



GIET UNIVERSITY GUNUPUR, ODISHA

Incorporated by Act 23 of Govt. of Odisha and under approval of UGC & AICTE

Accredited by NAAC with a CGPA of 3.28/4 at A+ Grade

Seven UG Programs CSE, ME, CHE, AEIS, ECE, BT & EEE Accredited by NBA

Gunupur - 765022, Dist.- Rayagada, Odisha, INDIA www.giet.edu

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING

DETAILED SYLLABUS STRUCTURE

MECHANICAL ENGINEERING

ACADEMIC REGULATION -2019



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D. N. Panda
N. K. Panda

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

Structure of Undergraduate Engineering Program

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER								TOTAL CREDITS
		I	II	III	IV	V	VI	VII	VIII	
1	Humanities and Social Sciences including Management Courses	3	3	2	2	-	-	2	-	12
2	Basic Science Courses	8	8	4	-	-	-	-	-	20
3	Engineering Science Courses including workshop, drawing, basics of electrical mechanical/computer etc.	10	10	5	3	2	3	-	-	33
4	Professional Core Courses	-	-	10	15	15	13	-	-	53
5	Professional Elective Courses relevant to chosen specialization / branch	-	-	-	-	3	6	6	3	18
6	Open subjects - Electives from other technical and/or emerging Subjects	-	-	-	-	3	3	3	2	11
7	Project work, Seminar and Internship in industry or elsewhere	-	-	1	1	3	1	5	6	17
8	Mandatory Courses [Environmental Sciences, Induction Training, Indian Constitution, Essence of Indian Traditional Knowledge]	0	0	0	0	-	-	-	-	0
	TOTAL	21	21	22	21	26	26	16	11	164



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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

I Semester [First Year]

Branch/ Course Common to all branches of UG Engineering & Technology

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses	BBSBS1010	Engineering Mathematics-I	3	1	0	4
2	Basic Science Courses	BBSBS1021 / BBSBS1121	Engineering Physics	3	0	2	4
		BBSBS1022 / BBSBS1122	Engineering Chemistry				
3	Engineering Science Courses	BESBS1031	Basics Of Mechanics	3	1	0	4
4	Engineering Science Courses	BESBS1040 / BESBS1140	Programming for Problem Solving	2	0	4	4
5	Humanities and Social Sciences including Management Courses	BHSBS1050 / BHSBS1150	Communicative English and Soft Skills	2	0	2	3
6	Engineering Science Courses	BESBS1161	Engineering Graphics & Design	1	0	2	2
		BESBS1162	Workshop/Manufacturing Practices				
7	Mandatory Courses	BMCBS1170	Induction Program	-	-	-	0
Total Credits:				14	2	10	21

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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

II Semester [First Year]

Branch/Course Common to all branches of UG Engineering & Technology

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses	BBSBS2010	Engineering Mathematics-II	3	1	0	4
2	Basic Science Courses	BBSBS1021 / BBSBS1121	Engineering Physics	3	0	2	4
		BBSBS1022 / BBSBS1122	Engineering Chemistry				
3	Engineering Science Courses	BESBS1032 / BESBS1132	Basic Electrical & Electronics Engineering	3	0	2	4
4	Engineering Science Courses	BESBS2040 / BESBS2140	Data Structure & Algorithms	2	0	4	4
5	Humanities and Social Sciences including Management Courses	BHSBS2050 / BHSBS2150	Communicative English-2	2	0	2	3
6	Engineering Science Courses	BESBS1161	Engineering Graphics & Design	1	0	2	2
		BESBS1162	Workshop/Manufacturing Practices				
7	Mandatory Courses	BMCBS2170	NCC/NSS/Yoga	-	-	-	0
Total Credits:				14	1	12	21



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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

III Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses	BBSBS3010	Engineering Mathematics-III	3	1	0	4
2	Engineering Science Courses	BESCS3051/ BESCS3151	Object Oriented Programming	3	0	2	4
3	Professional Core Courses	BPCME3020	Engineering Thermodynamics	3	0	0	3
4	Professional Core Courses	BPCME3030/ BPCME3130	Mechanics of Solids	3	0	2	4
5	Professional Core Courses	BPCME3040	Material Science	3	0	0	3
6	Humanities and Social Sciences including Management Courses	BHSMS3061	Organizational Behavior	2	0	0	2
		BHSME4060	Optimization In Engineering				
7	Engineering Science Courses	BPCME3160	Computer Aided Design Lab	0	0	2	1
8	Project	BPCTP3170	Summer Industry Internship	-	-	2	1
9	Mandatory Courses	BMCAU3081	Environmental Sciences	-	-	-	0
Total Credits:				17	1	8	22

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DEPARTMENT OF MECHANICAL ENGINEERING

IV Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Engineering Science Courses	BESME4050	Database Management Systems	3	0	0	3
2	Professional Core Courses	BPCME4010/ BPCME4110	Fluid Mechanics and Hydraulic Machines	3	0	2	4
3	Professional Core Courses	BPCME4020/ BPCME4120	Manufacturing Science-I	3	0	2	4
4	Professional Core Courses	BPCME4030/ BPCME4130	Kinematics of Machinery	3	0	2	4
5	Professional Core Courses	BPCME4040	Quality Control and Reliability	3	0	0	3
6	Humanities and Social Sciences including Management Courses	BHSME4060	Optimization In Engineering	2	0	0	2
		BHSMS3061	Organizational Behavior				
8	Project	BPCME4180	Mini Project -1	0	0	2	1
Total Credits:				17	0	8	21

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

V Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses	BPCME5010/ BPCME5110	Dynamics of Machinery	3	0	2	4
2	Professional Core Courses	BPCME5020	Machine Design-I	3	0	0	3
3	Professional Core Courses	BPCME5030/ BPCME5130	Manufacturing Science-II	3	0	2	4
4	Professional Core Courses	BPCME5040/ BPCME5140	Internal Combustion Engines	3	0	2	4
5	Professional Elective Courses	BPEME5050	Automobile Engineering	3	0	0	3
		BPEME5051	Modern Manufacturing Processes				
		BPEME5052	Advanced Mechanics of Solid				
		BPEME5053	Advanced Fluid Mechanics				
6	Open Elective Courses	BOEME5060	Research Methodology	3	0	0	3
		BOEME5061	Microprocessors And Microcontrollers				
		BOEME5062	Process Dynamic And Control				
		BOEME5063	Energy Conversion Techniques				
7	Project	BPCTP5190	Summer Industry Internship	-	-	2	1
8	Project	BPCME5180	Mini Project -2	0	0	4	2
9	Engineering Courses	BHSBS5080	Humans Values and Professional Ethics	2	0	0	2
Total Credits:				20	0	12	26

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VI Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses	BPCME6010/ BPCME6110	Heat Transfer	4	0	2	5
2	Professional Core Courses	BPCME6020/ BPCME6120	Machine Design-II	4	0	2	5
3	Professional Core Courses	BPCME6030	Production And Operations Management	3	0	0	3
4	Professional Elective Courses	BPEME6040	Product Design & Product Tooling	3	0	0	3
		BPEME6041	CAD / CAM				
		BPEME6042	Fatigue, Creep and Fracture				
		BPEME6043	Refrigeration & Air Conditioning				
5	Professional Elective Courses	BPEME6050	Additive Manufacturing	3	0	0	3
		BPEME6051	Computational fluid Dynamics				
		BPEME6052	Vibrational and Structural Dynamics				
		BPEME6053	Hydraulics and Pneumatics				
6	Open Elective Courses	BOEME6060	Internet Of Things	3	0	0	3
		BOEME6061	Corrosion Engineering				
		BOEME6062	Renewable Energy Sources				
		BOEME6063	Industrial Instrumentation				
7	Project	BPCME6180	Mini Project	0	0	2	1
8	Engineering Courses	BMCHS6070	Dietetics and Nutrition	3	0	0	3
Total Credits:				23	0	6	26

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VII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses	BPEME7011	Advanced Welding Technology	3	0	0	3
		BPEME7012	Gas Dynamics and Jet Propulsion				
		BPEME7013	Finite Element Method				
		BPEME7014	Tribology				
2	Professional Elective Courses	BPEME7021	Fire and Safety Engineering	3	0	0	3
		BPEME7022	Design and Analysis of Heat Exchanger				
		BPEME7023	Non-Destructive Evaluation and Testing				
		BPEME7024	Nano Science				
3	Open Elective Courses	BOEME7031	Intellectual Property Rights Industrial Robotics	3	0	0	3
		BOEME7032	Green Technology				
		BOEME7033	Industrial Robotics				
		BOEME7034	Industrial Automation & Control				
4	Humanities and Social Sciences including Management Courses	BHSMS7040	Entrepreneurship Development	2	0	0	2
		BHSMS7041	Engineering Economics and Costing				
		BHSMS7042	Marketing Management				
		BHSMS7043	Human Resource Management				
5	Project	BPCTP7170	Summer Industry Internship	-	-	2	1
6	Project	BPCTP7180	Project Work-I	0	0	8	4
Total Credits:				11	0	10	16

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VIII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses	BPEME8011	Composite Materials	3	0	0	3
		BPEME8012	Power Plant Engineering				
		BPEME8013	Mechatronics				
		BPEME8014	Cryogenics				
2	Open Elective Courses	BOEME8021	Reverse Engineering	2	0	0	2
		BOEME8022	Artificial Intelligence And Expert Systems				
		BOEME8023	Disaster Management				
4	Project	BPCTP8180	Project Work-II &Dissertation	0	0	10	5
5	Project	BPCTP8170	Seminar and Comprehensive Viva-Voce	0	0	2	1
			Total Credits:	5	0	12	11

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APR 2019
Principal
Vice-Chancellor
Dean
Coordinator
In-charge



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Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
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1	Basic Science Courses	BBSBS1010	Engineering Mathematics-I	3	1	0	4
2	Basic Science Courses	BBSBS1021 / BBSBS1121	Engineering Physics	3	0	2	4
		BBSBS1022 / BBSBS1122	Engineering Chemistry				
3	Engineering Science Courses	BESBS1031	Basics Of Mechanics	3	1	0	4
4	Engineering Science Courses	BESBS1040 / BESBS1140	Programming for Problem Solving	2	0	4	4
5	Humanities and Social Sciences including Management Courses	BHSBS1050 / BHSBS1150	Communicative English and Soft Skills	2	0	2	3
6	Engineering Science Courses	BESBS1161	Engineering Graphics & Design	1	0	2	2
		BESBS1162	Workshop/Manufacturing Practices				
7	Mandatory Courses	BMCBS1170	Induction Program	-	-	-	0
Total Credits:				14	2	10	21

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Subject Code	Title of the subject	L	T	P	C	QP
BBS051010	Engineering Mathematics-I	3	1	0	4	A

Course Educational Objectives

CEO1	To find critical points, and use them to locate maxima and minima.
CEO2	To provide the standard methods for solving differential equations.
CEO3	To study Fourier series and to express a function in Fourier series.
CEO4	To use matrices, determinants and techniques for solving systems of linear equations in the different areas of Linear Algebra.

Course Outcomes: Towards the end of the course students will be able to :

CO1	Implement the engineering problems using the concept of Partial differentiation and series and to understand its application.
CO2	Solve the initial value and boundary value problem of ODE related to Electrical circuit.
CO3	Execute the technique of Fourier series for applying in Engineering applications.
CO4	Find the Eigen value and vector of a matrix by using properties of linear algebra

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2													
CO2	2	3													
CO3	1	3													
CO4	2	3													
Avg.	1.5	2.75													

SYLLABUS

UNIT-I MULTI-VARIABLE CALCULUS

(10 Hours)

Limit and Continuity, Partial differentiation, Euler's theorem, Total derivative, Taylor's theorem for function of two variable (without proof), Maxima and Minima for function of two variables, Differentiation under integral sign (Leibnitz).

UNIT:2 DIFFERENTIAL EQUATION-I

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Hours Ordinary differential Equations : First order and first degree differential equations and their method of solving, Application to Electrical circuits and heat conduction

Differential Equation-II

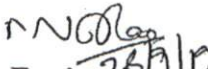
Linear differential equations of higher order and their different methods of solutions (operator methods). Second order linear differential equations and their solutions: Euler Cauchy equation, solution by undermined coefficient method and variation of parameters. Simple application to electrical circuits.

UNIT-III	Fourier series	(8 Hours)
Fourier series, Fourier expansion of functions of arbitrary period, Even and odd functions, Half Range Expansion.		
UNIT -IV	LINEAR ALGEBRA:	(10 Hours)
Matrices, Types of matrices, Rank of matrix, Eigen values and Eigen vectors, Cayley – Hamilton theorem (without proof), system of linear equations, Orthogonal matrices, Complex matrices, Hermitian and skew-Hermitian matrices, Unitary matrices, similarity of matrices. Quadratic forms and Canonical forms.		
Teaching Methods: Chalk& Board/ PPT/Video Lectures		
Prescribed Books:		
1. <i>Advanced Engineering Mathematics</i> by E. Kreyszig, Tenth Edition, Willey. 2. <i>Differential Calculus</i> by Sanku Narayan and Mittal, S.Chand Publications.		
Reference Books:		
1. <i>Higher Engineering Mathematics</i> by BS Grewal : Khanna Publishers, New Delhi. 2. <i>Higher Engineering Mathematics</i> by B.V.Ramana, McGraw Hills Education 3. <i>Advanced Engineer methods</i> by N. P. Bali & Manish Goyal.		


