DEPARTMENT OF TECHNOLOGY
SHIVAJI UNIVERSITY, KOLHAPUR

STRUCTURE AND SYLLABUS
OF
FINAL YEAR B. TECH.
(MECHANICAL ENGINEERING)

TO BE EFFECTIVE FROM
ACADEMIC YEAR 2023- 2024

DEPARTMENT OF TECHNOLOGY FINAL YEAR B.TECH Scheme of Teaching and Examination Semester – VII (Mechanical Engineering) Academic Year 2023-24

Course Code	Sr. No	Course Title	Teaching Scheme with Credits(Hours / Week)				Examination Scheme (Marks)					
							Theory			Practical		
			L	T	P	Credits	Scheme	Max. marks	Min. Passing $	Scheme	Max. marks	Min. Passing
ME701	1	Refrigeration and Air conditioning	4	-	-	4	MSE	30	40	-	-	-
							SEE	70				
ME702	2	Mechanical System Design	4	-	-	4	MSE	30	40	-	-	-
							SEE	70				
ME703	3	Hydraulics and Pneumatics	4	-	-	4	MSE	30	40	-	-	-
							SEE	70				
ME704	4	Industrial Engineering	3	-	-	3	MSE	30	40	-	-	-
							SEE	70				
ME705	5	Elective I	3	-	-	3	MSE	30	40	-	-	-
							SEE	70				
ME701L	6	Laboratory Refrigeration and Air Conditioning	-	-	2	1	-	-	-	IPE	50	20
										EOE	50	20
ME702L	7	Laboratory Mechanical System Design	-	-	2	1	-	-	-	EOE	50	20
ME703L	8	Laboratory Hydraulics and Pneumatics	-	-	2	1	-	-	-	EPE	50	20
ME706L	9	Major Project Phase I*	-	-	2	3	-	-	-	IOE	50	20
ME707L	10	Industrial Training	-	-	-	1	-	-	-	IOE	50	20
		Total	18	-	8	25	-	500	-	-	300	-
	Audit Course											
ME701A	11	Constitution of India	2	-	-	-	-	-	-	-	-	-

$ In theory student should appear for the CIE (Mid Semester Exam), submit the assignment and must secure 40% marks in SEE.
Total Credits = 25 Note:
1. Students are expected to do self-study for two hours as per the guide hence contact hours to be taken as two for the calculation of contact hours.
2. Tutorials and Practical to be conducted in batches with batch strength not exceeding 20 students.

MSE: Mid Semester Evaluation SEE: Semester End Examination
IPE: Internal Practical Evaluation EPE: External Practical Examination
IOE: Internal Oral Evaluation EOE: External Oral Examination

Elective – I:
1. Finite Element Analysis
2. Cryogenics
3. Operations Research
4. Enterprise Resources Planning
5. Industrial Health and Safety Management

Open Elective (Energy Conservation & management / Nano Technology/Automobile Engineering / Industrial Engineering)

Note on Electives:
A particular elective will be offered when at least 20 students opt for it.

Note on Open Elective:
In order to promote interdisciplinary study,Mechanical Engineering program can offer open electives to the students of other engineering program.

DEPARTMENT OF TECHNOLOGY FINAL YEAR B.TECH Scheme of Teaching and Examination Semester – VIII (Mechanical Engineering) Academic Year 2023-24

Course Code	Sr. No	Course Title	Teaching Scheme with Credits(Hours / Week)				Examination Scheme (Marks)					
							Theory			Practical		
			L	T	P	Credits	Scheme	Max. marks	Min. Passing $	Scheme	Max. marks	Min. Passing
ME801	1	Automobile Engineering	4	-	-	4	MSE SEE	30 70	40	-	-	-
ME802	2	Power Plant Engineering	4	-	-	4	MSE SEE	30 70	40	-	-	-
ME803	3	Mechatronics	4	-	-	4	MSE SEE	30 70	40	-	-	-
ME804	4	Costing and Cost Control	3	-	-	3	MSE SEE	30 70	40	-	-	-
ME805	5	Elective – II	3	-	-	3	MSE SEE	30 70	40	-	-	-
ME801L	6	Laboratory Automobile Engineering	-	-	2	1	-	-	-	EOE	50	20
ME802L	7	Laboratory Power Plant Engineering	-	-	2	1	-	-	-	EOE	50	20
ME803L	8	Laboratory Mechatronics	-	-	2	1	-	-	-	EOE	50	20
ME806L	9	Major Project(Phase II)*	-	-	2	04*	-	-	-	IPE EPE	50 100	20 40
		Total	18	-	8	25	-	500	-	-	300	-
	Audit Course											
ME801A	10	Human Values and Professional Ethics	2	-	-	-	-	-	-	-	-	

$ In theory student should appear for the CIE (Mid Semester Exam), submit the assignment and must secure 40% marks in SEE.
Total Credits =25 Note:
1. Students are expected to do self-study for two hours as per the guide hence contact hours to be taken as two for the calculation of contact hours.
2. Tutorials and Practical to be conducted in batches with batch strength not exceeding 20 students.

MSE: Mid Semester Evaluation SEE: Semester End Examination
IPE: Internal Practical Evaluation EPE: External Practical Examination
IOE: Internal Oral Evaluation EOE: External Oral Examination

Elective – II:
1. Internet of Things
2. Nanotechnology
3. Machine Tool Design
4. Industrial Automation and Robotics
5. Production and Operations Management

Open Elective (Energy Conservation & management / Nano Technology/Automobile Engineering / Industrial Engineering)

Note on Electives:
A particular elective will be offered when at least 20 students opt for it.

Note on Open Elective:
In order to promote interdisciplinary study, Mechanical Engineering program can offer open electives to the students of other engineering program.

Equivalence of Pre Revised and Revised Structure
Final Year B. Tech. (Mechanical Engineering) Semester VII and VIII

The below detailed syllabus is a revised version of the Final Year B. Tech (Mechanical Engineering) Program being conducted by the Shivaji University at the Technology Department of the University. This syllabus is to be implemented from June 2023, (Academic year 2023-24). The prime feature of this revision is the transformation of the existing curriculum into the Outcome based curriculum as specified in NBA rules and regulations.

The Equivalence for the courses of Mechanical Engineering at Final Year B. Tech. Semester VII and VIII pre-revised and Revised Program under the faculty of Engineering and Technology is as follows.

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

Sr. No	Final Year B. Tech. (Mechanical Engineering) Semester VII Pre-revised syllabus	Final Year B. Tech. (Mechanical Engineering) Semester VII Revised syllabus	Remark
	Credits = 25	Credits = 25	No change in credits
1.	Refrigeration and Air - conditioning	Refrigeration and Air - conditioning	Slight modification in the content
2.	Machine Design – III	Mechanical System Design	Course Name Change Slight modification in the content
3.	Hydraulics and Pneumatics	Hydraulics and Pneumatics	Slight modification in the content
4.	Manufacturing Engineering III	Industrial Engineering	Course Name Change Slight modification in the content
5.	**Elective I**	**Elective I**	
	Finite Element Analysis	Finite Element Analysis	Slight modification in the content
	Cryogenics	Cryogenics	Slight modification in the content
	Operations Research	Operations Research	Slight modification in the content
	Tribology	Enterprise Resources Planning	New Course Introduced
	Production Management	Industrial Health and Safety Management	New Course Introduced
6.	**Laboratory** Refrigeration and Air-conditioning	**Laboratory** Refrigeration and Air-conditioning	Slight modification in the content
7.	**Laboratory** Hydraulics and Pneumatics	**Laboratory** Hydraulics and Pneumatics	Slight modification in the content

8.	**Laboratory** Manufacturing Engineering III	**Laboratory** Mechanical System Design	Change in Laboratory
9.	**Laboratory** Major Project Phase I	**Laboratory** Major Project Phase I	Slight modification in the content
10.	**Laboratory** Report on Industrial Training	**Laboratory** Report on Industrial Training	Slight modification in the content
11.	Audit Course Constitution of India	Audit Course Constitution of India	No change
For above Theory Courses 1 to 5 the Continuous Internal Evaluation pattern is changed as below.			
	CIE = 50 (UT I = 25, UT II = 25)	MSE = 30 (MSE = 20, Course work* =10)	Revised MSE marks distribution.

Audit course have not been assigned any credits. The students will be evaluated for these courses by the concerned course in charge. There will be grade conferred to the student. The grade will be based on conversion of marks obtained out of 50. (Obtaining passing grade is essential). Please refer to chart in the detail examination scheme. The chart shows the marks range and the respective grade.

* **Course work:** It consists of assignments, quiz, seminars, presentations, research papers and research articles, developing working models, surveys and activities related to course as designed by the course coordinator to suit the needs of the course and to complement programme outcomes. The practical work and its journal is not part of course work.

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

Sr. No	Final Year B. Tech. (Mechanical Engineering) Semester VIII Pre-revised syllabus	Final Year B. Tech. (Mechanical Engineering) Semester VIII Revised syllabus	Remark
	Credits = 25	Credits = 25	No change in credits
1.	Automobile Engineering	Automobile Engineering	Slight modification in the content
2.	Power Plant Engineering	Power Plant Engineering	Slight modification in the content
3.	Mechatronics and Robotics	Mechatronics	Course Name Changed Slight modification in the content
4.	Total Quality Management	Costing and Cost Control	New Course Introduced
5.	**Elective II***	**Elective II***	
	Computational Fluid Dynamics	Internet of Things	New Course Introduced
	Vibration and Noise	Production and Operation Management	New Course Introduced
	Nanotechnology	Nanotechnology	Slight modification in the content
	Machine Tool Design	Machine Tool Design	Slight modification in the content
	Flexible Manufacturing Systems	Industrial Automation and Robotics	New Course Introduced
6.	**Laboratory** Automobile Engineering	**Laboratory** Automobile Engineering	Slight modification in the content
7.	**Laboratory** Power Plant Engineering	**Laboratory** Power Plant Engineering	Slight modification in the content
8.	**Laboratory** Mechatronics and Robotics	**Laboratory** Mechatronics	Course Name Changed Slight modification in the content
9.	Major Project Phase II	Major Project Phase II	Slight modification in the content
10.	Audit Course Human Values and Professional Ethics	Audit Course Human Values and Professional Ethics	No change
For above Theory Courses 2 to 6 the Continuous Internal Evaluation pattern is changed as below.			
	CIE = 50 (UT I = 25, UT II = 25)	MSE = 30	Revised MSE marks distribution.

		(MSE = 20, Course work* =10)	

Audit course have not been assigned any credits. The students will be evaluated for these courses by the concerned course in charge. There will be grade conferred to the student. The grade will be based on conversion of marks obtained out of 50. (Obtaining passing grade is essential). Please refer to chart in the detail examination scheme. The chart shows the marks range and the respective grade.

* **Course work:** It consists of assignments, quiz, seminars, presentations, research papers and research articles, developing working models, surveys and activities related to course as designed by the course coordinator to suit the needs of the course and to complement programme outcomes. The practical work and its journal is not part of course work.

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	REFRIGERATION AND AIR CONDITIONING		**Course Code: ME701**	
Teaching Scheme (Hours)		Lecture = 4 Hrs/ Week	**Total Credits: 4**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Knowledge of Engineering Thermodynamics, Fluid Mechanics, Heat and Mass Transfer			
Course Domain	Core			

Course Objectives:

The course aims to:

a. To understand the fundamentals of refrigeration, air conditioning and psychrometry
b. To study of various refrigeration cycles and evaluate performance using Ph chart and property tables.
c. To study and understand working of different components used in refrigeration system and properties of refrigerants.
d. To study various vapour absorption systems and basic cryogenic system.
e. To Understand basics of psychrometry, air conditioning processes and different air conditioning systems.
f. To calculate cooling load for its applications in comfort and industrial air conditioning.

Course Outcomes:

On completion of the course, students will be able to

a. Illustrate the principles and remember the applications of refrigeration systems
b. Analyze performance of vapor compression refrigeration system desirable properties of refrigerants.
c. Explain working principle of components used in refrigeration system and classify the refrigerants.
d. Analyze vapour absorption system and applications of cryogenic system.
e. Analyze psychrometric terms its application in HVAC, comfort conditions.
f. Evaluate refrigeration and air-conditioning systems under different load conditions.

