simulation with ARENA”, Kelton, Sadowsky and Sadowsky, Tata McGraw Hill International Editions (with CD of ARENA Simulation Software), 2nd Edition .
6. “CAD / CAM / CIM”, Radhakrishnan, Subramanyan, John Wiley.
7. “Computer Aided Fixture Design”,Rong, Yeming; Marcel Dekker, ISBN 0-8247-9961-5
8. “Production Planning and Scheduling in Flexible Assembly Systems”, Sewik, Springer Verlag, ISBN 3-540-64998-0.
9. “Lean Manufacturing Implementation”,Hobbs, J. Ross Publishing, ISBN 1-932150-14-2
10. “Agile Manufacturing”, Chowdiah, Gargesa and Kumar, Tata McGraw Hill Publication
11. “Automation, Production System and Computer Integrated Manufacturing”,Groover , Englewood Publication.
12. “Design and Operation of SMS”, Rankey, IFS.
13. “Flexible Manufacturing System”, Wernecks, Spring-Verlag.
14. “FMS in Practice”, Bonetto, Northox Ford Publication
15. “Flexible Manufacturing Cells and Systems” W.W. Luggen, Publication, Prentice Hall of India.
16. “Performance Modeling of Automated Manufacturing Systems”,Vishwanathan and Narahari, Prentice Hall of India.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
6. INDUSTRIAL TRAINING

Examination Scheme:
Term Work: 50 Marks

Course Objective:
The course aims to:

1. Familiar the students to realize an industrial work.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Comprehend the knowledge gained in the course work
2. Create, select, learn and apply appropriate techniques, resources, and modern engineering tools.

Industrial Training
The students have to undergo an industrial training of minimum two weeks in an industry preferably dealing with Mechanical engineering during the semester break after Sixth semester and complete within 15 calendar days before the start of seventh semester. The students have to submit a report of the training undergone and present the contents of the report before the evaluation committee constituted by the department. An internal evaluation will be conducted for examining the quality and authenticity of contents of the report and award the marks at the end of the semester.
It is expected that students should undertake small assignment or work related to any of the course related aspect. Report is based on compilation of work carried out related to facility and layout planning, Industrial engineering- time study and motion study, Line efficiency evaluation and improvement, Process capability evaluation, Industrial automation, Process or machinery modification as identified.

Industrial Training Report Format:
Maximum fifteen students in one batch, involving three groups of maximum five students, shall work under one Faculty. The same group shall work for project under the same guide. However, each student should have different industrial training and its presentation.
The report should be of 20 to 30 pages. For standardization of the report the following format should be strictly followed.

1. Page Size: Trimmed A4
2. Top Margin: 1.00 Inch
3. Bottom Margin: 1.32 Inches
4. Left Margin: 1.5 Inches
5. Right Margin: 1.0 Inch
6. Para Text: Times New Roman 12 Point. Font
7. Line Spacing: 1.5 Lines
8. Page Numbers: Right Aligned at Footer. Font 12 Point . Times New Roman
9. Headings: Times New Roman, 14 Point ., Bold Face
10. Certificate: All students should attach standard format of Certificate as described by the department. Certificate should be awarded to batch and not to individual student. Certificate should have signatures of Guide, Head of Department and Principal/Director.

The entire report should be documented as one chapter with details like
1. “Name of Industry with address along with completed training certificate”
2. Area in which Industrial training is completed

All Students have to present their reports individually.

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VII**
7. PROJECT PHASE– I

Teaching Scheme:	**Examination Scheme:**
Practical: 2 Hrs/Week/Batch	Term Work: 50 Marks
	Oral Exam: 25 Marks

Course Objectives:
The course aims to:

1. Embed the skill in group of students to work independently on a topic/ problem/ experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.
2. Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Improve the professional competency and research aptitude in relevant area.
2. Develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Project Phase I Load:
A batch of maximum three groups of four to five students per group, shall work under one Faculty member of department. The group of one student is strictly not allowed.

Project Phase I Definition:
The project phase I work can be a design project / experimental project and or computer simulation project on Mechanical engineering or any of the topics related with Mechanical engineering stream. The project phase I work is allotted in groups on different topics.
The students groups are required to undertake the project phase-I during the seventh semester and the same is continued in the eighth semester (Phase-II). Project Phase-I consists of reviews of the work carried earlier and the submission of preliminary report. Report should highlight scope, objectives, methodology, approach and tools to be used like software and others, outline of project and expected results and outcome along with timeframe.
The project phase I work is to be extended for project phase II at B. E. (Mech.) Sem. VIII with same group working under guidance of same Faculty member assigned for project phase I.

Project Phase I Term Work:
The term work under project submitted by students shall include
1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly. The contents of work diary shall reflect the efforts taken by project group for

a. Searching suitable project work
b. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring up the project.

c. Day to day activities carried out related to project work for entire semester.
d. Synopsis.

The group should submit the synopsis in following format

i. Title of Project
ii. Names of Students
iii. Name of Guide
iv. Relevance
v. Present Theory and Practices
vi. Proposed work
vii. Expenditure
viii. References

2. The synopsis shall be signed by the each student in the group, approved by the guide and endorsed by the Head of the Department
3. Presentation: The group has to make a presentation in front of the Faculty members of department at the end of semester.

Project Phase I Report Format:

Project Phase I report should be of 25 to 30 pages (typed on A4 size sheets). For standardization of the project phase I reports the following format should be strictly followed.

1. Page Size: Trimmed A4
2. Top Margin: 1.00 Inch
3. Bottom Margin: 1.32 Inches
4. Left Margin: 1.5 Inches
5. Right Margin: 1.0 Inch
6. Para Text: Times New Roman 12 Point . Font
7. Line Spacing: 1.5 Lines
8. Page Numbers: Right Aligned at Footer. Font 12 Point. Times New Roman
9. Headings: Times New Roman, 14 Point , Bold Face
10. References: References should have the following format

For Books: "Title of Book", Authors, Publisher, Edition
For Papers: "Title of Paper, Authors, Journal/Conference Details, Year

Important Notes:

- Project group should continue maintaining a diary for project and should write (a) Book referred (b) Company visited (c) Person contacted (d) Computer work done (e) Paper referred (f) Creative thinking.
- The Diary along with Project Phase I Report shall be assessed at the time of oral examination
- One copy of the report should be submitted to Institute/ Department, One copy to Guide and one copy should remain with each student of the project group.

SHIVAJI UNIVERSITY, KOLHAPUR
B. E. (Mechanical Engineering) Semester- VIII
1. MECHATRONICS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term Work: 25 Marks
	Oral Exam: 25 marks

Course Objectives:

The course aims to:

1. Produce competent Mechanical engineers with comprehensive knowledge of Mechatronics to enable them to apply the relevant knowledge and technologies for the design and realization of innovative systems and products.
2. Supply qualified personnel to meet the requirement of specialist in Mechatronics.
3. Prepare Mechanical Engineering students for advanced graduate studies in Mechatronics, Manufacturing engineering and related field.

Course Outcomes:

Upon successful completion of this course, the student will be able to

1. Understand the importance of integration of Mechanical, Electronics and Control in the design of Mechatronics system.
2. Understand key elements of sensors and transducers and interfacing the same with problem under consideration through PLC.

Unit 1 Introduction [07]

Introduction to Mechatronics, Mechatronics systems, Measurement systems, Multi discipline scenario Transducers and Sensors:-Position Sensors: Limit switch, Photoelectric switches, Proximity sensors, Pneumatic limit valves and backpressure sensors, Pressure switches, resolvers, Incremental and absolute encoders, Decoders and relays. Displacement: Potentiometer sensors, LVDT, Capacitive displacement sensors. Velocity sensors: Tachogenerator, Use of encoders, Introduction to VFD.

Unit 2 Signal Conditioning [07]

Signal conditioning process, Operational amplifier (inverting amplifier, Non-inverting amplifier, Summing, Integrating amplifier, Differtianting amplifier, Logarithmic amplifier), Protection, Filtering, Data acquisition, Multiplexer, Analog to Digital Converter (ADC), Digital to Analog Converter (DAC). Oscillators to generator sinusoidal, Square, Triangular and impulse waveforms, 555 timer, Sample and hold, Demultiplexing. Interfacing input output ports, Serial and parallel interfacing requirements, Buffers, Handshaking, Polling and interrupts.

Unit 3 Digital Circuits, Microprocessor and Microcontroller [06]

Digital logic, Number systems, Logic gates, Boolean algebra, Application of logic gates, Sequential logic, Flip flop, D flip flop, JK flip flop, Master slave flip flop.

Microcontroller: Comparison between microprocessor and micro controller, Organization of a microcontroller system, Architecture of MCS 51 /ATMEL /PIC controller, Pin diagram of 8051, Addressing modes, Instruction types and set, Selection and Applications of Microcontroller

Unit 4 Programmable Logic Controllers (PLC) [07]

Introduction, Definition, PLC system and components of PLC Input output module, PLC advantages and disadvantages. Ladder diagram and PLC programming fundamentals:
Basic components and other symbols, Fundamentals of ladder diagram, Machine control terminology, Update – Solve ladder – Update, Physical components Vs. program components, Light control example, Internal relays, Disagreement circuit, Majority circuit, Oscillator, Holding (sealed or latches) contacts, Always ON always OFF contacts, Nesting of ladders.

Unit 5 PLC Programming [07]

PLC Input instructions, Outputs, Coils, Indicators, Operational procedures, Contact and coil input output, Programming example, Fail safe circuits, Simple industrial applications. PLC Functions
PLC timer functions – Introduction, Timer functions, Industrial applications, Industrial process Timing applications, PLC control functions – PLC counters and its industrial applications, Introduction to SCADA and MEMS.

Unit 6 Mechatronics Systems [06]

Traditional Vs Mechatronic Design, Case studies of Mechatronic systems designs, like piece counting system, Pick and place manipulator, Simple assembly task involving a few parts, Part loading / unloading system, Automatic tool and pallet changers etc. Fault finding and troubleshooting.

Term Work:

1. Trial on sensors (minimum four),
2. Assignment on Microprocessor and Microcontroller.
3. PLC Programming on Industrial Applications based on Timers, Counters, Internal Relays (Minimum 4 applications),
4. Fabrication of Simple Mechatronics working project by a group of 4/5 students using hardware and suitable software.
5. Assignment on PLC Data handling and Fault finding,
6. Assignment on SCADA and MEMS,
7. Industrial visit to study Mechatronic system application and submission of visit report.

Note: Mechatronics Laboratory is expected to have a simple 8 input 8 output PLC

Text Books:

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

Reference Books:

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

SHIVAJI UNIVERSITY ,KOLHAPUR

B.E.(Mechanical Engineering) SEMESTER VIII

2. ENERGY AND POWER ENGINEERING

Teaching Scheme:
Lectures:- 3 Hrs/week
Practical:-2 Hrs/week

Examination Scheme:-
Theory Paper:100Marks
Term Work:25 Marks

Course Objectives:
The course aims to:

1. Acquire the knowledge of renewable sources of energy and utilization.
2. Enable the student to estimate the potential of energy sources.
3. Study various power stations , Performance and economic analysis
4. Understand the new trends in power and energy sectors.

