DKTE Society's
TEXTILE & ENGINEERING INSTITUTE
(An Autonomous Institute)
'Rajwada', Ichalkaranji 416115

DEPARTMENT: MECHANICAL ENGINEERING

CURRICULUM

Mechanical Engineering Program

Final Year

With Effect From

2023-24

DKTE
Promoting Excellence in
Teaching, Learning & Research

DKTES Textile and Engineering Institute, Ichalkaranji (*An Autonomous Institute*)

Teaching and evaluation Scheme for year 2023-24

Final Year B. Tech.(Semester – VII) In Mechanical Engineering

Sr. No.	Course Code	Course Title	Course Category	Teaching scheme				Course Credits	Evaluation scheme					
									Theory			Practical		TOTAL
				L	T	P	Contact Hrs/wk		CIE		SEE	CIE	SEE	
									MSE	ISE				
1	MEL451	Finite Elements & Analysis	PCC	3	-	-	3	3	30	20	50	-	-	100
2	MEL452	Industrial Engineering	HSMC	3	-	-	3	3	30	20	50	-	-	100
3	MELEL1	Elective-I:	PEC	3	-	-	3	3	30	20	50	-	-	100
4	MELEL2	Elective-II:	PEC	3	-	-	3	3	30	20	50	-	-	100
5	MEP453	Advanced engineering lab	PCC	-	-	2	2	1	-	-	-	50	-	50
6	MEP454	Entrepreneurship Development	HSMC	2	-	-	2	1	-	-	-	50	-	50
7	MEPEL3	Elective-II: Lab	PEC	-	-	2	2	2	-	-	-	50	50	100
8	MED455	Project Phase- I	PST	-	-	10	10	4	-	-	-	50	-	50
				14	**0**	**14**	**28**	**20**	**120**	**80**	**200**	**200**	**50**	**650**

	Elective I: (Theory)		**Elective II: (Theory)**		**Elective II: (Practical)**
MEL456	Total Quality Management	MEL461	Automotive Fabrication (BIW)	MEP466	Automotive Fabrication (BIW) Lab
MEL457	Automobile Engineering	MEL462	Indl. Automation and Robotics	MEP467	Indl. Automation & Robotics Lab
MEL458	Industrial Product Design	MEL463	Mechatronics	MEP468	Mechatronics Lab
MEL459	Flexible Manufacturing Systems	MEL464	Refrigeration Systems	MEP469	Refrigeration Systems Lab
MEL460	Smart Materials	MEL465	Experimental Mechanics	MEP470	Experimental Mechanics Lab
MEL471	Building Automation, Energy Audit & IoT				

L-Lecture, SE-I :Semester Examination-I CIE – Continuous In Semester Evaluation

T-Tutorial, SE-II : Semester Examination-II SEE – Semester End Examination

P-Practical

Course Category	HSMC (Hum. & Social Sc.,Mgt)	BSC (Basic Sc.)	ESC Engg. Sc.)	PCC (Prof. Core Courses)	PEC (Prof. Elect.Courses)	OEC (Open Elct. Courses)	MC (Mandatory Courses)	PST (Project / Seminar / Ind. Training)
Credits	4	--	--	4	7	--	--	5
Cumulative Sum	10	18	27	81	7	5	--	8

Progressive Total Credits: 20 + 136 =156

DKTES Textile and Engineering Institute, Ichalkaranji. (*An Autonomous Institute*)

Teaching and evaluation Scheme for year 2023-24

Final Year B. Tech.(Semester – VIII) In Mechanical Engineering

Sr. No.	Course Code	Course Title	Course Category	Teaching scheme				Course Credits	Evaluation scheme					
									Theory			Practical		TOTAL
				L	T	P	Contact Hrs/wk		CIE		SEE	CIE	SEE	
									MSE	ISE				
1	MELOE4	Open Elective through MOOC	OEC	3	-	-	3	3	30	20	50	-	-	100
2	MEL475	Production Management	HSMC	3	-	-	3	3	30	20	50	-	-	100
3	MELEL3	Elective-III:	PEC	3	-	-	3	3	30	20	50	-	-	100
4	MELEL4	Elective-IV:	PEC	3	-	-	3	3	30	20	50	-	-	100
5	MEPEL4	Elective-IV: Lab	PEC	-	-	2	2	1	-	-	-	50	-	50
6	MED476	Project Phase-II	PST	-	-	14	14	7	-	-		50	50	100
				12	**-**	**16**	**28**	**20**	**120**	**80**	**200**	**100**	**50**	**550**

	Elective III: (Theory)		**Elective IV: (Theory)**		**Elective IV: (Practical)**
MEL477	Reliability Engineering	MEL482	PLC & SCADA Programming	MEP488	PLC & SCADA Prog. Lab
MEL478	Micro-electro Mechanical System	MEL484	Energy and Power Engineering	MEP489	Energy and Power Engg Lab
MEL479	Advanced Automobile Design	MEL485	Noise & Vibration	MEP490	Noise & Vibration Lab
MEL480	Cryogenics	MEL486	Advanced Foundry Processes	MEP491	Advanced Foundry Processes Lab
MEL481	Optimization	MEL487	Operation Research	MEP492	Operation Research Lab.

L-Lecture, T-Tutorial, P-Practical

SE-I :Semester Examination-I

SE-II : Semester Examination-II

CIE – Continuous In Semester Evaluation

SEE – Semester End Examination

Course Category	HSMC (Hum. & Social Sc.,Mgt)	BSC (Basic Sc.)	ESC Engg. Sc.)	PCC (Prof. Core Courses)	PEC (Prof. Elect.Courses)	OEC (Open Elct. Courses)	MC (Mandatory Courses)	PST (Project / Seminar / Ind. Training)
Credits	3	--	--	--	7	3	--	7
Cumulative Sum	13	18	27	81	14	8	--	15

Progressive Total Credits: 20 + 156 =176

Final Year B. Tech. Mechanical Engineering Semester VII
MEL451: Finite Element Analysis

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	SE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Engg. Mathematics, CAD-I, CAD-II, Strength of Materials.

Course Objectives

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

Course Outcomes

C451.1 Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts.
C451.2 Identify mathematical model for solution of common engineering problems.
C451.3 Formulate simple problems into finite elements.
C451.4 Solve structural, thermal, fluid flow problems.
C451.5 Use professional-level finite element software to solve engineering problems in solid mechanics, fluid mechanics and heat transfer.

Course Contents

Unit 1 Introduction : **6 Hrs.**
Introduction, past present and future of FEM, NAFEMS, basic concept of FEM- approximation of the circumference of circle, comments on steps in FEM, applications of FEM, advantages of FEM. (J. N. Reddy, Logan)

Unit 2 Discretization of the problem and interpolation models: **6 Hrs.**
Geometrical approximations, simplification through geometry, basic element shapes and behavior, choice of element type, size and number of elements, element and node numbering.
Simplex complex and multiplex elements, linear interpolation polynomials for simplex elements, natural coordinates, axisymmetric element.

Unit 3 Finite element formulation for elasticity problems : **8 Hrs.**
Approximate analytical methods, Rayleigh Ritz method, Galerkin method, principle of minimum potential energy, one-dimensional elasticity, two-dimensional elasticity, axisymmetric elasticity.

Unit 4 Finite element formulation for field problems : **6 Hrs.**
Variational formulation, weighted residual method, thermal problems: one-dimensional, two-dimensional heat transfer, torsion problems, fluid flow problems.

Unit 5 Assembly and solution : **7 Hrs.**
Coordinate transformations, assembly of the element equations, incorporation of boundary conditions, solution of the equations.
Model validity and accuracy, mesh design and refinement, element distortion, result processing.

Unit 6 Higher order element formulation : **6 Hrs.**
Natural coordinate systems and numerical integration, one dimensional quadratic and cubic elements, evaluation of element equations, isoparametric triangular and quadrilateral elements, features of commercial FE software's .

Text Books

1. J. N. Reddy, An introduction to the finite element method, 2 ed. McGraw Hill
2. M. J. Fagan, Finite element analysis, Longman Scientific and Technical
3. D. L. Logan, A first course in finite element method, 4 ed. Cengage learning

Reference Books

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

Final Year B. Tech. Mechanical Engineering Semester VII
MEL452: Industrial Engineering

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Basic Mechanical Engg., Machine Tools and Manufacturing Processes.

Course Objectives

1. To gain an understanding and appreciation of principles of human work in industry.
2. To understand and apply the techniques to evaluate human efforts, required time; and increase productivity.
3. To develop managerial approach to understand human work and try to create comfort at work.

Course Outcomes

C452.1 Understand the concept of Industrial Engineering and its objectives.
C452.2 To know the details about work study, its techniques & application areas.
C452.3 To understand the use of Method Study and Work Measurement to increase productivity.
C452.4 To know about the evaluation of Actual Work Content and Human Efforts.
C452.5 Develop managerial skills in relation with Human Engineering.

Course Contents

Unit 1 Introduction to Industrial Engineering: **5 Hrs.**
Definition, History, Development, objectives, activities, Functions of Industrial Engineering, Techniques of Industrial Engineering, Place in organization. Industrial Engineering in Service Sector. System approach.

Unit 2 Productivity & Work Study: **5 Hrs.**
Productivity concept, Role of management in increasing productivity, Techniques of increasing productivity, Work Study, Definition, Objectives, Techniques of Work study, Relation of work study with productivity.

Unit 3 Method Study: **8 Hrs.**
Definition, Objectives, Steps of Method Study, details of each step, various charts, diagrams and symbols used for recording Process Analysis, Outline process chart, Flow process chart (Man, Machine and Material). Two handed process chart, Multiple activity chart, Micromotion study, Gilbreth's therbligs, SIMO Chart.

Unit 4 Work Measurement: **7 Hrs.**

Definition, Steps, Objectives, Concept of Total Time, Work content added due to – 1) Defects in design, specifications, 2) Inefficient Method, 3) Short Comings of management, 4) Workers.

Techniques of Work Measurement – Time Study, Work Sampling, Predetermined time standards, Synthesis, Estimating.

Time Study – Steps, elements, Performance rating, Allowances, Stop watch procedure problems, Concept of Standard time, problems.

Unit 5 Job evaluation & Merit Rating : **7 Hrs.**

Introduction, Job evaluation – Definition, Objectives, procedure, Job Analysis – Stages, Job description, Job specification, Job evaluation System.

Unit 6 Human Engineering: **7 Hrs.**

Introduction, Definition, Objectives, Ergonomics in multidisciplinary, Ergonomics, Productivity and Working environment. Study of Human engineering areas, Man machine System, Environmental factors, Anthropometry, Manual Material Handing (MMH), Psychological aspects of muscular work. Work station – Design and egnomomics.

Text Books

1. Industrial Engineering & Production Management, Martand Telsang, S. Chand Publications, New Delhi.
2. Industrial Engineering, O.P. Khanna.
3. Industrial Engineering, Banga Sharma.

Reference Books

1. Introduction to Work Study – ILO.

Final Year B. Tech. Mechanical Engineering Semester VII
MEP453: Advanced Engineering Lab

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	50

Course Objectives:

Upon completion of the course, the student should be able to:

1. Distinguish RP and other related technology
2. Understand the principles behind the design of the product, ways to redesign and improve the performance of the system.
3. Use appropriate tooling for rapid prototyping process.
4. Create component with RP applications

List of Experiments:

1. Review of CAD Modelling Techniques and Introduction to RP
2. Generating STL files from the CAD Models & Working on STL files
3. Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation)
4. Fabricating the physical part on a RP machine
5. Prepare a CAD model with complex geometry and study effect of slicing parameters on final product manufactured through RP.
6. Generate a Model from a Product
7. Cloud Point Generation
8. Mesh Generation from Cloud Point data
9. Curve Generation
10. Surface Generation & Optimization

Submission:

Completed Journal.