CONTENT	**Hours**
Unit 1: **Basic Refrigeration Cycles:** The Second Law Interpretation, Carnot cycle, Reversed Carnot cycle, Bell Coleman cycle, Introduction to aero-plane air conditioning cycles (Only Theory). Introduction to Heat pump, Heat Engine and Refrigerator (with Numerical treatment), Applications of refrigeration.	7
Unit 2: **Vapour Compression System** Introduction to Vapour Compression Cycle. Energy Ratios (EER), BEE star rating, Pressure Enthalpy Diagram and Calculations (Numerical on VCR Cycle), effect of Liquid Sub cooling, effect of Vapour Superheating, Calculations and performance of above cycles, Actual Vapour	8

Compression Cycle. Removal of flash gas, Flash intercooling, Water-cooling, Multistage Multi-evaporator system, Cascade System.	
Unit 3: **Refrigeration System Components and Refrigerants** **Refrigeration System Components:** Types of Compressors, Condenser, Evaporator, Expansion devices, safety controls. **Refrigerants:** Classification, Desirable Properties like Thermodynamic, physical and chemical. Effect on Ozone depletion and global warming, Alternative Refrigerants. Secondary refrigerants.	8
Unit 4: **Vapour Absorption System and Cryogenics** **Vapour Absorption System:** Vapour Absorption System, Practical Vapour Absorption system, Aqua Ammonia system, H_2O-$LiBr_2$ absorption system, Comparison with vapour compression system (Descriptive treatment only). **Cryogenics:** Introduction to cryogenic engineering and application, liquification of gases, Linde Cycle, Claude Cycle.	6
Unit 5: **Psychrometry and Human Comfort** Psychrometric properties of air, Use of Psychometric tables and charts, Psychrometric processes, Apparatus Dew Point, Sensible heat factor, Bypass factor, Air washer. Requirements of comfort air conditioning, thermal analysis of human body, human comfort, effective temperature comfort chart.	9
Unit 6: **Heating and Cooling Load Calculations** Different Heat sources- Mixing of air streams, sensible heat factor, RSHF, GSHF, ERSHF, Ventilation and infiltration, Inside and outside Design condition, Cooling Load estimation, Energy conservation in air conditioning, Energy requirements of different types of air conditioning systems, Inverter Units, Introduction to Inverter technology and its use in power failure.	10

General Instructions

Text Books:

1.	"Refrigeration and Air Conditioning" Arora C P, Tata McGraw Hill
2.	"A course in Refrigeration and Air Conditioning" Arora and Domkundwar, Dhanpat Rai and Sons, Delhi
3.	"Refrigeration and Air Conditioning" Dr. S.N. Sapali, PHI Learning Pvt. Ltd. Delhi

Reference Books:

1.	"Principal of Refrigeration" Dossat Ray J., S.I. Version, Wiley Eastern Limited,
2.	"Refrigeration and Air-conditioning" Manohar Prasad, Wiley Eastern Limited, 1983
3.	"Refrigeration and Air-conditioning" Stocker W.F. and Jones J.W., McGraw Hill International editions 1982
4.	"Basic of Refrigeration and Air Conditioning", Anantnarayan, Tata McGraw Hill Publications
5.	"Industrial Refrigeration", Wilbert Stocker, McGraw Hill Publications

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	MECHANICAL SYSTEM DESIGN		**Course Code: ME702**	
Teaching Scheme (Hours)		Lecture = 4 Hrs/ Week	**Total Credits: 4**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Engineering Mechanics, Manufacturing Process, Strength of Materials, Machine design, Engineering Mathematics, Theory of Machines, Dynamics of Machinery, and IC Engines.			
Course Domain	Core			

Course Objectives:

The course aims to:

a. To develop competency for system visualization and design.
b. To enable student to design cylinders and pressure vessels and to use IS code.
c. To enable student select materials and to design internal engine components.
d. To introduce student to optimum design and use optimization methods to design mechanical components.
e. To enable student to design machine tool gearbox and material handling systems.

Course Outcomes:

On completion of the course, students will be able to

a. Understand the difference between component level design and system level design.
b. Design various mechanical systems like pressure vessels, machine tool gear boxes, material handling systems, etc. for the specifications stated/formulated.
c. Learn optimum design principles and apply it to mechanical components.
d. Handle system level projects from concept to product.

CONTENT	**Hours**
Unit 1: **Aesthetic and Ergonomic Consideration in Design:** Basic types of product forms, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry, Contrast etc. Morgan's color code. Ergonomic considerations Relation between man, machine and environmental factors. Design of displays and controls. Practical examples of products or equipment's using ergonomics and aesthetic design principles. Creativity concept in designing.	6
Unit 2: **Design of cylinder and Pressure Vessels** Design of Cylinders: Thin and thick cylinders, Lame's equation, Clavarino's and Birnie's equations, design of hydraulic and pneumatic cylinders, auto-frettage and compound cylinders (No Derivation) gasketed joints in cylindrical vessels (No derivation). Design of Pressure vessel: Modes of failures in pressure vessels, unfired pressure vessels, classification of pressure vessels as per IS: 2825 - categories and types of welded joints, weld joint efficiency, stresses induced in pressure vessels, materials for pressure vessel, thickness of cylindrical shells and design of end closures as per code, nozzles and openings in pressure	8

vessels, reinforcement of openings in shell and end closures - area compensation method, types of vessel supports (theoretical treatment only).	
Unit 3: **Design of Belt Conveyor System for Material Handling** System concept, basic principles, objectives of material handling system, unit load and containerization. Belt conveyors, Flat belt and troughed belt conveyors, capacity of conveyor, rubber covered and fabric ply belts, belt tensions, conveyor pulleys, belt idlers, tension take-up systems, power requirement of horizontal belt conveyors for frictional resistance of idler and pulleys.	8
Unit 4: **Design of Gear Boxes for Machine Tool Applications:** Determination of variable speed range- Graphical representation of speeds- Structure diagram Deviation diagram- Ray diagram- Selection of optimum ray diagram- Difference between number of teeth of successive gears in a change gear box- Analysis of twelve speed gear box Compound ray diagram	10
Unit 5: **Design of I. C. Engine Components:** Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, Design of cylinder liners, Design of piston and piston-pins, Piston rings, Design of connecting rod, Design of crank-shaft and crank-pin.	8
Unit 6: **Optimum Design:** Objectives of optimum design- Johnsons Method of Optimum Design (MOD), Adequate and optimum design. Primary, Subsidiary and Limit equations- Optimum design with normal specifications of simple machine elements like tension bar, transmission shaft, helical spring. Introduction to optimum design with Langrange Multiplier.	6

General Instructions

Text Books:

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

Reference Books:

1.	"Handbook of Gear Design", Jitin Maitra,Tata Mc-Graw Hill Publication.
2.	"Machine Design", Black P.H.and O.Eugene Adams, Tata Mc- Graw Hill Publication.
3.	"Mechanical Design Synthesis with Optimisation Applications",Johnson R.C.,Von Nostrand-Reynold Publicaion.

4.	"Engineering Design", Dieter G.E., Tata Mc- Graw Hill Publication, 4th Edition.
5.	"Product Design and Process Engineering", Benjamin W. Niebel, Alan B. Draper, Tata Mc- Graw Hill Publication.
6.	"Design of Pressure Vessel", Harve, CBS Publishers and Distributors Van Nostrand Reinhold
7.	"Engineering Optimization Theories and Practice", S.S.Rao, New Age Publication, 3rd Edition.
8.	"Process Equipment Design", M. V. Joshi, Macmillal Publication, 3rd Edition.
9.	"Machine Design", Robert L. Norton, Tata Mc- Graw Hill Publication.

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	HYDRAULICS AND PNEUMATICS		**Course Code: ME703**	
Teaching Scheme (Hours)		Lecture = 4 Hrs/ Week	**Total Credits: 4**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Engineering Physics, Fluid Mechanics and Turbo machinery.			
Course Domain	Core			

Course Objectives:

The course aims to:

a. To introduce industrial hydraulics and pneumatics their elements, function and their structure
b. To apply physical laws and principles that governs the behaviour of fluid power systems
c. To study different ISO/JIC symbol used in hydraulic and pneumatic system.
d. To explain various hydraulic and pneumatic circuit.
e. To explain troubleshooting caused in hydraulic and pneumatic system and general safety rule in fluid power system.
f. To identify application of hydraulic and pneumatic in various industries.

Course Outcomes:

On completion of the course, students will be able to

a. Identify, understand and select various components used in hydraulics system.
b. Make use of ISO/JIC symbols of fluid power systems to prepare fluid power circuits.
c. Develop efficient hydraulic and Pneumatic circuits with their application.
d. Identify troubleshooting of fluid power system and suggest suitable remedial actions to correct it.

CONTENT	**Hours**
Unit 1: **Introduction To Fluid Power :** a. Classification, Basic Elements of Fluid Power System, comparison of various systems, advantages and limitations, applications of fluid power in various fields of engineering, various hydraulic and pneumatic ISO/JIC Symbols. b. Principle of hydraulic system, functions, properties, Types and selection of hydraulic fluids and effect of temperature and pressure on hydraulic fluids. c. Introduction and Application of pneumatics, Physical properties, Principles, basic requirement of pneumatic system, comparison with hydraulic System.	8
Unit 2: **Hydraulic System Elements :** a. Classification, Types of Seals, Sealing Material, Pipes, Hoses, Compatibility Of Seal With Fluid, Sources Of Contamination And Its Control, Strainer, Filter, Heat-Exchanger, Reservoir.	8

b. Pumps-Types, Selection of Pumps From Gear, Vane, Piston, Screw, Ball Pump Etc. For Various Applications. c. Actuators-Linear and Rotary, Hydraulic Motors, Types of Hydraulic Cylinders and Their Mountings. d. Accumulators, Intensifier and Their Applications.	
Unit 3: **Control of Fluid Power Elements :** a. Requirements of Pressure control, direction control and flow control valves. b. Principle of pressure control valves directly operated and pilot operated pressure relief valve, pressure reducing valve, sequence valves, counter balance valve. c. Principles and Types of direction Control valves-2/2, 3/2, 4/2, 4/3, 5/2. Open center, close center, tandem center, manual operated, mechanical operated solenoid, pilot operated direction control valves, check valves. d. Principles of flow control valves, temperature compensated, pressure compensated temperature and pressure compensated flow control valve.	8
Unit 4: **Elements of Pneumatic System :** a. Air compressor- Types, selection criteria, capacity control, piping layout, fitting and connectors, Pneumatic controls, Direction control valves (two way, three way, four way), check valves, flow control valves, pressure control valves, speed regulators, quick exhaust valves, time delay valve, shuttle valve and twin pressure valve. Solenoid operated, pilot operated valves, Pneumatic actuators, Rotary and reciprocating cylinders–types and their mountings, Air motor – types, Comparison with hydraulic and electric motor. b. Serving of compressed air – types of filters, regulators, lubricators (FRL UNIT), mufflers, dryers.	8
Unit 5: **Circuits and its Application** **A. Hydraulic Circuits** a. Speed control circuits – Meter-in, Meter-out, Bleed off, Regenerative, Fast approach and slow traverse. b. Sequence circuits – Travel dependent and Pressure dependent c. Synchronizing circuit. d. Regenerative circuit. **B. Pneumatic Circuits** a. Speed control circuits b. Impulse operation circuit. c. Sequence circuits. d. Time delay circuit.	8
Unit 6: **System Design, Maintenance and Troubleshooting and Servo Controls** a. Design of Hydraulic Pumps, Design of Hydraulic motor, Design of Hydraulic Cylinder, Design considerations for Hydraulic Cylinders. b. Maintenance, troubleshooting and safety of hydraulic and pneumatic systems. c. Hydraulic and Pneumatic servo system for linear and rotary motion.	8

General Instructions

Text Books:

1.	"Industrial Fluid Power", S.S. Kuber, Nirali Prakashan, 3rd Edition.

2.	"Hydraulic and Pneumatic",H.L.Stewart,Industrial Press.
3.	"Industrial Fluid Power", D. S. Pawaskar, Nishant Prakashan.
4.	"Hydraulics and Pneumatics", Shaikh and Khan, R.K. Publication.
5.	"Fluid Power with Application", Esposito, Pearson Education, 7th Edition.
6.	Eaton-Vickers, Industrial Hydraulics Manual. Eton Corporation.
7.	"Industrial Fluid Power", S.S. Kuber, Nirali Prakashan, 3rd Edition.
Reference Books:	
1.	"Industrial Fluid Power", S.S. Kuber, Nirali Prakashan, 3rd Edition.
2.	"Hydraulic and Pneumatic",H.L.Stewart,Industrial Press.
3.	"Industrial Hydraulic", J. J. Pipenger , Tata McGraw Hill.
4.	"Power Hydraulics", Goodwin 1st Edition.
5.	"Introduction to Hydraulic and Pneumatic", S. Ilango and V Soundararajan, Prentice Hall of India, 2nd Edition.
6.	"Pneumatic Control",Joji P., Wiley, 1st Edition.
7.	"Fluid Power", Jagadeesha T., Wiley Publications.

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	INDUSTRIAL ENGINEERING		**Course Code: ME704**	
Teaching Scheme (Hours)		Lecture = 3 Hrs/ Week	**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Engineering Economics			
Course Domain	Core			

Course Objectives:

The course aims to:

a. To study and develop an integrated approach to improve the material handling system.
b. To identify and solve economical problems of machine tools by using analytical techniques involving comparison, selection and alternatives.
c. To study and learn about the importance of data generation and management in CIMS.
d. To understand the role and functions of ERP in carrying out business processes in an industry.
e. To understand the computer networking basics used in the manufacturing industry.
f. To explore the potential of additive manufacturing in different industrial sectors.