Course Outcomes:
Upon successful completion of this course, the student will be able to

1. Demonstrate need of different energy sources and their importance
2. Analyze the utilization of solar, wind energy etc.
3. Comprehend various equipments/systems utilized in power plants
4. Illustrate power plant economics

Unit 1 **[08]**

Introduction to Renewable Energy sources , Solar potential, Solar radiation spectrum, Solar radiation geometry (Numerical on angle of incidence only), Solar radiation data, ,Solar Collectors (Flat plate, evacuated tube, Cylindrical parabolic, Concentrating paraboloid),Graphical representation of efficiency of various Collectors , Testing of Solar flat plate collectors – BIS code (No numerical), Thermal Energy storage (Introduction and types)

Unit 2 **[07]**

Operating Principle of Photovoltaic cell concepts, Photo-cell materials, Cell module array, Series and parallel connections, Maximum power point tracking, Design of standalone system with battery and AC or DC load (Descriptive Treatment), Applications, Introduction, Principle and operation of fuel cells, classification and types of fuel cell. Fuel for fuel cells, Application of fuel cells.

Unit 3 **[05]**

Wind parameters and wind data, Power from wind, Site selection, Wind energy conversion systems and their classification, Construction and working of typical wind mill, Introduction to OTEC and Hybrid systems (Diesel-PV, Wind-PVBiomass-Diesel systems)

Unit 4 **[06]**

Power scenario in india and world, NTPC, NHPC and their role in Power development in India, Power generation in Private sector, Power distribution, Power grid corporation of India, State

grids, Railway grids and International grids, Different types of power plants – Thermal, Hydro, IC Engine, Gas Turbine, Nuclear and their characteristics, Combined Cycle, Pumped storage, Compressed Air storage power plants and their characteristics. Comparison of Power plants with respect to various parameters. Issues in Power plants.

Unit 5 **[09]**

i)Load Curves

Load Curves and Load duration curves (Numerical treatments), Performance and operational characteristics of power plants, Peak load, Intermediate load and Base load plants and their characteristics, Input output characteristics of power plants, Economic division of between Base load plant and peak load plants, Tariff methods (Numerical Treatments).

ii)Instrumentation

Flow measurement of feed water, fuel, air, steam with correction factor for temperature, Speed measurement, Level recorders, Radiation detectors , Smoke density measurement ,Dust monitor. Flue gas oxygen analyser – Analysis of impurities in feed water and steam – Dissolved oxygen analyser – Chromatography – PH meter-fuel analyser – Pollution monitoring instruments

Unit 6 **[05]**

Energy Management, Energy Marketing: Selling and marketing in India, Creating supply chain in India, Successfully working with business and virtual teams in India, Navigating the financial, legal and accounting environment, Human Resources issues, India's business culture in energy sector

Term Work:

1. Demonstration and measurement of solar radiation using pyranometer.
2. Performance on PV Cell (I-V Charactrcristics curves)
3. Visit to Wind power farm with detailed report
4. Study of Indian electricity grid code 2003 and its amendments
5. Study of combined cycle gas based and coal based Power plant
6. Study of typical load curve of Hydro/ Thermal power plant and its performance analysis.
7. Economic Analysis of power plants and Selection of plant for power generation (Numerical Treatment)
8. Industrial visit to power plant and switch yard
9. Energy Audit -:Case study of an organization and report

Text Books:

1. "Solar Energy",S.P.Sukhatme and J.K.Nayak, Tata McGraw-Hill, 3rd Edition, (2008).
2. "Non Convent Ional Energy Sources", G.D.Rai.- Khanna Publisher, 4th Edition.
3. "Power Plant Technology", M.M.El Wakil, Tata Mc Graw Hill. Int , 2nd Edition.Reprint, (2010).
4. "Power Plant Engineering", Domkundwar and Arora, Dhanpatrai and Sons.
5. "Modern Power Engineering" John Weisman and L.E. Eckart, , Prentice Hall of India, (1985).

ReferenceBooks:

1. "Solar Photovoltaic Fundamentals ,Technologies and Applications", Chetan Singh Solanki, Prentice Hall of India Publications.
2. "Modern Power Station Practice", Vol.6, Instrumentation, Controls and Testing, by Pergamon Press, Oxford, (1971).

3. “Power System Analysis”, Grainger John J, and Stevenson Jr.. W.D.,Tata McGraw Hill, (2003).
4. “Economic Operation of Power Systems”, L.K.Kirchmeyer,John Wiley and Sons, (1993).
5. “Power System Analysis”, C.A.Gross, John Wiley and Sons, Inc.(1986).

SHIVAJI UNIVERSITY, KOLHAPUR,
B.E. (Mechanical Engineering) **Semester VIII**
3. NOISE AND VIBRATIONS

Teaching Scheme:
Lectures: 3 Hrs/week
Practical: 2 Hrs/week

Examination Scheme:
Theory Paper: 100 marks
Term Work: 25 marks
Oral Exam: 25 marks

Course Objectives:
The course aims to:

1. Study basic concepts of vibration analysis
2. Acquaint with the principles of vibration measuring instruments
3. Create awareness about principles of sound level measurement and noise

Course Outcomes:
Upon successful completion of this course, the student will be able to

1. Develop mathematical model to represent dynamic system
2. Estimate natural frequency of mechanical element/system
3. Analyze vibratory response of mechanical element/system
4. Estimate the parameters of vibration isolation system
5. Carryout measurement of various vibration parameters
6. Understand relevance of noise in mechanical systems

Unit 1
Introduction **[04]**

Vibration and oscillation, Causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non-periodic, harmonic, non- harmonic, Degree of freedom, Static equilibrium position, Vibration classification, Steps involved in vibration analysis, Simple harmonic motion, Vector and Complex method of representing vibration, Fourier series and harmonic analysis.

Unit 2
Single DOF System **[08]**

a) Damped free vibrations, Types of damping, Logarithmic decrement and damping materials.
b) Forced Vibrations: Types of excitation, Forced excitation, Support excitation, Excitation due to unbalance in machines, Response of systems to above types of harmonic excitations, Transmissibility-Force transmissibility and motion transmissibility, Vibration isolators, commercial isolation materials and shock mounts.

Unit 3
Two DOF System **[08]**

a) Free undamped vibrations – Principal modes and natural frequencies, Co-ordinate coupling and principal co-ordinates.
b) Forced vibrations (Undamped) – Harmonic excitation, Vibration Dampers and absorbers, Dynamic vibration absorber – Tuned and Untuned type

Unit 4

Introduction to Multi DOF System **[07]**

a) Free vibrations of Multi DOF System-Flexibility and stiffness influence coefficient matrix, Equation of motion

b) Rayleigh's method, Matrix iteration method and Holzer method

Unit 5

Vibration Measuring Instruments **[05]**

Instruments for measurement of displacement, velocity, acceleration and frequency of vibration, Sensors and Actuators, Introduction of X – Y plotter, Spectral analyzers, Exciters FFT analyzer. Introduction to Condition Monitoring and Fault Diagnosis

Unit 6

Introduction to Noise **[08]**

a) Sound Level and Subjective Response to Sound

Frequency dependent human response to sound, Sound pressure dependent human response, Decibel scale, Relation among sound power, Sound intensity and sound pressure level, Octave Band Analysis.

b) Noise- Effects, Rating and regulation

Non auditory effects of noise on people, Auditory effects of noise, Noise standards and limits, Ambient emission noise standards in INDIA, Hazardous noise explosion, Day night noise level, Noise sources and control, Automotive noise control principles, Sound in enclosures, Sound energy absorption, Sound transmission through barriers.

Term Work:

Minimum ten Experiments out of following list.

1. Experiment on equivalent spring mass system.
2. Experiment on study of forced vibration characteristics
3. Determination of logarithmic decrement for single DOF damped system
4. Experiment on torsional vibration of two rotor without damping
5. Experiment on free vibration of a coupled pendulum and/or double pendulum
6. Experiment on torsional vibration of three rotor without damping
7. Use of different types of exciters for vibration analysis
8. Measurement of vibration parameters using vibration measuring instruments
9. Introduction to FFT analyzer, and prediction of spectral response of vibrating machine from workshop.
10. At least two case studies in detail based on Conditioning Monitoring and Fault Diagnosis
11. Measurement of Noise by using noise measuring instruments
12. Vibration analysis of mechanical system using MATLAB minimum two assignments

Reference Books:

1. "Mechanical Vibration",Austin Church, Wiely Eastern. 2nd Edition.
2. "Schaumm's Outline series in Mechanical Vibration", S. Graham Kelly, 6th Edition.
3. "Kinematics, Dynamics and Design of Machinery",Waldron, Willey India, 2nd Edition.
4. "Mechanical Vibrations", J.P. Den Hartog, Tata McGrawhill Book Company Inc., 4th Edition.
5. "Introduction to Dynamics and Control", Leonard Meirovitch, J. Wiley, New York.

6. “Elements of Vibration Analysis” Leonard Meirovitch, Tata McGrmv-Hill, New York. 2nd Edition.
7. “Principles of Vibration”,Benson H. Tongue,Oxford University Press., 4th Edition.
8. “Vibrations and Noise for Engineers”, Kewal Pujara Dhanpat Rai and Sons, (1992).
9. “Mechanical vibration”, William J Palm III Wiley India Pvt. Ltd., ISBN 978-81-265-3168-4, 1st Edition.

Text Books:

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

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
4. INDUSTRIAL ENGINEERING (ELECTIVE-III)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

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

Course Outcomes:
Upon successful completion of this course, the student will be able t**o**

1. Analyze and design new method of performing job.
2. Measure and estimate standard time for job.
3. Understand different types of plant layouts.
4. Interpret job evaluation and merit rating.

Unit 1 Introduction to Industrial Engineering and Productivity [06]
Introduction to Industrial Engineering – Definition, Scope, Responsibilities, Important contributors to I.E., Tools and techniques of industrial engineering.
Productivity – Concept, objectives, Factors affecting productivity, Tools and techniques to improve productivity, Productivity measurement models

Unit 2 Work Study [08]
Historical background, Role of work study in improving productivity, Method study procedure, Selection of jobs, Information, Collection and recording; Recording techniques, Charts, Diagrams, Templates, Models, Critical analysis, Development, Installation, and maintaining better method

Unit 3 Motion Study and Human Factor Engineering (Ergonomics) [06]
A) Motion Study: Principles of motion economy, Micro motion study, SIMO chart, MEMO motion study, Cycle graph, Chronocycle graph
B) Human Factor Engineering (Ergonomics): Introduction, Definition, Man machine system, Physiological work measurement, Design of controls

Unit 4 Work Measurement (Time Study) [08]
Definition, Objectives, Procedure, Time study equipment, Performance rating, Allowances, Concept of normal time and standard time, Calculation of standard time, Work sampling, Predetermined motion time analysis

Unit 5 Facility Design **[06]**

Plant site selection, Factors influencing the selection, Optimum decision on choice of site and analysis, Types of plant layout, Advantages and disadvantages of layout, Principles and objectives of plant layout, Tools and techniques of layout planning, Material handling

Unit 6 Value Analysis and Job Evaluation and Merit Rating **[06]**

A] **Value Analysis:** Definition, Concept of approaches of value analysis and engineering, steps, Evaluation, and applications of value analysis.

