Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

Course Contents (Syllabus) for

Third Year B. Tech.
(Mechanical Engineering)
Sem - V to VI

AY 2020-21

Professional Core (Theory) Courses

Title of the Course: Applied Thermodynamics Course code: 4ME301	L	T	P	Cr
	3	0	0	3

Textbooks:

1. P. K. Nag *"Engineering Thermodynamics"*, Tata McGraw Hill Publication, 6th Edition, 2017
2. R. Yadav, *"Fundamentals of Thermodynamics"*, Central Publication house, Allahabad, Revised 7th Edition, 2011

References:

1. Cengel and Boles, *"Thermodynamics an Engineering Approach"*, Tata McGraw-Hill publication, Revised 9th Edition, 2019
2. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., *"Fundamentals of Thermodynamics"*, John Wiley and Sons, 7th Edition, 2009
3. Moran, M. J. and Shapiro, H. N., *"Fundamentals of Engineering Thermodynamics"*, John Wiley and Sons, 8th Edition, 1999

Course Objectives :

1. To learn about the first law for reacting systems and heating value of fuels.
2. To learn about gas and vapor cycles and their first law and second law efficiencies.
3. To understand about the properties of dry and wet air and the principles of psychometric.
4. To learn about gas dynamics of air flow and steam through nozzles.
5. To learn about the compressors with and without intercooling.
6. To analyze the performance of steam turbines

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Understand various practical power cycles and heat pump cycles.	II	Understanding
CO2	Recognize phenomena occurring in high speed compressible flows	II	Understanding
CO3	Analyze energy conversion in various thermal devices such as combustors, air coolers, nozzles, diffusers, steam turbines and compressors	III	Applying

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1 Combustion	6 Hrs.
Introduction to solid, liquid and gaseous fuels– stoichiometry, exhaust gas analysis- first law	

analysis of combustion reactions- heat calculations using enthalpy tables- adiabatic flame temperature- chemical equilibrium and equilibrium composition calculations using free energy	
Module 2 Power Cycles	**9 Hrs.**
Vapor power cycles: Rankine cycle with superheat, reheat and regeneration **Gas power cycles:** Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle, effect of reheat, regeneration and intercooling- combined gas and vapor power cycles **Vapor compression refrigeration cycles:** refrigerants and their properties	
Module 3 Psychrometry	**4 Hrs.**
Psychrometry: Properties of dry and wet air, use of psychrometric chart **Psychrometric processes:** involving heating/cooling and humidification/dehumidification	
Module 4 Compressible Flow	**7 Hrs.**
Fundamentals: Basics of compressible flow, stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow **Applications:** Flow of steam and refrigerant through nozzle, supersaturation- compressible flow in diffusers, efficiency of nozzle and diffuser	
Module 5 Air Compressors	**7 Hrs.**
Classification of compressor, **Reciprocating compressors:** construction, work input, necessity of cooling , isothermal efficiency, heat rejected, effect of clearance volume, volumetric efficiency, necessity of multistage, optimum intermediate pressure for minimum work required, after cooler, free air delivered, air flow measurement, capacity control. Roots blower and vane blower. **Rotodynamic Air Compressors:** Centrifugal compressor, velocity diagram, theory of operation, losses, adiabatic efficiency, effect of compressibility, diffuser, pre-whirl, pressure coefficient, slip factor, performance **Axial flow compressors:** velocity diagram, degree of reaction, polytrophic efficiency, surging, chocking, stalling, comparison with centrifugal	
Module 6 Steam Turbines	**6 Hrs**
Types of steam turbine, Analysis of steam turbines, velocity and pressure compounding of steam turbines. Numerical on steam turbine	

Module wise Measurable Students Learning Outcomes :

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

1. Understand the fundamental terms with their significance along with introduction first law of thermodynamics to chemical systems.
2. Explain different types of thermodynamic cycles through their working and comparison.
3. Understand properties of dry and wet air.
4. Understand the basics of compressible flow.
5. Explain the working of different types of compressors.
6. Analyze different types steam.

Title of the Course: Heat Transfer Course code: 4ME302	L	T	P	Cr
	3	0	0	3

Textbooks:

1. P.K. Nag, *"Heat Transfer"*, Tata McGraw Hill Publishing, 3rd Edition, 2011
2. Yunus. A. Cengel, *"Heat Transfer – A Practical Approach"*, Tata McGraw Hill,5th Edition, 2017
3. Incropera and Dewitt, *"Fundamentals of Heat and Mass Transfer"*, Wiley publications, 7th Edition, 2013

References:

1. H. Schlichting , K. Gersten, *" Boundary Layer Theory"* Springer, 8th Edition, 2000
2. K Ramesh Shah, Dusan P. Sekulic, *"Fundamentals of Heat Exchanger Design"* Wiley, 5th Edition, 2012

Course Objectives :

1. To introduce the various mechanisms of heat and mass transfer that characterizes a given physical system.
2. To make the students familiarize conservation equations along with models for heat transfer processes.
3. To prepare the students for analysis of one-dimensional steady and unsteady partial differential equations.
4. To train the students to develop representative models of real-life heat transfer processes and systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Demonstrate the basic laws of heat and mass transfer and compute heat transfer rates.	III	Applying
CO2	Analyze problems involving steady and transient state heat transfer.	IV	Analyzing
CO3	Assess the heat exchanger performance by using the LMTD and NTU.	V	Evaluating

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction	**2 Hrs**
Introduction to Heat transfer, difference between thermodynamics and heat transfer, modes of heat transfer. laws of heat transfer, thermal conductivity and coefficient of heat transfer.	.
Module 2 Conduction	**9 Hrs.**
Simple steady state problems in heat conduction, concept of thermal resistance and conductance. General equation of temperature field in three dimensional Cartesian co-ordinate systems. Application of above (one dimensional case) equation to the system of plane wall (including composite structure) as well as to the system with radial heat conduction i.e. cylinders and Sphere (including composite structures). Steady state conduction one dimensional) through extended surface (fins) of constant cross section. One dimensional steady state heat conduction with uniform heat generation, (plane wall and solid cylinder) critical radius of insulation. Concept of unsteady state heat conduction. Transient heat flow system with negligible internal resistance	
Module 3 Radiation	**9 Hrs.**
Nature of thermal radiation, definitions of absorptivity, reflectivity, transmissivity, monochromatic emissive power, total emissive power and emissivity, concept of black body and gray body, Kirchhoff laws, Wien's law and Planck's law, deduction of Stefan Boltzmann equation. Lambert's cosine rule, intensity of radiation, energy change by radiation between two black surfaces with non-absorbing medium in between and in absence of reradiating surfaces, geometric shape factor, energy exchange by radiation between two gray surfaces without absorbing medium and absence of radiation and radiosity, radiation network method, network for two surfaces	
Module 4 Free and Forced Convection	**9 Hrs.**
Mass, momentum and energy conservation equations, non-dimensional numbers, hydrodynamic and thermal boundary layers, basics of heat transfer in external and internal laminar and turbulent flows, and use of co-relations. Free Convection and use of its co-relations	
Module 5 Boiling and Condensation	**5 Hrs**
Nucleate and film boiling phenomenon: drop wise and film wise condensation, Nusselt's theory of condensation nature of heat transfer in such phenomenon. Introduction to Mass Transfer: Introduction, modes of mass transfer, analogy between heat and mass transfer, Mass diffusion, (Mass basis/Mole basis/Fick's law of diffusion)	.
Module 6 Heat Exchangers	**5 Hrs**
Exchangers, Tubular heat exchangers, Extended surface heat exchangers. Classification according to flow arrangement. Fouling factor, mean temperature difference, LMTD for parallel flow, counter flow, mean temperature for cross flow, correction factor, and special cases. The effectiveness by NTU method, effectiveness of parallel, counter flow and cross flow heat exchangers other design consideration. Heat pipe component and working principle.(Elementary treatment only) Types of Heat exchangers	.

Module wise Measurable Students Learning Outcomes :

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

1. Describe the basics modes of heat transfer and basic properties like thermal conductivity, heat transfer coefficient.
2. State Fourier's law of conductions and it's applications to Cartesian, cylindrical and polar coordinate system. Understand the thermal resistance concept, solve the problems regarding fin analysis, to draw temperature distribution along the various bodies.
3. Classify mechanisms of convection, draw profiles of boundary layers like thermal, hydraulic, and solve problems to calculate HTC.
4. Discuss basic phenomenon of radiation, laws governing to radiation, solve numerical on resistance concept of radiation and shape factor calculations.
5. Summarize concept of boiling and condensation, nusselt theory of condensation, differentiate the phenomenon of heat and mass transfer.
6. Discuss the classification of Heat Exchanger, Calculate the performance of heat exchangers by LMTD and NTU method.

Title of the Course: Manufacturing Technology Course code: 4ME303	L	T	P	Cr
	3	0	0	3

Textbooks:

1. Kalpakjian and Schmid, *"Manufacturing Processes for Engineering Materials"*, Pearson India,5th Edition, 2014
2. P.C.Shrma, *"Text Book of Production Engineering"*, S.Chand Company, New Delhi, 2008
3. P.N.Rao, *"Manufacturing Technology"*, Tata McGraw Hill, 3rd Edition, Vol.II, 2015

References:

1. Dr. B.J.Rangnath, *"Metal Cutting and Tool Design"*, Vikas Publishing, New Delhi, 2nd Edition, 2018
2. G.C.Sen, A.Bhattacharya, "Principle of Machine Tools", New Central Book agency(P) Ltd., Kolkatta,5th Edition, 2009
3. P.H.Joshi, "Jigs and Fixtures", Tata McGraw-Hill Publishing Ltd., New Delhi, 2010

Course Objectives :

1. To summarize the tooling techniques.
2. To illustrate the knowledge to students on various concepts of manufacturing technology.
3. To decide tooling and method for given scenario.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Summarize the tooling techniques.	II	Understanding
CO2	Illustrate the knowledge to students on various concepts of manufacturing technology.	III	Applying
CO3	Analyze optimum tooling and resources for given scenario.	IV	Analysing

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1 Study of Tooling	6 Hrs.
Tooling for conventional machining processes, mold and die design, press tools and their profiles, cutting tools	
Module 2 Jigs and Fixtures	**7 Hrs.**

Holding tools, Jigs and fixtures, principles, applications and design	
Module 3 Press Tools	**6 Hrs.**
Press tools – configuration, design of die and punch; principles of forging die design	
Module 4 Assembly Practices	**7 Hrs.**
Assembly practices, manufacturing and assembly, process planning, selective assembly, Material handling and devices	
Module 5 Production Planning and Control	**6 Hrs.**
Forecasting models, production planning, materials requirement planning, various control techniques	
Module 6 Inventory Management	**7 Hrs.**
Inventory Models, Economic Order Quantity, quantity discount models, deterministic and stochastic inventory models	

Module wise Measurable Students Learning Outcomes :

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

1. Select the tooling essential for manufacturing processes.
2. Implement knowledge of jigs and fixtures
3. Apply principles of press tool design and basics of forging die design.
4. Analyze methods of manufacturing and compare assembly processes.
5. Describe process planning and control and material handling objectives.
6. Elaborate Inventory Models and Economy Order Quantity.