Course Outcomes:

On completion of the course, students will be able to

a. Apply the material handling techniques in existing production system.
b. Analyse and solve economical problems of machine tools using analytical techniques.
c. Apply knowledge of data management and its importance for decision-making in CIMS environment.
d. Understand the role and functions of ERP in the manufacturing industry.
e. Recognize the communication trends of Computer Networking used in the manufacturing industry.
f. Apply knowledge of additive manufacturing for various real-life applications

CONTENT	**Hours**
Unit 1: **Manufacturing Systems Designs:** Definition, objectives and types of Manufacturing Systems, Plant site selection, factors influencing the selection, optimum decision on choice of site and analysis, types of plat layout, advantages and disadvantages of layout, principles and objectives of plant layout, tools and techniques of layout planning Systematic Layout Planning (SLP), Computerized Plant Layout-CRAFT, ALDEP, and CORELAP.	6
Unit 2: **Manufacturing System Economics:** Introduction, costs of production, the concept of cost, cost centre, cost unit, classification of cost, analysis of production costs, break-even analysis.	6

Concept of time value of money, Preparation of time profile of project, Single payment, Equal Series payment, Depreciation and its methods, Machine tool replacement and basic methods of economy studies: Payback period, Present worth, Annual worth, Cost-benefit ratio.	
Unit 3: **Computer Integrated Manufacturing Systems:** **Group technology:** Introduction, Part families, parts classification and coding, production flow analysis, application considerations in GP, cellular manufacturing. holonic manufacturing, artificial intelligence. **Flexible manufacturing systems:** What is FMS, FMS components, application and benefits, FMS planning and implementation issues.	6
Unit 4: **MRP, MRP-II, ERP And Supply Chain Management :** Aggregate production planning and the master production schedule, material requirement planning (MRP), capacity planning, shop flower control, inventory control, Manufacturing resources planning (MRPII), just-in-time production system, Enterprise Resource Planning (ERP): introduction, Evolution, features, purpose of modeling an enterprise, information mapping, generic model of ERP, Modules in ERP, Methodology of implementation, ERP package selection, and Supply Chain Management (SCM).	6
Unit 5: **Fundamentals of Networking:** Introduction, Principle of networking, networking techniques, LAN, standards and developments, network operating system, system security, networking in manufacturing company, NFS, ATM networks, Enterprise Wide Networks.	6
Unit 6: **Rapid Prototyping Processes And Operation:** Introduction, subtractive processes, additive processes- classification of RP Processes, Working principle, models and specification process, application, advantages and disadvantages of Rapid Tolling and STL format, Stereo Lithography Apparatus (SLA), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS), 3D Printing., Fused Deposition Modelling [FDM], virtual prototyping, self-replicating machines,	6

General Instructions

Text Books:

1.	"Automation, production systems, and computer-integrated manufacturing", Mikell P. Groover, Prentice Hall of India PVT. LTD.
2.	"Manufacturing Engineering and Technology", Serope Kalpakjian, S. R. Schmid, K. S. Vijay Sekar, Pearson.
3.	"Production Engineering" P. C. Sharma, S Chand and Company Pvt. Ltd.
4.	CAD/CAM/CIM, P Radhakrishnan, V. Raju, New age International Publishers.
5.	"Rapid Prototyping Principles and Applications" Rafiq Noorani, Wiley
6.	"Production operations management" Chary, TMH, New Delhi.
7.	"Engineering Management: Industrial Engineering and Management", SC Sharma, Khanna Publishing House, Delhi
8.	"Industrial Engineering and Operations Management", SK Sharma

Reference Books:	
1.	"Production Planning and Inventory Control" Narasimham etal, PHI, New Delhi
2.	"Production Operations Management" Adam and Ebert, PHI, New Delhi
3.	"Production and operations management" Martinich, John Wiely , New Delhi
4.	" Industrial Organization and Engineering Economics" Banga and Sharma, Khanna publication
5.	"Toyota Production System" Taichi Ohno, Productivity Press India Ltd, Bangalore.
6.	"Fundamental of CIM technology", David L. Goetsch, Delmar publication
7.	"Principles and Practice of Cost Accounting" N. K. Prasad, Book Syndicate Pvt. Ltd.
8.	"Production Planning and Inventory Control" Narasimham etal, PHI, New Delhi
9.	"Production Operations Management" Adam and Ebert, PHI, New Delhi

Class, Part and Semester	**Final Year B. Tech (Mechanical Engineering), Part VII**			
Course Title	**ELECTIVE I :** FINITE ELEMENT ANALYSIS		**Course Code: ME705L1**	
Teaching Scheme (Hours)	Lecture = 3 Hrs/ Week		**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Fluid Mechanics, Heat transfer, Numerical methods, Programming Languages.			
Course Domain	Elective			

Course Objectives:

The course aims to:

1. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics and thermal analysis problems.
2. To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
3. It provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states.
4. To study approximate nature of the finite element method and convergence of results are examined.
5. To provides some experience with a commercial FEM code and some practical modeling exercises

Course Outcomes:

On completion of the course, students will be able to

1. Understand the different techniques used to solve mechanical engineering problems.
2. Derive and use 1-D and 2-D element stiffness matrices and load vectors from various methods to solve for displacements and stresses.
3. Apply mechanics of materials and machine design topics to provide preliminary results used for testing the reasonableness of finite element results.
4. Explain the inner workings of a finite element code for linear stress, displacement, temperature and modal analysis.
5. Use commercial finite element analysis software to solve complex problems in solid mechanics and heat transfer.
6. Interpret the results of finite element analyses and make an assessment of the results in terms of modeling (physics assumptions) errors, discretization (mesh density and refinement toward convergence) errors, and numerical (round-off) errors.

Content	Hours
Unit 1: **Fundamental Concepts** Introduction to FEA, Brief History, General FEM procedure, Simplification of problem through Symmetry, Various terminologies associated with FEA (Discretization, nodes and element) Stiffness matrix and its properties.) Application of FEM in various fields. Advantages and Disadvantages of FEA	04
Unit 2:	07

One Dimensional Element Introduction to One dimensional element, Types of One dimensional element, Derivation of Stiffness matrix and Shape function for one dimensional Linear and Quadratic element. Stress analysis of a Stepped bar, Thermal analysis of a Composite Wall and Torsion analysis of a shaft using 1 D element. Treatment of Boundary conditions by Elimination approach and Penalty approach	
Unit 3: **Two-Dimensional Element** Introduction to two-dimensional element, Derivation of Stiffness matrix and Shape function for two dimensional linear element. Numerical on Two Dimensional analysis using 2D elements (Constant Strain Triangle)	08
Unit 4: **Analysis of Axisymmetric Solids** Introduction and applications of Axisymmetric elements, axisymmetric formulation, finite element modeling, triangular element and stress calculations	06
Unit 5: **Analysis of Truss** Trusses:-Plane trusses, Local and Global coordinate systems, Derivation of Global stiffness matrix, Formulae for calculating L and M, element stiffness matrix, Stress Calculations, Assembly of global stiffness matrix.	08
Unit 6: **Scalar Field Problems** Introduction, Steady state heat transfer, one dimensional heat transfer in thin fins, Two dimensional steady state heat conduction, Two dimensional fins.	07
LIST OF ASSIGNMENTS: Assignment on each unit	
General Instructions:	

Text Books	
1.	Daryl L, A First Course in the Finite Element Method,. Logan, 2007.
2.	G Lakshmi Narasaiah, Finite Element Analysis, B S Publications, 2008.
3.	Y.M.Desai, T.I.Eldho and A.H.Shah, Finite Element Method with Applications in Engineering, Pearson Education, 2011
4.	Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002.
5.	P., Seshu, Text book of Finite Element Analysis, PHI Learning Private Ltd. , New Delhi, 2010.
Reference Books:	
1.	Bathe K. J., Finite Element Procedures Prentice, Hall of India (P) Ltd., New Delhi.
2.	R. D. Cook, et al., Concepts and Applications of Finite Element Analysis. Wiley, India
3.	Kwon Y. W., Bang H., Finite Element Method using MATLAB, CRC Press, 1997
4.	Peter Kattan, MATLAB Guides to Finite Elements- An Interactive Approach, Springer, 2008.
5.	S. Moaveni, Finite element analysis, theory and application with Ansys, Prentice Hall
6.	Erdogan Madenci and Ibrahim Guven, "The Finite Element Method and Applications in Engineering Using Ansys", Springer, 2006.
7.	David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill
8.	Gokhale N. S., et al., Practical Finite Element Analysis, Finite to Infinite, Pune, 2008.

Class, Part and Semester	**Final Year B. Tech (Mechanical Engineering), Part VIII**			
Course Title	**ELECTIVE I :** CRYOGENICS		**Course Code: ME705L2**	
Teaching Scheme (Hours)	Lecture = 3 Hrs/ Week		**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Fluid Mechanics, Heat transfer, Numerical methods, Programming Languages.			
Course Domain	Elective			

Course Objectives:

The course aims to:

1. Provide the information of fundamental concepts of cryogenics, and its importance and applications.
2. Articulate the gas liquefaction and Cryo cooler system.
3. Explore the gas separation, purification system and measurements it's of low temperature application.
4. Develop the Cryogenic fluid storage and components of transfer system.

Course Outcomes:

On completion of the course, students will be able to

1. Illustrate the applications and importance of Cryogenics.
2. Describe the gas liquefaction systems, and classify the Cryo-coolers.
3. Articulate Gas Separation, Purification and Low Temperature applications measurement systems.
4. Summarize Cryogenic Fluid Storage and Transfer Systems.

Content	Hours
Unit 1: **Introduction to Cryogenic:** History and development its importance, cryogenic temperature scale. Behavior of materials at low temperature: Low temperature properties of materials, Mechanical Properties Thermal properties, electric and magnetic properties, Properties of cryogenics and fluids.	08
Unit 2: **Gas Liquification Systems:** Introduction- production of low temperature , Liquefaction systems for N2, Neon, Hydrogen, He etc.(Numerical Treatment)	08
Unit 3: **Cryo Coolers:** Sterling, G-M and pulse tube cry coolers.	08

Unit 4: **Gas Separation and Purification Systems:** Thermodynamically ideal separation systems- properties of mixtures , principles of gas separation Rectification column-Linde single and double column system of air separation. Measurement Systems For Low Temperatures Measurement of different parameters at low temperature like temperature, pressure level mass flow rate etc.	06
Unit 5: **Cryogenic Fluid Storage and Transfer Systems:** Dewar vessel, insulation types and importance. Components of transfer system with importance. Importance of vacuum and its measurement.	08
Unit 6: **Application of Cryogenic Systems:** Applications in mechanical, electrical, food preservation, biological and medical, space technology etc.	07
LIST OF ASSIGNMENTS: Assignment on each unit	
General Instructions:	

Text Books	
1.	“Cryogenic Systems”, Barron F. Randall, Oxford University Press, New York.
2.	"Cryogenic Engineering”, Thomas M. Flynn, Marcel Dekkcr. Inc, New York.
3.	''Cryogenic Process Engineering”,Klaus D. Timmerhaus, Thomas M. Flynn, Plenum Publishing Corporation (1989).
4.	"Applied Cryogenic Engineering”,Vance, R. W, and Duke, Isted, W. M., John Wiley (1962).
5.	“Introduction to Cryogenics” B. S. Gawali, Mahalaxumi Publication.
Reference Books:	
1.	“Experimental Techniques in low Temperature Physics”, Guy, K White, Claredon Press, Oxford, (1987).
2.	“Cryogenic Research and Applications”, Marshall Sitting and Stephen Kidd, D. Van Nostrand, Inc USA, (1963).
3.	“Cryo-Cooler: Fundamentals Part-I”, G. Walker, Plenum Press, New York.
4.	“Cryo-Cooler: Fundamentals Part-II”, G. Walker, Plenum Press New York.
5.	“International Journal of Cryogenics”, Elsevier Publication.
6.	“Advanced Cryogenic Engineering”, Proceedings of Cryogenic Engineering Conference, Vol. 1-145, Plenum Press, New York (1968).

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	ELECTIVE 1: OPERATION RESEARCH		**Course Code: ME705L3**	
Teaching Scheme (Hours)		Lecture = 3 Hrs/ Week	**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Engineering Mathematics, Numerical Methods			
Course Domain	Elective			

Course Objectives:

The course aims to:

a. To understand operation research principals.
b. To study the transportation and assignment model for industrial applications.
c. To understand Fundamentals of PERT/CPM Model.
d. To study the sequencing, replacement model, inventory model, decision theory and network analysis of industrial applications.

Course Outcomes:

On completion of the course, students will be able to

a. Formulate and solve the problem by using operation research principals.
b. Evaluate problems of transportation and assignment model.
c. Apply and analyze PERT/CPM models
d. Formulate and Analyze problems regarding sequencing, replacement model, inventory model, decision theory and network analysis of industrial applications

CONTENT	**Hours**
Unit 1: **Introduction to Operation Research** Development of operations Research, characteristics and scope of operations Research, Models in operations Research, Model Formulation, Types of mathematical models, Limitations of operations Research. L.P. models, simplex method, the algebra of simplex method. (Minimization and Minimization problem) method, post optimality analysis, essence of duality theory, Application of sensitivity analysis.	8
Unit 2: **Transportation and Assignment Models** Structure, industrial and business applications. **a. Transportation problems** Use of various methods for solving transportation problems, degeneracy and its solution.	8

b. Assignment problems: Solution of various types of problems, Traveling Salesman problem.	
Unit 3: **Fundamentals of CPM / PERT Networks** **CPM** – construction of networks, critical path, forward and backward pass, floats and their significance, crashing for minimum cost and optimum and minimum duration, resource allocation and leveling. **PERT** – Time Estimates, Construction of Networks, Probability of completing projects by given date.	8
Unit 4: a. **Sequencing:** Sequencing of n jobs and 2 and 3 machines, 2 jobs and m machines, Gantt chart. b. **Replacement Analysis:** With and without time value of money, single item and group replacement.	8
Unit 5: **Inventory Models**: Various costs involved, classification of models, EOQ model with and without shortage, EOQ with uniform demand and production lot size model, EOQ model with single price break.	8
Unit 6: a. **Decision Theory:** Pay off and regret tables, decision rules, decisions under uncertainty and risk, decision tree. b. **Network Techniques**: Shortest Path Model- Systematic Method, Dijkstra's Algorithm.	8

General Instructions

Text Books:

1.	Operation Research an Introduction", Hamdy A. Taha, Pearson, 9th Edition.
2.	"Operations Research", J. K. Sharma, McMillan India Publication New Delhi, 5th Edition.
3.	"Operations Research", Hira and Gupta, S.Chand and Co. New Delhi.
4.	"Operations Research", Manohar Mahajan Dhanapat Rai and Sons.
5.	"Engineering Optimization Methods and Application", A Ravindran ,K.M. Ragdell ,G.V. Rklaitis, Willey India Ltd.

Reference Books:

1.	"Production and Operation Management", Tripathy, Scitech Publication, 2nd Edition.