B] **Job Evaluation and Merit Rating:** Definition, Objectives, Procedure of job evaluation, Different schemes and their advantages and disadvantages.

Term Work:

1. Problems on productivity.
2. Two case studies on method study.
3. Man; Machine chart program.
4. Two handed process chart.
5. Stop watch time study for an operation.
6. Work sampling.
7. Plant site location analysis.
8. Plant layout problems.
9. Case study on Value analysis concept.
10. Case study on job evaluation and merit rating.

Text Books:

1. "Introduction to Work Study", ILO, Geneva and Oxford and IBH Publication Co. Pvt. Ltd,. 2nd Edition.
2. "Industrial Engineering and Production Management", M. Telsang, S. Chand Publication.
3. "Industrial Engineering", L.C. Jhamb,Everest Publication, Pune.
4. "Work Study", O.P. Khanna, Dhanpat Rai Publication New Delhi, 17th Edition.

Reference Books:

1. "Motion and Time Study Design and Measurement of Work"R.M. Barnes, John Willey and Sons Inc. 7th Edition.
2. "Industrial Engg. Handbook", H.B. Maynard and Others,Tata McGraw Hill Publication.4th Edition.
3. "Production and Operation Management", J. Adam EE, R J Ebert Prentice Hall Englewood Cliff N.
4. "Productivity Engg. and Management",David Sumanth,T ata McGraw Hill, New Delhi.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
4. PRODUCTION MANAGEMENT (ELECTIVE-III)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

1. Get acquainted with basic aspects of Production management
2. Study various important planning, organizing and controlling aspects of Operations management
3. Study different operational issues in manufacturing and service organizations.

Course Outcomes:
Upon successful completion of this course, the student will be able to

1. The students will have fair understanding of the role of Production / Operations Management played in business processes.
2. Emphasis on both familiarization of various production processes and service systems and quantitative analysis of problems arising in the management of operations.

Unit 1 Introduction to Production Management [07]
Production types, Objectives and scope of Production Management, Production Planning and Control (PPC)- Definition and elements and activities of production planning and production control Relevance, Strategy formulation process, Order qualifiers and order winners, Strategic options for Operations- Product – Process Matrix, Product portfolio, Process technology, WCM practices

Unit 2 Product and Process Design [06]
Determinants of process characteristics- Volume, Variety, Flow, Types of processes, Choice of Process, Equipment selection, Use of BEP in selection process- Product matrix. Estimation of Demand- Time series Analysis and causal forecasting techniques, Least square method, Moving average and exponential smoothing forecasting method Role of Product Development in competitiveness, Product Life Cycle (PLC), Product Development Process.

Unit 3 Capacity and Scheduling of Operations: [07]
Capacity- Definition, Measure of Capacity, Capacity strategies,Estimation of number of machines, Overcapacity and under capacity factors, Aggregate Planning, Aggregate Planning Strategies, Use of transportation model approach to aggregate planning Loading, scheduling and sequencing, Priority sequencing rules. Sequencing problems, n job 2 machines, n Job '3' machines. Forward and backward scheduling, Critical ratio scheduling, Production Control Activities

Unit 4 Supply Chain Management and Advanced Manufacturing Techniques: [08]
Concept of supply chain and supply chain management, Manufacturing supply chain, SCM activities, Supply chain strategies, Managing supply chain, Measuring supply chain performance,

JIT Philosophy, Origin and core logic of JIT, Elements of JIT, Kanban System- Design of Kanban containers, JIT.Implementation issues and performance, Lean Manufacturing- Pillars, features and process comparison with Traditional Manufacturing.

Unit 5 Total Productive Maintenance and Replacement : [06]

Introduction, Definition, Six big losses, Stages of maintenance, Pillars stages of TPM Development, Overall Equipment Effectiveness (OEE) Computation Replacement - need, Replacement of items whose maintenance cost increases with time (with and without considering time value of money), Replacement of items that fail suddenly

Unit 6 Production Economics [06]

Demand and supply, Demand curve and supply curve, Equilibrium of supply and demand, Elasticity of demand Production function, Factors of production, Isoquants, Review - Time value of money, Cash flows, Evaluation criteria for capital projects (investment) Payback period, IRR and BCR

Term Work:

1. Presentation on Case study on "Interdepartmental relationship in a business organization"
2. Presentation on Case study on "Design for Manufacturing and Assembly".
3. Assignment on Demand Forecasting.
4. Problems on Job sequencing- Single Machine Scheduling, Priority Sequence and Johnson's Algorithm.
5. Presentation on Case study on "Implementation of JIT in a small/ medium company".
6. Problems on Estimate OEE and Replacement Analysis.
7. Exercises on Analyzing tools in Project preparation.
8. Presentation on World Class Manufacturing Practices like Toyoto Mfg. system, etc.

Text Books:

1. "Industrial Engineering and Production Management", Martand Telsang, S Chand and Company New Delhi, (2009).
2. "Productions and Operations Management", Kanishka Bedi, Oxford Higher Education., 3rd Edition .
3. "Production and Operation Management", Tripathi, , Scitech Publications.
4. "Production and Operation Management", S. N. Chary, Tata McgGraw Hill, 5th Edition.

Reference Books:

1. "Production and Operations Management", Buffa. Elwood modern Wiley India,8th Edition.
2. "Operation Management, Process and Value Chain", Krajewski and Ritzman, Malhotra Pearson Education.
3. "Production and Operations Management", Ashwathappa, Bhat , Himalaya Publishing
4. "Techniques of Value Analysis and Engineering", Miles Lawrence.
5. "Operation Management Theory and Practice", Mahadevan B Pearson Education,(2007)
6. "Operations Management" Kaither and Frazer, Cengage Publication
7. "Production and Operation Management", Everett E. Adam and Ebert, PHI Publication, ISBN no. 9788120308381.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
4. FRACTURE MECHANICS (Elective III)

Teaching Scheme:
Lectures: 3 Hrs/Week
Practical: 2 Hrs/Week

Examination Scheme:
Theory Paper: 100 Marks
Term Work: 25 Marks

Course Objectives:

The course aims to:

1. Define the near field equations to determine the stress strain and load displacement fields around a crack tip for linear elastic cases.
2. Identify and formulate the stress intensity factor ((k) for typical crack configurations
3. Identify and formulate the strain energy release rate (g).
4. Identify and formulate j - integral and the stress and strain fields around a crack tip for non linear and elastoplastic materials.
5. Define fracture toughness of materials using kc , gc and jc.
6. Employ the standard and non standard fracture mechanics tests to determine the fracture toughness of materials.
7. Predict the fatigue life of structures using fracture mechanics approaches.

Course Outcomes:

Upon successful completion of this course, the student will be able to

1. Understand and account for the theoretical background of linear and nonlinear fracture mechanics.
2. Carry out fracture mechanics analysis and design, using handbooks, of simple crack problems in linear and nonlinear materials.
3. Determine the loading applied on a crack.
4. Evaluate fracture mechanics testing.
5. Carry out analyses of crack growth
6. Determine whether or not stable crack growth can become unstable.
7. Apply the knowledge from the course on practical cases where linear fracture mechanics is sufficient

Unit 1 **[07]**

Theories of Failure: Maximum shear stress theory, Maximum normal stress theory, Maximum distortion energy theory, Maximum strain theory, Applicability of theories of failure.

Unit 2 **[06]**

Fracture: Type of fracture, Theoretical cohesive strength of metals, Griffith theory of brittle fracture, fracture single crystals, MetallograPhic aspects of fracture, Dislocation theories of brittle fracture, Ductile fracture, Notch effects, Fracture under combined stresses.

Unit 3[07]

Elements of Fracture Mechanics: Strain- energy release rate, Stress intensity factor, Fracture toughness, Plane - strain toughness testing, Crack-opening displacement, J- Integral to solve energy of crack formation, R-curves, Toughness of material.

Fatigue Failure: Stress cycle, S-N curve, Description of fatigue fractured parts, Phases of fatigue fracture, Fatigue crack propagation, Effects of metallurgical variables, Temperature, Stress concentration, Size and surface factors, Fatigue under combined stresses.

Unit 4 **[07]**

Creep Failure: Creep curve, Structural changes and mechanisms during creep, Activation energy for steady-state creep, Fracture at elevated temperature.

Brittle Fracture: Transition temperature curves, Fracture analysis diagrams, Various types of embitterment, Fracture under very rapid loading.

Unit 5 **[06]**

Ductile Fracture: Condition for necking, Dislocation and void formation activities, Types of fractured parts.

Assessment of Types of Fractures by Observation: Comparison between different fractured parts undergoing various type of fracture.

Unit 6 **[07]**

Design Application of the Knowledge of Failure: Design considering fatigue-Geber's parabola, Soderberg equation, Lubricating optimally to combat bearing failures. Selection of materials to prevent seizure, galling, etc. Wear reduction techniques, Fracture toughness consideration in design.

Term Work:

Minimum eight assignments from the following

1. The Evaluation of Fracture toughness by Numerical Methods of finite elements.
2. Methods for Evaluating Fracture toughness by Numerical Methods of Finite Differences (FD).
3. Evaluating Fracture toughness by Numerical Methods of Boundary Integral Equations.
4. The Evaluation of Fracture toughness by Experimental Methods.
5. Study of the Methods for Evaluating Fracture toughness by Compliance Method.
6. The Evaluation of Fracture toughness by Photo elasticity.
7. The Evaluation of Fracture toughness by Interferometery and Holography.
8. The Experimental evaluation of Fracture toughness by
   a. Plane strain fracture toughness method
   b. J Integral
9. Comparison between computer modeling and Experimental verification of Fatigue properties of S-N diagram, fatigue limit, fatigue crack growth rate, Paris law.

Text Books:-

1. “Fracture Mechanics – Fundamentals and application”, T.L. Anderson,CRC Press.
2. “Elements of Fracture Mechanics”, Prashant Kumar, Tata McGraw –Hill, New Delhi.

Reference Books:

1. “Metal Fatigue Design and Theory”,.Madoyag, F.
2. “Fatigue Design of Machine Components”, Sors, L., , Pergamon Press.
3. “Fracture and Fatigue Control Structures”, Rolfe, S.T. and Barson, J.M., , Prentice Hall of India.
4. “Elementary Engineering Fracture Mechanics”, Broek, D., , Noordnoff.
5. “Mechanical Metallurgy”, Dieter, G.E., ,Tata McGraw Hill Book Co., New Delhi.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
4. RELIABILITY ENGINEERING (Elective – III)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term work: 25 Marks

Course Objectives:
The course aims to:

1. Introduce principles of reliability in engineering design.
2. develop understanding of concepts of failures, maintainability and availability of the intended products/systems and services.
3. Develop an ability to analyze field failure data in order to evaluate system reliability.
4. Develop an ability to apply various reliability techniques to solve interdisciplinary reliability problems.