Course Coordinator


BOS, Chairman


Principal


Registrar


Dean (Academics)



Subject Code		Title of the subject		L	T	P	C	QP				
BBSBS1022		Engineering Chemistry		3	0	0	3					
Course Educational Objective												
CEO1: To impart the knowledge of application of chemical sciences in the field of engineering												
CEO2: To give an idea about microscopic chemistry in terms of atomic and molecular orbitals.												
CEO3: The course aims at elucidating principles of applied chemistry in industrial systems, water treatment and engineering materials												
CEO4: To give detailed knowledge about the reactivity of metal with environment and it's prevention from corrosion.												
CEO5: To enlighten the students with the applications of advanced materials.												
Course Outcome												
CO1	The students will be able to analyze microscopic chemistry in terms of atomic and molecular orbitals.											
CO2	Identify suitable water treatments techniques for domestic and industrial purposes											
CO3	Differentiate various types of corrosion, and gain knowledge on control measures associated with corrosion											
CO4	Understand various types of polymers, their preparation along with applications											
CO / PO-MAPPING												
COs	PROGRAMME OUTCOMES (Pos)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2	3	1					1					
CO3	3	1										1
CO4	2	1					1					
UNIT-1									(10Hours)			
ATOMIC AND MOLECULAR STRUCTURE												
Schrodinger's wave equation(no derivation), Significance of wave functions, Particle in a 1D box, Application for conjugated molecule, Molecular Orbital theory and Energy level diagram for Homo nuclear diatomic molecules and Hetero nuclear diatomic molecule (CO & NO)												
UNIT-2									(10 Hours)			
WATER CHEMISTRY												
Types of Hardness, Determination of Hardness by EDTA method, Treatment of water for Domestic use, Water softening processes Lime-soda process, Ion Exchange method, Boiler feed water, Scale and Sludge, Caustic embrittlement, Carbonate and phosphate conditioning, Colloidal conditioning, Calgon conditioning.												
UNIT-3									(10 Hours)			
CORROSION												
EMF, Relation between E.M.F and free energy, Electrochemical series, Galvanic series												
Definition of corrosion, Types of corrosion: Dry corrosion and wet corrosion, Galvanic corrosion, Concentration cell corrosion, Factors influencing corrosion, Corrosion control: Cathodic protection (Sacrificial anodic protection and Impressed current cathodic protection), Protective coatings: Galvanization and Tinning.												

14
UNIT -4 (10 Hours)

POLYMER CHEMISTRY

Introduction, polymer, Classification of polymers, Plastics: Thermosetting and thermoplastic pastics, Preparation , Properties and uses of different plastics such as PVC, PE, PTFE, Bakelite, Nylon-6,Nylon-6,6,Conducting Polymer (Polyaniline, Polyacetylene), Bio-Degradable polymer.

Text Books: 1.Engineering chemistry by Jain & Jain, DhanpatRai publishing company (p) Ltd.

Reference books:

- 1.A Text Book of Engineering Chemistry by S.S.Dara, S Chand Publishers.
2. A Text Book of Engineering Chemistry by SashiChawla, Dhanpat Rai Publishing house.
3. Text Book of Engineering Chemistry, 2nd edition, by R.Gopalan, D.Venkapaya &Sulochana Nagarajan, Vikas Publishing House Pvt. Ltd.
4. B. Tech Chemistry- I and II by P. K. Kar, S. Dash, B. Mishra kalyani publishers.
5. Physical Chemistry By P.W Atkins
6. Engineering Chemistry(NPTEL Web Book) by B . L Tembe, Kamaluddin and M.S. Krishna
7. Fundamentals of Molecular spectroscopy By C . N Banwell
8. University chemistry by B.H. Mahan


Course Coordinator


BOS, Chairman


Principal


Registrar


Dean (Academics)

Lab Code	Name of the lab	L	T	P	C	QP									
	Engineering Chemistry Laboratory	0	0	2	1										
Course Educational Objectives															
CEO	To train the students about the applications of chemical sciences in the field of engineering and technology														
Course Outcomes: Upon successful completion of this course, students should be able to:															
CO1	Understand the basic methods of chemical analysis and instrumentations involved														
CO2	Understand the various method to determine the water quality parameters														
CO3	Able to know the proximate analysis of coal and sproperties of fuel														
CO4	Synthesis of drugs														
CO-PO & PSO Mapping															
COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1		1	2											
CO2	1		2	2											
CO3			2	2			1								
CO4	1		1									3			
Avg.	1		1.5	2			1					3			
List of Experiments: (Any ten to be performed)															
1. Determination of amount of OH^- and CO_3^{2-} present in supplied water sample. 2. Determination of total hardness of water. 3. Standardization of KMnO_4 using sodium oxalate. 4. Determination of ferrous ion in Mohr's salt by standard KMnO_4. 5. Determination of percentage of dissolved oxygen in given water sample. 6. Estimation of available chlorine in bleaching powder/ chloride content. 7. Determination of rate constant of acid catalyzed hydrolysis of ester. 8. Preparation of drug (aspirin). 9. Determination of Flash point of oil. 10. Determination of Acid value of oil. 11. Determination of strength of HCl and CH_3COOH acid from the mixture of acids using NaOH by Conductrometry. 12. Determination moisture and ash content of coal. 13. Determination of partition coefficient of iodine in benzene and water. 14. Preparation and determination of pH of buffer solution. 15. Determination of viscosity of supplied sample.															

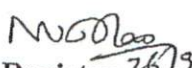
Practical Text Books:

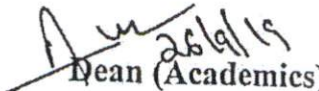
1. Chemistry Practicals By S. Dara.
2. Theory and Practicals of Engineering Chemistry By Dr Sunita Ratan S.K. Kataria & Sons; Reprint 2012 edition (2013)
3. B. Tech Practical Chemistry By Kar, Dash & Mishra, Kalyani Publications.


Course Coordinator


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Dean (Academics)



SUBJECT CODE	TITLE OF THE SUBJECT												L	T	P	C	QP	
BE3B51031	BASICS OF MECHANICS												3	0	0	3		
Pre -Requisite: Math and Physics																		
Course Educational Objective																		
CEO1:	To apply the established engineering method to complex engineering problem.																	
CEO2:	To understand the vectorial and scalar representation of forces and moments																	
CEO3:	To evaluate the different forces exhibit in truss member.																	
CEO4:	To obtain the knowledge on kinematics and kinetics of particle to analyze simple and practical problems																	
Course outcomes: At the end of the course, the student will be able to:																		
CO1	Determine the resultant force and moment for given force system.																	
CO2	Evaluate the forces in members of trusses, frames and problems related to friction.																	
CO3	Analyze the properties of surface in relation to centroid and moment of inertia																	
CO4	Calculate dynamic forces exerted on a rigid body.																	
CO-PO & PSO Mapping																		
COs	PROGRAMME OUTCOMES												PSOs					
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2				
CO1	3	2										1						
CO2	3	3										1	2	2				
CO3	2	3												2				
CO4	3	2										1						
Unit:1																		
STATICS OF PARTICLES																		
Fundamental concepts and principles of engineering mechanics, resolution of forces, resultant of several concurrent forces, free body diagram. Principles of transmissibility, moment of a force, varignon's theorem equivalent system of forces, types of supports and corresponding reactions. Parallel forces in a plane and couple.																		
UNIT:2																		
ANALYSIS OF TRUSSES AND FRICTION																		
Introduction to Truss - Analysis of Trusses - Method of joints, Method of sections. Laws of Friction - Angle of Friction-Angle of Repose-Ladder and Wedge Friction																		
UNIT:3																		
PROPERTIES OF SURFACES																		
Determination of first moment area of plane figures by integration – Determination of centroid of composite figures by using standard formula. Determination of second moment area of plane figures by integration - Parallel and perpendicular axis theorems - Determination of area moment of inertia of composite figures by using standard formula - Polar moment of inertia - Radius of gyration. Distributed forces in a plane.																		



UNIT:4

[10 Hours]

DYNAMICS OF PARTICLES

Rectilinear motion: Uniform velocity and uniformly accelerated motion, Newton second law-D'Alembert's principle and its applications- work and energy equation- Impulse and Momentum - Impact of elastic bodies.

Teaching Methods: Chalk& Board, PPT

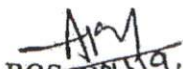
Text Books:

1. S.Timoshenko, and D.H.Young, "Engineering Mechanics", Tata Mc-Graw Hill Book, 5th edition
2. S. S. Bhavikatti, "Engineering Mechanics", New Age International, 6th edition

Ref. Books:

1. Dr. Bansal.R.K, & Sanjay Bansal, "A Text book of Engineering Mechanics", Lakshmi publications.
2. A.K.Tayal, "Engineering Mechanics Statics And Dynamics", Umesh Publications, 14th edition
3. Rajasekaran.S, & Sankarasubramanian.G, "Engineering Mechanics", Vikas Publishing House Pvt Ltd, 3rd edition.
4. Engineering Mechanics by Statics and Dynamics K.Vijaya Kumar Reddy and J Suresh Kumar, BS Publications, 3rd edition.


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Dean (Academics)

Course Code	Course Title					L	T	P	C	QP		
BE5051040	Programming for Problem Solving					3	0	0	3			
Pre-Requisite: computer basics.												
Course Educational Objective												
CEO1: To formulate algorithm, translate into program and then execute the programs for verifying its correctness.												
CEO2: To analyze a problem for knowing its efficiency and decompose it into functions using divide and conquer approach.												
Course Outcome: student can able to												
CO1	Formulate simple algorithms for arithmetic and logical problems and translate into programs.											
CO2	Understand and develop programs using loop, arrays and analyse its complexity.											
CO3	Understand and develop programs using strings, functions and recursions.											
CO4	Develop programs using pointers and structures, and understand their functionality.											
CO-PO MAPPING												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1									
CO2	1	3	2									
CO3	1	3	3									
CO4	2	2	3									
UNIT- I (10 Hours)												
Programming: Introduction to Structured Programming Approach, Basic structure of C program, C compilers, Compilation and Execution Process, Error debugging.												
C Tokens, keywords, identifiers, data types, constants, variables, standard I/O statements, Operators classifications, Operator precedence and associativity, Implicit and Explicit type casting.												
Control Flow Statements: Selection Logic: if, if..else, else if ladder, nested if												
UNIT- II (10 Hours)												
switch..case, Iteration Logic: while, do-while and for loop, break, continue, nested loop.												
Arrays: 1-D Array: declaration, initialization, array operations, 2-D Array: declaration, Initialization, 2-D array operations												
UNIT- III (10 Hours)												
Character arrays and Strings: String handling operations, strcmp(), strcat(), strcpy(), strlen().												
User Defined Functions: Function categories, Parameter passing in functions, Passing arrays to functions, Recursive functions, storage classes												
UNIT- IV (10 Hours)												
User Defined Data Types: Structures: Declaration and initialization of structures, accessing structure elements, nested structures, structures and arrays, structures and functions, typedef												
Pointers: Declaration and initialization of pointers, Pointer arithmetic, Pointer and Arrays, call by value and call by address, Function returning pointer, pointer to structure, Dynamic memory allocation.												
Text Books:												
1) E. Balaguruswamy, Programming in ANSI C, 7 th edition, Tata McGraw-Hill												
2) Let us 'C' by Yashwant Kanethkar, 16 th edition, BPB Publications												
3) Byron Gottfried, Schaum's Outline of Programming with C, 3 rd edition, McGraw-Hill												
References:												
1) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2 nd edition, Prentice Hall of India												
2) Programming in C, by Reema Thareja, 2 nd edition, OUP India												
3) C Programming and Coding by swatisaxena, BPB Publications												

Umesh Kumar Senapathy
Course Coordinator

Dr. J. Jayaraman
BOS, Chairman

Dr. P. S. Srinivasan
Principal

M. S. Srinivasan
Registrar

Dr. J. Jayaraman
Dean (Academics)

Course Code	Course Title	L	T	P	C	QP
	Programming for Problem Solving Laboratory	3	0	0	3	A
Pre-Requisite:						
Course Educational Objective						
CEO1: To develop programs for problems on different applications of array, functions, pointers and structure.						
CEO2: To analyse different problems by comparing and implementing in programming.						
Course Outcome						
CO1	To understand operating system and its simple commands, writing programs, compilation, debug and execution process.					
CO2	To develop programs using loop controls, arrays and understand the complexity using different programs.					
CO3	To develop programs using functions and recursive function by decomposing a problem and analyse them.					
CO4	To Solve numerical problems, develop different programs using pointers, structures and analyse their functionality.					

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1									
CO2	1	2	2	1								
CO3	1	2	2	1								
CO4	1	2	2	1								

Lab Experiment 1: Familiarization with programming environment

- 1) Introduction to OS: Before starting experiments explain the facilities and operations of OS.
- 2) Introduction to the C compiler, Compilation and Execution Process & writing simple programs.

Lab Experiment 2: Simple computational problems using arithmetic expressions.

- 1) WAP to input radius of a circle and Find the area, perimeter of it.
- 2) WAP to input two numbers and swap them without using intermediate variable.

Lab Experiment 3: Simple computational problems using arithmetic expressions.

- 1) Write a program to accept Fahrenheit and calculate its equivalent Celsius.
- 2) WAP to input three unequal numbers and find the greatest using conditional operator.