2.	"Introduction to Operation Research", Paneer-Selvam, Prentice Hall of India publication, 2nd Edition.
3.	"Operation Research", Pradeep J. Jha, Tata McGraw Hill Publication.
4.	"Operation Research", S.R. Yadav, A.S. Mallik, Oxford University Press,(2014).
5.	"Operation Research – Principle and Applications", Shriniwasan, Prentice Hall of India Publication, 2nd Edition.
6.	"Operation Research", Natrajan, Pearson Publication. 2nd Edition.
7.	"Operation Research", Mariappan, Pearson Education

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	ELECTIVE 1: ENTERPRISE RESOURCES PLANNING		**Course Code: ME705L4**	
Teaching Scheme (Hours)		Lecture = 3 Hrs/ Week	**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Tool Engineering, Engineering Economics			
Course Domain	Elective			

Course Objectives:

The course aims to:

a. To understand the basic concept of ERP systems
b. To study the steps and activities in the ERP life cycle
c. To develop process-driven thinking towards business processes
d. To describe the concept of ERP and the ERP model; define key terms; explain the transition from MRP to ERP; identify the levels of ERP maturity.
e. To explain how ERP is used to integrate business processes; define and analyze a process; create a process map and improve and/or simplify the Process; apply the result to an ERP implementation.
f. To describe the elements of a value chain, and explain how core processes relate; identify how the organizational infrastructure supports core business processes; explain the effect of a new product launch on the three core business processes.

Course Outcomes:

On completion of the course, students will be able to

a. Demonstrate a good understanding of the fundamental issues in ERP systems
b. Analyze the strategic options for ERP identification and adoption
c. Design the ERP implementation strategies
d. Describe the advantages, strategic value, and organizational impact of utilizing an ERP system for the management of information across the functional areas of a business: sales and marketing, accounting and finance, human resource management, and supply chain.
e. Demonstrate a working knowledge of how data and transactions are integrated into an ERP system to manage the sales order process, production process, and procurement process.
f. Understand the need for Business Systems and Processes through strategic analysis of ERP systems

CONTENT	**Hours**
Unit 1: ERP Introduction, Benefits, Origin, Evolution and Structure: Conceptual Model of ERP, the Evolution of ERP; what is ERP?, Reasons for the Growth of ERP; Scenario and Justification of ERP in India; Evaluation of ERP; Various Modules of ERP.	6

Unit 2: An Overview of Enterprise; Integrated Management Information; Business Modeling; ERP for Small Business; ERP for Make to Order Companies; Business Process Mapping for ERP Module Design; Hardware Environment and its Selection for ERP Implementation, Business Process Reengineering, Data ware Housing, Data Mining, Online Analytic Processing (OLAP), Product Life Cycle Management (PLM), LAP, Supply chain Management. (SCM)	7
Unit 3: ERP and Related Technologies; Business Process Reengineering (BPR); Management Information System (MIS); Executive Information System (EIS); Decision Support System (DSS);	6
Unit 4: ERP Implementation Basics, ERP Implementation Life Cycle, Role of SDLC/SSAD, Object Oriented Architecture, Consultants, Vendors and Employees. Issues in Implementing ERP Packages; Pre-evaluation Screening; Package Evaluation; Project Planning Phase; Gap Analysis; Reengineering; Configuration; Implementation; Team Training; Testing; Going Live; End-User Training; Post Implementation (Maintenance Mode).	8
Unit 5: ERP and E-Commerce, Future Directives- in ERP, Critical success and failure factors, Integrating ERP into organizational culture. E-Procurement; E-Logistics; Internet Auctions; E-markets; Electronic Business Process Optimization; Business Objects in SCM; E-commerce	7
Unit 6: Introduction, SAP AG, Baan Company, Oracle Corporation, People Soft, JD Edwards World Solutions Co, System Software Associates, Inc. (SSA); QAD; 2. A Comparative Assessment and Selection of ERP Packages and Modules. Using ERP tool: either SAP or ORACLE format to the case study.	6

The suggested list of Tutorials and Assignments:
Minimum 6 assignments. One assignment for each unit covers application-oriented understanding.

Text Books:

1.	Manufacturing Resource Planning (MRP II) with Introduction to ERP; SCM; a CRM by Khalid Sheikh, Publisher: McGraw-Hill
2.	The Impact of Enterprise Systems on Corporate Performance: A study of ERP, SCM, and CRM System Implementations [An article from Journal of Operations Management] by K.B. Hendricks; V.R. Singhal; and J.K. Stratman, Publisher: Elsevier
3.	ERP and Supply Chain Management by Christian N. Madu, Publisher: CHI
4.	Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning Concepts and Practice", PHI.
5.	Joseph A Brady, Ellen F Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Thompson Course Technology.

Reference Books:

1.	Alexis Leon, "ERP Demystified", Tata McGraw Hill
2.	Rahul V. Altekar "Enterprise Resource Planning", Tata McGraw Hill,
3.	Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning – A Concepts and Practice", PHI
4.	Mary Summer, "Enterprise Resource Planning"- Pearson Education

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	ELECTIVE 1: INDUSTRIAL HEALTH AND SAFETY MANAGEMENT			**Course Code: ME705L5**
Teaching Scheme (Hours)		Lecture = 3 Hrs/ Week		**Total Credits: 3**
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	NIL			
Course Domain	Professional Elective course relevant to chosen specialization/branch			

Course Objectives:

The course aims to:

a. To discuss about Industrial safety programs, Industrial laws, regulations.
b. To describe industrial hazards and its risk assessment.
c. To impart Knowledge of accidental prevention techniques to the students.
d. To impart knowledge about occupational health, industrial hygiene.
e. To make students aware about safety auditing and management systems.
f. To discuss pollution prevention techniques.

Course Outcomes:

On completion of the course, students will be able to

a. Realize the basics of Occupational Health Hazards.
b. Introduce about common occupational diseases
c. Introduce the Safe use of machines and tools.
d. Be acquainted with the use of personal protective equipment's (PPE)
e. Recognize principles of accidents prevention.
f. Identify major accident control in industry.

CONTENT	**Hours**
Unit 1: **Introduction and Scope** Definition of Occupational Health as per WHO/ILO, Occupational Health and Environmental Safety Management – Principles Practices, Common Occupational diseases: Occupational Health Management Services at the work place, Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.	6
Unit 2: **Monitoring for Safety, Health and Environment** Importance of Industrial safety, role of safety department, Safety committee and function, Role and responsibilities of safety officer, Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust	6

Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures.	
Unit 3: **Safe use of Machines and Tools** Ergonomics of machine guarding guards, Guarding of different types of machinery including special precautions for paper, rubber and printing machinery, wood working. Preventive maintenance, periodic checks for safe operation. Associated hazards and their prevention. Working in different areas: Working in confined spaces, Working Underground, Working at heights - use of stairways, clamps, working platforms, ladders of different types, Boatswain's chair and safety harness Zorking on roofs, Lifting machinery lifts and hoists. Guarding of different types of machinery including special precautions for machine, tools etc. Built-in-safety devices, maintenance and repairs of guards, Operation, inspection and maintenance of industrial trucks, loose gears conveyors, Safe working load for mechanical material handling equipments.	8
Unit 4: **Personal Protective Equipment's (PPE)** Need for personal protection equipment, selection, applicable standards, and supply, use, care and maintenance, respiratory and non-respiratory personal protective equipment. Selection of respiratory personal protective devices, Non-respiratory personal protective devices: Head protection, Ear protection. Face and Eye protection. Hand protection, Foot protection, body protection. Working at Heights: Incidence of accidents. Safety features associated with design, construction and use of stairways, ramps, working platforms, gangway.	7
Unit 5: **Principles of Accidents Prevention** Definition: Incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes, etc. Accident Prevention : Theories / Models of accident occurrences, Principles of accident prevention, Accident and Financial implications, Hazard identification and analysis, fault tree analysis, Event tree analysis, failure modes and effects analysis, Hazop studies, Job safety analysis – examples, Plant safety inspection - objectives and types check procedure inspection report. Causes of accidents, Types of accidents, accident statistics, Cost of accident, Direct and indirect cost of an accident, accident/ incident reporting, accident Investigation report.	7
Unit 6: **Plant Design and Housekeeping** Plant layout, design and safe distance, Ventilation and heat stress, Significance of ventilation, Natural ventilation, Mechanical ventilation Air conditioning. Safety and good housekeeping, Disposal of scrap and other trade wastes Spillage prevention, Use of colors as an aid of housekeeping, Cleaning methods, Inspection and Checklists.	5

Text Books:

1.	R. K. Jain and Sunil S. Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2.	Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.
3.	Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2, Butterworth-Heinemann Ltd., London (1991).

Reference Books:

1.	Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York.
2.	Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
3.	Grimaldi and Simonds, Safety Management, AITBS Publishers, New Delhi (2001).
4.	Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973
5.	The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai
6.	Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York.

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	LABORATORY: REFRIGERATION AND AIR CONDITIONING		**Course Code: ME701L**	
Teaching Scheme (Hours)	Practical = 2 Hrs/ Week		**Total Credits: 1**	
Evaluation Scheme (Marks)	IOE: NIL	IPE: 50	EOE = 50	EPE : NIL
Revision:			**Month:**	June 2023
Pre-requisites (if any)	Engineering Thermodynamics, Fluid Mechanics, Heat Transfer			
Course Domain	Core			

Course Objectives:

The course aims to:

a. To get new knowledge and skills to fulfill needs of Industry in future.
b. To perform different experiments and analyze results.
c. To use different tools and techniques in refrigeration and Air Conditioning system.
d. To Develop professional and research approach for lifelong learning in refrigeration system.

Course Outcomes:

After completing the course, students will be able to

a. Express complete understanding of vapour compression cycle.
b. Perform the different experiments of refrigeration and air conditioning
c. Analyze the different experiments in refrigeration and air conditioning systems.
d. Write reports in effective way.

List of Experiments

a. Study of basic components and controls of simple vapour compression refrigeration system.
b. Study and demonstration of refrigeration system (Domestic Refrigerator/ Water Cooler/ Cold Storage)
c. Study and demonstration of Vapour Absorption system.
d. Trial on Refrigeration Test Rig.
e. Trial on Ice plant Test Rig.
f. Trial on two stage cascade Refrigeration system Test Rig.
g. Trial on heat pump Test Rig.
h. Trial on Window Air conditioning system Test Rig.
i. Industrial Visit related to refrigeration and air conditioning system.
j. Market survey of various refrigeration and air conditioning systems which include the Equipment's with related specifications, manufacturers, cost and comparison with respect to tonnage, cost. Presentation of report in the laboratory.

General Instructions: Experiments will be checked after completion of Trial.	
Suggested Text Books:	
1.	"Refrigeration and Air Conditioning" Arora C P, Tata McGraw Hill
2.	"Refrigeration and Air Conditioning" Arora Domkundwar , Dhanpat Rai and Sons
3.	"Principal of Refrigeration" Dossat Ray J., S.I. Version, Wiley Eastern Limited,
4.	"Refrigeration and Air-conditioning" Manohar Prasad, Wiley Eastern Limited

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	LABORATORY: MECHANICAL SYSTEM DESIGN		**Course Code: ME702L**	
Teaching Scheme (Hours)	Practical = 2 Hrs/ Week		**Total Credits: 1**	
Evaluation Scheme (Marks)	IOE: NIL	IPE: NIL	EOE = 50	EPE : NIL
Revision:			**Month:**	June 2023
Pre-requisites (if any)	Theory of Machines, Machine Design and Machine Drawing			
Course Domain	Core			

Course Objectives:

The course aims to:

a. To get new knowledge and skills to fulfill needs of Industry in future.
b. To perform different design analysis.
c. To use different tools and techniques for optimization.
d. To develop professional and research approach for lifelong learning in Mechanical system Design.

Course Outcomes:

After completing the course, students will be able to

a. Express complete understanding of detailed design report.
b. Perform the different design calculation.
c. Analyze the different material handling systems.
d. Write reports in effective way.

Practical List

1. A detail design report and A2 size sheet containing working drawing of detail and assembly of (Any Two)
   a. Design of Machine Tool Gear Box.(Three Stage, Twelve speed gear Box)
   b. Pressure vessel design
   c. Brake design or Clutch design.
2. Assignment based on
   a. Aesthetic and Ergonomic design considerations –case study.
   b. Problems on Material Handling System.
   c. Minimum four Problems on Design of IC Engine components such as connecting rod, crank shaft, piston with piston rings and pins, cylinder and cylinder head.
3. Industrial visit to Process industry.

Text Books:

1.	"Design of machine element", V. B. Bhandari, Tata Mc- Graw Hill Publication, 3rd Edition.
2.	"Mechanical Engineering Design", Shigley and C. R. Miscke, Tata Mc- Graw Hill Publication.
3.	"Mechanical Design Analysis", M. F. Spotts, Prentice Hall Publication.
4.	"Design of Machine Tools", S. K. Basu and D.K. Pal Oxford and IBH Publication, 6th Edition.

5.	"Machine Tools Design", N.K. Mehta, Tata Mc- Graw Hill Publication, 5th Edition.
6.	"Design Data Book", P. S. Gill (PSG) 3rd Edition.
7.	I.S.:2825 Code for Unfired Pressure Vessels.
Reference Books:	
1.	"Handbook of Gear Design",Jitin Maitra,Tata Mc-Graw Hill Publication.
2.	"Machine Design", Black P.H.and O.Eugene Adams, Tata Mc- Graw Hill Publication.
3.	"Mechanical Design Synthesis with Optimisation Applications",Johnson R.C.,Von Nostrand-Reynold Publicaion.
4.	"Engineering Design", Dieter G.E., Tata Mc- Graw Hill Publication, 4th Edition.
5.	"Product Design and Process Engineering", Benjamin W. Niebel, Alan B. Draper, Tata Mc- Graw Hill Publication.
6.	"Design of Pressure Vessel", Harve, CBS Publishers and Distributors Van Nostrand Reinhold
7.	"Engineering Optimization Theories and Practice", S.S.Rao, New Age Publication, 3rd Edition.
8.	"Process Equipment Design", M. V. Joshi, Macmillal Publication, 3rd Edition.
9.	"Machine Design", Robert L. Norton, Tata Mc- Graw Hill Publication.