Course Outcomes:
Upon successful completion of this course, the student will be able to

1. Explain basics of reliability, maintainability and availability and differentiate among them.
2. Apply fundamentals of reliability to estimate reliability of mechanical systems, electronic devices, softwares and human.
3. Analyze field failure data for reliability analysis.
4. Evaluate system reliability using various techniques.

Unit 1 Fundamentals of Reliability and its Measures [07]

Brief history of reliability, Concepts, Terms and definitions, System safety, Quality and reliability, Life cycle cost of a product or system, System effectiveness, Concept of failure, Laws of probability, Random variables, Discrete and continuous probability distributions.
Measures: Reliability function, Hazard rate function, CDF, PDF, MTTF, MTBF, Median time to Failure, Mean, Mode, Median, Skewness, Kurtosis, Variance and standard deviation, Typical forms of hazard rate function, Bathtub curve.

Unit 2 Reliability Distributions [06]

Basic reliability distribution, Conditional reliability, Constant Failure Rate (CFR) model, Binomial distribution, Normal, Poisson, Lognormal, Rayleigh, Weibull etc., Fitting probability distributions graphically and estimation of distribution parameters, Calculation of R(t), F(t), f(t), $\lambda(t)$, MTTF, t_{med}, t_{mode} for above distributions.

Unit 3 Reliability Evaluation of Systems[07]

System Reliability block diagram- Series configuration, Parallel configuration, Mixed configurations, Redundant systems, Standby redundant, Load sharing systems etc. High level versus low level redundancy, k-out-of-n redundancy, Network reduction and decomposition methods, Cut and tie set approach for reliability evaluation.

Fault tree analysis (FTA), Success tree method, Failure mode and effect analysis (FMEA), Failure modes effects and criticality analysis (FMECA), Morkov analysis, Monte Carlo simulation.

Unit 4 Maintainability and Availability [07]

Maintainability - Objectives of maintenance, Types of maintenance, Concept of maintainability, factors affecting maintainability, System downtime, Measures of maintainability, Mean time to repair (MTTR), Analysis of downtime, Repair time distributions, Stochastic point processes, Reliability centered maintenance (RCM).

Availability -Availability concepts and definitions, Important availability measures, Inherent, achieved and operational availability.

Unit 5 Reliability Testing and Data Analysis [06]

Reliability Testing - Life testing, Burn-in testing, Acceptance testing, Accelerated life testing, highly accelerated life testing (HALT) and reliability growth testing.

Data Collection and Analysis - Data collection, Empirical methods, Estimation of performance measures for ungrouped compete data, Grouped complete data, Analysis of censored data, Pareto analysis, and Goodness-of-fit tests.

Unit 6 Interdisciplinary Approach and Life Cycle Cost (LCC) [07]

Electronics - Reliability of electronic components, Component types and failure mechanism.

Software – Introduction, errors, Software testing, Hardware/ software interface.

Human reliability analysis (HRA) - Introduction, human error in maintenance, Impact on system reliability. Reliability costs, effect of reliability on LCC, Categories of costs, Calculation of LCC.

Term Work:

A. Any Four Assignments out of following.

1. Theory of Reliability and Probability.
2. Fitting probability distributions graphically and estimation of distribution parameters.
3. Numerical based on Reliability Evaluation of Systems.
4. Maintainability and availability
5. Reliability testing

B. Any Two Case Studies:

1. Reliability Analysis of Mechanical Systems
2. Reliability centered maintenance (RCM)
3. Life cycle cost analysis.

Text Books:

1. "Introduction to Probability Models", Sheldon M. Ross, Elsevier,9th Edition.
2. "An Introduction to Reliability and Maintainability Engineering", Charles E. Ebling, Tata McGraw Hill Education Private Limited, New Delhi (2004).
3. "Reliability Engineering", L. S. Srinath, East West Press, New Delhi (1991).
4. "Reliability Engineering", K. K. agarawal, Springer International Edition.
5. "Reliability Engineering", E. Balagurusamy, Tata McGraw Hill.
6. "Reliability Engineering: Theory and Practice", Alessandro Birolini, Springer (2010).
7. "Reliability Evaluation of Engineering Systems: Concepts and Techniques", Roy Billiton and Ronald Norman Allan,Springer (1992).
8. "Practical Reliability Engineering",Patrick D.T. O'Conner, David Newton, Richard Bromley, John Wiley and Sons.(2002)
9. "Reliability Engineering: Probabilistic Models and Maintenance Methods", Joel A. Nachlas Taylor and Francis (2005).
10. "Reliability in Engineering Design", K. C. Kapur, L. R. Lamberson, John Wiley and Sons.
11. "Reliability Theory with Application to Preventive Maintenance", I. Gertsbakh , Springer Inc. Edition.
12. "Reliability Engineering and Quality Management", Onkar N. Pandey, Bhupesh Aneja, Katson and Sons.

Reference Books:

1. "Reliability Engineering and Risk Analysis – A practical Guide", Mohammad Modarres, Mark Kaminskiy, Vasiliy Krivstov,CRC Press, Taylor and Francis Group.
2. "Life Cycle Reliability Engineering", Guangbin Yang, John Wiley and Sons (2007).
3. "Case studies in Reliability and Maintenance", W. R. Blischke, D.N.P. Murthy, John Wiley and Sons (2003).
4. "Maintenance, Replacement and Reliability: Theory and Applications", Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, CRC/Taylor and Francis (2006).
5. "Engineering Reliability – New Techniques and Applications", B. S. Dhillon, Chanan Singh, John Wiley and Sons (1981).
6. "Engineering Maintainability", B. S. Dhillon Prentice Hall of India.,(1999).

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
4. ADVANCED I C ENGINES (Elective III)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

1) Understand modern fuel injection systems.
2) Understand thermodynamics of combustion phenomenon.
3) Understand cause of emission and its control.
4) Understand alternative fuels for I C engines.

Course Outcomes:
Upon successful completion of this course, the student will be able to

1) Analyze fuel injection system of IC engines
2) Analyze the combustion in thermodynamic point of view.
3) Know design aspects of combustion chamber.
4) Know new trends in IC engines.
5) Know the modification in engines for alternative fuels.
6) Know advanced emission control methods

Unit 1 **SI Engines** **[06]**

Review of SI engine, Over-expanded engine cycle, Fuel characteristics, Fuel rating. Modern Carburetor. Recent Spark Plug, Spark Timing. Multi-Point Fuel injection system and its components, Sensors and transducers, ECU. Feedback system, Flow intake Manifold- Design requirements, Air flow and fuel flow phenomenon, Fuel injection pumps.

Unit 2 **CI Engines** **[06]**

Review of CI engine, Electronic fuel injection system, ECU, sensors and transducers, Feedback system, Fuel spray behavior, Recent fuel injector and injection timing, Advanced diesel fuel injection pump, Advance turbo charging system.

Unit 3 **Combustion** **[08]**

SI engine combustion phenomenon, Turbulence characteristics, Combustion chamber design using simulation software's (Introductory), Chamber optimization Strategy, Thermodynamic analysis of SI engine combustion (Combustion Analyzer)

CI Engine combustion phenomena, Swirl, Swirl Measurement, Generation of Swirl during induction, Swirl within cylinder, Combustion chamber design using simulation software's (Introductory), Chamber optimization Strategy, Thermodynamic analysis of CI engine combustion (Combustion Analyzer)

Unit 4 Alternate Fuels [07]

Hydrogen and Fuel cells, Ethanol, Bio-Diesels, Alcohols, LPG- Engine Modification, Combustion and Emission characteristics of SI and CI Engine using alternative fuels.

Unit 5 Engine Emission, Pollution And Its Controls [07]

Formation of HC, NOx, CO mechanism, Smoke and Particulates emission, Methods of Controlling Emissions, Measuring Equipment's and methods, International and National Emission Norms

Unit 6 Trends In IC Engines [06]

Quadra jet, Variable Valve Timing, Recent CRDI engine, Variable Turbo Geometry system, 3-Way Catalytic Converter, SOHC, DOHC, Homogeneous Charge Compression Ignition, Variable compression ratio engine , Low Heat Rejection Engine, Lean Burn Engine, Six-Stroke Engine, Gasoline Direct Injection System.

Term Work:

Seven assignments (One Assignment on each unit and two assignments on unit three) and One case Study.

Text Books:

1. "Internal Combustion Engines Fundamentals", E. F. Obert, Harper and Row Publication, New York.
2. "Internal Combustion Engines",J. B. Heywood, McGraw Hill.
3. "Internal Combustion Engines", Maleev, CBS Publication and Distributors.
4. "Internal Combustion Engines",V. Ganesan.

Reference Books:

1. "Internal Combustion Engines",Gills and Smith.
2. "Diesel and High Compression Gas Engines",P. M. Kates.
3. "Engg. Fundamentals of the I.C.Engines" W.W.Pulkrabek, Pearson Education.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
4. MACHINE TOOL DESIGN (Elective III)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs./Week	Theory Paper:100 Marks
Practical: 2 Hrs./Week/ Batch	Term Work: 25 Marks

Course Objectives:

The course aims to:

1. Know the classification, requirements and design considerations of machine tools.
2. Understand various motions, drives, and transmissions of machine toolsand their design
3. Study parameters and procedure for design of machine tool structures
4. Understand the design procedure of other functional elements of machine tools
5. Understand the source and effect of vibrations in machine tools
6. Study various control systems and their application in automation.

Course Outcomes:

Upon successful completion of this course, the student will be able to

1. Identify ,formulate and solve engineering problems
2. Identify areas for research oriented work based on the course content
3. Apply the knowledge of the course in solving real life problems
4. Apply the knowledge of machine tool designing
5. Design a machine tool to meet the desired needs such as manufacturability and sustainability.
6. Use techniques, skills and modern engineering tools necessary for engineering practice.
7. List down the factors that influence the application of the course content in the industrial environment,

Unit 1 Introduction to Machine Tool Design [05]

Classification of machine tools based on their construction, Precision, Control, Drives and rate of production. Elements of machine tools, General requirements of machine tool design, Engineering design process applied to machine tools, Layout of machine tools, Various motions introduced in machine tools, Parameters defining limits of motions.

Unit 2 Design of Machine Tool Drives [09]

Requirements of machine tools drives, Mechanical and hydraulic transmission used in machine drives ,their elements ,Selection of speed and feed ,Types of Speed and feed regulation, Stepped, step-less, mechanical, electrical, Hydraulic methods of speed regulation and their comparison. Stepped drives of machine tools- Gear drives, Gear box design, Graphical representation of gear box operation with ray diagram, Structural diagram, Deviation diagram. Drives for CNC machine tools- AC and DC servomotors, Stepper motors.

Unit 3 Design of Machine Tool Structures [06]

Functional requirements of machine tool structures, Consideration used in design for strength and rigidity, Design procedure for machine tool structures, Materials for machine tool structures, Design of beds, columns and housings.

Unit 4 Design of Guide ways, Slide ways, Spindles and Spindle Supports [08]

Function and types of guide ways, Design of slide ways-Shape and Materials, Protecting devices for Slide ways, Force analysis of Lathe guide ways, Guide ways operating under liquid friction conditions, Design of antifriction guide ways, Design of Aerostatic slide ways, Design of Antifriction slide ways, Introduction to design of power screws.