Lab Experiment 4: Problems involving if, switch

- 1) Write a program to input a lower case alphabet and test whether it is vowel or consonant.(using else..if and switch both)
- 2) Write a program to find the greatest among three numbers.(using else..if and switch both)

Lab Experiment 5: while, do..while and for loops:

- 1) Write a program to find the Greatest Common Divisor of two integers using while statement.
- 2) Write a program to accept a positive integer and test it for Armstrong or not using do..while statement.

Lab Experiment 6: Nested Loop

- 1) Write a program to calculate the following sum using nested for statement:

$$\text{Sum} = 1 - (x^2)/2! + (x^4)/4! - (x^6)/6! + (x^8)/8! - (x^{10})/10!$$
- 2) Write a program to generate the following pyramid using nested for statement:

```

1
1 2 1
1 2 3 2 1
1 2 3 4 3 2 1

```

Lab Experiment 7: 1D Array interaction

- 1) Write a program to accept 10 integers in to an array and find largest and smallest integers present in them.
- 2) Write a program to input 10 elements into an array. Then search for a given value in the array to know its existence.

Lab Experiment 8: 2D Array interaction

- 3) Write a program to input values into two matrices A(3x4), B(4x3). Perform matrix multiplication and display the resultant matrix.
- 4) Write a program to input two strings and test whether they are equal or not using string handling functions.

Lab Experiment 9: User Defined Functions

- 1) Write a C program which contains three UDF's namely add(), subtract() and multiply(). Each function accepts two integers as their arguments and calculate and return the results
- 2) Write a program to create an UDF and test a number is prime or not.

Lab Experiment 9: Recursive Functions

- 1) Write a program to accept 10 elements into an integer array. Find the largest element present using recursive function.
- 2) Write a program to generate Fibonacci series using a recursive function.

Lab Experiment 10: structures

- 1) Write a program to store 11 cricket players' details into an array of structure. The structure having member's player name, team name and batting average. Displays the name of players whose batting average is ≥ 30 .
- 2) Write a program to create a structure COMPLEX. Input two complex numbers using UDF and find the sum of them.

Lab Experiment 11: Pointers and Dynamic Memory Allocation

- 1) Write a program to create user defined function called swap having two integer pointers as its arguments and it has no return value. Call this function using call-by-address.
- 2) Write a program to store 'n' integers using dynamic memory allocation. Find the average value of the integers using a user defined function.

Lab Experiment 12: structure with pointer

- 1) Write a program create a structure PRODUCT having members Product no, Name and Price. Using a pointer Input 5 product details into a structure array and then display those products whose price is > 1000 rupees.
- 2) Write a program to create a structure EMPLOYEE to store N employee details i.e: employee no, name, salary. Display only those employee names whose salary ≥ 50000 .

Teaching Methods: Chalk& Board/ PPT/Video Lecture

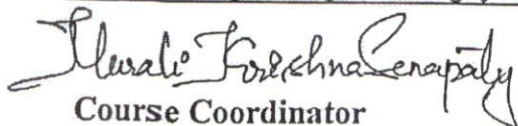
- A case study can be given to each student for each UNIT.
- A Mini Project can be given which the student have to do during the semester break.

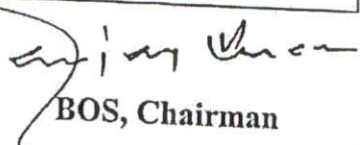
Text Books:

- 1) E. Balaguruswamy, Programming in ANSI C, 7th edition, Tata McGraw-Hill
- 2) Let us 'C' by Yashwant Kanetkar, 16th edition, BPB Publications
- 3) Byron Gottfried, Schaum's Outline of Programming with C, 3rd edition, McGraw-Hill

References:

- 1) Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2nd edition, Prentice Hall of India
- 2) Programming in C, by Reema Thareja, 2nd edition, OUP India
- 3) C Programming and Coding by swatisaxena, BPB Publications


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Dean (Academics)



GIET UNIVERSITY GUNUPUR-765022

DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT										L	T	P	C	QP
BESES4162	ENGINEERING WORKSHOP										0	0	2	1	
Pre Requisite: Concept of Measurement and dimension.															
Course Educational Objectives:															
CEO1	To learn the different types of hand and machine tools for various industrial application.														
CEO2	To familiarize with the basic manufacturing processes and to study various tools and equipment used hands on training is given in different sections.														
CEO3	To know principle of metrology and measurement in industries.														
CEO4	To develop basic principles and devices involved in measuring and surface textures.														
Course Outcomes: Upon successful completion of this course, students should be able to:															
CO1	Understand various safety precautions and identify the use of different hand tools, machine tools and their operation.														
CO2	Demonstrate the process configuration and basic mechanism of different machines like Lathe, Shaper, Milling machine, Drilling machine, Grinding machine and CNC.														
CO3	Apply welding and fabrication knowledge and skills to meet expectation of various industries.														
CO4	Identify various measuring tools and device such as Sine bar, Slip gauge, Surface roughness tester, and express error of various measuring devices.														
CO-PO & PSO Mapping															
COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	1			1											
CO2	2			2											
CO3	1			3											
CO4	1			3											
Minimum:10 Experiment															
Unit 1															
Safety Precaution: To study the various Safety precautions in workshop.															
Fitting :															
Study of different hand tools and Machine tools used in fitting.															
Unit 2															
Machining:															
Study of various components and working principle of lathe machine															
Preparation of a cylindrical job by lathe (Facing, Taper turning, Step Turning, knurling)															
Study on Shaper and Milling Machine.															
Overview to CNC Lathe machine.															



GIET UNIVERSITY GUNUPUR-765022

DEPARTMENT OF MECHANICAL ENGINEERING

Unit 3

Welding Practice :

Hands on practice on Electric Arc Welding to prepare Lap Joint, Butt Joint, T Joint and Corner Joint.
Preparation of Lap joint with the help of Oxyacetylene Gas welding.

Unit 4

Measurement and Calibration :

Measurement of length, height and diameter by Vernier caliper and Micrometer

Angular measurement by using sine bar.

Measurement of flatness of surface plate by using spirit levels.

Measurement of surface roughness using surface roughness tester.

Calibration of LVDT using indicator / CRO

Calibration of load cell using electrical resistance strain gauge.

Calibration of thermocouples.

Teaching Methods: Chalk & Board, Hands on practice.

Text Book:

1. Elements of Workshop Technology, Vol. I and II by Hajra choudhary, Khanna Publishers (7th Edition 2011)

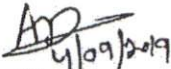
2. Workshop Technology by WAJ Chapman, Viva Books (5th Edition 1985)

Reference Books:

Workshop Manual by Kannaiah / Narayana, Scitech Publications(P) Ltd. (3rd Edition 2015)

Mechanical measurement, instrumentation and control by A.K. sawhney and Punnet sawhney ,
Dhanpat Rai Publication (7th Edition 2017)

Engineering Metrology R.K. Jain, Khanna Publication (7th Edition 2018)


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Incorporated by Act 23 of Govt. of Odisha and under approval of UGC & AICTE

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

II Semester [First Year]

Branch/Course Common to all branches of UG Engineering & Technology

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses	BBSBS2010	Engineering Mathematics-II	3	1	0	4
2	Basic Science Courses	BBSBS1021 / BBSBS1121	Engineering Physics	3	0	2	4
		BBSBS1022 / BBSBS1122	Engineering Chemistry				
3	Engineering Science Courses	BESBS1032 / BESBS1132	Basic Electrical & Electronics Engineering	3	0	2	4
4	Engineering Science Courses	BESBS2040 / BESBS2140	Data Structure & Algorithms	2	0	4	4
5	Humanities and Social Sciences including Management Courses	BHSBS2050 / BHSBS2150	Communicative English-2	2	0	2	3
6	Engineering Science Courses	BESBS1161	Engineering Graphics & Design	1	0	2	2
		BESBS1162	Workshop/Manufacturing Practices				
7	Mandatory Courses	BMCBS2170	NCC/NSS/Yoga	-	-	-	0
Total Credits:				14	1	12	21

Subject Code	Title of the subject										L	T	P	C	QP
13B4552010	Engineering Mathematics-II										3	1	0	4	A
Course Educational Objectives															
CEO1	To focus on partial derivative and its methods.														
CEO2	To make them understand about laplace and fourier transform.														
CEO3	To calculate the gradients and directional derivatives of functions of several variables														
CEO4	To introduce the concept of Vector differentiation and integration that finds applications in various fields like solid mechanics, fluid flow, heat problems and potential theory														
Course Outcomes: Towards the end of the course the students will be able															
CO1	To know how to solve the partial differential equation by suitable method.														
CO2	I. To Solve Ordinary differential and integral equation by using Laplace transform, II. Execute the technique of Fourier Integral and transform for learning in advanced Engineering Mathematics.														
CO3	To relate gradient, curl and divergence and its application in fluid dynamics.														
CO4	To evaluate multiple integrals by using Green's, Stokes' and divergence theorem to give physical interpretation of the curl and divergence of a vector field .														
CO-PO & PSO Mapping															
COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2													
CO2	2	3													
CO3	1	3													
CO4	2	3													
Avg.	2	2.75													
SYLLABUS															
UNIT - I															
(08 Hours)															
INTRODUCTION OF PARTIAL DIFFERENTIAL EQUATIONS:															
Formation of Partial differential equations, Linear partial differential equation of first order: Lagrange's linear differential equation, Non-Linear partial differential equation of first order by Charpit's method.															
UNIT-II															
(12 Hours)															
Laplace Transforms: Definition, existence of Laplace Transforms, Properties of Laplace Transforms, Evaluation of integrals by Laplace Transforms, Inverse transforms, convolution theorem, transforms of unit step function, unit impulse function, periodic function. Simple application to ordinary differential equations by Laplace Transform method, Definition of Fourier Integral and Fourier transform.															

UNIT - III	(8 Hours)
Vector differential calculus: vector and scalar functions and fields, Derivatives, Curves, tangents and arc Length, gradient, divergence, curl and their simple application.	
UNIT - IV	(12 Hours)
Vector integral calculus: Definition and evaluation of double integration and triple integration, Evaluation of line integral, Surface integral and volume integral and their applications, Transformations theorems- Green's Theorem in plane , Stoke's Theorem, Gauss Divergence Theorem and their applications.	
Teaching Methods: Chalk& Board/ PPT/Video Lectures	
<i>Prescribed Books</i>	
1. <i>Advanced Engineering Mathematics</i> by E. Kreyszig, John Willey & Sons Inc. 10th Edition	
<i>References:</i>	
1. <i>Higher Engineering Mathematics</i> by B. V. Ramana , Mc Graw Hill Education.	
2. <i>Higher Engineering Mathematics</i> by BS Grewal : Khanna Publishers, New Delhi.	
3. <i>Advanced Engineering mathematics</i> by H. K. Dass.	


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Dean (Academics)

Subject Code		Title of the subject										L	T	P	C	QP
BSBS1021		Engineering Physics										3	0	0	3	A
Course Educational Objectives																
CEO1	Providing fundamental knowledge about the oscillations and waves															
CEO2	To familiar with structure and different properties of materials.															
CEO3	Providing knowledge of mathematical concepts to solve electromagnetic problems and fundamental information about Quantum mechanics with applications.															
Course Outcomes: Upon successful completion of this course, students should be able to:																
CO1	Understand and analyze the concept of oscillation and wave mechanics.															
CO2	Describe the principle of lasing and optoelectronics devices in communication system..															
CO3	Explain the ideas of crystal structure, crystal diffraction and classification of materials.															
CO4	Interpret the fundamentals of electromagnetism and deduce the electromagnetic wave equations.															
CO5	Express the basics of quantum mechanics and illustrate the quantum mechanical problems.															
CO-PO & PSO Mapping																
COs	PROGRAMME OUTCOMES												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	3	2														
CO2	1	2														
CO3	1	2														
CO4	2	2														
CO5	2	2														
Avg.	1.8	2														
SYLLABUS																
UNIT:1 Interaction of Wave and Matter (10 Hours)																
Introduction to Oscillatory motion, Damped harmonic oscillator and its characteristics, Waves and its Characteristics, Superposition of Waves, coherent and incoherent superposition, Interference of light waves, Newton's Ring experiment, diameter of rings, determination of wavelength of unknown light and refractive index of a liquid substance.																
LASER, Lasing action and characteristics & application of laser beam, construction and working of He-Ne Laser, applications of Laser. Optical fiber, Acceptance angle, Numerical aperture, Step index and Graded index fibers, Attenuations in optical fibers, applications of optical fiber in communication systems.																
UNIT:02 Physics of Materials (10 Hours)																
Introductions to materials, Crystal structure, crystal direction and plane, Miller indices, Inter planar spacing, Reciprocal Lattice and its characteristics, Reciprocal Lattice of SC, FCC and BCC, Brillouin Zone, X-ray diffraction (XRD), Bragg's law. Energy bands in solids (conduction band, valence band and Fermi level), Classification of materials on the basis of band theory. Magnetic properties of Materials (Dia, Para, Ferro) & their applications. Di-electric materials and Nano materials & their applications.																
UNIT: 03 Electromagnetic theory and wave (10 Hour)																
Review of grad, divergence and curl, Gauss divergence theorem and Stoke's theorem (no derivations), fundamental laws of electrostatics, magneto-statics and electromagnetism, displacement current and conduction current, Maxwell's equations, Equation of continuity using Maxwell's Relations. Electromagnetic wave and its characteristics, electromagnetic wave equation for free space and in charge free conducting medium, electromagnetic energy and Poynting vector, proof of Poynting theorem.																