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	LABORATORY: HYDRAULICS AND PNEUMATICS		**Course Code: ME703L**	
Teaching Scheme (Hours)	Practical = 2 Hrs/ Week		**Total Credits: 1**	
Evaluation Scheme (Marks)	IOE: NIL	IPE: NIL	EOE = 50	EPE : NIL
Revision:			**Month:**	June 2023
Pre-requisites (if any)	Engineering Physics, Fluid Mechanics and Turbo machinery.			
Course Domain	Core			

Course Objectives: The Course teacher will

a. Apply knowledge of basic components, ISO/JIC symbols and applications of hydraulics and pneumatics in various fields of industries
b. Study various elements used in modern hydraulic and pneumatic system
c. Develop various hydraulic and pneumatic circuits.
d. Design of hydraulic and pneumatic circuits for given application.

Course Outcomes: Students will be able to

a. Interpret any hydraulic and pneumatic application circuits with practice of symbols and ISO/JIC standard
b. Choose the suitable hydraulic or pneumatic components for a specific fluid power application
c. Develop simple circuits for hydraulic and pneumatic applications.
d. Design the hydraulic or pneumatic system for given industrial application

List of Experiments (Any Eight)

1. Study and Demonstration of ISO/JIC Symbols for hydraulic and pneumatic systems.
2. Study and Demonstration of basic hydraulic and pneumatic system.
3. Study and Demonstration of different types of valves used in hydraulic and pneumatic system.
4. Study and Demonstration of accumulators/actuators/intensifiers/hydraulic and pneumatic power brakes.
5. Preparation of following circuits on hydraulic circuit trainer Kit:-
    a. Study of Direction Control Valve :
    b. Bleed off Flow Control Circuit
    c. Study of Meter-In Circuit
    d. Study of Meter Out Circuit
    e. Sequencing of Two Hydraulic Cylinders
    f. Study of Direction Control of Rotary Actuator
    g. Automation of a double acting cylinder by a solenoid operated Direction Control Valve.
6. Preparation of following circuits on pneumatic circuit trainer Kit:-
    a. Control of single acting cylinder by one 3/2 push button valve
    b. Control of single acting cylinder by a 3/2 lever operated valve.
    c. Control of single acting cylinder by a pilot operation.
    d. Automation of a double acting cylinder by a pilot valve.
    e. Automation of a double acting cylinder by a solenoid operated Direction Control Valve.
    f. Automation of two double acting cylinder by a two solenoid operated Direction Control Valve.
    g. Study of Rotary Actuator

7. At least two Circuit preparations using Fluid Simulation Software.
8. Design of hydraulic / pneumatic system and related components for any one of the following: Shaping machine /Broaching machine /Slotting machine /Hydraulic clamps /Pneumatic clamp /any one industrial application.
9. Industrial visits for applications of pneumatic and hydraulic system and their reports.

General Instructions	
Suggested Text Books:	
1.	"Industrial Fluid Power", S.S. Kuber, Nirali Prakashan, 3rd Edition.
2.	"Hydraulic and Pneumatic",H.L.Stewart,Industrial Press.
3.	"Industrial Fluid Power",D. S. Pawaskar, Nishant Prakashan.
4.	"Hydraulics and Pneumatics", Shaikh and Khan, R.K. Publication.
5.	"Fluid Power with Application", Esposito, Pearson Education, 7th Edition.
6.	Eaton-Vickers, Industrial Hydraulics Manual. Eton Corporation.
7.	"Industrial Fluid Power", S.S. Kuber, Nirali Prakashan, 3rd Edition.
Suggested Reference Books:	
1.	"Industrial Fluid Power", S.S. Kuber, Nirali Prakashan, 3rd Edition.
2.	"Hydraulic and Pneumatic",H.L.Stewart,Industrial Press.
3.	"Industrial Hydraulic", J. J. Pipenger ,Tata McGraw Hill.
4.	"Power Hydraulics", Goodwin 1st Edition.
5.	"Introduction to Hydraulic and Pneumatic", S. Ilango and V Soundararajan, Prentice Hall of India, 2nd Edition.
6.	"Pneumatic Control",Joji P., Wiley, 1st Edition.
7.	"Fluid Power", Jagadeesha T., Wiley Publications.

Final Year B. Tech (Mechanical Engineering), Part VII				
Course Title	MAJOR PROJECT PHASE I			**Course Code** ME706L
Teaching Scheme (Hours)	Practical = 2 Hrs/Week			**Total Credits:** 3
Evaluation Scheme (Marks)	IOE: 50	IPE: NIL	EOE = NIL	EPE : NIL
Revision:		**Month:**		June 2023
Pre-requisites (if any)	NIL			
Course Domain	Core			

Course Objectives:

The course aims to:

a. 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.
b. Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Course Outcomes:

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

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

Project Phase I Load:

A batch of maximum three groups of four 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 time frame.

The project phase I work is to be extended for project phase II at B. Tech (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: TrimmedA4
2. Top Margin: 1.00Inch
3. Bottom Margin: 1.32Inches
4. Left Margin: 1.5Inches
5. Right Margin: 1.0Inch
6. Para Text: Times New Roman 12 Point. Font
7. Line Spacing: 1.5Lines
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), Part VII				
Course Title	INTRODUCTION TO INDIAN CONSTITUTION			**Course Code:**
Teaching Scheme (Hours)	Practical = 2 Hrs/ Week			**Total Credits: NIL**
Evaluation Scheme (Marks)	IOE: NIL	IPE: NIL	EOE = NIL	EPE : NIL
Revision:		**Month:**		
Pre-requisites (if any)	It has no any pre-requisites. Every citizen of the country ought to study the course content.			
Course Domain	Audit Course at institute level , Humanities and Social Science			

Course Rationale: As a citizen of India, every student should have basic knowledge about Indian constitution. Every student should know the importance of Fundamental rights, Fundamental duties as well as Directive Principles. This course fulfills all these requirements. This course also includes knowledge about state as well as union legislature, judiciary and executive. It helps to understand emergency provisions, electoral process and amendment procedures. This course is helpful for the students to be legally updated.

Course Objectives: The Course teacher will

a. Familiarize students with the preamble
b. Describe fundamental rights and duties of citizens.
c. Explain union and state executives.
d. Discuss constitutional provisions.
e. Illustrate electoral process.
f. Summarize role of democracy in social welfare.

Course Outcomes: Students will be able to

a. Get associated with Indian Constitution
b. Understand their fundamental duties and rights.
c. Recognize union and state executives.
d. Interpret about constitutional provisions.
e. Understand and follow the electoral process
f. Realize importance of democracy in social welfare.

Content	**Hours**
Unit I: Introduction to Preamble and Fundamental Rights Preamble to the constitution of India. Fundamental rights under Part – III – details of Exercise of rights, Limitations and Important cases.	**4**
Unit 2 Fundamental Duties and Directive Principles. Relevance of Directive principles of State Policy under Part – IV. Fundamental duties and their significance.	**5**
Unit 3 Union Legislature, Judiciary and Executive: President, Prime Minister, Parliament and the Supreme Court of India.	**4**
Unit 4 State Legislature, Judiciary and Executive. : Governors, Chief Minister, State Legislator and High Courts.	**5**
Unit 5 Constitutional Provisions: Provisions for Scheduled Castes and Tribes, Women and Children and Backward classes. Emergency Provisions.	**5**
Unit 6 Electoral process and Amendment procedures:	**5**

Constitution of election commission, system of adult suffrage, procedure for amendment. 42nd, 44th, 74th, 76th, 86th and 91st Constitutional amendments.	

Text Books:	
1.	Durga Das Basu: "Introduction to the Constitution of India" (Students Edn.) Prentice – Hall EEE, 19th/20th Edn. 2001.
2.	R.C.Agarwal, "Indian Political System", (1997) S.Chand and Company, New Delhi. Maciver and Page, "Society: An Introduction Analysis", Mac Milan India Ltd., New Delhi.
3.	K.L.Sharma, "Social Stratification in India: Issues and Themes", (1997), Jawaharlal Nehru University, New Delhi.
Reference Books:	
1.	An Introduction to Constitution of India" by M.V.Pylee, Vikas Publishing, 2002. Sharma, Brij Kishore, "Introduction to the Constitution of India: Prentice Hall of India, New Delhi.
2.	U.R.Gahai, "(1998) Indian Political System ", New Academic Publishing House, Jalandhar.
3.	R.N. Sharma, "Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd.
4.	Yogendra Singh, "(1997) Social Stratification and Charge in India ", Manohar, New Delhi.

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	AUTOMOBILE ENGINEERING		**Course Code: ME801**	
Teaching Scheme (Hours)		Lecture = 4 Hrs/ Week	**Total Credits: 4**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Internal Combustion Engines, Engineering Thermodynamics and Heat and Mass Transfer			
Course Domain	Core			

Course Objectives:

a. To study and understand various components, sub-assemblies, and assembly of an automobile.
b. To study the design of various automobile systems.
c. To study and diagnose the effects of various factors on the subassemblies of an automobile
d. To evaluate the performance of an automobile.

Course Outcomes:

On completion of the course, students will be able to

a. Implement the knowledge obtained in theory towards the design procedure of various automobile systems
b. Understand the components and layout of the automobile
c. Analyze the effect of various factors on subsystems of automobiles and remedies can be proposed
d. Evaluate the performance of an automobile

CONTENT	Hours
Unit 1 **Clutch:** Requirements of Clutches, Types of Clutches; Single Plate, Multi-plate, Wet Clutch, Semicentrifugal, Centrifugal. Clutch materials. Clutch operating mechanisms; Mechanical, Electric, Hydraulic, and Vacuum. Free Pedal Play. **Transmission:** Necessity of gearbox. Sliding mesh, Constant mesh, and Synchromesh Gear selector mechanisms. Overdrives and hydrodynamic torque converter, Troubleshooting and remedies. **Propeller Shaft and Axle:** Propeller shafts and universal joints, Types and construction, Different types of universal joints and constant velocity joints Types of live axles; semi, three quarter and full floating axles Types of Front Stub Axles; Elliot, Reverse Elliot, Lamoine, and Reverse Lamoine	6
Unit 2 **Final Drive and Differential:**	8

Types of Final drive; spiral, bevel, Hypoid and worm drives. The necessity of differential, Working of differential, Conventional and non-slip differential, Troubleshooting and remedies **Steering System:** Steering geometry, Steering requirements, Steering linkages and steering gears. Over steer and understeer, Cornering power, Reversibility of steering gears. **Braking System:** Requirement of brake, Classification of brakes, Brake Actuation Methods; Mechanical, Hydraulic, Pneumatic, Electro and vacuum brakes. Types of Disc brakes and Drum Brakes, Brake troubleshooting, Introduction to antilock braking system (ABS)	
Unit 3 **Suspension System** Objects of suspension, Basic requirements, Sprung and un-sprung mass, Types of Independent and rigid axle suspension. Air suspension and its features. Pitching, rolling and bouncing. Shock absorbers and its types Wheels and Tyres: Requirements of wheels and tyres. Types of wheels, types of tyres and types of carcass	8
Unit 4 **Automotive Electrical System:** **Storage System:** Lead-Acid Battery; construction, working, ratings, types of charging methods, Alkaline, ZEBRA, Sodium Sulphur and Swing batteries Charging System Dynamo: Principle of operation, Construction and Working. Regulators, combined current and voltage regulator. **Alternator:** Principle of operation, Construction, Working. Rectification from AC to DC Starting system: Requirements, Various torque terms used, Starter motor drives; Bendix, Rubber compression, Compression Spring, Overrunning Clutch. Starter motor solenoids and switches	10
Unit 5 **Body Engineering:** Importance of Body design, Materials for body construction-Styling forms-Coach and bus body style, layouts of passenger cars, Bus and truck bodies. **Chassis types and structure types:** Open, Semi integral and integral bus structure Frames: functions and types of frames, Loads on frames, Load distribution of structure, Location of power plant	8
Unit 6 **Recent trends in Automobiles:** Intelligent Vehicle Systems: Cruise Control, Adaptive Cruise Control (ACC), Electronic Stability Program (ESP), Electronic Brake Distribution (EBD), Traction Control System (TCS), Integrated Starter Alternator (ISA), Introduction to Electric Vehicle (EV), comparison with conventional system.	6
Text Books:	
1.	Automobile Engineering, Kirpal Singh, Vol I & II, Standard publishers Distributors ,Delhi

2.	The Automobile by Harbans Singh Reyat
3.	The Automobile Engineering by T.R. Banga and Nathu Singh
Reference Books:	
1.	Automotive Engineering Fundamentals by Richard Stone, Jeffrey K. Ball,SAE International
2.	Vehicle body engineering by J Powlowski
3.	Automobile Mechanics, N. K. Giri, 8 thEdition, Khanna Publishers
4.	Automotive Mechanics by William H. Crouse and Donald L. Anglin, 10th Edition, McGraw Hill
5.	Automotive Mechanics by Joseph Heitner
6.	Automobile Electrical and Electronics by Tom Denton

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	POWER PLANT ENGINEERING		**Course Code: ME802**	
Teaching Scheme (Hours)		Lecture = 4 Hrs/ Week	**Total Credits: 4**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Engineering Thermodynamics, Engineering Economics			
Course Domain	Core			

Course Objectives:

a. Understand the different power generation methods, its economics and global energy situation.

b. Familiarize with Equipment, Plant layout, and working principle of various power plants.

c. Understand Hydroelectric Power Plant and Non-conventional power plants.

d. Study environmental impact and economic analysis of various power plants.

