Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering
SoE & Syllabus 2018
3rd to 8th Semester
Mechanical Engineering

28 June 2019

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

SoE No. ME-201

B.E. SCHEME OF EXAMINATION 2018-19

(Revised Scheme of Examination w.e.f. 2020-21 onward)

Mechanical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
TOTAL FIRST & SECOND SEM										47				
Third Semester														
1	3	BS	GE2201	Engineering Mathematics III	T	3	0	0	3	3	30	30	40	3
2	3	PC	ME2201	Material Science & Metallurgy	T	3	0	0	3	3	30	30	40	3
3	3	PC	ME2202	**Lab:-** Material Science & Metallurgy	P	0	0	2	2	1	0	60	40	
4	3	PC	ME2203	Manufacturing Process -I	T	3	0	0	3	3	30	30	40	3
5	3	PC	ME2204	**Lab:-** Manufacturing Process -I	P	0	0	2	2	1	0	60	40	
6	3	PC	ME2205	Mechanics of Material	T	4	0	0	4	4	30	30	40	3
7	3	PC	ME2206	**Lab:-** Mechanics of Material	P	0	0	2	2	1	0	60	40	
8	3	PC	ME2207	Kinematics of Machines	T	3	0	0	3	3	30	30	40	3
9	3	PC	ME2208	Fluid Mechanics	T	4	0	0	4	4	30	30	40	3
10	3	PC	ME2209	**Lab:-** Fluid Mechanics	P	0	0	2	2	1	0	60	40	
					TOTAL	**20**	**0**	**8**	**28**	**24**				
Fourth Semster														
1	4	BS	GE2204	Advance Mathematical Techniques	T	3	0	0	3	3	30	30	40	3
2	4	PC	ME2251	Design of Machine Elements	T	3	0	0	3	3	30	30	40	3
3	4	PC	ME2252	Engineering Thermodynamics	T	3	0	0	3	3	30	30	40	3
4	4	PC	ME2253	**Lab:-** Machine Drawing	P	0	0	2	2	1		60	40	
5	4	PC	ME2254	Manufacturing Process-II	T	3	0	0	3	3	30	30	40	3
6	4	PC	ME2255	**Lab:-** Manufacturing Process-II	P	0	0	2	2	1		60	40	
7	4	PC	ME2256	Mechanical measurement & Metrology	T	4	0	0	4	4	30	10	60	3
8	4	PC	ME2257	**Lab:-** Mechanical measurement & Metr	P	0	0	2	2	1		60	40	
					TOTAL	**16**	**0**	**6**	**22**	**19**				
Audit Courses														
1	4	HS	GE2121	Env Studies for 4 Sem. CV,ME,EE,IT	A	3	0	0	3	0				

MSEs* = Two MSEs of 15 Marks each will conducted and marks of of these 2 MSEs will be considered for Continuous Assessment

TA ** = for Theory : 12 marks on lecture quizzes, 12 marks on two TA2 activitied decided by course teacher, 2 marks on class attendance and 4 marks on TA4 activities

TA = for Practical : MSPA will be 15 marks each**

Chairperson	Dean (Acad. Matters)	June 2020	1.02
		Date of Release	Version

Applicable for AY 2020-21 Onwards

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Mechanical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
Fifth Semester														
1	5	HS	GE2311	Fundamental of Management	**T**	3	0	0	3	3	30	30	40	3
2	5	PC	ME2301	Heat Transfer	**T**	3	0	0	3	3	30	30	40	3
3	5	PC	ME2302	**Lab:-** Heat Transfer	**P**	0	0	2	2	1		60	40	
4	5	PC	ME2303	Dynamics of Machines	**T**	3	0	0	4	3	30	30	40	3
5	5	PC	ME2304	**Lab:-** Dynamics of Machines	**P**	0	0	2	2	1		60	40	
6	5	PC	ME2305	Production Management	**T**	3	0	0	3	3	30	30	40	3
7	5	OE		Open Elective - I *	**T**	3	0	0	3	3	30	30	40	3
8	5	OE		Open Elective - II *	**T**	3	0	0	3	3	30	30	40	3
9	5	STR	ME2310	**Industry Visit and its report**	**P**	0	0	0	0	1		100		
					TOTAL	**18**	**0**	**4**	**23**	**21**				

Open Electives -I

1	5	OE	ME2331	OE I : Operations Research Techniques
2	5	OE	ME2332	OE I : Automobile Engineering
3	5	OE	ME2333	OE I : Control System Engineering
4	5	OE	ME2334	OEI: Robotics and Subtractive Manufacturing

Open Electives -II

4	5	OE	ME2341	OE II : Total Quality Management
5	5	OE	ME2342	OE II : Reliability Engineering
6	5	OE	ME2343	OE II : Power Generation Engineering
7	5	OE	ME2344	OE II : Project Evaluation & Management

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TA = for Practical : MSPA will be 15 marks each**

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Mechanical Engineering

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						L	T	P	Hrs		MSEs*	TA**	ESE	
Sixth Semester														
1	6	HS	GE2312	Fundamental of Economics	**T**	3	0	0	3	3	30	30	40	3
2	6	PC	ME2351	Fluid Machines	**T**	3	0	0	3	3	30	30	40	3
3	6	PC	ME2352	**Lab:-** Fluid Machines	**P**	0	0	2	2	1		60	40	
4	6	PC	ME2353	Computer Aided Design (CAD LAB)	**P**	0	0	2	2	1		60	40	
5	6	PC	ME2354	Design of Mechanical Drives	**T**	3	0	0	3	3	30	30	40	3
6	6	PE-I		Professional Elective I	**T**	3	0	0	3	3	30	30	40	3
7	6	PE-I		**Lab:- Professional Elective I**	**P**	0	0	2	2	1		60	40	
8	6	OE-III		Open Elective - III **	**T**	3	0	0	3	3	30	30	40	3
9	6	OE-IV		Open Elective - IV **	**T**	3	0	0	3	3	30	30	40	3
				TOTAL		**18**	**0**	**6**	**24**	**21**				
Audit Courses														
1	6	IT	IT1121	Industrial Programmin Language	**A**	3	0	0	3	0				

Professional Electives -I

1	6	PE-I	ME2361	PE I : Finite Element Methods
	6	PE-I	ME2362	PE I : Lab:- Finite Element Methods
2	6	PE-I	ME2363	PE I : Computer Graphics
	6	PE-I	ME2364	PE I : Lab:- Computer Graphics
3	6	PE-I	ME2365	PE I : I.C. Engines
	6	PE-I	ME2366	PE I : Lab:- I.C. Engines
4	6	PE-I	ME2367	PE I : Refrigeration & Cryogenics
	6	PE-I	ME2368	PE I : Lab:- Refrigeration & Cryogenics
5	6	PE-I	ME2369	PE I : Computer Integrated Manufacturing
	6	PE-I	ME2370	PE I : Lab:- Computer Integrated Manufacturing
6	6	PE-I	ME2371	PE I : Mechatronics
	6	PE-I	ME2372	PE I : Lab:- Mechatronics
7	6	PE-I	ME2373	PE I : Data Structures & Algorithms
	6	PE-I	ME2374	PE I : Lab:- Data Structures & Algorithms
8	6	PE-I	ME2375	PE I : Management Information System
	6	PE-I	ME2376	PE I : Lab:- Management Information System

Open Electives -III

1	6	OE-III	ME2381	OE III : Operations Research Techniques
2	6	OE-III	ME2382	OE III : Automobile Engineering
3	6	OE-III	ME2383	OE III : Control System Engineering
4	6	OE-III	ME2384	OE III : Robotics and Subtractive Manufacturing

Open Electives -IV

1	6	OE-IV	ME2391	OE IV : Total Quality Management
2	6	OE-IV	ME2392	OE IV : Reliability Engineering
3	6	OE-IV	ME2393	OE IV : Power Generation Engineering
4	6	OE-IV	ME2394	OE IV : Project Evaluation & Management

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		June 2020	1.02
Chairperson	Dean (Acad. Matters)	Date of Release	Version

Applicable for AY 2020-21 Onwards

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Mechanical Engineering

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						L	T	P	Hrs		MSEs*	TA**	ESE	
Seventh Semester														
1	7	PC	ME2401	Automation In Production	**T**	3	0	0	3	3	30	30	40	3
2	7	PC	ME2402	**Lab:-** Automation In Production	**P**	0	0	2	2	1		60	40	
3	7	PE		Professional Elective II	**T**	3	0	0	3	3	30	30	40	3
4	7	PE		Professional Elective III	**T**	3	0	0	3	3	30	30	40	3
5	7	PE		**Lab:-** Professional Elective III	**P**	0	0	2	2	1		60	40	
6	7	PE		Professional Elective IV	**T**	3	0	0	3	3	30	30	40	3
7	7	PE		Professional Elective V	**T**	3	0	0	3	3	30	30	40	3
8	7	STR	ME2409	Mini Project	**P**	0	0	4	4	2		60	40	
9	7	STR	ME2410	Campus Recrutment Training (CRT)	**P**	0	0	0	0	2		100		
					TOTAL	**15**	**0**	**8**	**23**	**21**				
Professional Electives -II														
1	7	PE-II	ME2411	PE II : Tool Design										
2	7	PE-II	ME2412	PE II : Additive Manufacturing										
3	7	PE-II	ME2413	PE II : Fuel Cell Technology										
4	7	PE-II	ME2414	PE II : Refrigeration and Air Conditioning										
5	7	PE-II	ME2415	PE II : Material Handling Systems										
6	7	PE-II	ME2416	PE II : Reliability Engineering										
7	7	PE-II	ME2417	PE II : Advanced Manufacturing Techniques										
8	7	PE-II	ME2418	PE II : Optimization Techniques										
Professional Electives -III														
9	7	PE-III	ME2421	PE III : Vibration										
10	7	PE-III	ME2422	PE III : Lab:- Vibration										
11	7	PE-III	ME2423	PE III : Comuter Aidded Design and Manufacturing										
12	7	PE-III	ME2424	PE III : Lab:- Comuter Aidded Design and Manufacturing										
13	7	PE-III	ME2425	PE III : Vehicle Engineering										
14	7	PE-III	ME2426	PE III : Lab:- Vehicle Engineering										
15	7	PE-III	ME2427	PE III : Solar Energy and It'S Utilisation										
16	7	PE-III	ME2428	PE III : Lab:- Solar Energy and It'S Utilisation										
17	7	PE-III	ME2429	PE III : CNC & Robotics										
18	7	PE-III	ME2430	PE III : Lab:- CNC & Robotics										
19	7	PE-III	ME2433	PE III :Pipe Design Engineering										
20	7	PE-III	ME2434	PE III : Lab:- Pipe Design Engineering										
21	7	PE-III	ME2435	PE III : Earth Moving Equipments										
22	7	PE-III	ME2436	PE III : Lab:- Earth Moving Equipments										
Professional Electives -IV														
23	7	PE-IV	ME2441	PE IV : Sysnthesis of Mechanism										
24	7	PE-IV	ME2442	PE IV : Design for Manufacturing & Assembly										
25	7	PE-IV	ME2443	PE IV : Renewable Energy System										
26	7	PE-IV	ME2444	PE IV : Engineering of Plastics										
27	7	PE-IV	ME2445	PE IV : Finance & Cost Management										
28	7	PE-IV	ME2446	PE IV : Artificial Intelligence										
29	7	PE-IV	ME2447	PE IV : Maintenance Management										
30	7	PE-IV	ME2448	PE IV : Total Quality Management										
31	7	PE-IV	ME2449	PE IV : Project Evaluation & Management										
Professional Electives -V														
32	7	PE-V	ME2461	PE V : Stress Analysis										
33	7	PE-V	ME2462	PE V : Product Design and Development										
34	7	PE-V	ME2463	PE V : Power Plant Engineering										
35	7	PE-V	ME2464	PE V : Value Engineering										
36	7	PE-V	ME2465	PE V : Design of Experiments and Taguchi Methods										
37	7	PE-V	ME2466	PE V : Industrial Safety										
38	7	PE-V	ME2467	PE V : Control System Engineering										
39	7	PE-V	ME2468	PE V : Tribology										
40	7	PE-V	ME2469	PE V : Turbines										

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		June 2021	**1.03**	**Applicable for AY 2021-22 Onwards**
Chairperson	**Dean (Acad. Matters)**	**Date of Release**	**Version**	

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SoE No.
ME-201

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(Revised Scheme of Examination w.e.f. 2020-21 onward)

Mechanical Engineering

SN	Sem	Type	Sub. Code	Subject	T/P	Contact Hours				Credits	% Weightage			ESE Duration Hours
						L	T	P	Hrs		MSEs*	TA**	ESE	
Eigth Semester														
1	8	STR	ME2451	Major Project	**P**	0	0	12	12	9		60	40	
2	8	STR	ME2452	Extra curricular Activity Evaluation	**P**	0	0	0	0	1		100		
				TOTAL		**0**	**0**	**12**	**12**	**10**				
				GRAND TOTAL		**87**	**0**	**44**	**132**	**163**				

MSEs* = Two MSEs of 15 Marks each will conducted and marks of of these 2 MSEs will be considered for Continuous Assessment

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TA = for Practical : MSPA will be 15 marks each**

		June 2020	**1.02**	**Applicable for AY 2021-22 Onwards**
Chairperson	**Dean (Acad. Matters)**	**Date of Release**	**Version**	

III Semester
GE2201 - Engineering Mathematics III

Objectives	Outcomes
1. Able to find numerical solution of various mathematical equations 2. Give knowledge of Laplace transform, Z transform, Fourier transform 3. Define the periodic functions in the form of Fourier series 4. Solve partial differential equations	The student will be able to: 1. Estimate the Calculus of Numerical Function. 2. Determine transforms and inverse transforms of various functions of variables and use it to solve Mathematical equations. 3. Discuss the nature of periodic function and express it in terms of series. 4. Use appropriate method/s to solve partial differential equations.

Unit I: Finite Differences
Difference table; Operators E and Δ, Central differences, Factorials notation, Numerical differentiation and integration, Difference equations with constant coefficients. **(6 hours)**

Unit II: Laplace Transform
Laplace Transforms: Laplace transforms and their simple properties, Unit step function, inverse of Laplace transform, convolution theorem, Applications of Laplace transform to solve ordinary differential equations .**(7 hours)**

Unit III: Z-transform
Z-Transform definition and properties (with proof), inversion by partial fraction decomposition and residue theorem, Applications of Z-transform to solve difference equations with constant co-efficient. **(6 hours)**

Unit IV: Fourier Series
Periodic Functions and their Fourier series expansion, Fourier Series for even and odd function, Change of interval, half range expansions **(7 hours)**

Unit V: Partial Differential Equation
Partial Differential Equations of first order first degree i.e. Lagrange's form, linear homogeneous equations of higher order with constant coefficient. Application of variable separable method to solve first and second order partial differential equations. **(7 hours)**

Unit VI : Fourier Transform : Definition: Fourier Integral Theorem, Fourier sine and cosine integrals, Finite Fourier sine & cosine Transform Parseval's Identity, convolution Theorem**.** **(6 hours)**

Text Books:

SNo	Title	Edition	Authors	Publisher
1	Advance Engineering Mathematics	9th Edition (September 2009)	Kreyszig.	Wiley
2	Higher Engineering Mathematics	40th edition, (2010)	B.S. Grewal	Khanna Publishers (2006)
3	Advanced Engineering Mathematics	8th revised edition, 2007	H.K. Dass	Publisher: S.Chand and Company Limited

Reference Books:

SNo	Title	Edition	Authors	Publisher
1	Mathematics for Engineers	19th edition, (2007)	Chandrika Prasad.	John Wiley & Sons
2	Advanced Mathematics for Engineers	4th edition, (2006)	Chandrika Prasad	John Wiley & Sons
3	Applied Mathematics for Engineers	3rd edition, (1970)	L.A. Pipes and Harville	McGraw Hill
4	A text Book of Applied Mathematics	3rd edition, (2000)	P.N. and J.N. Wartikar	Pune Vidyarthi Griha Prakashan
5	A text book of Engineering Mathematics	Reprint 2008	N.P. Bali and Manish Goyal	Laxmi Prakashan

3rd SEMESTER

ME2201	Material Science and Metallurgy		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total		ESE Duration
	30	10	60	100		3 Hours

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
1. To impart Knowledge for analysing different Microstructure and Crystalline nature of metals.	1. Student will be able to distinguish microstructure and analyse the effect of Crystalline nature of metals
2. To impart knowledge of Iron-Iron carbide equilibrium diagram and microstructure, general properties and heat treatment practices of commercial steels and Cast Iron.	2. Student will be able to construct Iron-Iron carbide equilibrium diagram and analyse microstructure, general properties and heat treatment practices of commercial steels and Cast Iron.
3. To impart knowledge of various heat treatment processes.	3. Student will be able to analyse and implement suitable heat treatment processes
4. To impart basic knowledge of powder Metallurgy for Powder metallurgical components	4. Student will be able to perceive the basics of powder Metallurgy for powder metallurgical components.

UNIT-1:[5 hrs]

Introduction to materials, classification of materials. Properties and applications of materials. Crystalline nature of metals, specially microscopic and macroscopic examinations of metals. Alloys and solid solutions, types and their formations, modified Gibbs's phase rule, Lever rule for phase mixtures and their application in system. **[CO1]**

UNIT-2:[8 hrs]

Study of equilibrium diagrams and invariant reactions. Iron-Iron carbide equilibrium diagram, critical temperatures. Microstructure of slowly cooled steels. Estimation of carbon from microstructures; structure property relationship. Classification and applications of steels. Effect of alloying elements. **[CO 1,2]**

UNIT-3:[8 hrs]

Classification and application of plain carbon steels. Examples of alloy steel such as Hadfield Manganese Steel, ball Bearing Steels, etc.Tool Steels – Classification, composition, application and commercial heat treatment practice for HSS, Secondary hardening. Stainless Steels - Classification, composition, application and general heat treatment practice for Stainless Steels. **[CO 1,2,3]**

UNIT-4:[8 hrs]

Heat treatment and its importance. Annealing, Normalizing, Hardening, Quench Cracks, Hardenability test.
TTT diagram and its construction and related Heat Treatment Processes such as Austempering, Martempering, Patenting etc.
Retention of Austenite, Effects and elimination of retained austenite, Tempering.Case / Surface hardening treatments such as Carburising, Nitriding, Cyaniding, Carbonitriding, Flame and Induction hardening. **[CO 1,2,3]**

3rd SEMESTER

ME2201	Material Science and Metallurgy		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

UNIT-5:[8 hrs]

Cast Iron – Classification, White cast Iron, Gray Cast Iron, Nodular Cast Iron, Malleable Cast Iron, Chilled and alloy Cast Iron. (Production route, Composition, Microstructure and applications) Effects of various parameters on structure and properties of Cast Iron, Alloy cast Iron such as Ni-resist, Ni-hard.
Non-Ferrous Alloys – Study of non-ferrous alloys such as brasses (Cu-Zn diagram), Bronzes (Cu-Sn diagram), Aluminum Alloys (e.g. Al-Si & Al-Cu diagram), Bearing materials. [**CO 1,2,3]**

UNIT-6:[8 hrs]

Powder Metallurgy: Powder manufacture and Conditioning, Production of Sintered Structural Components, Self lubricating bearing, Cemented Carbides, Ceramics, Sintered Carbide cutting tools. **[CO 1,2]**

Reference books:

1	Introduction to Engineering Metallurgy	21st revised edition, 2007	Dr. B K Agrawal	Tata McgraHill
2	Introduction to Physical Metallurgy	29st revised edition, 2009	Sidney H.Avner	McGraw-Hill,1964
3	Engineering Physical Metallurgy and Heat Treatment	21st revised edition, 1988	Yu Lakhtin	Mir publishers, Moscow, Russia
4	Metallurgy for Engineers	4th Revised edition 1987	E C Rollason	E. Arnold,

3rd SEMESTER

ME2202	Lab :Material Science and Metallurgy		L=0	T=0	P=2	Credits=1
Evaluation Scheme	MSEs	TA	ESE	Total		ESE Duration
	--	40	60	100		---

Objective	Course Outcome
(1) To provide general information of material science and metallurgy to the engineering students. The student is required to understand important relationship between structure of metals and its properties.	(1)Students will be able to create specimen for metallographic examination . (2))Students will be able to analyze the microstructure and investigate various properties of ferrous and non-ferrous Materials (3) Students will be able to test different Engineering Materials

List of Practical

A set of 10 Experiments from following list to be performed.

A set of 10 Experiments from following list to be performed.

1) Study of Metallurgical Microscope. **[CO 1,2]**
2) Preparation of Specimen for metallographic examinations. **[CO 1,2]**
3) Study and drawing of microstructures of Steels. **[CO 1,2]**
4) Study and drawing of microstructures of Cast Iron.. **[CO 1,2]**
5) Study and drawing of microstructures of Non Ferrous Metals.. **[CO 1,2]**
6) Study of the effect of annealing and normalizing on properties of steels. **[CO 1,2,3]**
7) Determination of hardenability of steels by Jominy End Quench test.. **[CO 1,2,3]**
8) Tensile test on Mild Steel and Aluminum test specimen.. **[CO 1,2,3]**
9) Measurement of hardness of ferrous and non-ferrous materials with the help of Brinell hardness tester. **[CO 1,2,3]**
10) Measurement of hardness of ferrous and non-ferrous materials with the help of Vicker hardness tester. **[CO 1,2,3]**
11) Measurement of hardness of ferrous and non-ferrous materials with the help of Rockwell hardness tester. **[CO 1,2,3]**
12) Study the heat treatment of high speed steels. . **[CO 1,2,3]**
13) Study the heat treatment of stainless steel.. **[CO 1,2,3]**
14) Study of effect of alloying elements on properties of steels. **[CO 1,2,3]**
15) Study of macroscopic examinations. . **[CO 1,2,3]**
16) Study of mechanisms of quenching. . **[CO 1,2,3]**
17) Study of Pack carburizing of steel samples. . **[CO 1,2,3]**

3rd SEMESTER

ME2203	Machining Processes		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
1. To understand the basic tool geometry of cutting tool and basic machining parameters. 2. To analyse the various machining processes. 3. To identify and explain basic components and function of different machine tools. 4. To understand the application and limitations of various machining processes with regard to shape formation and surface quality.	After completion of this course, Students will be able to 1. Distinguish among various cutting tool materials and tool geometries. 2. Examine the different processes and machine tools for cylindrical surface machining. 3. Differentiate various machining processes and conditions for flat surface machining using SPCT. **4.** Justify machining processes for flat surfaces marching using MPCT.

Unit I

Mechanics of Machining And Machinability: Introduction to machining, geometry of SPCT. Mechanism of chip formation, Orthogonal and Oblique cutting, Use of chip breaker in machining, Merchant Circle (Analytical treatment expected), thermal aspects of machining, cutting temperature measurement during machining, Cutting Fluids, Machinability, Estimation of Tool life, Tool materials. [CO 1]

Unit II

Lathe: Kinematic systems and operations of lathes, attachments for various operations, machine specifications, basis for selection of cutting speed, feed and depth of cut, time estimation for turning operations such as facing, step turning, taper turning, threading, knurling. Capstan and Turret Lathe and special purpose Machines: Construction, Operation and selection of Machining Parameters, Machining Centers, Tool Heads and indexers. [CO 2]

Unit III

Shaper: Introduction, type, specification, description of machines, hydraulic drives in shapers, cutting parameters, attachments for shaper, work holding devices, shaper operations.

Planer: Introduction, specifications, description, type of planner, Mechanism for planner: Driving mechanism, feeding mechanism, planner cutting tools, cutting parameters

Slotter: Introduction, specifications, description, type of drives for slotter, types of slotting. [CO I,3]

Unit IV

Milling: Kinematic systems and operations of milling machines, attachments for Milling. Cutting parameters, Types of milling cutters, Tool geometry & their specifications. Indexing- simple, compound and differential. Screw threads and Gear Manufacturing Methods.. [CO 1,4]

Unit V

Grinding operations, grinding wheel, specifications & selection, cylindrical &centre less grinding operation, surface grinding, tool & cutter grinding, time estimation for grinding operations.

Super finishing process: Honing, Lapping, super finishing, polishing, buffing, metal spraying, galvanizing and electroplating. Process parameters and attainable grades of surface finish, surface roughness measurement. [CO 1,4]

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3rd SEMESTER

ME2203	Machining Processes	L=3	T=0	P=0	Credits=3

Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration
	30	10	60	100	3 Hours

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Unit VI

Drilling: Introduction, tools for drilling, classification of drills, twist drills, drill size and specifications, carbide tipped drills, type of drilling machines, Drilling machines operations, time estimation for drilling.
Reaming: Introduction, description of reamers, type of reaming operations.
Boring: Introduction, types of boring machine, horizontal boring machine, vertical boring machine, jig boring machine, micro boring, boring operations.
Broaching: Introduction, type of broaches, and nomenclature of broaches, type of broaching machines. [CO I1,4]

Text Books:

S. No.	Title	Authors	Edition	Publisher
1	Workshop Technology - Part I,	Chapman W.A.J	Fifth edition	CBS Publishers
2	Manufacturing Technology (Metal Cutting & Machine Tools)	P N Rao	2nd Edition (2009)	The McGraw-Hill Companies
3	Manufacturing Science	Ghosh & Malik	2nd Edition (2010)	East West
4	Workshop Technology (Volume-II)	Hajra Choudhary	2nd Edition (2012)	The McGraw-Hill Companies

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1	Manufacturing Engineering & Technology	S Kalpakjian & SR Schmid	1st Edition (2009)	Pearson Education Canada
2	Technology of machine Tools	Krar & Oswald	1st Edition (1984)	Gregg Division, McGraw-Hill
3	Manufacturing Processes	M Begman	1st Edition (1974)	Ballinger Pub. Co
4	Processes & Materials of Manufacture	R Lindberg	1st Edition (1990)	Allyn and Bacon Technology & Engineering
5	Production Technology	s. Karunakaran	1st Edition (2008)	HMT
6	Workshop Technology (Volume I & II)	Bawa	2nd Edition (2009)	The McGraw-Hill Companies

3 SEMESTER

ME2204	Lab :Machining Processes		L=0	T=0	P=2	Credits=1
Evaluation Scheme	MSEs	TA	ESE	Total	ESE Duration	
	--	40	60	100	---	

Objective	Course Outcome
1. Understand the basic tool geometry of cutting tool and Identify basic components and function of different machine tools. 2. Understand the application and limitations of various machining processes with regard to shape formation and surface quality.	fter completion of this course, Students will be able to 1. Distinguish among various cutting tool materials and tool geometries. 2. Examine the different processes and machine tools for cylindrical surface machining. 3. Differentiate various machining processes and conditions for flat surface machining using SPCT. 4. Justify machining processes for flat surfaces marching using MPCT.

LIST OF PRACTICALS:

S No	Name of Experiment
1	Demonstration of single point cutting tools, their nomenclature, geometry materials and applications. CO 1
2	Demonstration of multi point cutting tools, their nomenclature, geometry materials and applications. CO 1
3	Demonstration of working of Lathe Machine and study of its mechanism. CO 2
4	Demonstration of working of Shaper Machine and study of its mechanism CO 3
5	Demonstration of working of Milling machine and study of its mechanism. CO 4
6	Demonstration of working of Drilling machine and study of its mechanism. CO 4
7	Practical on lathe for turning , facing , step turning , taper turning and threading. CO 2
8	Practical on Shaper with exposure to auto feed. CO 3
9	Practical on milling machine for slot cutting. CO 4
10	Practical on Drilling machine for drilling. CO 4
11	Demonstration of boring operations. CO 2
12	Study of Grinding machine and super finishing processes. CO 4
13	Introduction to NC and CNC machines. CO 4

3 SEMESTER

ME2205	Mechanics of Material		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
1) The student should be able to acquire elementary knowledge of stress, strains and material properties. 2) To impart the knowledge on shear force and bending moment calculations for beams. 3) To impart the knowledge about bending and shear stress and its importance. 4) To impart basic knowledge on strain energy calculations due to various types of loads and to estimate the load carrying capacity of columns. 5) To impart basic knowledge to calculate deflection of beams. 6) To impart knowledge on the principal stresses and planes in three dimensional stress systems.	After completion of this course, Students will be able to 1) Describe the basic concepts of stress, strain and their variations under different types of loading 2) Apply the basic concepts involved in mechanics of materials, bending moment, shear force, stresses in beams to solve complex problems 3) Analyze strain, impact loading and crippling load 4) Evaluate the torsional shear stress in shaft and solve the problem on Slope and deflection in beams under different loading and support conditions.

Unit 1 **[8 hrs]**

Concept of simple stresses and strains: Introduction, Stress, strain, types of stresses, stress - strain diagram for brittle & ductile material, elastic limit, Hooks law, modulus of elasticity, modulus of rigidity, factor of safety, analysis of tapered rod, analysis of composite section, thermal stress and strain, thermal stresses with heat flow in cylinders and plates, Hertz's contact stresses. Longitudinal strain & stress, lateral stresses and strains, Poisson's ratio, volumetric stresses and strain with uni-axial, bi-axial & tri-axial loading, bulk modulus, relation between Young's modulus and modulus of rigidity, Poisson's ratio and bulk modulus. **[CO-1]**

Unit 2 **[8 hrs]**

Shear force and bending moments in Beam: Types of beam (cantilever beam, simply supported beam, overhung beam etc.), Types of loads (Concentrated and UDL), shear force and bending moment diagrams for different types of beams subjected to different types of loads, sign conventions for bending moment and shear force, shear force and bending moment diagrams for beams subjected to couple, Relation between load, shear force and bending moment. **[CO-2]**

Unit 3 **[6 hrs]**

Stresses in beams: Pure bending, theory of simple bending with assumptions & expressions for bending stress, derivation of bending equation, bending stresses in symmetrical sections, section modulus for various shapes of beam sections.
Shear stresses in beams: - Concept, derivation of shear stress distribution formula, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress. **[CO-2]**

Unit 4 **[7 hrs]**

Strain energy and impact: Concept of strain energy, derivation and use of expressions for deformation of axially loaded members under gradual sudden and impact loads. Strain energy stored in bending & torsion. Castingliano's theorem.

3 SEMESTER

ME2205	Mechanics of Material		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Column & Struts: Failure of long & short column, slenderness ratio, Euler's column theory, End conditions for column. Expression for crippling load for various end conditions of column. Effective length of column, limitations of Euler's formula, Rankine formula, Johnson's parabolic formula. **[CO-3]**

Unit 5 **[8 hrs]**

Torsion of circular shafts: Derivation of torsion equation. Torsional shear stress induced in the shaft, when it is subjected to torque. Torque transmitted by solid & hollow circular shaft. Derivation of maximum, minimum principal stresses and maximum shear stress induced in shaft when it is subjected to bending moment, torque & axial load.
Deflection of beams: Derivation of differential equation of elastic curve, Deflection & slope of cantilever, simply supported, overhung beams subjected to concentrated loads, UDL, Relation between slope, deflection & radius curvature McCauley's method, area moment method to determine deflection of beam.**[CO-4]**

Unit 6 **[8 hrs]**

Combined Stresses: Definition of principal planes & principal stresses, analytical method of determining stresses on oblique section when member is subjected to direct stresses in one plane in mutually perpendicular two planes, when member is subjected to shear stress and direct stresses in two mutually perpendicular planes, Mohr's circle for representation of stresses. Derivation of maximum and minimum principal stresses & maximum shear stresses when the member is subjected to different types of stresses simultaneously (i.e. combined stress) **[CO-1]**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1	Strength of Materials	Ramamrutham S.	16th Edition (2010)	DhanpatRai Publishing
2	Strength of Materials	Beer and Johnston	4th Edition (2009)	McGraw-Hill
	Strength of Materials	P.Purushothama and V.Ramasamy	1st Edition 2012	Pearson

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1	Strength of Materials	Timoshenko and Young	Seventh Edition1984	CSB Publisher
2	Strength of Materials	Singer F. L	4th (February 1987)	Harper and Row Publications
3	Introductionto Mechanics of Materials	Popov E.P	2nd (June 1998)	Prentice Hall Publication

3 SEMESTER

ME2206	Lab : Mechanics of Material		L=0	T=0	P=2	Credits=1
Evaluation Scheme	MSEs	TA	ESE	Total	ESE Duration	
	--	40	60	100	---	

Objective	Course Outcome
• The student should be able to acquire elementary knowledge ofstress,strainsandmaterialproperties. • To impart the knowledge on shear force and bending moment calculations for beams. • To impart the knowledge about bending and shear stress and its importance. • To impart basic knowledge on strain energy calculations due to various types of loads and to estimate the load carrying capacity of columns. • To impart basic knowledge to calculate deflection of beams. • To impart knowledge on the principal stresses and planes in three dimensional stress systems.	fter completion of this course, Students will be able to 1) Describe the basic concepts of stress, strain and their variations under different types of loading 2) Apply the basic concepts involved in mechanics of materials, bending moment, shear force, stresses in beams to solve complex problems 3) Analyze strain, impact loading and crippling load 4) Evaluate the torsional shear stress in shaft and solve the problem on Slope and deflection in beams under different loading and support conditions.

List of Practical

A set of 8 Experiments from following list to be performed.

1. Study and demonstration of Universal Testing Machine & its attachments. **[CO-1]**
2. Tension Test on mild steel on Universal Testing Machine. **[CO-1]**
3. Compression test on Aluminum on Universal Testing Machine.**[CO-1]**
4. To perform flexture test.**[CO-1,2]**
5. Izod&Charpy - Impact tests of a standard specimen. .**[CO-3]**
6. Torsion Test on Mild steel bar. **[CO-4]**
7. To study the spring testing machine and perform the compression test on open coil helical spring. **[CO-3]**
8. To study the Rockwell hardness testing machine & perform the hardness test.**[CO-1]**
9. Assignments: Drawing sheet on shear force & bending Moment diagrams for a given loading (At least four problems.) **[CO-2]**
10. Estimation of principal stresses and maximum shear strain for a given combined loading by analytical & Mohr's circle method. (At least two problems).**[CO-4]**
11. Experiment on fatigue analysis. **[CO-4]**

3 SEMESTER

ME2207	Kinematics of Machinery		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
• To provide a study of understanding the concept of kinematics in Mechanisms and machines to students of mechanical engineering though the theoretical principles involved have immediate application to practical problems • To provides the foundation for the study of displacements, velocities, accelerations and static and dynamic forces. Required for the proper design of mechanical linkages, cams and geared systems.	1) Students should be able to understand the mechanical system, mechanism its components, relative between them. 2) Students should be able to determine the relative velocity & Acceleration of a kinematic link of a given mechanism and various forces coming on links in static condition. 3) Students should be able to identify the motion as per the application & draw the profile of a cam followers mechanism. 4) Students should be able to understand various types of Gears used in Machine terminologies and concepts of velocity ratios in gear trains.

Unit 1 **[8 hrs]**

Basic concept of mechanism, link, kinematics pairs, kinematics chain, mechanism, machine, simple & compound chain, Degree of freedom, estimation of degree of freedom of mechanism by Grubber's criterion and other methods. Harding's notations, classification of four bar chain [class-I & Class-II], inversion of four-bar-chain, Kutchbach theory of multiple drives, **[CO 1]**

Unit 2 **[7 hrs]**

Quantitative kinematics analysis of mechanism: - Displacement, Velocity and Acceleration analysis of planer mechanism by graphical method as well as analytical method [complex number method/matrix method], Instantaneous center method, Kennedy's theorem. **[CO 2]**

Unit 3 **[8 hrs]**

Concepts of cam mechanism, comparison of cam mechanism with linkages. Types of cams and followers and applications. Synthesis of cam for different types of follower motion like constant velocity, parabolic, SHM, cycloid etc.
Analysis of follower motion for cams with specified contours like eccentric cam, tangent cam and circular arc cam with concave and convex curvature. Pressure angle in cam, parameters affecting cam performance. **[CO 3]**

Unit 4 **[7 hrs]**

Concept of motion transmission by toothed wheels, comparison with cams and linkages, various tooth profiles, their advantages and limitations, gear tooth terminologies, concept of conjugate action, law of conjugate action, kinematics of in volute gear tooth pairs during the contact duration, highlighting locus of the point of contact, arc of contact, numbers of pairs of teeth in contact, path of approach and path of recess, interference, undercutting for in volute profile teeth. **[CO 4]**

Unit 5 **[8 hrs]**

Kinematics of helical, bevel, spiral, worm gears, rack and pinion gears, kinematics analysis, and torque analysis of simple epicyclical and double epicyclical gear trains. **[CO 4]**

Unit 6 **[7 hrs]**

Static force analysis: Free body diagram, condition of equilibrium. Analysis of all links of given linkage, cam, gear mechanism and their combinations without friction. **[CO 2]**

3 SEMESTER

ME2207	Kinematics of Machinery		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1	Theory of mechanisms & machines	Shigley J. E	4TH Edition 2014	Tata McGraw-Hill
2	Theory of Mechanism and Machine	Khurmi & Gupta	Second Edition 2005	S. Chand
3	Mechanism and Machine Theory	Rao J.S & DukkiPati R.V.	4th Edition 2014	New Age International (P) Limited
4	Theory of Machine	Rattan S.S	4th Edition 2014	Tata McGraw-Hill
5	Theory of Machine	V. P. Singh	6th Edition 2014	Dhanpat Rai & Co.