Title of the Course: Metrology and Quality Control Course code: 4ME304	L	T	P	Cr
	2	0	0	2

Textbooks:

1. R.K. Jain, *"Engineering Metrology"*, Khanna Publisher, 2009
2. M. Mahajan, *"Statistical Quality Control"* Dhanpat Rai & Co., 2012
3. I.C. GUPTA, *"Engineering Metrology"*, Dhanpat Rai & Sons, 2018

References:

1. J.F.W. Gayler and C.R. Shotbolt, *"Metrology for Engineers"*, Cassell, 5th Edition, 2015
2. K.W.B. Sharp, *"Practical Engineering Metrology"*, Pitman London, 1st Edition 1973
3. R.C. Gupta, *"Statistical Quality Control"*, Khanna Publication, 9th Edition,1998

Course Objectives:

1. To elaborate basic concepts of metrology, various standards and methods of dimensional measurement.
2. To explain importance of measurement of various parameters of screw threads, gears and surface quality by using different tools.
3. To train the students to apply knowledge of statistical tools for analysis of quality.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Compare types of standards and methods of measurement.	II	Understanding
CO2	Utilize measuring instruments for different dimensional parameters.	III	Applying
CO3	Estimate limits of gauges and control charts.	IV	Analyzing

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1: Introduction to Metrology	**5 Hrs**
Errors in measurement, standards of measurement. Linear measurement: slip gauges and other devices of linear measurements. Angular measurement: bevel protractor, spirit level, clinometers, angle dekkor, sine bar, angle slip gauges.	
Module 2: Tolerances and Gauging	**4 Hrs.**
Unilateral and bilateral tolerances, limit and fits, types of fits, plain gauges and gauge design, interchangeability	

Module 3: Magnification and Interferometry	**4 Hrs.**
Magnification: mechanical, optical, electrical, pneumatic methods of magnification, comparator Interferometry: principles of interferometry and application in checking of flatness and height	
Module 4: Screw and Gear Inspection	**4 Hrs.**
Measurement of external threads: errors in screw threads, measurement of major, minor, effective diameters, pitch and thread angle, floating carriage diameter measuring machine. Measurement of spur gear: errors in gears, checking of individual elements and composite errors, gear tooth Vernier caliper	
Module 5: Surface Finish Measurement	**4 Hrs.**
Surface finish: Types of textures obtained during m/c operation, direction of lay, texture symbols, instruments used in surface finish assessment	
Module 6: Statistical Methods in Quality Control	**5 Hrs.**
Statistical quality control, process capability, control charts for variables and attributes, operating characteristics curves	

Module wise Measurable Students Learning Outcomes :

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

1. Use the linear and angular measurement tools.
2. Select various types of fits and design plain gauges.
3. Explore the principles of magnification and interferometry.
4. Explain importance of measurement in case of screw threads and gears.
5. Demonstrate surface finish measurement.
6. Compute process capability and control limits by using statistical tool.

Professional Core (Lab) Courses

Title of the Course: Applied Thermodynamics Lab Course code: 4ME351	L	T	P	Cr
	0	0	2	1

Textbooks:

1. P. K. Nag *"Engineering Thermodynamics"*, Tata McGraw Hill Publication, 2017, 6th Edition
2. R. Yadav, *"Fundamentals of Thermodynamics"*, Central Publication house, Allahabad, 2011, Revised 7th Edition

References:

1. Cengel and Boles, *"Thermodynamics an Engineering Approach"*, Tata McGraw-Hill publication, Revised 9th Edition, 2019
2. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., *"Fundamentals of Thermodynamics"*, John Wiley and Sons, 7th Edition, 2009
3. Moran, M. J. and Shapiro, H. N., *"Fundamentals of Engineering Thermodynamics"*, John Wiley and Sons, 8th Edition, 1999

Course Objectives :

1. To learn about of I law for reacting systems and heating value of fuels.
2. To develop the student's skills in applying the isentropic flow and normal shock to some flow systems.
3. To develop student's ability to demonstrate different power and refrigeration cycles.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Determine the adiabatic flame temperatures of different types of fuels.	II	Understanding
CO2	Understand the physics of compressible flow and its application in engineering devices.	II	Understanding
CO3	Demonstrate different power and refrigeration cycles.	III	Applying

CO-PO Mapping :

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

Lab Assessments :

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

IMP: Lab ESE is a separate head of passing.

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

Week 1 indicates starting week of Semester.

Lab activities/Lab performance shall include performing experiments, mini-project, presentations,

drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

Following practical's should be considered for ISE and ESE evaluation.

List of experiments (study type) 1. Determination of adiabatic flame temperatures for various types of fuels at specific conditions. 2. Study of factors affecting the performance of Rankine cycle through numericals. 3. Study of different psychrometric processes through numericals. 4. Study of nozzles and diffusers. 5. Study of velocity and pressure compounding in steam turbines. **List of experiments (Trial / Demonstration type)** 6. Trial on gasoline engine to understand air standard Otto cycle. 7. Trial on diesel engine to understand air standard Diesel cycle. 8. Trial on reciprocating compressor. 9. Trial of vapor compression cycle. 10. Trial of air conditioning tutor. 11. Trial on steam power plant and demonstration on Power Plant simulator. 12. Trial of Gas Power Plant on simulator.	**2 Hrs. /week**

Title of the Course: Heat Transfer Lab Course code: 4ME352	L	T	P	Cr
	0	0	2	1

Textbooks:

1. P.K. Nag, *"Heat Transfer"*, Tata McGraw Hill Publishing, 3rd Edition, 2011
2. Yunus. A. Cengel, *"Heat Transfer – A Practical Approach"*, Tata McGraw Hill,5th Edition, 2017
3. Incropera and Dewitt, *"Fundamentals of Heat and Mass Transfer"*, Wiley publications, 7th Edition, 2013

References:

1. H. Schlichting , K. Gersten, *" Boundary Layer Theory"* Springer, 8th Edition, 2000
2. K Ramesh Shah, Dusan P. Sekulic, *"Fundamentals of Heat Exchanger Design"* Wiley, 5th Edition, 2012

Course Objectives:

1. Introduce the various mechanisms of heat and mass transfer that characterizes a given physical system.
2. Formulate conservation equations along with models for heat transfer processes and use of analytical to solve one-dimensional steady and unsteady partial differential equations.
3. To develop representative models of real processes and systems and draw conclusions concerning process/system design or performance from attendant analysis.
4. To develop a professional approach to lifelong learning in design of some thermal systems to include the awareness of social and environment issues associated with engineering practices.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Understand the basic laws and concepts of Conduction, Convection and Radiation, Boiling and Condensation heat transfer.	II	Understand
CO2	Analyze problems of Radiation, Convection Heat Transfer and problems involving steady and transient state heat conduction in simple geometries.	IV	Analyze
CO3	Evaluate the heat exchanger performance by using the method of log mean temperature difference and effectiveness methods.	V	Evaluate

CO-PO Mapping :

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

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

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

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

Course Contents:

Following practical's should be considered for ISE and ESE evaluation.

Experiments

1. To find Thermal Conductivity of metal bar, insulating powder.
2. To find thermal conductivity of Composite wall and evaluate the performance of Pin fin.
3. To verify the Stefan –Boltzmann constant and find the emissivity of non-black surface.
4. To find the Heat Transfer coefficient in Natural Convention.
5. To find the Heat Transfer coefficient in Forced Convention.
6. Trial on Heat exchanger – parallel / counter flow.
7. To conduct the experiment on Pool Boiling, critical heat flux.
8. To find the Heat Transfer coefficient in Drop and film condensation.
9. Experiment on unsteady state heat transfer.
   Trial on compact heat exchanger and its performance

Demonstration / Study

1. Heat Pipe Demonstration.
2. Various applications of heat exchanger in process and food industries.
3. Visit to / Demonstration of Heat exchanger manufacturing plant/dairy plant.

Title of the Course: Metrology and Quality Control / Manufacturing Technology Lab Course code: 4ME353	L	T	P	Cr
	0	0	2	1

Textbooks:

1. Kalpakjian and Schmid, *"Manufacturing Processes for Engineering Materials"*, Pearson India, 5th Edition, 2014
2. P.C.Shrma, *"Text Book of Production Engineering"*, S. Chand Company, New Delhi, 2008
3. R.K. Jain, *"Engineering Metrology"*, Khanna Publisher, 21st Edition

References:

1. P.H.Joshi, *"Jigs and Fixtures"*, Tata McGraw-Hill Publishing Ltd., New Delhi, ISBN: 9780070680739, 2010
2. J.F.W. Gayler and C.R. Shotbolt, *"Metrology for Engineers"*, Cassell, 1990

Course Objectives:

1. To summarize the tooling techniques.
2. To illustrate the knowledge to students on various concepts of manufacturing technology.
3. To elaborate various techniques for measuring the dimensions of manufactured parts.
4. To explore the importance of measurement of various parameters of screw threads and gears.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Summarize the tooling techniques.	II	Understanding
CO2	Illustrate the knowledge on various concepts of manufacturing technology.	III	Applying
CO3	Use measuring instruments for dimensional measurement and calibration purpose.	III	Applying

CO-PO Mapping :

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

Lab Assessments :

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

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

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

Course Contents:

List of Experiments

1. To study of tool geometry.
2. To design jig and fixture.
3. To design press tool.
4. Case study of selection of material handling devices.
5. To calibrate dial gauge using dial gauge calibration tester.
6. To measure angle by using sine bar / autocollimator.
7. Trial on optical flat.
8. To measure parameters of screw thread using floating carriage diameter measuring machine.
9. To inspect gear using gear tooth Vernier caliper.
10. To use Profile projector and Tool Maker's microscope.
11. To study and use coordinate measuring machine.

Open Electives Courses

Title of the Course: Manufacturing Engineering Course code: 4OE329	L	T	P	Cr
	3	0	0	3

Textbooks:

1. Amitabha Ghosh and Asok Kumar Mallik, " Manufacturing Science" Affiliated East-West Press Pvt. Ltd., 2nd Edition, 2010
2. P. N. Rao, "*Manufacturing Technology*", Tata McGraw Hill Education, Volume I, 4th Edition, 2013
3. P. C. Sharma, "*A Textbook of Production Technology: Manufacturing Processes*", S. Chand Publications, 8th Edition, 2014

References:

1. John A. Schey, "*Introduction to Manufacturing Processes*", Tata McGraw Hill Education, Third Edition, 2000
2. S. K. Sharma, Savita Sharma, "*Manufacturing Processes*", I. K. International Publishing House Pvt. Ltd., First Edition, 2011
3. J. P. Kaushish, "*Manufacturing Processes*", PHI Learning, Second Edition, 2010

Course Objectives :

1. To introduce various engineering materials and their importance to the students
2. To make students familiar with various conventional and advanced manufacturing processes, along with their capabilities and global perspectives
3. To convey the sense of quality of manufactured product.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Identify the various Engineering Materials, and their peculiar properties with applications	I	Remember
CO2	Describe the various conventional and advanced manufacturing processes	II	Understand
CO3	Summarize the requirements of process elements and equipments and examine the Quality and Economic considerations for processes	III	Apply

CO-PO Mapping :

Civil

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

Electronics

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

Electrical

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

Computer Science and engineering

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

Information Technology

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

Assessments :

Teacher Assessment:

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

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

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

Module 1:Study of Engineering Materials	**5 Hrs.**
Classification of engineering materials, iron and steel, nonferrous materials, alloying of metals, polymers, ceramics and glasses, composite materials, smart materials, general mechanical properties of engineering materials	
Module 2: Casting	**7 Hrs.**
Classification of manufacturing processes, importance of casting as manufacturing processes, casting advantages and disadvantages, casting processes and foundry operations, types of casting, types of patterns and cores, properties of moulding sand, sand testing, casting defects	
Module 3:Metal Forming Processes	**Hrs.**
Classification of metal forming processes, rolling process, types of rolling mills, forging process,	7

Open and closed die forging, forging presses, defects, direct extrusion, indirect extrusion, wire drawing, tube drawing, sheet metal operations, types of dies	
Module 4:Metal Joining Processes	**6 Hrs.**
Soldering, Brazing, Welding, Oxy-Acetylene Welding, SMAW, GTAW, Submerged arc welding, resistance welding, friction welding, Haz, weld defects, weld quality testing	
Module 5:Machining	**6 Hrs.**
Conventional machine tools and machining processes, concept of speed, feed, and depth of cut in machining, geometry of single point cutting tool, tool life equation, introduction to economics of machining	
Module 6:Processing of Plastics and Advanced Manufacturing Processes	**7 Hrs.**
Thermosetting and thermoplastic materials, shaping of plastics by casting, blow moulding, injection moulding, introduction to non-conventional machining and 3D printing, micromachining and photo chemical machining, introduction to micromachining and photo chemical machining	

Module wise Measurable Students Learning Outcomes :

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

1. Know the various engineering materials.
2. Articulate the casting and foundry processes thoroughly with sand properties and their testing.
3. Explain the various metal forming process and sheet metal shearing dies.
4. Summarize the various metals joining process and illustrate weld quality and Non-Destructive Testing Methods.
5. Discuss the various machining operations and machine tools and estimate Tool Life and Explore the Machining Economics.
6. Elaborate Plastic Processing and classify the advanced manufacturing processes.