UNIT: 04 Quantum Mechanics**(10 Hours)**

Introduction to dual nature: Black body radiation, photoelectric effect, Compton effect (qualitative ideas only), de-Broglie's hypothesis, Heisenberg's uncertainty principle and its application to non-existence of electron inside the nucleus and ground state energy of one dimensional harmonic oscillator, Basic postulates of Quantum Mechanics, Wave function and its characteristics, probability density, normalization, eigen values, eigen functions and expectation values, Schrödinger's equation (time dependent and time independent). Application of Schrödinger equation to one dimensional potential well and its Energy eigen values, Qualitative ideas on potential step and potential barrier with transmission probability (no derivation, only formula).

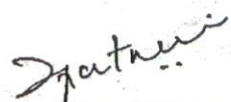
Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. *Engineering Physics* by D. K. Bhattacharya and Poonam Tanden, Oxford University Press.
2. *Engineering Physics*, H K Malik and A K Singh, Tata McGraw Hill, MGH.

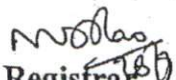
Reference Books:

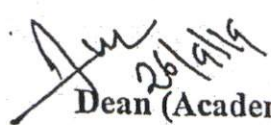
1. *Materials Science & Engg.*, V. Raghvan, Prentice Hall of India.
2. *Concepts of Modern Physics*, A. Beiser, S. Mahajan, S.R. Choudhary, Tata McGraw Hill.
3. *Lasers & Optical engineering*, P Dass, Narosa Publishers, Springer Publisher.
4. *Engineering Physics* by B. B. Swain and P. K. Jena, KitabMahal, Cuttack
5. *Quantum Mechanics* by SatyaPrakash, KitabMohal, etc. KedarNath Ram Nath Publisher


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Dean (Academics)

Engineering Physics Laboratory												0	0	2	1	
Course Educational Objectives																
CEO1	Providing fundamental information on basic instruments and their uses.															
CEO2	To familiarize with different apparatus and applications to different experiments.															
Course Outcomes: Upon successful completion of this course, students should be able to:																
CO1	Understand the concepts of oscillation and waves through experimental observation.															
CO2	Study and explain the experimental observation of interference and diffraction pattern															
CO3	Interpret the fundamental characteristics of various materials and semiconductor materials through experiments															
CO4	Analyze the quantum concept of light by experimental observation.															
CO-PO & PSO Mapping																
COs	PROGRAMME OUTCOMES												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	2		1	1												
CO2	2		1	1												
CO3	2		1	1												
CO4	2		1	2												
Avg.	2		1	1.25												
List of Experiments:																
1. Determination of the acceleration due to gravity by using Bar/Kater's pendulum. 2. Verification of the laws of transverse vibration by using sonometer. 3. Determination of Rigidity modulus of a wire by Static/Dynamic method. 4. Determination of wavelength of light by Newton's Rings apparatus. 5. Determination of no. of lines of a diffraction grating plate. 6. Determination of slit width of a double slit. 7. Determination of plank's constant using photo-voltaic cell. 8. Determination of band gap energy of PN junction (Ge/Si) diode. 9. Determination of the resistivity of a semiconductor with temperature by four- probe method. 10. Determination of dielectric constant of given solid by Lecher wire method. 11. Determination of coefficient of Thermal conductivity (K) of a metal (Cu) by using Searle's apparatus. 12. Study of mono-chromaticity and divergence of the given laser beam. 13. Study of reflection and total internal reflection by optical fibers. 14. Study of B-H curve of ferromagnetic substance. 15. Study the Hall effect.																

Practical Text Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Prathvi
Course Coordinator

Prathvi
BOS, Chairman

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Principal

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Registrar

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Dean (Academics)

Subject Code	Title of the subject												L	T	P	C
BESBS1032	Basic Electrical and Electronics Engineering												3	0	0	3
Course Outcomes: Upon successful completion of this course, students should be able to:																
CO1	Understand basics of Electrical Engineering and to solve complex electrical networks mathematically															
CO2	Demonstrate basic laws and techniques to develop a working knowledge of the network theorems of analysis used.															
CO3	Analyze modern electronic circuits and systems.															
CO4	Formulate mathematical descriptions and procedures in designing new electronic systems and technically present															
CO-PO & PSO Mapping																
COs	PROGRAMME OUTCOMES												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	2	1														
CO2	3	2														
CO3	3	2														
CO4	3	3														
Avg.	2.75	2														
SYLLABUS																
Unit – I [12 Hrs]																
DC Circuits & Theorems : Introduction to electrical terminology, Ohm's Law, Equivalent Resistance, series-parallel circuits, star-delta transformation, types of elements, source conversion, ideal and practical voltage & current sources; Kirchhoff's Law, Mesh and Nodal Analysis, Superposition Theorem, Thevenin theorem, Norton theorem excited by independent sources																
Single Phase AC Circuits: AC Fundamentals: RMS & Average value, form and peak factors, Complex algebra, concepts of reactance, impedance and their representation, AC through pure R, L, C, series RL, series RC, series RLC circuit																
Unit – II: [12 Hrs.]																
Three-phase AC Circuits: Comparison between 1-ph & 3-ph AC circuit, Star & Delta connection, relation between line and phase quantities,																
Magnetic Circuits: Magnetic flux, Magnetic flux density, Magnetic fields intensity, Relation between B & H, B-H curve, Analogy between Electric and Magnetic circuit, Leakage flux, Hysteresis loss, eddy current loss																
DC Machines: Introduction, construction and working principle of DC Generator and D.C motor, Types, EMF equation of generator.																
AC Machines: Construction and working principle Transformer, EMF equation, Turns and transformation ratio, 3-phase Induction motor principle of operation, Rotating magnetic field, Types of rotors, Synchronous speed and slip, Introduction to 1-phase Induction motor.																
Unit – III [12 Hrs.]																
Semiconductor Diodes: Introduction; Ideal Diode; Semiconductor Materials; Energy Levels; Extrinsic Materials- n- and p-Type; Semiconductor Diode; Resistance Levels; Diode Equivalent Circuits; Half-Wave Rectification; Full-Wave Rectification																
Bipolar Junction Transistors: Introduction; Transistor Construction; Transistor Operation; Common-Base Configuration; Transistor Amplifying Action; Common-Emitter Configuration; Common-Collector Configuration																

Unit - IV [12 Hrs.]

Electronic Instrumentation: Introduction; Basic Principle; CRT Features; Block Diagram of Oscilloscope; Function Generator; Standard Signal Generator; Digital Multimeters

Digital Electronics Fundamentals: Binary, Octal, Hexadecimal and Decimal Number System and their Conversion; Binary Arithmetic; 1's and 2's Complements; Axioms and Laws of Boolean Algebra; Reducing Boolean Expressions; Logic Gates; Boolean Expressions and Logic Diagrams

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.
2. Basic Electrical Engineering, N K De, Dipu Sarkar, University Press, 2016
3. D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.
4. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
5. Electronic Devices and Circuit Theory by Robert L Boylestad and Louis Nashelsky, 11th Edition, Prentice Hall.
6. Electronic Instrumentation by H S Kalsi, 3rd Edition, McGraw Hill.
7. Digital Design by M. Morris Mano, 5th Edition, Pearson Education.

Reference Books:

1. Microelectronic Circuits by A. S. Sedra and Kenneth C. Smith, 7th Edition, Oxford University Press.
2. Fundamentals of Digital Circuits, 4th Edition, A. Anand Kumar, PHI.
3. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.

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Lab Code	Name of the Lab	L	T	P	C
	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1

List of experiments/demonstrations:

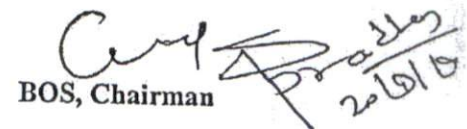
Electrical Part: (Any 5 Experiments) :

1. Basic safety precautions. Introduction and use of measuring instruments – voltmeter, ammeter, multi-meter, oscilloscope. Real-life resistors, capacitors and inductors.
2. Measuring the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope).
3. Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification. Observation of phase differences between current and voltage.
4. Loading of a transformer: measurement of primary and secondary voltages and currents, and power.
5. Demonstration of cut-out sections of machines: DC machine (commutator- brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winding - slip ring arrangement) and single-phase induction machine.
6. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

Electronics Part: (Any 5 Experiments) :

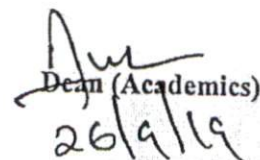
1. Familiarization of electronic components and devices (testing of semiconductor diodes and transistors using digital multimeter)
2. Study and use of oscilloscope, signal generator to view waveforms and measure amplitude and frequency of a given waveform.
3. V-I characteristics of semiconductor diode and determining its DC and AC resistance.
4. Studies on half-wave and full-wave rectifier circuits without and with capacitor filter; recording of the waveforms and measurement of average and rms values of the rectifier output.
5. V-I characteristic of an n-p-n or p-n-p transistor, DC biasing the transistor in common-emitter configuration and determination of its operating point (i.e., various voltages and currents).
6. Studies on Logic gates (Truth table verification of various gates).


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Dean (Academics)

Course Code	Course Title	L	T	P	C	QP
BE505 2040	DATA STRUCTURES	3	0	1	3	
Pre -Requisite: Basic knowledge of Algorithms						
Course Educational Objective						
CEO1: Develop algorithms for performing different operations on arrays, stack, Queue, linked list. Analyze the difference between them and understand different applications. Understand different searching and sorting methods and applications.						
CEO2: Understand and analyze Binary search Tree, AVL Tree, Heap Tree and their applications. Understand the memory representation of graph, its traversal methods and applications. Analyze the Hashing techniques in compare with other sorting techniques.						
Course Outcome: student can able to						
CO1	Develop algorithms for performing different operations on 1D array, matrix, stack, Queue, analyze the difference between them and understand different applications.					
CO2	Understand different searching and sorting methods, Linked lists and them compare them in terms of performance and applications.					
CO3	Understand the Binary Tree and its memory representation; analyze Binary search Tree and its applications, compare the BST with AVL Tree, Heap Tree and examine the advantages.					
CO4	Understand the memory representation of graph; analyze traversal methods and applications of graph. Analyze the Hashing techniques in compare with other sorting techniques.					

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2									
CO2	3	2	3									
CO3	3	3	3									
CO4	2	3	2									

UNIT- I

(11 Hours)

Basic concepts: Data abstraction, Data structures and types. Algorithm specification, 1D array: operations, 2D array: row major order and column major order

Stack: Basic concepts, operations and implementation of stack using arrays, Mathematical procedure for conversions of arithmetic expressions. Applications of stack: infix to postfix conversion and postfix evaluation. Queue: Linear queue, operations and implementation using arrays, circular queue and its operations, Basics concepts of Double ended Queue and priority queue

UNIT- II

(11 Hours)

Searching: Linear search and Binary search on elements in a linear array.

Sorting: Bubble sort, Insertion sort, Selection sort using linear array.

Linked Lists: Basic concepts and operations of single linked list, linked stack, linked queue, circular single linked list, and Doublelinked list. Basic concept of Circular double linked list.

UNIT- III

(11 Hours)

Trees: Introduction, Terminology, Binary Trees, Memory Representation of Binary Trees using arrays and linked lists, Binary Tree traversal methods(recursive and non-recursive), Construction of binary tree using in-order & pre-order sequences, in-order & post-order sequence. Expression Tree, Construction of expression tree using stack.

Binary Search Trees: Algorithm for construction, searching and insertion operation, Introduction to Height Balanced trees, Balance factor, Balancing the BST by rotations during insertions of a node.

UNIT- IV	(11 Hours)
Heaps: Introduction to binary heaps, definition of a Max-heap, Min-heap, creating Max-Heap Tree using insertion, Graphs: Terminologies, Memory Graph representation - Adjacency matrix, Incidence Matrix, Linked Representation, path matrix, Warshall's Algorithm to find path matrix, Graph Traversals (BFS & DFS), Topological Sorting Hashing: Hashing Functions: Division, Mid-square, Folding methods. Collision, linear probing, chaining	
Teaching Methods: Chalk& Board/ PPT	
Text Books:	
1. "Fundamental of Data Structure" (Schaums Series) Tata-McGraw-Hill. 2. Pai: "Data Structures & Algorithms; Concepts, Techniques & Algorithms "Tata McGraw Hill. 3. Gilberg and Forouzan: "Data Structure- A Pseudo code approach with C" by Thomson publication	
Reference Books:	
1. "Fundamentals of data structure in C" Horowitz, Sahani& Freed, Computer Science Press. 2. "Data Structures and algorithms" by Narasimha Karumanchi, CareerMonk Publications 3. "Data structures through C in depth" by S.K.Srivastava, BPB Publications	

Heali Kishna Senapaty

Course Coordinator

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Principal

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BOS, Chairman

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Registrar 26/5

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Dean (Academics)
26/9/17

Subject Code	Name of the Subject										L	T	P	C	QP
	Data Structures using 'C++' Laboratory										0	0	2	1	
Course Outcomes: Upon successful completion of this course, students should be able to:															
CO1	Understand the concepts of algorithms and implement in developing the programs for different operations of 1D array														
CO2	Develop programs for performing different operations on matrix, analyze the them and understand their applications.														
CO3	Design code for stack and queue operations and analyze their performance.														
CO4	Develop the codes for different operations on linked list, implement concepts or stack and queue using linked list and compare them.														
CO-PO Mapping															
COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	3												
CO2	2	3	3												
CO3	3	2	2												
CO4	2	2	1												
Avg.	2.2	2.2	2.2												
	5	5	5												
SYLLABUS															
Experiment-1(functions)															
Q1) Write a program to create methods for performing addition, subtraction, multiplication and division on 2 integers.															
Experiment 2: (concepts of array)															
Q1)Write a C program to create methods for operations insertion, deletion, searching and display on 1D array of elements.															
Experiment 3:(matrix)															
Q1) Write a C program to create function for performing matrix multiplication.															
Experiment-4: (pointer and DMA)															
Q1) Write a program to store N numbers using dynamic memory allocation and then find the largest element using UDF.															
Experiment 5:(structure and DMA)															
Q1) Write a C program to create a structure called student to store your rollno, name, age. Create an array to input 5 students data and then create an UDF to display details where age>=20.															
Experiment 6: (stack)															
Q1) Write a program using C++ to create a stack and perform:															
(i) push operation (ii) pop operation (iii) display operation															
Experiment 7: (linear queue)															
Q1) Write a C program to create a linear queue and perform the following operations: (i) insertion ii) deletion and iii) Traversal															
Experiment 8: (circular queue)															
Q1) Write a C program to create a circular queue and perform the following operations: (i) insertion ii) deletion and iii) Traversal															
Experiment 9: (sorting)															
Q1) write a program to implement bubble sort and selection sort on a list of array elements															
Experiment 10: (sorting)															
Q1) Write a program to implement linear and binary search on array elements using UDF															
Experiment 11: (sorting)															
Q1) write a program to implement insertion sort on a given list of array elements.															