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1	Theory of machines	Thomas Bevan	Third Edition	Pearson Education India
2	Theory of Machines	Sandor & Erdman	Fourth Edition	Tata McGraw-Hill

3 SEMESTER

ME2208	Fluid Mechanics		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
Develop an understanding of fluid statics, kinematics and dynamics in Mechanical. Learn to apply Bernoulli's Equation and momentum equation to Fluid flow systems. Study various flow measuring devices. Understand the concept of viscosity as applied in real flows. Learn to use equations in combination with experimental data to determine losses in flow systems.	(1) The student will be able to EVALUATE various fluid properties and ANALYZE hydrostatic forces acting on submerged flat bodies [**PO: 1,3,5,12,13**] (2) The students will be able to CLASSIFY AND ANALYZE the various flow pattern, AND WILL BE ABLE TO EVALUATE velocity and acceleration using fluid kinematics. [**PO: 1,3,5,12,13**] (3)The students will be able to analyze and SOLVE ideal flow and real flow problems by applying Bernoulli's equations and momentum equations. The students will also be able to DESCRIBE AND ANALYZE the fluid flow over bodies . [**PO: 1,3,5,12,13**] (4) The students will be able to ALAYZE THE flow, through pipes. The students will be able to EVALUATE HEAD LOSSES, DISCHARGE, POWER LOST ETC FOR THE FLOW THROUGH PIPES WITH AND WITHOUT FITTINGS [**PO: 1,3,5,12,13**]

Unit1 **[8 hrs]**

Introduction to Fluid Mechanics: Definition of Fluid, Properties of fluids, Newton's law of viscosity, Pascal's law, Basic equation of fluid static, Pressure variations in compressible & incompressible fluids, Fluid pressure & its measurement (Manometers & Bourdon's pressure gauge), Hydrostatics: Forces on submerged plane surfaces **[CO:1]**

Unit2 **[7 hrs]**

Kinematics Of Fluid Flow: Types of flow, Stream line, Path line, Streak line, Stream tube, Continuity equation, One and Two dimensional flow, Velocity and Acceleration at a point, Circulation and Vorticity, Stream function and Velocity potential. **[CO:2]**

Unit3 **[8 hrs]**

Dynamics Of Fluid Flow: Integral Momentum Equation, One-dimensional method for flow analysis, Impact of jet on stationary and moving Flat and curved vanes, Theory of Rotodynamic machines. **[CO:3]**

Unit4 **[7 hrs]**

Derivation of Bernoulli's equation for incompressible flow & its applications for various ideal and practical systems, Venturimeter, Orifice Meter and Pitot tube **[CO:3]**

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3 SEMESTER

ME2208	Fluid Mechanics		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Unit5 **[8 hrs]**

Viscous Flow: Newton's law of viscosity and its applications, Introduction to laminar and turbulent flow through pipes, Reynolds number and its significance, Boundary layer concept, Wall shear and boundary layer thickness, Kinetic energy correction factor, Momentum energy correction factor, Drag and Lift on immersed bodies. . **[CO:3]**

Unit 6 **[7 hrs]**

Flow Through Pipes: Equations for pipe flow, Friction charts and their uses, Losses in pipes and fittings, Hydraulic gradient lines and total energy lines, Pipes in series and parallel. Siphon, Water hammer phenomenon, Economics of pipe systems. Power Transmission Through Pipeline: Condition for maximum power transmission through a given pipeline (single pipe), Relationship of nozzle diameter to pipe diameter for maximum power transmission. **[CO:4]**

Reference Books:

S. No.	Title	Authors	Publisher
1	Fluid Mechanics: Fundamentals and Applications	Yunus A. Cengel and John M. Cimbala	McGraw-Hill
2	Engineering Fluid Mechanics	K. L. Kumar	S. Chand & Company Ltd.
3	Basic Fluid Mechanics	C.P. Kothandaraman & R. Rudramoorthy	New Age Publication
4	Fluid Mechanics	J.F.Douglas, J.M.Gasiorek & J.A. Swaffield	ELBS Publication
5	Fluid Mechanics	A.K.Mohanty	Prentice Hall Publication
6	Fluid Mechanics & Fluid Power Engineering	D. S. Kumar	S. K. Kataria Publication
7	Fluid Mechanics	A.K.Jain	Khanna Publishers

3 SEMESTER

ME2209	Lab : Fluid Mechanics		L=0	T=0	P=2	Credits=1
Evaluation Scheme	MSEs	TA	ESE	Total	ESE Duration	
	--	40	60	100	---	

Objective	Course Outcome
Develop an understanding of fluid statics, kinematics and dynamics in Mechanical. Learn to apply Bernoulli's Equation and momentum equation to Fluid flow systems. Study various flow measuring devices. Understand the concept of viscosity as applied in real flows. Learn to use equations in combination with experimental data to determine losses in flow systems.	(1) The student will be able to EVALUATE various fluid properties and ANALYZE hydrostatic forces acting on submerged flat bodies [**PO: 1,3,5,12,13**] (2) The students will be able to CLASSIFY AND ANALYZE the various flow pattern, AND WILL BE ABLE TO EVALUATE velocity and acceleration using fluid kinematics.[**PO: 1,3,5,12,13**] (3)The students will be able to analyze and SOLVE ideal flow and real flow problems by applying Bernoulli's equations and momentum equations. The students will also be able to DESCRIBE AND ANALYZE the fluid flow over bodies . [**PO: 1,3,5,12,13**] (4) The students will be able to ALAYZE THE flow, through pipes. The students will be able to EVALUATE HEAD LOSSES, DISCHARGE, POWER LOST ETC FOR THE FLOW THROUGH PIPES WITH AND WITHOUT FITTINGS [**PO: 1,3,5,12,13**]

LIST OF PRACTICALS

1) Study of Pressure Measuring Devices **[CO:1]**
2) To determine hydrostatic Force on vertical Surface**[CO:1]**
3) To determine hydrostatic Force on horizontal Surface**[CO:1]**
4) Verification of Bernoulli's Equation**[CO:3]**
5) To Determine Coefficient of Discharge of Venturimeter**[CO:3]**
6) To Determine Coefficient of Discharge of Open Orifice **[CO:3]**
7) To Determine Coefficient of Discharge of Orifice for compressible fluids**[CO:3]**
8) To Determine Coefficient of Discharge of Triangular notch**[CO:3]**
9) To Determine Coefficient of Discharge of Rectangular Notch**[CO:3]**
10) To Determine friction factor of fluid flowing through pipe**[CO:4]**
11) Performance on pipes in series**[CO:4]**
12) Performance on pipes in parallel**[CO:4]**
13) To Determine Minor losses and Coefficients of Minor Losses**[CO:4]**
14) To Determine Force exerted by Jet**[CO:3]**
15) Study of fluid flow over immersed bodies **[CO:3]**
16) Any other practical based on Fluid Mechanics syllabus**[CO:1,3,4]**

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering
SoE & Syllabus 2018
4th Semester
Mechanical Engineering

28 June 2019

IV Semester
GE2204 - Advanced Mathematical Techniques

Objective	Outcomes Students will be able to
• To introduce various Numerical Methods to solve algebraic and differential equations • To understand the concept of Probability distribution • To introduce the concept of Fuzzy Set theory and functions • To make aware of different optimization techniques	• Utilize numerical techniques to obtain approximate solutions of mathematical equations • Measure the Statistical parameters for random variables • Explain the basic concept of fuzzy sets, Relations and fuzzy logic. • Design and determine the solution of linear programming problems

Unit I:
Numerical Methods for Algebraic And Transcendental Equations: Errors in numerical calculation, Errors in series approximation, Rounding of error solutions of algebraic and transcendental equations, Iteration method, Bisection method, False position method, Newton Raphson method and their convergence
Numerical Methods System of Algebraic Equations: Solution of System of linear equations, Gauss- Seidel method, Crouts method**.** **(7 hours)**

Unit II:
Numerical Methods for Differential Equations: Numerical solution of ordinary differential equation by Taylor's series method, Picard's method, Runge's second and third order method, Runge-Kutta 4^{th} order method, Euler's method, Euler's modified method, Milne's Predictor and Corrector method. **(6 hours)**

Unit III:
Random Variables and Probability Distribution: Discrete and continuous random variables, probability density function of one and two variables, Probability distribution function of one and two variables, Joint distributions and conditional distributions. **(6 hours)**

UNIT IV:
Mathematical Expectation: Definition of mathematical expectation, functions of one and two random variables, The variance and standard deviations, moment generating function other measures of central tendency and dispersion, Skewness and Kurtosis. **(7 hours)**

UNIT V:
Fuzzy Sets And Fuzzy Logic: Fuzzy sets and systems, crisp sets, overview of fuzzy logic and classical logic, fuzzy compliment, fuzzy union, fuzzy intersection and combinations of these fuzzy sets operations crisp and fuzzy relations. **(7 hours)**

Unit VI:
OPTIMIZATION TECHNIQUES: Definition of basic concepts of LPP, Formulation of LPP and its Solution by graphical, simplex methods and Big M method. **(6 hours)**

IV Semester
GE2204 - Advanced Mathematical Techniques

Text Books:

SN	Title	Edition	Authors	Publisher
1	Computer based Numerical and Statistical Techniques	Paperback Firstedition 2003	M. Goyal	Laxmi Publication
2	Numerical Methods	Fourth Edition (2004)	S.S. Sastri	PHI Publishers
3	Fuzzy Engineering	Softcover edition (2005)	Bari Kosko	Prentice Hall PTR
4	Optimization Techniques	Year-2009.First Edition	C.Mohan and Kasum Deep	New Age International Publication

Reference Books:

SN	Title	Edition	Authors	Publisher
1	Advanced Engineering Mathematics	4th edition 2006	H.K.Dass	S. Chand Group
2	Advanced Engineering Mathematics	9th Edition-2007	Kreyszig	JOHN WILEY & SONS
3	Mathematics for Engineers	19th edition 2007	Chandrika Prasad.	JOHN WILEY & SONS
4	Advanced Mathematics for Engineers	4th edition 2006	Chandrika Prasad	JOHN WILEY & SONS
5	Higher Engineering Mathematics	40 edition 2010	B S Grewal	Khanna Publishers
6	A text book of Engineering Mathematics	Reprint 2008	N.P. Bali and Manish Goyal	LaxmiPrakashan

4th SEMESTER

ME2251	Design of Machine Elements		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
This subject occupies a predominant position in the curriculum of Mechanical Engineering. It consists of application of scientific principles, technical information & creative thinking for the development of a new or improved machine or mechanical system, to perform desired function with maximum efficiency.	Student will be able to 1) Apply the knowledge of design principal in machine components. 2) Design and analyze various joints i.e., Welded joints, Bolted joints and Riveted joints. 3) Learn the design principals of power screw, springs, clutches and brakes. 4) Apply principal of design of pressure vessel and power transmission shafts.

Unit1 **[8 hrs]**

Definition of design, types of design, design process, need, defining the problem, feasibility, design alternatives, final design selection, preliminary and final plant drawings.

Theories of failure, Design for Fatigue & manufacturing considerations in design, basis of good design, failure of machine parts, Mechanical properties, Design considerations and selection of materials. **[CO – 1]**

Unit2 **[7 hrs]**

Design of Joints:

Welded joint: design of single transverse, double transverse, parallel fillet, combination fillet butt joint, Eccentrically loaded welded joints.

Bolted joint: Design of bolted fasteners, bolt of uniform strength, bolted joints under eccentric loading.

Design of riveted joints. **[CO – 2]**

Unit3 **[7 hrs]**

Power screw and Leaf spring: Design of power screw

Design of Helical and Leaf Springs. **[CO – 3]**

Unit4 **[7 hrs]**

Brakes and clutches: Kinematics of Friction Drives such as Brakes, Clutches Design of Friction Clutch, Single Plate, Multiple Plate, Cone, Centrifugal Clutch, Design of Brake, Shoe Brake, Band Brake,, Internal Expanding brake. **[CO – 3]**

Unit5 **[7 hrs]**

Pressure Vessel: Classification of Thick and Thin Cylindrical Pressure Vessel, Stresses in Thin and Thick Cylindrical Pressure Vessels when it is subjected to internal pressure, Expression for Circumferential and Longitudinal stresses, Design of pressure vessel, Heads and Cover Plate. **[CO – 4]**

Unit 6 **[8 hrs]**

Design of Shafts: Design of transmission Shafts on the Basis of Strength and rigidity, ASME Code for shaft Design, Design of Stepped shaft Axle splined Shaft, Keys. **[CO – 4]**

		June 2019	1.00	Applicable for AY 2019-20 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

4th SEMESTER

ME2251	Design of Machine Elements		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1	Mechanical Engg. Design	Shigley J. E	7 th Edition. 2000	McGraw-Hill,
2	Design of Machine Element	Shiwalkar B. D	3rd Edition 2008	Denett & Co.
3	Design of machine elements	Bhandari V.B.	5th Edition	Design of machine elements
4	Machine Design	U. C. Jindal	2010	Dovling Kinderslay

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1	Mechanical Design of Machine	Maleev hartman	5th Edition.	Cbs Publishers & Distributors
2	Design Data Book	Shiwalkar B. D	7th Edition	PSG Tech, Coimbatore, India

4th SEMESTER

ME2252	Engineering Thermodynamics		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
To develop the understanding of thermodynamic principles/laws for ideal gas/pure substance and to use it for evaluation of the energy interaction with the thermodynamic systems undergoing process.	***On completion of this course, the student will be able to:*** 1) **Apply**the First and zeroth law of thermodynamics for the **analysis** of thermodynamic systems to **evaluate** energy interactionin various processes. a. (Analyzing, Applying, Evaluate) b. (Programme Outcome: PO-1, PO-3, PO-5, PO-12, PO-13) 2) **Evaluate** the performance of cyclic devices, change in the entropy and availability in various processes **applying** the laws of thermodynamics. a. (Evaluating, Applying) b. (Programme Outcome: PO-1, PO-3, PO-5, PO-12, PO-13) 3) **Evaluate** various thermodynamic parameters in various *processes with phase change***using** phase change diagrams, relations and steam tables/ charts**applying** Law of thermodynamics. a. (Evaluating, Analyzing, Applying) b. (Programme Outcome: PO-1, PO-3, PO-5, PO-12, PO-13) 4) **Analyze** the performance of various Thermodynamic cycles **applying** Law of thermodynamics for **evaluation** of energy interaction. a. (Evaluating, Analyzing, Applying) b. (Programme Outcome: PO-1, PO-3, PO-5, PO-12, PO-13)

UNIT I:
Introduction To Thermodynamics:
Basic concepts of Thermodynamics, Continuum and macroscopic approach; thermodynamic system, Concept of energy and various forms of energy; internal energy, enthalpy; specific heats;, thermodynamic properties and equilibrium; state of a system, state postulate, state diagrams, paths / processes and cycles on state diagrams . The Ideal Gas equation of state.
The concepts of heat and work interactions. Evaluation of different modes of work.
Zeroth Law of Thermodynamics, concept of temperature [CO 1]

UNIT II
First Law of Thermodynamicsapplied to the various processes in Closed Systems, Various Steady flow systems, Steady-Flow Engineering Devices and Unsteady Flow process such as: charging and discharging of gas cylinder. [CO 1]

4th SEMESTER

ME2252	Engineering Thermodynamics		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

UNIT III
Second Law of Thermodynamics :
Limitations of the Zeroth and First law of thermodynamics,
concepts of Thermal energy reservoirs, heat engines and heat pumps/refrigerators,
Kelvin-Planck and Clausius statements and their equivalence; reversible and irreversible processes;
Carnot cycle and Carnot principles/theorems; thermodynamic temperature scale; [CO 2]

UNIT IV
Entropy:
Clausius inequality and concept of entropy; microscopic interpretation of entropy, the principle of increase of entropy, T-s diagrams, Change in entropy for processes in Closed and Steady flow systems.
Introduction to concept of Availability. [CO 2]

UNIT V
Properties of Pure Substances (Steam) :
Thermodynamic properties of pure substances in solid, liquid and vapor phases; P-v-T behavior of simple compressible substances, phase rule, thermodynamic property tables (Steam Tables) and charts.
Calculations of work and heat interactions in non- flow and steady flow processes.
Determination of dryness fraction using various calorimeters. [CO 3]

UNIT VI:
Thermodynamic Cycles
Vapor Power Cycles: Carnot vapor cycle, Rankine cycle: ideal and the reheat, the analysis of vapor power cycle.
Air-standard cycles:air standard assumptions,basic considerations and the analysis of power cycles: Otto cycle, Diesel engine cycle, and Brayton cycle.
Refrigeration Cycle: Introduction to Vapor-compression Refrigeration Cycle [CO 4]

Text books:				
1	Engineering Thermodynamics	6th edition 2017	P. K. NAG	Tata McGraw-Hill
2	Thermodynamics- An Engineering approach	7TH Edition (2017)	Yunus A. Cengel, Michael A. Boles	McGraw-Hill
3	Thermodynamics & Heat Engines vol-I & II	8TH Edition (2017)	R.YADAV	Central Publishing House,.
Reference books				
1	Fundamentals of Classical Thermodynamics	1st edition 2007	GordenJ.VanWylen Richard E.Sonntag	John Wiley
2	Basic Engineering Thermodynamics	3rd edition 2009	5 Reiner Joel	Longman

		June 2019	1.00	Applicable for AY 2019-20 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

4th SEMESTER

ME2253	Lab : Machine Drawing		L=0	T=0	P=2	Credits=1
Evaluation Scheme	MSEs	TA	ESE	Total	ESE Duration	
	--	40	60	100	---	

Objective	Course Outcome
To familiarize the students with- 1) To gain knowledge of different types of line and its application, conventional representation of various machining and mechanical details as per IS 2) To visualize an object and convert it into a drawing. 3) To become conversant with 2D and 3D.	The student will able to 1) Apply standards practices and conventions in machine drawing. 2) Draw a Orthographic and Isometric drawing 3) Preparing and visualizing detailed drawing of various machine components. 4) Create a 2D and 3D using CAD software with due manufacturing consideration.

Unit1 **[8 hrs]**

Drawing Standards for following- Drawing Sheets, Name Blocks, Lines, Dimensioning of Tolerances, Standard features, Machining Symbols, Welding Symbols, Heat Treatment, manufacturing Instructions, Allowances, and Materials. [CO 1]

Unit2 **[6 hrs]**

Orthographic Projection of Elements, section, dimensioning, Dimensioning of tolerances, Orthographic Projections, Sectional Views, Missing Views, conventional representation of machine elements. [CO 2]

Unit3 **[6 hrs]**

Preparation of drawing of machine Elements such as - threads, Bolts, Nuts, Washers, Rivets, Welds, Keys and Keyways, splines, Couplings, shaft. [CO 1,2]

Unit4 **[8 hrs]**

Assembly and Dismantling Principles : Fits and Tolerances (Standards, Types Application and Selection) , Tolerance Charting, Surfaces Finishing Requirement for Assembly, Geometry suitable for Assembly, Assembly / Dismantling Tools, Bearing Assemblies, Assemblies by Fastening. [CO 3]

Unit5 **[9 hrs]**

Study of some Standard Assemblies.
Assembly Drawings: Principles, Techniques and standards for Preparing Component Drawings, Subassembly Drawing, Full Assembly Drawing, Exploded Views.
Assembly drawings of :- Lathe machine tail stock and tool post , radial engine sub assembly, plummer block, steam stop valve or safety valve, etc. [CO 3,4]

Unit 6 **[8 hrs]**

Production Drawing : Name Plates, Part List, Revisions Etc., Essential Parts/ Formats Required for Production Drawings, Process Sheet, blue print reading. [CO 4]

4th SEMESTER

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ME2253	Lab : Machine Drawing		L=0	T=0	P=2	Credits=1
Evaluation Scheme	MSEs	TA	ESE	Total	ESE Duration	
	--	40	60	100	---	

LIST OF PRACTICALS

1. Drawing of some Standard Components. (Two Sheets). [CO 1]
2. Drawings of two Standard Assemblies with Components. (Two Sheets). [CO 2]
3. Computer printout of a small Assembly with Components. [CO 4]
4. Pencil Drawing / Computer printout of a Large Assembly with components Drawings, subassembly drawings and assembly drawings using all standard formats. [CO 4]
5. Computer Printout of Production Drawing and process Sheets for One Component having maximum five Operations. Pencil Drawing should be in full imperial sheet folded to quarter Imperial size, Computer printouts should be on a plotter in A3 size. All drawings should be submitted in one folder. [CO 4]
6. To parts and assembly drawing using suitable CAD software. [CO 3,4]

Text Books:

S. No.	Title	Authors	Edition	Publisher
1	Machine Drawing	Bhatt N.D	38th Edition 2010	CharotarPulishe
2	Machine Drawing	SiddheshwarShastri	6th Edition 2009	Kanhaiah. Tata Mcgraw Hill
3	Machine Drawing	Parkinson	4th Edition 2011	Sir Isaac Pitman & Sons Limited
4	Machine Drawing	Venkat Reddy, Narayan and Kanhaiya	2nd Edition	B.S. publication
5	Fundamentals of Engineering Drawing	Warren J. Luzadder	11th Edition 2017	Parson
6	Machine Drawing	K. L. Narayana & Kannaiah	3rd Edition 2012	New Age Publications
7	Machine Drawing	P. S. Gill	BD Katariya & sons	

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1	Relevant IS Codes		Edition	TATA McGraw hill

4th SEMESTER

ME2254	Manufacturing Processes-II		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
Subject is the essential framework of manufacturing processes and is composed of the scientific and practical inter relationship among the processing, structure, properties and performance of all conventional methods of manufacturing techniques	After completion of this course, 1) The student will be able to illustrate the basics of moulding process and compare various casting processes 2) The student will be able to analyze various Forming and sheet metal working processes. 3) The student will be able to Elaborate and classify different welding processes. 4) The student will be able to discuss and analyze unconventional machining processes.

Unit 1 **[8 hrs]**

Casting Process: Introduction, Pattern making: Types, materials used, Pattern making allowances, color codes. Core making: - Types, core material & its properties. Molding: Types of sand moulds, molding sand composition, molding sand properties, molding machines. Gating design – Elements of gating systems, pouring time, riser design Choke area (Analytical treatment). **[CO-1]**

Unit 2 **[5 hrs]**

Foundry mechanism: Special casting processes such as investment Casting, Centrifugal Casting, Shell Molding, CO Molding, Slush Casting, Die Casting, Cleaning, inspection & casting defects. **[CO-1]**

Unit 3 **[5 hrs]**

Mechanics of forming processes (including analytical treatment). Rolling (Determination of variables in Rolling), Forging (Hammer/Press), Extrusion & Wire Drawing. Melting furnaces – Types, Electric furnace, Induction furnace,Cupola-construction & operation. **[CO-2]**

Unit 4 **[7 hrs]**

Sheet metal working:- Introduction, Terminology, Types of Presses and operations, Classification of dies, Introduction to design parameters, Analytical treatment—Blanking dies (calculation of cutting force), Bending dies (calculation of blank length, bending force) , Drawing dies (design of blank size, calculation of drawing force, blank holder force) **[CO-2]**

Unit 5 **[9 hrs]**

Joining processes: Introduction to Welding, Soldering, Brazing Processes. Types of Welding, Arc Welding & Gas Welding Processes, Defects & Inspection of Welding Joints, Electrodes, Weldability of Metals, Welding equipments of Fixtures. Advance Welding Methods: Introduction to TIG, MIG, spot welding, Plasma Arc welding, Electron Beam, and Electron Laser Beam welding. **[CO-3]**

4th SEMESTER

ME2254	Manufacturing Processes-II		L=3	T=0	P=0	Credits=3
Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration	
	30	10	60	100	3 Hours	

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Unit 6 **[7 hrs]**

Nonconventional Machining Processes: Characteristics, Operation, applications, Limitation and selection of process parameters of the following processes, Abrasive Jet Machining, Ultrasonic Machining, Water Jet Machining, EDM, and ECM. **[CO-4]**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1	Manufacturing Technology (Foundry Forming & Welding)	P N Rao	4 th Edition (2013)	The McGraw-Hill Companies
2	Manufacturing Science	Ghosh & Malik	2nd Edition (2010)	
3	Workshop Technology (Volume-I)	HajraChoudhary	2nd Edition (2009)	The McGraw-Hill Companies
4	Manufacturing Engineering & Technology	S Kalpakjian& SR Schmid	1st Edition (2018)	Pearson Education Canada
5	Manufacturing Technology	Adithan, Gupta	5 TH Edition (2012)	
6	Modern Machining Processes	Pandey, Shah	1st Edition (2008)	The McGraw-Hill Companies

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1	Workshop Technology: Vol. I - III	WAJ Chapman	2ndEdition	St. Martin's Press
2	Manufacturing Processes	M Begman	1st Edition	Ballinger Pub. Co
3	Processes & Materials of Manufacture	R Lindberg	1st Edition	Allyn and BaconTechnology & Engineering
4	Workshop Technology (Volume I & II)	Bawa	2nd Edition	The McGraw-Hill Companies
5	Workshop Technology Vol. I & II	B.S. Raghuvanshi	1st Edition	Dhanpat Rai & Sons

4th SEMESTER

ME2255	Lab: Manufacturing Processes-II		L=0	T=0	P=2	Credits=1
Evaluation Scheme	MSEs	TA	ESE	Total	ESE Duration	
	--	40	60	100	---	

Objective	Course Outcome
Practical is the essential framework of manufacturing processes and is composed of the scientific and practical inter relationship among the processing, structure, properties and performance of all conventional methods of manufacturing techniques.	**(1)** The student will be able to illustrate the basics of moulding practices and various casting process . **(2)** The student will be able to illustrate CUPOLA and other furnaces. **(3)** The student will be able to Elaborate and classify different welding processes. **(4)** The student will be able to discuss various SMW processes

List of Practical:-

A set of 10 Experiments from following list to be performed.

- Preamble about Foundry practices used in industries.[CO 1]
- Preparation of mould sand. [CO 1]

- Study of Various moulding processes. [CO 1]
- Study of various types of melting furnaces and cupola in detail. [CO 2]
- Study of different types of wooden pattern[CO 1]
- Grain fineness test of moulding sand. [CO 1]
- Demonstration of mould making along with Study of foundry tools. [CO 1]
- Preparation of mould making. [CO 1]

- Preparation of casting job along with Study of casting processes. [CO 1]
- Preparation of wooden pattern in pattern making shop. [CO 1]
- Job making involving various operations such as MIG ,TIG welding processes etc. [CO 3]
- Preparation of job on punching press. [CO 4]
- Report of foundry visit [CO 1]

A Visit: A visit to a foundry shop for more understanding of the casting practices**.** [CO 4]

4th SEMESTER

ME2256	Mechanical Measurement and Metrology	L=4	T=0	P=0	Credits=4

Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration
	30	10	60	100	3 Hours

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Objective	Course Outcome
To make the student aware of various Fundamental principles applicable to instruments used for measuring various mechanical parameters. To expose the students about limits, fits, tolerances & implement them to achieve the goal of interchangeable manufacturing. To impart the fundament quality control concepts & their implementation in manufacturing industry.	The Students will be able to – (1) Demonstrate the basic knowledge of measuring instruments and evaluate various characteristics(Static & Dynamic) (2) Select proper measuring instrument & use it for measuring various mechanical paramenters. (3) Demonstrate the basic knowledge of limits, fits, tolerance & design of limit gauges, tolerance charts. (4) Various quality control concepts & implement them to control quality of manufacturing processes.

UNIT 1
Purpose, Structure, and elements of a general measurement system. Static characteristics of measurement system, measurement error, Type of inputs, methods of corrections. Dynamic characteristics of measurements system, Mathematical modeling, transfer function, order of system, Standard input signals. Response of Zero, First and second order instruments.(no analytical treatment) [CO 1]

UNIT 2
Standards of measurements, interchangeability, simple gauging instruments for linear and angular measurements, form measurement, surface finish measurement, comparators, measurement of straightness and flatness, measurement thread , interferometers, calibration of equipment, CMM. [CO 2]

UNIT 3
Tolerance analysis of limit and fits, Design of limit gauges(analytical treatment), types of fits, shaft basis system ,hole basis system, selective assembly ,allowances, process planning sheet, preparation of tolerance chart (analytical treatment). [CO 3]

UNIT 4
Study of instruments for measurements of linear & angular displacement, speed, acceleration, force, torque, power and Strain.. [CO 2]

UNIT 5
Study of instruments for measurement of temperature, level, pressure and flow. [CO 2]

UNIT 6
Acceptance sampling techniques, O.C. Curve, sampling plans, (analytical treatment), inspection types and objective. Quality control and control charts. [CO 4]

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Chairperson	Dean (Acad. Matters)	Date of Release	Version	

4th SEMESTER

ME2256	Mechanical Measurement and Metrology	L=4	T=0	P=0	Credits=4

Evaluation Scheme	MSEs *	TA	ESE	Total	ESE Duration
	30	10	60	100	3 Hours

*** MSEs = 3 MSEs of 15 Marks each will conducted and marks of better 2 of these 3 MSEs will be considered for Continuous Assessment**

Text Books:

S. No.	Title	Authors	Edition	Publisher
1	Measurement Systems	Beckwith and Buck	6th edition 2014	Pearson Education India,
2	Mechanical Measurements Applications and Design	Doebelin	6 Edition 2014	McGraw-Hill.
3	Text book of Engineering Metrology	R. K. jain	20th Edition 2014	Khanna Publicatiion Delhi
4	Production Engineering	P. C. Sharma	2009	S. Chand Co.
5	Mechanical measurement & Instrumentation	Er. R. K. Rajput	2nd Edition 2017	SK Katariya & sons
6	Mechanical measurement & Instrumentation	A. K. Sawhney	12th Edition 2010	Dhanpatrai & Co

Reference Books:

S. No.	Title	Authors	Edition	Publisher
1	Engineering Metrology `	I.C. Gupta	15th Edition 2003	Dhanpatrai & Co
2	SQC	E L. Grant	3rd Edition 19988	McGraw-Hill.
3	SQC	Mahajan	2015	Dhanpatrai & Co

4th SEMESTER

ME2257	Lab: Mechanical Measurement and Metrology	L=0	T=0	P=2	Credits=1

Evaluation Scheme	MSEs	TA	ESE	Total	ESE Duration
	--	40	60	100	---

Objective	Course Outcome
To make the student aware of various Fundamental principles applicable to instruments used for measuring various mechanical parameters. To expose the students about limits, fits, tolerances & implement them to achieve the goal of interchangeable manufacturing. To impart the fundament quality control concepts & their implementation in manufacturing industry.	The Students will be able to – (1) Demonstrate the basic knowledge of measuring instruments and evaluate various characteristics(Static & Dynamic) (2) Select proper measuring instrument & use it for measuring various mechanical paramenters. (3) Demonstrate the basic knowledge of limits, fits, tolerance & design of limit gauges, tolerance charts. (4) Various quality control concepts & implement them to control quality of manufacturing processes.

List of Practical:-

A set of 10 Experiments from following list to be performed.

1. Measurement of strain by using a basic strain gauge and hence verify the stress induced.[CO 1,2]
2. Speed Measurement by using Stroboscope. [CO 1,2]
3. Speed Measurement by using Magnetic Pick Up [CO 1,2]
4. Speed Measurement by using Photo-electric Pick Up [CO 1,2]
5. Measurement of flow by using Rota meter. [CO 1,2]
6. Displacement measurement by inductive transducer. [CO 1,2]
7. Calibration of Thermocouple. [CO 1,2]
8. Calibration of RTD. [CO 1,2]
9. Calibration of LVDT [CO 1,2]
10. Determination of negative temperature coefficient and calibration of a thermistor. [CO 1,2]
11. Measurement of force & weight by using a load cell. [CO 1,2]
12. Liquid Level Measurement by using Capacitive Transducer system. [CO 1,2]
13. Measurement of Air velocity using Hot wire anemometer. [CO 1,2]
14. Measurement of Air velocity using turbine type anemometer[CO 1]
15. Scope of metrology lab and study of all metrological instruments. [CO 1]
16. Study of slip gauges and its uses. [CO 1,2]
17. To find half taper angle of a w/p using sine bar[CO 1,2]
18. To find various parameters of screw thread using TMM. [CO 1,2]

4th SEMESTER

ME2257	Lab: Mechanical Measurement and Metrology		L=0	T=0	P=2	Credits=1
Evaluation Scheme	MSEs	TA	ESE	Total	ESE Duration	
	--	40	60	100	---	

19. To find effective diameter of a threaded plug by two wire method using floating carriage machine. [CO 1,2]
20. Study of flatness of surface using monochromatic light with the help of fringe pattern. [CO 1,2]
21. To measure the surface roughness of a given w/p using Stylus probe. [CO 1,2]
22. To study the profile of given w/p using optical profile projector. [CO 1,2]
23. Design of limit gauge. [CO 3]
24. Preparation of process planning sheet and tolerance chart. [CO 3]
25. Problems on acceptance sampling. [CO 4]

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering

SoE & Syllabus 2018

5th Semester

Mechanical Engineering

28 June 2020

V Semester
GE2311 - FUNDAMENTALS OF MANAGEMENT

Objective	Outcomes Students will be able to
To introduce the fundamentals and legal provision of Management	Explain the Legal provision and Functions of Management.
To introduce the Human Resource and Financial practice of organization	Analyze the role of Human Resource and Financial Management in the organization.
To Introduce the Project Management	Analyze the project life cycles.
To provide knowledge of Marketing Activities of Management	Identify tools and techniques for the marketing of goods and services.

Unit – 1 - Principle of Management

Evolution of Management Thought : Scientific and Administrative Theory of Management , Definition and Concept of Management, Functions of Management : Planning, Organizing, Directing, Coordinating and Controlling, Motivational Theories, Concept of Leadership

UNIT-2: Legal Aspects of Management

The Indian Contract Act, 1872 – Formation of Valid Contract, Discharge of Contract, Quasi Contract, Indemnity and Guarantee. The Indian Partnership Act, 1932- Essentials of Partnership, The Companies Act – Nature and Definition of Company, Registration and Incorporation, Memorandum and Article of Association, Kinds of companies, Winding up of the Company

UNIT-3: Human Resource Management

Human Resource Management-Meaning and Scope, Principles of HRD, Job Analysis – Job Description and Job Specification, Job Enrichment, Job Rotation, Training and Development – Purpose and Methods, Performance Appraisal- Purpose, Procedure and Techniques, Grievance Redressal Procedure .

UNIT-4: Project Management

Concept, Classification and Characteristics of Project, Project Life Cycle, Project Proposal, Tools and Techniques of Project Management, Network techniques - Introduction and Use of CPM &PERT for planning, SWOT Analysis, Project Risk Analysis, Project Control.

UNIT-5: Marketing Management

Marketing Management - Definition & scope, Selling & Modern Concepts of Marketing, Market Research, Customer Behaviors, Product Launching, Sales Promotion, Pricing, Channels of Distribution, Advertising, Market Segmentation, Marketing Mix, Positioning, Targeting

V Semester
GE2311 - FUNDAMENTALS OF MANAGEMENT

UNIT-6: Financial Management

Definition & Functions of Finance department, Sources of finance, Types of capital, Profit maximization vs. Wealth maximization, Functions of Finance Manager in Modern Age, Concept of Risk and Return , Break Even Analysis, Budgets & Budgetary Control, Make or Buy Analysis, Introduction to financial statement – profit and loss A/c and Balance Sheet

Text book and Reference

1. Harold Koontz Ramchandra, Principles of Management, Tata McGrow hills
2. Bare Acts – Indian Contract Act, Indian Partnership Act and Company Law
3. Dr. V.S.P.Rao - Human Resource Management - Text and Cases
4. C.B.Mamoria and S.V.Gankar, A Text book of Human Resource Management,
5. Lock, Gower - Project Management Handbook
6. Ramaswamy V.S. and Namakumari S - Marketing Management: Planning, Implementation and Control (Macmillian, 3rd Edition).
7. Rajan Saxena: Marketing Management, Tata McGraw Hill.
8. Fabozzi - Foundations of Financial Markets and Institutions (Pretice hall, 3rd Ed.)
9. Parameswaran- Fundamentals of Financial Instruments (Wiley India)
10. Bhole L M - Financial Institutions and Markets (Tata McGraw-Hill, 3rd edition, 2003)
11. Khan M Y - Financial Services (Tata Mc Graw Hill, 19

V Semester

ME2301 - HEAT TRANSFER

Objective	Course Outcome
The student should be able to 1) The contents of syllabus intend to understand basic principles and physical phenomenon of Thermal Energy transfer and to understand heat transfer applications and formulate the problem. 2) To apply experimental tools for analysis of heat transfer applications in engineering. 3) To receive results from experimental and the mathematical tools and interpret the results to provide solutions for improvement. 4) In all to generate interest in learning to develop intuitive understanding in Heat Transfer.**[a,e,k,l,m]**	**On completion of this course, the student will be able to** 1) Analyze and solve the problems of unidirectional steady state heat conduction systems. 2) Investigate and apply the empirical correlations in convection and phase change processes to estimate the heat transfer coefficient. 3) Design & analyze the heat exchangers with LMTD & ϵ-NTU methods 4) Examine and evaluate the net thermal radiation exchange between surfaces and estimate radiation view factors using tables, graphs and the view factor relationships.