Title of the Course: Energy Engineering Course code: 4OE330	L	T	P	Cr
	3	0	0	3

Textbooks:

1. G. D. Rai, "*Non-Conventional Energy Sources*", Khanna Publishers, 5th Edition, 2014
2. V. M. Domkundwar, "*Solar Energy and Non-Conventional Energy Sources*", Dhanpar Rai & Co. Ltd., 1st Edition, 2010
3. R. K. Singal, "*Non-Conventional Energy Sources*", Katson Publication, 2nd Edition, Reprint, 2013

References:

1. Jhon Twidell and Tony Weir, "*Renewable Energy Resources*", Roultledge Publication, 2nd Edition, 2005
2. S. P. Sukhatme, "*Solar Energy*", McGraw Hill Publication, 4th Edition, 2017
3. G. S. Sawhney, " *Non-Conventional Resources of Energy*", PHI Publication, 5th Edition, 2012
4. Recent reports of agencies: International Energy Agency (IEA), Ministry of New and Renewable energy (MNRE), Technology and Action for Rural Advancement (TARA)

Course Objectives :

1. To introduce students about alternate energy sources, their importance, needs, global scenario and economic considerations.
2. To provide knowledge of solar, bio, wind and ocean energy plants and its design methodology.
3. To prepare the students to analyze and evaluate the performance of solar and ocean thermal energy systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Discuss global energy scenario and energy systems.	II	Understanding
CO2	Distinguish and analyze solar, wind and bio mass as alternate sources of energy.	IV	Analyzing
CO3	Assess the performance and economic considerations of energy systems.	V	Evaluating

CO-PO Mapping :

Civil

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

Electronics

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

Electrical

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

Computer Science

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

Information Technology

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

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction to Non-Conventional Energy Sources	**7 Hrs**
Introduction, Indian and global energy scenario, fossil fuels, India's energy production, consumption and demand of energy, solar energy and other non-conventional energy resources, role of alternate energy sources of worlds power generation in future	
Module 2 Solar Energy	**7 Hrs**
Extra-terrestrial solar radiation, solar radiation on earth, beam and diffused radiation, global radiation on a surface, solar radiation geometry, solar energy collectors, solar energy storage, solar pond, applications of solar energy, cooking, pumping, distillation, solar PV energy generation	
Module 3 Wind Energy Conversion Systems	**6 Hrs**
Wind data and energy estimation, availability of wind energy and wind velocity, site selection, basic wind energy conversion systems, types of wind machines, performance of wind m/c, energy storage, and applications of wind energy	
Module 4 Bio-Energy and Fuel cell	**7 Hrs**
Bio-mass and photosynthesis, biogas generation, types of biogas plants, factors affecting biogas generation, community biogas plants, biogas digester design, design of community biogas plant for a village, problems related to biogas plant Fuel cells- Design and principle of Operation of a fuel cell, Classification and types of fuel cells, Advantages and Disadvantages of Fuel Cell, Applications of Fuel Cells, Batteries- Basic Batteries Theory, Classification of Batteries	
Module 5 Ocean Energy	**6 Hrs**
Ocean thermal energy conversion (OTEC): principle of OTEC, open and closed cycle OTEC, working fluids for OTEC	

Tidal energy: principle of tide generation, tidal power plants, estimation of energy from tides, site selection for tidal power plants Wave energy: wave energy, wave energy conversion systems, energy and power from waves		
Module 6 Energy Economics and Environment	**6 Hrs**	
Life cycle costing, present worth factor, present worth of capital and maintenance cost, energy conservation opportunities, energy audit, co-generation systems, waste heat utilization, impact of conventional energy use on environment		

Module wise Measurable Students Learning Outcomes :

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

1. Summarize alternate energy resources and its need.
2. Describe solar radiation on various collectors and understand applications and storage of solar energy.
3. Explain various wind energy conversion systems and estimate wind velocity.
4. Identify volume of bio-gas digester, based on solid waste availability.
5. Articulate the various ocean energy power plants.
6. Evaluate the economic considerations of energy alternatives.

Title of the Course: Mechanisms and Machines Course code:4OE331	L	T	P	Cr
	3	0	0	3

Textbooks:

1. Ratan S.S, *"Theory of Machines"*, Tata McGraw Hill, New Delhi, 3rd Edition, 2011
2. Sadhu Singh, *"Theory of Machines"*, Pearson Education, 3rd Edition, 2011
3. H. G. Phakatkar, *"Theory of Machines I"*, Nirali Publication, 6th Edition 2012

References:

1. Thomas Bevan, *"Theory of Machines"*, CBS Publishers, New Delhi, 1st Edition, 2010.
2. J. E. Shigley, *"Theory of Machines and Mechanism"*, , McGraw Hill, New York. 4th Edition, 2011
3. G.S. Rao and R.V. Dukipatti, *"Theory of Machines and Mechanism"*, New Age International Publications Ltd. New Delhi, 2011

Course Objectives :

1. Understand the various concepts and terms used in theory of machines.
2. Study of kinematics which deals with relative motion of parts constituting a machine neglecting the forces producing the motion.
3. To study the different types of planar mechanisms and its inversions.
4. To study the graphical and analytical methods to analyze planar mechanisms and its inversions.
5. To develop mechanisms and machine for a specific application and analyze it.
6. Understand concept of friction through some simple applications.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Identify mechanism that should be used according to application and find degrees of freedom of different mechanisms.	I	Remembering
CO2	Analyze the given mechanism for its velocity and acceleration and forces.	IV	Analyzing
CO3	Select cam and follower for given application.	III	Applying

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1 Basic Concept of Mechanisms	6 Hrs.
Links, kinematics pairs (lower and higher), kinematic chain, mechanisms, inversion of	

mechanisms, types of constraints, Grubbler's criterion, slider crank chain and its inversions, double slider crank chain and it's inversions, four bar chain and it's inversions. Pantograph, Exact and approximate straight line mechanisms, Steering gear mechanisms, Hooke's joint, Demonstrate rigid body dynamics (forward and inverse kinematics) using Simulink	
Module 2 Velocity and Acceleration in Mechanisms (Graphical Methods)	**7 Hrs.**
Velocity and acceleration diagram for different mechanisms using relative velocity and acceleration method, Coriolli's component of acceleration, Klein's construction for slider crank mechanism, velocity analysis by instantaneous center method for four bar chain and slider crank chain mechanism	
Module 3 Velocity and Acceleration in Mechanisms (Vector Algebra Method)	**7 Hrs.**
Position vector of point, relative position vector, loop closure equation, velocity and acceleration analysis for slider crank chain and its inversions and four bar chain	
Module 4 Synthesis of Mechanism	**6 Hrs.**
Types of synthesis, Chebychev method to find precision points, method of position synthesis for four bar chain and slider crank mechanism –two position, three position synthesis, analytical method of synthesis by least square technique	
Module 5 Kinetic analysis and Flywheel	**7 Hrs.**
Inertia force and torque, D'Alembert's principle, dynamically equivalent system, force analysis of reciprocating engine mechanism, function of flywheel and study of turning moment diagram	
Module 6 Governors and Gears	**6 Hrs.**
Porter and Hartnell governor, controlling force and stability of governor, hunting, sensitivity, isochronisms Gear profiles, law of gearing, helical, bevel, worm, rack and pinion gears, epicyclical and regular gear train kinematics	

Module wise Measurable Students Learning Outcomes :

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

1. Identify mechanisms that are to be used according to application and find degrees of freedom of different mechanisms.
2. Analyze the given mechanism for its velocity and acceleration using graphical methods.
3. Analyze the given mechanism for its velocity and acceleration using vector method.
4. Synthesize slider crank mechanism and four bar mechanism for given input positions.
5. Analyze forces coming on engine mechanisms during motion.
6. Understand basics of governors and cams and develop cam profile.

EVEN Semester

Credit System and Evaluation Scheme

Professional Core (Theory) Courses

Title of the Course: Design of Machine Elements Course code: 4ME321	L	T	P	Cr
	3	0	0	3

Textbooks:

1. V. B. Bhandari, "*Design of Machine Elements*", Tata McGraw Hill Publication, 3rd Edition, 2008
2. J.F. Shigley, "*Mechanical Engineering Design*", McGraw Hill Publication, 8th Edition, 2008
3. R. L. Norton, "*Design of Machinery*", McGraw Hill Publication, 3rd Edition, 2003

References:

1. Timothy Wentzell, "*Machine Design*", Cengage Learning, 1st Edition, 2009
2. M. F. Spotts, T.E Shoup, Hornberger,Jayaram,Venkatesh, "*Design of Machine Elements*", Pearson Education, 8th edition, 2011
3. PSG Design Data Book, Third Edition, 1978

Course Objectives :

1. To take overview of codes, standards and design guidelines for different machine elements.
2. To explain effect of combined loading on machine elements and safety critical design.
3. To appreciate the relationships between component level design and overall machine system design and performance.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	To apply theories of failure in design of various machine elements.	III	Applying
CO2	To estimate design parameters of machine elements.	IV	Analyzing
CO3	To evaluate the performance of machine elements subjected to different loading conditions.	V	Evaluating

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1 Basics of engineering design	**6 Hrs.**
General Design process and procedure, types of loads, factor of safety- its selection and significance, theories of failure and their applications, aesthetic and ergonomic considerations in design	
Module 2 Design of shafts and accessories	**6 Hrs.**
Design of solid and hollow shafts based on elastic theories of failure, transmission and line shafts, splined shafts, types of couplings, design of muff, rigid flange and flexible bushed pin type flange couplings, design of keys and splines	
Module 3 Design of screws and joints	**7 Hrs.**
Forms of threads, design of power screws and nuts, types of induced stresses, efficiency of power screw, self-locking and overhauling properties, introduction to re -circulating ball screw. Types of welded, bolted and riveted joints, design of welded, bolted and riveted joints subjected to transverse and eccentric loads	
Module 4 Design of clutches, brakes and springs	**7 Hrs.**
Uniform pressure and wear theory, types of clutches and brakes, types of springs, stress and deflection equation for helical springs	
Module 5 Design of rolling contact bearing	**6 Hrs.**
Design and analysis of rolling contact bearings, selection of bearings from manufacturer's catalogue	
Module 6 Design of sliding contact bearing	**7 Hrs.**
Design and analysis of sliding contact bearings, hydrodynamic and hydrostatic bearings, Reynold's equation and numerical solutions using dimensionless parameters	

Module wise Measurable Students Learning Outcomes :

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

1. Apply theories of failure in design of simple machine elements.
2. Calculate stresses present in shafts and its accessories.
3. Determine motion and force transmission in power screws.
4. Design of brake, clutch and springs.
5. Select appropriate bearing for given application.
6. Calculate dependent parameters for hydrodynamic bearing.