References

1. http://nptel.ac.in/syllabus/syllabus.php?subjectId=112104156
2. https://youtu.be/Y0h6eGrwVKQ, https://youtu.be/Cy5RjsLwOAk, https://youtu.be/PQdCfoTM-jQ
3. https://youtu.be/Gxbp33QEc2k
4. https://youtu.be/j-mvZcTCAnM
5. https://youtu.be/CF304T9nECc

Final Year B. Tech. Mechanical Engineering Semester VII
MEL454: Entrepreneurship Development

Teaching Scheme	
Lectures	2 Hrs/ Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	50

Course Objectives:
1. Basic concepts in the area of entrepreneurship.
2. Role and importance of entrepreneurship for economic development
3. Developing personal creativity and entrepreneurial initiative
4. Adopting of the key steps in the elaboration of business idea

Course Outcomes: At the end of the course students will be able to –
C454.1 Understand the meaning of entrepreneurship and its different classifications.
C454.2 Understand the importance of management in small businesses venture.
C454.3 Develop capabilities and skills necessary to entrepreneurial activity
C454.4 To execute Government Policy for Small Scale Enterprises.

Course Contents

Unit 1	Entrepreneurship: Concepts and Overview of Entrepreneurship, Role of Entrepreneurship in Economic Development	**4 Hrs.**
Unit 2	Business Idea and Feasibility: Creativity, innovation and entrepreneurship; mental locks" that limit individual creativity, steps in the creative process; techniques for improving the creative process; protection of intellectual property involving patents, trademarks, and copyrights.	**6 Hrs.**
Unit 3	Rules & Regulations: Licensing and Registration procedure; Appreciation of important provisions of Factory Act, Shops & Commercial Establishment Act;	**6 Hrs.**
Unit 4	Finance & Accounting: Sales of Goods Act, Partnership Act; Contract Act; Income Tax, sales tax and Excise rules; Insurance	**6 Hrs.**
Unit 5	Ethics in Business: Ethics, Values and Morale at Workplace	**4 Hrs.**

Term Work:
03 assignments including case studies related to above units will be given to the students per semester.

Text Books
1. Khanka. S.S., "Entrepreneurial Development" S.Chand& Co. Ltd.
2. E-Business & E-Commerce Paperback by Dr. P. Rizwan Ahmed

Reference Books
1. B. S. Moshal (2008) „Business and Industrial Law", Latest Edition, Ane Books India
2. Das Gupta, Ananda, 'Ethics, business and society: managing responsibly', Response Books.
3. Mike Martin and Ronald Schinzinger, "Ethics in Engineering", McGraw-Hill, NY, 2005.

Final Year B. Tech. Mechanical Engineering Semester VII
MED455: Project Phase–I

Teaching Scheme	
Practicals	10 Hrs/ Week
Total Credits	4

Evaluation Scheme	
CIE	50
Total	50

Course Objectives

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.
3. To study the concepts of optimization of mechanical systems/ elements.

Course Outcomes

C455.1 Improve the professional competency and research aptitude in relevant area.

C455.2 Develop the work practice in students to apply theoretical and practical tools/techniques
to solve real life problems related to industry and current research.

Course Contents

Project Phase I Load:

A batch of maximum three groups of four 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.

Final Year B. Tech. Mechanical Engineering Semester VII
MEL456: Total Quality Management (Elective I)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Metrology and Quality Control, Industrial Management & Operations Research.

Course Objectives

1. To introduce students to various TQM approaches, tools, techniques and principles forquality and productivity improvement in manufacturing and service organizations.
2. To make students aware about the recent trends and practices and their need in industries for customer satisfaction and retention.
3. To analyze the real life manufacturing or service sector problems and find out solutions by
working in teams .

Course Outcomes

C456.1 Discuss various concepts related to TQM such as principles and approaches to TQM, ISO 9001:2008, tools and techniques of TQM, quality assurance, customer satisfaction and retention.

C456.2 Calculate and improve reliability of system and design experiments by developing robust product approach

C456.3 Evaluate and suggest solution for a defect or problem through planning quality and using old and new QC tools, APQP, FTA, FMECA, QFD, Six sigma, etc.

Course Contents

Unit 1 Quality Assurance System: **5 Hrs.**
Concept of total quality, role and objectives of Q.A., Q.A. Vs Q. C., Process approach to Q.A, Q.A. cycle (input-process-output), Significance of feedback, Field complaints analysis in Q.A., Significance of internal customer approach, Defect prevention programs for Q.A., PDCA cycle.

Unit 2 Planning and Controlling Techniques for Quality: **8 Hrs.**
Planning for quality – The Dimensions of Quality, Specifications for quality dimensions, 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.

Unit 3	Robust and Reliable Product Approach for Quality : Product and system reliability: Basic concepts- Bath tub curve, Types of failure, Prediction and evaluation of parallel, Series and combined system reliability, Reliability tests (life testing, burn-in test, accelerated life testing), Reliability improvement, Fault Tree Analysis, FMEA (Failure Mode Effect and Criticality Analysis), Taguchi's quality philosophy - System design, Parameter design, Tolerance design, Orthogonal arrays, S/N ratio, Loss functions.	**7 Hrs.**
Unit 4	Principles and Approaches to TQM : 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.	**5 Hrs.**
Unit 5	The Essentials of TQM : Customer Focus,- Customer perception of quality, Quality function deployment, Voice of customer, 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, Quality culture, Total Employee Involvement (TEI), Tools and Techniques for TQM: 5-S campaign, quality circles, Poka-yoke, KAIZEN.	**8 Hrs.**
Unit 6	Current Trends in TQM : 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 Quality Management Systems: ISO 9001:2008 Series Standards – Clauses and contents, Audit Sector Specific Standards – AS 9100, ISO/ TS 16949, TL9000, Quality Awards: National and International quality awards. Digitization in quality management – Existing scenario, benefits and threats.	**6 Hrs.**

Text Books

1. Total Quality Management, Dr. Suri and Dr. Sharma, Wiley Publication, (ISBN 978-935004-317-2).
2. Statistical Quality Control, M.S. Mahajan, Dhanpat Rai & Co., ISBN 978-81-7700-065-8

Reference Books

1. "Total Quality Management", Dale H. Besterfiled, et.al. ,Pearson Education, Asia (ISBN 97881-317-3227-4).3.
2. "Total Quality Management", Dr. Poornima Charantimath Pearson Education, Asia (ISBN 978-81-317-3262-5) ,2nd Edition.
3. "Quality Management", Kanishka Bedi, Oxford University Press, ISBN 0-19-567795-1

Final Year B. Tech. Mechanical Engineering Semester VII
MEL457: Automobile Engineering (Elective I)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Basic Mechanical Engg, Thermal Engg, I.C. Engines..

Course Objectives:
The student will be able to learn –
1. The layout and arrangement of principal parts of an automobile.
2. The working of transmission, steering, suspension and braking systems.
3. To develop competencies in performance analysis of vehicles.
4. To understand the emerging trends of electric vehicles, hybrid electric vehicles

Course Outcomes
C457.1 Understand the basic lay-out of an automobile.
C457.2 Understand the principles of transmission, suspension, steering and braking systems.
C457.3 To analyze the performance of the vehicle.
C457.4 To apply the knowledge ofelectric and hybrid vehicles.

Course Contents

Unit 1 **Introduction and Transmission System**: **8 Hrs.**
Automobile history and development, Classification, Components of an automobile, vehicle layouts- engine location and drive arrangement, Chassis types, Types of Frames. Clutch – Function and requirements, Classification, Construction and working of Single-, Multi-plate, Diaphragm spring and centrifugal clutches.
Gear Box – Necessity, classification, construction of manual gear boxes like Sliding mesh, constant mesh, Synchromesh, Overdrive, Propeller shaft, Differential and final drive.

Unit 2 **Steering and Suspension Systems**: **7 Hrs.**
Live and dead axles, live axle arrangement. Steering systems function, steering geometry, Steering Mechanism, cornering force, slip angle, steering linkages and steering gearbox, power steering. Suspension system- Functions, Sprung and unsprung mass, Types of suspension linkages, types of spring - leaf, coil, air springs, telescopic shock absorber, and Air suspension.

Unit 3 **Brakes, Wheels and Tyres**: **6 Hrs.**
Brakes: Need, principle, types, Drum and disc brakes, hydraulic braking system, air brakes, servo and power braking, ABS, 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 4 **Performance of Automobiles**: **6 Hrs.**
Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Gradability and draw bar pull, Traction and Tractive effort, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio. (Numerical)

Unit 5 **Electric Vehicles**: **6 Hrs.**
Introduction, Components, Propulsion Methods- DC motors-series wound, shunt wound and separately excited motors, AC motors - induction motors.
Automotive batteries - Principle and construction of Lead Acid Battery, Nickel – Cadmium Battery, Nickel Metal, Sodium Sulphur Battery and Aluminium Air Battery-Choice of Batteries for automotive applications, battery charging system, battery parameters, introduction to lithium batteries.

Unit 6 **Hybrid Vehicles**: **6 Hrs.**
Introduction, hybrid vehicle configuration, series hybrid, series-parallel, parallel and complex hybrid, hybrid vehicle operation,Parallel and SeriesPlug-in hybrid electric vehicles (PHEVs),regenerative braking, hybrid vehicle benefits.

Text Books

1. Automobile Engineering - Dr. Kirpal Singh (Vol. I& II) Standard Publishers, New Delhi.
2. Automobile Mechanics - N K Giri.
3. Automobile Engineering - G.B.S. Narang Khanna Publication, 3rd Edition.
4. Electric & Hybrid Vehicles Design Fundamentals - Iqbal Hussain, Second Edition, CRC Press, 2011.

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.
4 The Electric Car: Development & Future of Battery, Hybrid & Fuel-Cell Cars - Dr Mike Westbrook, M H Westbrook, British library Cataloguing in Publication Data, UK, ISBN0 85296 0131.
5 Electric & Hybrid Vehicles - Robin Hardy, Iqbal Husain, CRC Press, ISBN 0-8493 1466-6.
6 Propulsion Systems for Hybrid Vehicles - John M. Miller, Institute of Electrical Engineers, London, ISBN0 863413366.
7 Electric Vehicle Technology Explained - James Larminie, John Wiley & Sons, 2003.
8 Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals – Mehrdad Ehsani, Yimin Gao, Ali Emadi, CRC Press, 2010.
9 Electric Vehicle Battery Systems - Sandeep Dhameja, Newnes, 2001.

Final Year B. Tech. Mechanical Engineering Semester VII
MEL458: Industrial Product Design (Elective I)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Machine Design.

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:
C458.1 Find the Customer Needs for a Quality Product through Market Research in product development process, Concept Generation, Selection and Testing.
C458.2 Describe basics of Product Architecture, Prototyping and Cost and Value Engineering. Select the Standard Ergonomics and Industry Safety parameters in Product Design.