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO
CO1	Analyze and solve the problems of unidirectional steady state heat conduction and lumped heat capacitance systems.	3	3	3	2	3	1	2	1	1	1	2	2	3	3
CO2	Investigate and apply the empirical correlations in convection and phase change processes to estimate the heat transfer coefficient.	3	3	3	2	3	1	2	1	1	1	2	2	3	3
CO3	Design & analyze the heat exchangers with LMTD & ϵ-NTU methods.	3	3	3	2	3	1	2	1	1	1	2	2	3	3
CO4	Examine and evaluate the net thermal radiation exchange between surfaces and estimate radiation view factors using tables, graphs and the view factor relationships.	3	3	3	2	3	1	2	1	1	1	2	2	3	3

V Semester

ME2301 - HEAT TRANSFER

Unit No.	Contents	Max. Hrs.
1	**Introduction:** Modes of Heat Transfer, Basic Laws of Heat Transfer and Conservation of Energy requirement. Derivation of **general Heat conduction equation** in Cartesian, Cylindrical and Spherical Co-ordinates, Thermal conductivity and Thermal diffusivity. **One dimensional steady state conduction equation** for the plane wall, Cylinder and Sphere, Thermal resistance of composite structures, Contact resistance, and overall heat transfer coefficient.	6
2	**Conduction with uniform internal heat generation**: within plane wall, solid Cylinder and solid sphere, **Extended Surfaces** with uniform cross section area, temperature distribution and their heat transfer rate, Fin efficiency and effectiveness,	5
3	**Forced Convection:** Physical signification of related non-dimensional parameters, Newton's law of cooling, Concept of velocity and thermal boundary layer, Local and average heat transfer coefficient, **Using Empirical co-relation** (from heat transfer data book) for heat transfer during external and internal flow in laminar and turbulent regime for UHF and UWT condition, for determination of heat transfer coefficient.	5
4	**Natural Convection:** Grashoff number, Rayleigh number, Hydrodynamic and Thermal Boundary Layer. **Using Empirical co-relation** (from heat transfer data book) for heat transfer during external flow in laminar and turbulent regime for UHF and UWT condition (over plates & cylinders in Horizonal and vertical position, and over sphere). **Heat transfer with phase change (Theory only):** Pool boiling phenomenon, curve and regimes of pool boiling, Film and drop wise condensation, Film wise condensation on vertical surface (plate & cylinder), horizontal tube & bank of tubes, effect of superheated and non-condensable gasses on condensation heat transfer.	5
5	**Heat Exchanger:** Classification of heat exchangers, overall heat transfer coefficient, fouling factor, temperature distribution **Heat Exchanger Analysis** for parallel & Counter flow heat exchangers using LMTD Approach and Effectiveness -NTU approach	6
6	**Radiation** **Basic Radiation Concepts:** Fundamentals, Basic ideas, spectrum, basic definitions, radiative properties of opaque surfaces, Spectral and directional variations, emissive power, radiosity, intensity of radiation and solid angle, Band Emission. **Black Body Radiation Laws:** Planck's law, Stefan Boltzmann law, Wien's Displacement law, Kirchhoff's law, Lambert cosine law, **Radiation Energy Exchange:** Concept of black and gray bodies, Radiation exchange between black surfaces, Radiation exchange between gray surfaces Shape Factor Concepts– Definition, relations and its properties. Radiation network for radiative exchange. Radiation between parallel plates, concentric Cylinders and concentric spheres & simple enclosures .	6

V Semester
ME2301 - HEAT TRANSFER

Text Books				
SN	**Title**	**Edition**	**Authors**	**Publisher**
1				

Reference Books				
SN	**Title**	**Edition**	**Authors**	**Publisher**
1	Introduction to heat transfer	5th Edition(2006)	Incropera & Dewitt J. Wiley	John Wiley & Sons
2	Elements of heat transfer	Edition (2007)	M.N.Ozisik	McGraw-Hill
3	Heat transfer	4th Edition(2005)	S.P.Sukhatme	Universities press (India)
4	Heat Transfer	Edition (1998)	Yunus A Cengel	McGraw-Hill,
5	Fundamentals of Heat & Mass transfer	1st Edition (2006)	M. Thirumaleshwar	Pearson
6				

V Semester

ME2302 - LAB : HEAT TRANSFER

Objective	Course Outcome
The student should be able to 5) The contents of syllabus intend to understand basic principles and physical phenomenon of Thermal Energy transfer and to understand heat transfer applications and formulate the problem. 6) To apply experimental tools for analysis of heat transfer applications in engineering. 7) To receive results from experimental and the mathematical tools and interpret the results to provide solutions for improvement. 8) In all to generate interest in learning to develop intuitive understanding in Heat Transfer.**[a,e,k,l,m]**	**On completion of this course, the student will be able to** 5) Analyze and solve the problems of unidirectional steady state heat conduction systems. 6) Investigate and apply the empirical correlations in convection and phase change processes to estimate the heat transfer coefficient. 7) Design & analyze the heat exchangers with LMTD & ϵ-NTU methods 8) Examine and evaluate the net thermal radiation exchange between surfaces and estimate radiation view factors using tables, graphs and the view factor relationships.

List of Practical

A set of 9 Experiments from following list to be performed.

List of Practical: Minimum eight experiments from the following:

1D steady state Conduction:

1) Determination of **thermal conductivity of metal bar**.
2) Determination of **thermal conductivity of insulating material** in the powder form (Lagged Pipe).
3) Determination of thermal conductance of a **composite wall**.
4) Heat Transfer through **FINs**.

Steady State convection:

5) Determination of **forced convection heat transfer coefficient** for fluid flow through a closed conduit.
6) Determination of **natural convection heat transfer coefficient** for a vertical surface.

Heat Exchanger:

7) Determination of **effectiveness and overall heat transfer coefficient** for parallel flow and counter flow concentric tube heat exchangers.

Steady State Radiation

8) Determination of **emissivity** of non black surfaces.
9) Determination of **Stefan-Boltzmann constant.**

Study:

1) Study of different methods of temperature measurements with special emphasis on thermocouples.
2) Study of **heat pipes**
3) Study of **pool boiling phenomenon** (Nukiyama Curve).
4) Study of **condensation heat transfer** in film wise & drop wise modes.

V Semester

ME2303 - DYNAMICS OF MACHINERY

Objective	Course Outcome
To develop the concept of rigid body motion and impart knowledge of rigid body dynamics. To enables the students to analyze dynamic forces in mechanism. To introduce the concept of unbalanced forces need for balancing of various machines and the different ways to achieve balancing. To impart elementary knowledge of vibrations, its effect on machines .To prepares students for calculations of important parameters and vibration isolation	**On completion of this course, the student will be able to** 1) Differentiate static and dynamic forces on different machines and mechanisms. 2) Analyze the unbalanced in rotating & reciprocating machines and corrections required to balance the same. 3) Identify the vibrations in different machines. 4) Evaluate and justify vibrations

Unit No.	Contents	Max. Hrs.
1	**Introduction:** D'Alembert principle, Dynamic force analysis of simple mechanism **Gyroscope:** simple precession and gyroscopic couple, gyroscopic effect on airplane, ship, vehicles and grinding mills.	8
2	Governors **– Classification, Watt, Portal, Proell, Hartnell governors etc,** **Fly wheel:** Turning moment Vs crank angle diagram for single- cylinder and multiple-cylinder engines, punching machines etc. Flywheel selection.	7
3	**Balancing in rotating mechanism:** Static & Dynamic balancing in rotating masses, balancing of multiple masses rotating in same plane, Balancing of several masses rotating in different planes, Dynamic balancing machine.	7
4	Balancing of reciprocating masses**: Primary and secondary unbalanced forces of reciprocating masses. Partial balancing of unbalanced primary forces in a reciprocating engine.** Balancing of primary and secondary force and couples in multiple inline engine, Balancing of radial engines (Direct and reverse crank method)	8
5	**Vibration:** Derivation of equation of motion for vibratory system. Free vibration of single-degree-of-freedom system with and without damping. Logarithmic decrement and damping estimation. Forced vibration of single-degree-of-freedom and vibration isolation, whirling of shaft and critical speed of rotors.	8
6	**Torsional vibration:** Lagranges equations and introduction to multi degree freedom systems. Equation of motion for two-degree-of-freedom system. Natural frequencies and mode shapes vibration absorber. Torsional oscillation of two-disc and three disc rotors	7

V Semester

ME2303 - DYNAMICS OF MACHINERY

Text Books				
SN	**Title**	**Edition**	**Authors**	**Publisher**
1	Theory of Machines and Mechanism	4 Edition (2009)	Shigley	Oxford University
2	Theory of Machines and Mechanism	2 Edition (1999	Ghosh & Mallik	Affiliated East-West
3	Theory of Mechanism	2 Edition (2005)	Rattan S. S	Tata McGraw-Hill
4	Mechanism and Machine Theory	3rd edition 2004	Rao & Dukipatti	Wiley & Sons
5	Theory of Vibrations	2nd edition 1995	Thomson W T	Prentice Hall of India

Text Books				
SN	**Title**	**Edition**	**Authors**	**Publisher**
1	Theory of Machine	3rd Edition (2009)	Thomas Bevan	Pearson Education
2	Theory of Machines	4th Edition (2006)	Sandor & Erdman	Prentice Hall
3	Mechanical vibrations	3rd Edition (2009)	Grover M.P	prentice hall of india
4	Theory of Machine	3rd Edition (2009)	Thomas Bevan	Pearson Education
5	Theory of Vibrations	2nd edition 1995	Thomson W T	Prentice Hall of India

V Semester

ME2304 – LAB : DYNAMICS OF MACHINERY

Objective	Course Outcome
To develop the concept of rigid body motion and impart knowledge of rigid body dynamics. To enables the students to analyze dynamic forces in mechanism. To introduce the concept of unbalanced forces need for balancing of various machines and the different ways to achieve balancing. To impart elementary knowledge of vibrations, its effect on machines .To prepares students for calculations of important parameters and vibration isolation	**On completion of this course, the student will be able to** 1) Differentiate static and dynamic forces on different machines and mechanisms. 2) Analyze the unbalanced in rotating & reciprocating machines and corrections required to balance the same. 3) Identify the vibrations in different machines. 4) Evaluate and justify vibrations

List of Practical
A set of 8 Experiments from following list to be performed.

1. Study of static and dynamic force analysis
2. Determination of Gyroscopic couple through motorized Gyroscope
3. Experiments on Governors - Pronell Governor, Hartnell Governor
4. Determination of Balancing of rotating mass, statically and dynamically.
5. Determination of natural frequency of longitudinal vibration
6. Determination of natural frequency of transverse vibration of beam.
7. Determination of natural frequency of simply supported beam using dunkerlays method.
8. Determination of natural frequency of torsional vibration of single rotor.
9. Determination of natural frequency of torsional vibration of double rotor.
10. Determination of whirling speed of shaft.

V Semester

ME2305 - PRODUCTION MANAGEMENT

Objective	Course Outcome
The course aims to develop an insight into working of production systems, their evaluation analysis and control. The overall objective is to learn to plan, design, execute or operate, control and measure the efficiency/ effectiveness of production systems.	Students will have i) Ability to estimate and evaluate manage production system using work study. ii) Ability to design and evaluate plant layouts. iii) Ability to predict and evaluate future demand using forecasting. iv) Ability to estimate production costing and apply by judging production planning and control.

Unit No.	Contents	Max. Hrs.
1	Work Study: Productivity, factors affecting productivity. Measurement of productivity. Work study and methods study: Definitions, objectives, steps in method study, Process charts, string diagram, motion study, micro motion study, SIMO Chart	7
2	Work measurement: Objectives, definition, stop watch study, work sampling, PMTs, MTM & Work factor method Value analysis and value Engineering:, Introduction, steps involved in value analysis. Applications in Manufacturing.	8
3	Plant Layout: Types of Plant Layout, Layout Functions and problems, Organization, Automated material handling, Concepts of AGVs, AS/RS and other automated devices. Design of integrated plant layout for product handling system.	8
4	Forecasting: Need for forecasting, classification of forecasting methods, like judgmental technique, time series analysis, least square method, moving average method, exponential smoothing method.	7
5	Production planning and control: Definition, objectives of PPC, functions of PPC, types of production, Inventory control, EOQ, Techniques in inventory control and associated problems.	7
6	**Process analysis and Cost Estimation:** Steps involved in manual production planning, Selection of process, analysis. Aims of Cost Estimation, Difference between cost and Estimation, Elements of cost: material, Product cost, Analysis of overhead expenses, Product cost estimation.	8

Text Books

SN	Title	Edition	Authors	Publisher
1	Introduction to Work study	4th Edition (1992)	George Kanawaty	ILO
2	Motion and Time study	1st Edition (1980)	Barnes	Wiley
3	Ergonomics	1st Edition (1985)	Murell	Chapman & Hall
4	Production Planning and Control	2nd Edition (2006)	Jain & Agrawal	McGraw-Hill
5	Industrial Engg. And Project management	2nd Edition (2006)	Mart and Telsang	S. Chand
6	Plant layout and Material Handling	1st Edition (1977)	James Apple	Wiley, Technology & Engineering

V Semester

ME2331 - OPERATION RESEARCH TECHNIQUES

Objective	Course Outcome
The course aims to develop the engineering - analysis capability for engineering-problems using basic statistical tools and techniques. Detailed treatment of various data analysis and handling technique leading to complete understanding and modeling the processes including its optimization is envisaged in this course.	**On completion of this course, the student will be able to** 1) Apply basic operations research techniques to formulate given situation as LLP and solving by graphical & simplex method 2) .To Solve Transportation and Assignment Models and analyze the concept of dynamic programming to Solve problems of discreet and continuous variables. 3) Analyze projects for minimum total cost and smooth level of resources. 4) Evaluation of different replacement policies and its application in operation research and analysis of the application of simulation, inventory control model and waiting line model

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PS	PS
CO	Apply basic operations research techniques to formulate given situation as LLP and solving by graphical & simplex method.	3				3	2			1				3	
CO	To Solve transportation and Assignment Models and analyse the concept of dynamic programming to Solve problems of discreet and continuous variables.	3				2	3			3				3	
CO	Analyze projects for minimum total cost and smooth level of resources.	3			2	2	2				2	3		3	
CO	Evaluation of different replacement policies and its application in operation research and analyse of the application of simulation, inventory control model and waiting line mode.	3				2	2	1	1			2	3	3	

V Semester

ME2331 - OPERATION RESEARCH TECHNIQUES

Unit No.	Contents	Max. Hrs.
1	Introduction to OR & Basic OR Models, Definition Characteristics and limitations of OR. Linear programming solutions (LPP) by graphical methods and simplex method. Sensitivity analysis. **(CO-1)**	7
2	Assignment Model and Transportation Model. **(C0- 2)**	7
3	Dynamic programming - characteristics, approach and its formulations. Application of Dynamic programming in Employment smoothening problem, Resource allocation, Inventory control & Linear programming. (CO- 2)	6
4	Project Management: Network Scheduling by CPM & PERT, Cost considerations in PERT and CPM. (CO- 3)	7
5	Replacement Models: Replacement of Models that deteriorate with time,Concept of equivalence , Interest Rate and Present worth. Replacement of items that fails suddenly considering Individual and Group replacement policy. (CO- 4)	4
6	Queuing Theory: Queuing Systems, Kendelalls for representing queuing models, Classification of queuing models (No derivations expected), Simulations, Monte- Carlo Simulation. Inventory Control with Deterministic models. (CO- 4)	6

Text Books

SN	Title	Edition	Authors	Publisher
1	Introduction to Operation Research: Computer Oriented Algorithmic approach	2007	Billy E.Gillet	Tata McGraw Hill Publishing Co. Ltd. New Delhi.
2	Operations Research	3rd edition 2008	Prem Kumar Gupta & D.S. Hira	S. Chand& Co.
3	Operations Research: Theory and Applications	2nd edition 2002	J.K. Sharma	Mac Millan
4	Introductory Operations Research	2006	S.C. Sharma	Discovery Publishing House
5	Optimization Theory and Application	2nd edition 2010	S.S. Rao	Halsted Press
6	Operations Research - An Introduction	9th Edition 2010	Hamdy A. Taha	Prentice Hall of India Pvt. Ltd., New Delhi.

V Semester

ME2332 - AUTOMOBILE ENGINEERING

Objective	Course Outcome
The main objective of the syllabus to understand basic knowledge about vehicle systems which are used in the regular automobiles. The modernization in automobile is also included to understand recent trend in the field.	1) Student will be able to analyze various systems of Engine, its function including fuel supply, cooling and lubrication system in vehicle. 2) Student will be able to describe various power transmission systems from clutch to wheel in vehicle. 3) Student will be able to evaluate and describe control systems like steering and brakes in vehicle. 4) Student will be able to illustrate and describe the necessary electrical and luxurious systems and safety system in vehicle.

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO
CO1	Student will be able to analyze various systems of Engine, its function including fuel supply, cooling and lubrication system in vehicle.	3	2												3
CO2	Student will be able to describe_various power transmission systems from clutch to wheel in vehicle.	3	2												3
CO3	Student will be able to evaluate and describe control systems like steering and brakes in vehicle.	3	2												3
CO4	Student will be able to illustrate and describe the necessary electrical and luxurious systems and safety system in vehicle.	3			2					2					3

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

BE SoE and Syllabus 2018

(Revised Scheme of Examination w.e.f. 2020-21 onward)

SoE No. ME-201

MECHANICAL EGNINEERING

V Semester

ME2332 - AUTOMOBILE ENGINEERING

Unit No.	Contents	Max. Hrs.
1	• Introduction, Automobile history and development and classification. Vehicles layout. • Engine Classification, construction and working 2 stroke and 4-stroke cycle. • Introduction to Fuel supply system: Carburettor and fuel injection.(Only basic) • Engine cooling and lubrication systems. [CO-1]	7
2	Clutch – Necessity, requirements of a clutch system. Types of Clutches: Single & multi plate clutch, Diaphragm clutch and centrifugal clutch. Gear box: Necessity of gear box with gear theory, working principle, Classification: Sliding mesh, constant mesh, synchromesh, and Transfer case gear box, Gear Selector mechanism, Defects and remedies in Gear box. Working of CVT (Continuous variable transmission) [CO-2]	6
3	• Transmission system: Propeller shaft, Universal joint, Hotchkiss drive, torque tube drive. • Differential - Need and working principle and Differential lock. • Rear Axles and Front Axles • Wheel and Tyres: Classification, various constituents of tyres with cross section, specification, factors affecting tyre performance [CO-2]	7
4	• Steering systems, principle of steering, steering linkages, steering geometry and wheel alignment, steering gear box and its types. • Brakes - Need, types: Mechanical, hydraulic (Master and wheel cylinder), Air brakes. Drum and Disc brakes, Comparison • Suspension systems – Function, conventional and Independent suspension System, Telescopic shock absorber. [CO-3]	6
5	• Electrical systems: Battery construction. Specification. Operation and maintenance of Batteries. • Alternator, starter motor, Battery Ignition and magneto ignition systems, Lighting, Horn, Side indicator , wiper.(only basic) • Automobile air-conditioning, • Panel board instruments. [CO-4]	6
6	• Resistance to vehicle motion: Air, Road and gradient resistance and power calculation. • Advances in automobiles such as ABS, Power Steering. • Safety aspect in Automobile. • Overall Vehicle specifications • Servicing, Overhauling and Engine tune up. [CO-4]	6

Text Books

SN	Title	Edition	Authors	Publisher
1	Automotive Technology		H.M.Sethi	Tata McgraHill
2	Automobile Engineering-I & II	First Edition - 2010	P.S.Gill	S.K.Kataria & sons
3	Automotive Mechanics		Joseph Heitner	
4	Motor Vehicle Technology		J.A. Dolan	
5	Automotive Engines		W.H. Crouse	

		June 2020	1.02	Applicable for AY2020-21 Onwards
Chaiperson	Dean (Acad. Matters)	Date of Release	Version	

V Semester

ME2333- PLASTIC ENGINEERING

Objective	Course Outcome
To Familiarize students with : 1) Various Plastic materials, their properties and Applications. 2) The various processing techniques of material, testing and applications of fibre reinforced plastics. 3) Learn the basic of machining and joining of plastics by various adhesions and welding techniques.	**Students will be able to :** 1) Students will be able to identify the plastic materials for some specified applications based 'on its property. 2) Students will be able to investigate suitable plastic Processing technique. 3) Students will be able to evaluate the suitable machining and joining **of plastic materials.**

Unit No.	Contents	Max. Hrs.
1	Chemistry and Classification of Polymers - Properties of Thermo Plastics - Properties of Thermosetting Plastics - Applications - Merits and Disadvantages.	7
2	Extrusion - Blow Molding – Thermo Forming – Rotomolding	8
3	Compression and Transfer Molding - study of compression molds	7
4	Injection Molding- study of injection molding machines and molds.	7
5	General Machining properties of Plastics - Machining Parameters and Their effect - Joining of Plastics -Mechanical Fasteners - Thermal bonding - Press Fitting. Testing of plastic	8
6	Fibers - Glass, Boron, Carbon, Organic, Ceramic and Metallic Fibers - Matrix Materials - Polymers, Metals and Ceramics. Open Mould Processes, Bag Molding, Compression Molding with BMC and SMC - Filament winding - Pultrusion - Centrifugal Casting - Injection Molding - Application of PMC's.	8

Text Books

SN	Title	Edition	Authors	Publisher
1	Plastic Engineering		Patten	
2	Plastic Processing		R. J. Crawfortd	
3	Plastics Extrusion technology	1988	F.Hensen,	
4	Injection Moulding Machines	1983	F.ohannaber	Hanser Publishers,
5	Polymer extrusion	1990	C.Rauwendaal,	Hanser Publishers,
6	Blow Moulding Handbook	1989	D.V.Rosatao,	Hanser Publishers,
7	Modern Plastics Moulding		E.B Seamour,	John Wiley.
8	Manufacturing Engineering & Technology	6th Edition (2013)	S Kalpakjian & SR Schmid	Pearson Education Canada
9	Machining of Plastics	1981	Akira Kobyashi,	Mc-Graw Hill.

V Semester

OE-I : ME2334- CONTROL SYSTEMS ENGINEERING

Objective	Course Outcome
• To develop an ability to define transfer function. • To analyze the performance of control system in time domain and frequency domain	**Students will be able to :** 1) Describe the mathematical representation of various control system components and determine the transfer function of mechanical, electrical, thermal and fluid system. 2) Analyse the construction and working of various control system components and electrical motors. 3) Evaluate the performance of control system using time response analysis and stability analysis. 4) Analyze the performance of control system on the basis of frequency response and design suitable compensation for the control system

Unit No.	Contents	Max. Hrs.
1	Introduction, System concept Open and Closed loop control systems. Transfer function, Mathematical Modeling of Physical System and system representation through Block Diagram. Transfer function through Block Diagram Simplification. Signal Flow Graph, Masons Gain Formula Block diagrams of various control systems.	7
2	**Representation of Control components:** Mechanical and Electrical components; Analogous systems; Thermal and Fluid systems.	7
3	**Electrical systems: -** ac/dc servomotors; field controlled and armature controlled servomotors; positional servomechanisms; stepper motors. **Hydraulic systems: -** Hydraulic pumps (gear; vane; and reciprocating piston) Cylinders, Direction control valves (2, 3, 4 way) Flow control valve; Relief valve Hydraulic servomotor.	8
4	Transient and steady state response of first and second order systems Concept of stability; relative stability; Routh stability criteria.	8
5	Frequency response and its characteristics; Bode plots; Nyquist plots. Gain margin and phase margin. Identification of system transfer function.	8
6	Basic control actions; Proportional Integral and Derivative control actions and their effect on system performance. Root locus technique. Introduction to control system design log load compensation Feed Back Compensation and Pole -Zero placements.	7

Text Books

SN	Title	Edition	Authors	Publisher
1	Modern Control Engineering	3rd Edition (2009	Ogata	Prentice Hall
2	Control system Engineering	4th Edition (2007)	Nise	John Wiley & Sons
3	Control system	4th Edition (2009)	Nagrath & Gopal	New Age International
4	Modern Control System	12th Edition (2009)	Dorf	Pearson

V Semester

OE-II : ME2341- TOTAL QUALITY MANAGEMENT

Objective	Course Outcome
• The course aims to build an overall capability to understand Quality and its relevance in today's dynamic market. • Various Quality Improvement tools and technique shall be introduced and practiced so as to develop skills and knowledge to function as a good quality professional in the Engineering Profession.	**Students will be able to :** 1) Develop an understanding on quality management philosophies and frameworks. 2) Develop in-depth knowledge on various tools and techniques of quality management. 3) To Evaluate the applications of quality tools and techniques in both manufacturing and service industry 4) Ability to use quality management methods analyzing and solving problems of organization.

Unit No.	Contents	Max. Hrs.
1	Principles of Quality Management, Pioneers of TQM, Quality costs, Quality system Customer Orientation, Benchmarking, Re-engineering	7
2	Leadership, Organizational Structure, Team Building, Information Systems and Documentation – Quality Auditing, ISO 9000 - QS 9000.QMS, Quality awards.	7
3	Single Vendor Concept, J.I.T., Quality Function deployment, Quality Circles, KAIZEN, SGA POKA - YOKE, Taguchi Methods. SMED, Kanban system. Cost of quality. Robust design	8
4	Methods and Philosophy of Statistical Process Control, Control Charts for Variables and Attributes	8
5	Cumulative sum and exponentially weighted moving average control charts, Others SPC Techniques – Process Capability Analysis. Acceptance Sampling Problem, Single Sampling Plans for attributes, double, multiple and sequential sampling,]	8
6	Six sigma manufacturing concepts. Six-sigma philosophy Quality strategy and policy. Motivation and leadership theories. Continuous vs. breakthrough improvements. Management of change, DMAIC Methodology. Lean manufacturing	7

Text Books

SN	Title	Edition	Authors	Publisher
1	Total Quality Management for Engineers	1991	Mohamed Zairi	Woodhead Publishing Limited 1991
2	Production and Operations mangament - Total Quality and Responsiveness	1995	Harvid Noori and Russel	McGraw-Hill Inc, 1995
3	Managing for Total Quality	1998	N.Logothetis	Prentice Hall of India Pvt .Ltd,1998
4	The Essence of Total Quality Management	1995	John Bank	Prentice Hall of India Pvt.Ltd., 1995.
5	Introduction to Statistical Quality Control	1991	Douglus C. Montgomery	2nd Edition, John Wiley and Sons, 1991.
6	Statistical Quality Control	1984	Grant E.L and Leavensworth	McGraw-Hill, 1984.

V Semester

OE-II : ME2342- RELIABILITY ENGINEERING

Objective	Course Outcome
1) To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply a few well understood basic principles to find its solution. 2) Learn how to get higher operating plant and equipment reliability that lifts efficiency and output of operating assets, stops equipment failures and creates higher plant and equipment reliability, with this subject.	1) Student will be able to use reliability modeling as a tool for evaluating system performance. 2) Student will be able to analyze the failure of a machine, determine the failure rate of systems or components. 3) Student will able to understand importance of the maintenance of engineering systems and factors affecting maintainability. 4) Student will be able to prepare the production & maintenance schedule of particular engineering system.

Unit No.	Contents	Max. Hrs.
1	**Fundamental concepts:-** Reliability definitions, failure, Failure density, Failure Rate, Hazard Rate, Mean Time To Failure, MTBF, maintainability, availability , safety and reliability, Quality, cost and system effectiveness, Life characteristic phases, modes of failure, Quality and reliability assurance rules, product liability, Importance of Reliability,	7
2	**Probability theory:-** Set theory, laws of probability, total probability theorem, probability distributions, parameters and applications.	7
3	**System reliability and modeling:** Series and parallel components, mixed configuration, complex systems. Redundancy, element redundancy, unit redundancy, standby redundancy. Types of stand by redundancy, parallel components. Markov models for reliability estimation.	8
4	Maintainability and Availability: Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system down time. Availability - Inherent, Achieved and Operational availability, reliability and maintainability trade-off. Markov models for availability estimation.	8
5	System reliability Analysis: Reliability allocation or apportionment. Reliability apportionment techniques . Reliability block diagrams and models. Reliability predictions. Life testing and accelerated testing.	8
6	Strength based reliability: Safety factor, safety margin, Stress strength interaction, Failure Mode, Effects and Criticality Analysis-, , FMECA examples, Ishikawa diagram .fault tree construction, basic symbols development of functional reliability block diagram, Fault tree analysis, fault tree evaluation techniques, Design of Mechanical components and systems:-Material strengths and loads.	7

V Semester

OE-II : ME2342- RELIABILITY ENGINEERING

Text Books				
SN	**Title**	**Edition**	**Authors**	**Publisher**
1	Concepts of Reliability Engg	1985	L.S. Srinath	Affiliated East-Wast Press (P) Ltd
2	Reliability Engineering	1983	A.K. Govil	Tata McGraw-Hill Publishing Co. Ltd
3	Reliability Engineering	1984	E. Balagurusmy	Tata McGraw-Hill Publishing Co. Ltd
4	Engineering Reliability	1980	B.S. Dhillion, C. Singh	John Wiley & Sons
5	Probabilistic, Reliability	1968	M.L. Shooman	McGraw-Hill Book Co.,
6	Practical Reliability Engg	1985	Patric D.T.O'connor	Heyden and sons ltd.
7	Reliability in Engineering Design	1977	K.C. Kapur, L.R. Lamberson	John-Wiley and sons.
8	Reliability Engineering, Theory and Practice	3rd Edition, 1999	A.Birolini	Springer,

V Semester

OE-II : ME2343- POWER GENERATION ENGINEERING

Objective	Course Outcome
The main objective of the syllabus to understand basic knowledge about vehicle systems which are used in the regular automobiles. The modernization in automobile is also included to understand recent trend in the field.	1) Student will be able to describe basics of power generations systems. 2) Student will be able to analyze various conventional & non-conventional power plants. 3) Student will be able to analyze and examine combined operations of different power plants. 4) Student will be able to evaluate and describe Hydroelectric power plant nuclear power plant

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO
CO1	Student will be able to describe basics of power generations systems.	3	2											3	
CO2	Student will be able to analyze various conventional & non-conventional power plants.	3	2											3	
CO3	Student will be able to analyze and examine combined operations of different power plants.	3	2											3	
CO4	Student will be able to evaluate and describe Hydroelectric power plant nuclear power plant	3			2					2				3	

Unit No.	Contents	Max. Hrs.
1	**THERMAL POWER PLANT- I** Introduction to thermal power plants and power plant layouts. Site selection. Fuel characteristics, handling, storage, preparation & firing methods. Ash & dust collection and handling. • Boiler: classification, general arrangement, details of different components and system like draught system, steam turbine systems, condenser, cooling towers **[CO-1]**	7
2	**THERMAL POWER PLANT- II** Gas Turbine Power Plant: -Introduction, power plant layouts, Open cycle, close cycle power plants. Various components and systems. Methods to improve efficiency. Reheat and Regeneration cycle and their combinations Diesel Electric Power Plant: - Introduction, Outline, type of engines, different components, performance, plant layout. Comparison with other power plant. (visit to nearby power plant shall be arrange for the students) **[CO-2]**	8

3	**HYDROELECTRIC POWER PLANT.** Hydrology: - Rainfall, Runoff, Hydro graph, flow duration curve, mass curve. Hydroelectric power plant: - Site selection, classification of hydroelectric power plant, general arrangement, details of different components, turbine selection.Governing. • Comparison with other power plant. **[CO-2]**	7
4	**POWER PLANT ECONOMICS** Load Analysis - Fluctuating Load on power plants, Load curves, various terms & definition, peak load, effect of fluctuating load. • Economic Analysis: - Cost of electric energy **[CO-3]**	8
5	**NUCLEAR POWER PLANT** Introduction to Nuclear Engineering, Global scenario, prominent installations worldwide, present & proposed nuclear plant in India. Nuclear Reactors: - Types of reactors, PWR, BWR, CANDU, Gas cooled, liquid metal cooled, Breeder reactor. Operational requirements and difficulties, site selection for location of a nuclear power station Nuclear Waste Disposal. • Comparison with other power plant. **[CO-4]**	8
6	**COMBINED OPERATION OF DIFFERENT POWER PLANTS** Combined operation: - Need division, combination of different plant & their coordination, advantages. **NON CONVENTIONAL POWER GENERATION SYSTEMS** Introduction to Non Conventional power Generation Systems • Geo-Thermal Power Plant, Tidal Power Plant, Wind Power Plant, Solar Power Plant. **[CO-4]**	7

Text Books

SN	Title	Edition	Authors	Publisher
1	Power Plant Engineering	2002	Domkundwar.	Dhanpat Rai & Co.
2	Power Plant Engineering	2007	Vopal & Slortzki	
3	Power Plant Engineering	2010	P K Nag	

V Semester

OE-II : ME2344- PROJECT EVALUATION & MANAGEMENT

Objective	Course Outcome
The course focuses on developing complete understanding of formulating a problem/project and finding possible solutions against the given constraints. The overall learning shall resolve project identification evaluating its technical and economic feasibility and developing skills for its planning, and establishing controls. Relevant techniques, writing skills and monitoring methods shall be dealt with in details.	**The students will be able** 1) To apply the concepts of monitoring and evaluation, appraise 2) To analyse the best monitoring methods, appreciate evaluation in the context of developmental project work 3) To perform problem analysis, determine relevant indicators and data necessary for evaluation, 4) Implement a monitoring and evaluation process, establish baselines and targets..

Unit No.	Contents	Max. Hrs.
1	**Project Identification** considering objectives and SWOT analysis, Screening of Project Ideas, Technical, Market, Financial, Socioeconomic and Ecological Appraisal of a project demand forecasting, secondary data, accuracy, confidence level, uncertainty	7
2	**Technical feasibility**: Process selection, Level of automation, plant capacity, acquiring technology, Appropriate technology plant location, Equipment selection & procurement, Govt. policies. Value analysis and project evaluation:	7
3	**Economic feasibility:** Cost of Project, working capital analysis, fixed cost, means of finance, estimation of sales & production price analysis, Breakeven point, Projected cash flow statements, projected balance sheet, projected profit & loss statement, projected cash flow, rate of return, Discounted payback period, cost benefit analysis, return after taxes.	9
4	**Project Planning and Control:** Work break down structure and network development. Basic Scheduling, Critical Path and four kinds of floats. Scheduling under probabilistic durations, Time Cost tradeoffs, CPM, PERT, Optimum project duration, resource allocation, updating	7
5	**Project report:** Preparation of project report, risk analysis, sensitivity analysis, methods of raising capital	7
6	Initial review, performance analysis, ratio analysis, sickness, project revival, Project Monitoring with PERT/Cost, Organizational aspects, Computer packages and Project Completion environ-mental & social aspects**.**	8

Text Books

SN	Title	Edition	Authors	Publisher
1	Projects	7th Edition 2007	Prasanna chandra	Tata mc graw Hill publishing company Ltd.
2	CPM & PERT		L. S. Srinath	East West publisher
3	Projects	1963	P.K. Joy	Macmillon
4	Engineering Economy	5th edition	H. G Thuesen, W J Fabricky, G,J, Thuersen	Prentice-Hall
5	Finance series 'Project management' , Vol-I1 and Vol-III	2009	ICFAI	ICFAI,Press Hyderabad
6	Finance Management	6th Edition 2010	M.Y.Khan	Tata McGraw hill
7	Financial Management	4th Edition	Chandra, Prasanna	Tata McGraw-Hill Education, 1997
8	Engineering Economics	8th Edition	G. J. Thuesen, Wolter J. Fabrycky	Prentice Hall, 1993

		June 2020	1.02	Applicable for AY2020-21 Onwards
Chaiperson	Dean (Acad. Matters)	Date of Release	Version	

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

BE SoE and Syllabus 2018

(Revised Scheme of Examination w.e.f. 2020-21 onward)

SoE No. ME-201

MECHANICAL EGNINEERING

V Semester

OE-II : ME2343- POWER GENERATION ENGINEERING

Objective	Course Outcome
The course focuses on developing complete understanding of formulating a problem/project and finding possible solutions against the given constraints. The overall learning shall resolve project identification evaluating its technical and economic feasibility and developing skills for its planning, and establishing controls. Relevant techniques, writing skills and monitoring methods shall be dealt with in details.	**The students will be able** 5) To apply the concepts of monitoring and evaluation, appraise 6) To analyse the best monitoring methods, appreciate evaluation in the context of developmental project work 7) To perform problem analysis, determine relevant indicators and data necessary for evaluation, 8) Implement a monitoring and evaluation process, establish baselines and targets..

Unit No.	Contents	Max. Hrs.
1	**Project Identification** considering objectives and SWOT analysis, Screening of Project Ideas, Technical, Market, Financial, Socioeconomic and Ecological Appraisal of a project demand forecasting, secondary data, accuracy, confidence level, uncertainty	7
2	**Technical feasibility**: Process selection, Level of automation, plant capacity, acquiring technology, Appropriate technology plant location, Equipment selection & procurement, Govt. policies. Value analysis and project evaluation:	7
3	**Economic feasibility:** Cost of Project, working capital analysis, fixed cost, means of finance, estimation of sales & production price analysis, Breakeven point, Projected cash flow statements, projected balance sheet, projected profit & loss statement, projected cash flow, rate of return, Discounted payback period, cost benefit analysis, return after taxes.	9
4	**Project Planning and Control:** Work break down structure and network development. Basic Scheduling, Critical Path and four kinds of floats. Scheduling under probabilistic durations, Time Cost tradeoffs, CPM, PERT, Optimum project duration, resource allocation, updating	7
5	**Project report:** Preparation of project report, risk analysis, sensitivity analysis, methods of raising capital	7
6	Initial review, performance analysis, ratio analysis, sickness, project revival, Project Monitoring with PERT/Cost, Organizational aspects, Computer packages and Project Completion environ-mental & social aspects**.**	8

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Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering

SoE & Syllabus 2018

6th Semester

Mechanical Engineering

28 June 2019

VI Semester
GE2312 - Fundamental of Economics

Objectives	Outcome (Students will be able to)
Recognizes consumer's behavior and pricing.	Relate their buyer behaviour to particular product and the pricing in the market.
Extrapolates an operations in market with productions constrain.	Examine and classify various market structure and factors of production and its role in production process.
Describes the national income accounting and public finance.	Analyse the national income accounting and the various issues related to banking, taxation, and inflation.
Interprets international trade and institutions.	Elaborate about international economics, foreign trade and its agreement, export, foreign exchange and the various international financial institutions.