Title of the Course: Automation in Manufacturing Course code: 4ME322	L	T	P	Cr
	3	0	0	3

Text Books:

1. Mikell P. Groover, "*Automation, Production systems and computer integrated manufacturing*", Prentice Hall, 2007
2. Serope Kalpakjain and Steven R. Schmid, "*Manufacturing Engineering and Technology*", 7th edition, Pearson, 2013
3. Ibrahim Zeid, *CAD/CAM : Theory & Practice*, 2nd edition, 2006

References:

1. Yoram Koren, "*Computer control of manufacturing system*", McGraw Hill, 1st edition, 2017
2. Webb and Reis, "*Programmable Logic Controller – Principles and Applications*", Prentice Hall of India, 5th Edition, 2002
3. Kolk R.A. and Shetty Devdas, "*Mechatronics System Design*", Thomson Learning, 2007, 3rd Edition

Course Objectives :

1. To understand the importance of automation in the of field machine tool based manufacturing.
2. To get the knowledge of various elements of manufacturing automation-CAD/CAM, sensors, pneumatics, hydraulics and CNC.
3. To understand the basics of product design and the role of manufacturing automation.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Identify basic elements of mechanical, electrical, and control systems for automation and analyze them.	III	Applying
CO2	Employ use of software's, controllers and optimization techniques for automation systems.	IV	Analyzing
CO3	Verify automation systems knowledge into various modern applications	V	Evaluating

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE

Course Contents:

Module 1 Introduction to Automation	**6 Hrs.**
Why automation, current trends, CAD, CAM, CIM; Rigid automation: Part handling, machine tools. Flexible automation: Computer control of machine tools and machining centers	
Module 2 NC and CNC	**6 Hrs.**
NC and NC part programming, CNC- adaptive control, automated material handling, assembly, flexible fixturing	
Module 3 Computer Aided design	**7 Hrs.**
Fundamentals of CAD- Hardware in CAD- Computer graphics software and data base, Geometric modeling for downstream applications and analysis methods	
Module 4 Computer Aided Manufacturing	**7 Hrs.**
CNC technology, PLC, Micro controllers, CNC-Adaptive control	
Module 5 Robotics and automation	**7 Hrs.**
Introduction to robotics, mechanical and electro mechanical systems, pneumatics and hydraulics, Illustrative examples and case studies	
Module 6 Modeling and Simulation	**6 Hrs.**
Product design, process route modeling, optimization techniques, case studies and industrial applications	

Module wise Measurable Students Learning Outcomes :

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

1. Understand meaning of automation system.
2. Understand the role of NC and CNC in product design and manufacturing.
3. Use of CAD and graphic software's in manufacturing.
4. Understand Computer Aided Manufacturing.
5. Understand different low cost automation systems.
6. Apply optimization techniques for product design and manufacturing.

Professional Core (Lab) Courses

Title of the Course: Design of machine Elements Lab Course code: 4ME371	L	T	P	Cr
	0	0	2	1

Textbooks:

1. V. B. Bhandari, "Design of Machine Elements", TMGH Publication, 3rd edition, 2008
2. J.F. Shigley, "Mechanical Engineering Design", McGraw Hill Publication, 8th Edition, 2008
3. R. L. Norton, "Design of Machinery", McGraw Hill Publication, 3rd Edition, 2003

References:

1. Timothy Wentzell, "Machine Design", Cengage Learning, First Edition, 2009
2. M. F. Spotts, T.E Shoup, Hornberger,Jayaram,Venkatesh,"Design of Machine Elements", Pearson Education, 8th edition, 2011
3. PSG Design Data Book, Third Edition, 1978

Course Objectives : The objective of the course are

1. To familiarize the students with Mechanical Engineering Design Process.
2. To explain the mathematical process required for design of mechanical systems.
3. To use the data tables for design of machine elements.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	Apply knowledge of theories of failure and other design considerations for design of springs, brakes and clutches	3	Applying
CO2	Use data tables for selection and analysis of bearings, couplings, clutches, breaks and welds.	3	Applying
CO3	Investigate stresses in machine elements	4	Analyzing

CO-PO Mapping :

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

Lab Assessment:

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

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

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

Course Contents:

Term Work contains following:-

1. Aesthetic and ergonomic considerations in product design
2. Design of shaft
3. Design of rigid / flexible flange coupling
4. Design of screw jack
5. Design of spring
6. Design of clutch
7. Design of brake
8. Bearing design and selection
9. Design of bolted / riveted / welded joints
10. Design of gears

Title of the Course: Mechanical Workshop II Course code: 4ME 372	L	T	P	Cr
	0	0	2	1

Textbooks:

1. P.C.Sharma,"Text Book of Production Engineering.", S. Chand Company, New Delhi, [ISBN:81-219-042-1-8], 2006.
2. P.H.Joshi ,"*Jigs and Fixtures*", Tata McGraw-Hill Publishing Ltd., N.Delhi, ISBN: 9780070680739 Pub.Date:Aug.-2010.
3. P.H.Joshi,"*Press Tools-Design and Construction*" ,S.Chand & Company Ltd., ISBN:81-219-2938-5, 2010.
4. A. Ghosh and A. K. Mallik, "*Manufacturing science*", PEARSON India, ISBN-13: 978-8176710633, 2010.

References:

1. W.A.J. Chapman ,"Workshop Technology"– Vol I, II & III, CBS Publication & Dist.N.Delhi,1995
2. G.C.Sen, A.Bhattacharya, "Principle of Machine Tools", New Central book agency, Kolkata,2003.
3. HMT, "*Production Technology*", Tata McGraw-Hill Pub. Ltd.,N.Delhi,2010.
4. Edward G.Hoffmann ,"*Jigs and Fixtures Design*", 5th Indian Edition, Delmar CENGAGE Learning, N.Delhi, 2011.

Course Objectives:

1. To make students aware of the various concepts and terms used in metal cutting and Machine Tools, Press- tools working and their key design aspects.
2. To impart students knowledge of thread cutting on workpiece by V-tool on Center Lathe.
3. To prepare students for design of Jigs and Fixtures in mass production.
4. To develop skill of using metrological instruments for measurement of job dimensions.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Distinguish between various terminologies of machine tools	II	Understanding
CO2	Perform various machining operations and dimensional measurements on jobs	III	Applying
CO3	Discuss the working of Die-Punch set, Metal Strip layout	IV	Evaluating

CO-PO Mapping :

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

Lab Assessment:

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

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

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

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

Course Contents:
Term work:- Performance of Job and List of Experiments

1. **Turning section**: Already finished Simple turning Job from Mechanical Workshop-Taper Turning, external threading, and Knurling on lathe machine.
2. **Milling and shaping section**: One component of Job consisting of face milling operation and making slot on shaping machine.
3. Demonstration on spur gear cutting by simple indexing method.
4. Design of press tools and calculations of economical strip layout.
5. Measurement of cutting forces in turning/milling process using tool dynamometer.
6. Demonstration on EDM, CNC, micromachining center, and laser machining.

Professional Elective (Theory) Courses

Title of the Course: Internal Combustion Engines Course code: 4ME331	L	T	P	Cr
	3	0	0	3

Textbooks:

1. Ganeshan, *"Internal Combustion Engines"*, Tata Mac Hill Publication, 4th Edition, 2017
2. John B Heywood, *"Internal Combustion Engines fundamentals"*, McGraw-Hill, Revised 2nd Edition, 2017

References:

1. F. Obert, *"Internal Combustion Engines and Air Pollution"*, In-text Educational Publishers, 1st Edition, 1973
2. Heisler H, *"Advanced Engine Technology"*, Edward Arnold, 1995

Course Objectives :

1. To familiarize with the terminology associated with IC engines and understand the basics of I. C. Engines.
2. To study Ideal /Actual Engines cycles and performance parameters such as BMEP, Torque, BSFC and their relationship to operating conditions.
3. To understand combustion, and various parameters and variables affecting it in various types of I. C. engines.
4. To understand the concept of supercharging and turbocharging. Effect of SC and TC on engine performance.
5. To study the performance characteristics and performance maps of engine.
6. To understand the emission formation, parameters affecting the emissions and techniques to reduce the same.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Relate the basic Thermodynamics, Heat Transfer with actual cycle analysis and actual losses in engines.	III	Applying
CO2	Analyzing the effect of different engine parameters i.e. combustion, fuel injection valve timing, ignition delay etc. A/F ratio, engine geometry, fuel type, on engine performance and emissions.	IV	Analyzing
CO3	Evaluating the Engine performance and select the appropriate engine type for typical applications.	V	Evaluating

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

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

Course Contents:

Module 1 Introduction and I.C. Engine Cycles	**5 Hrs.**
Introduction, Basic engine components and nomenclature, Classification of I.C. Engines. Engine cycles, Deviation of actual cycles from air standard cycles, Valve timing diagram for high and low speed engines, Port timing diagram for two strokes S.I. Engines	
Module 2 Fuel system for S.I. and C.I. Engines	**10 Hrs.**
Engine fuel requirements, Carburetor and its various systems (Float, Idling and Acceleration system, Choke, Compensating system, Economizer), Derivation and calculation of A/F ratio, Electronic Petrol injection system (MPFI). GDI concept. Requirements of fuel injection system for S.I. engines, Fuel metering, pressurizing and injecting system, Types of injection systems- Individual pump, Common rail and Distributor systems, Unit injector, Types of fuel nozzles- single hole, multi hole, pintle and pintaux, Formation of Spray, Atomization and penetration. Governing of C.I. engines, Pneumatic governors, Electronic control for diesel engine management, (Numerical on calculations of main dimensions of fuel injection system)	
Module 3 Air Induction	**3 Hrs.**
Air induction, supercharging-power required and effect on engine performance, different type of turbochargers, purpose of supercharging, thermodynamic cycle of supercharged engines, types of superchargers, turbo charging, advantages and disadvantages, limitations of supercharging for S.I. and C.I. Engines	
Module 4 Combustion in S.I. and C.I. Engines	**10 Hrs.**
Stages of combustion in S.I. engines, Ignition lag, Flame propagation, Factors affecting flame speed, Abnormal combustion, Influence of engine design and operating variables on detonation, Fuel rating, Octane number, Fuel additives, HUCR, requirements of combustion chambers of S.I. engines and its types. Stages of combustion in C.I. engines, delay period, factors affecting delay period, Abnormal combustion-Diesel knock, Influence of engine design and operating variables on diesel knock, Comparison of abnormal combustion in S I and C I engines, Cetane number, Additives, Requirements of combustion chambers for C.I. engines and its types	
Module 5 Performance, testing and selection of I.C. Engines	**7 Hrs.**
Performance parameters, Performance curves, measurement of performance parameters like torque, power, volumetric efficiency, mechanical efficiency, BSFC, brake and indicated thermal efficiencies, heat balance sheet. (numerical on engine performance). Selection of an I.C. engine for Automotive, Locomotive, Aircraft, Marine, Agriculture, Power generation based on criteria such as operating cycle, fuel used, cooling method, cylinder numbers and arrangement, speed, fuel economy and power to weight ratio	

Module 6 Engine emission and control, alternate fuels and current trends in I C Engines	5 Hrs.
S.I. engine emission (HC, CO, NOx) Control methods- ELCD, Thermal, Catalytic converters, C.I. Engines Emission (CO, NOx, Smog, Particulate), Control methods- Chemical, EGR, Standard pollution Norms. Alternative fuels for S. I. engines and C. I. engines, Blending, Use of CNG, Bio-gas, Non-edible oils, Ethanol, Methanol, Hydrogen, Electronic engine management system. Recent technology in I C Engines	

Module wise Measurable Students Learning Outcomes :

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

1. To know basic Thermodynamics and Heat Transfer with cycle analysis.
2. Ability to analyze actual cycle and actual losses in engines.
3. Recognize functioning and differences among fuel introduction systems of different engines also designs of fuel carburetor and design principles.
4. Ability to determine and understand the effects of spark timing, valve timing, A/F ratio, engine geometry, fuel type, and manifold on engine performance and emissions.
5. Ability to prepare a performance report and emissions analysis of an internal combustion engine
6. Able to plot performance characteristics curve during testing and to know about engine emissions.