Experiment 12: (sorting)

Q1) Write a C program to implement quick sort to a given list of integers to sort in ascending order.

Experiment 13: (single linked list)

Q1) Write a C program that uses functions to perform the following operations on single linked list:

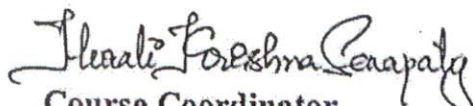
i) Insertion at beginning, ii) insertion at end, iii) insertion at node item, iv) Deletion of 1st node, v) deletion of last node, vi) deletion of a given node item, vii) search for a node item, iv) display all nodes

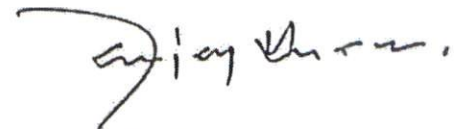
Experiment 14: (linked stack)

Q1) Write a C program that uses functions to implement linked stack on single linked list.

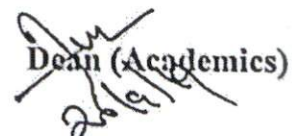
Experiment 15: (linked queue)

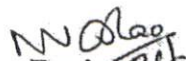
Q1) Write a C program that uses functions to implement linked queue on single linked list.


Course Coordinator


BOS, Chairman


Principal


Dean (Academics)


Registrar



GIET UNIVERSITY GUNUPUR-765022

DEPARTMENT OF MECHANICAL ENGINEERING

33

SUBJECT CODE	TITLE OF THE SUBJECT											L	T	P	C	QP
BE5B51161	ENGINEERING GRAPHICS & DESIGN LAB											0	0	2	1	
Pre-Requisite:																
Course Educational Objectives																
CEO1	To enable students to acquire and use engineering drawing skills as a means of accurately and clearly communicating ideas, information and instructions															
CEO2	To enable students to acquire requisite knowledge, techniques and attitude required for advanced study of engineering drawing and basic of AUTOCAD.															
Course Outcomes: <i>Upon successful completion of this course, students should be able to:</i>																
CO1	Able to prepare the orthographic projections of points and straight lines placed in various quadrants															
CO2	Demonstrate the ability to draw orthographic projections of various solids.															
CO3	Ability to draw and interpret the sectioned views of solids															
CO4	To provide students with adequate knowledge and experience in preparing engineering drawings using AutoCAD															
CO-PO & PSO Mapping																
COs	PROGRAMME OUTCOMES												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
CO1	2			2												
CO2	2			3												
CO3	2			3												
CO4	3			3												
Unit 1																
Introduction: Drawing Instruments and their uses, BIS conventions, Types of line, Dimensioning line Conventions.																
Orthographic Projections :																
Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only), True and apparent lengths, True and apparent inclinations to reference planes. 1-Sheet																
Unit 2																
Orthographic Projections of Plane Surfaces (First Angle Projection Only):																
Introduction, Definitions-projections of plane surfaces-triangle, square, rectangle, rhombus, pentagon, hexagon and circle, planes in different positions by change of position method																
1-Sheet																
Projections of Solids (First Angle Projection Only) :																
Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions. 1-Sheet																
Unit 3																
Sections and Development of Lateral Surfaces of Solids:																
Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP. 1 – Sheet																



GIET UNIVERSITY GUNUPUR-765022

DEPARTMENT OF MECHANICAL ENGINEERING

Unit 4

AUTO CAD:

Layout of the software, standard tool bar/menus and description of most commonly used toolbars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP & LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints.

Teaching Methods: Chalk& Board, Computer software(AUTO CAD)

TEXT BOOKS

Engineering Drawing - N.D. Bhatt & V.M. Panchal, Charotar Publishing House, Gujarat.

Computer Aided Engineering Drawing - S. Trymbaka Murthy, 4th Ed, University Press

Engineering Drawing by N.S. Parthasarathy and Vela Murali Oxford University Press.

Reference Books

Engineering Graphics - K.R. Gopalakrishna, Subash Publishers Bangalore.

Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production-Luzadder Warren J., Duff John M., Eastern Economy Edition, Prentice-Hall of India Pvt. Ltd., New Delhi.

Computer Aided Engineering drawing, Prof. M. H. Annaiah, New Age International Publisher, New Delhi

Shashank
4.9.19
Course Coordinator

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Principal

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Registrar
26/9

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BOS, Chairman

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Dean (Academics)
26/9



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Seven UG Programs CSE, ME, CHE, AEIE, ECE, BT& EEE Accredited by NBA

Gunupur - 765022, Dist.-Rayagada, Odisha, INDIA www.giet.edu

SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

III Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Basic Science Courses	BBSBS3010	Engineering Mathematics-III	3	1	0	4
2	Engineering Science Courses	BESCS3051/ BESCS3151	Object Oriented Programming	3	0	2	4
3	Professional Core Courses	BPCME3020	Engineering Thermodynamics	3	0	0	3
4	Professional Core Courses	BPCME3030/ BPCME3130	Mechanics of Solids	3	0	2	4
5	Professional Core Courses	BPCME3040	Material Science	3	0	0	3
6	Humanities and Social Sciences including Management Courses	BHSMS3061	Organizational Behavior	2	0	0	2
		BHSME4060	Optimization In Engineering				
7	Engineering Science Courses	BPCME3160	Computer Aided Design Lab	0	0	2	1
8	Project	BPCTP3170	Summer Industry Internship	-	-	2	1
9	Mandatory Courses	BMCAU3081	Environmental Sciences	-	-	-	0
Total Credits:				17	1	8	22

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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE		TITLE OF THE SUBJECT										L	T	P	C	QP
		ENGINEERING MATHEMATICS – III										3	1	0	4	A
Pre -Requisite: Fundamentals of complex numbers, series																
Course Educational Objectives																
CEO1	To test the nature of complex function															
CEO2	To identify the different methods for complex integration															
CEO3	To analyze error by using different methods.															
CEO4	To know about different types of probability distributions.															
Course Outcomes: Upon successful completion of this course, students should be able to:																
CO1	To know Analytic function and their properties.															
CO2	To Evaluate Real Integral by using Series method															
CO3	To apply numerical methods in Engineering Mathematical Problems															
CO4	To investigate probability distribution problem to understand Binomial distribution, Poisson distribution and normal distribution.															
CO-PO & PSO Mapping																
COs	PROGRAMME OUTCOMES												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	2	2														
CO2	2	3														
CO3	2	3														
CO4	2	3														
Avg.	2	2.75														
SYLLABUS																
UNIT:1													[12 Hours]			
Complex Analysis:																
Analytic function, Cauchy-Riemann equations, Harmonic Function, Complex integration: Line integral, Cauchy's integral theorem, Cauchy's integral formula.																
UNIT:2													[8 Hours]			
Taylor's series, Laurent's series, Singularities and zeros, Residues, Cauchy Residue theorem, Evaluation of real integrals.																
UNIT:3													[10 Hours]			
Numerical methods:																
Errors, Solving of algebraic and transcendental equations by using fixed point iteration and Newton-Raphson's method. : Newton divided differnterpolation,Lagrange interpolation ,Newton's forward and backward interpolation.Numerical Differentiation,Numerical integration:The trapezoidal rule, The simpson's rules, Ordinary differential equation: Modified Euler's method, Runge-kutta methods.																
UNIT:4													[18 Hours]			
PROBABILITY:																
Random variables. Probability distributions. Mean and variance of distribution,																

Regulation -2019



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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

Binomial, Poisson and uniform distributions, Normal distribution, Random sampling, Estimation of Parameters (maximum likely hood method), Confidence intervals, Testing of hypothesis, Acceptance sampling, Regression and correlation analysis, fitting of straight line by least square method.

Teaching Methods: Chalk& Board

Text Books:

1. Advanced Engineering Mathematics by E. Kreyszig, Tenth Edition, Willey
2. Numerical Methods by Jain and Iyengar.

Ref. Books:

1. Higher Engineering Mathematics by BS Grewal : Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by B.V.Ramana, McGraw Hills Education
3. Numerical Methods by Dutta and Jena.

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Regulation -2019



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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	ENGINEERING THERMODYNAMICS	3	1	0	3	A

Pre -Requisite: Fundamentals of Thermodynamics, Mathematics & Chemistry

Course Educational Objectives

CEO1	Students can Understand the principle and law of thermodynamics to analysis of different systems such as IC Engines, steam & Gas power plant, Refrigeration system and capable to analyze the parameters in various cycle etc.
CEO2	Students can understand the basics of properties of pure substance like steam and its conditions and Application of Thermodynamics in vapour power cycles
CEO3	Students can analyze the availability for open and closed systems, Maxwell and TDS equation in ideal gases.
CEO4	Students can Apply the laws of thermodynamics to refrigerators, heat engines, heat pumps compressors and nozzles etc.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Explain the basic concepts of system, control volume, thermodynamic properties, thermodynamic equilibrium, temperature, work and heat energy.
CO2	Apply the laws of thermodynamics to refrigerators, heat engines, heat pumps compressors and nozzles etc.
CO3	Evaluate properties of pure substances & Identify the methods to increase the efficiency of vapor, gas and refrigeration cycles.
CO4	Interpret and apply the concept of entropy to thermodynamic systems.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												2
CO2	3	3												2
CO3	2	3												2
CO4	3	3	2											2
Avg.	2.75	2.75	0.5											2

SYLLABUS

UNIT:1 Fundamental of thermodynamics

[12 Hours]

Basic concepts & definition, scope of thermodynamics. Macroscopic & microscopic approach. Definition of fixed mass (closed) system & control volume (open) system, isolated system. Thermodynamic properties (extensive & intensive), state & its representation on a property diagram, process and its representation, cyclic process. Characteristics of properties (point & path function), reversible & irreversible process, Quasistatic Process. Thermodynamic equilibrium.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

Energy transfer; Work transfer(definition & calculation), different modes of work Displacement work for various process, Free expansion work, Heat transfer, types of heat transfer, modes of heat transfer, basic laws in conduction, convection & radiation.

UNIT:2 Review of First and Second laws:

[13 Hours]

First law of thermodynamics, formal statement (using cyclic process) first law for processes of fixed masses (closed system) Introduction of internal energy, enthalpy as thermodynamic properties Definition of sp.heats (C_p & C_v) and their use in calculation of internal energy & enthalpy with emphasis on ideal gas.

Application of first law to control volume (Steady Flow); nozzle, diffuser, compressor, turbine, throttling device. First law analysis of unsteady flow control volumes,

Second law of thermodynamics, Kelvin Planck & Clausius statements, Carnot cycle. Reversible & irreversible engines and their efficiency (Thermal and maximum Efficiency)

UNIT:3 Pure substance & Vapour Power Cycles:

[12 Hours]

Properties of pure substance, P v, T s, h s diagram for steam, Steam properties, Introduction to steam table with respect to specific volume, pressure, temperature, enthalpy & entropy, Mollier Diagram.

The Carnot vapor cycle and its limitations, The Rankine cycle, Means of increasing the Rankine cycle efficiency, The reheat cycle, The regenerative feed heating cycle, Cogeneration (Back pressure and Pass-out turbines), Combined cycle power generation systems, Binary vapour cycles.

UNIT:4 Concepts of Entropy:

[10 Hours]

Entropy concepts, Clausius inequality, Entropy Principle. Entropy generation, Entropy balance for closed systems and steady flow systems, Available energy, Quality of energy, Availability for non flow and flow process, Irreversibility, Exergy balance, Second law efficiency.