Course Contents

Unit 1 **Introduction:** Challenges of product development, Identify customer needs, Successful product development, Quality aspect of product design, Market Research, Survey **6 Hrs.**

Unit 2 **Product Development Process and Planning :** Innovation and Creativity in Product Design, Product Planning Processes, Product specifications: Process of setting specifications. (Concept Generation–Selection–Testing). **7 Hrs.**

Unit 3 **Product Architecture :** 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. **7 Hrs.**

Unit 4	**Design for Manufacturing and Assembly:** Tolerance, Design of Gauges, Design for Environment, Prototyping, Engineering Materials, Concurrent Engineering, Product Costing, Value engineering.	**7 Hrs.**
Unit 5	**New Product Development :** Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR). Application of Aesthetic and Ergonomic considerations to new product design.	**7 Hrs.**
Unit 6	**Industrial Safety:** 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.	**5 Hrs.**

ISE will be in the form of Presentation of a Case Study 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.

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..

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.
6. "Human Factor Engineering", L P Singh , Galgotia Publication Pvt.Ltd, 1st Edition.

Final Year B. Tech. Mechanical Engineering Semester VII
MEL459: Flexible Manufacturing Systems (Elective I)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites: -- Machine Tool & Processes, Tool Engg.

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 –
C459.1 Understand meaning of flexible manufacturing system
C459.2 Explain the concept of group technology, and how it relates to cellular manufacturing.
C459.3 Explore primary capabilities of flexibility in the FMS.
C459.4 Know about different types of FMS with components.

Course Contents

Unit 1 Introduction and Control Structure of FMS : 7 Hrs.
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 : 6 Hrs.
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 : 7 Hrs.
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 : 8 Hrs.

GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part machine group analysis, Methods for cell formation, Cellular vs. FMS production. 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 : 6 Hrs.

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 : 6 Hrs.

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.

Final Year B. Tech. Mechanical Engineering Semester VII
MEL460: Smart Materials (Elective I)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Manufacturing processes, Thermodynamics, Machine drawing, Materials Engineering and metallurgy.

Course Objectives

1. To introduce the fundamental concepts and principles of smart materials.
2. To provide an understanding of the synthesis, characterization, and properties of various types of smart materials.
3. To explore the applications and potential of smart materials in various fields.
4. To develop the skills required for the design and development of smart material-based systems.

Course Outcomes

C460.1 Explain the basic concepts and principles of smart materials.
C460.2 Demonstrate knowledge of different types of smart materials and their properties.
C460.3 Analyze and evaluate the suitability of smart materials for specific applications.
C460.4 Apply appropriate techniques for the synthesis and characterization of smart materials.

Course Contents

Unit 1 Introduction to Smart Materials: Definition and characteristics of smart materials, Historical development and significance, Types of smart materials: shape memory alloys, piezoelectric materials, electroactive polymers, etc. Applications in engineering, biomedical, aerospace, and other industries, Structure and Properties of Smart Materials, Molecular and microstructural basis of smart materials, Mechanical, electrical, thermal, and optical properties, Relationship between structure and properties **7 Hrs.**

Unit 2 Shape Memory Materials: **6 Hrs.**
• Introduction to shape memory effect
• Shape memory alloys (SMA): composition, phase transformation, and properties
• Shape memory polymers (SMP): synthesis, behaviour, and applications

Unit 3 Piezoelectric Materials: **6 Hrs.**
• Principles of piezoelectricity
• Crystal structures and piezoelectric coefficients
• Applications in sensors, actuators, and energy harvesting

Unit 4	Electroactive Polymers (EAP): Introduction to EAPs, Types of EAPs: dielectric elastomers, conducting polymers, Electro-mechanical coupling and applications	**6 Hrs.**
Unit 5	Magnetostrictive and Magnetorheological Materials: • Magnetostrictive materials: principles and properties • Magnetorheological materials: behavior and applications • Electromagnetic actuation and sensing	**6 Hrs.**
Unit 6	Self-Healing Materials: • Introduction to self-healing materials • Mechanisms and types of self-healing materials • Applications in coatings, composites, and structural materials • Fabrication and Characterization Techniques • Fabrication methods for smart materials • Characterization techniques: microscopy, spectroscopy, mechanical testing, • Testing and evaluation of smart materials' performance • Emerging Trends and Future Applications	**9 Hrs.**

Text Books

1. "Smart Materials and Technologies: For the Architecture and Design Professions" by Michelle Addington and Daniel L. Schodek.
2. "Smart Materials: In Architecture, Interior Architecture & Design" by Rosemarie Wagner
3. "Smart Materials for Tissue Engineering: Applications" by Qun Wang and Xiumei Mo.
4. "Smart Materials for Advanced Environmental Applications" by Shao-Yuan Leu, Zhi-Yong Yin, and Xian-Feng Fan
5. "Smart Materials-Based Actuators at the Micro/Nano-Scale: Characterization, Control, and Applications" by Chenguang Yang, Yu Zhang, and Tao Zhang

Reference Books

1. "Smart Materials" by Mel Schwartz
2. "Introduction to Smart Materials" by Manfred Kohl and Hans-Jürgen Schneider
3. "Smart Materials and Structures: New Research" by Jonathan W. Bailey and Maurice J. Casey
4. Sujata V., Bhat., “Biomaterials”, Narosa Publication House, New Delhi, 2002
5. M. V. Gandhi and B. S. Thompson, “Smart Materials and Structures”, Chapman and Hall, London, First Edition, 1992.

Final Year B. Tech. Mechanical Engineering Semester VII
MEL471: Building Automation, Energy Audit & IoT (Elective I)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Basics of Electronics and Instrumentation.

Course Objectives

1. Enable students to understand basic concept of building automation.
2. Learn to create safe, secure, comfortable, healthy, and sustainable environment in buildings.
3. Learn to bring energy efficiency in building systems.
4. Learn the concept of Smart homes and basics of Internet of Things.

Course Outcomes

C471.1 Articulate the purpose and operation of HVAC system components, the operation of HVAC systems.
C471.2 Learn basics of Internet of Things and Smart infrastructure.
C471.3 Understanding importance of fire safety systems, Security & Access Control System.
C471.4 Understand Building energy management and Energy Audit.

Course Contents

Unit 1 Introduction to Building Automation Systems: **7 Hrs.**

Intelligent buildings, its architecture and structure. Evolution of intelligent buildings. Facilities management vs. intelligent buildings, Lifecycle of building. BAS System Hierarchy – Field level components, Direct Digital Control (DDC), Supervisory Controller, Server, and Operator Workstation (OWS). Different systems in BAS which includes HVAC, security, fire, lighting systems. Importance of each system in BAS. Process of BAS design, Role of different stakeholders (Architect, contractor, consultant, application engineer and engineer) in BAS system design. BAS communication protocols and addressing concepts – BACnet and LON.

Unit 2 Introduction to Systems in HVAC : **6 Hrs.**

Refrigeration cycle: Working, mechanical configuration of different types of components used in refrigeration cycle - evaporator, condenser, compressor, expansion valve.

Chilled water system: Design, different types of chilled water systems - single chiller system, series chiller system, parallel chiller system. Working of different components of chilled water system - decoupler line, bypass line, primary circuit, secondary circuit, and condenser pumps.

Hot Water Systems: Working and design of different types of boilers- fire tube, water tube, packaged boiler.
Air Handling Units: Concept of Air handling unit. Design, working of different components in AHU - damper, filter, cooling coil, heating coil, fan, heat recovery wheel, humidifier.
Variable Air Volume (VAV) system: Design, working, use of different types of VAV- CAV, cooling only, with reheat

Unit 3 **What is IoT** – History, Overview, Definition, Architecture and Application. Technical Building blocks of IoT, Device, Communication Technologies, Data, Physical design of IoT. IoT Issues and Challenges- Planning, Costs and Quality, Security and Privacy, Risks. Case Studies Smart Home: Characteristics of Smart Home - Smart Home Energy Management, Smart Appliances, Communication Technologies for Smart Homes, maintenance, security, challenges. **6 Hrs.**

Unit 4 **Introduction to Fire Alarm System, Fire Detection and Access Control:** What is Fire? Fire alarm System-The History, FAS architecture & operation. Classification of Fire Alarm System, Conventional and Addressable Fire Alarm System. Important Codes-NFPA72, IS 2189, BS 5839. FAS Loops-Classification of Loops and Examples. Network terminology for Fire Systems, Classification of Cables, Class of Cables, Types, and distance Supported specific to fire alarm system. Working Principles of Fire Alarm devices and its working Application in building safety. Basic Concept of Access Control System it's benefits & architecture. Secure and Non-Secure Concept. Basic of CCTV system, System Architecture of CCTV System **6 Hrs.**

Unit 5 **Energy Management and Audit:** Definition and Objectives of Energy Management. Definition and need for Energy Audit. Types of Energy Audits and Approach: Preliminary, Targeted, Detailed Audits. Energy Audit Report. Understanding energy Costs. Energy Performance: Plant Energy Performance, Production Factor. Maximizing System Efficiencies. Optimizing Input Energy Requirements. Instruments and Metering for Energy Audit. **6 Hrs.**

Unit 6 **Energy Efficiency in HVAC and Refrigeration systems:** Selection of a Suitable Refrigeration system. Performance Assessment of Refrigeration Plants. Factors Affecting Performance & Energy Efficiency of Refrigeration Plants. Performance Assessment of window Split and package air conditioning units, Energy Efficiency Ratio. Energy Saving Opportunities: Cold Insulation, Building Envelope, Building Heat Loads Minimization, Process Heat Loads Minimization and At the Refrigeration A/C Plant Area. Building Energy Management System. Star Rating of Buildings: Energy Performance Index. Energy Efficiency Measures in Buildings: For Air-Conditioning System and Lighting System. **9 Hrs.**

Text Books

1. Robert Gagnon, Design of Special Hazards and Fire Alarm Systems.
2. Damjanovski, Vlado, CCTV, Butterworth-Heinemann , 3rd ed.
3. Benantar M., Access Control System
4. Montgomery R, Fundamentals of HVAC Control Systems , Elsevier Publications.
5. Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition.
6. James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3.
7. "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)
8. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.
9. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e- ISBN 978-3-642-19157-2, Springer

Reference Books:

1. "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping).
2. "Chillers Basics", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0009 for online shopping).
3. "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers.
4. "Handbook – Industrial Ventilation Application", 2004, Indian Society of Heating, Refrigerating & Air Conditioning Engineer.
5. Hakima Chaouchi, "The Internet of Things Connecting Objects to the Web" ISBN: 978-1-84821-140-7, Willy Publications.
6. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications.

Web References:

1. Energy Management and Energy Audit:
   https://s3.ap-south
   1.amazonaws.com/aipnpc.org/downloads/T_5053_GENERAL_ASPECTS_OF_ENERGY_MANAGEME T_AND_ENERGY_AUDIT.pdf
2. Energy Management and
   Energy Audit:
   https://s3.ap-south
   1. amazonaws.com/aipnpc.org/downloads/T_5052_ENERGY_EFFICIENCY_IN_ELECTRICAL_UTILITIES_ BOOK_03.pdf

Final Year B. Tech. Mechanical Engineering Semester VII
MEL461: Automotive Fabrication (BIW) (Elective-II)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	SE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Metallurgy, Strength of Materials, CAD-I & II, Tool Engineering

Course Objectives

1. Make familiar basic parts of BIW and Plastic trims.
2. Study different materials and joining processes for BIW.
3. Demonstrate use of modern trends, techniques and skill to fulfill industrial needs.

Course Outcomes

C461.1 Understand types of bodies and concept of PLM in automotive and different gateways for BIW.
C461.2 Apply to learn different joining and design verification processes in BIW.
C461.3 Understand interior and exterior structure of automotive body.
C461.4 Analyse different defect in plastic interior trims.