Functions of spindle unit and requirements, Materials, Machine tool compliance and machining accuracy, Design calculations of spindles, Bearings for spindles,Sliding bearing used for spindles.

Unit 5 Dynamics of Machine Tools[07]

Effect of vibrations, Source of vibrations, Self excited vibration, Single degree of freedom chatter, Velocity principle and related models, Regenerative principles, Chatter in lathe, drilling, milling and grinding, Machine tool elastic system, General procedure for assessing Dynamic stability of equivalent elastic system. Finite Element Analysis (FEA) techniques for Vibration analysis of machine tool structure and methods of elimination of Vibrations.

Unit 6 Machine Tool Control and Automation [05]

Control Systems: Functions, requirements and classification, Control systems for speeds and Feeds, Various motions etc. Manual and automatic control systems. Basic principle of control, Hydraulic controls, Fluid controls, Numerical controls, Feed-back systems, Primary systems programming.

Automation: Systems such as mechanical, electrical, electronics, optical, pneumatic/hydraulic used for position control, their application in automation, Degree of automation, Semi automation.

Term Work:

1. Design of at least two elements of machine tool - analytical and numerical using FEA
2. Design of one sub- assembly like gear box, feed box, with design report containing allCalculations, Sketches for design; and sheet of A2 size containing drawing of details and assembly.
3. **Any four assignments on the following**
   (a) Transmission used in machine drives.
   (b) Design of power screws for a machine tool.
   (c) Machine tool compliance and machining accuracy in a machine tool.
   (d) Design of guide-ways based on wear resistance and stiffness.
   (e) Vibration analysis of machine tool structure.
   (f) Machine tool control and Automation

*Standard Design data books for all above experiments should be used.

Text Books:

1. "Machine Tool Design and Numerical Control", N.K Mehta, TMH, 3rd Edition.
2. "Principles of Machine Tools" Sen and Bhattacharya, New Central Book Agencies.

Reference Books:

1. "Machine Tools Handbook: Design and Operation" P. H. Joshi, McGraw Hill.
2. "Machine Tool Engineering", Nagpal G.R., Khanna Publications.
3. "Design of Machine Tool Design" S.K. Basu and D. K. Pal, Oxford IBH Publishing Co.
4. "Machine Tool Design Handbook", CMTI, TMH.
5. "Machine Tool Design", Basu and Pal,Oxford and IBH.

SHIVAJI UNIVERSITY ,KOLHAPUR
B.E. (Mechanical Engineering) SemesterVIII
4. DESIGN OF AIRCRAFT SYSTEMS (ELECTIVE – III)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term work: 25 Marks

Course Objectives:

The course aims to:

1. Study the fundamentals of aircraft design and structural analysis
2. Study the aircraft materials and processes
3. Study structural analysis of various components like plates, shells, beams.
4. Know about airworthiness
5. Study aircraft structural repair

Course Outcomes:

Upon successful completion of this course, the student will be able to

1. Understand the basics of aircraft systems and aircraft structures.
2. Know industry practices on design of aircraft structures and systems.
3. Understand the applicability of design aspects in aircraft design.
4. Relate the theoretical knowledge with the design of aircraft structures and systems.

Unit 1 Fundamentals of Aircraft Design and Structural Analysis [06]

Introduction, Phases of Aircraft Design, Aircraft Conceptual Design Process, Conceptual Stage, Preliminary Design, Detailed Design, Design Methodologies

Review of Hooke's Law, Principal stresses, Equilibrium and Compatibility, Determinate Structures, St Venant's Principle, Conservation of Energy, Stress Transformation, Stress Strain Relations.

Unit 2 Aircraft Structures and Loads [07]

Types of Structural members of Fuselage and wing section Ribs, Spars, Frames, Stringers, Longeron, Splices, Sectional Properties of structural members and their loads, Types of structural joints, Type of Loads on structural joints

Aerodynamic Loads, Inertial Loads, Loads due to engine, Actuator Loads, Maneuver Loads, VN diagrams, Gust Loads, Ground Loads, Ground conditions, Miscellaneous Loads.

Unit 3 Aircraft Materials and Manufacturing Processes [07]

Material selection criteria, Aluminum Alloys, Titanium Alloys, Steel Alloys, Magnesium Alloys, Copper Alloys, Nimonic Alloys, Non Metallic Materials, Composite Materials, Use of Advanced materials Smart materials, Manufacturing of A/C structural members, Overview of types of manufacturing processes for Composites, Sheet metal Fabrication ,Machining, Welding, Super plastic Forming And Diffusion Bonding.

Unit 4 Structural Analysis of Aircraft Structures - I [08]

Theory of Plates - Analysis of plates for bending, stresses due to bending, Plate deflection under different end conditions, Strain energy due to bending of circular, rectangular plates, Plate buckling, Compression buckling, shear buckling, Buckling due to in plane bending moments, Analysis of stiffened panels in buckling, Rectangular plate buckling, Analysis of Stiffened panels in Post buckling, Post buckling under shear

Theory of Shells- Analysis of Shell Panels for Buckling, Compression loading, Shear Loading / Shell Shear Factor, Circumferential Buckling Stress.

Unit 5 Structural Analysis of Aircraft Structures - II [08]

Theory of Beams- Assumptions in theory of Bending, Moment of resistance, Section modulus, Neutral axis, Stress distribution diagram for cantilever and simply supported beam. Equation of Bending. Symmetric Beams in Pure Bending, Deflection of beams, Unsymmetrical Beams in Bending, Plastic Bending of beams,Shear Stresses due to Bending in Thin Walled Beams, Bending of Open Section Beams, Bending of Closed Section Beams, Shear Stresses due to Torsion in Thin Walled Beams

Theory of Torsion- Assumptions in theory of pure torsion, Torsion equation for solid and hollow circular shaft. Shafts of Non-Circular Sections, Torsion in Closed Section Beams, Torsion in Open Section Beams, Multi Cell Sections

Unit 6 Airworthiness and aircraft Structural Repair [04]

Airworthiness Regulations, Regulatory bodies, Type Certification, General Repair, Airframe Requirements, Landing Requirements, Fatigue and Failsafe Requirements.

Types of Structural damage, Nonconformance, Rework, Repair, Allowable Damage Limit, Repairable Damage Limit, Overview of ADL Analysis, Types of Repair, Repair Considerations and best practices

Term Work:

Eight Assignments based on the Syllabus.

Out of eight, two assignments should contain the following:

- Hands-on calculation on Exercises related to Fundamentals of Structural Analysis
- Hands-on Calculation on Exercises involving, plate theory, beam theory and shell theory, Panel buckling, Shear flow Exercises in Aircraft Structures.

Industrial Visits

With an intent to get some exposure on Aerospace and related industries, arrange

- Industry Visits to some of the Industries in Aerospace like HAL (Hindustan Aeronautics Limited), NAL (National Aerospace Limited), ISRO (Indian Space Research Organization) **OR**
- Visits to Aerospace Museums **OR**
- Building miniature Models of Aircraft /Gliders etc as a Hands on Exercises conducted as competitions

Text Books:

1. "Aircraft Design-A Conceptual Approach", Daniel P.Raymer, AIAA education series,6th Edition.
2. "Airframe Structural Design", Michael Niu, Conmilit Press, ,2nd Edition (1988).
3. "Airframe Stress Analysis and Sizing",Michael Niu, Conmilit Press,3rd Edition (1999).

Reference Books:

1. "Mechanics of flight", A.C. Kermode, Pearson Education, 5th Edition.
2. "The Elements of Aircraft Preliminary Design", Roger D. Schaufele, Aries Publications (2000).
3. "Aircraft Structural Maintenance", Dale Hurst, Avotek publishers, 2nd Edition (2006).
4. "Aircraft Maintenance and Repair", Frank Delp, Michael J. Kroes and William A. Watkins, Glencoe and McGraw-Hill,6th Edition (1993).

SHIVAJI UNIVERSITY,KOLHAPUR

B.E. (Mechanical Engineering) Semester VIII

5. INDUSTRIAL AUTOMATION AND ROBOTICS (Elective-IV)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term Work: 25 Marks

Course Objectives:

The course aims to:

1. Introduce automation and basic elements of automated systems.
2. Get knowledge of advanced automated and levels of automations.
3. Introduce the industrial robotics and its applications.
4. Knowledge of programming associated with robo-control.

Course Outcomes:

Upon successful completion of this course, the student will be able to

1. Design techniques for the analysis and control of discrete event system
2. Apply knowledge of automation tools and other equipments for manufacturing and assembly components
3. Operate in research and development centre for automation
4. Identify efficiencies and limitation and provide in depth evaluation of robotic system for automated manufacturing applications

Unit 1 Introduction to Automation [06]

Automated manufacturing systems, Fixed /programmable/ flexible, Automation, Need of automation, Basic elements of automated systems- Power, program and control. Low cost automation, Economic and social aspects of automation, Advanced automation functions, Levels of automation.

Unit 2 Industrial Control and Transfer Line [08]

A. Industrial control systems in process and discrete manufacturing industries, Continuous and discrete control; Computer process control.
B. Fundamentals of transfer lines, Configurations, Transfer mechanisms, Storage buffers, Control, Applications; Analysis of transfer lines with and without storage buffers.

Unit 3 Assembly Automation [06]

Assembly Automation: Types and configurations, Parts delivery at workstations, Various vibratory and non-vibratory devices for feeding and orientation, Product design for automated assembly, Quantitative analysis of assembly system.

Unit 4 Fundamentals of Industrial Robots [06]

Specifications and Characteristics, Criteria for selection, Robotic Control Systems: Drives, Robot Motions, Actuators, Power transmission systems, Robot controllers, Dynamic properties

of robots-stability, Control resolution, Spatial resolution, Accuracy, Repeatability, Compliance, Work cell control, Interlocks.

Unit 5 Robotic End Effectors and Sensors [07]

Transducers and sensors- Sensors in robotics and their classification, Touch (Tactile) sensors, Proximity and range sensors, Force and torque sensing, End Effectors- Types, grippers, Various process tools as end effectors; Robot End effector interface, Active and passive compliance, Gripper selection and design, Transformation, Relative transformation, Direct and inverse kinematics solutions, DH representation and displacement matrices for standard configuration (theoretical treatment).

Unit 6 Robot Teaching [07]

Introduction, Various teaching method, Task programming, Survey of Robot level programming languages, A Robot program as a Path in space, Motion interpolation, WAIT, SIGNAL and DELAY commands, Branching, Robot language structure, Various textual robot, Languages such as VAL II, RAIL, AML and their features, Typical programming examples such as palletizing, Loading a machine etc., Application of Robot.