UNIT-1: Introduction to Economics and Consumers' Behaviors:
Definitions, meaning and importance of economics Utility analysis: concept and measurement (cardinal and ordinal), Law of diminishing marginal utility, exceptions to law of diminishing marginal utility, law of equi-marginal utility, Indifference curve analysis: Meaning and properties of indifference curve, marginal rate of substitution, budget constraint, Complement and substitute goods, Consumer's equilibrium. Demand Analysis: Meaning and determinants of demand, law of demand, exception to law of demand, Elasticity of Demand-price, cross and income elasticity, measurement of elasticity of demand. **(8 Hours)**

UNIT-2: Production and Costs
Factors of Production: Land, Labour, Capital, Enterprise and their peculiarities, Importance of Capital in production process. Entrepreneur and Innovations, Product and Process innovations, Concepts and types of costs: Fixed vs variable, total, average and marginal costs, Short run and long run cost curves. Law of Variable proportions (Law of diminishing marginal returns) and Return to Scale (Increasing, constant and decreasing), Economies and diseconomies of scale. Depreciation: Meaning and various method of calculating depreciation. **(6 Hours)**

UNIT-3: Market structures - equilibrium output and price
Forms of market structures: Perfect competition, monopolistic competition, oligopoly, duopoly and monopoly, Demand and revenue curves for firm and industry in various forms of market structure, Total, average and marginal revenue curves, equilibrium of firms and industries under various forms of market structures, Price discrimination - Degrees and conditions of discrimination. **(7 Hours)**

UNIT-4: National income accounting:
Concepts of GDP and GNP, Estimation of GDP and GDP at factor and market prices, at constant and current prices, difference between GDP and NDP, GNP and NNP, per capita income as a measure of economic well-being, concepts of economic growth and development, Factors affecting economic growth and development. Capital formation and accumulation. **(5 Hours)**

UNIT-5: Money, Banking and Public Finance
Money: definition, functions and role, Evolution of money, Banking- reserve ratios and credit creation by commercial banks, Functions of a central bank and instruments of credit control, Functions of money market. Inflation: Meaning, types, causes and consequences, measures to control inflation, Concepts of deflation and Stagflation. Sources of public revenue and forms of government expenditure, Taxation: Cannons of taxation. Classification of taxes-Direct (Income tax, Wealth tax, Corporation tax, tax on capital, capital gains, etc) and Indirect Taxes (GST, Import duties), Revenue and capital expenditure.

(7 Hours)

VI Semester
GE2312 - Fundamental of Economics

UNIT-6: International Trade and Institutions

Definitions of closed vs. open economy, small open economy, Concept of exchange rate- Fixed, flexible and managed, Role of Multilateral institutions, viz., IMF, World Bank, WTO (GATT) in promoting, Trade, growth and international financial transactions. **(5 Hours)**

Text Books:

1. Modern Economics: H. L. Ahuja, 13th Edition, S. Chand Publisher, 2009.
2. Modern Economic Theory: K. K. Devett, 3rd edition, S. Chand Publisher, 2007

Reference Books:

1. Advance Economic Theory: H. L. Ahuja, 17th Edition, S. Chand Publisher, 2009.
2. International Trade: M. L. Zingan, 12th edition, Vindra Publication, 2007.
3. Macro Economics: M. L. Zingan, 11th edition, Vindra Publication, 2007.
4. Economics: Samuelson,
5. Monitory Economics: M. L. Sheth, 1st Edition, Himayalaya Publisher, 1995.
6. Economics of Development and Planning: S. K. Misra and V. K. Puri, 12th edition, Himalaya Publishing House, 2006.

VI Semester
ME2351 - Fluid Machines

Objective	Course Outcome
Students should apply the fundamentals of fluid dynamics and thermodynamics to compressors. To understand basic cycles, types and components of I.C. Engines. To understand the basics of refrigeration, air conditioning.**[a,e,k]**	**CO:1** The student will be able to describe and analyze the working of Positive Displacemnt Pumps .[a,e,k]
	CO:2 The student will be able to describe and analyze the working Centrifugal Pumps .[a,e,k]
	CO:3 The student will be able to define evaluate Static and Stagnation properties and; describe and analyze the compressible flow.[a,e,k]
	CO:4 The student will be able to describe and analyze the working of compressors.[a,e,k]

Unit No.	Contents	Max. Hrs.
Unit 1	Classification of Positive displacement Pumps: Study of Rotary pumps such as vane pump, Gear pump and Screw pump. Reciprocating pumps: Basic principle, types, Main components, Slip, Work done. Indicator diagrams, Separation, Air vessels **[CO:1]**	**[8 hrs]**
Unit 2	Centrifugal Pumps: Components and Principles of operation, Classification, Priming, Fundamental equation, Various heads, Velocity triangles and their analysis, Effect of outlet blade angle, Vane shapes, Losses & efficiencies of pumps, N.P.S.H , Cavitations in pumps, Performance characteristics [**CO:1]**	**[7 hrs]**
Unit 3	Reciprocating compressors: - Parts, Operations, Work done during isothermal, polytropic & adiabatic compression process, P-V diagram, isothermal efficiency, Effect of clearance, volumetric efficiency, Mechanical efficiency. Multistaging in reciprocating compressor, condition for minimum work input, capacity control, Actual indicator diagram [**CO:1]**	**[8 hrs]**
Unit 4	Compressible Flow: Stagnation properties, speed of sound wave, Mach number, one dimensional isentropic flow, Stagnation properties, Isentropic flow through convergent-divergent nozzles, Adiabatic Expansion in Nozzles, Maximum Discharge Critical Pressure Ratio and effects of Friction, Calculation of Throat and Exit Areas, [**CO:2]**	**[7 hrs]**
Unit 5	Centrifugal compressor:-Principle, operation, parts, velocity diagram, static & stagnation quantities, work done by impeller, isentropic efficiency of compressor. Slip factor, pressure coefficient and power input factor. [**CO:3]**	**[7 hrs]**
Unit 6	Axial flow compressor:-Principle, operation, parts. Velocity diagram, work done, degree of reaction stage efficiency compressor characteristics, surging & chocking. [**CO:4]**	**[8 hrs]**

VI Semester
ME2351 - Fluid Machines

Reference books:				
1	Thermal Engineering	20 Edition (1994)	P.L.Ballaney	Khanna Publication
2	Thermal Engineering and heat engines	(1994)	R.Yadav	Central Publishing house
3	Heat power engg	3rd Edition (Yr of publication)	Kumar & Vasandani	Metro Politon Publisher
4	IC Engine	3rd Edition (2008)	V. Ganeshan	Tata McGraw Hill
5	Refrigeration & Air Conditioning	2nd Edition (2000)	C.P. Arora	Tata McGraw Hill
6	Internal Combustion Engines	3rd Edition (1968)	E.F. Obert	International Textbook Co.
7	Gas Turbine	5th Edition (1992)	Dubey & Khajuria	Dhanpat Rai Publications
8	Thermal Engineering	8th Edition (2010)	R.K.Rajput	Laxmi Publication

VI Semester
ME2352 - Fluid Machines Lab

List of Practical

A set of 8 Experiments from following list to be performed.

1) Study of Positive Displacement Rotary Pumps
2) **Trial on Reciprocating Pump**
3) **Trial on Centrifugal Pump**
4) Trial on reciprocating compressor **[CO:1]**
5) Trial on rotary Blower. **[CO:1]**
6) **Trial on Pelton wheel [CO:2]**
7) **Trial on Francis Turbine**
8) **Trial on Kaplan Turbine**
9) Performance testing of a single cylinder I.C. Engine. **[CO:2]**
10) Trial on Petrol Engine with energy balance sheet. **[CO:2]**
11) Heat balance on Multicylinder Diesel Engine. **[CO:2]**
12) Performance on Vapor Compression Refrigeration System (VCRS). **[CO:3]**
13) Performance on air-conditioning system. **[CO:4]**

1. Mapping:

MAPPING **COURSE OUTCOMES** (**CO's**) LEADING TO THE ACHIEVEMENT OF **PROGRAM OUTCOMES (PO's)**:

	PO's												
CO's	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***
i	*3*		*3*		*3*							*3*	*3*
ii	*3*		*3*		*3*							*3*	*3*
iii	*3*		*3*		*3*							*3*	*3*
iv	*3*		*3*		*3*							*3*	*3*
Avg.	**3**		**3**		**3**							**3**	**3**

Correlation levels 1,2 or 3 as defined below:
1: Slight (Low)
2: Moderate (Medium)
3: Substantial (High)

VI Semester
ME2353 –Computer Aided Design LAB

Objectives:	Course outcomes:
To educate students on -Main concepts of computer aided design -Graphics representation of curves. -Surface and solids.	Students will be able to: 1. Distinguish the various CAD CAM tools and also evaluate criteria for CAD CAM systems 2. Design 2D and 3D Transformation matrices 3. Calculate and analyse the parametric equations for wire frame. surface and solid modeling entities. 4. Design the applications of modeling and evaluate data exchange formats

List of Practical

A set of 10 Experiments from following list to be performed.

1. Introduction to CAD software.
2. Simple examples of two dimensional transformations
3. Simple examples on three dimensional transformations.
4. Programs on 2-D transformations- scaling, rotation, reflection and translation
5. 3-D Wireframe object modeling using any CAD software.
6. Generation of analytical curves using any CAD software
7. Generation of synthetic curves using any CAD software
8. Basics of surface modeling using Extrude, Revolve, fill, sweep, variable section sweep commands using any CAD software.
9. Creating fill surfaces, lofted multi-section surfaces, blended surfaces using any CAD software.
10. Analyzing the curve and surface quality using any CAD software.
11. Generation of at least two simple solid models showing geometric properties using any CAD software.
12. To generate at least two simple assembly model using any CAD software.
13. Solid model generation using feature based modeling using any CAD software
14. Drafting of the solid models previously developed in any CAD software.**[a,e,k]**
15. Programs on windowing and clipping.**[a,e,k]**

VI Semester
ME2354 – Design of Mechanical Drives

Objectives:	**Course Outcome:**
To develop the concept of drive system and impart knowledge of various components of industrial drives. To enable the students in selecting proper drive system. To make the students capable of selecting proper gear drive and design the components of geared system. To emphasize the need of reducing cyclic fluctuations in speed by providing appropriate flywheel. To enable to take up small projects in design of haulage system.	Students will be able to: 1. Dscribe the design process, material selection & calculations of stresses in flat belt, V belt, chain drive and rope drive, and finding its ailure criteria. 2. Design the various gear drive such as spur, helical, worm & worm wheel and bevel gears, and finding its failure criteria. 3. Summarize the knowledge on shafts, coupling and flywheel and finding its failure criteria. 4. Evaluate the radial and thrust load for journal bearings, antifriction bearings and finding its failure criteria.

Unit No.	Contents	Max. Hrs.
Unit 1	**Flat belt drive:** Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley. **V belt drive:** Types of V-belt, analysis of V-belt tension, design of V belt pulley.	**[8 hrs]**
Unit 2	**Chain Drive:** Design of roller chain drive, types of chain, concept of chordal action, lubrication ,types of sprocket, **Rope drive:** Introduction to haulage system, construction of rope, design of wire rope, sheave and drums Electric motor rating, their Characteristics, controls, selection motors.	**[7 hrs]**
Unit 3	**Gear drive:** Review of Kinematics of gears & terminology, interference, tooth profiles, formative number of teeth etc. Bukingham equation, design of spur gear drive, helical gear drive.	**[8 hrs]**
Unit 4	**Worm gear drive:** Types and proportion of worm and worm gear, force analysis, beam strength of worm gear teeth, dynamic tooth load, wear load, thermal rating of worm gear, design of worm and worm gear. **Bevel gear drive:** Types of bevel gear, proportions of bevel gear, force analysis of bevel gear drive design of bevel gear drive.	**[8 hrs]**
Unit 5	**Coupling: Types of shaft coupling, design of flange coupling, flexible bush coupling.** Flywheel: Coefficient of fluctuation of energy and Coefficient of fluctuation of speed, energy store in flywheel, stresses in flywheel, design of flywheel.	**[7 hrs]**
Unit 6	**Bearing:** Surface finish, friction wears, lubrication, oil seals, design of journal bearings for radial and thrust loads, selection of ball and roller bearing for radial and thrust loads. Failures of antifriction bearing, design of hydrostatic pocket type thrust bearing such as circular step thrust bearing, bearing housing.	**[7 hrs]**

VI Semester
ME2354 –Design of Mechanical Drives

Text books:				
1	Mechanical Design of Machine	4th Edition (1965)	Maleev, Hartman	International Textbook Co.
2	Machine Design	3rd Edition (1968)	Black P.H	Tata McGraw Hill
3	Mechanical Engg. Design	8th Edition (2008)	Shigley	Tata McGraw Hill
4	Design Data book	1st Edition (2005)	Shiwalkar B.D	Central Techno Publication
5	Design of Machine Elements	Edition (Yr of publication)	Bhandari V. B	Publisher
6	Machine Design	2nd edition	Norton	McGraw publication

Reference books:				
1	Hand book of Machine Design	3rd Edition (2004)	Shiglay&Mischke	Tata McGraw Hill
2	Mechanical Engineering Hand book (Vol 1 & 2)	Vol 1: 12 Edition (1950) Vol 2: 11Edition	Kent	J.Wiley& Sons inc
3	PSG. Tech. Machine Tool Design Data Book	(1966)	CMTI	PSG College of Technology

VI Semester
ME2361 – PE-I : Finite Element Method

Objective	Course Outcome
To develop ability to analyze simple mechanical engineering problems. To understand and apply basic governing principals in logical manner to find solutions. [e]	(I) The students will be able to understand fundamentals of finite element method.[e]
	(II) The students will be able to analyse the Mechanical engineering problems[e]
	(III) The students will be able to find solutions for simple mechanical Engineering problems.. [e]
	(Iv) The students will be able to analyze structure.. [e]

Unit No.	Contents	Max. Hrs.
1	Fundamentals of stress & strain, stress & strain components, stress strain relationship, Elastic constants, plane stress, plane strain., differential equation of equilibrium, compatibility equations, boundary conditions, Saint Venant's principle.	7
2	Fundamental concepts of FEM -' Historical background, Scope of FEM in Engg. Applications, Principle of minimum potential energy. Concept of Virtual work. Raleigh-Ritz method. FEM analysis procedure. Mathematical understanding required for FEM, Matrix algebra & operations, Eigen values & Eigen vectors. Methods for solution of simultaneous equations. like Gauss elimination. Matrix decomposition method. Concept of discritization of body into elements. degrees of freedom, bandwidth, Basic types of 2-D & 3-D elements, displacement models, convergence requirements, shape function. Programming for above matrices	7
3	Finite element modeling and analysis of one dimensional problems: Finite element modeling & analysis using Bar & Beam element -stiffness matrix, assembly, boundary conditions, load vector, temperature effects. Two dimensional plane trusses-Local & Global coordinate system, element stiffness matrix, assembly, boundary conditions, load vector, force & stress calculations. Programming for simple bar and beam elements.	8
4	Two dimensional problems using CST & LST -formulation of CST & LST elements, elemental stiffness matrix, assembly, boundary conditions, load vector. stress calculation. Temperature effect . Axi-symmetric solids subjected to axi-symmetric loading -axi-symmetric formulation using CST ring, element, stiffness matrix, boundary conditions, load vector, calculation of stresses. Programming for simple 2-D problems using CST and LST elements.	8
5	Introduction to Isoperimetric & Higher order elements. Introduction to Numerical Integration. Introduction to dynamic analysis, formulation of mass matrix for one-dimensional bar element, free vibration analysis using one-dimensional bar element. Torsion of prismatic bars using triangular elements. Programming for these elements.	7
6	Application of commercial software for simple machine elements and interpretation of results.	8

VI Semester
ME2361 – PE-I : Finite Element Method

Text books:				
S.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Introduction to Finite Elements in Engineering	4th edition 2011	Chandrupatla T.R; Belegundu AD	Pearson Education
2	Theory of Elasticity	2nd edition 1951	Timoshenko S.P	Tata McGraw-Hill Education
3	Concept and applications of Finite element Analysis	2nd edition revised, 2010	Cook RD	I. K. International Pvt Ltd
4	The Finite Element Method -A basic introduction for engineers	2nd edition	Griffiths D. W; Nethercot D.A	BSP Professional, 1983
5	Finite element methods	6th edition, 2005	O. C. Zienkiewicz, Richard Lawrence Taylor, Perumal Nithiarasu, J. Z. Zhu	Butterworth-Heinemann
6	Applied elasicity	--	Chi The Wang	Amazon
7	Finite to Infinite	--	--	Infinite seris

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	Study, analyse and develop the fundamentals of Finite Elements Method for mechanical engineering problems.	3	3			3	2	1	1	2	1	1		3	1
CO2	Evaluate the stresses, strains and deformation in simple machine elements and design solutions for simple problems.	3	3	3		3	3	1	1		1	1	1	3	3
CO3	Build the solutions using the commercial softwares for simple machine elements.	3	3			3	2	1	1	2	1	2	1	3	3
CO4	PE-III: Lab: FINITE ELEMENT METHOD	3	3			3	2	1	1	2	1	1		3	1

VI Semester
ME2362 – PE-I : Lab: Finite Element Method

Objectives:	Course outcomes:
• To develop an ability to analyze simple mechanical engineering problems using analysis software • To examine and build the solutions using the commercial softwares for simple machine elements [PO-1,2,3,5,6,7,8,9,10,11,12,PSO-1,2]	*After completion of the course students would be able to* **1.** Study, analyse and develop the fundamentals of Finite Elements Method for mechanical engineering problems. **2.** Evaluate the stresses, strains and deformation in simple machine elements and design solutions for simple problems. **3.** Build the solutions using the commercial softwares for simple machine elements.

List of Practical:-

1. To study about Finite Element Methods **[PO-1,3,5,6,7,8,9,10,11,PSO-1,2]**
2. To determine stress and strain in 1-D bar element **[PO-1,2,3,5,6,7,8,9,10,11,12,PSO-1,2**
3. To determine stress and strain in Composite element **[PO-1,2,3,5,6,7,8,9,10,11,12,PSO-1,2]**
4. To determine principle stress and strain in CST element **[PO-1,2,3,5,6,7,8,9,10,11,PSO-1,2]**
5. To determine stress and strain in CST element **[PO-1,2,3,5,6,7,8,9,10,11,12,PSO-1,2]**
6. To study the performance of structural tutorial **[PO-1,3,5,6,7,8,9,10,11,PSO-1,2]**
7. Deflection of Beam (Simply Supported Beam) **[PO-1,2,3,5,6,7,8,9,10,11,12,PSO-1,2]**
8. Tutorial of 2D truss analysis in Mechanical APDL (Ansys). **[PO-1,2,3,5,6,7,8,9,10,11,2,PSO-1,2]**

VI Semester
ME2363 – PE-I : Industrial Fluid Power

Objective	Course Outcome
• To understand the working principle of hydraulic and pneumatic components and its selection. • To design hydraulic and pneumatic circuits for different applications.	1) To **investigate** the hydraulic fluids and **apply** the fluid power laws and principals for **analysis** of simple fluid power system. 2) To **identify**, **analyze**, and **justify** selection of suitable components of fluid power system for specific applications based on its function, performance and working characteristics. 3) To **design** and **examine** the fluid power system and to **compose** and **interpret** its circuit diagrams **using** standard symbols. 4) To **examine** the safety measures, maintenance, and trouble shooting for fluid power systems.

Unit No.	Contents	Max. Hrs.
1	**Fluid power systems:** Components, advantages, applications in the field of M/c tools, material handling, hydraulic presses, mobile & stationary machines, clamping & indexing devices etc. **Transmission of power at static & dynamic states**. Pascal's law and its application to hydraulics, Bernoulli's principle , continuity equation, analysis of simple hydraulic jack . **Types of Hydraulic fluid,** petroleum based, synthetic & water based. Properties of fluids. Selection of fluids, additives, effect of temperature & pressure on hydraulic fluids, SAE grades and ISO viscosity numbers. **Filters**, strainers, types and sources of contamination of fluid & its control, effects, ISO contaminant code. JIC symbols/ISO Symbols for hydraulic & pneumatic circuits. **Hydraulic Reservoirs and Power Pack** : functions and its elements, standard designs.	5
2	**Pumps:** Types, classification, principle of working & constructional details of pumps used in Hydraulic system such as vane pump, gear pumps, radial & axial plunger pumps, power and efficiency calculations, characteristic Curves, selection of pumps for hydraulic power transmission. **Accumulators & Intensifiers**: Types & functions of accumulators & intensifiers, applications, selection & design procedure.	6

VI Semester
ME2363 – PE-I: Industrial Fluid Power

Unit No.	Contents	Max. Hrs.
3	**Unit 3** **[5 hrs]** **Control Of Fluid Power:** Necessity of pressure control, directional control and flow control valves, **methods of actuation of valves.** **Pressure Control Valves**: Principle of pressure control valves, types, constructional features, direct operated, pilot operated, relief valves, pressure reducing valve, sequence valve. **Flow Control Valves:** Principle of operation, types, constructional features, pressure compensated, temperature Compensated flow control valves, meter in & meter out flow control circuits, bleed off circuits. **Direction Control Valves:** constructional features , types, Check valves, types of D.C. valves:- Two way two position, four way three position, four way two position valves, open center, close center, tandem center valves, method of actuation of valves, manually operated, solenoid operated, pilot operated etc	5
4	**Actuators:** Classification, constructional features and working, Linear & Rotary actuators. **Hydraulic motors:** Types, vane, gear piston, radial piston. Theoretical torque, power & flow rate hydraulic motor performance. **Hydraulic Cylinders:** Types of cylinder & mountings, cushioning, calculations of force, velocity and power from a cylinder. Design consideration for cylinders.	5
5	**Design and analysis of Hydraulic Circuit such as:** 1) Control of single and Double -acting hydraulic cylinder, 2) regenerative circuit, 3) pump unloading circuit, 4) double pump hydraulic system, 5) counter balance valve application, 6) hydraulic cylinder sequencing circuits, 7) cylinder synchronizing circuit using different methods, 8) hydraulic circuit for force multiplication; 9) speed control of hydraulic cylinder metering in, metering out and bleed off circuits. 10) Pilot pressure operated circuits. 11) Hydraulic circuit examples with accumulator /intensifier. 12) circuit to lift and hold heavy load, 13) Pressure control for cylinders, 14) Flow divider circuits **Safety precautions, maintenance and trouble shooting of Hydraulic Circuits.**	6

VI Semester
ME2363 – PE-I: Industrial Fluid Power

Unit No.	Contents	Max. Hrs.
6	**Pneumatics:** **Introduction** to pneumatic power sources, Characteristics of compressed air , air compressors used and Components of pneumatic system. **Air preparation units**, filters, regulators & lubricators and silencer. compressed air distribution system in a plant; **Actuators**, linear, single & double acting, rotary actuators, air motors, **Pressure Regulating Valves, Directional Control Valves, Flow Control Valves**. methods of actuation, , use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, **Signal Processing Elements:** Use of Logic gates - OR and AND gates in pneumatic applications. Practical examples involving the use of logic gates. **Pneumatic circuits** for industrial applications & automation.	6

Books recommended :

1. Introduction to Hydraulics and Pneumatics, 2nd. ed. by **Ilango** and Soundararajan, PHI.
2. Fluid Power with Applications by A. **Esposito**, 6th Ed, Pearson Prentice Hall.
3. Pneumatic Systems : Principles and Maintenance by S.R. **Majumdar**, Tata McGraw Hill.
4. Fluid Power and Control Systems by E. C. **Fitch**, Jr, Mc Graw Hill Book Co.
5. Industrial Hydraulics by Banks and Banks, Prentice Hall.
6. Oil Hydraulic Systems, Principle and Maintenance by S R **Majumdar**, McGraw-Hill.
7. **Srinivasan**. R., "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints Private Limited, 2011.
8. Fluid Power: Generation, Transmission and Control, **Jagadeesha** T., Thammaiah Gowda, Wiley.
9. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics can be referred.

Reference Books:

1. Industrial Hydraulics by John **Pippenger** and Tyler Hicks, McGraw Hill.
2. William W.Reaves, "Technology of Fluid Power", Delmer Publishers, 1997.
3. Petor Rohner, "Fluid Power Logic circuit", Design Macmillon Press Ltd., 1990.
4. FESTO, "Fundamentals of Pneumatics", Vol I, II and III.
5. The Analysis & Design of Pneumatic Systems by B. W. **Anderson**, John Wiley.
6. Control of Fluid Power Analysis and Design by Mc Clay **Donaldson**, Ellis Horwood Ltd.
7. Hydraulic and Pneumatic Controls: Understanding made Easy, K.**Shanmuga** Sundaram, S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009)
8. Basic Pneumatic Systems, Principle and Maintenance by S R Majumdar, McGraw-Hill.
9. Basic fluid power Dudley, A. Pease and John J. Pippenger, , Prentice Hall, 1987
10. Thomson, "Introduction to Fluid power", Prentice Hall, 2004.
11. Pinches, Industrial Fluid Power, Prentice hall

VI Semester
ME2363 – PE-I: Industrial Fluid Power

CO-PO Weightage details 2020 **Industrial Fluid Power (Lab)** **CODE:6ME03**

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PS	PS
CO1	To investigate the hydraulic fluids and apply the fluid power laws and principals for analysis of simple fluid power system.	3	3	2	1	3	1	2	1	1	1	2	2	3	3
CO2	To identify, analyze, and justify selection of suitable components of fluid power system for specific applications based on its function, performance and working characteristics.	3	3	3	1	3	1	1	1	1	1	2	2	3	3
CO3	To design and examine the fluid power system and to compose and interpret its circuit diagrams using standard symbols.	3	3	3	1	2	1	1	1	1	1	2	2	3	3
CO4	To examine the safety measures, maintenance, and trouble shooting for fluid power systems.	3	2	3	1	3	1	2	1	1	1	2	2	3	3

VI Semester
ME2364 – PE-I : Lab: Industrial Fluid Power

Objective	Course Outcome
• To understand the working principle of hydraulic and pneumatic components and its selection. • To design hydraulic and pneumatic circuits for different applications.	1. To **investigate** the hydraulic fluids and **apply** the fluid power laws and principals for **analysis** of simple fluid power system. 2. To **identify**, **analyze**, and **justify** selection of suitable components of fluid power system for specific applications based on its function, performance and working characteristics. 3. To **design** and **examine** the fluid power system and to **compose** and **interpret** its circuit diagrams **using** standard symbols. 4. To **examine** the safety measures, maintenance, and troubleshooting for fluid power systems.

List of Experiments: Minimum Eight out of the following areas shall be performed:

A. Experiments on Hydraulics Circuits:

1. Extend-Retract and Stop system of a linear actuator.
2. Regenerative circuit.
3. Speed Control circuits: meter-in, meter-out and bleed off.
4. Sequencing circuit
5. Use of solenoid operated DCV.
6. Traverse and Feed circuit.

B. Experiments on Pneumatic Circuits:

7. Study of Compressor, FRL unit and 5/3 DCV.
8. Reciprocating motion of a single and a double acting actuators.
9. Speed control circuits.
10. Automatic to & fro motion of a pneumatic linear actuator.
11. Sequencing circuit.
12. Logical circuits.

Other practical work:

13. Design **report** of a hydraulic or pneumatic system using **manufacturer's catalogue**.
14. Study of accumulators and intensifiers.
15. **Industrial visit** to study automation by means of hydraulic and pneumatics such as LPG bottling plant etc
16. Study of **compressed air generation and distribution** systems.
17. Study of **simple hydraulic systems** used in practice such as hydraulic clamps, jack, dumper, forklift etc.
18. **Other circuits possible on the trainer kit, relevant to the syllabus**

VI Semester
ME2364 – PE-I : Lab: Industrial Fluid Power

C. Students should build up the above circuits on computer using software and simulate the flow of fluid during the operation if possible. Afterwards, they themselves can physically connect the circuit on the hydraulic/pneumatic trainer and run the circuit.

Major Equipment:
1. A hydraulic trainer
2. A pneumatic trainer
3. Simulation Software (not mandatory)

List of Open Source Software/learning website:
1. Autosim Premium
2. Hydrosym

ACTIVE LEARNING ASSIGNMENTS:
Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered.

VI Semester
ME2365 – PE-I : I.C. Engines

Objectives:	Course Outcome
To understand basic working cycles, types and development of I.C. Engines. To study the various systems related to I.C. Engines. To understand testing and performance of Engines. To study fuels, combustion, pollution and its control of engines..	*On completion of this course, the student will be able :* 1. Student should able to analyze basic working cycles, construction and and systems of I.C. Engines. 2. Student should able to analyze fuels, combustion process, pollution and its control of engines. 3. Student should able conduct a trial for Engine performance evaluation.

Unit No.	Contents	Max. Hrs.
1	Engines classification, Working cycles and operation, P-V, Valve Timing diagrams, Engine components and their material .Engine cycle Energy Balance, various losses in the engine like Frictional losses, blow by losses, pumping loss etc. Engine Lubrication systems, cooling systems and their importance.	7
2	I.C.Engines fuel and its desirable properties. Requirements of S.I and C.I. Engine fuel Other fuel like CNG, LPG, Alcohols Rating of I.C. engine fuels	8
3	Fuel supply systems for S. I. Engine: A-F mixture requirements, Basic principle, Simple Carburetor and systems like main metering, choke, idle, acceleration pump. Operating difficulties for carburetors. Petrol Injection SPFI., MPFI, Direct Gasoline Injection, Ignition system & components for S.I.Engine - Battery, Magneto & Electronic .	8
4	Combustion in S. I. Engine: Stages of combustion with p-θ diagram. Factors affecting various stages of combustion. Abnormal combustion Pre ignition, Detonation and Knocking. HUCR,S.I.Engine combustion chamber.	7
5	Fuel supply systems for C.I.Engine: Requirements of an ideal FI system, Types of Injection, Fuel injection pumps, fuel injectors and nozzles. Combustion in C. I. Engines. Stages of combustion with p-θ diagram, Factors affecting various stages of combustion. Abnormal combustion Diesel Knock, Supercharging and turbo charging in engine.	7
6	Engine performance Parameters. MEP, Torque ,speed, power, Specific fuel consumption and various efficiencies., Air measurement, Excess air and Volumetric efficiency, Measurement and Testing of friction power ,indicated power, Brake power, Fuel consumption, Air consumption, etc. Heat balance sheet calculation. Air pollution from I.C.Engines and their control using EGR, Catalytic converters, particulate traps.	8

VI Semester
ME2365 – PE-I : I.C.Engines

.**Reference books:**

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Internal Combustion Engine Fundamentals	1988	John B. Heywood	McGraw-Hill
2	Internal Combustion Engines and Air pollution	1973	Edward F. Obert	
3	Internal Combustion Engines	2007	M. C. Mathur, R.D. Sharma.	McGraw-Hill
4	Internal Combustion Engines	2007	V. Ganesan	McGraw-Hill
5	Internal Combustion Engines	2010	V. M. Domkundwar	Dhanpat Rai & Co
6	Internal Combustion Engines	2012	R.K.Rajput	Laxmi publications (P) Ltd.

VI Semester
ME2366 – PE-I : I.C. Engines LAB

List of Practical

1. Study and demonstration of working of 2-S & 4-S Engines.
2. Study and demonstration of Lubrication & Cooling systems.
3. Study of fuel systems for S.I. engines
4. Study of fuel systems for C.I. engines.
5. Determination of Air: Fuel ratio for Petrol Engine.
6. Determination of Air: Fuel ratio for Diesel Engine
7. Determination of BP/FP/IP of Engine.
8. Heat balance sheet calculation.
9. Visit to Automobile Industry / workshop.

VI Semester
ME2367 – PE-I: Refrigeration & Cryogenic

Objectives	Course Outcome
• To study and analyse Vapour Compression Refrigeration Systems. • To study vapour absorption and other refrigeration systems. • To study and analyse Air Cycle Refrigeration Systems. • To study cryogenic technology	1. The student will be able to describe, analyze and evaluate Vapour Compression Refrigeration System. 2. The student will be able to describe and analyze other refrigeration system such as Vapour Absorption Refrigeration System, Electrolux refrigeration system, steam jet refrigeration systems, thermoelectric refrigeration and vortex tube refrigeration 3. The student will be able to describe, analyze and evaluate Air Cycle Refrigeration Systems. 4. The student will be able to describe and analyze Cryogenic Systems.

Unit No.	Contents	Max. Hrs.
1	**Air refrigeration systems** Gas cycle refrigeration, reversed Brayton /Joules/Bell Coleman cycle, aircraft refrigeration, simple cycle, boot strap cycle, reduced ambient air cycle, regenerative cycle. **[CO3]**	7
2	**Vapor Compression Refrigeration system** Introduction to refrigeration, applications of refrigeration, development of simple saturated Vapour compression Refrigeration cycle, effect of change in evaporator and condenser pressure, effect of pressure drops, polytropic compression, sub cooling, superheating. **[CO:1]**	8
3	**Multistage Refrigeration systems** Working and analysis of multistage systems multiple evaporator and multiple compressor systems. **[CO:I]**	7
4	**Components of Vapour compression system** Various components used in refrigeration system like compressors, condensers, evaporators, expansion devices and its types, cooling towers, various control use in refrigeration system **Refrigerants** Types and classification, properties and nomenclature, environment friendly refrigerants. **[CO:1]**	8
5	**Other refrigeration systems** Vapor absorption systems (NH3- H20, LiBr- H2O) , Electrolux refrigeration system, Steam jet refrigeration systems, Thermoelectric refrigeration, Vortex tube refrigeration. **[CO:2]**	7
6	**Cryogenics** Introduction and applications of cryogenics, Cascade refrigeration, Joules Thomson effect, methods of air liquefaction, Linde's and Claude's cycle .Liquefaction of hydrogen, Liquefaction of helium, cryogenic insulation. Hazards and safety, production of dry ice. **[CO:4]**	8

VI Semester
ME2367 – PE-I: Refrigeration & Cryogenic

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	The student will be able to describe, analyze and evaluate Vapour Compression Refrigeration System.	3		3		3							3	3	3
CO2	The student will be able to describe and analyze other refrigeration system such as Vapour Absorption Refrigeration System, Electrolux refrigeration system, steam jet refrigeration systems, thermoelectric refrigeration and vortex tube refrigeration	3		3		3							3	3	3
CO3	The student will be able to describe, analyze and evaluate Air Cycle Refrigeration Systems.	3		3		3							3	3	3
CO4	The student will be able to describe and analyze Cryogenic Systems.	3		3		3							3	3	3

Recommended Books:

1. Dossat Roy J.; Principles of Refrigeration, 4th Ed.; Pearson Education Asia Publication
2. Arora C.P.; Refrigeration and Air conditioning, 2nd Ed.; Tata Mc Graw Hill Publication
3. Ballaney P.L.; Refrigeration and Air conditioning; Khanna publishers
4. Prasad Manohar; Refrigeration and Air conditioning, 2nd Ed.; New edge Publication
5. Arora, Domkundwar; A course in Ref. &Air Conditioning, 7th Ed.; Dhanpat Rai Publications.
6. Pita Edward G.; Air conditioning principles and systems, 4th Ed.; Prentice Hall
7. ASHRAE handbook and CARRIER hand book.

VI Semester
ME2368 – PE-I: Refrigeration & Cryogenic Lab

Objectives	Course outcome
1 To study and analyse Vapour Compression Refrigeration Systems. 2 To study vapour absorption and other refrigeration systems. 3 To study various components used in Refrigeration Systems. 4 To study the refrigeration system and components used in Industry.	1. The student will be able to describe and analyse Vapour Compression Refrigeration System. 2. Student will be able to describe various components and controls used in vapour compression refrigeration system 3. The student will be able to describe Vapour Absorption Refrigeration System. 4. Student will be able to describe refrigeration system and other components used in Industry.