Course Contents

Unit 1 Basic concepts and consideration in BIW : **5 Hrs.**
Requirement specification in the pre-program stage, Product life cycle and important of gateway for BIW, Identification of commodities for BIW, Design concepts and consideration in BIW

Unit 2 Material and Different joining methods : **7 Hrs.**
BIW materials and grades (Steel, Aluminium, Composites), Sheet metal joining: Welds, Adhesives, Design of strip layout for sheet metal, Welding & assembly.

Unit 3 Design verification : **7 Hrs.**
CAE methods and Gateway supports, CAE analysis: NVH, Crash & Durability, Test validation & Assessment, Manufacturing sequence, welding & assembly, Future trends in BIW, Examples & case studies.

Unit 4 Interior and Exterior of Cars : **5 Hrs.**
Introduction, Automotive Interior Trim Overview, Exterior of the car, Styled Parts in Automotive Interior Trim & exterior. Assemblies and Parametric Linking. Plastic Parts in interior/exterior.

Unit 5 Injection moulding Consideration of Interior/Exterior Plastic Parts: **8 Hrs.**
Injection moulding Introduction, Injection Moulding, Wall Thickness, Mould Halves, Draft Flow, Undercuts, Openings, Materials, Material Selection, Parting Lines and Proposal of core and cavity.

Common Features: Common Features Introduction-Ribs, Snaps, Locators, Dog house/retainer, Clip tower, Heat steaks, Depressions, Boss, Flange, Gussets, Design Considerations of Engineering features.

Unit 6 Plastic Part Assemblies and Evaluating Plastic Parts : **7 Hrs.**
Introduction, Plastic Part Assemblies, Press Fits, Snaps, Fasteners, Bonding, Ultrasonic Welding, Other Welding Techniques.
Evaluating Plastic Parts: Evaluating the Model Unit Introduction, Measure Item-between-inertia-curvature analysis-draft analysis, FMEA, DFMEA, DFM, DFA, Car coordinate system, packaging feasibility, Locating strategy, 3-2-1 Principle, Future Trends and Future materials for trims, Examples & case studies.

Text Books

1. Practical finite element analysis by Nitin Gokhale.
2. "Reliability Engineering", L. S. Srinath, East West Press, New Delhi (1991)

Reference Books

1. Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)
2. Dimensional Control Fundamentals: Automotive Body-in-White and Interior Trim (Dimensional Management Book 2) Kindle Edition
3. Plastic Injection Molding, Manufacturing Startup and Management, Douglas M. Bryoe, Society of Manufacturing Engineers.
4. Injection Molding Handbook, Dominick V. Rasato, CBS Publication.

Final Year B. Tech. Mechanical Engineering Semester VII
MEL462: Industrial Automation and Robotics (Elective II)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Basic Electronics, Control Engineering.

Course Objectives

1. To introduce students to automation and basic elements of automated systems.
2. To provide students with knowledge of levels of automation, transfer lines and automated material handling systems.
3. To explain the fundamentals of industrial robotics and sensors used in automation system.
4. To introduce students to various applications of industrial automation in Industrial field.

Course Outcomes

C462.1 Students will able to Describe and discuss concepts related to automation, industrial control, PLC, sensors, etc.
C462.2 Students will able to select the appropriate components of automation for the given system.
C462.3 Students will able to apply the concepts of logic gates and number systems to solve digital logic problems.
C462.4 Students will able to analyze the problems with traditional system and suggest solution for the given application for implementation of automation.

Course Contents

Unit 1 **Introduction to Automation:** Basic hydraulics and pneumatics system, Definition of Automation, Automated manufacturing systems, Types of Automation – Fixed/programmable/ flexible, Need of automation, Basic elements of automated systems, Economic and social aspects of automation, Advanced Automation functions, Levels of automation. **6 Hrs.**

Unit 2 **Industrial Control and Transfer Lines:** Industrial control systems in process and discrete manufacturing industries, Continuous and discrete control; Computer process control, Fundamentals of transfer lines, Configurations, Transfer mechanisms, Applications, System configurations for automated production lines. **6 Hrs.**

Unit 3 **Automated Material Handling Systems:** Definition and objectives of material handling, Principles, Symptoms of bad material handling, Selection of material handling equipments, Automated Guided Vehicle, Types, Advantages and Limitations, Applications, Introduction to Automated Storage and Retrieval System. **7 Hrs.**

Unit 4	**Digital Logic and Sensors:** Digital logic, Number systems, Logic Gates, Boolean Algebra, Application of logic gates, Sequential Logic, Transducers and sensors- Sensors in robotics and their classification, Touch (Tactile)sensors, Proximity and range sensors, Pressure sensors.	**6 Hrs.**
Unit 5	**Fundamentals of Industrial Robots and Programmable Logic Controller:** Specifications, Robot Anatomy, Criteria for selection, Robotic Control Systems: Drives, Robot Motions, Joint notation scheme, Selection guidelines for typical application, Robot related terminology like Stability, Resolution, Spatial resolution, Accuracy, Repeatability, Compliance, Work cell control, Resilience. Concept of interlocks and types of interlocks, End effectors and types.	**6 Hrs.**
Unit 6	**Robotic Grippers and Robot Programming:** Force analysis of gripper mechanism, Selection considerations for gripper, Problems on gripper selection. Introduction to robot programming, Programming approaches for robot, robot programming basics for simple tasks like Pick and place, Sorting, Palletizing and De-palletizing.	**8 Hrs.**

Text Books

1. "Automation, Production Systems and Computer Integrated Manufacturing", Groover, M.P., Pearson Education, ISBN: 81-7808-511-9 2nd Edition (2004)
2. A textbook on Industrial Robotics by Ganesh Hegde, Laxmi Publication
3. Robotic Engineering: An Integrated Approach by Klafter Richard D., Chmielewski Thomas A., Negin Michael, PHL Publications

Reference Books

1. "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
2. "Mechatronics", W. Bolton, Third Edition, Pearson Education
3. "Robot Technology Fundamentals", Keramas, James G, Thomson Learning –Delmar ISBN: 981-240-621-2,(1998)
4. "Introduction to Robotics, Analysis, Systems and Applications", Niku, Saeed B. (2002), Prentice Hall of India
5. "Mechatronics", N. Mahalik, Tata McGraw Hill

Final Year B. Tech. Mechanical Engineering Semester VII
MEL463: Mechatronics (Elective II)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Fundamental of Electronics & Computer Programming, Industrial Hydraulics & Pneumatics, Control Engineering.

Course Objectives

1. To introduce students to various concepts of automation, Mechatronics and PLC and the integration of different branches of engineering in Mechatronics.
2. To make students aware of the recent trends and practices in Mechatronics in manufacturing and service sector for productivity improvement and cost, time and human intervention reduction and comparison with equivalent traditional systems.
3. To make students design, analyse, modify if required, validate and implement ladder programs using PLC for various industrial, home and office automation problems along with necessary fault finding.

Course Outcomes

C463.1 Describe and discuss sensors, microprocessors, microcontrollers, PLC, digital circuits and signal conditioning.
C463.2 Distinguish between traditional and mechatronics system and justify the given system is mechatronics system.
C463.3 Design and communicate automated solutions for economic, global and environmentalproblems for industries through selection of appropriate components and programming instructions.

Course Contents

Unit 1 **Introduction to Mechatronics** : **5 Hrs.**
Introduction to Mechatronics: What is Mechatronics, Mechatronics systems, Measurement systems, Control systems, Multidisciplinary scenario, Traditional Vs Mechatronics Design, Case studies of Mechatronics system designs likepiece counting system, pick and place manipulator, automatic tool changer, handling system, bathroom scales, DSLR, engine management, etc.

Unit 2 **Transducers & Sensors** : **7 Hrs.**
Performance Terminology, Position Sensors: Limit switch, photoelectric switches, proximity sensors, pneumatic limit valves and backpressure sensors, pressure switches, resolvers, incremental & absolute encoders, Displacement: Potentiometer, LVDT, capacitive displacement sensors. Velocity sensors: Tachogenerator, Temperature sensors, Selection of sensors.

Unit 3 **Signal Conditioning** : **7 Hrs.**
Signal conditioning process, Operational amplifier (inverting amplifier, non-

inverting amplifier, summing, integrating amplifier), protection, filtering, data acquisition, multiplexer, analog to digital converter (ADC), digital to analog converter (DAC). Sample and hold, Interfacing input output ports, interfacing requirements, buffer, handshaking, polling and interrupts.

Unit 4 Current advancements in Mechatronics: **7 Hrs.**

Industry 4.0 – Definition, evolution, advantages and limitations, Industry 4.0 Technologies – Internet of Things and Cyber Physical System, Artificial Intelligence, Machine Learning and Big Data, Controllers in IoT – Arduino, Raspberry Pi, Microcontroller and Microprocessor: Comparison between microprocessor and micro controller, architecture of microcontroller and microprocessor

Unit 5 Programmable Logic Controller (PLC): **7 Hrs.**

Introduction, Definition of PLC, PLC system and components of PLC input output module, PLC advantages and disadvantages,Block diagram for interfacing of PLC, computer and system to be controlled. Machine control terminology, update – solve ladder – update, physical components Vs. program components, light control example, disagreement circuit, majority circuit, oscillator, holding (sealed or latches) contacts, always ON always OFF contacts, fail safe circuit, AND-OR and OR-AND circuits.

Unit 6 Ladder diagram & PLC programming fundamentals: **6 Hrs.**

Basic components and other symbols, Fundamentals of ladder diagram, PLC input instructions, outputs, coils, indicators, operational procedures, contact and coil input output, nesting of ladders, programming example, simple industrial applications.

PLC timer functions – Introduction, timer functions, industrial applications, industrial process timing applications, PLC control functions – PLC counters and its industrial applications, Internal Relays.

PLC system fault finding - Fault detection techniques, common hardware faults.

Text Books

1. Mechatronics, W. Bolton, 4th Edition, Pearson Education, Jan.2010, ISBN: 8131732533
2. "Mechatronics", N. P. Mahalik, TATA McGraw Hill Edu, 2017, ISBN: 978-0070483743
3. "Introduction to PLC programming", NIIT, Prentice Hall of India, ISBN: 9788120325258
4. "Microprocessor 8085", Ramesh Gaonkar, Penram Int. Pub. 2013, ISBN:978-8187972884

Reference Books

1. Programmable logical controller, Hackworth & Hackworth, Pearson Education
2. Programmable logical controller, Reis Webb, Prentice Hall
3. Mechatronics and Microprocessor, Ramchandran Willey India
4. Mechatronics : Integrated Mechanical Electronic System, Ramchandran Willey India
5. Programmable logical controller, Third edition, Gary Dunning Cengage Learning

Final Year B. Tech. Mechanical Engineering Semester VII
MEL464: Refrigeration Systems (Elective II)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Applied Thermodynamics, Heat & Mass Transfer, Engines and Air conditioning.

Course Objectives
After completion of the course, students will be able 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
C464.1 Explain the working of types refrigerating system
C464.2 Evaluate the performance of vapour compression system
C464.3 Identify and explain the function of various components of refrigeration system.
C464.4 Evaluate the impact of refrigerants on the performance and on earth

Course Contents

Unit 1 Application of Second law of thermodynamics: **5 Hrs.**
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: **8 Hrs.**
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.

Unit 3 Multi pressure systems: **6 Hrs.**
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. Vapour absorption system.

Unit 4 Refrigerants: **8 Hrs.**

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.