Teaching Methods: Chalk& Talk, PPT, Video Lectures, Demonstrative models

Text Books:

1. Cengel. Y and M.Boles, "Thermodynamics - An Engineering Approach", 7th Edition, Tata McGraw Hill, 2016.
2. Engineering Thermodynamics by Gordon Rogers and Yon Mayhew, Pearson Education Ltd, 4th Edition.
3. Nag.P.K., "Engineering Thermodynamics", 4th Edition, Tata McGraw-Hill, New Delhi, 2008.
4. Rathakrishnan. E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice-Hall of India Pvt. Ltd, 2006

Ref. Books:

1. Holman.J.P., "Thermodynamics", 3rd Edition, McGraw-Hill, 2012.
2. Applied Thermodynamics by P.L.Ballaney, Khanna Publishers
3. Steam Tables in SI Units by Ramalingam, Scitech publication.

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DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	MECHANICS OF SOLIDS	3	0	0	3	A

Pre -Requisite: Basic mathematics and Engineering Mechanics

Course Educational Objectives

CEO1	To define the concept of load, stress, strain, stress vs strain diagram and elastic constant relationship.
CEO2	To Solve engineering problems through the relationship between stress and strain.
CEO3	To determine shear force and bending moment diagrams for variously loading conditions
CEO4	Learn to solve problems for calculation of torsion and Twisting moment in solid and hollow circular shafts.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Find the basic mechanical properties of material, tension, compression, torsion, bending and combined stress using the fundamental concepts of stress, strain and elastic behavior of materials.
CO2	Apply the stress- strain distributions, diagrammatically representation of shear force & bending moment for different beams under various load conditions by using suitable methods.
CO3	Analyze the slope and deflections for different cross sectional beams and columns, torsion effect for shaft and springs under different load conditions.
CO4	Solve the engineering problems by applying mechanical engineering concepts and theories.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												1
CO2	2	2												
CO3	2	3												1
CO4	2	2												0.5
Avg.	2.25	2.25												

SYLLABUS

[14 Hours]

UNIT:1

Concept of stress: Load, Stress, Hook's law, poisson's ratio, Stress-strain diagram, working stress, Factor of safety, Principle of St. Venant, Principle of Superposition, Shear stress, Complimentary shear stress, Compound Bars, Shear strain, Modulus of rigidity, Modulus of elasticity, Relationship among elastic constants. Strain energy, Resilience, Impact load. Analysis of axially loaded members: Composite bars in tension and compression, Temperature stresses in composite rods, concept of statically indeterminate problems.

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UNIT:2	[14 Hours]
Thin Cylinders: Thin Cylinders and Shells under internal pressure, wire winding of thin cylinder. Biaxial state of stress: Plane stress, principal plane, principal stress, Mohr's circle for biaxial stress, Calculation of Principal stresses from principal strain. Shear force and Bending moment diagram : Concept of Shear Force and Bending Moment, Types of load and types of support, Support reactions, Relationship between bending moment and shear force, point of inflection, Shear force and bending Moment Diagram.	
UNIT:3	[10 Hours]
Bending of Beams: Theory of simple bending, Bending stress, Shear stresses in beams, Distribution of shearing stress over a rectangular section, triangular section, I-section and T-section. Deflection of Beams: Differential equation of the elastic line, slope and deflection of beams by integration method	
UNIT:4	[8 Hours]
Torsion : Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, Strength of solid and hollow circular shafts, Strength of shafts in combined bending and twisting, Close-coiled helical spring.	
Teaching Methods: Chalk & Board	
Text Books:	
1. Elements of Strength of Materials by S.P. Timoshenko and D.H. Young, Affiliated East West Press.	
2. Strength of Materials by S.S. Rattan, Tata Mc Graw Hill	
Ref. Books:	
1. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill.	
2. Mechanics of Materials by R.C. Hibbeler, Pearson Education	
3. Mechanics of Materials by William F. Riley, Leroy D. Sturges and Don H. Morris, Wiley Student Edition	

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	MATERIAL SCIENCE	3	0	0	3	A

Pre -Requisite: Solid physics

Course Educational Objectives

CEO1	To familiarize with the concept crystal structures, bonding of solids and their influence on properties of materials
CEO2	To acquaint with the construction of phase diagrams and describe the phase relationship with variables i.e. chemical composition, pressure, temperature etc
CEO3	To develop a fundamental understanding of the relationships between Composition-Structure-property -performance and processing of material
CEO4	To develop an understanding of the processes occurring in metals during heating that influences the microstructure and properties

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand the atomic arrangement in different crystallographic planes and directions and their influence on bonding strength of metals.
CO2	Ability to construct the phase diagram and interpret the phase relationship effect on properties of materials.
CO3	Analyze the effect of heat treatment on micro structural change on properties of different materials.
CO4	Apply the fundamental concepts to develop new materials for suitable applications

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2											1	
CO2	3	2												
CO3	3	3												
CO4	2	2											2	
Avg.	2.5	2.75											0.75	

SYLLABUS

UNIT:1

[16 Hours]

Classification of Engineering Materials, Characteristic property of metals, bonding in solids, ionic, covalent and metallic bond, Crystal systems, crystallographic planes and directions, atomic packing efficiency, crystal imperfection and voids in common crystal systems. Solidification of pure metal, Homogeneous and heterogeneous nucleation processes, cooling curve, concept of super cooling, microstructures of pure metals, solidification of metal in ingot mould.

UNIT:2

[12 Hours]

Concept of alloy formation, types of alloys, solid solutions, factors governing solids

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solubility viz. size factor, valence factor, crystal structure factor and chemical affinity factor; order-disorder transformation. Binary phase diagrams a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d) Eutectoid system and (e) Peritectoid system. (f) Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors and microstructure of different alloys belonging to those systems, Effect of non-equilibrium cooling, coring and homogenization. Iron-cementite and iron-graphite phase diagrams.

UNIT:3 [12 Hours]
Equilibrium cooling behaviour of hypo, eutectoid, hyper eutectoid steels. microstructure and properties of different alloys. Heat treatment of steels, i.e. annealing, normalizing, hardening and tempering; microstructural effects brought about by these processes and their influences on mechanical properties; Concept of T.T.T diagram, factor affecting hardenability. Alloy steels: Stainless steel, tool steel, HSS, high strength low alloy steel, heat treatment, properties, microstructure and applications. Types of cast irons, their microstructures and typical uses. Concept of plastic deformation of metals, yield point phenomena, CRSS, Recovery recrystallization and grain.

UNIT:4 [10 Hours]
Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres. Plastic-: Thermosetting and thermoplastics. Ceramics: Types, structure, Mechanical properties, application Composite Materials: Agglomerated Materials: Cermets .Reinforced Materials: Reinforced Concrete. Glass fiber reinforced plastics, Carbon fibre reinforced plastics, fibre reinforced plastics, laminated plastic sheets. Teflon, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite. Introduction to Nano-materials

Teaching Methods: Chalk& Talk,PPT

Text Books:
1. Introduction to physical metallurgy – Sydney Avner
2. Fundamentals of materials science and engineering W. Callister

Ref. Books:
1. Mechanical Metallurgy by Dieter, Tata MacGraw Hill
2. Engineering Physical Metallurgy and Heat Treatment by Y.Lakhtin, Mir Publisher, Moscow.
3. Physical Metallurgy by Vijayendrasingh.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	OPTIMIZATION ENGINEERING	3	0	0	3	A

Pre -Requisite: Basics of Mathematics, matrix, partial differential equation addition of linear equations

Course Educational Objectives

CEO1	To introduce the students how to use variables for formulating complex mathematical models in management science, industrial engineering and transportation science
CEO2	To provide students with opportunity using various software package for solving liner programming and integer programming models
CEO3	To introduce the students to use of basic methodology for solution of linear programs and integer programs
CEO4	To introduce the students to advance methods for large scale transportation and assignment problems

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Analyze, formulate and solve linear programming problems using appropriate techniques.
CO2	Conduct and interpret post-optimal analysis and explain the application of transportation & assignment problems
CO3	Develop mathematical skills to analyze and solve integer programming problem Queueing and Game theory.
CO4	Communicate ideas, explain procedures and interpret solution for Non-linear programming problems

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3												
CO2	2	3												
CO3	3	2												
CO4	2	3												
Avg.	2.25	2.75												

SYLLABUS

UNIT:1

Introduction Historical overview of operations research, fundamentals of OR Modeling Approach. [12 Hours]

Linear Programming: Basic assumptions, formulation, graphical method, simplex method, Big-M method, two phase method, duality theory, Dual simplex.

UNIT:2

Sensitivity analysis: Change in objective function coefficient, Change in RHS, Deletion of variable [10 Hours]

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Transportation Problems: Methods for obtaining basic feasible solutions (NWCR, LCM & VAM), Methods for obtaining optimum solution (Stepping stone & Modi method) Specific features of transportation problem.

Assignment Problem: Hungarian method for solving assignment problems. Maximization in Assignment problem, Unbalanced assignment problem.

[10 Hours]

UNIT:3

Integer programming: Special features, branch-and-bound technique

Queueing: Basic elements of queuing model, role of Poisson & exponential distribution, single server model.

Game theory: Maxi-min and Mini-max principle, mixed strategy, dominance theory

[14 Hours]

UNIT:4

Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method.

Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method

Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming

Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/PPT

Text Books:

1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010Book

2. KantiSwarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7thEdition, Sultan chand& Sons, New Delhi, 2005

Ref. Books:

1. P.K.Gupta, D.S.Hira, "Operations Research", S.Chand and Company Ltd

2. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7thEdition, TMH, 2009.

3. Kalyanmoy Deb, "Optimization for Engineering Design", PHI Learning Pvt Ltd

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	COURSE TITLE	L	T	P	C	QP
	MECHANICS OF SOLIDS LABORATORY	0	0	2	1	

Pre-Requisite: Mechanics of Solid

Course Educational Objectives

CEO1	In this laboratory, students will have the opportunity to apply loads to various materials under different equilibrium conditions
CEO2	The student will perform tests on materials in tension, compression, torsion, bending, and impact
CEO3	The machines and equipment used to determine experimental data include universal testing machines, torsion equipment, spring testing machine, compression testing machine, impact tester, hardness tester, etc
CEO4	Data will be collected using Dial indicators, extensometers, strain gages and strain indicator equipment, as well as load and strain readouts on the machinery and graphing capabilities to print relevant plots for analysis
CEO5	Analysis of subsequent data obtained from the performed test and to present the results in a professionally prepared report

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Conduct tension, compression & bending test on UTM.
CO2	Perform impact & fatigue test of mild steel specimen.
CO3	Determine the Brinell, Rockwell and Vicker's hardness of different material.
CO4	Measure strain by using strain gauge and strain rosette.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1				3									2	
CO2				2									2	
CO3				3										
CO4				2									1	
Avg.				2.5										

LIST OF EXPERIMENTS

LIST OF EXPERIMENT (Minimum 8 experiments)

1. Determination of tensile strength of materials by Universal Testing Machine
2. Determination of compressive strength of materials by Universal Testing Machine
3. Determination of bending strength of materials by Universal Testing Machine
4. Double shear test in Universal Testing Machine

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5. Determination of Impact strength of material (Charpy and Izod)
6. Determination of Hardness strength of materials (Brinell, Rockwell and Vickers)
7. Determination of Rigidity modulus of material
8. Determination of Fatigue strength of material
9. Estimation of Spring Constant under Tension and Compression.
10. Load measurement using Load indicator, Load Cells.
11. Strain measurement using Strain Gauge.
12. Stress measurement using strain rosette.

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SUBJECT CODE	COURSE TITLE	L	T	P	C	QP
	CAD LAB	0	0	2	1	

Pre -Requisite: Mechanics of Solid

Course Educational Objectives

CEO1	Learn to sketch and take field dimensions.
CEO2	To develop the practical knowledge in the field of mechanical engineering design,
CEO3	To impart the fundamental knowledge in design and drafting.
CEO4	To prepare the student for future engineering challenges.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Demonstrate basic concept of Auto-CAD software.
CO2	Ability to manipulate engineering drawings through editing techniques.
CO3	Produce 2D and 3D dimensional drawings through Auto-CAD.
CO4	Ability to use the Auto-CAD software for drafting and modeling

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1				3									2	
CO2				2										
CO3				3									2	
CO4				2										
Avg.				2.5									1	

LIST OF EXPERIMENTS

LIST OF EXPERIMENT (Minimum 8 experiments)

1. AutoCAD – basics : Initiating the Graphics Package; Setting the paper size, space; setting the limits, units; use of snap and grid commands
2. Dimensioning the drawing and adding text,
3. Draw Commands
4. Drawing of primitives (Line, arc, circle, ellipse, triangle etc.)
5. 2 - D Figures Using AutoCAD
6. Drawing a flange
7. Drawing a bushing assembly
8. Isometric Drawings Using Auto-CAD
9. 3-D solid figures using Auto-CAD
10. Part And Assembly

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IV Semester [Second Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Engineering Science Courses	BESME4050	Database Management Systems	3	0	0	3
2	Professional Core Courses	BPCME4010/ BPCME4110	Fluid Mechanics and Hydraulic Machines	3	0	2	4
3	Professional Core Courses	BPCME4020/ BPCME4120	Manufacturing Science-I	3	0	2	4
4	Professional Core Courses	BPCME4030/ BPCME4130	Kinematics of Machinery	3	0	2	4
5	Professional Core Courses	BPCME4040	Quality Control and Reliability	3	0	0	3
6	Humanities and Social Sciences including Management Courses	BHSME4060	Optimization In Engineering	2	0	0	2
		BHSMS3061	Organizational Behavior				
8	Project	BPCME4180	Mini Project -1	0	0	2	1
Total Credits:				17	0	8	21

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	FLUID MECHANICS & HYDRAULICS MACHINES	3	0	0	3	A

Pre -Requisite: Physics, Thermodynamics, Mechanics, Mathematics

Course Educational Objectives

CEO1	To know the concept of fluid and its properties, manometer, hydrostatic forces acting on different surfaces and also problem solving techniques.
CEO2	To relate the basic laws of fluids, flow patterns, viscous flow through pipes and their corresponding problems.
CEO3	To analyze the hydrodynamic forces acting on vanes and their performance evaluation
CEO4	To evaluate of the importance, function and performance characteristics of hydro machinery

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand the basic properties and characteristics of incompressible fluid.
CO2	Apply basic fundamental theorems governing fluid flows i.e., continuity, energy and momentum and flow through pipes.
CO3	Compare the concept of measurement of different fluid properties using various types of equipments like manometer, venturimeter, orificemeter, pitot-tube, siphon etc.
CO4	Analyze the working of hydraulic machines and evaluate the performance of hydraulic turbines and pumps.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												
CO2	3	3												
CO3	3	3												
CO4	2	3												
Avg.	2.75	2.75												

SYLLABUS

UNIT:1

(10 Hours)

Scope of fluid mechanics and its development as a science Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid statics: Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer. Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface. Buoyancy and

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floatation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height. (14 Hours)

UNIT:2

Fluid kinematics:

Introduction, description of fluid flow, classification of fluid flow. Reynolds number, Acceleration of fluid particles, flow rate and continuity equation, differential equation of continuity, Mathematical definitions of irrotational and rotational motion. Circulation, potential function and stream function. Flow net

Fluid dynamics :

Introduction, Euler's equation along a streamline, energy equation, Bernoulli's equation and its application to siphon, venturimeter, orificemeter, pitot tube. Flow in pipes and ducts: Loss due to friction, Minor energy losses in pipes Flow through nozzles.