List of experiment

1. Experiment on Determination of COP of Refrigeration trainer [CO:1]
2. Trial on ice-plant test rig [CO:1]
3. Study of expansion devices used in vapour compression refrigeration system [CO:2]
4. Study of condensers and cooling towers used in vapour compression refrigeration system [CO:2]
5. Study of Evaporators used in vapour compression refrigeration system [CO:2]
6. Study of vapour absorption refrigeration system [CO:3]
7. Study of Electrolux refrigeration system [CO:3]
8. Study of controls used in refrigeration system [CO:2]
9. Visit to air liquefaction plant [CO:4]
10. Visit to cold storage [CO:4]
11. Visit to Industrial cooling tower [CO:4]
12. Visit to ice plant [CO:4]

VI Semester
ME2368 – PE-I: Refrigeration & Cryogenic Lab

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	The student will be able to describe, analyse and evaluate Vapour Compression Refrigeration System.	3		3		3			3				3	3	3
CO2	Student will be able to describe various components and control used in vapour compression refrigeration system	3		3		3			3				3	3	3
CO3	The student will be able to describe Vapour Absorption Refrigeration System	3		3		3			3				3	3	3
CO4	Student will be able to describe refrigeration system and other components used in Industry.	3		3		3			3				3	3	3

VI Semester
ME2369 – PE-I: Computer Integrated Manufacturing

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.	CO1 : The Students will have ability to design and evaluate experimentation on CNC machines. CO2: Designing of GT cell layouts for transforming into flexible manufacturing system. CO3: The students will be able to compose and transform robot programs various industrial applications. CO4: The students will have ability to justify CAPP and CAQC to design computer integrated manufacturing

Unit No.	Contents	Max. Hrs.
1	Concept and scope of CIM, components of CIM, benefits, limitations.Basics of computer graphics NC basics, NC words, Manual part programming (NC part programming) Punch Tape, Tape Format CNC , DNC, APT programming Adaptive control, application. Tooling for CNC machine.	7
2	Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT. Part families , classification and coding , Production flow analysis , Machine cell design , Benefits	7
3	Introduction & Components of FMS , Application work stations , Computer control and functions , Planning, scheduling and control of FMS , Scheduling , Knowledge based scheduling , Hierarchy of computer control , Supervisory computer Manufacturing data systems , data flow , CAD/CAM considerations , Planning FMS database	8
4	Industrial robotics Robot anatomy, Robot control, accuracy, repeatability, End Effectors Sensor, Introduction to robot programming, Robot application (Material handling processing assembly and inspection) introduction to robot Kinematics.	8
5	Process Planning in the Manufacturing cycle , Process Planning and Production Planning Process Planning and Concurrent Engineering, CAPP, Variant process planning , Generative approach , Forward and Backward planning, Input format, Logical Design of a Process Planning , Implementation considerations ,manufacturing system components, Automated material handling systems, AS/RS, general considerations , selection, evaluation and control . Inspection and Quality control, CAQC, CMM types, working, applications Expert process planning	10
6	Totally integrated process planning systems, Integration of CNC robotics for CIM, Agile manufacturing, Nano Manufacturing. Simulation	5

VI Semester
ME2369 – PE-I: Computer Integrated Manufacturing

Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Systems Approach to Computer Integrated Design and Manufacturing	1996	Nanua Singh	John Wiley & Sons, 1996.
2	Automation, Production Systems and Computer Integrated Manufacturing	2002	Groover M.P	Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
3	Handbook of Flexible Manufacturing Systems	1991	Jha, N.K	Academic Press Inc., 1991
4	Group Technology in Engineering Industry	1979	Burbidge, J.L	Mechanical Engineering pub. London, 1979.
5	G.T Planning and Operation, in The automated factory-HandBook: Technology and Management	1991	Askin, R.G. and Vakharia, A.J	Cleland, D.I. and Bidananda, B (Eds), TAB Books, NY, 1991.
6	Cellular Manufacturing Systems		Irani, S.A	Hand Book
7	Planning, design and analysis of cellular manufacturing systems	1995	Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds)	Elsevier

VI Semester
ME2370 – PE-I: Computer Integrated Manufacturing Laboratory

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.	CO1 : The Students will have ability to design and evaluate experimentation on CNC machines. CO2: Designing of GT cell layouts for transforming into flexible manufacturing system. CO3: The students will be able to compose and transform robot programs various industrial applications. CO4: The students will have ability to justify CAPP and CAQC to design computer integrated manufacturing

List of Practical

1. Study of CIM.
2. Study of CAD systems
3. Numerical control – Fundamental & Application
4. CNC- Lathe – Features, Specification, & Part Program.
5. CNC- Milling – Features, Specification, & Part Program.
6. Group Technology.
7. FMS & CIM.
8. Computer Aided Process Planning.
9. Manual Part Programming.
10. APT Part Programming.
11. Robots Fundamental and Applications
12. AGVS- Fundamental and applications
13. CNC Lathe – Programming, Simulation & Actual Machining of Part.(Thread Cutting , Facing , Turning , Grooving etc.)
14. CNC Milling – Programming , Simulation & Actual Machining of Part. (Profile Cutting , Various Interpolation , Pocketing , Mirroring etc.)
15. Programming , Simulation of Robot

VI Semester
ME2371 – PE-I: Mechatronics

Objective	Course Outcome
(1) Understand the concept of Mechatronics (2) Develop the ability to understand the working of various electronically and computer control devices. (3) Concept development to bridge the existing gap between machines, Automation and Computer control system.**[a,b,c,i,j]**	(I) Students will be able to model various mechatronic systems.
	(II) Students will be able to understand the working of various motors used in mechatronic systems
	Analyze the characteristics and use of various IC's.
	(III) Student will be able to analyze the characteristics and use various IC's.
	(IV) Students will be able to analyze the internal hardware structure in Mechatronics Systems.

Unit No.	Contents	Max. Hrs.
1	Introduction, sensors, actuators, modeling of systems. Recent trend of designing machine units along with electronic circuits for operation and supervision of mechanisms. Techniques of interfacing mechanical devices with computer hardware.	7
2	Basic principles ,working and specific applications of armature and field controlled D.C. Motors, Variable voltage and variable frequency control of 3 phase and single phase Induction motors, speed control of synchronous motors, Different types of stepper motors-Constriction ,working and application. Position control of stepper motors.	8
3	Common and commercial I.Cs used for amplification, timing and digital indication. Different types of actuators, working of synchro-transmitter and receiver set, Pressure to current (P/I) and I/P conversion. Electrical and hydraulic servomotors. Design of solenoid plungers and pressure and force amplification devices.	8
4	Add-on cards for sampling and actuation, 4-20 mA ports, AD-DA conversion, Peripheral interface organization, general layout of data bus and data transfer through serial and parallel modes of communication, schemes of computer networking and hierarchy in supervisory control.	7
5	Study of various integrated systems by using block diagrams. Study of systems used in Ink Jet Printers, Photo copying, Washing Machines, IC Engine fuel injection system etc	7
6	General philosophy of Artificial Neural Network simulations, Fuzzy logic for operation and control of mechatronic systems.	7

VI Semester
ME2371 – PE-I: Mechatronics

Text books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Introduction to Mechatronics and Measurement Systems	2007	Michael B.Histand and David G. Alciatore	Tata McGraw-Hill Education
2	Mechatronics	2007	Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ.,	Chapman and Hall, 1991
3	Microprocessor Architecture, Programming and Applications	2002	Ramesh.S, Gaonkar	Prentice Hall
4	Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics	1996	Lawrence J.Kamm	John Wiley and Sons
5	Introduction to Microprocessors for Engineers and Scientists	2004	Ghosh, P.K. and Sridhar	PHI Learning Pvt. Ltd.

VI Semester
ME2372 – PE-I: Mechatronics Laboratory

Objective	Course Outcome
(1) Understand the concept of Mechatronics (2) Develop the ability to understand the working of various electronically and computer control devices. (3) Concept development to bridge the existing gap between machines, Automation and Computer control system.	(I) Students will be able to model various mechatronic systems.. (II) Students will be able to understand the working of various motors used in mechatronic systems. Analyze the characteristics and use of various IC's. (III) Student will be able to analyze the characteristics and use various IC's. (IV) Students will be able to analyze the internal hardware structure in Mechatronics Systems.

List of Practical (Minimum 10 Experiments)

1. Verification of P, P+I, P+D, P+I+D control actions.
2. Demonstration on XY position control systems.
3. Demonstration on linear conveyor control system.
4. Demonstration on rotary table positioning systems.
5. Demonstration on different switches and relays.
6. Analysis of control system using software like MATLAB/SIMULINK or equivalent.
7. Development of ladder diagram/programming PLC for level control, position control or any other mechanical engineering application.
8. Demonstration on A/D and D/A converters.
9. Demonstration on Flip Flops and Timers.
10. Demonstration on Application of Op – Amp circuits.
11. Demonstration on Data acquisition system.
12. Demonstration on Microcontrollers.

VI Semester
ME2373 – PE-I : Thermal Engineering Systems

Objective	Course Outcome
	CO:1 The student will be able to describe and analyze the Solar and Biogas Energy Systems [**PO: 1,2,3,4,5,6,7,8,9,10,11,12 PSO-1,2**] **CO:2** The student will be able to describe and analyze the working of I.C.Engines. [**PO: 1,2,3,4,5,7,8,9,10,11,12 PSO-1,2**] **CO:3** The student will be able to describe and analyze the working of Refrigeration systems [**PO: 1,2,3,4,5,7,8,9,10,11,12 PSO-1,2**] **CO:4** The student will be able to define evaluate Psychromatic properties and; describe and analyze the air conditioning processes. [**PO: 1,2,3,4,5,7,8,9,10,11,12 PSO-1,2**]

Unit No.	Contents	Max. Hrs.
1	Solar Energy: Introduction, solar constant, spectral distribution of solar radiation, beam & deffuse radiation, Solar radiation geometry, solar angles, estimation of average solar radiation, radiation on horizontal and tilted tilted surface.	5
2	Solar flat plate collectors: Types of collectors, liquid flat plate collectors, solar air heaters Concentrating collectors: line focusing, point focusing and non focusing type Applications of solar energy to water heating, space heating, space cooling, drying refrigeration, distillation, pumping. Solar furnaces, solar cookers, solar thermal electric conversion, solar photo- voltaics	6
3	***Wind Energy:*** **-**Power in wind, forces on blades, wind energy: Basic principle of wind energy conversion, basic components of WECS Classification of WEC systems, savonius and darrieus rotars applications of wind energy ***Biogas: -*** Introduction, bio gas generation, fixed dome & floating drum biogas plants their constructional details, raw material for biogas production, factors affecting generation of biogas and methods of maintaining biogas, production, fuel properties of biogas and utilisation of biogas	5
4	I.C.Engines: Air standard cycles, parts of I.C.Engines, working of I.C. Engines, Classification of IC Engines, I.C.Engines Testing:-Measurement of power: indicated, friction &brake power, measurement of speed, fuel & air consumption, calculation of indicated &brake thermal efficiency, volumetric efficiency, mechanical efficiency, Heat balance sheet.	6

VI Semester
ME2373 – PE-I : Thermal Engineering Systems

5	Refrigeration: Introduction, unit of refrigeration, Vapour compression refrigeration system.	5
6	Air conditioning: Introduction, psychrometric properties, Evaporative cooling, Bypass factor, Air Conditioning Processes, Typical summer and winter air conditioning system(concept only). [**CO:4]**	6

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	3	2	3	3	2	2	3	3	3	3	3	3	3
CO2		3	3	1	2	3	1	1	2	2	2	1	2	3	3
CO3		3	3	1	2	3	1	1	2	2	2	1	2	3	3
CO4		3	3	1	2	3	1	1	2	2	2	1	2	3	3

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Non Conventional Energy Sources - G D Rai	2000	Dr.C.P. Arora	Tata McGraw-Hill Education
2	Solar Energy	2008	Dr.. -S.P. Sukhatme	Tata McGraw-Hill
3	Internal Combustion Engines	2007	V. Ganesan	McGraw-Hill
4	Refrigeration & Air Conditioning	2nd Edition (2000)	C.P. Arora	Tata McGraw Hill

REFERENCE BOOKS:

1	Refrigeration & Air-conditioning	1986	Stocker & Jones	McGraw-Hill
2	Principle of Refrigeration & Air-conditioning	1997	Roy J.Dossat	Prentice Hall
3	ASHRAE hand books	2003		ASHRAE
4	Air conditioning Principles & System. Energy approach	1989	E.G. Pita	Wiley
6	Basic Refrigeration& Air-conditioning	2005	P.N. Ananthnarayanan	Tata McGraw-Hill Education

VI Semester
ME2374 – PE-I : Thermal Engineering Systems Laboratory

List of Practical

A set of 8 Experiments from following list to be performed.

1. Solar Radiation Measurements **[CO:1]**
2. Flat Plate Solar Water Heater **[CO:1]**
3. Flat Plate Solar Air Heater **[CO:1]**
4. Flat Plate Collector with Reflector **[CO:1]**
5. Parabolic Tube Collector **[CO:1]**
6. Evacuated Tube Collector **[CO:1]**
7. Solar Cookers 8. Thermal Storage System **[CO:1]**
8. Study on Solar Cell Characteristics**[CO:1]**
9. Demostration of 2 stroke and 4 stroke engine **[CO:2]**
10. Performance testing of a single cylinder I.C. Engine. **[CO:2]**
11. Trial on Multicylinder Petrol Engine with energy balance sheet. **[CO:2]**
12. Heat balance on Multicylinder Diesel Engine. **[CO:2]**
13. Performance on Vapor Compression Refrigeration System (VCRS). **[CO:3]**
14. Experiment on desert cooler. **[CO:4]**
15. Demonstration & Study on household Refrigerator. **[CO:3]**
16. Performance on air-conditioning system. **[CO:4]**

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3	3	2	3	3	2	2	3	3	3	3	3	3	3
CO2		3	3	1	2	3	1	1	2	2	2	1	2	3	3
CO3		3	3	1	2	3	1	1	2	2	2	1	2	3	3
CO4		3	3	1	2	3	1	1	2	2	2	1	2	3	3

VI Semester
OE-III : ME2381 – Operation Research Techniques

Objective	Course Outcome
The course aims to develop the engineering - analysis capability for engineering-problems using basic statistical tools and techniques. Detailed treatment of various data analysis and handling technique leading to complete understanding and modeling the processes including its optimization is envisaged in this course.	After completion of this course, Students will be able to 1) Apply basic operations research techniques to formulate given situation as LLP and solving by graphical & simplex method. 2) To Solve Transportation and Assignment Models and analyze the concept of dynamic programming to Solve problems of discreet and continuous variables. 3) Analyze projects for minimum total cost and smooth level of resources. 4) Evaluation of different replacement policies and its application in operation research and analysis of the application of simulation, inventory control model and waiting line model.

Unit No.	Contents	Max. Hrs.
1	Introduction to OR & Basic OR Models, Definition Characteristics and limitations of OR. Linear programming solutions (LPP) by graphical methods and simplex method. Sensitivity analysis. **(CO-1)**	7
2	Assignment Model and Transportation Model. **(CO-2)**	7
3	Dynamic programming - characteristics, approach and its formulations. Application of Dynamic programming in Employment smoothening problem, Resource allocation, Inventory control & Linear programming. (CO- 2) [6 hrs]	6
4	Project Management: Network Scheduling by CPM & PERT, Cost considerations in PERT and CPM. **(CO- 3)**	7
5	Replacement Models: Replacement of Models that deteriorate with time,Concept of equivalence , Interest Rate and Present worth. Replacement of items that fails suddenly considering Individual and Group replacement policy. **(CO- 4)**	6
6	Queuing Theory: Queuing Systems, Kendelalls for representing queuing models, Classification of queuing models (No derivations expected), Simulations, Monte- Carlo Simulation. Inventory Control with Deterministic models. (CO- 4)	4

VI Semester
OE-III : ME2381 – Operation Research Techniques

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PS	PS
CO	Apply basic operations research techniques to formulate given situation as LLP and solving by graphical & simplex method.	3				3	2			1				3	
CO	To Solve transportation and Assignment Models and analyse the concept of dynamic programming to Solve problems of discreet and continuous variables.	3				2	3			3				3	
CO	Analyze projects for minimum total cost and smooth level of resources.	3			2	2	2				2	3		3	
CO	Evaluation of different replacement policies and its application in operation research and analyse of the application of simulation, inventory control model and waiting line mode.	3				2	2	1	1			2	3	3	

Text books:

Sr. No	Title of the book	Edition(Year of publication)	Author(s)	Publisher
1	Introduction to Operation Research: Computer Oriented Algorithmic approach	2007	Billy E.Gillet	Tata McGraw Hill Publishing Co. Ltd. New Delhi.
2	Operations Research	Third edition 2008	Prem Kumar Gupta & D.S. Hira	S. Chand& Co.
3	Operations Research: Theory and Applications	Second edition 2002	J.K. Sharma	Mac Millan
4	Introductory Operations Research	2006	S.C. Sharma	Discovery Publishing House
5	Optimization Theory and Application	Second edition 2010	S.S. Rao	Halsted Press
6	Operations Research - An Introduction	Ninth Edition 2010	Hamdy A. Taha	Prentice Hall of India Pvt. Ltd., New Delhi.

VI Semester
OE-III : ME2382 – Automobile Engineering

Objective	Course Outcome
The main objective of the syllabus to understand basic knowledge about vehicle systems which are used in the regular automobiles. The modernization in automobile is also included to understand recent trend in the field.	(1) Student will be able to analyze various systems of Engine, its function including fuel supply, cooling and lubrication system in vehicle.
	(2) Student will be able to describe various power transmission systems from clutch to wheel in vehicle.
	(3) Student will be able to evaluate and describe control systems like steering and brakes in vehicle.
	(4) Student will be able to illustrate and describe the necessary electrical and luxurious systems and safety system in vehicle.

Unit No.	Contents	Max. Hrs.
1	• Introduction, Automobile history and development and classification. Vehicles layout. • Engine Classification, construction and working 2 stroke and 4-stroke cycle. • Introduction to Fuel supply system: Carburettor and fuel injection.(Only basic) • Engine cooling and lubrication systems. [CO-1]	7
2	Clutch – Necessity, requirements of a clutch system. Types of Clutches: Single & multi plate clutch, Diaphragm clutch and centrifugal clutch. Gear box: Necessity of gear box with gear theory, working principle, Classification: Sliding mesh, constant mesh, synchromesh, and Transfer case gear box, Gear Selector mechanism, Defects and remedies in Gear box. Working of CVT (Continuous variable transmission) [CO-2]	6
3	• Transmission system: Propeller shaft, Universal joint, Hotchkiss drive, torque tube drive. • Differential - Need and working principle and Differential lock. • Rear Axles and Front Axles • Wheel and Tyres: Classification, various constituents of tyres with cross section, specification, factors affecting tyre performance. [CO-2]	7
4	• Steering systems, principle of steering, steering linkages, steering geometry and wheel alignment, steering gear box and its types. • Brakes - Need, types: Mechanical, hydraulic (Master and wheel cylinder), Air brakes. Drum and Disc brakes, Comparison • Suspension systems – Function, conventional and Independent suspension System, Telescopic shock absorber. [CO-3]	6
5	• Electrical systems: Battery construction. Specification. Operation and maintenance of Batteries. • Alternator, starter motor, Battery Ignition and magneto ignition systems, Lighting, Horn, Side indicator , wiper.(only basic) • Automobile air-conditioning, • Panel board instruments. [CO-4]	6

VI Semester
OE-III : ME2382 – Automobile Engineering

Unit No.	Contents	Max. Hrs.
6	• Resistance to vehicle motion: Air, Road and gradient resistance and power calculation. • Advances in automobiles such as ABS, Power Steering. • Safety aspect in Automobile. • Overall Vehicle specifications • Servicing, Overhauling and Engine tune up. [CO-4]	6

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PS	PS
CO	Student will be able to analyze various systems of Engine, its function including fuel supply, cooling and lubrication system in vehicle.	3	2												3
CO	Student will be able to describe_various power transmission systems from clutch to wheel in vehicle.	3	2												3
CO	Student will be able to evaluate and describe control systems like steering and brakes in vehicle.	3	2												3
CO	Student will be able to illustrate and describe the necessary electrical and luxurious systems and safety system in vehicle.	3			2					2					3

Reference books:

S.N.	Title of Book	Edition	Authors	Publication
1	Automotive Technology		H.M.Sethi	Tata McgraHill
2	Automobile Engineering-I & II	First Edition - 2010	P.S.Gill	S.K.Kataria & sons
3	Automotive Mechanics		Joseph Heitner	
4	Motor Vehicle Technology		J.A. Dolan	
5	Automotive Engines		W.H. Crouse	

VI Semester
OE-III : ME2383 – Control Systems Engineering

Course Objectives	Course Outcome
• To develop an ability to define transfer function. • To analyze the performance of control system in time domain and frequency domain.	(I) Describe the mathematical representation of various control system components and determine the transfer function of mechanical, electrical, thermal and fluid system. (II) Analyse the construction and working of various control system components and electrical motors. (III) Evaluate the performance of control system using time response analysis and stability analysis. (IV) Analyze the performance of control system on the basis of frequency response and design suitable compensation for the control system

Unit No.	Contents	Max. Hrs.
1	Introduction, System concept Open and Closed loop control systems. Transfer function, Mathematical Modeling of Physical System and system representation through Block Diagram. Transfer function through Block Diagram Simplification. Signal Flow Graph, Masons Gain Formula Block diagrams of various control systems.	7
2	Representation of Control components: Mechanical and Electrical components; Analogous systems; Thermal and Fluid systems.	7
3	Electrical systems: - ac/dc servomotors; field controlled and armature controlled servomotors; positional servomechanisms; stepper motors. Hydraulic systems: - Hydraulic pumps (gear; vane; and reciprocating piston) Cylinders, Direction control valves (2, 3, 4 way) Flow control valve; Relief valve Hydraulic servomotor.	8
4	Transient and steady state response of first and second order systems Concept of stability; relative stability; Routh stability criteria.	8
5	Frequency response and its characteristics; Bode plots; Nyquist plots. Gain margin and phase margin. Identification of system transfer function.	8
6	Basic control actions; Proportional Integral and Derivative control actions and their effect on system performance. Root locus technique. Introduction to control system design log load compensation Feed Back Compensation and Pole -Zero placements.	7

Text books:

1	Modern Control Engineering	3rd Edition (2009	Ogata	Prentice Hall
2	Control system Engineering	4th Edition (2007)	Nise	John Wiley & Sons
3	Control system	4th Edition (2009)	Nagrath & Gopal	New Age International
4	Modern Control System	12th Edition (2009)	Dorf	pearson

VI Semester

OE-III : ME2384 – Robotics and Subtractive Manufacturing

VI Semester
OE-IV : ME2391 – Total Quality Management

COURSE OBJECTIVES	COURSE OUTCOMES
• The course aims to build an overall capability to understand Quality and its relevance in today's dynamic market. • Various Quality Improvement tools and technique shall be introduced and practiced so as to develop skills and knowledge to function as a good quality professional in the Engineering Profession.	1. Develop an understanding on quality management philosophies and frameworks. 2. Develop in-depth knowledge on various tools and techniques of quality management. 3. To Evaluate the applications of quality tools and techniques in both manufacturing and service industry 4. Ability to use quality management methods analyzing and solving problems of organization.

Unit No.	Contents	Max. Hrs.
1	Principles of Quality Management, Pioneers of TQM, Quality costs, Quality system Customer Orientation, Benchmarking, Re-engineering	7
2	Leadership, Organizational Structure, Team Building, Information Systems and Documentation – Quality Auditing, ISO 9000 - QS 9000.QMS, Quality awards.	7
3	Single Vendor Concept, J.I.T., Quality Function deployment, Quality Circles, KAIZEN, SGA POKA -YOKE, Taguchi Methods. SMED, Kanban system. Cost of quality. Robust design	8
4	Methods and Philosophy of Statistical Process Control, Control Charts for Variables and Attributes	8
5	Cumulative sum and exponentially weighted moving average control charts, Others SPC Techniques – Process Capability Analysis. Acceptance Sampling Problem, Single Sampling Plans for attributes, double, multiple and sequential sampling,	8
6	Six sigma manufacturing concepts. Six-sigma philosophy Quality strategy and policy. Motivation and leadership theories. Continuous vs. breakthrough improvements. Management of change, DMAIC Methodology. Lean manufacturing	7

VI Semester
OE-IV : ME2391 – Total Quality Management

Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Total Quality Management for Engineers	1991	Mohamed Zairi	Woodhead Publishing Limited 1991
2	Production and Operations mangament - Total Quality and Responsiveness	1995	Harvid Noori and Russel	McGraw-Hill Inc, 1995
3	Managing for Total Quality	1998	N.Logothetis	Prentice Hall of India Pvt .Ltd,1998
4	The Essence of Total Quality Management	1995	John Bank	Prentice Hall of India Pvt.Ltd., 1995.
5	Introduction to Statistical Quality Control	1991	Douglus C. Montgomery	2nd Edition, John Wiley and Sons, 1991.
6	Statistical Quality Control	1984	Grant E.L and Leavensworth	McGraw-Hill, 1984.

VI Semester
OE-IV : ME2392 – Reliability Engineering

Objective	Course Outcome
1.To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply a few well understood basic principles to find its solution. 2.Learn how to get higher operating plant and equipment reliability that lifts efficiency and output of operating assets, stops equipment failures and creates higher plant and equipment reliability, with this subject.	(I) Student will be able to use reliability modeling as a tool for evaluating system performance. (II) Student will be able to analyze the failure of a machine, determine the failure rate of systems or components. (III) Student will able to understand importance of the maintenance of engineering systems and factors affecting maintainability. (IV) Student will be able to prepare the production & maintenance schedule of particular engineering system.

Unit No.	Contents	Max. Hrs.
1	Fundamental concepts:- Reliability definitions, failure, Failure density, Failure Rate, Hazard Rate, Mean Time To Failure, MTBF, maintainability, availability , safety and reliability, Quality, cost and system effectiveness, Life characteristic phases, modes of failure, Quality and reliability assurance rules, product liability, Importance of Reliability,	7
2	Probability theory:- Set theory, laws of probability, total probability theorem, probability distributions, parameters and applications.	8
3	System reliability and modeling: Series and parallel components, mixed configuration, complex systems. Redundancy, element redundancy, unit redundancy, standby redundancy. Types of stand by redundancy, parallel components. Markov models for reliability estimation.	7
4	Maintainability and Availability: Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system down time. Availability - Inherent, Achieved and Operational availability, reliability and maintainability trade-off. Markov models for availability estimation.	8
5	System reliability Analysis: Reliability allocation or apportionment. Reliability apportionment techniques . Reliability block diagrams and models. Reliability predictions. Life testing and accelerated testing.	7
6	Strength based reliability: Safety factor, safety margin, Stress strength interaction, Failure Mode, Effects and Criticality Analysis-, , FMECA examples, Ishikawa diagram .fault tree construction, basic symbols development of functional reliability block diagram, Fault tree analysis, fault tree evaluation techniques, Design of Mechanical components and systems:-Material strengths and loads.	8

VI Semester
OE-IV : ME2392 – Reliability Engineering

Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Concepts of Reliability Engg	1985	L.S. Srinath	Affiliated East-Wast Press (P) Ltd
2	Reliability Engineering	1983	A.K. Govil	Tata McGraw-Hill Publishing Co. Ltd
3	Reliability Engineering	1984	E. Balagurusmy	Tata McGraw-Hill Publishing Co. Ltd
4	Engineering Reliability	1980	B.S. Dhillion, C. Singh	John Wiley & Sons
5	Probabilistic, Reliability	1968	M.L. Shooman	McGraw-Hill Book Co.,
6	Practical Reliability Engg	1985	Patric D.T.O'connor	Heyden and sons ltd.
7	Reliability in Engineering Design	1977	K.C. Kapur, L.R. Lamberson	John-Wiley and sons.
8	Reliability Engineering, Theory and Practice	Third Edition, 1999	A.Birolini	Springer,

VI Semester
OE-IV : ME2393 – Power Generation Engineering

Objective	Course Outcome
The main objective of the syllabus to understand basic knowledge about vehicle systems which are used in the regular automobiles. The modernization in automobile is also included to understand recent trend in the field.	(1) Student will be able to describe basics of power generations systems. (2) Student will be able to analyze various conventional & non-conventional power plants. (3) Student will be able to analyze and examine combined operations of different power plants. (4) Student will be able to evaluate and describe Hydroelectric power plant nuclear power plant

Unit No.	Contents	Max. Hrs.
1	**THERMAL POWER PLANT- I** Introduction to thermal power plants and power plant layouts. Site selection. Fuel characteristics, handling, storage, preparation & firing methods. Ash & dust collection and handling. • Boiler: classification, general arrangement, details of different components and system like draught system, steam turbine systems, condenser, cooling towers **[CO-1]**	7
2	**THERMAL POWER PLANT- II** Gas Turbine Power Plant: -Introduction, power plant layouts, Open cycle, close cycle power plants. Various components and systems. Methods to improve efficiency. Reheat and Regeneration cycle and their combinations Diesel Electric Power Plant: - Introduction, Outline, type of engines, different components, performance, plant layout. Comparison with other power plant. (visit to nearby power plant shall be arrange for the students) **[CO-2]**	8
3	**HYDROELECTRIC POWER PLANT.** Hydrology: - Rainfall, Runoff, Hydro graph, flow duration curve, mass curve. Hydroelectric power plant: - Site selection, classification of hydroelectric power plant, general arrangement, details of different components, turbine selection. Governing. • Comparison with other power plant. **[CO-2]**	7
4	**POWER PLANT ECONOMICS** Load Analysis - Fluctuating Load on power plants, Load curves, various terms & definition, peak load, effect of fluctuating load. • Economic Analysis: - Cost of electric energy **[CO-3]**	4
5	**NUCLEAR POWER PLANT** Introduction to Nuclear Engineering, Global scenario, prominent installations worldwide, present & proposed nuclear plant in India. Nuclear Reactors: - Types of reactors, PWR, BWR, CANDU, Gas cooled, liquid metal cooled, Breeder reactor. Operational requirements and difficulties, site selection for location of a nuclear power station Nuclear Waste Disposal. • Comparison with other power plant. **[CO-4]**	8

VI Semester
OE-IV : ME2393 – Power Generation Engineering

Unit No.	Contents	Max. Hrs.
6	**COMBINED OPERATION OF DIFFERENT POWER PLANTS** Combined operation: - Need division, combination of different plant & their coordination, advantages. **NON CONVENTIONAL POWER GENERATION SYSTEMS** Introduction to Non Conventional power Generation Systems • Geo-Thermal Power Plant, Tidal Power Plant, Wind Power Plant, Solar Power Plant. **CO-4]**	7

CO	Statement	Mapped PO											PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PS	PS
CO	Student will be able to describe basics of power generations systems.	3	2												3
CO	Student will be able to analyze various conventional & non-conventional power plants.	3	2												3
CO	Student will be able to analyze and examine combined operations of different power plants.	3	2												3
CO	Student will be able to evaluate and describe Hydroelectric power plant nuclear power plant	3			2					2					3

Reference books:

S.N.	Title of Book	Edition	Authors	Publication
1	Power Plant Engineering	2002	Domkundwar.	Dhanpat Rai & Co.
2	Power Plant Engineering	2007	Vopal & Slortzki	
3	Power Plant Engineering	2010	P K Nag	

VI Semester
OE-IV : ME2394 – Project Evaluation & Management

Objective	Course Outcome
The course focuses on developing complete understanding of formulating a problem/project and finding possible solutions against the given constraints. The overall learning shall resolve project identification evaluating its technical and economic feasibility and developing skills for its planning, and establishing controls. Relevant techniques, writing skills and monitoring methods shall be dealt with in details.	The students will be able 1. To apply the concepts of monitoring and evaluation, appraise 2. To analyse the best monitoring methods, appreciate evaluation in the context of developmental project work 3. to perform problem analysis, determine relevant indicators and data necessary for evaluation, 4. Implement a monitoring and evaluation process, establish baselines and targets..

Unit No.	Contents	Max. Hrs.
1	**Project Identification** considering objectives and SWOT analysis, Screening of Project Ideas, Technical, Market, Financial, Socioeconomic and Ecological Appraisal of a project demand forecasting, secondary data, accuracy, confidence level, uncertainty	7
2	**Technical feasibility**: Process selection, Level of automation, plant capacity, acquiring technology, Appropriate technology plant location, Equipment selection & procurement, Govt. policies. Value analysis and project evaluation:	7
3	**Economic feasibility:** Cost of Project, working capital analysis, fixed cost, means of finance, estimation of sales & production price analysis, Breakeven point, Projected cash flow statements, projected balance sheet, projected profit & loss statement, projected cash flow, rate of return, Discounted payback period, cost benefit analysis, return after taxes.	9
4	**Project Planning and Control:** Work break down structure and network development. Basic Scheduling, Critical Path and four kinds of floats. Scheduling under probabilistic durations, Time Cost tradeoffs, CPM, PERT, Optimum project duration, resource allocation, updating	7
5	**Project report:** Preparation of project report, risk analysis, sensitivity analysis, methods of raising capital	7
6	Initial review, performance analysis, ratio analysis, sickness, project revival, Project Monitoring with PERT/Cost, Organizational aspects, Computer packages and Project Completion environ-mental & social aspects**.**	8

VI Semester
OE-IV : ME2394 – Project Evaluation & Management

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Projects	Seventh edition 2007	Prasanna chandra	Tata mc graw Hill publishing company Ltd.
2	CPM & PERT		L. S. Srinath	East West publisher
3	Projects	1963	P.K. Joy	Macmillon
4	Engineering Economy	Fifth edition	H. G Thuesen, W J Fabricky, G,J, Thuersen	Prentice-Hall
5	Finance series 'Project management' , Vol-I1 and Vol-III	2009	ICFAI	ICFAI,Press Hyderabad
6	Finance Management	Sixth edition 2010	M.Y.Khan	Tata McGraw hill
7	Financial Management	Fourth edition	Chandra, Prasanna	Tata McGraw-Hill Education, 1997
8	Engineering Economics	Eighth edition	G. J. Thuesen, Wolter J. Fabrycky	Prentice Hall, 1993

CO	Statement	Mapped PO												PSO	
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PS	PS
CO	Analyze and solve the problems of unidirectional steady state heat conduction and lumped heat capacitance systems.	3	3	3	2	3	1	2	1	1	1	2	2	3	3
CO	Investigate and apply the empirical correlations in convection and phase change processes to estimate the heat transfer coefficient.	3	3	3	2	3	1	2	1	1	1	2	2	3	3
CO	Design & analyze the heat exchangers with LMTD & ϵ-NTU methods.	3	3	3	2	3	1	2	1	1	1	2	2	3	3
CO	Examine and evaluate the net thermal radiation exchange between surfaces and estimate radiation view factors using tables, graphs and the view factor relationships.	3	3	3	2	3	1	2	1	1	1	2	2	3	3

Nagar Yuwak Shikshan Sanstha's

Yeshwantrao Chavan College of Engineering

(An Autonomous Institution affiliated to Rashtrasant Tukadoji Maharaj Nagpur University)

(Accredited 'A' Grade by NAAC with a score of 3.25)

Hingna Road, Wanadongri, Nagpur - 441 110

Bachelor of Engineering

SoE & Syllabus 2018

7th & 8th Semester

Mechanical Engineering

28 June 2019

VII Semester
ME2401 - Automation in Production systems

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles.	Students will have (I) Ability to design and evaluate product layout using line balancing. (II) Ability to compose and evaluate CNC programs. (III) Ability to examine the use of robot and automated material handling to design automated system. (IV) Ability design GT cells to build FMS.

Unit-1 **[7 hrs]**

Automation- Definition, types, reasons for automating, arguments for and against automation. Types of production, functions in manufacturing, Automated Flow 'Lines - Buffer storage. Analysis of flow lines- General terminology and analysis, analysis of transfer lines without storage, partial automation, and automated flow lines with storage buffers, manual assembly lines. Line Balancing Problem, Methods of line balancing. Automated Assembly Systems- Types, parts delivery system ,Throughput analysis for line balancing , Introduction to Simulation software's ,SIMUL8,WITNESS for line balancing

Unit-2 **[8 hrs]**

Numerical Control Production Systems- Basic concepts coordinate system and machine motion- Types of NC systems- Point to point, straight cut and continuous path. Machine control unit and other components, Tape and tape readers.
NC part programming- word address format, methods of part programming, Computer numerical control ,manual part programming: APT programming, Direct numerical control.. Adaptive control. Applications of CNC. CAM software's ,Post -processing in CAM

Unit-3 **[8 hrs]**

Industrial Robotics- Introduction, robot anatomy, robot control systems, accuracy and repeatability and other specifications, end effectors, sensors, introduction to robot programming, Robot applications- Characteristics of robot applications, work cell layout, robot applications in material handling, processing, assembly and inspection. Introduction of DH notations ,Robot simulation softwares

Unit-4 **[7 hrs]**

Automated material handling & storage-Conveyor systems: Automated Guided Vehicle Systems -

Types: - Driverless trains, AGVS pallet trucks, AGVS unit-load carriers. Vehicle guidance & Routing, Traffic control & safety, System management, Analysis of AGVS systems, AGVS applications. AGVS industrial case studies

Automated Storage & Retrieval System -

Types :- Unit load AS/RS , mini load AS/I{S , man on board AS/RS , automated item retrieval system, deep lane AS/RS -Basic components & special features of AS/RS , Carousel storage systems , Work in process storage, quantitative analysis. AS/RS industrial case studies

Unit-5 **[7 hrs]**

Automated inspection & Group technology:- Automated inspection principles & methods -100% automated inspection, off -line & on -line inspection, distributed inspection & final inspection; Sensor technologies for automated inspection , coordinate measuring machines -constructional , operation & benefits; Machine vision - image acquisition & digitization, image processing & analysis, interpretation, machine vision applications; Other optical inspection methods -Scanning laser systems , linear allay devices, optical triangulation techniques. Introduction to Group Technology. GT classification, GT Coding system, PFA ,GT interface for FMS ,GT industrial case studies

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

VII Semester
ME2401 - Automation in Production systems

Unit 6 **[7 hrs]**

Computer aided manufacturing: -Manufacturing planning, manufacturing control ; Computer integrated manufacturing ;
Flexible manufacturing systems -Components, Types of systems, FMS layout configuration computer functions, data files, system reports, FMS benefits. Desiginig FMS system ,Case studies of FMS
Computer aided process planning: Retrieval CAPP systems, generative CAPP systems, benefits of CAPP. Shop floor control. CAPP software's ,CAPP industrial case studies

Sem	Course code	Course title	CO	Co contain	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
VIII	8ME	Automation in Production	I.	The students will have ability to design and evaluate product layout using line balancing	3		3			3								
			II.	The students will be able to compose and evaluate CNC Programs.			3			3							2	
			III.	The students will be able to examine use of robot and automated material to design automated systems			3			3							2	
			IV.	The students will be able to design GT cells to built FMS.			3			3							2	

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Automation, production System & CIMS	Third edition (2007)	M P, Groover PHI	Prentice Hall
2	CAD/CAM	Fifth edition (2008)	Zimmers & Groover PIII	Pearson Education India
Reference Books:				
1	Numerical Control And Computer Aided Manufacturing	13th edition (2007)	Rao, N K Tiwari, T K Kundra	Tata McGraw-Hill Education
2	Computer Control of Manufacturing Systems	2005	Koren	Mcgraw Hill

ME2402 – Lab: Automation in Production systems

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles	The Students will be able to (I) Designing, experimentation and evaluation of CNC programs. (II) Designing and justifying robot programming for industrial applications. (III) Transform manual GT cell to build FMS. (IV) Evaluate and justify use of automated material handling and inspection for building automated industries.