Unit 5 Refrigeration equipment's: **7 Hrs.**

Insulation, types and different applications, properties of ideal insulations. Compressor, Condenser, Evaporator, Expansion devices, Types, selection. Component balancing, safety devices and refrigeration controls. Commissioning and maintenance, Efficiency, running cost and carbon footprint of refrigeration equipment's

Unit 6 Applications in food refrigeration/processing & Industrial air conditioning: **5 Hrs.**

Typical examples of food processing by refrigeration and storage, transport refrigeration, cooling and heating of foods, freezing of foods, freeze drying, heat drying of foods, industrial refrigeration, station air conditioning, tunnels ventilation, mine air conditioning and ventilation

Text Books

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

Reference Books

1 "Basic Refrigeration and Air Conditioning" PN 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" Hundy, Trott ad Welch, BH Publications
6 "Air Conditioning Applicationsand Design" W.P. Jones, Elsevier, 2nd Edition.
7 "Air Conditioning Engineering" W.P. Jones, Elsevier, 5th Edition

Final Year B. Tech. Mechanical Engineering Semester VII
MEL465: Experimental Mechanics (Elective II)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Applied Physics, Engg. Mathematics, Strength of Materials.

Course Objectives

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

C465.1 Student will Analyze photo elastic technique to stress analysis .
C465.2 Explain the concept of strain gages and its applications
C465.3 Elaborate the concept of coating methods
C465.4 Apply the knowledge of Moiré fringe method of stress analysis.

Course Contents

Unit 1 Principles of Experimental Approach : **3 Hrs.**
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 : **10 Hrs.**
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 : **6 Hrs.**
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** : **7 Hrs.**

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** : **7 Hrs.**

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** : **6 Hrs.**

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

Text Books

1. "Experimental Stress Analysis", Dr. Sadhu Singh; Khanna Publishers, 5th Edition.
2. "Experimental Stress Analysis", J.W. Dally and W.F. Riley, Tata McGraw Hill Book Company, 3rd Edition.

Reference Books

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

Final Year B. Tech. Mechanical Engineering Semester VII
MEP466: Automotive Fabrication (BIW) Lab (Elective-II)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	2

Evaluation Scheme	
CIE	50
SEE	50
Total	100

Course Objectives:	
1.	Make familiar basic parts of BIW and Plastic trims.
2.	Study different materials and joining processes for BIW.
3.	Demonstrate use of modern trends, techniques and skill to fulfill industrial needs.

List of Experiments:
Total 6 Experiments to be carried out from the bellow list

1.	Modelling of Some Automotive components like Bonnet, Tailgate, Side doors, Roof etc.
2.	Analysis of the above components by using FEA Software's
3.	Types of Welding study and Practical's on small components
4.	Rivet joining methods
5.	Different data collection methods (Case study on automotive design) Surveys
6.	Study of automobile Engine (Disassembly and Assembly)
7.	3D scanning & Printing of any automotive component.
8.	Study of RoboAnalyzer for Assembly line point of view.

Submission:
Completed Journal.

Text Books
1. Practical finite element analysis by Nitin Gokhale.
2. "Reliability Engineering", L. S. Srinath, East West Press, New Delhi (1991)

Reference Books
1. Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)
2. Dimensional Control Fundamentals: Automotive Body-in-White and Interior Trim (Dimensional Management Book 2) Kindle Edition
3. Plastic Injection Molding, Manufacturing Startup and Management, Douglas M. Bryoe, Society of Manufacturing Engineers.
4. Injection Molding Handbook, Dominick V. Rasato, CBS Publication.

Final Year B. Tech. Mechanical Engineering Semester VII
MEP467: Industrial Automation and Robotics Lab (Elective-II)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	2

Evaluation Scheme	
CIE	50
SEE	50
Total	100

Course Objectives

1. To introduce students to automation and basic elements of automated systems.
2. To provide students with knowledge of levels of automation, transfer lines and automated material handling systems.
3. To explain the fundamentals of industrial robotics and sensors used in automation system.
4. To introduce students to various applications of industrial automation in Industrial field.

List of Experiments:

1. Study of Automation
2. Case study on Automation
3. Study of Industrial Control and Transfer Lines
4. Case study on Industrial Control and Transfer Lines
5. Study of Automated Material Handling Systems
6. Case study on Automated Material Handling Systems
7. Study of Logic Gates and Sensors in Automation
8. Case study on Logic Gates and Sensors in Automation
9. Study of Robot Anatomy.
10. Robot Programming Exercises.
11. Robot Programming Exercises.
12. Robot Programming Exercises.

Submission: Completed Journal.

Text Book :

1. "Automation, Production Systems and Computer Integrated Manufacturing", Groover, M.P., Pearson Education, ISBN: 81-7808-511-9 2nd Edition (2004)
2. A textbook on Industrial Robotics by Ganesh Hegde, Laxmi Publication

References

1. "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
2. "Mechatronics", W. Bolton, Third Edition, Pearson Education
3. "Robot Technology Fundamentals", Keramas, James G, Thomson Learning –Delmar ISBN: 981-240-621-2,(1998)
4. "Introduction to Robotics, Analysis, Systems and Applications", Niku, Saeed B. (2002), Prentice Hall of India
5. "Mechatronics", N. Mahalik, Tata McGraw Hill

Final Year B. Tech. Mechanical Engineering Semester VII
MEP468: Mechatronics Lab (Elective-II)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	2

Evaluation Scheme	
CIE	50
SEE	50
Total	100

Course Objectives

1. To introduce students to various concepts of automation, Mechatronics and PLC and the integration of different branches of engineering in Mechatronics.
2. To make students aware of the recent trends and practices in Mechatronics in manufacturing and service sector for productivity improvement and cost, time and human intervention reduction and comparison with equivalent traditional systems.
3. To make students design, analyze, modify if required, validate and implement ladder programs using PLC for various industrial, home and office automation problems along with necessary fault finding.

List of Experiments:

1. Introduction to sensor and sensor applications
2. Introduction to PLC
3. Case study on Industry 4.0 Technologies
4. Introduction to controllers
5. PLC programming for simple process control
6. PLC programming based on timers
7. PLC programming based on counters
8. Industrial visit

Submission: Completed Journal.

Text Books:

1. Mechatronics, W. Bolton, 4th Edition, Pearson Education, Jan.2010, ISBN: 8131732533
2. "Mechatronics", N. P. Mahalik, TATA McGraw Hill Edu, 2017, ISBN: 978-0070483743
3. "Introduction to PLC programming", NIIT, Prentice Hall of India, ISBN: 9788120325258
4. "Microprocessor 8085", Ramesh Gaonkar, Penram Int. Pub. 2013, ISBN:978-8187972884

Reference Books

1. Programmable logical controller, Hackworth & Hackworth, Pearson Education
2. Programmable logical controller, Reis Webb, Prentice Hall
3. Mechatronics and Microprocessor, Ramchandran Willey India
4. Mechatronics : Integrated Mechanical Electronic System, Ramchandran Willey India
5. Programmable logical controller, Third edition, Gary Dunning Cengage Learning

Final Year B. Tech. Mechanical Engineering Semester VII
MEP469: Refrigeration Systems Lab (Elective-II)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	2

Evaluation Scheme	
CIE	50
SEE	50
Total	100

Course Objectives: After completion of the course, students will be able 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.

List of Experiments:

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 & demonstration on air conditioning systems. (Unitary & Central Air Condi./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 troubleshooting
12. Study & demonstration of controls and safety devices in refrigeration & 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 equipment's with related specifications, manufacturers, cost and comparison

Submission: Completed Journal.

Text Books:

1. Mechatronics, W. Bolton, 4th Edition, Pearson Education, Jan.2010, ISBN: 8131732533
2. "Mechatronics", N. P. Mahalik, TATA McGraw Hill Edu, 2017, ISBN: 978-0070483743
3. "Introduction to PLC programming", NIIT, Prentice Hall of India, ISBN: 9788120325258
4. "Microprocessor 8085", Ramesh Gaonkar, Penram Int. Pub. 2013, ISBN:978-8187972884

Reference Books

1.	Programmable logical controller, Hackworth & Hackworth, Pearson Education
2.	Programmable logical controller, Reis Webb, Prentice Hall
3.	Mechatronics and Microprocessor, Ramchandran Willey India
4.	Mechatronics : Integrated Mechanical Electronic System, Ramchandran Willey India
5.	Programmable logical controller, Third edition, Gary Dunning Cengage Learning

Final Year B. Tech. Mechanical Engineering Semester VII
MEP470: Experimental Mechanics Lab (Elective II)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	2

Evaluation Scheme	
CIE	50
SEE	50
Total	100

Course Objectives

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

List of Experiments:

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

Submission:

Any eight experiments from above.

References

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

Final Year B. Tech. Mechanical Engineering Semester VIII
MELOE4: Open Elective through MOOC

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		**100**

Course Contents

- Students are expected to choose a Course from MOOC sites like AICTE Swayam, CourseEra, edX and Udemy.
- Students have to find the Course material from above MOOC sites.
- After approval of the course, students have to prepare coursework as per guidance from subject teacher.
- Evaluation of the identified course will be done by the respective Guide.

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL475 : Production Management

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites: M/c Tool & Processes, Tool Engg..

Course Objectives

1. To gain an understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing firms.
2. To gain some ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy.
3. To understand the managerial responsibility for Operations, even when production is outsourced, or performed in regions far from corporate headquarters.

Course Outcomes

C475.1 Understand the core features of the operations and production management function at the operational and strategic levels.
C475.2 Analyse the product life cycle and the product impact on the environment and evaluate effectiveness of manufacturing products, processes and operations planning.
C475.3 Develop a sound understanding of the important role of supply chain management in today's business environment
C475.4 Apply problem solving and decision making frameworks that propose defensible solutions to organizational opportunities, challenges, in Mfg. and maintenance.
C475.5 Develop and utilize critical management skills, effective written and oral communications, critical thinking, team building and presentation skills as applied to business problems

Course Contents

Unit 1 **Introduction to Production management**: Production types, objectives and scope of Production Management, Production Planning and Control (PPC)- Definition, Activities of production planning and production control Interrelationship of Production with other functional areas. Strategy formulation process, order qualifiers and order winners, Product portfolio, Estimation of Demand- Time series Analysis and causal forecasting techniques, least square method, Moving average and exponential smoothing forecasting method. **7 Hrs.**

Unit 2 **Product and Process Design**: Product design, Product strategies, Product policy of an organization, Product design process. Product Life Cycle (PLC), Process design, Selection, Make or Buy decision. **6 Hrs.**

Unit 3 **Capacity, Aggregate Planning and Scheduling of operations**: Capacity- Definition, Measure of Capacity, Capacity strategies, Estimation of number of machines, Overcapacity and under capacity factors, Aggregate Planning, **7 Hrs.**

	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.	
Unit 4	**Supply chain Management and JIT:** Concept of supply chain and supply chain management, Manufacturing supply chain, SCM activities, Supply chain strategies, managing supply chain, JIT Philosophy, Origin and core logic of JIT, Elements of JIT, Kanban System-Design of Kanban containers, JIT, issues and performance, Lean Manufacturing- Pillars, features and process comparison with Traditional Manufacturing.	**6 Hrs.**
Unit 5	**Value Engineering:** Introduction, Definition of V.E., meaning, types of value, use, Value Analysis, application of V.A., unnecessary costs, Steps in V.A., FAST, Ten principles of V.A.	**6 Hrs.**
Unit 6	**Manufacturing Optimization and Engineering economics:** Evaluation criteria for Production/ Manufacturing Optimization, 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.	**7 Hrs.**

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 Edu, 3rd Ed.
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 & Value Chain, Krajewski & Ritzman, Malhotra Pearson Edu.
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.