Title of the Course: Energy Conservation and Management Course code: 4ME332	L	T	P	Cr
	3	0	0	3

Textbooks:

1. Witte L.C. Schmidt P.S. and Brown D.R., *"Industrial Energy Management and Utilization"*, Hemisphere Publ., Washington, 1988
2. Callaghn P.W., *"Design and Management for Energy Conservation"*, Pergamon Press, Oxford, 1981
3. Murphy W.R. and McKay G., *"Energy Management"*, Butterworths, London, 2003
4. Energy Manager Training Manual, Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2008 (available at www.energymanager training.com)

References:

1. Recent reports of agencies: International Energy Agency (IEA), Ministry of New and Renewable energy (MNRE), Technology and Action for Rural Advancement (TARA)
2. Dale R Patrick, Stephen W Fardo, *"Energy Conservation Guidebook"*, 2nd Edition, CRC Press
3. Albert Thumann, *"Handbook of Energy Audits"*, 6th Edition, The Fairmont Press
4. Bureau of Energy Efficiency Reference book: No.1, 2, 3 4

List of Open Source Software/learning website:

1. http://nptel.iitm.ac.in/
2. www.bee.com
3. www.powermin.nic.in

Course Objectives :

1. To introduce energy and power scenario, electrical systems, energy auditing, energy conservation and energy impact on environment.
2. To provide knowledge of energy management, energy auditing and energy conservation.
3. To develop skill to carry out energy audit and to suggest methodologies for energy savings.
4. To prepare the students for higher studies and research in the field of energy conservation and management.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Explain energy and power scenario, electrical systems, energy auditing, energy conservation and energy impact on environment.	II	Understanding
CO2	Carryout energy accounting and balancing.	III	Applying
CO3	Exercise energy audit and suggest methodologies for energy savings.	IV	Analyzing

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1 Introduction	**5 Hrs.**
Introduction to energy and power scenario of world; national energy consumption data, environmental aspects associated with energy utilization, energy auditing - need, types, methodology and barriers, role of energy managers, instruments for energy auditing	
Module 2 Electrical Systems	**7 Hrs.**
Components of EB billing, HT and LT supply, transformers, cable sizing, concept of capacitors, power factor improvement, harmonics, electric motors – motor efficiency computation, energy efficient motors, Illumination – Lux, Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting	
Module 3 Energy Management and Audit	**7 Hrs.**
Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering	
Module 4 Thermal Systems	**7 Hrs.**
Thermal systems, boilers, furnaces and thermic fluid heaters- efficiency computation and energy conservation measures; steam distribution and usage, steam traps, condensate recovery, flash steam utilization; insulation & refractories	
Module 5 Energy Conservation in major utilities	**7 Hrs.**
Energy conservation in major utilities, pumps, fans, blowers, compressed air systems, refrigeration& air conditioning systems, cooling towers, dg sets. energy economics- discount period, payback period, internal rate of return, net present value; life cycle costing- ESCO concept	
Module 6 Energy and environment, air pollution, climate change:	**6 Hrs.**
United nations framework convention on climate change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), clean Development Mechanism (CDM), Prototype Carbon Fund (PCF)	

Module wise Measurable Students Learning Outcomes :

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

1. Understand and analyze the energy data of industries.
2. Understand efficient electricity utilization, saving and recovery in different and electrical system.

3. Employ energy audit and conservation practices.
4. Understand efficient heat, saving and recovery in different thermal system.
5. Understand energy conservation in major mechanical utilities.
6. Learn effect of energy consumption on environment and measures to reduce it.

Title of the Course: Power Plant Engineering Course code: 4ME333	L	T	P	Cr
	3	0	0	3

Textbooks:

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

References:

1. Weisman, J., and Eckert, L., *"Modem Power Plant Engineering"*, Prentice Hall, 1st edition. 1999.
2. Kam W. Li and A. Paul Priddy, *"Power Plant System Design"*, John Wiley, 1st edition, 2018.
3. Recent reports of agencies: International Energy Agency (IEA), Ministry of New and Renewable energy (MNRE), Technology and Action for Rural Advancement (TARA)

Course Objectives :

1. To introduces the students about different power plants, energy audit and economics.
2. To prepare the students to analyze the power plants and its various parameters.
3. To develop the skill to select, analyze the power plant system and allied parameters.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Describe energy harvesting from water, fuels like coal, nuclear, diesel and hydrocarbon	I	Remembering
CO2	Distinguish and interpret the parameters related to power plants.	II	Understanding
CO3	Select the appropriate system, instruments and allied parameters based on performance, energy consumption and economics.	III	Applying

CO-PO Mapping :

Mechanical

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

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One

assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction	**5 Hrs.**
Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants	
Module 2 Hydro Electric Power Plants	**7 Hrs.**
Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants	
Module 3 Steam Power Plants	**7 Hrs.**
Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator	
Module 4 Other Power Plants	**7 Hrs.**
Basic principles and types of diesel plants, advantages and disadvantages of diesel plants ,operation performance of a diesel engine, construction and working principles of gas turbine power plants, basic components and auxiliary systems used in gas turbine power plan, different types of fuels and materials used in gas turbine power plants. Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, advantages and limitations	
Module 5 Power Plant Instrumentation and Energy Audit	**6 Hrs.**
Steam pressure and steam temperature measurement, flow measurement of feed water, fuel, air and steam with correction factor for temperature, speed measurement, level recorders, smoke density measurement, dust monitor, flue gas oxygen analyzer – analysis of impurities in feed water and steam, dissolved oxygen analyzer, ph meter-fuel analyzer, and pollution monitoring instruments, current simple methods of energy auditing	
Module 6 Power Plant Economics	**7 Hrs.**
Load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing and simple numerical	

Module wise Measurable Students Learning Outcomes :

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

1. Narrate about energy sources, supply and demand.
2. Explain different Hydro Electric Power Plants.
3. Describe steam Power Plants.
4. Summarize of different Diesel, Gas and Nuclear Power Plants.
5. Explain power Plant Instrumentation and Energy audit basics.
6. Explain the economics of power plant and categorize power plant as base and peak plant.

Title of the Course: Mechatronics Systems Course code: 4ME334	L	T	P	Cr
	3	0	0	3

Text Books:

1. Devdas Shetty & Richard A. Kolk, *"Mechatronics System Design"*, PWS Publishing Company (Thomson Learning Inc.), 2010.
2. R. K. Rajput, *"A Textbook of Mechatronics"*, S. Chand & Company Private Limited, 2007.
3. William Bolton, *"Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering"*, Prentice Hall,2010.

References:

1. Robert H. Bishop, "*Mechatronics: An Introduction*", 2006
2. Godfrey C. Onwubolu, "*Mechatronics: Principles and Applications*", 2005
3. William Bolton, *"Mechatronics: A Multidisciplinary Approach"*, Pearson Education,2008.

Course Objectives :

1. To understand the principle of automatic/ real time control systems with the help of drives, actuators, sensors and their applications in various fields.
2. To design system with the help of microprocessors, microcontroller, PLC and their applications in mechanical devices.
3. To deal with ultra-modern technologies for Industrial world.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Identify basic electrical/ electronic components to form meaningful circuits and analyze them.	II	Understanding
CO2	Employ use of sensors for various mechanical systems with electronic control systems.	III	Applying
CO3	Verify mechatronic system knowledge into various modern applications.	V	Evaluating

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

Assessment	Marks
ISE 1	10
MSE	30

ISE 2	10
ESE	50

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

Module 1 Introduction to mechatronics	**6**
Definition, philosophy and approach, integrated design issues, key elements, system design process. modeling and simulation of physical systems	**Hrs.**
Module 2 Sensors and transducers	**6**
Introduction, classification, various sensors like motion, position, force, torque, tactile, flow, temperature, ultrasonic, range etc. fiber optics in mechatronics	**Hrs.**
Module 3 Drives and actuators	**7**
Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control. Timers, counters, Nyquist Criteria, Analog to digital converters, Digital to analog converters, microprocessor architecture, microcontroller architecture, Introduction to ARDUNIO and Raspberry Pi.	**Hrs.**
Module 4 Control system	**7**
Logic gates, relay logic, contactors and relays, P, PI and PID controller, programmable logic controller architecture, programming methods, working with ladder diagram, PLC programming for various applications	**Hrs.**
Module 5 Robotics	**7**
Industrial robots and their applications, robot sub system, actuators and grippers, sensors, classification, robot architecture, pose of rigid body, coordinate transformation, Feedback and control in robots	**Hrs.**
Module 6 Advanced applications	**6**
Introduction to machine learning, deep learning, artificial intelligence (AI), machine vision system, smart factory, internet of things (IoT), cloud computing	**Hrs.**

Module wise Measurable Students Learning Outcomes :

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

1. Understand meaning of mechatronic system.
2. Understand the role of sensors, actuators and machine intelligence in product design.
3. Use of drives, actuators, embedded systems and PLC.
4. Use fundamental control systems.
5. Understand different robot applications in mechatronic systems.
6. Apply advanced mechatronic techniques for various applications.

Title of the Course: Microprocessors in Automation Course code: 4ME335	L	T	P	Cr
	3	0	0	3

Textbooks:

1. William H. Gothmann, *"Digital Electronics: An Introduction to Theory and Practice"*, PHI Learning Private Limited, 2nd Edition, 1982
2. Albert Paul Malvino, *"Digital Computer Electronics: An Introduction to Microcomputers"*, Tata McGraw-Hill Publishing Company Ltd, 3rd Edition, 2017
3. Ramesh Gaonkar, *"Microprocessor Architecture, Programming, and Applications with the 8085"*, PENRAM International Publishers, 6th Edition, 2013

References:

1. Benjamin C. Kuo, *"Digital Control Systems"*, Oxford University Press, 2nd Edition, 2007
2. Lance A. Leventhal, *"Microcomputer Experimentation with the Intel SDK-85"*, Prentice Hall, 1980
3. S. G. Tzafestas, "Microprocessors in Robotic and Manufacturing Systems", Springer Publications, 1981

Course Objectives :

1. To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller.
2. To perform the analysis and design of various digital electronic circuits.
3. To perform the assembly language programs.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Understand basics of microprocessor and its components	II	Understand
CO2	Demonstrate use of microprocessor in control and communication	III	Demonstrate
CO3	Apply digital control algorithms for signal processing	IV	Apply

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1 Introduction	7 Hrs.

Number Systems, codes, digital electronics: logic gates, combinational circuits design, flip-flops, sequential logic circuits design: counters, shift registers, introduction to 8085 functional block diagram, registers, ALU, bus systems, timing and control signals	
Module 2 Machine cycles	**7 Hrs.**
Machine cycles, instruction cycle and timing states, instruction timing diagrams, memory interfacing	
Module 3 Assembly language programming	**7 Hrs.**
Assembly language programming, addressing modes, instruction set, simple programs in 8085; concept of interrupt, need for interrupts, interrupt structure, multiple interrupt requests and their handling, programmable interrupt controller; interfacing peripherals, programmable peripheral interface (8255). Comparison with Arduino/Raspberry pie	
Module 4 Interfacing	**7 Hrs.**
Interfacing Analog to Digital Converter & Digital to Analog converter, multiplexed seven segments LED display systems, stepper motor control	
Module 5 Data communication	**6 Hrs.**
Data communication, serial data communication (8251), programmable timers (8253), 8086/ 8088 microprocessor and its advanced features. Comparison with Arduino/Raspberry pie	
Module 6 Introduction to digital control	**6 Hrs.**
Introduction to Digital Control, sampling theorem, signal conversion and processing, z transform, digital filters, implementation of digital algorithm	

Module wise Measurable Students Learning Outcomes :

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

1. Explain the applications of sequential circuits.
2. Analyze the memory interfacing circuit and specify the memory addresses of a given memory device.
3. Use different operations to write an assembly language program.
4. Explain Analog to Digital Converter & Digital to Analog converter.
5. Explain the functions of microprocessor and its components.
6. Write digital algorithm and implement it.