Sem	Course code	Course title	CO	Co contain	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
VIII	8ME1	Automation in Production Lab	I.	The students will have ability to design and evaluate product layout using line balancing	3	2	3	2	2	3	2		2	2	3	2		
			II.	The students will be able to compose and evaluate CNC Programs.	3	2	3		2	3		2	2	2	2	2	2	
			III.	The students will be able to examine use of robot and automated material to design automated systems	3	2	3	2	2	3		2	2	2	2	2	2	
			IV.	The students will be able to design GT cells to built FMS.	3		3		2	3	2		2	2	2	2	2	

Practicals:

1) Practice Programming on Manual Part Program **,**Drilling ,Milling
2) Performance, Simulation on CNC milling with Siemens 828D controller (atleast two Complex Geometries)
3) Performance, Simulation on lathe with Siemens 828D controller (at- least two Complex Geometric)

VII Semester

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

ME2402 – Lab: Automation in Production systems

4) Practice Programming on APT
5) Case Study on Automated System of any Industry.
6) Performance/ Practical on Robot. Robot programming using Teach pendant
7) Forward and Inverse kinematics using Simulation softwares
8) Part Coding and Group Technology case studies
9) Study of FMS industrial case studies
10) Study of Automated material handling ,AGVS ,AS/RS with industrial case studies
11) Study of Automated inspection with latest industrial case studies
12) Performance on Additive manufacturing system using MAKERBOT replicator

VII Semester
ME2411– PE-II : Tool Design

COURSE OBJECTIVES:	**Course Outcome**
1. To provide the knowledge of the tools for machining, production, inspection, press working and forging. 2. To learn the procedure of design and manufacturing of tools	CO I: Student will be able to explain the fundamentals of Tool Design CO II: Design various cutting tools, Sheet Metal Dies, Jigs / Fixtures and Forging dies CO III: Evaluate the failure modes of tools and costing CO IV: Compose planning for manufacturing of tools for various components

Unit1 **[8 Hrs]**

Design of single Point Cutting Tool ,Theory of metal Cutting Introduction, Mechanics of chip formation, Cutting tool materials, Single point cutting tool, Designation of cutting tools, ASA system, Importance of Tool angles, Orthogonal rake system, Classification of cutting tools, Types of chips, determination of shear angle, velocity relationship, force relations, Merchant's Theory, Cutting power, Energy consideration in metal cutting, Tool wear, Tool life, Tool life criteria, variable affecting tool life, Machine ability [**1,3, 5,6,9,11,12**]

Unit2 **[8hrs]**

Form tools- Introduction, Types, design of form tools. Drills- Introduction, Types, Geometry, Design of drill. Milling cutters - Introduction, Types, Geometry, and Design of milling cutters**. [1,3,5,6,9,11,12]**

Unit3 **[10hrs]**

Press tool Design

Introduction, Press operations - Blanking, piercing, Notching, Perforating, Trimming, Shaving, Slitting, Lancing, Nibbling, Bending, Drawing, Squeezing. Press working equipment - Classification, Rating of a press, Press tool Equipment, arrangement of guide posts. Press selection, press working

\Terminology, Working of a cutting die, Types of dies - Simple dies, inverted die, Compound dies, combination dies, progressive dies, Transfer dies, multiple dies Principle of metal cutting, strip layout, clearance, angular clearance, clearance after considering elastic recovery, cutting forces, method of reducing cutting forces, Die block, Die block thickness, Die opening, Fastening of die block, back up plate, Punch, Methods of holding punches, Strippers. Stoppers, Stock stop, Stock guide, Knockouts, Pilots. Blanking & Piercing die design - Single & progressive dies. **[1,3, 5,6,9,11,12]**

Unit4 **[10hrs]**

Bending Forming & Drawing dies Bending methods - Bending Terminology, V- Bending, Air bending, bottoming dies, spring back & its prevention. Design Principles - Bend radius, Bend allowance, Spanking, width of die opening, Bending pressure. Metal flow during drawing, Design, Design consideration - Radius of draw die, Punch radius, Draw clearance, Drawing speed, Calculating blank size, Number of draws, Drawing pressure, Blank holding pressure.[**1,3**, **5,6,9,11,12**]

Unit5 **[7 Hrs]**

Forging Die Design: Introduction, Classification of forging dies, Single impression dies, Multiple Impression dies. Forging design factors - Draft, fillet & corner radius, parting line, shrinkage & die wear, mismatch, finish allowances, webs & ribs Preliminary forging operation - fullering, edging, bending, drawing, flattering, blacking finishing, cutoff. Die design for machine forging - determination of stock size in closed & open die forging. Tools for flash trimming & hole piercing, materials & manufacture of forging dies.[**1,3**, **5,6,9,11,12**]

Unit6 **[10 Hrs]**

Design of jigs & fixture: - Introduction, locating & clamping - principle of location, principle of pin location, locating devices, radial or angular location, V - location, bush location. Design principle for location purpose, principle for clamping purposes, clamping devices, design principles common to jigs & fixtures. Drilling Jigs: - Design principles, drill bushes, design principles for drill bushings, Types of drilling jigs - Template jig, plate type jig, open type jig, swinging leaf jig, Box type jig, channel type jig . Jig feet. Milling Fixtures: - Essential features of a milling fixtures, milling machine vice, Design principles for milling fixtures, Indexing jig & fixtures, Automatic clamping Devices. [**1,3**,**5,6,9,11,12**]

Sem	Course code	Course title	CO	Co contain	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
VII	ME14	PE-I: Tool Design	I	Student will be able to explain the fundamentals of Tool Design	3	2	3		3	3	1	1	3	1	2	2	3	
			V.	Design various cutting tools, dies, Jigs & Fixtures and Forging dies	1	2	3		3	3	1	1	3	1	2	2	3	
			VI.	Evaluate the failure modes of tools and cost estimation	3	2	3		3	3	1	1	3	1		1	3	
			VII.	Compose planning for manufacturing of tools for various parts	3	2	3		3	3	1	1	2	1	1	1	3	

.**Reference books:**

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	"Tool design"	2001	Donaldson	TATA Mc-Graw Hill.
2	"Fundamentals of Tool design	1988	ASTME,	TATA Mc-Graw Hill.
3	"Fundamentals of Tool design"	1962	Pollock,	Reston Publishing Company
4	Fundamentals of Tool design"	1971	Kempster	Hall of India Pvt. Ltd
5	Computer aided fixture design	--	Rong , Yeming	Marcel Dekker

VII Semester
PE-II ME-2412 - Additive Manufacturing

Objective	Course Outcome
Objective: The main objective of this course is to acquaint students with the concept of AM, various AM technologies, selection of materials for AM, modeling of AM processes, and their applications in various fields	**Upon successful completion of the course the students will be able to:** Understand current technology and additive manufacturing trends, the working principles and process parameters of additive manufacturing processes (L-II) Explore different additive manufacturing processes and summarise them with materials, suggest suitable methods for building a particular component. (L-IV) 3. Design and develop a working model using different techniques. (L-VI) 4. Discuss the contemporary issues in processing software's/algorithms and testing. (L-VI)FMS.

Unit:1	Additive Manufacturing (AM) Overview:	7 Hours

- Introduction to AM, AM evolution, Distinction between AM & CNC machining, Product development cycle, Rapid prototyping, Reverse Engineering, Industry 4.0 and AM, Current industry and manufacturing trends driving AM, Other applications, Future trends. **[CO-I]**

Contemporary Issues related to Topic: (May be covered in TA/Case Study)

- Generalized additive manufacturing steps.

Unit:2	AM Technologies & Limitations of AM Systems:	7 Hours

- Classification of AM technologies, VAT photopolymerization, Material jetting (MJ), Binder jetting, Material extrusion, Powder bed fusion, Sheet lamination, Directed Energy Deposition (DED), New AM technologies,
- Defects, Form, fit, function trade-off, time and cost. [**CO-II]**

Contemporary Issues related to Topic: (May be covered in TA/Research Paper Study/Visit)

- Other advanced methods can be covered.

Unit:3	Materials Science for AM:	6 Hours

- Types of materials in AM, Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship. [**CO-II]**

Contemporary Issues related to Topic: (May be covered in TA/Research Paper Study/Visit)

- Case studies should be discussed and assigned for more clarification.

Unit:4	CAD Models for AM:	7 Hours

- Solid modeling (Introduction-Types), Tesselation, error minimization, firmware interface with 3 D Models, STL File: Introduction-data structure- ASCII-Binary-resolution-deviation & angle tolerance, Manipulation of

STL files: Orientation of STL file-support structure-optimal part orientation, Classification Slicing methods, Tool path planning, Area filling methods. [**CO-III]**

Contemporary Issues related to Topic: (May be covered in TA/Visit)

- Transport phenomena models and numerical modeling of AM process can be covered.

Unit:5	**Process Planning for AM:**	**7 Hours**

- Pre-processing, In-Situ processing, Post-processing, Quality standards for AM, Build strategies, Minimum feature size, Surface finish, Elimination of support structures.
- Guidelines for internal geometry like flow paths, cooling channels, cavities and others, Guidelines for making lightweight objects, Guidelines for making functionally gradient objects. [**CO-III]**

Contemporary Issues related to Topic: (May be covered in TA/Visit)

- Case study on selection methods for a part may be planned.

Unit :6	**Slicing Software's and Algorithms:**	**6 Hours**

- Slicing Software's, Algorithms: Uniform slicing-Stair-step effect- Adaptive Slicing-Curved Layer Slicing-Direct Slicing etc. [**CO-IV]**

Contemporary Issues related to Topic: (May be covered in TA/Research Paper Study/Visit)

- Case Studies and Application of software's/algorithms in AM.

	Total Lecture Hours	**40 Hours**

Text books:

1	Additive Manufacturing Technologies, Rapid Prototyping to Direct Digital Manufacturing, Ian Gibson, David W Rosen,Bent Stucker, Springer New York 2010.
2	3D Printing and Additive Manufacturing: Principles and Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition.
3	A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf,A xel Nordin and Damien Motte, Springer, 2020.
4	Laser Assisted Fabrication of Materials, J D Majumdar and I Manna, Springer Series in Material Science.
5	Understanding Additive Manufacturing: Rapir Prototyping, Rapid Tooling, Rapid Manufacturing, Andreas Gebhardt, Hanser Publishers, 2011.
6	Numerical Modeling of the Additive Manufacturing Process of Titanium Alloy, ., Zhiqiang Fan and Frank Liou, In Tech, 2012
7	Laser-induced Materials and Processes for Rapid Prototyping, L Lu, J Fuh and Y S Wong, Kluwer Academic Press, 2001
8	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D T Pham, S S Dimov, Springer 2001

9	Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006
10	Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & amp: Francis Group, 2020
11	Additive Manufacturing: Principles, Technologies and Applications, C P Paul, A N Junoop, McGraw Hill, 2021.
Reference Books:	
1	Rapid Prototyping, Laser-based and other technology, Patri K. Venuvinod and Weiyin Ma, Springer 2004.
2	The 3 D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer and Brian Garret, 3 D Hubs, 2017
YCCE e- library book links [ACCESSIBLE FROM COLLEGE CAMPUS]	
1	http://link.springer.com/openurl?genre=book&isbn=978-1-4613-6193-0
2	https://onlinelibrary.wiley.com/doi/book/10.1002/9780470168042
MOOCs Links and additional reading, learning, video material	
1	https://onlinecourses.nptel.ac.in/noc21_me115/preview
2	https://onlinecourses.nptel.ac.in/noc22_me130/preview
Online resources:	
1	https://www.nist.gov/additive-manufacturing
2	https://www.metal-am.com/
3	http://additivemanufacturing.com/basics/
4	https://www.3dprintingindustry.com/
5	https://www.thingiverse.com/
6	https://reprap.org/wiki/RepRap
7	https://courses.gen3d.com/courses/enrolled/988400
8	https://markforged.com/resources/blog/design-for-additive-manufacturing-dfam
9	https://www.hubs.com/knowledge-base/how-design-parts-metal-3d-printing/
10	https://www.rapidmade.com/design-for-additive-manufacturing
11	https://all3dp.com/1/design-for-additive-manufacturing-dfam-simply-explained/#where-to-learn-dfam

CO-PO Mapping of Additive Manufacturing

❖ **COURSE OUTCOMES:**

Upon successful completion of the course the students will be able to:

COURSE OUTCOME	STATEMENT	BLOOMS LEVEL
CO-I	Understand current technology and additive manufacturing trends, the working principles and process parameters of additive manufacturing processes	**L-II**
CO-II	Explore different additive manufacturing processes and summarise them with materials, suggest suitable methods for building a particular component.	**L-IV**
CO-III	Design and develop a working model using different techniques.	**L-VI**
CO-IV	Discuss the contemporary issues in processing software's/algorithms and testing.	**L-VI**

❖ **CO-PO Articulation Matrix:**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO-1				3	2		1					2	2	2
CO-2				3	3		1				3	2	3	3
CO-3	3	3	3	3	3	3	1				3	2	3	3
CO-4			2		2		1					2	2	2
Average Target	**3**	**3**	**3**	**3**	**3**	**3**	**1**				**3**	**2**	**3**	**3**

Use level 1- Low ,2-Medium ,3- High

Correlation levels 1, 2 or 3 as defined above: 1: Slight (Low) 2: Moderate (Medium)3: Substantial (High) and "-" if there is no correlation.

VII Semester
ME2413– PE-II : Fuel Cell Technology

OBJECTIVES	OUTCOMES
• Provide thorough understanding of performance characteristics of fuel cell power plant and its components • Outline the performance and design characteristics and operating issues for various fuel cells • The students will have sufficient knowledge for working in a fuel cell industry or R&D organization	By the conclusion of this course, each student should : 1. Have thorough understanding of performance behaviour, operational issues and challenges for all major types of fuel cells. 2. Apply know-how of thermodynamics, electrochemistry, heat transfer, and fluid mechanics principles to design and analysis of this emerging technology. 3. Apply techniques, skills, and modern engineering tools necessary for design and analysis of innovative fuel cell systems. 4. Develop enough skills to design systems or components of fuel cells.

Unit I: Introduction to Fuel Cells
Brief history of fuel cells, Operating principles, Types of fuel cells- Solid Oxide Fuel Cell (SOFC), Alkaline Fuel Cell (AFC), Molten Carbonate Fuel Cell (MCFC), Phosphoric Acid Fuel Cell (PAFC), Fuel Cell Stack, Advantages, Limitations and Applications of Fuel Cell, Polarization curve for performance characterization of fuel cells, Representing various losses (Activation, Ohmic, concentration loss), Hydrogen Production, Storage and Transportation.

Unit II: Fuel Cell Thermodynamics
Heat Potential (Enthalpy of Reaction), Work Potential (Gibbs free energy), Reversible fuel cell voltage (Nernst equation), Fuel Cell Efficiency.

Unit III: Fuel Cell Electrochemistry
Electrochemical Reaction Basics, Faraday's law, Tafel equation, Butler – Volmer equation, Exchange Current.

Unit IV: Fuel Cell Charge Transport and Mass Transport
Ion Transport (Electrolyte), Electron Transport, Gas phase (single phase) mass transport in different fuel cell components (Diffusion layer, flow channels), Multiphase Mass Transport in fuel cell components, Fuel Crossover and Internal Currents, Heat generation and transport in fuel cell.

Unit V: Fuel Cell Characterization
In Situ Versus Ex Situ Characterization, Polarization Test, Electrochemical Impedance Spectroscopy, Linear Sweep Voltammetry, Cyclic Voltammetry, Current Interrupt, High frequency resistance.

Unit VI: Polymer Electrolyte Membrane Fuel Cell (PEMFC)
\Components and Materials: Membrane, Catalyst Layer, Bipolar Plate, Current Collector, Water Management, Thermal Management, Direct Liquid Fuel Cell (DLFC), Advantage of Liquid Fuel over Gaseous Fuel, Different types of DLFC, Direct Methanol Fuel Cell (DMFC).

Textbooks/Reference Books

1. O'Hayre, R.P.,S. Cha, W. Colella, F.B.Prinz, Fuel Cell Fundamentals, Wiley, NY (2006).
2. J. Larminie and A. Dicks, Fuel Cell Systems Explained, 2nd Edition, Wiley (2003).
3. Matthew M. Mench, Fuel Cell Engines, Wiley (2008).
4. S. Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer (2006)

5. X. Li, Principles of fuel cells, Taylor & Francis (2005).

VII Semester
ME2414– PE-II : Refrigeration and Air Conditioning

Course Objectives	Course Outcome
OBJECTIVES To familiarize with terminologies associated with refrigeration and Air conditioning. To understand principle of Refrigeration and Air conditioning systems.. TO understand basic and applied psychrometry. To understand air conditioning load calculations and duct design. To understand energy conservations and management	1) The student will be able to understand and determine various psychrometric properties of air, analyze various psychrometric process and will be able to apply it to live problems 2) The students will be able to design air distribution system 3) The student will be able to analyze various types of VCRS refrigeration systems 4) The students will also have brief knowledge of non VCRS refrigeration systems & cryogenic systems

Unit 1 **[7 Hrs]**

PSYCHROMETRY: Introduction, psychometric properties of air, psychometric chart, psychometric processes bypass factor, apparatus dew point temperature.

HUMAN COMFORT: ***Mechanism of body heat losses, factors affecting human comfort, effective temperature, comfort chart.*** *[CO-1]*

Unit 2 **[8 Hrs]**

ADVANCED PSYCHROMETRY: Application of psychrometry to various air-conditioning systems. RSHF, GSHF, ESHF, air washers, air coolers.

HEAT LOAD CALCULATIONS: ***Data collection for load calculation. Various components of heat load estimate. Methods of cooling load calculation. Demonstration of air conditioning systems to students.*** *[CO-1]*

Unit 3 **[7 Hrs]**

AIR TRANSMISSION & DISTRIBUTION:

Principle of air distribution, types of grills & diffusers & their selection criteria, air alteration, types of air filters, distribution of air through ducts, pressure losses in ducts, methods of duct design, duct friction chart, air conditioning controls. [CO-2]

Unit 4 **[8 Hrs.]**

REFRIGERATION: Introduction, Definition, Applications.

Study of simple vapour compression refrigeration system.

Analysis of simple vapour compression refrigeration system, effect of sub cooling, superheating, polytropic compression & pressure drops on the performance of the system. Demonstration of performance of VCRS to students. **[CO-4]**

Unit 5 **[8 Hrs]**

MULTISTAGE VAPOUR COMPRESSION REFRIGERATION SYSTEMS:

\Multiple compressor & multiple evaporator systems, cascade refrigeration systems. Study of equipments such as compressors, evaporators, expansion devices & controls defrosting methods (types & principle only). Testing & charging of refrigeration systems. Demonstration of of above equipments to students.

REFEGERANTS:

Nomenclature of refrigerants, refrigerant properties, mixture refrigerants, global warming potential & Ozone depletion potential, Montreal & Kyoto protocol, alternate refrigerants. **[CO-4]**

Unit 6. **[7 Hrs]**

STUDY OF VAPOUR ABSORPTION REFRIGERATION SYSTEM:

Introduction Ammonia-Water, Lithium bromide-water systems, three fluid refrigerators.

OTHER REFRIGERATION TECHNIQUES:

Air cycle refrigeration, Applications in air refrigeration systems, Vortex tube, and thermoelectric refrigeration.

CRYOGENICS:

Introduction, Application of cryogenics, Joule- Thomson coefficient, inversion curve, methods of liquefaction of air **[CO-4]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
2	Refrigeration & Air-conditioning	2005	Dr. P.L. Ballany	Khanna
3	Refrigeration & Air-conditioning	2000	Dr.C.P. Arora	Tata McGraw-Hill Education
4	Refrigeration & Air-conditioning	2007	Dr. Manohar	New Age International
5	Refrigeration & Air-conditioning	2007	S.V. Domkundwar	Dhanpat Rai Company (P) Ltd
REFERENCE BOOKS:				
1	Refrigeration & Air-conditioning	1986	Stocker & Jones	McGraw-Hill
2	Principle of Refrigeration & Air-conditioning	1997	Roy J.Dossat	Prentice Hall
3	ASHRAE hand books	2003		ASHRAE
4	Air conditioning Principles & System. Energy approach	1989	E.G. Pita	Wiley
6	Basic Refrigeration& Air-conditioning	2005	P.N. Ananthnarayanan	Tata McGraw-Hill Education

VII Semester
ME2415– PE-II : Material Handling System

Objective	Course Outcome
To develop the awareness about principles and practices of material handling equipments. Study the different components design and applications of material handling devices.[c,e]	Students will be able to: 1. Explain the various typs of Material handling systems. 2. Design the various rope and chain assisted material handling systems. 3. Explin various attachments, drives and safety components of material handling system. 4. Analyze and select various material handling systems for different material handling situations.

Unit1 **[8 Hrs]**

Types of intraplant transporting facility, principles of material handling and classification of material handling equipments, selection of material handling equipment, hoisting equipment, screw type, hydraulic and pneumatic conveyors, general characteristics of hoisting machines, surface and overhead equipments, general characteristics of surface and overhead equipments and their applications. Introduction to control of hoisting equipments.

Unit2 **[8 Hrs]**

Component selection and design Flexible hoisting appliances like ropes and chains, welded load chains, roller chains, selection of chains, hemp rope and steel wire rope, selection of ropes, rope reeving arrangement and pulley blocks fastening of chains and ropes, different types of load suspension appliances, fixed and movable pulleys, different types of pulley systems, multiple pulley systems. Chain and ropes heaves and sprockets.

Unit3 **[7 Hrs]**

Load handling attachments, standard forged hook, hook weights, hook bearings, cross piece and casing of hook, crane grab for unit and piece loads, carrier beams and clamps, load platforms and side dump buckets, Electromagnetic lifting system, grabbing attachments for loose materials, crane attachments for handling liquid materials.

Unit 4 **[8 Hrs]**

Arresting gear, ratchet type arresting gear, roller ratchet, shoe brakes and its different types like electromagnetic, double shoe type, thrusters operated, controlled brakes, shoe brakes, Electro-Hydraulic thrusters safety handles, load operated constant force and variable force brakes, Rope drum design and assembly, design of guides and column,

Unit5 **[8 Hrs]**

Different drives of hoisting gears like individual and common motor drive for several mechanisms, travelling gear, travelling mechanisms for moving trolleys and cranes on runway rails, mechanisms for trackless, rubber-tyre and crawler cranes, motor propelled trolley hoists and trolleys, rails and travelling wheels, slewing, jib and lifting gears. Operation of hoisting gear during transient motion, selecting the motor rating and determining braking torque for hoisting mechanisms, selecting the motor rating and determining braking torque for travelling mechanisms, slewing mechanisms, jib and lifting mechanisms. (Elementary treatment is expected)

Unit6	**[7 Hrs]**
Cranes with rotary pillar, cranes with a fixed post, jib cranes with trolley, portal cranes with luffmg boom, cantilever cranes, cage elevators, safety devices of elevators, belt and chain conveyors and their power calculations, vibrating and oscillating conveyors, pneumatic and hydraulic conveyors, screw conveyors, hoppers, gates and feeders. Introduction to AGV's as new material handling device, use of robot for material handling.	

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Materials Handling Equipment-	1964	N. Rudenko ,	Envee Publishers, New Dehli
2	Materials Handling Equipment-	1968	M.P. Alexandrov.	Mir publications

VII Semester
ME2416– PE-II : Reliability Engineering

Objective	Course Outcome
1.To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply a few well understood basic principles to find its solution. 2.Learn how to get higher operating plant and equipment reliability that lifts efficiency and output of operating assets, stops equipment failures and creates higher plant and equipment reliability, with this subject.	(I) Student will be able to use reliability modeling as a tool for evaluating system performance. (II) Student will be able to analyze the failure of a machine, determine the failure rate of systems or components. (III) Student will able to understand importance of the maintenance of engineering systems and factors affecting maintainability. (IV) Student will be able to prepare the production & maintenance schedule of particular engineering system.

Unit	Contents	Max. Hrs.
1	Fundamental concepts:- Reliability definitions, failure, Failure density, Failure Rate, Hazard Rate, Mean Time To Failure, MTBF, maintainability, availability, safety and reliability, Quality, cost and system effectiveness, Life characteristic phases, modes of failure, Quality and reliability assurance rules, product liability, Importance of Reliability,	**7**
2	Probability theory:- Set theory, laws of probability, total probability theorem, probability distributions, parameters and applications.	**8**
3	System reliability and modeling: Series and parallel components, mixed configuration, complex systems. Redundancy, element redundancy, unit redundancy, standby redundancy. Types of stand by redundancy, parallel components. Markov models for reliability estimation.	**7**
4	Maintainability and Availability: Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system down time. Availability - Inherent, Achieved and Operational availability, reliability and maintainability trade-off. Markov models for availability estimation.	**8**
5	System reliability Analysis: Reliability allocation or apportionment. Reliability apportionment techniques . Reliability block diagrams and models. Reliability predictions. Life testing and accelerated testing.	**7**
6	Strength based reliability: Safety factor, safety margin, Stress strength interaction, Failure Mode, Effects and Criticality Analysis-, , FMECA examples, Ishikawa diagram .fault tree construction, basic symbols development of functional reliability block diagram, Fault tree analysis, fault tree evaluation techniques, Design of Mechanical components and systems:-Material strengths and loads.	**8**

Reference books:				
S.N.	**Title of the book**		**Author(s)**	**Publisher**
1	Concepts of Reliability Engg	1985	L.S. Srinath	Affiliated East-Wast Press (P) Ltd
2	Reliability Engineering	1983	A.K. Govil	Tata McGraw-Hill Publishing Co. Ltd
3	Reliability Engineering	1984	E. Balagurusmy	Tata McGraw-Hill Publishing Co. Ltd
4	Engineering Reliability	1980	B.S. Dhillion, C. Singh	John Wiley & Sons
5	Probabilistic, Reliability	1968	M.L. Shooman	McGraw-Hill Book Co.,
6	Practical Reliability Engg	1985	Patric D.T.O'connor	Heyden and sons ltd.
7	Reliability in Engineering Design	1977	K.C. Kapur, L.R. Lamberson	John-Wiley and sons.
8	Reliability Engineering, Theory and Practice	Third Edition, 1999	A.Birolini	Springer,

VII Semester
ME2417– PE-II : Advanced Manufacturing Techniques

Objective	Course Outcome
To develop the ability to understand & analyze different advanced manufacturing processes and different advanced manufacturing machines. **(a,c,k)**	Upon successful completion of the course, the student will be able to: CO I- Distinguish the various non-traditional manufacturing process based on energy sources. CO II Evaluate various advanced manufacturing process for new materials and the requirements of complex features on the basis of various parameters. CO III- Justify the various advanced welding techniques for different applications. CO IV- Evaluate the application of additive manufacturing advanced manufacturing techniques in industries.

Unit 1 **[8hrs]**

Mechanical Processes: Need, classification of AMT, Abrasive jet Machining, Water jet Machining & ultrasonic Machining, Abrasive-Water Jet Machining, Abrasive Flow Machining, Magnetic Abrasive Finishing & Ultrasonic Machining. (CO I)

Unit 2 **[6 hrs]**

Chemical Processes & Electro-chemical Processes: Electrochemistry of ECM, tool design, effect of variable on performance chemical milling, Chemical Engraving, Photo chemical machining, EC grinding. (CO II)

Unit 3 **[9 hrs]**

Thermo-electric Processes: Electric Discharge Machining, Wire Electric Discharge Machining. Electron Beam Machining, Laser Beam Machining, Ion Beam Machining & Plasma Arc Machining. (CO II)

Unit 4 **[6hrs]**

High energy rate forming processes: Burnishing, ballizing process and other miscellaneous forming processes, electroforming. Thermoform High velocity forming, Vacuum forming. (CO II)

Unit 5 **[8 hrs]**

Unconventional welding techniques: laser, electron beam, plasma arc, atomic hydrogen, submerged arc, explosive welding techniques, solid phase welding, technique such as ultrasonic welding, friction welding.(CO III).

Unit 6 **[7 hrs]**

Additive Manufacturing : Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.(CO IV)

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

Reference Books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Manufacturing Science	2007	A. Ghosh & A. Mallik.	Ellis Horwood, 1986
2	Non Traditional Machining	2005	P.C. Paonoey & H. S. Shan.	Tata McGraw-Hill Education, 1980
3	New Technology		A Bhattacharya	
4	Advance machining process		V.K.Jain	Allied publisher

VII Semester
ME2418– PE-II : Optimization Techniques

Objective	Course Outcome
The course aims to develop the most fundamental concepts in the field of optimization The basic principles of linear optimization for decision-making, using practical examples will help us learn to identify decision variables, objective function, and constraints of a problem, and use them to formulate and solve an optimization problem. This course is designed to connect data and models to real world decision-making scenarios in the field of manufacturing, finance, Project management, human resource management through various optimization tools which also includes the most recent global optimization. Thus, detailed treatment of various data analysis and handling technique will lead to complete understanding and modeling the processes including its optimization, is envisaged in this course.	After completion of this course, Students will be able to: **I.** Apply basic operations research techniques to formulate given situation as LLP and solving by graphical & simplex method. **II.** To Solve Transportation and Assignment Models and analyse the concept of dynamic programming to Solve problems of discreet and continuous variables. **III.** Analyze projects for minimum total cost and smooth level of resources. **IV.** Evaluation of different replacement policies and its application in operation research and analysis of the application of simulation, inventory control model and waiting line model.

Unit 1: **[7 hrs]** Introduction to Linear Programming Problems: Formulation of LPP, Geometry of LPP and Graphical Solution of LPP, Simplex Method, Big M- Method, Two Phase Method. (CO-I)
Unit 2: **[7 hrs]** Alternative Specifications & Special Cases in Linear Optimization, Modeling & Solving Linear Problems in Excel. (C0-I)
Unit 3: Transportation Problem and Assignment Problem. (CO-II) **[7 hrs]**
Unit 4: **[7 hrs]** Replacement Models: Replacement of Models that deteriorate with time, Concept of equivalence, Interest Rate and Present worth. Replacement of items that fails suddenly considering Individual and Group replacement policy. (CO-IV)

		June 2021	1.00	Applicable for AY 2021-22 Onwards
Chairperson	Dean (Acad. Matters)	Date of Release	Version	

Unit 6: **[7 hrs]**

Global Optimization: Dynamic programming, Evolutionary Algorithms (Any one like…..Genetic, Ant Colony, Scatter, etc.) Queuing Theory: Queuing Systems, Kendelalls for representing queuing models, Classification of queuing models (No derivations expected), The First Model. (CO-IV)

Sem	Course code	Course title	CO	Co contain	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
V	8M	Optimization for Decision Making	VIII.	Apply basic operations research techniques to formulate given situation as LLP and solving by graphical & simplex method.	3				3	2								
			IX.	To Solve transportation and Assignment Models and analyze the concept of dynamic programming to Solve problems of discreet and continuous variables.					2	3			3					
			X.	Analyze projects for minimum total cost and smooth level of resources.					2	2					3			
			XI.	Evaluation of different replacement policies and its application in operation research and application of global optimization and waiting line mode.					2	2						3		

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Introduction to Operation Research: Computer Oriented Algorithmic approach	2007	Billy E.Gillet	Tata McGraw Hill Publishing Co. Ltd. New Delhi.
2	Operations Research	Third edition 2008	Prem Kumar Gupta & D.S. Hira	S. Chand& Co.
3	Operations Research: Theory and Applications	Second edition 2002	J.K. Sharma	Mac Millan
4	Introductory Operations Research	2006	S.C. Sharma	Discovery Publishing House
5	Optimization Theory and Application	Second edition 2010	S.S. Rao	Halsted Press
6	Operations Research - An Introduction	Ninth Edition 2010	Hamdy A. Taha	Prentice Hall of India Pvt. Ltd., New Delhi.

VII Semester
ME2421– PE-III : Vibration

Objective	Course Outcome
To develop in students fundamentals knowledge of vibrations. To familiarize with energy methods for multi degree freedom systems. To impart, knowledge of vibration of continuous systems and applications of factor in vibration analysis. TO impart knowledge of use of FFT in vibration analysis for condition monitoring purpose	(I) The student will have ability to analyze various types of Vibrations..[b,e] (II) The student will have ability to measure Vibrations and carryout its analysis..[b,e]

Unit 1 **[7 hrs]**
SINGLE DEGREE OF FREEDOM: Free body diagram, free & forced vibration, un damped and damped single degree of freedom systems subjected to harmonic and other periodic excitations. Impulse response, convolution integral and response to arbitrary excitation. Vibration isolation and transmissibility. Solution using Laplace transform, Rungakutta method, structural damping

Unit2 **7 hrs]**
Energy method applied to TWO degree freedom system. Lagranges equation. Generalized mass formulation of mass , damping and stiffness matrix and its numerical solutions . Vibration absorber, conservative and non conservative systems. Geared rotor system, Influence Coefficients and flexibility matrix of bending vibration of beam and multi-disc rotor. Mode shapes and orthogonality principle

Unit3 **[8 hrs]**
Numerical techniques for Multi **degree** freedom system. systems. Matrix iteration method. Holzer"s method for torsional vibration. Dunkerley's method for critical speed determination of multi disc rotor. Rayleigh quotient sweeping matrix method for determination of all the natural frequencies and mode shapes. Rayleigh Ritz method. Modal matrix and expansion theorem. Free and forced response by modal analysis.

Unit4 **[8 hrs]**
Vibration of continuous system. Axial vibration of rod, bending vibration of beam and torsional vibration of shaft. Hamilton's principle and derivation of equation of motion, Rayleigh quotient. Modal co-ordinates and modal forces. Free and forced response through modal analysis.

Unit5 **[8 hrs]**
Vibration pickup, seismometers, accelerometer, proximity probe spectrum analyzer, FET & DFT (Discrete FT), torsional, Vibration measurement, Digital vibration measurement, philosophy of vibration. condition monitoring

Unit6 **[7 hrs]**
Introduction to Finite element method in vibration of continuous system. Natural frequencies and mode shape computation for simple rod and beam problem

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Theory of vibration	2001	Thomson W.T	Prentice hall
2	Elements of vibration analysis	1986	Meirovitch L	McGraw-Hill Science/Engineering/Math; 2 Sub edition (January 1, 1986)
3	Mechanical vibration	1984	Rao J.S.;Gupta K	Wiley Eastern, c1984

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
4	Theory of vibrations	1983	Morse TSE; Hinkle	New Delhi: CBS Publishers, 1983.
5	Advanced theory of vibration	1992	Rao J.S	Wiley, 1992
6	Vibration condition Monitoring of Machines	2000	Rao J.S	Alpha Science International Limited, 2000
7	Random vibration		Gandall& Mark	

VII Semester
ME2422– PE-III : Lab: Vibration

Objective	Course Outcome
To do Experimentation on Types of Vibrations. To do analysis of Vibration of different systems and machines using different methods And through Instrument. [b,e]	Students will be able to: 1. Analyze the various types of vibrations. 2. Evaluate vibrations and carry out its analysis. 3. Predict/judge vibration parameters and evaluate through different approaches for multidegree freedom system. 4. Form and work on transformation of matrices for vibration for evaluating frequencies..

List of Practical

1. To determine transmissibility of single degree freedom system using load cells and exciter
2. To Study the Transverse Vibrations of Cantilever Beam and to determine the frequency or period of Vibration (oscillation) theoretically and actually by experiment
3. To determine natural frequency of Torsional vibration of geared system
4. To Study the forced vibration of equivalent spring mass System
5. Study and determination of modes shapes for two degree and three degree freedom systems
6. To Study the Free Vibration of two rotor and three rotor System and to determine the natural frequency of vibration theoretically & experimentally.
7. To verify the Dunkerley's Rule.
8. Determination of Whirling of shaft.
9. To study the effect of damping on natural frequency and plot frequency response curves at various damping coefficient.
10. To determine vibration parameters (Amplitude Velocity acceleration for machines using FFT
11. To diagnose faults in simple machines like pumps motor gearbox using FFT.
12. To remove dynamic unbalance using FFT.

VII Semester
ME2423– PE-III : Computer Aided Design & Manufacturing

Objectives:	**Course outcomes:**
To educate students on -Main concepts of computer aided design -Graphics representation of curves. -Surface and solids	*After completion of the course students would be able to* 1. Distinguish the various CAD CAM tools and also evaluate criteria for CAD CAM systems 2. Design 2D and 3D Transformation matrices 3. Calculate and analyse the parametric equations for wire frame. surface and solid modeling entities **4.** Design the applications of modeling and evaluate data exchange formats

Unit 1 CAD TOOLS **[6 hrs]**

Definition of CAD Tools, Types of system, CAD/CAM system evaluation Criteria, functional areas of CAD, Modelling and viewing, efficient use of CAD software.

Unit2 Two/Three Dimensional Transformations **[8hrs]**

Two & Three dimensional geometric and co-ordinate transformations like scaling, translation, rotation, reflection, shear. Concept of homogeneous representation and concatenated transformations. Inverse transformations.