Final Year B. Tech. Mechanical Engineering Semester VIII
MED476: Project Phase II

Teaching Scheme	
Practical	14 Hrs/ Week
Total Credits	7

Evaluation Scheme	
CIE	50
SEE	50
Total	100

Course Objectives:

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.
3. To study the concepts of optimization of mechanical systems/ elements.

Course Outcomes

C476.1 Improve the professional competency and research aptitude in relevant area.
C476.2 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 students per group, shall work under one Faculty member of department. The group of one student is strictly not allowed.

Project Phase II Definition:

Project phase-II is a continuation of project phase-II 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 prequalifying 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.
   b. Brief report of feasibility studies carried to implement the conclusion.
   c. 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 & 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 atthe 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.

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL477: Reliability Engineering (Elective III)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Machine Tool, Manufacturing Process, Probability.

Course Objectives

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

Course Outcomes

At the end of the course students will be able to –

C477.1 Explain basics of reliability, maintainability and availability and differentiate among them.
C477.2 Apply fundamentals of reliability to estimate reliability of mechanical systems, electronics devices, softwares and human.
C477.3 Analyze field failure data for reliability analysis
C477.4 Evaluate system reliability using various techniques.

Course Contents

Unit 1 **Fundamentals of Reliability and its Measures:** Brief history of reliability, Concepts, Terms and definitions, system safety, quality & 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. **6 Hrs.**

Unit 2 **Reliability Distributions:** 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, tmed, tmode for above distributions. **8 Hrs.**

Unit 3 **Reliability Evaluation of Systems:** System Reliability block diagram- Series configuration, Parallel configuration, Mixed configurations, redundant systems, standby redundant, load sharing systems etc. High level versus low level **7 Hrs.**

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:** 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). **7 Hrs.**
Availability - Availability concepts and definitions, important availability measures, inherent, achieved and operational availability

Unit 5 **Reliability Testing and Data Analysis:** Reliability Testing - Life testing, Burn-in testing, Acceptance testing, Accelerated life testing, highly accelerated life testing (HALT) and reliability growth testing. **6 Hrs.**
Data Collection & 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):** Electronics - Reliability of electronic components, component types and failure mechanism. **6 Hrs.**
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.

Reference Books

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

13. Mohammad Modarres, Mark Kaminskiy, Vasiliy Krivstov, "Reliability Engineering and Risk Analysis – A practical Guide", CRC Press, Taylor and Francis Group.
14. Guangbin Yang, 2007, "Life cycle reliability engineering", John Wiley and Sons.
15. W. R. Blischke, D.N.P. Murthy, 2003, "Case studies in Reliability and Maintenance", John Wiley and Sons.
16. Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, 2006, "Maintenance, Replacement and Reliability: Theory and Applications", CRC/Taylor and Francis.
17. B. S. Dhillon, Chanan Singh, 1981, Engineering Reliability – New Techniques and Applications", John Wiley and Sons.
18. B. S. Dhillon, 1999, "Engineering Maintainability", Prentice Hall of India.

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL478: Micro-Electro Mechanical System - MEMS (Elective III)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Basic Electrical Engg., Engg. Physics, Strength of Material, Engg. Chemistry.

Course Objectives

1. Introduction to the fundamentals of micro-fabrication technology
2. Introduction to applications to the fields of MEMS (micro-electro-mechanical systems)
3. Identify various aspects of MEMS technology and its numerous applications

Course Outcomes

C478.1 Describe and discuss basics of micro-fabrication and micro machining.
C478.2 Examine the design process for MEMS devices and systems.
C478.3 Design and development of models with electrostatic and electromagnetic sensors and actuators.
C478.4 Select material suitable for MEMS considering their properties.

Course Contents

Unit 1 MEMS & Materials: **6 Hrs.**
Micro-Electro-Mechanical Systems (MEMS), Microsystems and their products, miniaturization, applications, Materials for MEMS – substrate and wafers, silicon as a substrate material, crystal structure, single crystal and polycrystalline, mechanical properties, silicon compounds, silicon piezo-resistors, gallium arsenide, quartz, piezo-electric crystals, polymers, packaging materials

Unit 2 Micro Fabrication Processes : **7 Hrs.**
Fabrication Processes – Bulk micro-manufacturing, photolithography, photo resists, structural and sacrificial materials, X-ray and electron beam lithography, Thin film deposition – spin coating, thermal oxidation, chemical vapour deposition (CVD), electron beam evaporation, sputtering; Etching – wet etching, dry etching; Surface micromachining, bulk vs. surface micromachining; LIGA process and applications

Unit 3 Microsensors : **7 Hrs.**
Sensing and actuation, Chemical sensors, Optical sensors, Pressure sensors, Thermal sensors – thermopiles, thermistors, micro-machined thermocouple probes, thermal flow sensors, MEMS magnetic sensor

Unit 4 Microactuators: **7 Hrs.**
Piezoelectric material as sensing and actuating elements capacitance piezo mechanics, Piezo actuators as grippers, micro-grippers, micro-motors, micro-

valves, micro-accelerometers, shape memory alloy, micro-spring thermal actuator actuation methods, micro-fluid dispensers, micro-needle, micro-fluid gates, micro-pumps

Unit 5 **Microsystem Design** : **6 Hrs.**

Design considerations, Design constraints and selection of materials, selection of manufacturing process, selection of signal transduction technique, Simulation based Microsystem design, need of simulation tool, use of finite element method, various simulation platforms

Unit 6 **Microsystems Packaging** : **6 Hrs.**

Mechanical packaging of microelectronics, Microsystem packaging – considerations and levels, interfaces in Microsystem packaging, packaging technologies, three dimensional packaging, Assembly of microsystems.

Text Books

1. Hsu, Tai-Ran, (2003), MEMS & MICROSYSTEMS: Design & Manufacture, TMH, ISBN:0-07-048709-X
2. Mahalik, N. P., (2007), MEMS, TMH, ISBN: 0-07-063445-9.

Reference Books

1. Bharat Bhushan (Ed.), (2004), Handbook of Nanotechnology, Spinger-Verlag Berlin Heidelberg New York, ISBN 3-540-01218-4
2. Mahalik, N.P. (Ed.) (2006), Micro-manufacturing & Nanotechnology, Springer India Pvt. Ltd., ISBN: 978-81-8128-505-8 (Distributed by New Age International, New Delhi)

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL479: Advanced Automobile Design (Elective III)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Basic Mechanical Engineering, Machine Design, I.C. Engines.

Course Objectives

1. To study various forces coming on the vehicle, engine component, and various systems
2. of automobile.
3. To study the performance of engine parameters.
   To study various ergonomics and safety parameters.

Course Outcomes

C479.1 Analyze various forces coming on the vehicle and deduce the power of the engine.
C479.2 Analyze various forces coming on the engine component and design the components.
C479.3 Analyze various forces coming on the Clutch and Gear box and design the components
C479.4 Analyze various forces coming on the frame and brake and suspension and design the components.
C479.5 Analyze various ergonomics and safety parameters.

Course Contents

Unit 1 **Design of Engine Components**: Selection of engine based on vehicle performance characteristics, Analysis of forces – Design procedure for cylinder, piston, piston rings and piston pin. Design procedure for connecting rod and crank shaft. Design of inlet and outlet valves, Design of valve springs, rocker arm, tappet, Cam, camshaft. **7 Hrs.**

Unit 2 Design of Clutch, Gear Box, Drive Line and Rear Axle, Design of single and multi-plate clutches. Selection of gear ratios - Design of gear box. Design of propeller shaft and final drive, Design of rear axle, selection of tyres. **7 Hrs.**

Unit 3 **Design of Frame, Suspension, Front Axle and Steering:** Force analysis and Design procedure for frame, Design of Suspension system – leaf spring, coil spring and torsion spring. Design procedure for front axle. Determination of steering torque, design of linkages, steering gear box. **7 Hrs.**

Unit 4 **Design of Braking System:** Force analysis, Energy Absorbed by a Brake, Heat to be dissipated during Braking, Materials for Brake Lining, design of drum and disc brakes, design of actuating mechanisms –mechanical, hydraulic and pneumatic. **7 Hrs.**

Unit 5 **Design of Vehicle Body:** Criteria for vehicle body design, sheet metal representation, Unit load method for structural deflection, Car body idealization, and bus body idealization for analysis - adhesives and sealants. **6 Hrs.**

Unit 6 **Vehicle Interior against Ergonomics and Safety:** Car interior ergonomics, ergonomics system design - seating dimensions, dash board instruments, commercial vehicle cabin ergonomics and goods vehicle layout, Crash tests, safety devices. **6 Hrs.**

Text Books

1. Khurmi R S, Gupta J K "A Text Book of Machine Design", Eurasia Publishing house., New Delhi, 2010.
2. Lichty "IC Engines", Kogakusha Co. Limited, Tokyo, 1986.
3. Heinz Heisler "Advanced Vehicle Technology", SAE International, 2002.
4. John Fenton "Handbook of Automotive Body and Systems Design", John Wiley & Sons, 2013.

Reference Books

1. Thomas D Gillespie "Fundamentals of Vehicle Dynamics", SAE., US, 1992.
2. Giles J G "Engine Design", Illiffee Books Ltd., London, 1968.
3. Heldt.P.M "Automotive Chassis", Chilton Co., New York, 1992.
4. Giles.K.G "Steering, Suspension and tyres", Illiffe Books Ltd., London, 1988.
5. Jnusz Pawlowski "Vehicle Body Engineering", Business Books Limited, 1989.

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL480: Cryogenics (Elective III)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Basic Thermodynamics, Heat & Mass Transfer..

Course Objectives

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

C480.1 Describe different Cryogenic systems.
C480.2 Understand and interpret the analysis report in the field of Cryogenics.
C480.3 Apply knowledge of mathematics, science, and engineering for the needs in Cryogenics.
C480.4 Design systems as per the desired needs based on economic, social, and environmental issues associated with engineering practices.
C480.5 Communicate required information

Course Contents

Unit 1 **Introduction :** Introduction, Industrial applications, Recent development, Properties of cryogenic Fluids, Applications of cryogenics in different areas such as Space, Medical, Manufacturing processes, Mechanical Design Behaviour of Structural Materials at Cryogenic Temperature: Mechanical properties, Thermal properties, Thermoelectric properties. **6 Hrs.**

Unit 2 **Liquefaction of cryogenic gases :** Ideal cycle, System performance parameters, Joule Thomson effect, Adiabatic expansion, Liquefaction systems; Simple Linde-Hampson system, Precooled Linde-Hampson system, Cascade system, Claude system, Comparison of above systems. **7 Hrs.**

Unit 3 **Liquefaction systems for neon, hydrogen, helium and heat exchanger :** Precooled Linde Hampson system for neon and hydrogen, Claude system for hydrogen, Helium refrigerated hydrogen liquefaction system, Heat exchanger used in liquefaction systems. **7 Hrs.**

Unit 4 **Cryogenic refrigeration systems :** Ideal refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvay refrigerator, Gifford-McMohan refrigerator, Pulse tube refrigerator. **6 Hrs.**

Unit 5 **Gas separation and purification** : Thermodynamic Ideal refrigeration system, Temperature composition diagram, Principles of Gas separation, Principles of Rectifiers 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. **7 Hrs.**

Unit 6 **Insulation:** Cryogenic fluid storage, Vacuum insulation, Fibrous materials, Solid foams, Gas filled power, Comparison, Critical thickness. Vacuum Technology: Importance, Pump down time, Flow regimes, Components of vacuum systems, Mechanical Vacuum pumps, and Ion pumps. **6 Hrs.**

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 Engg", Vance, R. W, and Duke, Isted, W.M., John Wiley 1962.