Term Work:

1. A Case study on low cost automation
2. Study of part delivery system at work stations in automated assembly.
3. Problems on analysis of transfer line
4. One Programming exercise on lead through programming.
5. Two Programming exercises using various commands of VAL II.
6. Demonstration of various robotic configurations.
7. One Industrial visit for Industrial automation and robotic application

Text Books:

1. "Automation, Production Systems and Computer Integrated Manufacturing", Groover, M.P., Pearson Education, ISBN: 81-7808-511-9 2nd Edition (2004).
2. "Industrial Robotics, Technology, Programming and Applications", Groover, M.P.; Weiss, M.; Nagel, R.N. and Odrey, N.G. , McGraw Hill Intl. Edition.,ISBN: 0-07-024989-X.
3. "Introduction to Robotics, Analysis, Control and Applications", Niku, Saeed B., Willey Publication, ISBN 9788126533121, 2nd Edition.
4. "Robotics-Control, Sensing, Vision and Intelligence", Fu, K.S.; Gonzalez, R.C. and Lee, C.S.G., McGraw Hill Intl. Ed., ISBN:0-07-100421-1.

Reference Books:

1. "Robot Technology Fundamentals", Keramas, James G, Thomson Learning –Delmar ISBN: 981-240-621-2,(1998).
2. "Handbook of Robotics", Noff, Shimon Y., John Wiley and Sons.
3. "Introduction to Robotics, Analysis, Systems and Applications", Niku, Saeed B. (2002), Prentice Hall of India.
4. "Robotics for Engineers", Koren, Yoram, Tata McGraw Hill.,(2003)

5. “Fundamentals of Robotics, Analysis and Control”, Schilling, Robert J, Prentice Hall of India, ISBN: 81-203-1047-0, (2004).
6. “Introduction to Robotics Mechanics and Control” J. J. Craig, Pearson Education,3rd Edition.
7. “Applied Robotics Volume I and II”, Edwin Wise, Cengage Learning.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
5. CRYOGENICS (Elective- IV)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hours/Week	Theory Paper: 100 Marks
Practical: 2 hours/Week	Term Work: 25 marks

Course Objectives:
The course aims to:

1. Enable the students to analyze and solve cryogenics related problems by applying principles of mathematics, science and engineering.
2. Prepare students to use modern tools, techniques and skills to fulfill industrial needs related to low temperature systems.
3. Effective communication skill to demonstrate cryogenics theories.
4. Develop skills in the analysis of cryogenics systems in research or design.
5. Develop a professional approach to lifelong learning in the cryogenics to include the awareness of social and environment issues associated with engineering practices.

Course Outcomes:
Upon successful completion of this course, the student will be able to

1. Describe: different Cryogenic systems.
2. Understand and interpret the analysis report in the field of Cryogenic.
3. Apply knowledge of mathematics, science, and engineering for the needs in Cryogenic.
4. Design systems as per the desired needs based on economical, social, and environmental issues associated with engineering practices.
5. Communicate required information to develop various ideas related to design/research in different Cryogenic systems.
6. Contribute knowledge to solve step by step problems for lifelong learning.

Unit 1 **[06]**
Introduction: Introduction**,** Industrial applications, Recent development, Properties of cryogenic Fluids, Applications of cryogenics in different areas such as Space, Medical, Manufacturing processes, Mechanical Design
Behavior of Structural Materials at Cryogenic Temperature: Mechanical properties, Thermal properties, Thermoelectric properties.

Unit 2 **[07]**
Liquefaction of Cryogenic Gases: Ideal cycle, System performance parameters, Joule Thomson effect, Adiabatic expansion, Liquefaction systems; Simple Linde-Hampson system, Precooled Linde-Hampson system, Cascade system, Claude system, Comparison of above systems.

Unit 3 **[07]**

Liquefaction Systems for Neon, Hydrogen, Helium and Heat Exchanger: Precooled Linde-Hampson system forneon and hydrogen, Claude system for hydrogen, Helium refrigerated hydrogen liquefaction system, Heat exchanger used in liquefaction systems

Unit 4 **[06]**

Cryogenic Refrigeration Systems: Ideal refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvay refrigerator, Gifford-McMohan refrigerator, Pulse tube refrigerator.

Unit 5 **[07]**

Gas Separation and Purification: Thermodynamic Ideal refrigeration system, Temperature composition diagram, Principles of Gas separation,Principles ofRectifiers column, Separation column design; Plate calculation, Types of rectification columns, Single column and double column air separation systems, Cryogenic air separation plants, Linde single Column separation system, Gas Purification methods

Unit 6 **[07]**

Insulation: Cryogenic fluid storage,Vacuum insulation, Fibrous materials, Solid foams, Gas filled power, Comparison, Critical thickness.

Vacuum Technology: Importance, Pump down time, Flow regimes, Components of vacuum systems, Mechanical Vacuum pumps, and Ion pumps

Term Work:

Any six experiments/ tutorial based on above syllabus

Text Books:

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

Reference Books:

1. "Experimental Techniques in low Temperature Physics", Guy, K White, Claredon Press, Oxford, (1987).
2. "Cryogenic Research and Applications", Marshall Sitting and Stephen Kidd, D. Van Nostrand, Inc USA, (1963).
3. "Cryo-Cooler: Fundamentals Part-I", G. Walker, Plenum Press, New York.
4. "Cryo-Cooler: Fundamentals Part-II", G. Walker, Plenum Press New York.
5. "International Journal of Cryogenics", Elsevier Publication.
6. "Advanced Cryogenic Engineering", Proceedings of Cryogenic Engineering Conference, Vol. 1-145, Plenum Press, New York (1968).

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering)Semester VIII
5. ENTERPRISE RESOURCE PLANNING (ELECTIVE-IV)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term Work: 25 Marks

Course Objectives:
The course aims to:

1. Know the basics, evolution , importance of ERP
2. Correlate ERP and related technology
3. Understand manufacturing perspectives of ERP
4. Know business modules of ERP
5. Understand the key implementation issues and some popular products in ERP
6. Understand implementation of ERP package

Course Outcomes:

Upon successful completion of this course, the student will be able to

1. Understand the structure of an ERP system and know how process chains in materials management, production, controlling and sales are implemented in an ERP system
2. Implementation and customize an ERP system using the appropriate modeling methods, that are Entity Relationship Modeling (ERM) and Event-Driven Process Chains (EPC)
3. Understand the customization of an ERP system and customize essential parts of materials management, production, controlling and sales in SAP ECC
4. Understand software design issues in state-of-the-art business software and realize the importance of project management in an ERP implementation project
5. Understand what to expect, and not to expect, from a consultant implementing an ERP system
6. Understand the importance of IT governance in long-term relationships with a software vendor, such as SAP

Unit 1 Introduction to ERP: **[07]**
Introduction, Evolution, Reasons for the growth of ERP market, Advantages, Reasons for failure of ERP. Benefits of ERP-Reduction of lead time, On time shipment, Reduction in cycle time, Improved resource utilization, Better customer satisfaction, Input supplier performance, Increased flexibility.

Unit 2 ERP and Related Technologies [08]

Data warehousing, Data mining, OLAP, Business Process Reengineering (BPR), Management Information System (MIS), Supply Chain Management (SCM), Decision Support System (DSS), Executive Information System (EIS),Customer relationship management (CRM),

Unit 3 ERP – A Manufacturing Perspective [05]

CAD/CAM, MRP, MRP II, Distribution Requirement Planning (DRP), Product Data Management (PDM).

Unit 4 ERP Modules [07]

Introduction and study of Business modules like Finance, Mfg. and Production, HR, Plant maintenance, Quality and Material Management, Sales and Distribution.

Unit 5 ERP Implementation Life Cycle [07]

Introduction, Pre-evaluation Screening, Package evaluation, Project planning, Gap Analysis, Re-engineering, Configuration, Team training, Testing, End user training and Post-implementation phases, Expanding ERP boundaries, Service oriented architecture, Enterprises application integration.

Unit 6 ERP Market and Case Studies [06]

Brief account of ERP market, various ERP packages like SAPAG, Oracle, PeopleSoft, etc. Indian scenario for ERP implementation, Case studies based on implementation of ERP for various areas in mfg., Marketing and other businesses, E-commerce, cloud based ERP system.

Term Work:

1. Six assignments on each of above units.
2. Detailed study of implementation of ERP and its benefits for any suitable application.

Text Books:

1. "Enterprise Resource Planning", Alexis Leon, Tata McGraw Hill Publication, ISBN 0-07-463712-6.
2. "Enterprise Resource Planning", Bret Wagner, Delmar Learning, International Edition, ISBN 10: 1439081085, ISBN–13: 978-1439081082.
3. "Enterprises Resource Planning", Venkateshswara, Scitech Publication.
4. "Entrepreneurship",Chris Boulton, Patric Turner, Willey India.
5. "Management Information System",S. Sadagopan, PHI, New Delhi, 2nd Edition.

Reference Books

1. "Modern ERP: Select Implement and Use", Marianne Bradford, Hand M Books, lulu.com, ISBN: 978-0-557-01291-6.
2. "Enterprises Resource Planning", E.F. Monk, B.J. Wagner, Cengage Learning.

3. “Enterprises Resource Planning”, A. R Singla, Cengage Learning.
4. “Enterprises Resource Planning-Concepts and Practices”, Vinod Kumar Garg and Venkitakrishnan N. K. , PHI, New Delhi.

SHIVAJI UNIVERSITY,KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
5. MICRO-ELECTRO-MECHANICAL SYSTEMS (MEMS) (Elective IV)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/ Week	Term Work: 25 Marks

Course Objectives:

The course aims to:

1. Understand the concepts and context of MEMS
2. Understand various MEMS fabrication technologies
3. Understand MEMS-specific design issues, constraints and dynamics and modeling of Microsystems
4. Understand applications of microsensors and microactuators
5. Getting access to fabrication and testing in academia and industry

Course Outcomes:

Upon successful completion of this course, the student will be able to

1. Gain a fundamental understanding of standard microfabrication techniques and the issues surrounding them
2. Know the major classes, components, and applications of MEMS devices/systems and to
3. Demonstrate an understanding of the fundamental principles behind the operation of these devices/systems
4. Understand the unique requirements, environments, and applications of MEMS
5. Apply knowledge of microfabrication techniques and applications to the design
6. Manufacturing of an MEMS device or a microsystem

Unit 1 Introduction [06]

Introduction to Micromachining and MEMS, IC Fabrication, Essential technical background for lithography-based micromachining, Glimpses of Microsystems, Scaling effects, Distributed and lumped modelling approaches used in MEMS analysis and simulations

Unit 2 Microsensors and Microactuators [08]

Microsensors: Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors – Thermopiles, Thermistors, Micromachined thermocouple probes, Thermal flow sensors, MEMS magnetic sensor, Microactuators: Capacitance, Piezomechanics, Piezoactuators as grippers, Microgrippers, Micromotors, Microvalves, Micropumps, Microaccelerometers, Shape memory alloy based optical switch, Thermally activated MEMS relay, Microspring thermal actuator, Microsystems: some examples

Unit 3 Microfabrication Processes[06]

Structure of silicon and other materials, Silicon wafer processing, Thin-film deposition, Lithography, Wet etching and Dry etching, Process integration, Bulk micromachining and Surface micromachining, Wafer-bonding, LIGA and other moulding techniques, Soft lithography

and polymer processing, Thick-film processing, Low temperature co-fired ceramic processing

Unit 4 Mechanics of Solids [08]

Stresses and deformation: Bars and beams, Microdevice suspensions: Lumped modelling, Residual stress and stress gradients, Poisson effect, Anticlastic curvature, Examples of micromechanical structures, Thermal loading: Bimorph effect, Dealing with large displacements, In-plane and 3D elasticity equations, Vibrations of bars and beams, Gyroscopic effect, Frequency response, Damping, Quality factor, Basic micro-flows for damping calculation

Unit 5 Thermal, Fluid Flow and Electrostatic Applications in MEMS[06]

Thermal sensors and actuators and their analysis, Microfluidics, Flow through microchannels, Miniature heat exchangers, Electrostatic actuation (parallel plate), Electrostatic actuation (comb drive), Electrostatic sensing, Piezoelectric actuation, Piezoelectric sensing

Unit 6Electronics and Packaging [06]

Semiconductor devices: Basics, Op-Ams and Op-Amp circuits, Signal conditioning for microsystem devices, Control and Microsystems, Vibration control of a beam, Integration of microsystems and microelectronics, Packaging, Testing and reliability of Microsystems: Why and how?