Course Outcomes:

On completion of the course, students will be able to

a. Describe the energy resources and energy systems available for the production of electric power in the India and the world.

b. Discuss construction and working of steam power plant, Gas turbine power plant, Nuclear power plant and Diesel power plant.

c. Describe construction and working principle of hydroelectric power plant, solar power plant, Wind Power plant and geothermal power plant.

d. Elaborate economic analysis and the environmental impact of electric power production on air quality, climate change, water, and land.

CONTENT	Hours
Unit 1 **Introduction Of Power Plant:** Introduction: Resources and development of power in India, NTPC, NHPC and their role in Power development in India, Present Power position in India and Maharashtra. Power Plants Introduction, Factors affecting Selection and relative merits of steam, Gas, Diesel, Hydro Power Plants.	6
Unit 2 **Steam And Gas Turbine Power Plant:**	6

Steam turbine power plant Introduction, general layout of steam power plant, necessity of feed water treatment, high pressure boilers and importance of water purity, effect of operating variable on thermal efficiency, regeneration, reheating, Cogeneration power Plant Gas turbine power plant Introduction, general layout of gas turbine power plant, effect of operating variable on thermal efficiency, regeneration, reheating, and performance of closed and semi closed cycle gas turbine plant.	
Unit 3 **Nuclear And Diesel Power Plant:** Nuclear power plant: Elements of nuclear power plant, Nuclear reactors and its types, fuel moderators, coolants, control rod, classification of nuclear power plants, waste disposal. Diesel Power Plant: Field of Use, Plant Layout, Different systems of Diesel Power Plant, application, advantages and disadvantages of Diesel power plant	6
Unit 4 **Hydroelectric Power Plant:** Hydroelectric Power Plant (HPP): site selection, classification of HPP, and their field of use, capacity calculation for hydro power, dam, head water control, penstock, water turbines, specific speeds, governors, hydroelectric plant auxiliaries, plant layout, automatic and pumped storage, project cost of hydroelectric plant. Advantages and limitations of hydro power plant.	6
Unit 5 **Non-Conventional Power Plants:** Wind Power plant: Introduction, wind availability measurement, types of wind machines, site select, selection, and wind power generation. Solar Power Plant: Introduction, components, Types of collectors and Solar Ponds, Solar Concentrators, Low and High Temperature Solar Power Plant. Photovoltaic power system, Heliostat Tidal, OTEC, geothermal, magneto hydro-dynamics, fuel cell, hybrid power plants, plants, Challenges in commercialization of non-conventional power plants.	6
Unit 6 **Economic Analysis And Environmental Impact:** Cost of energy production, selection of plant and generating equipment, performance characteristics and operating characteristics of power plants, tariffs for electrical energy. Environmental Impact due to Power Plant: Introduction, Different pollutants due to thermal pow power plant and their effect on human health, Global warming and greenhouse effect, thermal pollution of water and its control.	6

Text Books:	
1.	"Power Plant Engineering" Domkundwar and Arora, Dhanpat Rai and Sons, New Delhi
2.	"Power Plant Engineering" P. K. Nag,, Tata McGraw Hill, New Delhi
3.	"Power Plant Engineering" R.K.Rajput , Laxmi Publications, New Delhi.
4.	"Power Plant Engineering", Sharma P.C. and Nagpal, McGraw Hill Education, India.
Reference Books:	
8.	"Power Plant Engineering" El-Wakil M.M., McGraw Hill Education, India.
9.	"Steam and Gas turbines" R. Yadav, Central Publishing House, Allahabad.
10.	"Non-conventional energy sources" G. D. Rai, Khanna Publishers.
11.	"Power Plant Engineering", A.K. Raja, New age international publisher.

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	MECHATRONICS		**Course Code: ME803**	
Teaching Scheme (Hours)		Lecture = 4 Hrs/ Week	**Total Credits: 4**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Basic Electronics Engineering, Electrical Technology and Theory of Machine			
Course Domain	Core			

Course Objectives:

a. To learn how to apply the principles of Mechatronics and automation for the development of system.
b. To learn the automation technology and industrial automation as applications of Mechatronics in manufacturing system.
c. To supply qualified personnel to meet the requirement of specialist in Mechatronics.
d. To prepare Mechanical Engineering students for advanced graduate studies in Mechatronics, Manufacturing engineering and related field.

Course Outcomes:

On completion of the course, students will be able to

a. Develop a simulation model for simple physical systems and explain Mechatronics design process.
b. Selection of sensors and actuators for an engineering application
c. Write simple PLC programs.
d. Design and develop Mechatronic systems for engineering applications

CONTENT	Hours
Unit I **Introduction to Mechatronics** Introduction to Mechatronics, Mechatronics systems, multi discipline scenario Transducers & Sensors, Position Sensors: Limit switch, photoelectric switches, proximity sensors, incremental & absolute encoders, decoders & relays. Displacement: Potentiometer sensors, capacitive displacement sensors. Velocity sensors: Tachogenerator, use of encoders, advances in sensors.	6
Unit II **Signal Conditioning** Signal conditioning process, Operational amplifier (inverting amplifier, non-inverting amplifier, summing, integrating amplifier, differentiating amplifier, logarithmic amplifier), protection, filtering, data acquisition, multiplexer, analog to digital converter (ADC), digital to analog converter (DAC). Sample and hold, demultiplexing. Polling and interrupts.	8

Unit III **Digital circuits, Microprocessor and Microcontroller** Introduction to Digital logic gates, Boolean algebra, application of logic gates, Combinational and sequential logic, flip flop, D flip flop, JK flip flop, Master slave flip flop .Comparison between microprocessor and micro controller, organization of a microprocessor and microcontroller system, architecture of PIC controller, instruction types and set, Introduction and applications of Arduino and Raspberry, Pi microcontroller, Applications of microcontroller.	8
Unit IV **Introduction to PLC** Introduction, definition, PLC system and components of PLC input output module, PLC advantages and disadvantages. Ladder diagram & PLC programming fundamentals, machine control terminology, update – solve ladder – update, physical components Vs. program components.	10
Unit V **Applications of PLC** Internal relays, light control example, disagreement circuit, majority circuit, oscillator, holding (sealed or latches) contacts, always ON always OFF contacts, fail safe circuits, PLC timer and counter functions – Introduction and types. Industrial applications – Automatic liquid filling system, liquid mixture, traffic control.	8
Unit VI **Industrial control systems** Introduction Human machine Interface (HMI), Difference between HMI and PLC, Introduction to SCADA and its industrial applications, motion controller, applications of RFID technology and machine vision, Introduction to DCS.	6

Text Books:

1.	"Mechatronics and Robotics",W. Bolton, Pearson Education , 4th Edition
2.	"Mechatronics and Robotics",Mahalik, TATA McGraw Hill, (2006) Reprint
3.	"Microprocessor 8085", Gaokar Prentice Hall of India, 5th Edition
4.	"Introduction to PLC Programming" NIIT
5.	"Programmable Logical Controller", Hackworth, Pearson Education, (2008)
6.	"Programmable Logical Controller", Reis Webb, Prentice Hall of India 5th Edition.
7.	"MEMS and Microsystems", HSU Tairan, TATA McGraw Hill Publication. 1st Edition.
8.	"Automation, Production Systems and Computer Integrated Manufacturing", Groover, M.P., Pearson Education, ISBN: 81-7808-511-9 2nd Edition (2004).

Reference Books:

1.	"Mechatronics and Robotics" Appu Kuttam, Oxford Publications, 1st Edition.

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

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	COSTING AND COST CONTROL		**Course Code: ME804**	
Teaching Scheme (Hours)		Lecture = 3 Hrs/ Week	**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Engineering Economics			
Course Domain	Core			

Course Objectives:

a. To discuss the fundamentals of the costing system.
b. To discuss the process of costing for different industries.
c. To illustrate the cost accounting methods
d. To demonstrate the techniques of costing in cost control and cost reduction areas.

Course Outcomes:

On completion of the course, students will be able to

a. Demonstrate the fundamentals of the Costing System.
b. Apply the costing methods based on the type of industry.
c. Apply the different Cost accounting methods as per requirement.
d. Demonstrate his acquired skills in Cost Control and Cost Reduction

CONTENT	Hours
Unit 1 **Cost and Cost Estimation** Concept of cost, cost unit, cost center, classification of cost, elements of cost, Definition of costing, desirable conditions for a costing system. Cost sheet. Cost Estimating: Definition, purpose and functions of estimation, the estimator's role, constituents of estimates, and estimating procedures.	8
Unit 2 **Estimation of Weight and Material Cost** Process of breaking down product drawing into simpler elements or shapes, estimating the volume, weight and cost. Purchasing procedure, Inventory Valuation by LIFO, FIFO, Weighted average method.	8
Unit 3 **Estimation of various costs** Estimation of fabrication, foundry, forging and machining cost Constitutes, direct cost, indirect cost, Procedure of cost estimation for each type. Machine hour rate: Definition, constituents, direct cost, indirect cost, steps for estimating machine hour rate for conventional machines, CNC lathe and machining centre.	7
Unit 4 **Overheads**	6

Elements of overheads, classification, general considerations for collection, analysis of overheads, different methods for allocation, apportionment, and absorption of overheads.	
Unit 5 **Cost Accounting Methods** Job costing, Batch costing, Unit costing, Process costing, Contract costing, Activity-based costing	5
Unit 6 **Cost Control** Budget and budgetary control, standard cost, variance analysis, Cost Reduction Areas: Value analysis and Value engineering, Zero Base Budgeting, Cost Volume Profit Analysis, Profit volume ratio**.**	6

The suggested list of Tutorials and Assignments:

Note: Use of computers is essential for at least one exercise.

1. Estimating weight and material cost for an assembly of three to five components.
2. Valuation of inventory by LIFO, FIFO, and Weighted average method
3. Estimating machine hour rate for representative machines – one conventional machine and one CNC lathe or machining centre.
4. Case study on estimation of overheads for a manufacturing unit
5. Study of different methods for allocation, apportionment, and absorption of overheads
6. A case study in any one industry using any of the methods of costing.
7. Different examples illustrating cost control
8. Case studies of cost reduction

General Instructions:

Note: Numerical treatment on units 1, 2, 3, 4 and 5 is essential.

Text Books:

7.	Principles & Practice of Cost Accounting – N. K. Prasad (Book Syndicate Pvt. Ltd.)
8.	A Text Book of Estimating and Costing Mechanical – J.S. Charaya & G. S. Narang (Satya Prakashan)
9.	Practical Problems in Cost Accounting- S. P.Jain and K. L Narang, Kalyani publishes New Delhi

Reference Books:

1.	Cost Accounting- S. P.Jain and K. L Narang, Kalyani publishes New Delhi
2.	Principles and Practices of Costing - Lal and Nigam, Himalaya publishing house.
3.	Cost Management: Ravi M Kishore, Taxmann Publications
4.	Costing Simplified: Wheldom Series – Brown &Owier (ELBS)
5.	Cost Accounting: B. Jawaharlal (TMH)

6.	Cost Accounting, 13/e - B. K. Bhar, (Academic Publishers, Kolkata)

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	ELECTIVE 2: INTERNET OF THINGS (IoT)		**Course Code: ME805L1**	
Teaching Scheme (Hours)		Lecture = 3 Hrs/ Week	**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	NIL			
Course Domain	Professional Elective course			

Course Objectives:

a. To illustrate key elements of mechatronics, the principle of sensor and its characteristics
b. To demonstrate the utilisation of signal processing & interface systems such as ADC, DAC, Digital I/O
c. To demonstrate the determination of the transfer function by using the block diagram reduction technique
d. To demonstrate the application of different controller modes to an industrial application
e. To demonstrate the development of ladder programming for industrial applications.

Course Outcomes:

On completion of the course, students will be able to

a. Define key elements of mechatronics, the principle of sensor and its characteristics
b. Utilize the concept of signal processing & interface systems such as ADC, DAC, Digital I/O
c. Determine the transfer function by using the block diagram reduction technique
d. Apply the concept of different controller modes to an industrial application
e. Develop the ladder programming for industrial application

CONTENT	Hours
Unit I **Introduction to mechatronics, Sensors, Actuators** Introduction to Mechatronics, Need, Applications, building blocks of a typical mechatronic system, Sensors: Types of sensors; Motion Sensors – Encoder (Absolute & incremental), Lidar, Eddy Current, Proximity (Optical, Inductive, Capacitive), MEMS Accelerometer; Temperature sensor – Thermocouple, Thermistor, RTD, Pyrometer, Infrared Thermometer; Force / Pressure Sensors – Strain gauges, Piezoelectric sensor; Flow sensors – Electromagnetic, Ultrasonic, Hotwire anemometer; Colour sensor – RGB type; Biosensors – Enzyme, ECG, EMG, Selection of Sensors, Actuators: Stepper & Servo motor; Hydraulic and Pneumatic; linear electrical actuators & Selection of Actuators	10
Unit II **Introduction to IoT** Introduction of IoT: Definition and characteristics of IoT, Technical Building blocks of IoT, Device, Communication Technologies, Data, Physical design of IoT, IoT enabling	5

technologies, IoT Issues and Challenges- Planning, Costs and Quality, Security and Privacy, Risks	
Unit III **Data Acquisition and Embedded Systems** Introduction to DAQ, Types, Components of a Data Acquisition System (Sensor, Signal conditioning, processing, controlling and storage/display/action), Data Acquisition: Signal collection, Signal conditioning – Isolation& Filtering, Amplification, Sampling, Aliasing, Sample and hold circuit, Quantization, Analog-to-digital converters (4-bit Successive Approximation type ADC), Digital-to-Analog converters (4-bit R2R type DAC), Data storage, Embedded Systems: Architecture & Characteristics of ES, Types of Embedded systems, Examples of Embedded Systems. Embedded System on Chip (SOC), Components of ES: Hardware and software Hardware components of ES: Power supply: types, characteristics, selection criteria, Processing Unit, Input devices, Output Device.	10
Unit IV **Communication under IoT** Communication under IoT Development boards: Types of boards - Arduino, Raspberry pi, Beagle bone, ESP8266, selection criteria, interfacing of sensors with development boards. Communication under IoT: IoT Protocols: MQTT, CoAP, XMPP and AMQT, IoT communication models, IoT Communication technologies: Bluetooth, BLE, Zigbee, Zwave, NFC, RFID, LiFi, wifi, Interfacing of wifi, RFID, Zigbee, NFC with a development board	5
Unit V **Machine Learning for IoT** Compact, fast Machine Learning Accelerators for IoT devices: Edge Computing on IOT Devices, IOT Based Smart Buildings, Distributed Machine Learning, Machine Learning Accelerator, Machine Learning Model Optimization, Least-Squares-Solver for Shallow Neural Network: Introduction, Algorithm Optimization, Hardware Implementation	5
Unit VI **IoT Security** Securing the Internet of Things & Security Architecture, Security and Vulnerability in the Internet of Things, IoT Node Authentication, Data Protection & Security Requirements in IoT Architecture, Security in Enabling Technologies & Existing Security Scheme for IoT, Introduction to the Use Cases and Emerging Standards and Technologies for Security and privacy in IoT	5
A suggested list of Tutorials and Assignments: • The term work shall consist of a minimum of six assignments based on each of the above-mentioned units. • Students will give seminars illustrating the fundamentals and application part of IoT. **General Instructions regarding course delivery and assessment:** • The course teacher should demonstrate with examples the various principles of IoT and Machine Learning. • Real-life examples from industry, domestic, and processing should be considered, demonstrated, and evaluated.	