Title of the Course: Industrial Hydraulics and Pneumatics Course code: 4ME336	L	T	P	Cr
	3	0	0	3

Textbook:

1. S.R. Majumdar, "*Oil Hydraulic Systems-Principles and Maintenance*", Tata McGraw-Hill, New-Delhi, 2006
2. S.R. Majumdar, "*Pneumatic Systems: Principles and Maintenance*", Tata McGraw-Hill, New-Delhi, 2006

References:

1. D.A. Pease, "*Basic Fluid Power*", Prentice Hall Ltd., 1988
2. J .J. Pipenger, "*Industrial Hydraulics*". McGraw-Hill Publications, 1979
3. Goodwin, "*Power Hydraulics*".
4. Esposito A.P., "*Fluid Power*", Pearson Education Asia, 7th edition, 2005

Course Objectives :

1. To make the students to understand fundamental principles and working of hydraulic and pneumatic systems.
2. To provide the students the knowledge of construction and working of various components used in hydraulics and pneumatics
3. To prepare the students for the analysis of the different hydraulic and pneumatic circuits
4. To prepare the students to design / suggest hydraulic and pneumatic system for various industrial applications.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Explain the principles, working and applications of hydraulics and pneumatics systems and areas of applications	II	Understanding
CO2	Identify circuit components and build circuits for industrial applications with due consideration to safety and economy	III	Applying
CO3	Analyze the concept of automation through hydraulic and pneumatic systems	IV	Analyze

CO-PO Mapping :

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

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One

assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction to hydraulics	**6 Hrs.**
Classification, general features, applications of hydraulics and pneumatics in various fields of engineering, ISO / JIC Symbols, transmission of fluid power at static and dynamic states, hydraulic fluids, their properties and selection, effect of temperature on fluids, sources of contamination its control, strainers, filters, heat exchanger, seals, compatibility of seal with fluid, fluid conductors	
Module 2 Hydraulic actuators, motors and pumps	**7 Hrs.**
Actuators – linear and rotary, hydraulic motors, types of hydraulic cylinders and their mountings, calculation of piston velocity, thrust under static and dynamic operation and application, considerations of friction and inertia loads, pumps- types, classification, principal of working, power calculations, efficiency, characteristics curves, selection of pumps from vane, radial piston, axial piston, screw, ball pump etc. for various applications	
Module 3 Control of hydraulic fluid	**7 Hrs.**
Pressure control, direction control and flow control valves, principles and working of pressure control valves, direction control valves and flow control valves, meter-in and meter-out circuits and bleed off circuit	
Module 4 Accumulators, intensifiers and circuits	**6 Hrs.**
Study of accumulator, intensifier, linear and re-generation circuits with accumulator and intensifier, various hydraulic circuits, their working and applications, maintenance, troubleshooting and safety of hydraulic systems	
Module 5 Introduction to pneumatics	**7 Hrs.**
Applications of pneumatics, working principles, basic requirements of pneumatic system, comparison with hydraulic system, elements of pneumatic system, control valves in pneumatic systems - Direction control valves, check valves, flow control valves, pressure control valves, pneumatic actuators, air motors. Servicing of compressed air -Types of filters, regulators, lubricators (FRL unit)	
Module 6 Pneumatic circuits	**7 Hrs.**
Basic pneumatic circuit, impulse operation, speed control, sequencing of motion, time delay circuit and their applications, maintenance, troubleshooting and safety of pneumatic systems, Introduction to fluidics – study of simple logic gates, turbulence, amplifiers, pneumatic sensors, applications, applications of hydro-pneumatic systems, hydro-electrical systems	

Module wise Measurable Students Learning Outcomes :

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

1. Apply hydraulic and pneumatic systems, various important properties of hydraulic fluids, and their measurement. Able to understand the use and benefits of various fluids.
2. Describe different components like cylinders, pumps, valves, their applications, capacity calculations, construction details etc.

3. Identify circuit components and build circuits for industrial applications with due consideration to safety.
4. Identify different elements of pneumatic circuits, their construction details, applications and limitations.
5. Identify circuit components and build circuits for industrial pneumatic applications with due consideration to safety.
6. Explain the basic concepts and applications of fluidics, will be able to build circuits for pneumatic systems

Title of the Course: Operations Research Course code: 4ME337	L	T	P	Cr
	3	0	0	3

Textbooks:

1. Hira D.S. and Premkumar Gupta, "*Operation Research*", S. Chand and Co. Ltd., Revised Edition, 2008
2. Sharma J.K., "*Operations Research: Theory and Applications*", Macmillan publishers India Ltd., 4th Edition, 2009
3. Sharma S. D., "*Operation Research*", Kedarnath and Rannath & Co, 5th Edition, 2005

References:

1. R. Panneerselvam, "*Operations Research*", Prentice Hall India Pvt. Ltd., 2004
2. Vohra N.D., "*Quantitative Techniques in Management*", McGraw Hill, 4th Edition, 2010
3. Mahajan Manohar, "*Operations Research*", Dhanpat rai and Company Pvt. Ltd., 1st Edition 2006

Course Objectives:

1. To enable the students to formulate and solve linear and non-linear programming problems.
2. To prepare the students to use mathematical models for solving optimization problems.
3. To motivate the students to use decision making models.
4. To train the students to analyze real-world problems in view of finding opimal solutions.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Solve linear and non-linear programming problems.	III	Applying
CO2	Formulate mathematical models for real life cases.	IV	Analyzing
CO3	Select models for decision making under different constraints.	V	Evaluating

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1 Introduction of operation research and linear programming problem	**7 Hrs.**
History and development of OR, models and their applications, formulation of linear programming problem, graphical solution to LPP, simplex method for maximization and minimization	
Module 2 Duality concept and integer programming	**6 Hrs.**
Duality concept, dual simplex method for LPP, Gomery's cutting plane method for integer programming problems	
Module 3: Transportation and assignment models	**7 Hrs.**
Transportation model: Mathematical formulation, methods to obtain initial basic feasible solution, conditions for testing optimality, MODI method for testing optimality solution of balanced and unbalanced problems, degeneracy and its resolution. Assignment model: mathematical statement, balanced and unbalanced assignment problems, maximization problems, assignment with restrictions, traveling salesman problem	
Module 4: Dynamic and non-linear programming	**6 Hrs.**
Dynamic programming: Introduction, Bellman's Principle of optimality, shortest route problem, maximization problem, Cargo loading problem. Non Liner Programming: introduction, lagrangean method, Kuhn Tucker conditions for solutions of non linear programming problems	
Module 5: Decision and games theory	**7 Hrs.**
Decision theory: pay off table, opportunity loss or regret table, decisions under uncertainty, laplace criterion, maximin or minimax principle, hurcuilicz principle, decisions under risk, maximum likelihood criteria, expectation principle, expected opportunity loss or expected regret decision trees. Games theory: introduction, minimax and maximin principle, solution of zero sum two persons games, saddle point algebraic method, dominance properties, graphical method	
Module 6: Queuing and replacement model	**7 Hrs.**
Queuing model: introduction, queuing system, terminology, probability distributions in queuing models, Kendall's notation classification of queuing models, model I (M/M/I):(∞/∞/FCFS). Replacement model: replacement model for items whose maintenance cost increases with time (money value constant) and with change in money value, selection of best machine, replacement of items that fail suddenly, individual and group replacement policies	

Module wise Measurable Students Learning Outcomes :

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

1. Formulate and solve linear programming problem by graphical and simplex method.
2. Explore the concept of duality and integer programming.
3. Formulate and solve special cases of LPP such as transportation and assignment models.
4. Formulate nonlinear and dynamic programming problems.
5. Classify the decision making under the conditions of certainty, uncertainty and risk.
6. Examine the queue situations and take decisions of replacement policies.

Title of the Course: Fundamentals of Management and Economics for Engineers Course Code:4HS307	L	T	P	Cr
	4	0	0	4

Desirable Courses: Management Functions, Economics for Engineers

Textbooks:

1. Koontz and O'Donnell, Principles of Management
2. Joseph Messie, Essentials of Management
3. R. Paneerselvam, Engineering Economics, PHI Learning Pvt. Ltd.
4. Datta, Sundaram, Indian Economy, S. Chand
5. Mishra, Puri, Business Economics, Himalaya Publishing House

References:

1. Heinz Weiharich, Management, 12th Edition
2. Julie Nelson, Economics for Humans
3. Matthew Bishop, Essential Economics

Course Objectives :

1. To introduce concepts involved in management and economics.
2. To impart knowledge about practicing aspects of management and economics.
3. To develop students towards identifying rational solutions for managerial and economic problems.
4. To prepare students for working as team member and team leader.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	**Perceive** and describe management theories and approaches as well as economics terminologies.	II	Understanding
CO2	**Solve** industrial and business problems by grasping market scenario and using skills related to operations, financial and human resource management.	III	Apply
CO3	**Design** strategic plans to overcome managerial and economic difficulties faced by management of business and industrial organisations.	VI	Analyse

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

ISE 1 and ISE 2 are based on assignment/ test/ quiz/seminar/ Group discussion/ oral, etc.

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

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

Course Contents:

Module 1: Introduction to Management and its Processes	**Hrs.**
Introduction, history, characteristics, and functions of management; Different approaches to management; Administration and management; Functions and Principles of Management The Manager: functions and role; Challenges for management in global scenario.	**10**
Module 2: Leadership, Motivation and Group Dynamics	**Hrs.**
Leadership: Introduction, Characteristics, Qualities of a Successful Leader, Leadership Styles, Leadership Continuum, Contingency Approach to Leadership, Leadership Effectiveness. Motivation: Concept, Need and theories (Maslow's hierarchy of needs, Theory X and Theory Y, Herzberg's Two Factor Theory). Group Dynamics: Introduction, Classification of Group, Functions of the Groups, Principles of the Group Dynamics, Group Cohesiveness	**8**
Module 3: Functional Areas and Recent Trends in Management	**Hrs.**
Sources of funds, financial statements (Types and contents) Functions of HRM, recruitment, selection, Training-types, performance appraisal Operations management-Plant layout, production systems, site selection, productivity, inventory control and TQM Recent Trends: Change management, supply chain management, digital marketing, management in Post-Covid scenario.	**8**
Module 4: Management audit and Business/ Professional ethics	**Hrs.**
Management Audit: Objectives, need of management audit, **Business Ethics:** Need, Concept and elements, importance, characteristics & principles of business ethics, advantages of managing ethics in workplace, Ethics in business, Role of ethics in organizational culture, Challenges of business ethics and corporate leadership, Ethical principles in business – Indian perspective.	**9**
Module 5: Introduction to Economics	**Hrs.**
Basic Concepts of Economics: Definition & Scope of Economics, Few Fundamental Concepts, Demand, Supply, Equilibrium, Law of demand, Theory of Production, Theory of Cost. **Market:** Various Forms of Market, Concepts of Total Revenue, Average Revenue & Marginal Revenue, Pricing in Perfect and imperfect Competition, Applications on Basic	**9**

Concepts of Economics and Market. **Indian economics:** Features, sectors of economy, economic planning, GST	
Module 6: Engineering Economics	**Hrs.**
Elasticity of demand, Giffen goods, Demand forecasting methods, Factors of production, economies and diseconomies of scale, Utility curve, consumer surplus, break even analysis Balance of payment, GDP, National Income, PCI, GGDP Inflation-Concept, types, causes and controlling measures	**8**

Professional Elective (Lab) Courses

Title of the Course: Internal Combustion Engines Lab Course code: 4ME381	L	T	P	Cr
	0	0	2	0.5
	* Alternate week			

Textbooks:

1. Ganeshan, *"Internal Combustion Engines"*, Tata Mac Hill Publication, 2nd Edition, 1999
2. Mathur and Sharma, *"Internal Combustion Engines"*, Dhanapat Rai publication, 2nd Edition, 2000

References:

1. F. Obert, *"Internal Combustion Engines and Air Pollution"*, In-text Educational Publishers, 1st Edition, 1973
2. John B Heywood, *"Internal Combustion Engines fundamentals"*, McGraw-Hill, Revised 2nd Edition, 1988

Course Objectives :

1. To study Engines performance parameters such as BMEP, Torque, BSFC and their relationship to operating conditions.
2. To study Ideal air standard cycles and fuel/air cycles.
3. To understand roll of Parameters affecting volumetric efficiency, valve timing, port design.
4. To know about Turbocharging: compressor and turbine performance, matching components, introduction to impeller design.
5. To study combustion Processes in both spark and compression ignition engines: flame structure, cycle-to-cycle variation, knock, ignition, fuel injection, octane number, ignition delay, cetane number.
6. To study Emissions: NOx, CO, UHC, Smoke, and Catalytic converters.