Unit 3 Wire Frame Modeling **[7 hrs]**

Types of mathematical representation of curves, wire frame models, wire frame entities, parametric representation of analytical and synthetic curves- Hermit cubic splines, Bezier curves, B Splines

Unit4 Surface Modeling **[8 hrs]**

Mathematical representation of surfaces, Surface model, Surface entities, surface representation, parametric representation of surfaces, plane surface, ruled surface, surface revolution, Tabulated surface.

Unit 5 Solid Modeling & Data Exchange **[8 hrs]**

Solid Representation - Boundary Representation (B-rep), Constructive Solid Geometry (CSG) and other **methods, Evaluation** of data-exchange formats, IGES data representations and structure

Unit 6 Manufacturing **[8 hrs]**

Introduction to NC and CNC, Machine tools- Construction features with structure- Drives and CNC controllers. Manual part programming (Lathe & Milling machines) Introduction of CAM package. Group Technology, Cellular Manufacturing-Composite part concept-Types of Flexibility – FMS – FMS Components, Application and Benefits.

Sem	Course code	Course title	C	Co contain	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
V	ME	COMPUTER AIDED DESIGN	1	Distinguish the various CAD CAM tools and also evaluate criteria for CAD CAM systems	3				3	3	2		2	2	1		1	2
			2	Design 2D and 3D Transformation matrices	3		3		3	3	2		2	1			3	2
			3	Calculate and analyse the parametric equations for wire frame. surface and solid modeling entities	3				3	3	2		1	1			2	1
			4	Evaluate data exchange format, also develop part programme for Lathe & Milling Machine	3		3		3	3	2	1	2	2	1		3	1

Textbooks:

1 CAD/CAM, theory & practice: Ibrahim Zeid
2 Procedural elements for computer graphics: D Rogers
3 Computer Graphics: D Hearn & M.P.Baker
4 Computer Graphics: S Harrington.
5 Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
6 Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi,2000

VII Semester
ME2424– PE-III : Lab : Computer Aided Design & Manufacturing

Objectives:	Course outcomes:
• To educate Main concepts of computer aided design & Manufacturing • To use Graphics representation of curves	*After completion of the course students would be able to* 1. **Study, design and develop the model for mechanical engineering parts.** 2. **Conceptualize & model any machine component** 3. **Build the CAD Model and CAM Model for simple machine elements**.

List of Practical:-

1.	To study Introduction to CAD software.
2.	To Solve Simple examples of two dimensional transformations
3.	To Solve Simple examples on three dimensional transformations
4.	Programs on 2-D transformations- scaling, rotation, reflection and translation
5.	3-D Wireframe object modeling using any CAD software
6.	Generation of analytical curves using any CAD software
7.	Generation of synthetic curves using any CAD software
8.	Basics of surface modeling using Extrude, Revolve, fill, sweep, variable section sweep commands using any CAD software
9.	Creating fill surfaces, lofted multi-section surfaces, blended surfaces using any CAD software
10.	To generate at least two simple assembly model using any CAD software.

VII Semester
ME2425– PE-III : Vehicle Engineering

Objective		Course Outcome	Unit
The main objective of the syllabus to understand basic knowledge about vehicle systems which are used in the regular vehicle. The modernization in automobile is also included to understand recent trend in the field**.**	**(1)**	**Student will be able to analyze various systems of Engine, its function including fuel supply, cooling and lubrication system in vehicle. (PO-1,PO-2,PO-13)**	**1**
	(2)	**Student will be able to describe_various power transmission systems from clutch to wheel in vehicle. (PO-1,PO-2,PO-13)**	**2,3**
	(3)	**Student will be able to evaluate and describe_control systems like steering and brakes in vehicle. (PO-1,PO-2,PO-13)**	**4**
	(4)	**Student will be able to illustrate and describe the necessary electrical and luxurious systems and safety system in vehicle. (PO-1,PO-2,PO-4,PO-13)**	**5,6**

UNIT-1: **[8 hrs]**

- Introduction, Automobile history and development and classification. Vehicles layout.
- Various engine system and components
- Introduction to Fuel supply system: for Petrol and Diesel Engine.
- Engine cooling and lubrication systems.,

UNIT-2: **[8 hrs]**

- Resistance to vehicle motion: Air, Road and gradient resistance and power calculation.
- Clutch – Necessity, requirements of a clutch system. Types of Clutches: Single & multi plate clutch, Diaphragm clutch and centrifugal clutch.
- Gear box: Necessity of gear box, working principle, Classification: Sliding mesh, constant mesh, synchromesh, synchromesh and Transfer case gear box, Gear Selector mechanism, lubrication and control. Introduction to Automatic Transmission

UNIT-3: **[8 hrs]**

- Transmission system: Propeller shaft, Universal joint, constant velocity joint, Hotchkiss drive, torque tube drive.
- Differential - Need and working. Differential lock.
- Rear Axles and Front Axles.
- Wheel and Tyres: tyres specification, factors affecting tyre performance.

UNIT-4: **[8 hrs]**

- Steering systems, principle of steering, steering linkages, steering geometry and wheel alignment, steering gear box and its types.
- Suspension systems – Function, conventional and Independent suspension System, shock absorber
- Brakes - Drum and Disc brakes, Comparison, Mechanical, hydraulic (Master and wheel cylinder), Air brakes.

UNIT-5: **[8 hrs]**

- Electrical systems: Battery construction. Specification. Operation of Batteries. Charging of battery, Alternator.
- Starting system, Battery Ignition and magneto ignition systems, Lighting, Horn, Side indicator, wiper. and other electrical systems.

UNIT-6: **[8 hrs]**

- Automobile air-conditioning,
- Panel board instruments .
- Overhauling, Engine tune up.
- Recent Advances in automobiles such as ABS, Power Steering, Collision avoidance, Navigational aids etc.

Reference books:

S.N.	Title of Book	Edition	Authors	Publication
1	Automotive Technology		H.M.Sethi	Tata McgraHill
2	Automobile Engineering-I & II	First Edition - 2010	P.S.Gill	S.K.Kataria & sons
3	Automobile Engineering	First Edition - 2015	Dr.D.S.kumar	S.K.Kataria & sons
4	Automotive Mechanics		Joseph Heitner	
5	Automotive Engines		W.H. Crouse	

VII Semester
ME2426– PE-III : Lab. Vehicle Engineering

Objective	Course Outcome		Unit
The main objective of the syllabus to understand basic knowledge about vehicle systems which are used in the regular vehicle. The modernization in automobile is also included to understand recent trend in the field**.**	(1)	Student will be able to analyze various systems of Engine, its function including fuel supply, cooling and lubrication system in vehicle. (PO-1,PO-2,PO-13)	**1**
	(2)	Student will be able to describe_various power transmission systems from clutch to wheel in vehicle. (PO-1,PO-2,PO-13)	**2,3**
	(3)	Student will be able to evaluate and describe_control systems like steering and brakes in vehicle. (PO-1,PO-2,PO-13)	**4**
	(4)	Student will be able to illustrate and describe the necessary electrical and luxurious systems and safety system in vehicle. (PO-1,PO-2,PO-4,PO-13)	**5,6**

List of Practical: Minimum eight practical to be conducted

1. Demonstration to understand vehicle layout and important constituents of four wheel ,two-wheel & four-wheel drive vehicle
2. Demonstration to understand various components and working of 2S & 4S Engine.
3. Demonstration to understand working of single plate/Multiplayer/Diaphragm automobile clutch.
4. Demonstration of synchromesh gearbox with gear shifting mechanism.
5. Demonstration of final drive and differential.
6. Demonstration of working Hydraulic braking system and comparison with other braking system.
7. Demonstration to understand front wheel steering geometry and steering mechanism.
8. Demonstration to understand suspension system and working of shock absorber.
9. Demonstration of various components of battery and working of its charging system.
10. Demonstration of vehicle starting system(Kick start and Self-start).
11. Demonstration to understand working principle of Electric horn, Brake light and side indicator.
12. Visit to workshop to understand wheel balancing.
13. Visit to servicing station for vehicle maintenance, repairs and report.

VII Semester
ME2427– PE-III : Solar Energy & Utilization

Objective	Course Outcome

Unit1 Basics of solar energy **[7hrs]**

Brief History of solar energy &utilization, Various approaches of utilizing solar energy, Blackbody radiation, Relation between radiation field energy density and radiation spectrum, Planck's formula in energy unit, Maximum spectral density, Planck's formula in wavelength unit, Wien displacement law, Stefan - Boltzmann law, Photoelectric effect, Einstein's theory of photons, Einstein's derivation of the black-body formula.

Unit2 Solar radiation, measurement and estimation **[8hrs]**

History of solar energy utilization, basic definitions, Solar radiation and modeling, Empirical equations for predicting the availability of solar radiation, Measurement of global, direct and diffuse radiation, Radiation computations on inclined surfaces, Angstrom's turbidity, Solar chart, Standard radiation scale, Measurement of solar radiation, Solar energy measuring instruments, Pyranometer, Pyrheliometer, Sunshine recorder, Estimation of average solar radiation, Ratio of beam and total radiation on tilted surface of that on horizontal surface.

Unit3 Concentration of solar energy **[7hrs]**

Three types of imaging optics: trough or linear collectors, central receiver with heliostats, and parabolic dish concentrator with on -axis tracking, Solar thermal electricity is using Stirling engine or Ranking engine, Solar photovoltaic with concentration.

Unit4 Solar Thermal systems: **[7hrs]**

Liquid Flat, Plate collector, air heater and concentrating collector, Solar pond, Solar distillation, Solar drying. Thermal storage. Solar Passive Architecture Passive heating and cooling of Buildings. Solar Cooking, Distillation, Desalination, Solar Drying, Solar Chimney.

Unit5 Solar cells: **[8Hrs]**

Formation of a PN–junction, Space charge and internal field, Quasi - Fermi levels, The Shockley diode equation, Structure of a solar cell, The solar cell equation, Fill factor and maximum power, Various electron, hole-pair recombination mechanisms, Crystalline silicon solar cells, Thin film solar cells: CIGS, Cite and silicon - Tandem solar cells, Dye - sensitized solar cells, Organic solar cells. Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc., solar PV power plant, Net metering concept.

Unit6 Storage of solar energy: **[8Hrs]**

Types of Energy Storage, Thermal Storage, Simple water and rock bed storage, pressurized water storage system, Electrical Storage, Fundamental concept of batteries, measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries, Chemical Storage, Fuel Cell, History of Fuel cell, Principles of Electrochemical storage, Types, Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis, advantage and drawback of each type, hydro-

storage.

.Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1.	Solar Energy Utilization	2010	Rai, G.D.	Khanna Publishers, N. Delhi
2.	Solar Energy	3rd Edition, 2008	Sukhatme S.P.,	Tata McGraw Hills P Co.
3.	Solar Energy Thermal Process	2007	Duffie, J.A., and Beckman	John Wiley and Sons, NewYork,
4.	The Physics of Solar Cells	2003	Nelson	Imperial College Press
5.	Solar Energy: Principles of Thermal Collection and Storage	3rd Edition, 2008	S Sukhatme and J Nayak	Tata McGraw Hill,

VII Semester
ME2428– PE-III : Lab. : Solar Energy & Utilization

List of Experiments

1. Solar Radiation Measurements
2. **Flat Plate Solar Water Heater**
3. **Flat Plate Solar Air Heater**
4. **Flat Plate Collector with Reflector**
5. Parabolic Tube Collector
6. Evacuated Tube Collector
7. **Solar Cookers**
8. Thermal Storage System
9. **Study on Solar Cell Characteristics**
10. **Testing of SPV Standalone Systems**
11. **Testing of SPV system with tracking unit**
12. **Performance Evaluation of SPV**

VII Semester
ME2429– PE-III : CNC and Robotics

Objective	Course Outcome
To understand the need and process of automation in industry. Study the Computer Numerically Controlled machines and Robots, their components, functions, functions, programming and applications.[k,m]	Students will be able to: 1. Explain the structure of NC, CNC and DNC 2. Design the tooling of CNC and compose program for CNC. 3. Explain the structure and kinematics of Robot. 4. Explain the various grippers and sensors, deign the applications and compose the program for Robot.

Unit 1 **[7 hrs]**

Concepts of NC, CNC, DNC. Classification of CNC machines, MCU architecture and functionality, Machine configurations, Types of control, CNC controller's characteristics, Interpolators**.**

Unit 2 **[8 hrs]**

Qualified, semi qualified and preset tooling, tooling system for Machining centre and Turning centre, work holding devices, of CNC Machines.

Programming CNC machines, Part print analysis and Process planning, Advanced Programming features , Canned cycles. APT part programming CAD/CAM, Parametric Programming.**[**

Unit 3 **[8 hrs]**

Manual part programming for CNC turning, milling and machining center. Wire EDM machines. Computer assisted part programming techniques, Conversational and Graphics based software, Solid based part programming. Freeform surface machining. Simulation and Verification of CNC programs, Adaptive CNC control techniques. Integration of CNC machines for CIM.

Unit 4 **[7 hrs]**

Robotics, Basic concepts , Robot configurations , Basic robot motions , Types of drives , Applications

Transformations and kinematics, Vector operations, Translational transformations and Rotational transformations Properties of transformation matrices,

Homogeneous transformations and Manipulator, Forward solution, Inverse solution, Introduction to robot dynamics.

Controls, Control system concepts, Analysis, control of joints, Adaptive and optimal control.

Unit 5 **[8 hrs]**

End effectors, Classification, Mechanical, Magnetic, Vacuum, and Adhesive, Drive systems, Force analysis and Gripper design.

Robot programming, Methods, Languages ,Computer control and Robot Software – Programming Languages, Robot application (Assembly, inspection, material handling, processing) **[k,m]**

Unit 6 **[7 hrs]**

Sensory devices, Non optical and optical position sensors, Velocity and Acceleration, Range, Proximity, touch, Slip, Force, Torque. Machine vision, Image components , Representation , Hardware , Picture coding , Object recognition and categorisation Integration of Robots with CNC machines for CIM. **[k,m]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Robot Engineering An Intergrated approach	2004	Klafter R.D., Chmielewski T.A. and Negin M	Springer
Reference :				
1	CNC Technology and Programming	2003	Krar, S., and Gill	Industrial Press Inc
2	An Introduction to CNC Machining	1991	Gibbs, D.	Industrial Press
3	Computer Numerical Control Concepts and Programming	1991	Seames, W.S.	Thomson Learning EMEA, Limited
4	Computer Numerical Control for Machining	1993	Lynch, M	McGraw-Hill
5	Computer Control of Manufacturing Systems	2005	Koren Y	Tata McGraw-Hill Education
6	Robotics control, sensing, vision, and intelligence	2004	Fu K.S., Gonzalez R.C., and Lee C.S.G.	Tata McGraw-Hill Education
7	*Robotics Technology and Flexible Automation*	2001	*Deb S.R*	Tata McGraw-Hill Education
8	Introduction to Robotics Mechanics and Control	2008	Craig J.J	Pearson Education India

VII Semester
ME2430– PE-III : Lab. : CNC and Robotics

Objective	Course Outcome
To understand the need and process of automation in industry. Study the Computer Numerically Controlled machines and Robots, their components, functions, functions, programming and applications.[k,m]	Students will be able to: 1. Explain the structure of NC, CNC and DNC 2. Design the tooling of CNC and compose program for CNC. 3. Explain the structure and kinematics of Robot. 4. Explain the various grippers and sensors, deign the applications and compose the program for Robot.

List of Practical

1) Demonstration on Automation through development in NC machines.
2) Numerical control – Fundamental & Application.
3) Manual Part Programming.
4) APT Part Programming.
5) CNC- Lathe – Features, Specification, & Part Program.
6) CNC Lathe – Programming, Simulation & Actual Machining of Part.
7) Thread Cutting, Facing, Turning, Grooving etc.
8) CNC- Milling – Features, Specification, & Part Program.
9) CNC Milling – Programming, Simulation & Actual Machining of Part.
   (Profile Cutting, Various Interpolation, Pocketing, Mirroring etc.)
10) Robots Fundamental and configurations.
11) Robots Applications
12) Programming, Simulation of Robot.
13) Problems on Robot kinematics.

VII Semester
ME2433– PE-III : Piping Design and Engineering

Objective	Course Outcome
• The student should be able to acquire elementary knowledge of Piping Design and Engineering. • To impart the knowledge on selection of components for piping design • To impart the knowledge about selection of equipment for piping design • To impart basic knowledge on piping Engineering flow diagram and process system • To impart basic knowledge to Designing & engineering of Piping Diagram • To impart knowledge on ASME Engineering and pressure design	After completion of this course, Students will be able to **1.** Describe the basic concepts of Piping design and Engineering **2.** Apply the basic concepts involved in selection of components and equipment in piping design. **3.** Apply the knowledge of design and engineering for preparation of process diagram and piping diagram **4.** Describe the application of international standards for piping design

Unit 1 **[8 hrs]**

Fundamentals of Piping Design and Engineering

Introduction to piping designing & engineering, Evolution of piping, Manufacturing methods, Piping materials and selection, Pipe dimensioning, Schedule numbers, Common piping abbreviations, Major organizations for standards, Commonly American code in piping ASME/ANSI, Common abbreviations. **[CO-1]**

Unit 2 **[8 hrs]**

Basic Piping components

Type of Fittings - elbows, weld tee, stub in, couplings, reducers, weld cap, screwed and socket welded fittings, Pipe nipples, flanged fittings and use of fittings, Type Flange -Types, P-T ratings and facings, Gaskets, bolts and nuts, Major Valves - Types, Materials operations, applicability, codes and specifications. **[CO-2]**

Unit 3 **[6 hrs]**

Piping Equipment

Horizontal vessels/accumulators, fractionation columns, pumps, heat exchangers, re-boiler, air cooled heat exchanger, cooling towers, heaters/boilers, storage tanks, fractional distillation process and vendor data drawings, Prepare layout of Different type lights.**[CO-2]**

Unit 4 **[7 hrs]**

Piping Engineering flow diagram and process system

Uses of flow diagrams, process flow diagrams, mechanical flow diagrams, utility flow diagrams, piping symbols, line symbols, valve symbols, piping isometrics, general arrangement drawings- sections/elevations/ detail drawings, plot plan procedures, Purpose of P&ID'S, study of P&ID'S, stages of development of P&ID'S, symbols usage according to industrial practices, Purpose of P&ID in process industrial/plants. **[CO-3]**

Unit 5 **[8 hrs]**

Designing & engineering of Piping Diagram

Plant Co-ordinate Systems, Site Plans, Unit Plot Plan, Equipment Location Drawing, Foundation Location Drawing, Pipe Rack Spacing, Drawing pipe in the rack, pipe insulation shoes, pipe guides, field supports, dummy supports, hanger rods, spring hangers, pick-up pipe supports, plant utilities, control valve manifolds, utility stations, sewer and underground piping system.**[CO-3]**

Unit 6 **[8 hrs]**

ASME Engineering and pressure design

Pipe wall thickness calculations, operating pressure, design pressure, operating & design temperature ,max allowable operating pressure, Pressure design of Pipe, elbows, mitre bends, reinforcement pad calculation for branch connections, flanges, blanks, expansion joints and gaskets. **[CO-4]**

Se	Course code	Course title	CO	Co contain	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
VIII	ME 1485	Piping Design and Engineering	1.	Describe the basic concepts of Piping design and Engineering	3	2	3			3							3	2
			2.	Apply the basic concepts involved in selection of components and equipment in piping design.	3	2	3			3							3	2
			3.	Apply the knowledge of design and engineering for preparation of process diagram and piping diagram	3	2	3			3							3	2
			4.	Describe the application of international standards for piping design	2	2	3			3							3	1

Reference books:

1	Piping Handbook	07th Edition (2010)	Mohinder L Nayyar	McGraw-Hill Publishing

2	Offshore engineering an Introduction	1995	Angus Mather	Witherby & Company Ltd.
3	Handbook of piping design	1st Edition (2010)	G. K. Sahu	New age International
4	The fundamentals of piping Design	1st Edition (2007)	Peter Smith	Gulf Publishing Company

VII Semester
ME2434– PE-III : Lab. : Piping Design and Engineering

Objective	Course Outcome
• The student should be able to acquire elementary knowledge of Piping Design and Engineering. • To impart the knowledge on selection of components for piping design • To impart the knowledge about selection of equipment for piping design • To impart basic knowledge on piping Engineering flow diagram and process system • To impart basic knowledge to Designing & engineering of Piping Diagram • To impart knowledge on ASME Engineering and pressure design	After completion of this course, Students will be able to **1.** Describe the basic concepts of Piping design and Engineering **2.** Apply the basic concepts involved in selection of components and equipment in piping design. **3.** Apply the knowledge of design and engineering for preparation of process diagram and piping diagram **4.** Describe the application of international standards for piping design

List of Practical

A set of Experiments from following list to be performed.

1. Study of Fundamentals of Piping Design and Engineering using AVEVA PDMS Software. CO1
2. User interface Basics about AVEVA PDMS Software. CO1
3. Displaying modelled element. CO2
4. Working with 3D Views.CO2
5. Attributes, positioning and orientation. CO2
6. General Utilities. CO3
7. Introduction to model editor CO3
8. Introduction to Aveva primitives for piping design.CO4
9. Drafting Features – Automatic Drawing production CO3
10. Draft explorer and viewing control along with draft Hierarchy CO3
11. Dimensioning the drawing – Equipment, piping and structural arrangement CO4

Sem	Course code	Course title	CO	Co contain	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO 12	PSO-1	PSO-2
VIII	ME 1486	Piping Design and Engineering	1	Describe the basic concepts of Piping design and Engineering	3	2	3			3							3	2
			2.	Apply the basic concepts involved in selection of components and equipment in piping design.	3	2	3			3							3	2
			3.	Apply the knowledge of design and engineering for preparation of process diagram and piping diagram	3	2	3			3							3	2
			4.	Describe the application of international standards for piping design	2	2	3			3							3	1

Reference books:

1	Piping Handbook	07th Edition (2010)	Mohinder L Nayyar	McGraw-Hill Publishing
2	Offshore engineering an Introduction	1995	Angus Mather	Witherby & Company Ltd.
3	Handbook of piping design	1st Edition (2010)	G. K. Sahu	New age International
4	The fundamentals of piping Design	1st Edition (2007)	Peter Smith	Gulf Publishing Company

VII Semester
ME2435– PE-III : Earthmoving Equipments

Objective	Course Outcome
1. To introduce and understand the simple Hydraulic power systems and to realize its importance in the world of power transmission. 2. To study various fluids, filters and seals for hydraulic systems 3. To study various components of fluid power systems . 4. To understand symbols associated with Hydraulic circuits and Electronic circuitd. 5. To understand Electronics diagnostic and Computer Aided Diagnostic systems. **6.** Maintenance, troubleshooting and safety practices for Earthmoving equipments.	Students will be able to: (I) To understand and apply fluid power laws and principles (II) Students will be able to understand the basic fluid power hardware system components. (III) Students will be able to interpret and draw hydraulics and electronic system circuits. (IV) Students will be able to design, analyze, use, maintain, carryout troubleshooting, and establish safety procedures of Earthmoving equipments.

Unit 1 : Introduction **[8 hrs]**
Earthmoving equipments: Introduction, Types and applications.
Hydraulic systems: Components, advantages, applications in the field of Earthmoving Equipments.
Seals, sealing materials, selection of seals.
Filters, strainers, sources of contamination of fluid & its control.
Hoses & Pipes: Types, materials, pressure drop in hoses/pipes, valves and fittings. Hydraulic piping connections.
Types of Hydraulic fluid petroleum based, synthetic & water based. Properties of fluids. Selection of fluids, additives, effect of temperature & pressure on hydraulic fluids.

Unit 2 : Mechanical Systems: **[7 hrs]**
Super Structure : Cabin:- dashboard , drive controls and hydraulic controls. Boom, arm and related components.
Under Carriage : Transmission system: drive system , hydraulic systems for earthmoving, Turning system . Gear box and related components.
Attachments : Buckets: Backacter, cam shelve, screening adapter, special buckets.
End effectors: Earthwork attachments, drilling and boring attachment, piling attachment, crusher adapters, breakers, jaws, grabbing and loading attachments.

Unit 3 : Hydraulic Systems: **[7 hrs]**
Pumps: Types, classification, principle of working & constructional details of vane pump, gear pumps, radial & axial plunger pumps, power and efficiency calculations, characteristic Curves, selection of pumps for hydraulic power transmission.
Accumulators & Intensifiers: Types & functions of accumulators & intensifiers, applications, selection & design procedure.

Unit 4 : Hydraulic Systems : **[8 hrs]**
Valves: Types & functions of valves, applications, selection
Actuators: Linear & Rotary actuators.
Hydraulic motors: Types, vane, gear piston, radial piston. Hydraulic motor performance.
Hydraulic Cylinders: Types of cylinder & mountings, calculations of piston velocity, thrust under static & dynamic applications. Design consideration for cylinders.
Hydraulic Circuits: JIC symbols / ISO Symbols for hydraulic circuits
Different hydraulic circuits used in Construction equipments. Hydraulic circuit analysis

Unit 5 : Electrical and Electronics System: **[7 hrs]** Basic electrical components switches, cables, colour coding of cables, Relays,. The basic connections – series and parallel circuits. Electric circuits of earthmoving equipments.. **Electronics Circuits:** Symbols for Electronics circuits Different Electronics circuits used in earthmoving equipments. Electronics circuit analysis
Unit 6 : Maintenance of Earthmoving Equipments: **[8 hrs]** Preventive, predictive & breakdown maintenance. Trouble shooting & safety precautions. Electronics diagnostic and Computer Aided Diagnostic systems.

Text books:			
Title of the book	**Edition (Year of publication)**	**Author(s)**	**Publisher**
Introduction to Fluid Power	2002	James L Johnson	**Delmar Thomson Learning**
Fluid Power With Applications	6th	Anthony Esposito	PEARSON Prentice Hall
Industrial Hydraulics	3rd or above	J.J. Pipenger & T. G. Hicks	McGraw Hill Co.
Pneumatic Systems: Principles and Maintenance	16th (2006)	S. R. Majumdar	Tata McGraw-Hill Education
Reference Books:			
Power pneumatics	(2007)	Michael J. Pinches	Prentice Hall
Vickers manuals on Industrial Hydraulics	3rd edition or above	Vickers	Vickers, 1996
Hydraulics & Pneumatics	4th edition	Harry L. Stewart	Industrial Press
Fluid Power Design Handbook	3rd edition	Franklin D. Yeaple	Marcel Dekker, 1996

VII Semester
ME2436– PE-III : Lab. : Earthmoving Equipments

Objective	Course Outcome
1. To introduce and understand the simple Hydraulic power systems and to realize its importance in the world of power transmission. 2. To study various fluids, filters and seals for hydraulic systems 3. To study various components of fluid power systems . 4. To understand symbols associated with Hydraulic circuits and Electronic circuits. 5. To understand Electronics diagnostic and Computer Aided Diagnostic systems. **6.** Maintenance, troubleshooting and safety practices for Earthmoving equipments.	Students will be able to: (I) To understand and apply fluid power laws and principles (II) Students will be able to understand the basic fluid power hardware system components. (III) Students will be able to interpret and draw hydraulics and electronic system circuits. (IV) Students will be able to design, analyze, use, maintain, carryout troubleshooting, and establish safety procedures of Earthmoving equipments.

Practical:

1. Practical based on syllabus.
2. Industry visit / site visit to experience actual working of Earthmoving equipments.
3. Visit to Service station / workshop of Earthmoving equipments
4. Hands on experience of diagnosis, trouble shooting and repairing of Earthmoving equipments.

VII Semester
ME2441– PE IV : Sysnthesis of Mechanism

Objective	Course Outcome
To make the students understand various types of mechanisms and criterion used in their selection. To give detailed knowledge of type, number and dimensional synthesis of mechanisms. To introduce various graphical and analytical methods so as to enable students to design the mechanisms to meet kinematic needs. Introducing various optimization techniques for synthesis.	CO-I Describe the fundamentals of kinematic synthesis and its application. CO-II Formulate mathematical model of function generation, path generation and motion generation. CO-III Apply various graphical and analytical methods to design the mechanisms to meet kinematic needs. CO-IV Evaluate the various optimisations techniques for synthesis.

Unit 1 **[7 hrs]**

Introduction to kinematics, types of mechanism, kinematics synthesis, science of relative motion, tasks of kinematic synthesis with practical applications, Degree of freedom, class-I, class-II chain, Harding's notation, Grashof criterion, Grubler's criterion.

Unit 2 **[8 hrs]**

Introduction to position generation problem, concept of pole, two &three position generation synthesis, pole triangle, Relationship between moving & fixed pivots, Four position generation, opposite pole quadrilateral, center point &circle point curve, Burmester's point. Matrix method for position generation problem, rotation matrix, displacement matrix.

Unit 3 **[7 hrs]**

Introduction to function generation problem, co-ordination of input-output link motion, relative pole technique, inversion technique, overlay technique, graphical synthesis of quick return mechanisms for optimum transmission angle. Types of errors, accuracy points, cheby sher's spacing, frudenstein's equation with problems.

Unit 4 **[8 hrs]**

Introduction to path generation problem, synthesis for path generation with and without prescribed timing using graphical method. Coupler curves, cognate linkages, Robert's law of cognate linkages.

Complex number method for path generation problem 3 precision points.

Unit 5 **[7 hrs]**

Synthesis for infinitesimally separated position, concept of polode and centrod, Euler's savery equation, inflection circle, Bobbilier and Hartman's construction.

Unit 6 **[8 hrs]**

Optimal synthesis of planer mechanisms, powell's search method, least square method, penalty function. Introduction to spatial mechanisms, D-H notations, introduction to kinematic analysis of robot arm.

Reference books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Applied linkage synthesis	Fifth edition	Tao D.C.	New York, NY,
2	Advanced mechanism design	1984	Erdman A.G.; Sandor G.N	Prentice-Hall, 1984
3	Kinematics and mechanism design	Third edition 2010	Sue C.H; Radchiffe C.W	

VII Semester
ME2442– PE IV : Design for Manufacturing & Assembly

VII Semester
ME2443– PE IV : Renewable Energy System

Objective	Course Outcome
To realize the importance of various renewable energy sources in this era of energy crisis. To study the theory of conversation of various renewable energy such thermal, electrical, etc. Apply thermodynamics cycles to above systems. To study Magneto Hydrodynamic systems.	**CO-I**: Students will be able to analyse solar energy and equipment's related to solar energy **CO-II**: Students will be able to realize the potential of Solar Energy, biomass, biogas, gasifiers. **CO-III**: Students will be able to analyse the potential of Wind, OTEC & Tidal energy development **CO-IV**: Students will be able to know the awareness of geothermal energy and MHD power generation

Unit 1 **[8 hrs]**

Solar Energy: Introduction, solar constant, spectral distribution of solar radiation, beam & diffuse radiation, measurement of solar radiation and measuring instruments. Solar radiation geometry **[CO - I]**

Unit 2 **[8 hrs]**

Solar Collectors: Types of solar collectors, Solar flat plate collector, analysis of solar flat plate collector Concentrating Collectors: Line focusing, point focusing and non-focusing type, central receiver concept of power generations compound parabolic collector, comparison of flat & concentrating collectors. **[CO - I]**

Unit 3 **[8 hrs]**

Solar energy storage, sensible, latent and thermo chemical storage, solar pond

Applications of Solar Energy: Water Heater, air Heater, Apace Heating, Power Generation

Solar photo- voltaic cell,

Biogas and Biomass: - Types of Biogas plants, Methods of Biogas generation, factors affecting the biogas generation, site selection, gasifiers, classification of gasifiers & constructional details chemistry of gasification fuel properties, applications of gasifiers. **[CO – II]**

Unit 4 **[7 hrs]**

Wind energy*:* - Basic principle of wind energy conversion, Classification of WEC systems, savonius and darrieus rotars applications of wind energy. Site selection, Merits & demerits of wind power generation, combined wind/Diesel power plants, combined Solar/Wind power plant.

OTEC & Tidal energy: Introduction: - ocean thermal electric conversion open and closed cycle of OTEC, hybrid cycle, energy from tides basic principles of tidal power & components of tidal power plants, single & double basin arrangement, estimation of tidal power and energy, Advantages & Limitation of Tidal Power, Energy from ocean

waves -energy availability, wave energy conversion devices. **[CO – III]**

Unit 5 **[7 hrs]**

Geothermal power generation: Geothermal energy: Introduction, Thermal Gradient, Resources of Geothermal Energy: Hydrothermal, petro-Geothermal, Geopressure sources, classification of geothermal systems vapour dominated system, liquid dominated system, total flow concept, Merits and Demerits of Geothermal Energy Sources, applications of geothermal energy, operational & environmental problems, advanced concepts in Geothermal Energy. **[CO - IV]**

UNIT 6 **[7 hrs]**

Magneto Hydro Dynamic power generation: Introduction, working principles of MHD power generation, MHD open and closed systems, power output from MHD generators, design problems of MHD generation, gas conductivity, seeding, Application of MHD Power generation.

Fuel cells: overview, working principle of Operation of Fuel cells, Types of Fuel cells, Design of PEMFC system **[CO - IV]**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Energy Technology	3rd edition	Parulekar & Rao	Khanna Publishers
2	Non Conventional Energy Sources		G D Rai	Standard Publishers Distributors
Reference book				
1	Solar Energy	3rd edition	S.P. Sukhatme	Tata McGraw-Hill Education,
2	Solar Energy	3rd edition, 2006	John A. Duffie, William A. Beckman	Wiley
3	Solar energy engineering	2007	Jui Sheng Hsieh	Prentice-Hall,

VII Semester
ME2444– PE IV : Engineering of Plastics

Objective	Course Outcome
To familiarize students with : 1. Various Plastic materials, Their properties and applications 2. Different plastic processing techniques.**[c]**	1. Students will be able to identify the plastic materials for some specified applications based on its property. 2. Students will be able to investigate suitable plastic Processing technique. 3. Students will be able to evaluate the suitable machining and joining of plastic materials. 4. Students will be able to justify the suitable Solid State Fabrication Techniques

Unit 1 **[7 Hrs]**

Chemistry and Classification of Polymers - Properties of Thermo Plastics - Properties of Thermosetting Plastics - Applications - Merits and Disadvantages.**[c]**

Unit 2 **[7 Hrs]**

Extrusion - Blow Molding – Casting – Thermo Forming – Rotomolding Study of molds [**c]**

Unit 3 **[8 Hrs]**

Compression and Transfer Molding - Injection Molding- study of compression and injection molding moulds [**c]**

Unit 4 **[8 Hrs]**

General Machining properties of Plastics - Machining Parameters and Their effect - Joining of Plastics - Mechanical Fasteners - Thermal bonding - Press Fitting. Testing of plastic [**c]**

Unit 5 **[8 Hrs]**

Fibers - Glass, Boron, Carbon, Organic, Ceramic and Metallic Fibers - Matrix Materials - Polymers, Metals and Ceramics. Open Mould Processes, Bag Molding, Compression Molding with BMC and SMC - Filament winding - Pultrusion - Centrifugal Casting - Injection Molding - Application of PMC's. [**c]**

Unit 6 **[7 Hrs]**

Solid State Fabrication Techniques - Diffusion Bonding - Powder Metallurgy Techniques - Plasma Spray, Chemical and Physical Vapor Deposition of Matrix on Fibers - Liquid State Fabrication Methods - Infiltration - Squeeze Casting - Rheo Casting - Compocasting - Application of MMCS. [**c]**

.**Reference books:**

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Product Design and Process Engineering	1995.	Harold Belofsky,	Hanser Publishers,
2	High Performance Polymers	**1991**	Bera, E and Moet	Hanser Publishers,
3	Plastics Extrusion technology	**1988**	F.Hensen,	

.**Reference books:**				
4	Injection Moulding Machines	**1983**	F.ohannaber	Hanser Publishers,
5	Polymer extrusion	**1990**	C.Rauwendaal,	Hanser Publishers,
6	Blow Moulding Handbook	**1989**	D.V.Rosatao,	Hanser Publishers,
7	Modern Plastics Moulding		E.B Seamour,	John Wiley.
8	Plastics Moulding	**1952**	John Dalmonte,	John Wiley.
9	Machining of Plastics	**1981**	Akira Kobyashi,	Mc-Graw Hill.
10	Composite Materials science and Engineering	**1998**	Krishan K.Chawla	Springer-Verlag, 1987.

VII Semester
ME2445– PE IV : Finance & Cost Management

Objective	Course Outcome
•To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply a few well understood basic principles of Management to find its solution. •To be able to take a proper decision at proper time which will be beneficial in future.	(I) The student will have ability to evaluate the cost of the product (II) The student will have the ability to Analyze the financial requirement. (III) The student will have improved Decision making ability. (IV) The student will have ability to take a proper decision on waste or scrap material.

Unit 1 **[7 Hrs]**

Business Finance:

Need for finance, sources of finance (fixed and working capital), equity and preference shares, deposits from public, debentures, bonds, term loans, financial institutions in India, Financial statements and their analysis.

Unit 2 **[7 Hrs]**

Concept of Cost:

Concept of cost, classification of cost, direct and indirect , fixed and variable , semi variable, product and period, controllable and uncontrollable costs, opportunity costs , sunk cost, joint cost, prime cost, factory cost, cost of production, selling and distribution cost, administrative cost, cost of sales.

Unit 3 **[7 Hrs]**

Cost ascertainment and cost reduction:

Concept of overhead, collection of overheads, allocation and appointment, absorption of overheads, absorption rates, under – over absorption , cost centers, cost units, cost statement sheet.
Areas of cost reduction, techniques, productivity.

Unit 4 **[8 Hrs]**

Costing System:

Job costing, contract costing, cost plus contracts, batch costing, process costing, simple process costing, normal abnormal losses and gains, waste, scrap & spoilage, joint & byproducts, operating costing.