Text Books:	
1.	Raj Kamal, Internet of Things: Architecture and Design Principle", ISBN-13: 978-93-5260- 522-4, McGraw Hill Education (India) 2017
2.	Securing the Internet of Things, Shancang Li Li Da Xu, Syngress, 2017, Elsevier
3.	David Hanes, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, ISBN-13: 978-1-58714-456-1, ISBN-10: 1-58714-456-5, 2017
Reference Books:	
1.	Hantao Huang, Hao Yu, "Compact and Fast Machine Learning Accelerator for IoT devices," Edition: 1st ed. Publisher: Springer Singapore Year: 2019ISBN: 978-981-13-3323- 1
2.	Raj Kamal, "Embedded Systems: Architecture, Programming and Design", 2nd Edition,• McGraw-Hill, ISBN: 13: 9780070151253
3.	Lyla B. Das, "Embedded Systems: An Integrated Approach" Pearson
4.	William Bolton, Mechatronics: Electronics Control Systems in Mechanical and Electrical Engineering, 6th Ed, 2019
5.	K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008
6.	Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	ELECTIVE 1: NANOTECHNOLOGY		**Course Code: ME805L2**	
Teaching Scheme (Hours)		Lecture = 3Hrs/ Week	**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Engineering Physics, Engineering Chemistry			
Course Domain	Open Elective Course			

Course Objectives:

a. To discuss the fundamentals of Nanotechnology
b. To introduce the various synthesis and characterization techniques involved in Nanotechnology
c. To explain the different classes of nanomaterials.
d. To review the wide applications of nanotechnology in various technological fields

Course Outcomes:

On completion of the course, students will be able to

a. Understand the fundamentals of nanotechnology
b. Understand various synthesis methods of nanomaterial.
c. Comprehend characterization techniques involved in nanotechnology
d. Recognize different classes of Nanomaterial

CONTENT	Hours
Unit 1 **Introduction To Nanotechnology** Introduction and scientific revolutions, Time and length scale in structures, Definition of a Nanosystem, Dimensionality and size dependent phenomena, Surface to volume ratio, Properties at Nano scale	8
Unit 2 **Synthesis of Nanomaterials** Top down methods, Bottom -up methods, Mechanism of self-assembly	6
Unit 3 **Characterization Techniques** Introduction, Electron microscopes, Scanning probe microscopes, Diffraction techniques, Spectroscopies	6
Unit 4 **Lithography** Introduction, Photolithography, E-beam lithography, Scanning probe lithography, Soft lithography, Nano-imprint lithography	6
Unit 5	6

Different Classes Of Nanomaterials Classification based on dimensionality ,Quantum dots, wells and wires ,Carbon-based nano materials, Carbon Nanotubes and Graphene ,Metal based nano materials ,Metal oxide based nano materials ,Nanocomposites and nanopolymers, Nanoglasses and nano ceramics, Biological nanomaterials	
Unit 6 **Applications** Medicine and health care ,Electronics, energy, Automobiles, Sports, Textiles, Space and Defense, safety issues, Nanotechnology and Environment	4

Text Books:	
1.	A Textbook of Nanoscience and Nanotechnology" T. Pradeep,, Tata McGraw Hill Education Pvt. Ltd
2.	Nanotechnology: Principles and Practices" Sulabha K. Kulkarni,, Capital Publishing Company.
Reference Books:	
1.	Introduction to Nanoscience" Stuart M. Lindsay, Oxford University Press.
2.	Nanoscale Science and Technology" Robert Kelsall, Ian Hamley, Mark Geoghegan, John Wiley and Sons.
3.	Introduction to Nanoscience and Nanotechnology" Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore, CRC Press
4.	K.E. Drexler, Nanosystems, Wiley.
5.	C.P. Poole, F. J. Owens, Introduction to Nanotechnology.
Web Resources:	
1.	http://www.nanotech-now.com/
2.	www.nanowerk.com/

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	ELECTIVE 1: MACHINE TOOL DESIGN		**Course Code: ME805L3**	
Teaching Scheme (Hours)		Lecture = 3 Hrs/ Week	**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Engineering Mechanics, Manufacturing Process, Strength of Materials, Machine design, Engineering Mathematics, Theory of Machines, Dynamics of Machinery, and IC Engines.			
Course Domain	Professional Elective			

Course Objectives:

a. To study design for drives based on power requirement.

b. To understand design procedure for machine tool structure, guide ways and slide ways.

c. To understand design of spindles, spindle supports and power screws.

d. To analyze the dynamics of machine tool.

e. To understand special features in machine tool.

Course Outcomes:

On completion of the course, students will be able to

a. Design the drives based on power requirement.

b. Design and analyze of machine tool structure, guide ways and slide ways

c. Design of spindles, spindle supports and power screws.

d. Study the dynamic characteristics of the machine tool.

e. Perform design and analyze consideration for CNC, SPM and micro-machining.

CONTENT	Hours
Unit 1 **Drives** Design considerations for drives based on continuous and intermittent requirement of power, Types and selection of motor for the drive, Regulation and range of speed based on preferred number series, geometric progression. Design of speed gear box for spindle drive and feed gear box.	6
Unit 2	6

Design of Machine Tool Structure : Analysis of forces on machine tool structure, static and dynamic stiffness. Design of beds, columns, housings, bases and tables.	
Unit 3 **Design of Guide-Ways :** Functions and types of guide ways, design criteria and calculation for slide-ways, design of hydrodynamic, hydrostatic and aerostatic slide-ways, stick-slip motion in slide ways.	6
Unit 4 **Design of Spindles, Spindle Supports and Power Screws :** Design of spindle and spindle support using deflection and rigidity analysis, analysis of anti-friction bearings, preloading of antifriction bearing. Design of power screws: Distribution of load and rigidity analysis.	6
Unit 5 **Dynamics of Machine Tools:** Dynamic characteristic of the cutting process, Stability analysis, vibrations of machine tools. Control Systems, Mechanical and Electrical, Adaptive Control System, relays, push button control, and electrical brakes, drum control.	6
Unit 6 **Special Features in Machine Tool Design:** Design considerations for SPM, NC/CNC, and micro machining, Retrofitting, Recent trends in machine tools, Design Layout of machine tool using matrices. Step-less drives. Design considerations of Step-less drives, electromechanical system of regulation, friction, and ball variators, PIV drive, Epicyclic drive, principle of self locking.	6

Text Books:	
1.	"Machine Tool Design" N.K. Mehta,, Tata McGraw Hill, ISBN 0-07-451775-9
2.	"Principles of Machine Tool"Bhattacharya and S. G. Sen., New Central Book Agency Calcutta, ISBN 81-7381-1555.
3.	"Design of Machine Tool" D. K Pal, S. K. Basu, 4th Edition. Oxford IBH 2005, ISBN 81-204-0968
Suggested Reference Books:	
1.	"Machine Tool" N. S. Acherkan, Vol. I, II, III and IV, MIR publications.
2.	"Design Principles of Metal Cutting Machine Tools" F. Koenigsberger, The Macmillan Company New York 1964
3.	"Tool Design" Cyril Donaldson, George H. Lecain and V. C. Goold,, Tata McGraw Hill, ISBN 0070153922.

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	ELECTIVE II: INDUSTRIAL AUTOMATION AND ROBOTICS		**Course Code: ME805L4**	
Teaching Scheme (Hours)	Lecture = 3 Hrs/ Week		**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites (if any)	Theory of Machines, Electrical Technology			
Course Domain	Professional Core			

Course Objectives:

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

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

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

CONTENT	Hours
Unit 1 **Introduction to Automation** Automated manufacturing systems, Fixed/programmable/flexible, Automation and Need of automation, Basic elements of automated systems- Power, program and control. Low cost automation, Economic and social aspects of automation, Advanced automation functions, Levels of automation.	6
Unit 2 **Industrial Control and Transfer Line** A. Industrial control systems in process and discrete manufacturing industries, Continuous and discrete control; Computer process control. B. Fundamentals of transfer lines, Configurations, Transfer mechanisms, Storage buffers, Control, Applications	8
Unit 3 **Assembly Automation** Assembly Automation: Types and configurations, Parts delivery at workstations, Various vibratory and non-vibratory devices for feeding and orientation, Product design for automated assembly.	8

Unit 4 **Fundamentals of Industrial Robots** Specifications and Characteristics, Criteria for selection, Robotic Control Systems: Drives, Robot Motions, Actuators, Power transmission systems, Robot controllers, Dynamic properties of robots-stability, Control resolution, Spatial resolution, Accuracy, Repeatability, Compliance, Workcell control, Interlocks	6
Unit 5 **Robotic End Effectors and Sensors** Transducers and sensors, Sensors in robotics and their classification, Touch(Tactile)sensors, Proximity and range sensors, Force and torque sensing, End Effectors-Types, grippers, Various process tools as end effectors; Robot End effectors interface, Active and passive compliance, Gripper selection and design,	7
Unit 6 **Robot Teaching** Introduction, Various teaching method, Task programming, Survey of Robot level programming languages, A Robot programs a Path in space, Motion interpolation, WAIT, SIGNAL and DELAY commands, Branching, Robot language structure, Various textual robot, Languages such as VALII, Typical programming examples such as palletizing, Loading a machine etc., Application of Robot.	7

Text Books:

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

Reference Books:

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

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	ELECTIVE 2: PRODUCTION AND OPERATION MANAGEMENT		**Course Code: ME805L5**	
Teaching Scheme (Hours)		Lecture = 3 Hrs/ Week	**Total Credits: 3**	
Evaluation Scheme (Marks)	MSE = 20 Assignment =10	SSE = 70	Total = 100	**Duration SEE: 3 Hrs**
Revision:			**Month:**	June 2023
Pre-requisites	Metallurgy, Machine Design, Engineering Economics			
Course Domain	Professional Elective			

Course Objectives:

a. To understand basic aspects of production and operations management.
b. To study various important aspects of operations strategies.
c. aTo study product design and product analysis.
d. To study capacity and aggregate planning.
e. To study management concepts for properly managing the production.

Course Outcomes:

On completion of the course, students will be able to

a. The students will have fair understanding of the role of Production / Operations Management played in business processes.
b. Streamline the production removing all the hindrances in its way by applying management techniques like operations strategies.
c. Design of new product and its analysis based on industrial requirements.
d. To apply techniques of capacity and aggregate planning as per the requirements of an organization.
e. Proper use of maintenance management, total productive maintenance and material management etc. for smooth production.