Course Learning Outcomes:

CO	After the completion of the course the student should be able t	Bloom's Cognitive	
		Level	Descriptor
CO1	Understand the basics of Engine construction and working of 2 stroke , 4 stroke petrol and diesel engines.	II	Understanding
CO2	Analyze the heat balance sheet of 4 stroke petrol and Diesel Engine by taking trials.	IV	Analyzing
CO3	Evaluate the performance of Computerized multi cylinder 4 stroke engine.	V	Evaluating

CO-PO Mapping :

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

Lab Assessments :

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

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

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

Course Contents:

Term work shall contain any 5 to 6 experiments from following list :

Study group:-

1. Constructional details of I.C. Engines
2. Dismantling and assembly of I.C. Engine.
3. Study of Engine air inlet, exhaust, cooling and lubrication systems.
4. Study of Ignition system and starting system.
5. Study of carburetor and petrol injection system.
6. Study of fuel injection system of diesel engine.

Test group:-

1. Test on slow speed diesel engine.
2. Test on high speed diesel engine.
3. Test on variable speed four stroke petrol engine.
4. Morse test on multi cylinder engine.
5. Test on computerized I.C. engine test rig.
6. Measurement of I.C. engine emissions.

Title of the Course: Energy Conservation and Management Lab Course code: 4ME382	L	T	P	Cr
	0	0	2	0.5
	* Alternate week			

Textbooks:

1. Witte L.C. Schmidt P.S. and Brown D.R., *"Industrial Energy Management and Utilization"*, Hemisphere Publ., Washington, 1988.
2. Callaghn P.W., *"Design and Management for Energy Conservation"*, Pergamon Press, Oxford, 1981.
3. Murphy W.R. and McKay G., *"Energy Management"*, Butterworths, London, 1987.
4. Energy Manager Training Manual , Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at www.energymanager training.com).

References:

1. Recent reports of agencies: International Energy Agency (IEA), Ministry of New and Renewable energy (MNRE), Technology and Action for Rural Advancement (TARA)
2. Dale R Patrick, Stephen W Fardo, *"Energy Conservation Guidebook"* , 2nd Edition, CRC Press
3. Albert Thumann, *"Handbook of Energy Audits"*, 6th Edition, The Fairmont Press
4. Bureau of Energy Efficiency Reference book: No.1, 2, 3 4

List of Open Source Software/learning website:

1. http://nptel.iitm.ac.in/
2. www.bee.com
3. www.powermin.nic.in

Course Objectives :

1. To help them understand and analyze the energy data of industries.
2. To explain with problems energy accounting and balancing
3. To workout energy audit and help students to suggest methodologies for energy savings
4. To explain how to utilize the available resources in optimal ways.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Explain: energy and power scenario, electrical, mechanical systems, energy auditing, energy conservation and energy impact on environment	II	Understanding
CO2	Carryout energy accounting and balancing	III	Applying
CO3	Conduct energy audit and suggest methodologies for energy savings	IV	Analyzing

CO-PO Mapping :

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

Lab Assessments :

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

IMP: Lab ESE is a separate head of passing.

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

Week 1 indicates starting week of Semester.

Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.

The experimental lab shall have typically 8-10 experiments.

Course Contents:

Term work shall contain any 5 to 6 experiments from following list :

1. Trial on Compressor.
2. Trial on Vapour compression system
3. Trial on Vapour absorption system
4. Trial on Centrifugal pump system
5. Trial on Centrifugal blower system
6. Trail on water turbines.
7. Star rating of the refrigerator.
8. Energy management system auditing case study.
9. Electrical energy auditing and management case study.
10. Thermal energy auditing and management case study
11. Field visit of power plant.

Title of the Course: Power Plant Engineering Lab **Course code: 4ME383**	L	T	P	Cr
	0	**0**	**2**	**0.5**
	*** Alternate week**			

Textbooks:

1. EL-Wakil, *"Power plant Technology"*, M.M., McGraw Hill, 1st Edition, 1984
2. P.K. Nag , *"Power Plant Engineering"*, Tata McGraw Hill second Edition 2001
3. Domkundwar, Arora, *"Power plant Technology"*, Dhanpat Rai and Co. sixth edition 2013

References:

1. Weisman, J., and Eckert, L., *"Modem Power Plant Engineering"*, Prentice Hall, 1st edition. 1985.
2. Kam W. Li and A. Paul Priddy, *"Power Plant System Design"*, John Wiley, 1st edition, 1985.
3. Recent reports of agencies: International Energy Agency (IEA), Ministry of New and Renewable energy (MNRE), Technology and Action for Rural Advancement (TARA)

Course Objectives :

1. To introduces the students about different power plants, energy audit and economics.
2. To prepare the students to analyze the power plants and its various parameters.
3. To develop the skill to select, analyze the power plant system and allied parameters

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		Level	Descriptor
CO1	Explain the working of different power plants.	II	Understanding
CO2	Interpret the importance of energy audit and its methodology.	III	Applying
CO3	Analyze the performance characteristics of power plants.	IV	Analyzing

CO-PO Mapping :

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

Lab Assessments :

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

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

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

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

Course Contents:
Term work shall contain any 5 to 6 experiments from following list :

1. Trial on water turbine.
2. Trial on steam turbine.
3. Performance of Diesel power plant using simulator.
4. Performance of Cogeneration Boiler using simulator.
5. Performance of 210MW Coal Fired Power Plant using simulator.
6. Performing energy audit for any power plant – Case study
7. Performance of for condensate system using simulator
8. Performance of Pulveriser Fuel system using simulator
9. Economics of Power plant – Case study
10. Industrial visit to any power plant.

Title of the Course: Mechatronics System Lab Course code: 4ME384	L	T	P	Cr
	0	0	2	0.5
	* Alternate week			

Text Books:

1. Gaonkar, "*Introduction of 8085*", Penram International Publishing (I) Pvt. Ltd, 2002.
2. Hackworth J.and Hackworth D. Jr, "*Programmable Logic Controller – Programming Methods and Applications*", Pearson Education, 2006.

References:

1. "*Manufacturer's Manuals for different PLC Systems*".
2 Gary Dumming, "*Introduction to PLC*", Delmar Publication

Course Objectives :

1. To revise basic electronic/electrical concepts and understand use of basic electronics components like diodes, transistors etc. and their use in amplification and switching.
2. To Demonstrate use of sensors and their integration with microcontroller and PLC and use of microcontroller for doing various tasks.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Select appropriate electrical/ electronic components like diodes, transistors etc. to form meaningful circuits.	III	Applying
CO2	Analyse logic for operating a particular system by using a PLC or a microcontroller.	IV	Analysing

CO-PO Mapping :

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

Lab Assessment:

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

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

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

Course Contents:

Term work shall contain any 5 to 6 experiments from following list :

1. PLC based traffic control system for three, four, six road crossing.
2. PLC based programming and controlling for lift/ elevator system.
3. PLC based programming and controlling for coin counter system.
4. PLC based programming and controlling for annunciator.
5. PLC based programming and controlling for HMI.
6. PLC based programming and controlling for pick and place.
7. PLC based programming and controlling for Vending machine operation.

Title of the Course: Microprocessors in Automation Lab Course code: 4ME385	L	T	P	Cr
	0	0	2	0.5
	* Alternate week			

Textbooks:

1. William H. Gothmann, *"Digital Electronics: An Introduction to Theory and Practice"*, PHI Learning Private Limited, 2nd Edition, 1982
2. Albert Paul Malvino, *"Digital Computer Electronics: An Introduction to Microcomputers"*, Tata McGraw-Hill Publishing Company Ltd, 3rd Edition, 2017
3. Ramesh Gaonkar, *"Microprocessor Architecture, Programming, and Applications with the 8085"*, PENRAM International Publishers, 6th Edition, 2013

References:

1. Benjamin C. Kuo, *"Digital Control Systems"*, Oxford University Press, 2nd Edition, 2007
2. Lance A. Leventhal, *"Microcomputer Experimentation with the Intel SDK-85"*, Prentice Hall, 1980
3. S. G. Tzafestas, *"Microprocessors in Robotic and Manufacturing Systems"*, Springer Publications, 1981

Course Objectives :

1. To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller.
2. To acquire hands on experience on various experimental set ups.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Understand basics of microprocessor and its components	II	Understand
CO2	Demonstrate use of microprocessor in control and communication	III	Demonstrate
CO3	Apply digital control algorithms for signal processing	IV	Apply

CO-PO Mapping :

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

Lab Assessment:

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

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

Week 1 indicates starting week of Semester.
Lab activities/Lab performance shall include performing experiments, mini-project, presentations,

drawings, programming and other suitable activities, as per the nature and requirement of the lab course. The experimental lab shall have typically 8-10 experiments.

Course Contents:

Term work shall contain any 5 to 6 experiments from following list :

1. Introduction to Number Systems, codes, digital electronics: Logic Gates.
2. Examples on Boolean algebra.
3. Combinational circuits design, Flip-flops, Sequential logic circuits design.
4. Counters, Shift registers, registers.
5. ALU, Timing and control signals.
6. Analog to Digital Converter and Digital to Analog converter, Multiplexed seven segments LED display systems.
7. Interrupts and their use in control. - Pratically demonstrate use of interrupts using Arduino/Raspberry pie
8. Stepper Motor Control using Arduino/Raspberry pie. - Use PWM for speed control of DC motor, output measured motion for stepper motor
9. Serial communication and display.
10. Sampling theorem and its use. - Read data at different sampling frequencies and display the output
11. Read sensor input using Arduino/Raspberry pie (Sensors – temperature, proximity, Infrared encoder, light) and display the measured quantity
12. Signal conversion and processing in discrete domain. - Integration, differentiation, filtering, statistical processing, transform (Fourier, Cosine etc.)
13. Interfacing hardware for drives.