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).

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL481: Optimization (Elective-III)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites: M/c.Design I, M/c. Design II

Course Objectives

1. To understand Classical Optimization Techniques.
2. Apply Single-variable Optimization Techniques, and Multi-variable Optimization Techniques.
3. Understand Constrained Optimization Techniques.
4. Accustom with latest techniques like Genetic Algorithm, Simulated Annealing, Artificial Neural Networks.
5. Know theory of Constraints.

Course Outcomes: At the end of the course, students will be –

C481.1 Able to understand type of optimization problem.
C481.2 Able to apply Single-variable Optimization Techniques, and Multi-variable.
C481.3 Optimization Techniques as per requirement.
C481.4 Select and apply constraints in a problem.
C481.5 Demonstrate ability to use technique like ANN, GA.

Course Contents

Unit 1 **Classical Optimization Techniques:** Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method and Kuhn-Tucker Conditions. **5 Hrs.**

Unit 2 **Single-variable Optimization Techniques:** Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method **10 Hrs.**

Unit 3 **Multi-variable Optimization Techniques:** Evolutionary Optimization Method, Simplex Search Method, Pattern Search Method, Conjugate Direction Method, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon- Fletcher-Powell Method **10 Hrs.**

Unit 4 **Constrained Optimization Techniques:** Interior Penalty Function Method, Exterior Penalty function Method **5 Hrs.**

Unit 5 **Genetic Algorithm, Simulated Annealing, Artificial Neural Networks:** Genetic Algorithm, Simulated Annealing, Artificial Neural Networks **3 Hrs.**

Unit 6 **Theory of Constraints:** Introduction to TOC, Optimized Production Technology (OPT), Nine principles of OPT, Five Focusing Steps (The 5FS) of TOC, Capacity **6 Hrs.**

Constrained Resources and the Time Buffer, Modeling the Time Buffer, Modeling Return-On- Investment (ROI) in TOC, Comparison of TOC and Local Optimization Approaches.

Text Books

1. Deb K (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.
2. Dennis J Jr, Schnabel R (1996). Numerical Methods for Unconstrained Optimization and Nonlinear Equations, Society for Industrial and Applied Mathematics.
3. Rao S (1996). Engineering optimization, Theory and Practice, New Age International Publishers.

Reference Books

1. Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2nd edition, John Wiley and Sons Inc.
2. Goldratt, E. M. and Cox, J. (2004). The Goal: A Process of Ongoing Improvement. 3rd Edition, North River Press. ISBN-10: 0884271781, ISBN-13: 978-0884271789.
3. Dettmer, H. William (1997). Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement, American Society for Quality. ISBN 0873893700, 9780873893701.

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL482: PLC and SCADA Programming (Elective IV)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Fundamentals of Electronics & Computer Programming, Control Engineering..

Course Objectives

1. To expose students to fundamentals of PLC.
2. To enable students to apply PLC programming and SCADA

Course Outcomes

C482.1 Students will be able to understand PLC and its industrial applications.
C482.2 Students will be able to develop different programs using basic relay, timer and counter instructions and other programming instructions.
C482.3 Students will be able to apply the concept of SCADA system.
C482.4 Students will be able to interface SCADA with PLC.

Course Contents

Unit 1 **Basics of PLC Programming:** Hardwired logic Vs Programmed logic, symbols used in ladder logic, guidelines for ladder drawing, Relay type instructions, logical instructions, data comparison instructions, data computation instructions. **7 Hrs.**

Unit 2 **Basic Relay Instructions:** NONC, Instructions BIT instructions output & output latching instruction, Negated output Instruction and one shot instruction **5 Hrs.**

Unit 3 **Timer & Counter Instructions:** Introduction, types, timer instructions, counter instructions, applications, implementation of timers and counters for industrial problem solving. **8 Hrs.**

Unit 4 **Program Control Instructions:** Master Control and Zone control instructions, jump instructions and subroutine. Applications of above in PLC programming, PLC fault finding techniques and troubleshooting. **6 Hrs.**

Unit 5 **Supervisory Control And Data Acquisition (SCADA) Processing and Design:** Concept of SCADA, its industrial significance and applications. Interfacing of SCADA with PLC: Steps, methodology, procedure of implementation and protocols. **6 Hrs.**

Unit 6 Applications of SCADA: **7 Hrs.**

Applications of SCADA in process control, industrial automation and various manufacturing systems. Effecting Control using SCADA: Effecting control using data generated through SCADA, Analysis of data for various MIS related tasks.

Text Books

1. "Programmable Logic Controller – Principles and Applications", 5/e, J. W. Webb, R.A. Reis; Prentice Hall of India Ltd. ISBN 81-203-2308-4.
2. "Programmable Logic Controller – Principles and Applications, by NIIT; Prentice Hall Publications Pvt.Ltd. India, ISBN 81-203-2525-7.
3. "Programmable Logic Controller – Programming methods and Applications", Hackworth John R. and Hackworth Frederick D. Jr.; Pearson Education LCE, ISBN 81-297-0340.

Reference Books

1 Introduction to PLC – Gary Dumming – Delmar Pub.
2 Various PLC manufacturers catalogue
3 Programmable Logic Controller – FESTO Pneumatics, - Bangalore
4 SCADA, Stuart A. Boyer (ISA Publi.) ISBN 1-55617-660-0.
5 Practical SCADA for industry, David Bailey, (Elsevier Publi.) ISBN 0-7506-5805-3.

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL484: Energy and Power Engineering (Elective IV)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Basic Mechanical Engg., Thermodynamics, Power Plant Engg.

Course Objectives

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, its performance and economic analysis
4. Understand the new trends in power and energy sectors.

Course Outcomes

C484.1 Understand the need of different energy sources and their importance
C484.2 Analyze the utilization of solar, wind energy, fuel cell etc.
C484.3 Design a standalone system using solar, wind energy
C484.4 Understand the power scenario at local, state and national level
C484.5 Comprehend various equipments/systems utilized in power plants and Illustrate power plant economics

Course Contents

Unit 1 Introduction to solar energy : 8 Hrs.
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 Photo Voltaic and Fuel cell : 7 Hrs.
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), First, second and third generation solar cells, Applications, Introduction, Principle and operation of fuel cells, classification and types of fuel cell. Fuel for fuel cells, Application of fuel cells.

Unit 3 Wind and other energy forms : 5 Hrs.
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-PV Biomass-Diesel systems)

Unit 4 Introduction to Power plants : **6 Hrs.**

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 Load curves and instrumentation : **8 Hrs.**

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.

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 analyzer – Analysis of impurities in feed water and steam – Dissolved oxygen analyzer – Chromatography – PH meter-fuel analyzer – Pollution monitoring instruments

Unit 6 Economic analysis and energy audit : **5 Hrs.**

Economic analysis: Introduction, Cost of electric Energy, Fixed and operating cost, Selection and Type of Generation, Selection of generation equipment, Performance and Operation Characteristics of power plants and Tariff methods.

Energy audit and Energy Management, Energy Marketing: Selling and marketing in India, Creating supply chain in India, Human Resources issues, India's business culture in energy sector.

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 McGraw Hill., 2nd Ed. Reprint, 2010.
4. "Power Plant Engineering", Domkundwar and Arora, Dhanpatrai and Sons.
5. "Modern Power Engineering" John Weisman & L.E. Eckart, Prentice Hall of India, 1985.

Reference Books

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

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL485 : Noise and Vibration (Elective IV)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites: Theory of Machines II.

Course Objectives

1. Know the concepts of vibration and single degree of freedom systems.
2. Understand the working principle of various vibration measuring instruments.
3. Know the concepts of noise and the ways to control it.

Course Outcomes

C485.1 Understand the basic principles of vibratory systems and apply them to solve simple problems.
C485.2 Understand and analyze undamped and damped free vibrations and forced vibrations,
C485.3 Understand the working of vibration measuring instruments.
C485.4 Solve vibration problems pertaining to multiple degree of freedom systems.
C485.5 Understand the basic principles of noise and apply the various techniques to solve acoustic related problems.

Course Contents

Unit 1 **Introduction:** Revision of fundamentals of vibration: Importance & scope, Concepts and terms used, SHM, Vector and Complex method of representing vibration, Fourier series & harmonic analysis — **4 Hrs.**

Unit 2 **Single DOF system:** Damped free vibrations, Types of damping, Logarithmic decrement, Coulomb damping, and damping materials. — **6 Hrs.**
Forced Vibrations: Types of excitation, Forced excitation, Support excitation, Excitation due to unbalance in machines, Response due to above types of excitations, transmissibility, Force transmissibility & motion transmissibility, Vibration isolators, commercial isolation materials & shock mounts.
Forced vibrations of un-damped systems due to non-harmonic excitations

Unit 3 **Modal analysis and Condition Monitoring:** Signal analysis, dynamic testing of machines and structures, Experimental modal analysis, Machine condition monitoring and diagnosis — **7 Hrs.**

Unit 4 **Numerical Methods for multi degree freedom of systems:** Introduction, Maxwell's reciprocal theorem, Influence coefficients, Rayleigh's method, Dunkerley's method, Stodola method, Holzer's method, method of matrix iteration and Problems — **8 Hrs.**

Unit 5 **Introduction to Noise :** Basic concepts in sound, human hearing mechanisms, fundamentals of noise, decibels, sound pressure level, sound intensity, sound — **6 Hrs.**

fields, sound reflection, absorption and transmission, concept and governing equation with co-relation of each other.

Unit 6 **Experimental Noise and Vibration:** Instruments – Exciters, Measuring devices and analyzers. Types of Vibration Tests – Free and Forced. Human Exposure to Noise and Vibration - Acceptable vibration and Noise standards. Control – Basics of noise and vibration, Control of natural frequency, Vibration isolators, and Absorbers, Noise source control, path control, enclosures, absorbers, noise control at receiver (No numerical treatment) **8 Hrs.**

Reference Books:

1. Mechanical Vibration by G. K. Grover, Published by Nemchand & Brothers, Roorkee
2. Mechanical Vibration – Austin Church, Wiely Eastern
3. Schaumm's Outline series in Mechanical Vibration by S. Graham Kelly
4. Mechanical Vibration by Dr. V. P. Singh, Published by S. Chand & Sons New Delhi
5. Noise and vibration control by Leo L. Bernack, Tata Mc- Graw Hill Publication
6. Mechanical vibration & noise engineering by A.G. Ambekar prentice hall of INDIA
7. Kinematics, Dynamics and Design of Machinery by Waldron Willey India
8. Fundamentals of Vibrations By Balchandran Magrab CENGAGE LEARNING
9. "Mechanical Vibrations", J.B.K. Das and P.L. Srinivasamurthy, Sapna book House, Bangalore
10. "Vibrations and Noise for Engineers", K. Pujara, DhanpatRai and Sons, New Delhi.
11. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987
12. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL486: Advanced Foundry Processes (Elective IV)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Machine tool and Manufacturing processes, Thermodynamics, Machine drawing, Materials Engg and Metallurgy.