UNIT:3

Impact of Jet: Introduction, Force exerted by the jet on a stationary and movable plate (vertical, inclined, curved) Hydraulic turbines: Classification, Impulse and Reaction turbine; Tangential, Radial and axial turbine. Impulse turbine, Pelton wheel, bucket dimensions, number of buckets in pelton wheel, efficiency and performance curves. Reaction Turbines: Francis turbine and Kaplan turbine, velocity triangle and efficiencies, performance curve. Function of draft tube and casing cavitation (13 Hours)

UNIT:4

Centrifugal Pump:constructional features, vane shape, velocity triangles, Efficiencies, Pump Characteristic, NPSH and Cavitation. Positive displacement pumps:Reciprocating Pump, Working principle, Discharge, work done and power requirement, Slip, Indicator diagram (8 Hours)

Teaching Methods: Chalk& Talk/ PPT/Video Lectures/Demonstration

Text Books

1. Fluid Mechanics - Frank M. White II
2. Fluid Mechanics - Yunus Cengel and John Cimbala
3. Introduction To Fluid Mechanics And Fluid Machines - S Chakraborty
4. Fluid Mechanics and Hydraulic Machines, Modi & Seth

Ref. Books

- 1.Fluid Mechanics and Fluid Machines by A.K.Jain, Khanna Publishers
- 2.Introduction to Fluid Mechanics and Fluid Machines, S.K. Som and G. Biswas, TMH
3. Fluid Mechanics and Hydraulic Machines , Dr. R K Bansal, Laxmi Publication

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	MANUFACTURING SCIENCE -I	3	0	0	3	A

Pre -Requisite: Metallurgy

Course Educational Objectives

CEO1	To study basic definitions associated with casting terminology, its classification and various steps involved in it.
CEO2	To understand the application of the different joining techniques, and be able to select an appropriate technique according to a specific requirement.
CEO3	To understand the fundamentals of metal working process.
CEO4	To give the basic concept of the powder metallurgy processing and also the theory and technology of powder production, consolidation and sintering.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Select materials, types and allowances of patterns used in casting and analyze the components of moulds.
CO2	Design core, core print and gating system in metal casting processes.
CO3	Compare and contrast arc, gas, solid state and resistance welding processes.
CO4	Develop process for metal forming processes using plasticity principles and various techniques used in power metallurgy.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1											2	
CO2	1	2	2										1	
CO3	3	2											2	1
CO4	2	2											1	
Avg.	2.25	1.75	0.5										1.5	0.25

SYLLABUS

UNIT:1

[10 Hours]

Metal Casting Processes: sand mold making procedure. Patterns: Pattern materials, pattern allowances, types of pattern. Molding materials: Molding sand composition, sand preparation, sand properties and testing, Sand molding processes. Cores: Types of cores, core prints, chaplets, and chills. Design of Gating systems: Melting practice: Cupola furnace, solidification, defects in castings and their remedies, Shell molding, precision investment casting, permanent mold casting, die casting, centrifugal casting, continuous casting, Advantages and limitations.

UNIT:2

[10 Hours]

Welding Process: Principles of welding, brazing and soldering, Classification of Welding Processes, gas welding and cutting process, equipment. Arc welding power source and consumables. Resistance welding: Principle and equipments, resistance spot welding, resistance seam welding, electro slag welding, forge welding. Modern

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welding methods like plasma arc, laser beam, Electron beam, Ultrasonic, Explosive and friction welding. Destructive and Non destructive testing of casting and welding. [12 Hours]

UNIT:3

Metal Forming Processes:

Nature of plastic deformation, hot working and cold working. Principles of rolling, roll passes, roll pass sequences. Forging: Forging operations, smith forging, drop forging, press forging, forging defects.

Extrusion and Sheet metal operations:

Extrusion principle, hot extrusion, cold extrusion, wire drawing, swaging, tube making. Sheet metal operations: Press tools operations, shearing action, drawing dies, spinning, bending, stretch forming, embossing and coining. [10 Hours]

UNIT:4

Powder Metallurgy: Powder manufacturing, compaction and sintering processes. Advantages and applications of Powder Metallurgy. Brief introduction to explosive forming, coating and deposition methods. **Plastics:** Introduction, Raw material for plastics, Properties of plastics, types, Thermosetting plastics, Thermoplastics, Moulding compounds.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Manufacturing Technology-Foundry, Forming and Welding - P.N. Rao, Tata McGraw Hill,
2. Manufacturing Science - Ghosh A; Mallik A.K. Affiliated East-West Press Pvt. Ltd., New Delhi

Ref. Books:

1. Foundry Technology - K.P. Sinha, D.B. Goel, Roorkee Publishing House.
2. Welding and Welding Technology - Richard L. Little Tata McGraw Hill Ltd.
3. Principle of Metal casting - Rosenthal, Tata McGraw Hill, New Delhi

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	KINEMATICS OF MACHINERY	3	0	0	3	A

Pre -Requisite: Basic of Mechanics (Statics) topics like: Equilibrium of forces, Free body diagram, friction and D'Alemberts principle

Course Educational Objectives

CEO1	To obtain an idea of Mechanisms, basic of methodology of machines
CEO2	Apply knowledge to the selection of proper techniques and processes for velocity and acceleration using graphical and analytical techniques
CEO3	Basic knowledge of different types of Piston effort, force acting along the connecting rod, Crank effort, Turning moment on crank - shaft
CEO4	Analyze and study of various types of clutches and pivots, dynamometers, Various gear trains and classification of brakes etc

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Recognize the basic of elements of mechanisms and describe, understand differentiate between mechanisms, solve for mobility with synthesis of mechanisms.
CO2	Apply the concept of mechanism to interpret and examine the velocity and acceleration of different linkages in mechanisms by analytical and graphical methods.
CO3	Analyze the effect of friction and estimate the loss of power due to friction between moving elements (i.e., Gears, clutches, brakes, belt drives etc...)
CO4	Propose for the engineering challenges regarding human needs in daily life about machines and systems which are possible due to the design of machines.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												1
CO2	2	3												2
CO3	2	2												2
CO4	2	3				1								1
Avg.	2.25	2.5				0.25								1.5

SYLLABUS

UNIT:1

(No of Hours.12)

Mechanisms and machines, Rigid and resistant bodies, Link, Kinematic pair, Degrees of Freedom, Classifications of Kinematic pairs, kinematic-chain, Linkage, Mechanism, and structure, Classification of mechanisms, Equivalent Mechanisms, Four - Link (bar) Mechanism, Inversions of Slider - Crank Chain, Double - Slider Chain.

VELOCITY ANALYSIS: Introduction, Absolute and Relative Motion, Vectors, Addition and subtraction of Vectors, Motion of a Link, Four Link Mechanism, Angular Velocity of

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Links, Velocity of Rubbing, Slider - Crank Mechanism, Crank and Slotted Lever Mechanism.

UNIT:2 (No of Hours10)

PLANE MOTION OF BODY : Instantaneous centre, Notation, Number of I - Centres, Kennedy's theorem, Locating I - Centres, Angular velocity by I - Centre Method
ACCELERATION ANALYSIS:

Acceleration, Four-Link Mechanism, , slider-Crank Mechanism Angular acceleration of Links, Acceleration of Intermediate and offset points, Coriolis acceleration component, Crank and slotted lever Mechanism.

UNIT:3 (No of Hours10)

KINEMATIC SYNTHESIS:

Stages of synthesis-Concepts of type, Number and dimensional synthesis - Tasks of dimensional synthesis, Concepts of function generation, Rigid body guidance and path generation, Freudenstein equation for function generation using three precision points.

Cams: Definitions of cam and followers - their uses - Types of followers and cams - Terminology - Types of follower motion - Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes, Graphical synthesis of cam profile

UNIT:4 (No of Hours12)

GEARS : Introduction, Classification gear terminology, Law of Gearing, Velocity of Sliding, Forms of Teeth, Cycloidal Profile Teeth, Involute Profile Teeth, Path of contact, Arc of contact, Number of pairs of Teeth in contact, Interference in Involute Gears, Minimum number of Teeth, Interference between Rack and Pinion, Undercutting, Comparison of Cycloidal and Involute tooth forms.

GEAR TRAINS: Introduction, simple Gear Train, Compound Gear Train, Reverted Gear train, Planetary or Epicyclic Gear Train, Analysis of Epicyclic Gear Train, Torques in Epicyclic Trains. Tabular and Algebraic Methods

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books

1. Theory of Machines /S.S.Rattan - Tata McGraw Hill Publishers.
2. Theory of Mechanisms and Machines by Ghosh and Mallik

Ref. Books

1. Theory of Machines / R. S. Khurmi and J K Gupta /S.Chand
2. Theory of Machines / Sadhu Singh / Pearson.
3. Theory of Machines / Shigley / Oxford

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	Q P
	QUALITY CONTROL AND RELIABILITY	3	0	0	3	A

Pre -Requisite: Basics of Probability and Statics

Course Educational Objectives

CEO1	Introduces students to concepts and methods of modern statistical quality control
CEO2	To apply standard quality control tools. They learn the theoretical statistical concepts that justify the use of particular quality control tools in particular situations
CEO3	To learn theory and methods for analyzing the performance of different quality control tools
CEO4	Use of appropriate software for statistical and quality analysis is taught, and is necessary for successful completion of some homework assignments. Issues of ethics and professional responsibility and their relation to product quality are discussed

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand the concepts of quality control, improvement and management.
CO2	Relevant with sampling by attributes, operating characteristics curves and ISO standard set attributes in sampling plans
CO3	Apply quality engineering tools to the design of products and process controls
CO4	Recognize the need of reliability and carry out reliability data analysis

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1												
CO2	2	2												1
CO3	1		2		2									
CO4	3	1												1
Avg.	2.25	1	0.5		0.5									0.5

SYLLABUS

UNIT:1

[16 Hours]

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality control: Quality cost-Variation in process causes of variation -Theory of control chart- uses of control chart - Control chart for variables - X chart, R chart and $\bar{x}$ chart -process capability - process capability studies and simple problems.

Control chart for attributes -control chart for nonconforming- p chart and np chart - control chart for nonconformities- C and U charts, State of control and process out of

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control identification in charts, pattern study.

UNIT:2 [09 Hours]
Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – O.C. curves – producer's Risk and consumer's Risk. AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans.

UNIT:3 [10 Hours]
Total Quality Management perspective, methodologies and procedures; Roadmap to TQM, ISO 9000, KAIZEN, Quality Circles, Six sigma concepts, JIT. Taguchi Loss function, Orthogonal Array, Linear Graphs, Parametric Design, S/N Ratio, ANOVA

UNIT:4 [10 Hours]
Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate – Weibull model, system reliability, series, parallel and mixed configuration – simple problems. Maintainability and availability – simple problems. Acceptance sampling based on reliability test – O.C Curves.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Douglas's. Montgomery, "Introduction to Statistical quality control", 4th edition, John Wiley 2001.
2. A.Mitra, Fundamentals of Quality Control and Improvement, Pearson Education, 2nd ed. 2005.