Title of the Course: Industrial Hydraulics and Pneumatics Lab Course code: 4ME386	L	T	P	Cr
	0	0	2	0.5
	* Alternate week			

Textbook:

1. S.R. Majumdar, "*Oil Hydraulic Systems-Principles and Maintenance*", Tata McGraw-Hill, New-Delhi, 2006
2. S.R. Majumdar, "*Pneumatic Systems: Principles and Maintenance*", Tata McGraw-Hill, New-Delhi, 2006

References:

1. D.A. Pease, "*Basic Fluid Power*", Prentice Hall Ltd., 1988
2. J .J. Pipenger, "*Industrial Hydraulics*". McGraw-Hill Publications, 1979
3. Goodwin, "*Power Hydraulics*"

Course Objectives :

1. To develop an interest in oil hydraulic and pneumatic systems.
2. To prepare the students to select an appropriate system for an industrial problem with due reference to the advantages, limitations, cost, economy, etc.
3. To design a hydraulic and pneumatic system for various applications.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Operate and control the hydraulic and pneumatic systems.	III	Applying
CO2	Design and build hydraulic and pneumatic circuits for automation.	IV	Analyzing

CO-PO Mapping :

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

Lab Assessment:

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

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

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

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

Course Contents:

Term work shall contain any 5 to 6 experiments from following list :

1. Experiments on hydraulic trainer kit with following circuits
    a. Basic hydraulic circuit for linear and rotary motion.
    b. Regenerative circuit
    c. Traverse and feed circuit
    d. Meter-in, meter-out and bleed-off circuit.
    e. Sequencing circuit with sequence valve
    f. Synchronization motion of cylinders.

2. Experiments on pneumatic trainer kit with following circuits
    a. Pneumatic circuits for linear and rotary motion
    b. Sequencing circuits of type A+ B+ A—B— and A+ B+ B— A—
    c. Sequencing of cylinders with electric and electronic control

Title of the Course: Operations Research Lab Course code: 4ME387	L	T	P	Cr
	0	0	2	0.5
	* Alternate week			

Textbooks:

1. Hira D.S. and Premkumar Gupta, "*Operation Research*", S. Chand and Co. Ltd., Revised Edition, 2008
2. Sharma J.K., "*Operations Research: Theory and Applications*", Macmillan publishers India Ltd., 4th Edition, 2009
3. Sharma S. D., "*Operation Research*", Kedarnath and Rannath & Co, 5th Edition, 2005

References:

1. R. Panneerselvam, "*Operations Research*", Prentice Hall India Pvt. Ltd., 2004
2. Vohra N.D., "*Quantitative Techniques in Management*", McGraw Hill, 4th Edition, 2010
3. Mahajan Manohar, "*Operations Research*", Dhanpat rai and Company Pvt. Ltd., 1st Edition 2006

Course Objectives:

1. To prepare the students to use mathematical models for solving optimization problems.
2. To motivate the students to use decision making models.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Formulate mathematical models for real life cases.	IV	Analyzing
CO2	Select models for decision making under different constraints.	V	Evaluating

CO-PO Mapping :

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

Lab Assessment:

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

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

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

Course Contents:

Term work shall contain any 4 to 5experiments from following list :

1. **Case study on:**
   a. Linear programming problem.
   b. Transportation model.
   c. Assignment model.
   d. Dynamic programming.
   e. Decisions under uncertainty / risk.
   f. Queuing model.

Open Electives Courses

Title of the Course: Fundamentals of Power Plant Engineering Course code: 4OE336	L	T	P	Cr
	3	0	0	3

Textbooks:

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

References:

1. Weisman, J., and Eckert, L., *"Modem Power Plant Engineering"*, Prentice Hall, 1st edition, 1999
2. Kam W. Li and A. Paul Priddy, *"Power Plant System Design"*, John Wiley, 1st edition, 2018

Course Objectives :

1. To introduce students about energy resources, cycles and types of power plants.
2. To provide knowledge of hydro, steam, nuclear and other power plants and its design methodology.
3. To prepare the students to evaluate the performance parameters and analyze economic aspects of power plants.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Describe the working of different power plants.	II	Understanding
CO2	Outline parameters for design and installation of power plants.	III	Applying
CO3	Analyze the performance and economic considerations of power plant systems.	IV	Analyzing

CO-PO Mapping :

Civil

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

Electronics

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

Electrical

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

Computer Science

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

Information Technology

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

Assessment:

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

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

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction	**5 Hrs.**
Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants	
Module 2 Hydro Electric Power Plant	**7 Hrs.**
Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants	
Module 3 Steam Power Plants	**7 Hrs.**
Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator	

Module 4 Nuclear Power plant	**5 Hrs.**
Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, working advantages and limitations	
Module 5 Other Power Plants	**7 Hrs.**
Basic principles and types of diesel plants, advantages and disadvantages of diesel plants ,operation performance of a diesel engine, construction and working principles of gas turbine power plants, basic components and auxiliary systems used in gas turbine power plant, different types of fuels and materials used in gas turbine power plants, fuel cells	
Module 6 Power Plant Economics	**7 Hrs.**
Load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-output curves, efficiency, heat rate, economic load sharing and simple numericals	

Module wise Measurable Students Learning Outcomes.

Student should be able to:

1. Narrate about energy sources, supply and demand.
2. Explain different Hydro Electric Power Plants.
3. Describe steam Power Plants.
4. Interpret the working of Nuclear Power Plants.
5. Explain the working of other power plants.
6. Explain the economics of power plant and categorize power plant as base and peak plant.

Title of the Course: Joining Technology Course code: 4OE337	L	T	P	Cr
	3	0	0	3

Textbooks:

1. Shyamal Mukherjee, "*Metal Fabrication Technology*", PHI Learning, 1st Edition, 2010
2. P. C. Sharma, "*A Textbook of Production Technology", Manufacturing Processes*", S. Chand Publications, 3rd Edition, 2007

References:

1. Roger Timings, "*Fabrication and Welding Engineering*", Elsevier, 1st Edition, 2008
2. W Kenyon, "*Welding and Fabrication*", Pitman Engineering Craft Series, 1st Edition, 1987
3. Larry Jeffus, '*Welding, Principles and Applications*', Cengage Learning, 9th Edition, 2020
4. Joseph Edward Shigley, "*Mechanical Engineering Design*", McGraw Hill Publications, 4th Edition, 1983

Course Objectives :

1. To introduce the need, importance and scope of the Fabrication in manufacturing.
2. To familiarize students with various sheet metal working and metal joining processes.
3. To excel the students with various conventional and advanced welding technologies, and welding safety.
4. To aware the students with inspection and investigation techniques of the weld joint and metal weld-ability.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Summarize the Mechanical Properties of Metal and various sheet metal forming processes	II	Understanding
CO2	Calculate shearing force, bending allowance and strength of the joints	III	Applying
CO3	Investigate Welding Defects, Weld-Testing Procedures and distinguish between various joining processes	IV	Analyze

CO-PO Mapping :

Civil

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

Electronics

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

Electrical

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

Computer Science

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

Information Technology

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

Assessments :

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

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

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

Course Contents:

Module 1 Introduction to fabrication	**6 Hrs.**
Need and importance of fabrication industries and their scope, review of mechanical properties of metal, general fabrication procedure / Steps	
Module 2 Sheet metal working	**6 Hrs.**
Various sheet metal operations, shearing force, bending, spring-back effect, compensation for spring-back, bending allowances, stretch forming, spinning, swaging, deep drawing	
Module 3 Adhesive bonding and mechanical fastenings	**7 Hrs.**
Adhesive bonding of metals, types of adhesives, effect of temperature on adhesives, adhesive bonding capabilities, threaded joint of metals, design of threaded joint, riveted joint of metals, design concepts of riveted joint, self-secured joints	
Module 4 Soldering, brazing and fusion welding	**7 Hrs.**
Soldering and brazing comparison with welding, applications of soldering and brazing, welding classification, comparison with riveted and bolted joints, shielded metal arc welding (SMAW), submerged arc welding (SAW), tungsten inert gas welding, metal inert gas welding,	

Oxy-Acetylene welding	
Module 5 Solid state welding and advanced welding processes	**7 Hrs.**
Resistance welding, friction welding, friction stir welding, forge welding, cold welding, laser beam welding, ion beam welding, robotic welding, overview of welding environment and safety	
Module 6 Weld analysis	**6 Hrs.**
Basic welding joint design concepts, welding defects, inspection and testing of weldments, heat affected zone [HAZ], residual stresses, weldability and welding decay	

Module wise Measurable Students Learning Outcomes :

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

1. Describe the uniqueness of fabrication technology over other manufacturing technologies, and metal properties, Procedural sequence for fabrication.
2. Explain the sheet metal shearing and forming operations.
3. Discuss the Adhesive Bonding, Bolted /Riveted joint, define the strength of Bolted and Riveted Joints.
4. Compare the process capabilities of various conventional welding technologies with each other and with other joining processes.
5. Distinguish the process capabilities of advanced welding technologies over conventional welding processes, and explain the safety-acts during welding.
6. Design the Welded joint for strength, Identify Welding Defects, Investigate the weld quality by Non-Destructive Testing.

Title of the Course: Mechanical Power Transmission Course code: 4OE338	L	T	P	Cr
	3	0	0	3

Textbooks:

1. Ratan S.S, *"Theory of Machines"*, Tata McGraw Hill, New Delhi, 3rd Edition, 2011
2. V. B. Bhandari, *"Design of Machine Elements"*, Tata McGraw Hill, 3rd Edition, 2011
3. Sadhu Singh, *"Theory of Machines"*, Pearson Education, 2nd Edition, 2009

References:

1. Thomas Bevan, *"Theory of Machines"*, CBS Publishers, New Delhi, 1st Edition, 2010
2. J. F. Shigley, *"Mechanical Engineering Design"*, McGraw Hill, New York. 4th Edition, 2011

Course Objectives :

1. To make the students familiar with stress, strain and components like shaft, gears and belt drives.
2. To calculate dimensions of shaft, gears, belt drives.
3. To design gear trains and belt transmissions.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	Understand basics of stress, strain, and components like shaft, gears and belts.	II	Understanding
CO2	Analyze gear trains of specified configuration and Select proper belt for given required applications.	IV	Analyzing
CO3	Design of gear and belt transmissions.	V	Evaluating

CO-PO Mapping :

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

Assessments :

Teacher Assessment:

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

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

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

Course Contents:

Module 1 Introduction to Strength of Material	**6 Hrs.**
Stress strain, theories of failure, shear force and bending moment diagrams for beams under transverse loading, bending stresses, torsional shear stress	

Module 2 Shafts and accessories	**6 Hrs.**
Design of solid and hollow shafts for power transmission, design of keys and couplings, universal joint Case Studies – I, selection of shapes, Co-selection of materials and shapes, case studies – II	
Module 3 Toothed Gearing	**6 Hrs.**
Gear geometry, type of gear profiles, theory of spur gear, interference in involute gear and methods of prevention, contact ratio, path of contact , center distance of gears, introduction to other types of gears	
Module 4 Gear Trains	**6 Hrs.**
Gear trains, types of gear trains, simple, compound, epicyclic reverted gear trains, tabular method of finding gear ratio of epicyclic gears, differential gears	
Module 5 Spur Gears	**10 Hrs.**
Design considerations of gears, material selection, types of gear failures, gear tooth loads, no. of teeth, face width, strength of gear teeth, static beam strength(Lewis equation.), Barth equation, dynamic tooth load (Spott's equation), wear strength (Buckingham's equation), estimation of module based on beam strength and wear strength, gear design for maximum power, methods of gear lubrication, construction of gears such as hub, web, arm, rim type etc.	
Module 6 Belt Drives	**6 Hrs.**
Types of belts, calculation of length and power trans mitted, belt tension ratio, actual tension in a running belt, centrifugal and initial tension in a belt, slip and creep of belt, selection of flat and V belt from Manufacturer's catalogue, Losses in power transmission	

Module wise Measurable Students Learning Outcomes :

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

1. Understand types of loading and types of failures.
2. Design of shafts.
3. Understand basics of gears.
4. Analyze gear trains of specified configuration.
5. Design spur and helical gears.
6. Select proper belt for specific applications.