Term Work:

1. Case study of MEMS Sensors (Pressure sensor/ Accelerometer/ Gyroscope).
2. Case-study of MEMS Actuators (Micro-pump/RF switch).
3. Case-study of System on chip e.g., Drug delivery system.
4. Visit to Microfabrication facility.
5. Visit to MEMS characterization and testing facility.
6. Lumped modeling of MEMS sensors/actuators in MATLAB Simulink.
7. Introductory modelling of MEMS in multiphysics software e.g. ANSYS COVENTORWARE, INTELLISUITE, etc.

Reference Books:

1. "MEMS and MICROSYSTEMS: Design and Manufacture", Hsu, Tai-Ran, TMH, ISBN:0-07-048709-X, (2003).
2. "MEMS", Mahalik, N. P., TMH, ISBN: 0-07-063445-9, (2007).
3. "Micromanufacturing and Nanotechnology", Mahalik, N.P., Springer India Pvt. Ltd., ISBN: 978-81-8128-505-8 (Distributed by New Age International, New Delhi) (Ed.),(2006)
4. "Handbook of Microlithography, Micromachining and Microfabrication", P.Rai-Choudhury,SPIE, (1997).
5. "Introduction to Microelectronic Fabrication", Richard C. Jaeger, Prentice Hall, 2nd Edition, Volume V, ISBN: 0-201-44494-7, (2002).
6. "Nanosystems: Molecular Machinery, Manufacturing and Computation", K E Drexler, Wiley, ISBN 0471575186 ,(1992).
7. "Microsystem Design", Stephen D. Senturia, Kluwer Academic Publishers, Boston, (2001),

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
5. ADVANCED REFRIGERATION (Elective IV)

Teaching Scheme:	**Examination Scheme**
Lectures: 3 hrs/week	Theory Paper: 100 Marks
Practical: 2 hrs/week	Term Work: 25 Marks

Course Objectives:

Refrigeration and air conditioning subject is compulsory subject covered in final year of engineering graduation in mechanical engineering stream. This subject is designed to introduce theory behind the application in the field of Refrigeration and air conditioning. Refrigeration and air conditioning is fastest expanding field in the mechanical engineering stream with many new applications coming up in the field of ventilation, food processing and special purpose units. Also because of global warming and effects on the environment, conventional technology is also changing rapidly. To address all above problems and to impart latest knowledge to the students, who wish to take up their career in the field of RAC industries this elective subject **Advanced Refrigeration** is introduced. Syllabus is designed in such a way that it includes case studies to impart practical knowledge to the students who has opted for this elective subject. This subject is expected to impart advanced knowledge to the students in the design of various refrigeration systems.

Course Outcomes:
Upon successful completion of this course, the student will be able to

1. Update their knowledge in the subject and will bridge the gap between academics and industry
2. Aware about market trends in the field of RAC and availability of various components in the market
3. Impart knowledge of RAC system design for various applications.
4. Improve utility of the students to RAC industry and will improve employment opportunity for the students .

Unit 1 **[06]**
Multistage Systems:
Multi-evaporator system; Multi expansion system; Cascade systems; Study of P-h; T-s; h-s and T- h charts for various refrigeration cycles, Heat Pump (Analytical Treatment)

Unit 2
Vapour Absorption Refrigeration: **[06]**
Standard cycle and actual cycle, Thermodynamic analysis, Li-Br-water, NH3-water systems, Three fluid absorption systems, Half effect, Single effect, Single-double effect, Double effect, and triple effect system

Unit 3 **[08]**

Refrigerants: Refrigerant recycling, Reclaim and charging, Alternative refrigerants, Refrigerant-lubricant mixture behavior, Synthetic Lubricants, Blending of refrigerants, Secondary refrigerants.

Non-Conventional Refrigeration System (Principle and Thermodynamic Analysis Only): Thermoelectric refrigeration, Thermo-acoustic refrigeration, Adsorption refrigeration, Steam jet refrigeration, Vortex tube refrigeration, and Magnetic refrigeration.

Unit 4 **[05]**

Refrigeration Equipments: Study and Selection of Reciprocating, Screw, Scroll and Centrifugal Compressor based on applications.

Motor Selection: Selection ofSingle phase, Three phase, Starters, Constant speed and Variable speed Drive.

Unit 5 **[10]**

Evaporators : Design and Selection**,** Types, Thermal design, Effect of lubricants accumulation, Draining of lubricants, Selection and capacity control

Condenser: Design and selection, Types, Thermal design, Purging, Selection and capacity Control, Selection of\expansion devices, Design of refrigerant piping, Refrigeration system controls and safety devices, Solenoid valves, Suction and evaporator pressure regulators

Control and Instrumentation: Refrigeration system controller, High pressure receiver, Thermal design of low pressure receiver, Accumulator, Filters, Driers, Oil separators, Relief valves, Safety valves, High and low pressure cut out, Thermostats, Water regulators, System controller.

Cooling Load Estimation Equipment Selection and Design: Component Balancing, Analysis of designed equipment (Thermodynamic), Cost and feasibility analysis for designed equipments, Tools and equipments used in refrigeration.

Unit 6 **[05]**

Selection and design of various components for various Industrial refrigeration applications: Cold storage, Process applications - Textile, Pharmaceuticals, Chemical, Transport, Food preservation, Dairy etc. Application and selection softwares of refrigeration system.

Term Work:

Eight Assignments/Practical's / Tutorials based on above syllabus

1. Study and trial on cascade refrigeration system.
2. Study and trial on multi evaporator system.
3. Study andTrial on multi compressor system.
4. Study and trial on nonconventional refrigeration system.
5. Component selection case study.
6. Industrial visit and report.
7. Case study on design of commercial refrigeration system.
8. Case study of cold room.

Text Books:

1. "Principles of refrigeration", R.J. Dossat, Pearson Education Asia Pearson Education, 4th Edition.
2. "Refrigeration and Air-Conditioning", C.P. Arora, McGraw-Hill, 2nd Edition.
3. "Refrigeration and Air-conditioning", Stoecker and Jones.
4. "Refrigeration", Manohar Prasad.

Reference Books:

1. "Refrigeration and Air-conditioning", Jordan and Priester.
2. "Refrigeration and Air-conditioning", A.R. Trott, Butterworths.
3. "Thermal Environmental Engineering", J.L. Threlkeld, Prentice Hall of India
4. "Industrial Refrigeration Handbook", W.F. Stoecker, McGraw-Hill.
5. "Technician's guide to Refrigeration Systems",John A. Corinchock, McGraw-Hill.
6. "Industrial Refrigeration: Principles, Design and Applications", P.C. Koelet, Mcmillan.
7. "ASHRAE Handbook", (i) Fundamentals (ii) System iii) Applications.
8. "ISHRAE Handbooks"
9. "ARI Standards",
10. "Refrigeration Handbook", Wang, Mc Graw Hill, Int.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
5. TRIBOLOGY (Elective IV)

Teaching Scheme:	**Examination Scheme:**
Lectures : 03 Hrs/Week	Theory Paper:100 Marks
Practical: 02 Hrs/Week	Term Work: 25 Marks

Course Objectives:
The Course aims to:

1. Make student aware about Importance, scope and application of this subject
2. Introduce the concepts of wear friction and lubrication and its application in design of tribological systems.

Course Outcomes:
Upon successful completion of this course, the student will be able to

1. Awareness about the field of Tribology
2. Understand basis of friction, wear processes and lubrication
3. Aware about tribological issues in the design of machine components such as journal bearing, thrust bearing, and roller element bearing
4. Familiarize with antifriction and anti wear components of the material and the lubricants used therein
5. Design the tribological system from strength point of view

Unit 1 **[06]**

Introduction to Tribology

IntroductionDefinition of tribology, Friction, wear and lubrication, Importance of the tribological studies. Properties of oils and equation of flow: Viscosity, Newton's Law of Viscosity, Hagen-Poiseuille Law, Flow between parallel stationary planes, viscosity measuring apparatus. Lubrication principles, Classification properties and applications of lubricants. Regimes of lubrication,

Unit 2[05]

Friction and Wear

Friction: Introduction, laws of friction, Kinds of friction, Causes of friction, Friction measurement, Theories of friction, Effect of surface preparation.

Wear: Types of wear, Various factors affecting wear, Measurement of wear, Wear between solids and liquids, Theories of wear.

Unit 3 **[09]**

Hydrodynamic Lubrication

Friction forces and power loss in lightly loaded bearing, Petroff's law, Tower's experiments, mechanism of pressure development in an oil film, Reynold's investigation and Reynold's equation in 2D. Numerical problems.

Idealized Journal Bearing

Introduction to idealized journal bearing, Load carrying capacity, Condition for equilibrium, Sommerfeld's numbers and significance of it; Partial bearings, End leakages in journal bearing, Numerical problems

Unit 4 **[06]**

Slider / Pad Bearing With a Fixed and Pivoted Shoe

Pressure distribution, Load carrying capacity, Coefficient of friction, Frictional resistance and loss of Power in a pivoted shoe bearing, Numerical examples.

Unit 5 **[06]**

Hydrostatic Lubrication:

Introduction to hydrostatic lubrication, Hydrostatic step bearings, Load carrying capacity and oil flow through the Hydrostatic step bearing. Numerical Examples

Unit 6 **[08]**

Bearing Materials:

Commonly used bearings materials, Properties of typical bearing materials.Advantages and disadvantages of bearing materials.Tribological considerations in the design of gears, cams, reciprocating components, etc. Engine Tribology basics Tribology aspects of engine components such as bearings, piston assembly, valve train and dive train components etc.

Termwork:

Practicals and assignments/Seminars based on following: (Any 5 out of 1 to 7)

1. Journal Bearing Apparatus
2. Tilting pad and thrust Bearing Apparatus
3. Study of lubrication systems.
4. Friction in Journal Bearings.
5. Four Ball Tester
6. Coefficient of friction using pin on disc type friction monitor
7. Industrial visit to study techniques of coating – case study.
8. Assignments based on topics in the syllabus. (Minimum 5)

Text Books:

1. "Introduction to Tribology Bearings", Mujumdar B. C., S. Chand Company Pvt. Ltd (2008).
2. "Engineering Tribology" Prasanta Sahoo, PHI,Estern Economy Edition.
3. "Fundamentals of Tribology", Basu S K., Sengupta A N., Ahuja B.B., PHI (2006).
4. "Tribology in Industries", Srivastava S., S Chand and Company.
5. "Lubrication of Bearings – Theoretical Principles and Design", Redzimovskay E I., Oxford Press Company (2000)
6. "Tribology", Prof R B Patil, ISBN 978-81-8492-812-9.