Unit 5 **[8 Hrs]**

Cost Planning and Control:

Concept of budgeting, advantages and limitations, budgetary control, key factors, fixed and flexible budget.
Standard costing, selling of standards, variance analysis.

Unit 6 **[8 Hrs]**

Decision Making:

Marginal costing, break even analysis, cost volume, profit analysis, application of costing to various decisions like make or buy, add or drop products, cost or process further, operate or shut down, replace or retain.

Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Principles and Practice of Cost Accounting	Fifth edition	N.K.Prasad	Pearson Education
2	Cost Accounting		Jawahar Lal	
3	Management Accountancy	Third edition2010	J. Batty	Tata Mc Graw Hill
4	Financial Management		Khan and Jain	
5	Financial Management	2007	Prasanna Chandra	Tata Mc Graw Hill
6	Engineering Economy	1973	Paul Degarmo	Macmillan, 1973
7	Cost Accounting	2008	B.K.Bhar	Academic publishers
8	Costing and finance management	2012	Mrunalini Naik	Thakur publications

VII Semester
ME2446– PE IV : Artificial Intelligence

Objective	Course Outcome
• To learn about the automation of machines tools making the system intelligent. • Understanding the different techniques used for implementation of artificial intelligence	(I) The student will have ability to analyze the concept of NLP,Expert System and role of Knowledge base in Artificial Intelligence. (II) The student will have ability to understand the rule based System and rules for conflict resolution. (III) The student will have ability to analyze the role of Knowledge Engineer and Domain Expert with the help of routine example.. (IV) The student will have ability to analyze the NN/ANN applications in Mechanical Engineering.

Unit 1 **[7 hrs]**

Human and machine intelligence, Artificial Intelligence (AI), Programming in AI environment,. Natural Language processing (NLP) Architecture of an Expert system, Knowledge base, inference engine forward and backward chaining, Selection of inference mechanism.

Unit 2 **[7 hrs]**

Introduction, to Rule Based System, Conflict Resolution, Advantages and Drawbacks of Rule Based Systems Clausal Form Logic; Rule Base Verification, Refinement and Validation

Unit 3 **[9 hrs]**

Creating Knowledge Base, Knowledge Engineer and Domain Expert, Phases of Knowledge Engineering, Tools for Knowledge Engineering

Unit 4 **[7 hrs]**

Neural network applications, artificial neural network models, NN applications in Cellular manufacturing and other areas of mechanical Engg.**]**

Unit 5 **[7 hrs]**

Fundamentals of OOP (Object oriented programming), creating structures and objects, object operations, invoking procedures, programming applications, Object oriented expert systems.

Unit 6 **[8 hrs]**

Semantic nets, ruled systems for semantic nets, certainty factors, automated learning;

Reference books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Designing Knowledge Based System	1985	Addis, T.R	Prentice Hall
2	Principles of Artificial Intelligence and Expert Systems Development	1988.	Rolston, D.W	McGraw Hill
3	Handbook of Expert Systems in Manufacturing	1991	Maus, R. and Keyes	McGraw Hill
4	A comprehensive guide to artificial intelligence and expert systems	1990	Robert Levine	McGraw-Hill, 1990
5	Artificial Intelligence	1991	Elain Rich	McGraw-Hill, 1991
6	Rule based expert systems	1990	Sasikumar, Ramani	
7	Design for Knowledge Based Systems	1978	Graham Winstanley	Galgotia Publications
8	Artificial Neural Networks	1992	Zurada	West, 1992
9	Neural Networks and Fuzzy Logic		V.B. Rao and H.V. Rao, "C^{++} :	BPB Publications

VII Semester
ME2447– PE IV : Maintenance Management

Objective	Course Outcome
To Study (1) Functions of maintenance dept. (2) Types of maintenance policies (3) Various failures modes and their diagnosis (4) Various conditioned monitoring technique (5) Various types of maintenance costs & their estimation (6) Various techniques for measurement of maintenance work **(7)** Plan for maintenance of machines	The student will be able to, (I) understand the maintenance function, its importance, types and organize the maintenance department. (II) analyze the failure of a machine and plan the condition monitoring program for a machine .] (III) Estimate repair and maintenance cost and evaluate maintenance performance.] (IV) Understand the maintenance needs of basic electrical and mechanical devices.

Unit I **[8 Hrs]**

Objectives, scope, structure of maintenance organization and operating policies to guide management, policies with respect to work allocation, work force, intra and inter plant relation, material, finance and control.
Concept of life cycle maintenance, optimization of total maintenance, analysis of productivity ,Reliability ,Maintainability, and Availability,

Unit II **[7 Hrs]**

Maintenance policies, Preventive maintenance program, corrective maintenance guidelines, replacement policies-cyclic replacement, group replacement, standbys, economics of machine replacement, TPM, RCM and CMMS.

Unit III **[7 Hrs]**

Failure analysis:
General practice, failure classification , data collection, failure pattern recognition ,determination of replacement period, time between preventive maintenance checks. Use of various modern techniques to monitor the condition of machine to facilitate maintenance

Unit IV **[8 Hrs]**

Work measurement for maintenance:
Need for Work measurement ,various techniques for work measurement of direct and indirect labour. Work force requirement, location and size.

Unit V **[8 Hrs]**

Control and estimation of maintenance cost:
Job classification, various estimating techniques and its use.
Maintenance manual, plant performance improvement, Maintenance training program, Maintenance control indices and factor affecting them .Lubrication system-need ,design and implementation.

Unit VI **[7 Hrs]**

Maintenance of various mechanical and electrical equipments.

.**Reference books:**

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Maintenance engineering handbooks	2008	Mobley and Higgins	Mc-graw Hill
2	Guide to Complete Maintenance	1988.	Rolston, D.W	Heintzelment
3	Maintainability and maintenance management	1991	J. Patton	Maus, R. and Keyes
4	Operation research in Maintenance	--	Jarding	--
5	Introduction to reliability and maintainability Engineering.	--	Thomos Ebelling	Mc-graw Hill
6	Advanced operations management		R.P.Mohanty and S.G.Deshmukh	Pearson Education
7	Maintenance engineering and management		R.C.Mishra and K.Pathak	PHI Publications
8	Industrial Maintenance management		S.K.Shrivastava	S.Chand

VII Semester
ME2448– PE IV : Total Quality Management

COURSE OBJECTIVES	COURSE OUTCOMES
• The course aims to build an overall capability to understand Quality and its relevance in today's dynamic market. • Various Quality Improvement tools and technique shall be introduced and practiced so as to develop skills and knowledge to function as a good quality professional in the Engineering Profession.	1. Develop an understanding on quality management philosophies and frameworks. 2. Develop in-depth knowledge on various tools and techniques of quality management. 3. To Evaluate the applications of quality tools and techniques in both manufacturing and service industry 4. Ability to use quality management methods analyzing and solving problems of organization.

Unit 1 **[7 hrs]** Principles of Quality Management, Pioneers of TQM, Quality costs, Quality system Customer Orientation, Benchmarking, Re-engineering
Unit 2 **[7 hrs]** Leadership, Organizational Structure, Team Building, Information Systems and Documentation – Quality Auditing, ISO 9000 - QS 9000.QMS, Quality awards.
Unit3 **[8 hrs]** Single Vendor Concept, J.I.T., Quality Function deployment, Quality Circles, KAIZEN, SGA POKA -YOKE, Taguchi Methods. SMED, Kanban system. Cost of quality. Robust design
Unit4 **[8 hrs]** Methods and Philosophy of Statistical Process Control, Control Charts for Variables and Attributes
Unit5 **[8 hrs]** Cumulative sum and exponentially weighted moving average control charts, Others SPC Techniques – Process Capability Analysis. Acceptance Sampling Problem, Single Sampling Plans for attributes, double, multiple and sequential sampling,]
Unit6 **[7 hrs]** Six sigma manufacturing concepts. Six-sigma philosophy Quality strategy and policy. Motivation and leadership theories. Continuous vs. breakthrough improvements. Management of change, DMAIC Methodology. Lean manufacturing

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Reference books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Total Quality Management for Engineers	1991	Mohamed Zairi	Woodhead Publishing Limited 1991
2	Production and Operations mangament - Total Quality and Responsiveness	1995	Harvid Noori and Russel	McGraw-Hill Inc, 1995
3	Managing for Total Quality	1998	N.Logothetis	Prentice Hall of India Pvt .Ltd,1998
4	The Essence of Total Quality Management	1995	John Bank	Prentice Hall of India Pvt.Ltd., 1995.
5	Introduction to Statistical Quality Control	1991	Douglus C. Montgomery	2nd Edition, John Wiley and Sons, 1991.
6	Statistical Quality Control	1984	Grant E.L and Leavensworth	McGraw-Hill, 1984.

VII Semester
ME2449– PE IV : Project Evaluation & Management

Objective	Course Outcome
The course focuses on developing complete understanding of formulating a problem/project and finding possible solutions against the given constraints. The overall learning shall resolve project identification evaluating its technical and economical feasibility and developing skills for its planning, and establishing controls. Relevant techniques, writing skills and monitoring methods shall be dealt with in details	The students will be able 1. To apply the concepts of monitoring and evaluation, appraise 2. To analyze the best monitoring methods, appreciate evaluation in the context of developmental project work 3. To perform problem analysis, determine relevant indicators and data necessary for evaluation, 4. Implement a monitoring and evaluation process, establish baselines and targets..

Unit1 **[7 hrs]**

Project Identification considering objectives and SWOT analysis, Screening of Project Ideas, Technical, Market, Financial, Socioeconomic and Ecological Appraisal of a project demand forecasting, secondary data, accuracy, confidence level, uncertainty.

Unit2 **[7 hrs]**

Technical feasibility: Process selection, Level of automation, plant capacity, acquiring technology, Appropriate technology plant location, Equipment selection & procurement, Govt. policies. Value analysis and project evaluation.

Unit3 **[9 hrs]**

Economic feasibility: Cost of Project, working capital analysis, fixed cost, means of finance, estimation of sales & production price analysis, Break even point, Projected cash flow statements, projected balance sheet, projected profit & loss statement, projected cash flow, rate of return, Discounted payback period, cost benefit analysis, return after taxes.

Unit 4 **[7 hrs]**

Project Planning and Control: Work break down structure and network development. Basic Scheduling, Critical Path and four kinds of floats. Scheduling under probabilistic durations, Time Cost tradeoffs, CPM, PERT, Optimum project duration, resource allocation, updating.

Unit 5 **[7 hrs]**

Project report: Preparation of project report, risk analysis, sensitivity analysis, methods of raising capital

Unit6 **[8 hrs]**

Initial review, performance analysis , ratio analysis, sickness, project revival, Project Monitoring with PERT/Cost,

Organizational aspects, Computer packages and Project Completion environ-mental & social aspects.

Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Projects	Seventh edition 2007	Prasanna chandra	Tata mc graw Hill publishing company Ltd.
2	CPM & PERT		L. S. Srinath	East West publisher
3	Projects	1963	P.K. Joy	Macmillon
4	Engineering Economy	Fifth edition	H. G Thuesen, W J Fabricky, G,J, Thuersen	Prentice-Hall
5	Finance series 'Project management' , Vol-I1 and Vol-III	2009	ICFAI	ICFAI,Press Hyderabad
6	Finance Management	Sixth edition 2010	M.Y.Khan	Tata McGraw hill
7	Financial Management	Fourth edition	Chandra, Prasanna	Tata McGraw-Hill Education, 1997
8	Engineering Economics	Eighth edition	G. J. Thuesen, Wolter J. Fabrycky	Prentice Hall, 1993

VII Semester
ME2461– PE V : Stress Analysis

Objective	Course Outcome
To develop in the engineering students the ability to analyze any engineering problem in a simple and logical manner and to apply to its solution a few, well understood basic principles of stress analysis.[c,e]	(Students will be able to: 1. Analyze the stresses and strains in simple problems in Cartesian co-ordinate. 2. Analyze the stresses and strains in simple problems in Polar co-ordinate. 3. Analyze the stresses and strains using whole field method. 4. Analyze the stresses and strains using strain gauges, carryout of analysis for fracture and fatigue; design a proper stress analysis system for as per system requirements.

Unit 1 **[7 hrs]**

Two Dimensional Problems in. Cartesian Coordinate system -Fundamentals of stress & strain, stress-strain relationship, Elastic constant, plane stress, plane strain., differential equation of equilibrium Boundary conditions, Saint Venant's principle, compatibility equation.

Unit 2 **[7 hrs]**

Airys stress function. Stress analysis of cantilever subjected to concentrated load at its end and simply supported beam subjected to uniformly distributed load.

Two dimensional problems in polar coordinate systems -General equations of equilibrium in polar coordinate compatibility equation.

Unit 3 **[7 hrs]**

Stress distribution about symmetric. axis, stress analysis of cylinder subjected to ~ internal & external pressure, Pure bending of curved beams, effect of hole on the stress distribution in plates, Stress analysis of rotating circular disk.

Unit 4 **[8 hrs]**

Introduction to various methods of stress analysis like grid techniques, brittle coating method, Moire fringe method etc.

Two Dimensional Photo elasticity - Introduction to basic optics related to photo elasticity, stress optic law, plane & circular polariscope arrangements, diffusion and lens type polariscope .Effect of stressed model in plane & circular polariscope, Isoclinic & Isochromatics, stress trajectories, calibration of photo elastic material (determination of fringe constant). Various photoelastic materials and their properties, Casting of photo elastic models, Tardy's and other compensation technique. Separation techniques like, shear difference, oblique incidence & electrical analogy.

Unit 5	**[8 hrs]**
Strain gage technique for stress & strain analysis -Introduction to electrical resistance strain gages, gage . factor, bridge circuit, bridge balance, output voltage of Wheatstone bridge, balancing of bridge, temperature compensation, various bridge configurations, bonding of strain gages to the specimen, determination of principle strains & stresses using strain rosettes. Environmental effects on performance of strain gages, Strain gages response to dynamic strains, Effect of lead wires. Introduction to Strain measurement on rotating components, Static & Dynamic Strain Measurement introduction to semiconductor gages, high temperature strain gages & self-temperature compensated gages. Introduction to Commercial strain indicators.	
Unit 6	**[7 hrs]**
Introduction to fatigue and fracture mechanics.	

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Theory of Elasticity	2nd edition	Timoshenko S.P;	Tata McGraw-Hill Education, 1951
2	Experimental Stress Analysis	3rd edition	Dally ;Riley	McGraw-Hill, 1991
3	Experimental Stress Analysis	1982	Ray T.K.	S. Chand,
4	Experimental Stress Analysis	1984	Srinath L.S	Tata McGraw-Hill Publishing Company Limited, 1984
5	Vol - I and Vol – II."Theory of photoelasticity	2009	Max Mark Frocht	Pergamon Press, 1969
6	Applied elasicity	--	Chi The Wang	Amazon

VII Semester
ME2462– PE V : Product Design and Development

Objective	Course Outcome
To understand the Product Life Cycle. Study different design techniques, product development phases, process selection, material selection and costs associated with PDD	Students will be able to: (1) Evaluate the product life cycle (2) Analyze and select the materials and manufacturing processes for designed product. (3) Evaluate the product for different design criteria like Value engineering/ analysis, robust design, benchmarking, DFX,etc and estimate the product costing. (4) Explain the various prototyping methods and its economics.

UNIT 1	**Introduction** Importance of product design, types of design, product definition, product specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, concept generation and evaluation methods.	**[7 hrs]**
UNIT 2	**Material and Process selection** Material selection – Importance, classification, material performance characteristic, Selection criteria, Ashby Material selection chart. Process selection – Importance types of manufacturing processes and their classification, sources of information, selection criteria, Material and Process selection Methods- Expert systems, Computer Database Approach, Performance indices, decision matrix, AHP and fuzzy approach, introduction to material and process selection software	**[7 hrs]**
UNIT 4	**Benchmarking** Benchmarking – DFM, DFA, DFX, Early supplier involvement, robust design, QFD and concurrent engineering.	**[8 hrs]**
UNIT 5	**Product Costing** Mathematics of Time Value of Money, Cost Comparison, Depreciation, Taxes, Inflation, Profitability of Investment and Investment Decision Analysis Sensitivity Analysis. Methods of Cost Estimates. Creative thinking, Ergonomics in Design.	**[8 hrs]**
UNIT 6	**Rapid Prototyping** Product Development Cycle and Importance of Prototyping, Types of Prototypes, Principle and Advantages & Different Type of Generative Manufacturing Process, Viz, Stereolithography, FDM, SLS etc. Factors Concerning to RP: Consideration for Adoptions, Advantages, Accuracy and Economic Considerations	**[7 hrs]**

Book for reference:

1. Dieter George E. "Engineering Design", McGraw Hill Pub. Company, 2000
2. Ulirich Karl T. and Eppinger Steven D., "Product Design and Development" McGraw Hill Pub. Company, 1995.
3. Bralla, James G., "Handbook of Product Design for Manufacturing" McGraw Hill Pub. Company, 1986
4. HARRY NYSTROM, " Creativity and innovation", John Wiley & Sons, 1979.
5. BRAIN TWISS, " Managing technological innovation", Pitman Publishing Ltd., 1992.
6. HARRY B.WATTON, " New Product Planning ", Prentice Hall Inc. 1992.
7. P.N.KHANDWALLA - " Fourth Eye (Excellence through Creativity) – Wheeler Publishing ",Allahabad, 1992.
8. I.P.R. Bulletins, TIFAC, New Delhi,A.K. Chitale and R. C. Gupta, Product Design and

VII Semester
ME2463– PE V : Power Plant Engineering

Objective	Course Outcome
1. To study the basics of power generations systems. 2. To study conventional & non-conventional power plants. 3. To study the combined operations of different power plants. 4. To study Power load analysis & Economic analysis of power generations systems.	(I) Student will be able to understand the various systems of thermal power plant (Steam and Gas) (II) Student will be able to understand hydraulic power plants.] (III) Student will be able to undertake power load analysis & Economic analysis of power generations systems. (IV) Student will be able to understand nuclear power plat and safety aspect.

Unit1 **[7 Hrs]**

THERMAL POWER PLANT- I

Introduction to thermal power plants and power plant layouts.
Fuel characteristics, handling, storage, preparation & firing methods. Ash & dust collection and handling.
Boiler: classification, general arrangement, details of different components and system like draught system, steam turbine systems, condenser, cooling towers, water treatment, Waste Disposal-Present practices, environmental hazards and other social aspects**.**

Unit2 **[8 Hrs]**

THERMAL POWER PLANT- II

Gas Turbine Power Plant: -Introduction, power plant layouts, Open cycle, close cycle power plants. Various components and systems. Methods to improve efficiency. Reheat and Regeneration cycle and their combinations
Diesel Electric Power Plant: - Introduction, Outline, type of engines, different components, performance, plant layout.
Comparison with other power plant. Introduction to captive power plant.(To study the practical aspect ot power plant,the visit to nearby power plant shall be arrange for the students) **.**

Unit 3 **[7 Hrs]**

HYDROELECTRIC POWER PLANT.

Hydrology: - Rainfall, Runoff, Hydro graph, flow duration curve, mass curve.
Hydroelectric power plant: - Site selection, classification of hydroelectric power plant, general arrangement, details of different components, turbine selection, models & model testing, governing.
Comparison with other power plant.

Unit 4 **[8 Hrs]**

POWER PLANT ECONOMICS

Load Analysis - Fluctuating Load on power plants, Load curves, various terms & definition, peak load, effect of fluctuating load.

Economic Analysis: - Cost of electric energy, load division, and. Tariff methods for Electrical Energy.

Unit 5 **[8 Hrs]**

NUCLEAR POWER PLANT

Introduction to Nuclear Engineering, Global scenario, prominent installations worldwide, present & proposed nuclear plant in India.

Nuclear Reactors: - Types of reactors, PWR, BWR, CANDU, Gas cooled, liquid metal cooled, Breeder reactor. Operational requirements and difficulties, site selection for location of a nuclear power station Nuclear Waste Disposal-Present practices, environmental hazards and other social aspects.

Comparison with other power plant.

Unit 6 **[7 Hrs]**

COMBINED OPERATION OF DIFFERENT POWER PLANTS

Combined operation: - Need division, combination of different plant & their coordination, advantages.

NON CONVENTIONAL POWER GENERATION SYSTEMS

Introduction to Non Conventional power Generation Systems

Geo-Thermal Power Plant, Tidal Power Plant, Wind Power Plant, Solar Power Plant

Global scenario, prominent installations worldwide present & proposed plant locations.

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Power Plant Engineering	2002	Domkundwar.	Dhanpat Rai & Co.

Reference books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Power Plant Engineering	2007	Vopal & Slortzki	
2	Power Plant Engineering	1984	M.M. Wakil	TATA Mc-Graw Hill.
3	Power Plant Engineering	2008	P. K. Nag	TATA Mc-Graw Hill.
4	Power Plant Engineering	2005	R. K. Rajput	TATA Mc-Graw Hill.

VII Semester
ME2464– PE V : Value Engineering

Objective	Course Outcome
To familiarize students with : 1. Philosophy of Value Analysis / Value Engineering , its importance and application 2. The various steps involved in systematic implementation of Value Analysis / Value Engineering	Students will be able to: 1. Explain the various typs of Values and functions. 2. Evaluate the product life cycle. 3. Analyze the project selection and estimate life cycle costs. 4. Evaluate and improve value of product/system by designing and critically analyzing the VE job plans and othe VE/VA techniques.

Unit 1 **[7 hrs]**

Introduction to Value Engineering (V.E.) and Value Analysis, Quantitative definition of Value, Use Value and Prestige Value, Estimation of product quality/performance, Types of Functions.

Unit 2 **[7 hrs]**

Life Cycle of a Product, Product life cycle Management, Methodology of V.E.,

Unit 3 **[8 hrs]**

Relationship between Use Functions and Esteem Functions in product design, Functional Cost and Functional Worth, Effect of value improvement on profitability, Aims of VE systematic Approach

Unit 4 **[8 hrs]**

Introduction to V.E. Job plan / Functional Approach to Value Improvement, Various phases and techniques of the job plan

Unit 5 **[8 hrs]**

Factors governing project selection, Life Cycle Costing for managing the Total Value, Concepts in LCC, Present Value concept, Annuity concept, Net Present Value, Pay Back period, Internal rate of return on investment (IRR), Examples and illustrations

Unit 6 **[7 hrs]**

Creative thinking and creative judgment, False material, labor and overhead saving, System Reliability, Reliability elements in series and parallel, Decision matrix, Estimation of weights and efficiencies, Sensitivity analysis, Utility functions, Fast diagramming, Critical path of functions, DARSIRI method of value analysis, Purchase price analysis.

Reference Books				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Value Engineering	1962	L.D.Miles	Materials Management International,
2	Getting more at less cost	1995	Jagannathan	Tata McGraw-Hill Publishing Company Limited,
3	Value Engineering		Tufly	
4	Value Engineering	3rd edition	Donald Parker	
5	Value Engineering	4th edition	Zimmerman	City of Tulsa, 1984

VII Semester
ME2465– PE V : Design of Experiments and Taguchi Methods

Objective	Course Outcome
The course aims to develop the engineering - analysis capability for engg-problems using basic statistical tools and techniques. Detailed treatment of various data analysis and handling technique leading to complete understanding and modeling the processes including its optimization is envisaged in this course.	Students will be able to 1) Calculate and represent Frequency Distribution, Histograms and Probability distribution 2) Design the experiments 3) Distinguish and analyze the different optimization techniques. 4) Analyze the variance in observation data.

Unit 1 **[7 Hrs]**

Frequency Distribution & Histograms, Probability & its Distribution, Measures of Central Tendency & Distribution, Presentation of Statistical Data. Importance and significance of statistics in an engineering industry.

Unit 2 **[8 Hrs]**

Confidence intervals, Hypothesis Testing, Correlation, Liner & Multiple Repression Analysis, Signification Testing, Introduction to minitav

Unit 3 **[7 Hrs]**

Full & fractional factorial experiments, analysis of variance, Latin squares, response surface methology,

Unit 4 **[7 Hrs]**

Group Method of Data Handling, shainin variable search technique, Regression equation in matrix form.

Unit 5 **[8 Hrs]**

Taguchi techniques, concept of six sigma, DoE and six sigma, Six sigma implementation.

Unit 6 **[8 Hrs]**

Industrial application of Taguchi technique, orthogonal arrays, OA selection, DoE with Taguchi and comparison with conventional DoE

Text books:				
S.N.	**Title of the book**	**Edition (Year of publication)**	**Author(s)**	**Publisher**
1	Experimental Design	1950	Cochran & Cox	Wiley,
2	Taguchi Techniques in Quality Engineering	2nd edition	Phillip J. Ross	McGraw-Hill, 1996
3	Statistical Analysis for Engineers and Scientist	2010	Barnes	McGraw-Hill, 1994
4	Introduction to Probability and Statistics	4th edition 2003	Milton	McGraw-Hill,
5	Engineering Statistics	2nd edition	Bowker & Liberman	Prentice-Hall, 1972

VII Semester
ME2466– PE V : Industrial Safety

Objective	Course Outcome
•To understand the need and importance of safety. Study different types of accidents and its preventions. Also study the various safety equipments and their applications. •Learn how to get higher operating plant and equipment reliability that lifts efficiency and output of operating assets, stops equipment failures and creates higher plant and equipment reliability, with this subject.	(I) Student will be able to understand the risk management (II) Student will be able to handle the accidental situation in plant (III) Student will be able to understand the operations of different type of safety instruments. (IV) Student will be able to arrange the training for employees on Safety.

Unit 1 **[7Hrs]**

Introduction

Introduction to occupational safety & health, need for occupational safety, Safety Organization, Safety Policy, Safety Committee, Safety Officer, Medical Officer, Labour welfare Officer, Safety manual, Disaster management plan, Government & other autonomous occupational safety & health organizations. Introduction to OHSAS 18000.

Unit 2 **[8Hrs]**

Occupational Accidents

Accident, causes of accident, cost of accident, unsafe conditions, unsafe actions, unsafe personal factors, Accident causations models, accident reporting, accident investigation & analysis, Application of remedial measures, result monitoring, Personal Protective Equipments(ppe), Types of ppe, legal provisions of accident reporting, safety performance measurement, Frequency Rate, Severity Rate, Incidence Rate, Introduction to IS:3786.

Unit 3 **[7Hrs]**

Risk Identification & Risk management

Plant safety inspection, Job safety analysis, Hazards identification & Risk analysis **(HIRA)**, Fault tree analysis **(FTA)**, Hazards & operability Study **(HAZOP)**, Failure mode & Effect analysis**(FMEA)**, Failure mode, criticality & effect analysis **(FMCEA)**, Safety audits, Safety Integrity Level **(SIL)**, Level of Protection Analysis **(LOPA)**.

Unit 4 **[7Hrs]**

Safety & The Law

Introduction to various Laws & Rules pertaining to Safety, Health & Welfare of Indian work-force. Provisions of Factories Acts' 1948 pertaining to Safety only.

Unit 5 **[8Hrs]**

Safety with Machines

Safety in design, Plant layout & housekeeping, Machine maintenance, Machine guarding, types of machine guards, special tools for enhancing safety, safety in use of compressed gas cylinder, safety around grinding wheel, safety in drill machines, safety in use of hand tools, safety in press machines, handling and disposal of

hazardous chemicals, electrical safety, fire safety

Unit 6 **[7Hrs]**

Safety Training & Awareness

Safety training and safety education, safety awareness methods viz safety competitions, safety posters and hording, safety magazine, safety pamphlets, safety campaign, Tool-Box talk, Employees participation in promoting safety**.**

Text books:

S.N.	Title of the book	Edition (Year of publication)	Author(s)	Publisher
1	Industrial Safety	3rd editiion	Roland Patton Blake	Prentice-Hall, 1963
2	Industrial Safety	1977	Jack W. Boley	Gulf Publishing Company, Book Division,

VII Semester
ME2467– PE V : Control System Engineering

Objective	**Course Outcome :-** Students will be able to
• To develop an ability to define transfer function. • To analyze the performance of control system in time domain and frequency domain	(I) Describe the mathematical representation of various control system components and determine the transfer function of mechanical, electrical, thermal and fluid system. (II) Analyse the construction and working of various control system components and electrical motors. (III) Evaluate the performance of control system using time response analysis and stability analysis. (IV) Analyze the performance of control system on the basis of frequency response and design suitable compensation for the control system.

Unit 1 **[7hrs]**
Introduction, System concept Open and Closed loop control systems. Transfer function, Mathematical Modeling of Physical System and system representation through Block Diagram. Transfer function through Block Diagram Simplification. Signal Flow Graph, Masons Gain Formula Block diagrams of various control systems.

Unit 2 **[7 hrs]**
Representation of Control components: Mechanical and Electrical components; Analogous systems; Thermal and Fluid systems.

Unit3 **[8 hrs]**
Electrical systems: - ac/dc servomotors; field controlled and armature controlled servomotors; positional servomechanisms; stepper motors.
Hydraulic systems: - Hydraulic pumps (gear; vane; and reciprocating piston) Cylinders, Direction control valves (2, 3, 4 way) Flow control valve; Relief valve Hydraulic servomotor.

Unit4 **[8 hrs]**
Transient and steady state response of first and second order systems Concept of stability; relative stability; Routh stability criteria.

Unit5 **[8 hrs]**
Frequency response and its characteristics; Bode plots; Nyquist plots. Gain margin and phase margin. Identification of system transfer function.

Unit6 **[7 hrs]**
Basic control actions; Proportional Integral and Derivative control actions and their effect on system performance. Root locus technique. Introduction to control system design log load compensation Feed Back Compensation and Pole -Zero placements.

Text books:				
1	Modern Control Engineering	3rd Edition (2009	Ogata	Prentice Hall
2	Control system Engineering	4th Edition (2007)	Nise	John Wiley & Sons
3	Control system	4th Edition (2009)	Nagrath & Gopal	New Age International
4	Modern Control System	12th Edition (2009)	Dorf	pearson

VII Semester
ME2468– PE V : Tribology

Objective	Course Outcome
Tribology deals with design of fluid containment systems like seals and gasket, Lubrication of surfaces in relative motion to achieve reduced friction and wear. The structure of the bearing and the nature of fluid flow determine the loads that can be supported. Modeling systems as hydrostatic squeeze film and Elasto-hydrodynamic lubrication will be studied as infinite and later finite structures. Gas (air) lubricated and rolling contact type motions with deformation at contact will be studied as special systems.	

UNIT-1: Introduction Introduction to tribology, History of tribology, Interdisciplinary Approach, Economic Benefits.
UNIT-2: Friction Causes of Friction, Adhesion Theory, Abrasive Theory, Junction Growth Theory, Laws of Rolling Friction, Friction Instability.
UNIT-3: Wear Wear Mechanisms, Adhesive Wear, Abrasive Wear, Corrosive Wear, Fretting Wear, Wear Analysis
UNIT-4: Lubrication and Lubricants Importance of Lubrication, Boundary Lubrication , Mixed Lubrication , Full Fluid Film Lubrication ; Hydrodynamic, Elastohydrodynamic lubrication , Types & Properties of Lubricants, Lubricants Additives.
UNIT-5: Fluid film lubrication Fluid mechanics concepts, Equation of Continuity & Motion,Generalised Reynolds Equation with Compressible & Incompressible Lubricants
UNIT-6: Application Tribology Introduction, Rolling Contact Bearings, Gears, Journal Bearings - Finite Bearings.

Reference Books:

1. Dowson D, History of Tribology, Longman London, 1979.
2. Stachowiak G N, Batchelor A W and Stachowick G B "Experimental methods in Tribology", Tribology Series 44, Editor D Dowson, 2004.
3. Michael M Khonsari, Applied Tribology (Bearing Design and Lubrication),John Wiley & Sons, 2001.
4. Jost H P, Lubrication (Tribology) : A Report on the present position and industry`s needs, Her Majesty`s Stationary Office, London, 1966.
5. J Halling, Principles of Tribology, The Macmillan Press Ltd, London, 1975.
6. Archard J F and Hirst W, The Wear of Metals under Unlubricated Conditions, Proc. R. Soc., London, A 236, 397-410, 1956.
7. Ludema K C, Friction, Wear, Lubrication: A textbook in Tribology, CRC Press, 2010.

VII Semester
ME2469– PE V : Turbines

Objective	Course Outcome
Students should apply the fundamentals of fluid dynamics and thermodynamics to turbine. The student shall learn about equipment employed for converting water energy to electrical energy and different types of turbines and also understand steam turbine and gas turbine and its application.	**CO:1** The student will be able to describe and analyze the working of impulse water turbines.[a,e,k] **CO:2** The student will be able to describe and analyze the working Centrifugal Pumps .[a,e,k] **CO:3** The student will be able to define evaluate Steam nozzles and; describe and analyze the impulse steam turbines, reaction steam turbines.[a,e,k] **CO:4** The student will be able to describe and analyze the working of Gas turbines.[a,e,k]

Unit No.	Contents	Max. Hrs.
Unit 1	Impulse Water Turbines: Momentum Principle and its Application , Classification of water turbines, Pelton wheel, its construction and working, velocity triangles, efficiency, power, work done, Pelton wheel design, Governing of Pelton wheel **[CO:1]**	**[6 hrs]**
Unit 2	Reaction Water Turbines Principle of operation, Construction and working of Francis and Kaplan Turbine, Effect of modification of velocity triangles on runner shape, Draft tube, Cavitations calculation of various efficiencies, Power, Discharge, Blade angles, Runner dimensions etc. governing of Francis and Kaplan turbine, Draft tube types and analysis [**CO:2]**	**[7 hrs]**
Unit 3	Steam nozzles: Compressible fluid flow, Static and Stagnation properties, Isentropic flow, Flow of fluid through nozzles, Continuity equation, Variation of velocity, area and specific volume, Mass of discharge, Maximum discharge, Critical pressure ratio, Choking, Effect of friction, Nozzles and Diffusers efficiency, Back pressure effect, Super saturated flow. [**CO:3]**	**[7 hrs]**
Unit 4	Impulse Steam turbines : Types of turbines, Compounding, Velocity diagrams, Performance analysis, Reheat factor, Stage efficiency, Governing, and Losses in turbines. [**CO:3]**	**[6 hrs]**
Unit 5	Reaction Steam turbines: Types of turbines, Compounding, Velocity diagrams, Performance analysis, Reheat factor, Stage efficiency, Governing, and Losses in turbines. [**CO:3]**	**[6 hrs]**
Unit 6	Gas turbines: Classification of gas turbines, Analysis, Regeneration, Inter-cooling, Reheating, Applications, Types of jet engines, Construction and working; propulsive efficiency [**CO:4]**	**[7 hrs]**

Text books:			
S.N.	**Title of the book**	**Author(s)**	**Publisher**
1	Fluid Mechanics: Fundamentals and Applications	Yunus A. Cengel and John M. Cimbala	McGraw-Hill
2	Engineering Fluid Mechanics	K. L. Kumar	S. Chand & Company Ltd.
3	Fluid Mechanics & Fluid Power Engineering	D. S. Kumar	S. K. Kataria Publication
4	Thermal Engineering	P.L.Ballaney	Khanna Publication
5	Thermal Engineering and heat engines	R.Yadav	Central Publishing house
6	Heat power engg	Kumar & Vasandani	Metro Politon Publisher
7	Gas Turbine	Dubey & Khajuria	Dhanpat Rai Publications
8	Thermal Engineering	R.K.Rajput	Laxmi Publication

VIII Semester
ME2451 - Major Project

COURSE OBJECTIVES	COURSE OUTCOME
1. To apply knowledge of mathematics, science and engineering in a global, economic, environmental and societal context and engage in life-long learning. 2. To design a model, a system or components considering environmental, economic, social, political, ethical and sustainability and analyze and interpret the data. 3. To work on multidisciplinary teams, tackle engineering problems, understand professional and ethical responsibility and communicate effectively. 4. To apply knowledge of contemporary issues and use the techniques, skills, and modern engineering tools necessary for engineering practices. 5. To analyze and design RCC & steel structures, draw and prepare cost estimates of civil engineering structures.	On successful completion of the course students will be able to: 1. Demonstrate a sound technical knowledge of their selected project topic. 2. Undertake problem identification, formulation and solution. 3. Design engineering solutions to complex problems utilizing a systems approach including ability to work in a team. 4. Communicate effectively to discuss and solve engineering problems.
Mapped Program Outcomes : 1,2,3,4,5,6,7,8,9,10,11,12 **PSO** : i,ii,iii	

The group of students will continue to work for the project allotted previously and will submit a project report based on their studies. Evaluation will be done continuously and viva voce conducted at the end of the semester.

VIII Semester
ME2452 - Extra-Curricular Activity Evaluation

COURSE OBJECTIVES	COURSE OUTCOME
1. To expose to culture and tradition. 2. To provide opportunity for student to perform and present their hidden talent, still and art. 3. To nurture hobbies. 4. To organize co-curricular activities to make competitive spirit, cooperation, leadership, diligence, punctuality, team spirits. 5. To develop creative talent, self-confidence, sense of achievement. 6. To be able to design process on environmental, social, political, ethical, health and safety. 7. To develop broad education to understand the impact of engineering solution in a global economic, environmental, society.	1. An ability to work initially as well as part of team to achieve set goals. 2. An ability to work to serve society and for betterment of society. 3. An ability to communicate with people at large.
Mapped Program Outcomes : 5,6,7,9,10,11	

Due credits will be given to the students based on their performance and involvement in different extra and co-curricular activities conducted within the college or by other organizations/ institutions. Due credit will also be given to the student if they are successful in different competitive examinations conducted by different organizations. The guidelines as given in academic regulations will be followed for evaluation.