Course Objectives:

1. To acquaint students with the basic concepts of foundry processes
2. To impart knowledge of Ferrous and Non Ferrous Metal Processing
3. To study casting design process
4. To analyse casting process

Course Outcomes:
Upon completion of the course, the student should be able to:

C486.1 Understand basic casting design procedure.
C486.2 Understand fundamental knowledge of Ferrous and Non Ferrous Metal.
C486.3 Design of castings for different application.
C486.4 Understand need of cast ability

Course Contents

Unit 1 Metal Casting –Overview Applications and production, historical perspective, casting process, sand casting, investment casting, die casting, ferrous casting, nonferrous castings, new casting development. **6 Hrs.**

Unit 2 Solid modelling of casting: Casting features, modelling techniques, graphical user interface, model representation, model exchange format, model verifications. **7 Hrs.**

Unit 3 Pattern mold and core design : Orientation and parting, mould parting analysis, pattern design, cored features, core print design and analysis, Mould cavity layout. **7 Hrs.**

Unit 4 Feeder design and analysis : Casting solidification, solidification time and rate, feeder location and shape, feeder and neck design, feedaid design, solidification analysis, vector element method, optimization and validation, examples based on feeding design. **6 Hrs.**

Unit 5 Gating design and analysis : Mould filling, gating system and types, getting channel layout, optimal filling time, gating element design, mould filling analysis, numerical simulation, optimization and validation, examples based on gating design. **7 Hrs.**

Unit 6	Metal casting –overview: Applications and production, historical perspective, casting process, sand casting, investment casting, die casting, ferrous casting, nonferrous castings, new casting development.	**7 Hrs.**

Text Books :

1. Metal casting: computer aided design and analysis, B .Ravi, prentice hall india.
2. Principles of Metal Castings - Heine, Loper and Rosenthal (TMH)
3. Principles of Foundry Technology - P.L. Jain (TMH)

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. (McGraw Hill)
4. Metal Castings – Principles & Practice - T.V. Ramana Rao. (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 &Wulff (John Wiley)
9. The Foseco Foundryman's Handbook, -Foseco, CBS Publishers & Distributors
10. The New Metallurgy of Cast Metals Castings – Campbell, CBS Publishers & Distributors,

Final Year B. Tech. Mechanical Engineering Semester VIII
MEL487 : Operation Research (Elective IV)

Teaching Scheme	
Lectures	3 Hrs/ Week
Total Credits	3

Evaluation Scheme		
CIE	MSE	30
	ISE	20
SEE		50
Total		100

Pre-requisites:
Industrial Engineering.

Course Objectives

1. To get idea for optimizing and approximating industrial problems.
2. To devise appropriate measures for problem solving.
3. To apply scientific techniques to monitor the organizations ongoing activities.

Course Outcomes

C487.1 Develop models for optimizing the management and production systems from the verbal description of the real system.
C487.2 Make use of LPP technique for optimization of Production mix problem in industry.
C487.3 Evaluate transportation, transhipment, assignment and travelling salesman and Queuing problem.
C487.4 Apply quantitative techniques in machine replacement, game theory, business decision making under conditions of certainty, risk and uncertainty.
C487.5 Demonstrate Project management Problem.

Course Contents

Unit 1 **Operations Research:** Origin of Operation Research, Historical Standpoint, Methodology, Different Phases, Characteristics, Scope and Application of Operations Research. **4 Hrs.**

Unit 2 **Linear Programming Problem:** Introduction, Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods, Analytical Methods: Simplex, Big M and Two Phase, Special Case of LP Problem, Graphical Sensitivity Analysis.
Introduction of Primal and Dual Problems, Economic Interpretation. Introduction of Goal and Integer Programing.
Dynamic Programming: Steps involved in dynamic programming, characteristics and explanation of dynamic programming, formulation of Deterministic and probabilistic dynamic programming. **6 Hrs.**

Unit 3 **Transportation and Assignment:** Transportation Problems definition, Linear form, Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. Transhipment Problems. Assignment Problems and Travelling sales man Problem. **7 Hrs.**

Unit 4	**Queuing Theory:** Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models and preliminary examples of M/M/1:∞/∞/FCFS. **Replacement theory:** Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.	**8 Hrs.**
Unit 5	**Game Theory:** Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, M x2), Algebraic and graphical methods. **Decision Theory:** Introduction, Decision under certainty, Decision under risk, **Decision under uncertainty:** Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, Hurwicz criterion, Decision tree.	**8 Hrs.**
Unit 6	**Project Management**: Introduction to PERT and CPM, Critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.	**7 Hrs.**

Reference Books

1 Operations Research: An Introduction by HamdyTaha, Pearson Education Inc
2 Operations Research: Principles and Practice by Pradeep PrabhakarPai, Oxford Higher Education, Oxford University Press
3 Operations Research: Principles and Practice by Ravindran Phillips and Solberg by Wiley India Edition
4 Operations Research by P Mariappan, Pearson
5 Operations Research by A M Natarajan, P Balasubramani, A Tamilarasi, Pearson Edu. Inc.
6 Operations Research by H N Wagner, Prentice Hall
7 Optimization in Operations Research by Ronald Rardin, Pearson Education Inc.
8 Operations Research by R. Paneerselvam, Prentice Hall of India Pvt. Ltd.
9 Quantitative Techniques in Management by N D Vohra, Tata McGraw-Hill

Final Year B. Tech. Mechanical Engineering Semester VIII
MEP488: PLC and SCADA Programming Lab (Elective-IV)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	50

Course Objectives

1. To expose students to fundamentals of PLC.
2. To enable students to apply PLC programming and SCADA

List of Experiments:

1. Two experiments on ladder applications using basic programming.
2. Five experiments on timer and counter applications.
3. Demo of SCADA Applications using SCADA Software
4. Two problems on SCADA applications.

Submission:

Completed Journal.

Text Books

1. "Programmable Logic Controller – Principles and Applications", 5/e, J. W. Webb, R.A. Reis; Prentice Hall of India Ltd. ISBN 81-203-2308-4.2.
2. "Programmable Logic Controller – Principles and Applications, by NIIT; Prentice Hall Publications Pvt. Ltd. India, ISBN 81-203-2525-7.
3. "Programmable Logic Controller – Programming methods and Applications", Hackworth John R. and Hackworth Frederick D. Jr.; Pearson Education LCE, ISBN 81-297-0340-.

References

1. Introduction to PLC – Gary Dumming – Delmar Pub.
2. Various PLC manufacturers catalogue.
3. Programmable Logic Controller – FESTO Pneumatics, - Bangalore
4. SCADA, Stuart A. Boyer (ISA Publi.) ISBN 1-55617-660-0.
5. Practical SCADA for industry, David Bailey, (Elsevier Publi.) ISBN 0-7506-5805-3.

Final Year B. Tech. Mechanical Engineering Semester VIII
MEP489: Energy and Power Engineering Lab (Elective-IV)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	50

Course Objectives

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, its performance and economic analysis
4. Understand the new trends in power and energy sectors.

List of Experiments:

1. Demonstration and measurement of solar radiation using pyranometer.
2. Performance on PV Cell (I-V Characteristics 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.

Submission:

Completed Journal.

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 MGH, 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, PHI, 1985.

References

1. "Solar Photovoltaic Fundamentals ,Technologies and Applications", Chetan Singh Solanki, Prentice Hall of India Publications.
2. "Modern Power Station Practice",

Final Year B. Tech. Mechanical Engineering Semester VIII
MEP490: Noise and Vibration Lab (Elective IV)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	50

Course Objectives

1. Know the concepts of vibration and single degree of freedom systems.
2. Understand the working principle of various vibration measuring instruments.
3. Know the concepts of noise and the ways to control it.

List of Experiments:

Minimum Eight Experiments out of following list –

1. Experiment on study of forced vibration characteristics.
2. Determination of logarithmic decrement for single DOF damped system.
3. Experiment on torsional vibration of two rotor without damping.
4. Experiment on free vibration of a coupled pendulum.
5. Study of different types of exciters for vibration analysis.
6. Measurement of vibration parameters using vibration instruments.
7. Exercise on numerical calculation of natural frequencies by either Holzer, Raleigh's or matrix iteration method.
8. Measurement of Noise by using noise measuring instruments.
9. Assignment on dynamic analysis using FEA software.
10. Assignment on experimental modal analysis of machine element.
11. Vibration analysis of mechanical system using MATLAB minimum two assignments.

Submission:

Completed Journal.

Reference Books:

1. Mechanical Vibration by G. K. Grover, Published by Nemchand & Brothers, Roorkee
2. Mechanical Vibration – Austin Church, Wiely Eastern
3. Schaumm's Outline series in Mechanical Vibration by S. Graham Kelly
4. Mechanical Vibration by Dr. V. P. Singh, Published by S. Chand & Sons New Delhi
5. Noise and vibration control by Leo L. Bernack, Tata Mc- Graw Hill Publication
6. Mechanical vibration & noise engineering by A.G. Ambekar prentice hall of INDIA
7. Kinematics, Dynamics and Design of Machinery by Waldron Willey India
8. Fundamentals of Vibrations By Balchandran Magrab CENGAGE LEARNING
9. "Mechanical Vibrations", J.B.K. Das and P.L. Srinivasamurthy, Sapna book House, Bangalore
10. "Vibrations and Noise for Engineers", K. Pujara, DhanpatRai and Sons, New Delhi.
11. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987
12. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989

Final Year B. Tech. Mechanical Engineering Semester VIII
MEP491: Advanced Foundry Processes Lab. (Elective IV)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	50

Course Objectives:

1. To acquaint students with the basic concepts of foundry processes
2. To impart knowledge of Ferrous and Non Ferrous Metal Processing
3. To study casting design process
4. To analyse casting process

List of Experiments:

1. Moulding Practice in Sand Casting
2. Tests Performed on Moulding Sand
3. Design of Risering system
4. Design of Gating system
5. Casting Simulation
6. Laboratory Demonstration of Melting and Pouring
7. Casting defects analysis
8. Casting solidification analysis
9. Risering yield optimisation of casting
10. Sand Yield optimisation in sand casting

Submission:

Completed Journal.

Text Books :

1. Metal casting: computer aided design and analysis, B .Ravi, prentice hall india.
2. Principles of Metal Castings - Heine, Loper and Rosenthal (TMH)
3. Principles of Foundry Technology - P.L. Jain (TMH)

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. (McGraw Hill)
4. Metal Castings – Principles & Practice - T.V. Ramana Rao. (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 &Wulff (John Wiley)
9. The Foseco Foundryman's Handbook, -Foseco, CBS Publishers & Distributors
10. The New Metallurgy of Cast Metals Castings – Campbell, CBS Publishers & Distributors,

Final Year B. Tech. Mechanical Engineering Semester VIII
MEP492: Operation Research Lab. (Elective IV)

Teaching Scheme	
Practical	2 Hrs/ Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	50

Course Objectives

1. To get idea for optimizing and approximating industrial problems.
2. To devise appropriate measures for problem solving.
3. To apply scientific techniques to monitor the organizations ongoing activities.

List of Experiments:
The term work shall be based on the topics mentioned below –

1. Industrial Problems of Linear Programming
2. Industrial Problems on Transportation
3. Industrial Problems on Assignment
4. Industrial Problems on Queuing
5. Industrial Problems on PERT and CPM

Submission:
Completed Journal.

Reference Books

1 Operations Research: An Introduction by HamdyTaha, Pearson Education Inc
2 Operations Research: Principles and Practice by Pradeep PrabhakarPai, Oxford Higher Education, Oxford University Press
3 Operations Research: Principles and Practice by Ravindran Phillips and Solberg by Wiley India Edition
4 Operations Research by P Mariappan, Pearson
5 Operations Research by A M Natarajan, P Balasubramani, A Tamilarasi, Pearson Edu. Inc.
6 Operations Research by H N Wagner, Prentice Hall
7 Optimization in Operations Research by Ronald Rardin, Pearson Education Inc.
8 Operations Research by R. Paneerselvam, Prentice Hall of India Pvt. Ltd.
9 Quantitative Techniques in Management by N D Vohra, Tata McGraw-Hill