CONTENT	Hours
Unit I **Production Function:** Concept, objectives and scope of Production Management, Production types: Job production, Batch production, Project production, mass production, Production Planning and Control (PPC) - Definition, elements, Activities of production planning and production control Interrelationship of Production with other functional areas.	7
Unit II **Operations Strategy:** Strategic management process, Operations or manufacturing strategy, meaningful differentiation, Flexibility, Comparison: Traditional vs new approaches, Cost leadership, Operations strategies, key Success factors, SWOT analysis, Five force	8

model, Operations strategic action and its relationship with other functional areas of management, Operations functions role: A new concept.	
Unit III **Product Design And Development:** Product design, Organizational structure of product design and development department, Duties of product designer, factors determining the design of a product, Essentials of good design, Product life cycle, Company policy, Steps in new product design and development, Effect of competition on design, Product analysis: Marketing aspect, Product characteristics, Economic analysis, Production aspect, Tools for product development: Standardization, Simplification, Specialization, Diversification.	8
Unit IV **Capacity And Aggregate Planning:** Concept of capacity, Measurement of capacity, Measures of capacity, Factors influencing effective capacity, Capacity planning procedure, Overcapacity and under capacity factors, Aggregate planning, Aggregate planning strategies, Master production schedule (MPS), The relations of MPS with other manufacturing planning and control activities.	8
Unit V **Maintenance Management:** Objectives of good maintenance system, Functions of maintenance management, Maintenance costs, Maintenance system: Breakdown maintenance, Predictive maintenance, Preventive maintenance, Scheduled maintenance, Organization of maintenance management, Maintenance records. **Total Productive Maintenance** Introduction, Benefits of total productive maintenance (TPM), TPM management and union, TPM installation procedure, TPM goals.	8
Unit VI **Materials Management** Material management meaning, objectives, importance and functions of materials management, Duties of material manager, Organization of materials, Concept of integrated materials management, Material cycle, Purchasing, Objectives, functions of purchasing, Organization of the purchasing, Scientific Purchasing, Scientific purchasing procedure, Purchasing or buying methods, Vendor selection and rating, Evaluation of purchase performance.	8

General Instructions	
Text Books:	
1.	"Production and Operations management", S.S.Patil, N.K.Hukeri, Electrotech Publications
2.	"Production and Operations management", S.N.Chary, McGraw Hill Education
3.	"Production Management" R. Mayer, McGraw Hill
4.	"Modern Production Management" E.S. Buffa, John Wiley
5.	"Production Management" Burbridge, ELBS
6.	"Stores Management" K.S. Menon, Mac Millan
7.	"Total Quality Management" R S Naagarazan, A A Arivalagar, Publisher-New Age International.
8.	"Re-engineering the manufacturing system: applying the theory of constraints (TOC)". Stein, R. E., Marcel Dekker 1996.
9.	"Production and Operations management", S.S.Patil, N.K.Hukeri, Electrotech Publications
Reference Books:	
1.	"Production and Operations Management", Buffa. Elwood modern Wiley India,8th Edition.
2.	"Operation Management, Process and Value Chain", Krajewski and Ritzman, Malhotra Pearson Education.
3.	"Production and Operations Management", Ashwathappa, Bhat , Himalaya Publishing
4.	"Techniques of Value Analysis and Engineering", Miles Lawrence.
5.	"Operation Management Theory and Practice", Mahadevan B Pearson Education,(2007)
6.	"Operations Management" Kaither and Frazer, Cengage Publication
7.	"Production and Operation Management", Everett E. Adam and Ebert, PHI Publication, ISBN no. 9788120308381.

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	LABORATORY: AUTOMOBILE ENGINEERING		**Course Code: ME801L**	
Teaching Scheme (Hours)	Practical = 2 Hrs/ Week		**Total Credits: 1**	
Evaluation Scheme (Marks)	IOE: NIL	IPE: NIL	EOE = 50	EPE : NIL
Revision:			**Month:**	June 2023
Pre-requisites (if any)	Internal Combustion Engines, Engineering Thermodynamics and Heat and Mass Transfer			
Course Domain	Core			

Course Objectives: The Course teacher will

a. Give details components and layout of the automobile
b. To implement the knowledge obtained in theory towards working of various automobile systems
c. To study the effect of various factors on subsystems of automobiles and remedies can be proposed
d. To work out the performance of the automobile

Course Outcomes: Students will be able to

a. Explain the components and layout of the automobile
b. Apply the knowledge obtained in theory towards working of various automobile systems.
c. Examine the effect of various factors on subsystems of automobiles and remedies can be proposed.
d. Work out the performance of automobiles.

Practical List (any eight)

1. Study of Traffic Safety Driving Symbols.
2. Study and demonstration of four-wheeler chassis layout, Two-wheel and four-wheel drive layouts.
3. Assemble and Dissemble of working of any type of automobile clutch.
4. Assemble and Dissemble of the synchromesh gearbox, final drive and differential.
5. Assemble and Dissemble of working Hydraulic braking system.
6. Assemble and Dissemble of front wheel steering geometry and steering mechanism and suspension system of a four-wheeler.
7. Study and demonstration of battery, electrical starting, and charging system.
8. Visit servicing station for the study of vehicle maintenance, wheel balancing and front wheel alignment, and repairs with relevant visit report.
9. Market survey of any vehicle per student. (compulsory)

General Instructions	
Suggested Text Books:	
2.	"Motor Vehicles", Newton and Steed
3.	"Motor Manuals (Vol I to VII)", A.W. Judge., Chapman and Hall Publication.
4.	"Automobile Mechanics",W.H. Crouse.,Tata McGraw Hill Publishing Co.
5.	"Automobile Engineering", Dr. Kirpal Singh (Vol. I and II) Standard Publishers, New Delhi.

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title		LABORATORY: POWER PLANT ENGINEERING		**Course Code: ME802L**
Teaching Scheme (Hours)		Practical = 2 Hrs/ Week		**Total Credits: 1**
Evaluation Scheme (Marks)	IOE: NIL	IPE: NIL	EOE = 50	EPE : NIL
Revision:			**Month:**	June 2023
Pre-requisites (if any)	Engineering Thermodynamics, Engineering Economics			
Course Domain	Core			

Course Objectives: The Course teacher will

a. Understand the different power generation methods, its economics and global energy situation.
b. Familiarize with Equipment, Plant layout, and working principle of various power plants.
c. Understand Hydroelectric Power Plant and Non-conventional power plants.
d. Study environmental impact and economic analysis of various power plants.

Course Outcomes: Students will be able to

a. Describe the energy resources and energy systems available for the production of electric power in the India and the world.
b. Discuss construction and working of steam power plant, Gas turbine power plant, Nuclear power plant and Diesel power plant.
c. Describe construction and working principle of hydroelectric power plant, solar power plant, Wind Power plant and geothermal power plant.
d. Elaborate economic analysis and the environmental

List of Assignments/ Case Study/ Industrial Visits

a. Any three assignments covering important concepts of power plant engineering.
b. Any two case studies on principles underlying in the subject.
c. Industrial visit and detail study of any one operational power plant.

Text Books:

1.	"Power Plant Engineering" Domkundwar and Arora, Dhanpat Rai and Sons, New Delhi
2.	"Power Plant Engineering" P. K. Nag,, Tata McGraw Hill, New Delhi
3.	"Power Plant Engineering" R.K.Rajput , Laxmi Publications, New Delhi.
4.	"Power Plant Engineering", Sharma P.C. and Nagpal, McGraw Hill Education, India.

Reference Books:

1.	"Power Plant Engineering" El-Wakil M.M., McGraw Hill Education, India.
2.	"Steam and Gas turbines" R. Yadav, Central Publishing House, Allahabad.
3.	"Non-conventional energy sources" G. D. Rai, Khanna Publishers.
4.	"Power Plant Engineering", A.K. Raja, New age international publisher.

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	LABORATORY: MECHATRONICS		**Course Code: ME803L**	
Teaching Scheme (Hours)	Practical = 2 Hrs/ Week		**Total Credits: 1**	
Evaluation Scheme (Marks)	IOE: NIL	IPE: NIL	EOE = 50	EPE : NIL
Revision:			**Month:**	June 2023
Pre-requisites	Basic Electronics Engineering, Electrical Technology and Theory of Machine			
Course Domain	Core			

Practical List : Any Eight
The students should perform the following experiments. 1. Trial on sensors (minimum three) 2. Assignment on Microprocessor and Microcontroller. 3. PLC Programming on Industrial Applications based on Timers, Counters, Internal Relays (Minimum 4 applications) 4. Assignment on PLC Data handling and Fault finding, 5. Assignment on SCADA and MEMS 6. A Case study on low cost automation 7. Two Programming exercises using various commands of VAL II. 8. Demonstration of various robotic configurations. 9. Fabrication of Simple Mechatronics working project by a group of 4/5 students using hardware and suitable software. 10. Industrial visit to study Mechatronic system application/ Industrial automation and robotic application and submission of visit report
General Instructions

Text Books:	
1.	"Mechatronics and Robotics",W. Bolton, Pearson Education , 4th Edition
2.	"Mechatronics and Robotics",Mahalik, TATA McGraw Hill, (2006) Reprint
3.	"Microprocessor 8085", Gaokar Prentice Hall of India, 5th Edition
4.	"Introduction to PLC Programming" NIIT
5.	"Programmable Logical Controller", Hackworth, Pearson Education, (2008)
6.	"Programmable Logical Controller", Reis Webb, Prentice Hall of India 5th Edition.
7.	"MEMS and Microsystems", HSU Tairan, TATA McGraw Hill Publication. 1st Edition.
8.	"Automation, Production Systems and Computer Integrated Manufacturing", Groover, M.P., Pearson Education, ISBN: 81-7808-511-9 2nd Edition (2004).
Reference Books:	
1.	"Mechatronics and Robotics" Appu Kuttam, Oxford Publications, 1st Edition.
2.	"Automated Manufacturing Systems", S. Brain Morris, Tata McGraw Hill.
3.	"Mechatronics and Robotics and Microprocessor", Ramchandran, Willey India, (2009).
4.	"Mechatronics and Robotics: Integrated Mechanical Electronic System", Ramchandran , Willey India,1st Edition.
5.	"Programmable Logical Controller", Gary Dunning Cengage Learning, 3rd Edition.
6.	"Mechatronics and Robotics Source Book", N C Braga, Cengage Learning.

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	MAJOR PROJECT PHASE II			**Course Code** ME806L
Teaching Scheme (Hours)	Practical = 2 Hrs/ Week			**Total Credits:** 4
Evaluation Scheme (Marks)	IOE: NIL	IPE: 50	EOE = NIL	EPE : 100
Revision:		**Month:**		June 2023
Pre-requisites (if any)	NIL			
Course Domain	Core			

Course Objectives:

The course aims to:

a. 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.
b. Encourage creative thinking process to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Course Outcomes:

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

a. Improve the professional competency and research aptitude in relevant area.
b. 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. Same groups of Seventh Semester shall work under same faculty member of department.

Project Phase II Definition:

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

Project Phase II Term Work:

The term work under project submitted by students shall include

1. Work Diary: Work Diary maintained by group and countersigned by the guide weekly. The contents of work diary shall reflect the efforts taken by project group for
   a. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring up the project.
   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: TrimmedA4
2. Top Margin: 1.00Inch
3. Bottom Margin: 1.32Inches
4. Left Margin: 1.5Inches
5. Right Margin: 1.0Inch
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 Boldface
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:
    a) Title Sheet
    b) Certificate
    c) Acknowledgement
    d) Table of Contents.
    e) List of Figures
    f) List of Tables
        i. Introduction
        ii. Literature Survey/Theory
        iii. Design/ Fabrication/ Production/ Actual work carried out for the same and
        iv. Experimentation.
        v. Observation Results
        vi. Discussion on Result and Conclusion
12. References: References should have the following format

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

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

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

Important Notes:

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

Final Year B. Tech (Mechanical Engineering), Part VIII				
Course Title	PROFESSIONAL ETHICS		**Course Code:** ME801A	
Teaching Scheme (Hours)	Practical = 2 Hrs/ Week		**Total Credits: NIL**	
Evaluation Scheme (Marks)	IOE: NIL	IPE: NIL	EOE = NIL	EPE : NIL
Revision:		**Month:**	June 2023	
Pre-requisites				
Course Domain	Audit Course at institute level , Humanities & Social Science			

Course Objectives: The Course teacher will

a. Explain importance of engineers' connectivity with society and environment.
b. Make students aware of ethics and responsibility of engineers as professionals.
c. Make them able to undergo ethical judgments and solve problems.
d. Develop attitudes required of engineers and values shared by engineers
e. Help them practice decision making and team players.
f. Describe importance of lifelong learning.

Course Outcomes: Students will be able to

a. Realize the role of engineers towards society and environment.
b. Demonstrate ethical practices and responsibility as a professional.
c. Make ethical judgments and solve problems.
d. Get developed for engineers' attitude with sharing of values.
e. Practice decision making and team culture.
f. Follow lifelong learning attitude.

Content	Hours
Unit 1 Engineer, Society and Environment: Understanding of the relation between engineering and society/Environment. a. 1.1 Understanding of the effects and impacts of science and technology on human society. b. Understanding the effects and impacts of science and technology on the natural environment. c. Understanding the characteristics of the modern globalized world.	**7**
Unit 2 Ethics and engineering Profession: Understanding of ethics and responsibilities of engineers as Professionals. a. Understanding of the roles and responsibilities of engineers in Society. b. Understanding of the basic concepts and theories of ethics. c. Understanding the relation between law and ethics and having basic legal literacy. d. Understanding of the nature of professional ethics. e. Understanding of the purposes and roles of codes of ethics and those of conduct set by engineering societies and associations. f. Understanding of the social responsibility (SR) of organizations (companies in particular). g. Understanding of ethics in specific areas (and knowledge of concrete cases) h. Understanding the nature of ethics in research and development	**7**

Unit 3 Ethical Perception and Problem solving: Ability to make ethical judgments and solve problems. a. Understanding and application of methods to identify related factors in ethical issues and to make a structural analysis of them. b. Understanding and application of methods to analyze technical factors in ethical issues and make structural analysis of them. c. Understanding and 6application of methods to analyze organizational factors and provide organizational solutions. d. Ability to design one's conduct to solve ethical problems Based on the abilities to analyze factors gained e. Comprehensive problem-solving capability	**6**
Unit 4 Engineer's attitude and Social Responsibility: Attitude required of engineers and values shared by engineers. a. Attitude to think autonomously and independently based on an understanding of the responsibility of an engineer. b. Attitude to accept a diversity of values (recognizing the existence of the various value systems different from their own as well as the multiplicity of values). c. Attitude to share values (such as safety emphasized in the codes of ethics) to which engineers should assign paramount importance. d. Attitude and willpower to act on ethical judgments of their own.	**6**

Reference Books:	
1.	Charles D. Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 1999.
2.	Seth, M. L., "Principles of Economics", Lakshmi Narain Agarwal, Agra.
3.	Agarwal, A. N., "Indian Economy", Vikas Publishing House Pvt. Ltd., New Delhi.
4.	Datta R. and Sundharam, "Indian Economy", K. P. M., S. Chand & Co. Ltd., New Delhi