Reference Books:

1. “Theory and Practice of Lubrication for Engineers”, Fuller, D. New York company (1998).
2. “Theory and Practice of Lubrication for Engineers”, Dudley D.F., John Willey and Sons.
3. “Engineering Tribology”, Stachowiak G W and Batchelor A W, Elsevier Inc. 3rd Edition,(2005).
4. “Friction and Wear of Materials”, Rabinowicz.E, John Willey and Sons ,UK,(1995).
5. “Theory of Hydrodynamic Lubrication”, Pinkus '0', Stemitch.
6. “Basic Lubrication theory ", A.Cameron, Longman, U.K.., (1981).
7. “Lubrication”, Fuller D.D.
8. “Principles and Applications of Tribology”, Moore, Pergamaon Press (1998).
9. “Tribology Handbook ", M.J.Neale, Newnes. Butter Worth -Heinemann, U.K.,(1995).
10. “Principles of Tribology”, Halling J., McMillan Press Limited.
11. “Modern Tribology Handbook”, Bhushan, Vol 1 and 2.

Web Resources:

1. NPTEL Lectures series on Tribology by Dr.Harish Hirani, IIT, New Delhi
2. http://www.csetr.org
3. http://www.bstsa.org
4. http://www.sea.org

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
5. PRECISION ENGINEERING (ELECTIVE-IV)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/ Week	Theory Paper: 100 Marks
Practical: 2 Hrs/Week	Term Work: 25 Marks

Course objectives:
The course aims to:

1. Study the basics of precision engineering and different manufacturing technique in precision engineering
2. Get acquainted with various techniques of precision engineering like nano technology etc.
3. Understand importance of accuracy, influence of static stiffness, vibration accuracy etc.

Course Outcomes:
Upon successful completion of this course, the student will be able to

1. Specify what is meant by a precision engineering and list the basic components of an precision engineering
2. Explain how precision engineering can be specified.
3. Outline the Major issues of planning for the creation of precision engineering.
4. State points that arise from precision engineering quantitative analysis.

Unit 1 Accuracy and Alignment Tests [08]
General concept of accuracy – Spindle rotation accuracy – Test methods- Displacement accuracy – Clamping errors - Setting errors -Location of rectangular prism, Cylinder-Basic type of tests – Measuring instruments used for testing machine tools - Alignment tests-Straightness, Flatness, Parallelism, Squareness, Circularity, Cylindricity.
Geometric Dimensioning and Tolerancing
Tolerance Zone Conversion-Surfaces, Features, Features of Size, Datum Features- Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums - Datum Feature of Representation Form Controls, Orientation Controls-Logical Approach to Tolerancing.

Unit 2 Precision Machining [06]
Introduction - Top down and bottom up approach - Development of Nanotechnology - Precision and micromachining -Diamond turning of parts to nanometer accuracy- Stereo microlithography- Machining of micro-sized components-Mirror grinding of ceramics-Ultra precision block gauges.

Unit 3 Nano Measuring Systems [06]
In - process measurement of position of processing point - Post process and online measurement of dimensional features - Mechanical measuring systems - Optical measuring systems - Electron beam measuring systems – Pattern recognition and inspection systems.

Unit 4 Lithography [06]

Nano Lithography – Photolithography - Electron beam lithography – Ion Beam lithography - Optical lithography - LIGA process- Dip pen lithography-Deep UV lithography, Nanocoatings.

Unit 5 Reliability Engineering [06]

Introduction to reliability, System reliability, Quantification of reliability: MTBF, MTTF, Analytical treatment based on series, Parallel and combination systems, Failure modes, FMECA, calculation of Risk Priority Number (RPN).

Unit 6 Tolerance Analysis [08]

Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects. Feature Tolerances, Geometric Tolerances. Surface Finish: Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of Tolerances sure fit law, normal law and truncated normal law, tolerance stacking.

Term Work:

1. Various alignment test for sample component to check parallelism, circularity, straightness, flatness, surface finish and tolerance.
2. Understanding of fits with some practical hand on based on sample components and brief write up based on above.
3. Visit to suitable set up/industry/Research and Development Laboratory where nano-technology is used.
4. Numericals based on system reliability for series, parallel and combination (Min. Two problems on each type).
5. Numericals on tolerance analysis for any sample component.
6. Assignment on tolerance stacking.

Text Books:

1. "Precision Engineering in Manufacturing", Murthy.R.L, New Age International, Delhi.
2. "Nanotechnology", Norio Taniguchi, Oxford University Press, Cambridge, (1996).
3. "Precision Engineering", Venkantesh V.C., Inzman S., Tata McGraw Hill, New Delhi, (2007).

Reference Books:

1. "Precision Motion Control Design and Implementation", Lee Tong Hong, Springer Verlag, U.K., (2001).
2. "Precision Machining of Advanced Materials", Liangchi Zhang, Trans Tech Publications Ltd., Switzerland, (2001).
3. "Principles of Precision Engineering", Hiromu Nakazawa, Oxford Uni. Press, (1994).
4. "Geometric Dimensioning and Tolerancing", James D. Meadows, Marcel Dekker Inc. (1995).
5. "Engineering Design – A systematic Approach", Matousek, Blackie and Sons Ltd. London.

SHIVAJI UNIVERSITY, KOLHAPUR
B.E. (Mechanical Engineering) **Semester VIII**
6. PROJECT PHASE– II

Teaching Scheme:
Practical: 4 Hrs/Week/Batch

Examination Scheme:
Term Work: 50 Marks
Oral Exam: 75 Marks

Course Objectives:
The course aims to:

1. Embed the skill in group of students to work independently on a topic/ problem/ experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.
2. Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Course Outcome:
Upon successful completion of this course, the student will be able to

1. Improve the professional competency and research aptitude in relevant area.
2. Develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Project Phase II Load:
A batch of maximum three groups of four to five students per group, shall work under one Faculty member of department. The group of one student is strictly not allowed. Same groups of Seventh Semester shall work under same faculty member of department.

Project Phase II Definition:
Project phase-II is a continuation of project phase-I started in the seventh semester. Before the end of the eighth semester, there will be two reviews, one at start of the eighth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. The final evaluation of the project will be external evaluation.

Project Phase II Term Work:
The term work under project submitted by students shall include
1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly. The contents of work diary shall reflect the efforts taken by project group for
a. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring up the project.
c. Brief report of feasibility studies carried to implement the conclusion.
d. Rough Sketches/ Design Calculations/ Testing reports/ Experimentation results.

Project Report:

Project report should be of 50 to 60 pages (typed on A4 size sheets). For standardization of the project reports the following format should be strictly followed.

1. Page Size: Trimmed A4
2. Top Margin: 1.00 Inch
3. Bottom Margin: 1.32 Inches
4. Left Margin: 1.5 Inches
5. Right Margin: 1.0 Inch
6. Para Text: Times New Roman 12 Point. Font
7. Line Spacing: 1.5 Lines
8. Page Numbers: Right Aligned at Footer. Font 12 Point Times New Roman
9. Headings: Times New Roman, 14 Point Bold face
10. Certificate: All students should attach standard format of Certificate as described by the department. Certificate should be awarded to batch and not to individual student. Certificate should have signatures of Guide, Head of Department and Principal /Director
11. Index of Report:
    - i) Title Sheet
    - ii) Certificate
    - iii) Acknowledgement
    - iv) Table of Contents.
    - v) List of Figures
    - vi) List of Tables

    1. Introduction
    2. Literature Survey/ Theory
    3. Design/ Fabrication/ Production/ Actual work carried out for the same and Experimentation.
    4. Observation Results
    5. Discussion on Result and Conclusion
12. References: References should have the following format

    For Books: "Title of Book", Authors, Publisher, Edition

    For Papers: "Title of Paper, Authors, Journal/Conference Details, Year

13. The Project report shall be signed by the each student in the group, approved by the guide and endorsed by the Head of the Department
14. Presentation: The group has to make a presentation in front of the faculty of department at the end of semester.

Important Notes:

- Project group should continue maintaining a diary for project and should write (a) Books referred (b) Company visited (c) Person contacted (d) Computer work done (e) Paper referred (f) Creative thinking.
- The Diary along with Project Report shall be assessed at the time of oral examination
- One copy of the report should be submitted to Institute/ Department, One copy to Guide and one copy should remain with each student of the project group.

B.E. Mechanical Semester VII

EQUIVALANCE

Sr. No	Name of the Subject (Old Syllabus)	Semester (Old Syllabus)	Name of the Subject (New Syllabus)	Semester (New Syllabus)
1	Refrigeration and Air Conditioning	VII	Refrigeration and Air Conditioning	VII
2	Mechanical System Design	VII	Mechanical System Design	VII
3	Finite Element Analysis	VII	Finite Element Analysis	VII
4	Experimental Mechanics (El-I)	VII	Experimental Mechanics (El-I)	VII
	Noise and Vibration (El-I)	VII	Noise and Vibration	VIII
	Automobile Engineering (El-I)	VII	Automobile Engineering (El-I)	VII
	Jig and Fixture Design(El-I)	VII	-	-
5	Total Quality Management (El-II)	VII	Total Quality Management (El-II)	VII
	Nano Technology (El-II)	VII	-	-
	Industrial Product Design (El-II)	VII	Industrial Product Design (El-II)	VII
	Human and Professional Ethics (El-II)	VII	Human and Professional Ethics (El-I)	VII
6	Seminar	VII	Seminar	VI
7	Project	VII	Project Phase –I	VII
8	Industrial Training	VII	Industrial Training	VII

B.E. Mechanical Semester VIII

EQUIVALANCE

Sr. No	Name of the Subject (Old Syllabus)	Semester (Old Syllabus)	Name of the Subject (New Syllabus)	Semester (New Syllabus)
1	Mechatronics	VIII	Mechatronics	VIII
2	Industrial Engineering	VIII	Industrial Engineering (El-III)	VIII
3	Power Engineering	VIII	Energy and Power Engineering	VIII
4	Production Management (EL-III)	VIII	Production Management (EL-III)	VIII
	MEMS (EL-III)	VIII	Micro Electro Mechanical System (EL-IV)	VIII
	Machine Tool Design (EL-III)	VIII	Machine Tool Design (EL-III)	VIII
	Computational Fluid Dynamics (EL-III)	VIII	Computational Fluid Dynamics (EL-I)	VII
5	Industrial Automation and Robotics (EL-IV)	VIII	Industrial Automation and Robotics (EL-IV)	VIII
	Enterprise Resource Planning (EL-IV)	VIII	Enterprise Resource Planning (EL-IV)	VIII
	Cryogenics (EL-IV)	VIII	Cryogenics (EL-IV)	VIII
	P.L.C &SCADA Programming(EL-IV)	VIII	-	-
6	Project	VIII	Project Phase II	VIII