Ref. Books:

1. John's. Oakland. "Statistical process control", 5th edition, Elsevier, 2005
2. Connor, P.D.T.O., "Practical Reliability Engineering", John Wiley, 1993
3. Grant, Eugene .L "Statistical Quality Control", McGraw-Hill, 1996

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	OPTIMIZATION ENGINEERING	3	0	0	2	A

Pre -Requisite: Basics of Mathematics, matrix, partial differential equation addition of linear equations

Course Educational Objectives

CEO1	To introduce the students how to use variables for formulating complex mathematical models in management science, industrial engineering and transportation science
CEO2	To provide students with opportunity using various software package for solving liner programming and integer programming models
CEO3	To introduce the students to use of basic methodology for solution of linear programs and integer programs
CEO4	To introduce the students to advance methods for large scale transportation and assignment problems

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Analyze, formulate and solve linear programming problems using appropriate techniques.
CO2	Conduct and interpret post-optimal analysis and explain the application of transportation & assignment problems
CO3	Develop mathematical skills to analyze and solve integer programming problem Queueing and Game theory.
CO4	Communicate ideas, explain procedures and interpret solution for Non-linear programming problems

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3												
CO2	2	3												
CO3	3	2												
CO4	2	3												
Avg.	2.25	2.75												

SYLLABUS

UNIT:1

[12 Hours]

Introduction Historical overview of operations research, fundamentals of OR Modeling Approach.

Linear Programming: Basic assumptions, formulation, graphical method, simplex method, Big-M method, two phase method, duality theory, Dual simplex.

UNIT:2

[10 Hours]

Sensitivity analysis: Change in objective function coefficient, Change in RHS, Deletion of variable

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Transportation Problems: Methods for obtaining basic feasible solutions (NWCR, LCM & VAM), Methods for obtaining optimum solution (Stepping stone & Modi method) Specific features of transportation problem.

Assignment Problem: Hungarian method for solving assignment problems. Maximization in Assignment problem, Unbalanced assignment problem.

UNIT:3 [10 Hours]

Integer programming: Special features, branch-and-bound technique

Queueing: Basic elements of queuing model, role of Poisson & exponential distribution, single server model.

Game theory: Maxi-min and Mini-max principle, mixed strategy, dominance theory

UNIT:4 [14 Hours]

Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method.

Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method

Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming

Introduction to Genetic Algorithm.

Teaching Methods: Chalk& Board/PPT

Text Books:

1. Taha H.A., Operations Research 9th Edition, Prentice Hall of India, New Delhi, 2010Book

2. Kanti Swarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research 7th Edition, Sultan chand& Sons, New Delhi, 2005

Ref. Books:

1. P.K.Gupta, D.S.Hira, "Operations Research", S.Chand and Company Ltd

2. Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7th Edition, TMH, 2009.

3. Kalyanmoy Deb, "Optimization for Engineering Design", PHI Learning Pvt Ltd

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	COURSE TITLE	L	T	P	C	QP
	FLUID MECHANICS AND HYDRAULICS MACHINES LABORATORY	0	0	2	1	

Pre -Requisite: Mathematics, Fluid Mechanics and Hydraulic Machines

Course Educational Objectives

CEO1	To know the concept of fluid and its properties, manometer, hydrostatic forces acting on different surfaces and also problem solving techniques.
CEO2	To relate the basic laws of fluids, flow patterns, viscous flow through ducts and their corresponding problems.
CEO3	To analyze the hydrodynamic forces acting on vanes and their performance evaluation
CEO4	To evaluate of the importance, function and performance characteristics of hydro machinery

Course Outcomes: Upon successful completion of this course, students should be

CO1	Discuss the differences among measurement techniques, their relevance and applications.
CO2	Explain the condition of floating and submerging of any object in water.
CO3	Analyze the various parameters of flow through Orifice, Venturimeter
CO4	Calculate the performance analysis of turbines and pumps that can be used in power plants.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3			3						1				
CO2	2			3						2				
CO3	2			2						2				
CO4	2			3						2				
Avg	2.25			2.75						1.75				

LIST OF EXPERIMENTS

List of Experiment: (Minimum 8 Experiments)

1. Determination of Metacentric Height and application to stability of floating bodies.
2. Determination of Cv and Cd of Orifices.
3. Experiments on impact of Jets
4. Experiments on performance of Pelton Turbine
5. Experiments on performance of Francis Turbine
6. Experiments on performance of Kaplan Turbine
7. Experiments on performance of centrifugal pump
8. Experiments on performance of reciprocating pump
9. Experiments on Reynold's Apparatus
10. Experiments on Flow through pipes
11. Verifications of Bernoulli's equation

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT	COURSE TITLE	L	T	P	C	QP
	MANUFACTURING SCIENCE- I LABORATORY	0	0	2	1	

Pre -Requisite:

Course Educational Objectives

CEO1	Examine the principles associated with basic operations involving the casting ,forming and welding of engineering materials
CEO2	Interpret the advantages and limitations of each process and its influence on the properties of the material in the finished component
CEO3	To know the basic processes used in performing forming and welding operations on engineering materials
CEO4	Formulate practical design methods to materials working techniques

Course Outcomes: Upon successful completion of this course, students should be

CO1	Test the properties of moulding sands.
CO2	Fabricate joints using TIG, MIG, Brazing and soldering
CO3	Develop process maps for metal forming processes using plasticity principles.
CO4	Estimate formability limits for sheets and bulk metals

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1				3						1			1	
CO2				3						2				2
CO3				2						2			2	
CO4				2						2			1	
Avg				2.5						1.75			1	0.5

LIST OF EXPERIMENTS

List of Experiment: (Minimum 6 Experiments)

- 1.Determination of grain size, clay content, permeability and green compressive strength of Molding sand. (2 to 3 experiments)
- 2.Foundry Practices
3. Preparation of a wood pattern.
- 4.Determination of strength of brazed and solder joints
- 5.Practice and preparation of job in TIG/MIG welding
6. Practice and preparation of job in sheet metal using processes like forming and deep drawing.
- 7.Demonstration of different rolling mills
- 8.Demonstration of Extrusion processes

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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT	TITLE OF THE SUBJECT	L	T	P	C	QP
	KINEMATICS OF MACHINERY LABORATORY	0	0	2	1	

Pre Requisite: Physics , Mechanics, Theory of Machine

Course Educational Objectives

CEO1	To understand the concept of machines, mechanisms and elated terminologies
CEO2	Discriminate mobility (number of degrees-of-freedom). Enumeration of rigid links and types of joints within mechanisms. To make the students become familiar and understanding of the most commonly used mechanisms (4-bar, 6-bar linkages, and cams).
CEO3	To understand the Principles and working of various straight line motion mechanisms
CEO4	To develop and analyze cam profiles for different mechanisms.

Course Outcomes: Upon successful completion of this course, students should

CO1	Develop the design concepts of different types of mechanism with lower pairs and higher pairs
CO2	Analyze the velocity and acceleration of links of different mechanisms.
CO3	Study and analyze the gear profiles and gear trains.
CO4	Synthesis of the different mechanisms

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1			2						1				
CO2				2						2				
CO3	1			2						2				
CO4			2	2						2				
Avg										1.75				

LIST OF EXPERIMENTS

List Of Experiments: (Minimum 8 no. of Experiments)

1. Design of any one working model related to Kinematics of Mechanisms i.e., unit I and unit II.
2. Radius of Gyration of compound pendulum
3. Radius of Gyration of Connecting Rod.
3. Study of simple /compound/Reverted Gear trains
4. Experiment on Cam Analysis Apparatus.
5. Experiment on Coriolis component of acceleration.
- 7.Experiment on Journal Bearing Apparatus
8. Study of interference and undercutting for gear drives.
- 9.Experiment on Epicyclic gear train

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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

V Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses	BPCME5010/ BPCME5110	Dynamics of Machinery	3	0	2	4
2	Professional Core Courses	BPCME5020	Machine Design-I	3	0	0	3
3	Professional Core Courses	BPCME5030/ BPCME5130	Manufacturing Science-II	3	0	2	4
4	Professional Core Courses	BPCME5040/ BPCME5140	Internal Combustion Engines	3	0	2	4
5	Professional Elective Courses	BPEME5050	Automobile Engineering	3	0	0	3
		BPEME5051	Modern Manufacturing Processes				
		BPEME5052	Advanced Mechanics of Solid				
		BPEME5053	Advanced Fluid Mechanics				
6	Open Elective Courses	BOEME5060	Research Methodology	3	0	0	3
		BOEME5061	Microprocessors And Microcontrollers				
		BOEME5062	Process Dynamic And Control				
		BOEME5063	Energy Conversion Techniques				
7	Project	BPCTP5190	Summer Industry Internship	-	-	2	1
8	Project	BPCME5180	Mini Project -2	0	0	4	2
9	Engineering Courses	BHSBS5080	Humans Values and Professional Ethics	2	0	0	2
Total Credits:				20	0	12	26

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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

Subject Code	TITLE OF THE SUBJECT										L	T	P	C	Q P
	DYNAMICS OF MACHINERY										3	0	0	3	A
Pre -Requisite: Basic Mathematics, Physics , Mechanics															
Course Educational Objectives															
CEO1	To equip the student with fundamental knowledge of dynamics of machines so that student can appreciate problems of dynamic force balance, transmissibility of forces, isolation of systems, vibrations														
CEO2	Develop knowledge of analytical and graphical methods for calculating balancing of rotary and reciprocating masses														
CEO3	Develop understanding of vibrations and its significance on engineering design.														
CEO4	Develop understanding of dynamic balancing, flywheel analysis, gyroscopic forces and moments.														
Course Outcomes: Upon successful completion of this course, students should be able to:															
CO1	Classify the steering mechanisms and gyroscopic effects on various dynamic objects.														
CO2	Develop a cam profile to meet desired needs within realistic constraints, calculate the inertia forces in reciprocating and rotating masses along with turning moments in flywheels.														
CO3	Analyze static and dynamic balancing of rotating and reciprocating masses, classify the various kinds of governors, recognize the effect of controlling force.														
CO4	Analyze the effect of vibration in desired systems; determine the natural frequency of a vibration system.														
CO-PO & PSO Mapping															
COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	3	2													
CO2	3	3	1												
CO3	2	2												2	
CO4	3	3												1	
Avg.	2.75	2.5	0.25											0.75	
SYLLABUS															
UNIT:1 (12 Hours)															
Dynamic Force Analysis : Introduction, D'Alembert's Principle, Equivalent Offset Inertia Force, Dynamic Analysis of Slider - Crank mechanism (Using Analytical method) Velocity and Acceleration of piston, Angular velocity and Angular Acceleration of Connecting Rod, Piston Effort (Effective Driving Force), Crank Effort, Turning moment diagram –fluctuation of energy.															

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

Mechanisms with lower pairs: Motor Vehicle Steering Gears - Davis Steering Gear & Ackermann Steering Gear, Hooke's Joint.

UNIT:2

(12 Hours)

Gyroscopes - effect of precession - motion on the stability of moving vehicles such as motorcycle - motorcar - aeroplanes and ships.

Governors: Types of governors - Watt, Porter and Proell governors. Spring loaded governors - Hartnell and Hartung with auxiliary springs. Sensitiveness, isochronisms and hunting - stability - effort and power of the governors.

UNIT:3

(10 Hours)

Friction: pivots and collars - uniform pressure, uniform wear - friction circle and friction axis. Clutches - Types - Single plate, multi-plate and cone clutches.

Brakes and Dynamometers: Types of brakes: Simple block brake, band and block brake-internal expanding shoe brake-effect of braking of a vehicle. Dynamometers - absorption and transmission types. General description and methods of operation

UNIT:4

(16 Hours)

Balancing : Balancing of rotating masses- Primary, Secondary, and higher balancing of reciprocating masses. Analytical and graphical methods. Unbalanced forces and couples.

Examination of "V" and multi cylinder in-line and radial engines for primary and secondary balancing- locomotive balancing - Hammer blow - Swaying couple - variation of tractive effort.

Vibrations: Free Vibration of mass attached to vertical spring - Transverse loads - vibrations of beams with concentrated and distributed loads. Dunkerly's method - Raleigh's method. Whirling of shafts - critical speed - torsional vibrations -Free vibrations with viscous damping, Logarithmic Decrement.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books

1. Theory of Machines, S.S.Rattan.
2. Theory of Machines, R.K.Bansal (Lakshmi publications)

Ref. Books

1. Theory of Machines, Shigley, Mc Graw Hill Publishers
2. Theory of Machines, Thomas Bevan, CBS Publishers
3. Theory of Machines, R.S.Khurmi

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	MACHINE DESIGN -1	3	0	0	3	A

Pre Requisite: Mathematics, Mechanics of Solid

Course Educational Objectives

CEO1	To teach students how to apply the concepts of stress analysis, theories of failure and able to do tolerance analysis and specify appropriate tolerances for machine design applications by using data book.
CEO2	To analyze and design structural joints.
CEO3	To teach students how to apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems
CEO4	To analyze and design mechanical springs.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand component behavior subjected to loads and identify the failure criteria.
CO2	Design the cotter, knuckle, riveted and welded joints.
CO3	Develop the design of keys, shaft and couplings.
CO4	Explain the design procedure of lever and power screw.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												1
CO2	2	2	2											1
CO3	1	2	3											
CO4	2	2	2											1
Avg.	2	2	1.75											0.75

SYLLABUS

UNIT:1

[16 Hours]

Mechanical engineering design: Introduction to design procedure, Stages in design, Code and Standardization, Interchangeability, Preferred numbers, Fits and Tolerances, Use of Data books. Fundamentals of Machine Design: Types of load, Modes of failure, factor of safety concepts, Theories of Failure, concept and mitigation of stress concentration, Fatigue failure and curve, endurance limit and factors affecting it, Notch sensitivity, Goodman, Gerber and Soderberg criteria

UNIT:2

[12 Hours]

Machine Element Design: Design of Joints: Rivets, welds based on different types of loading, Boiler joints, cotter joints and knuckle joints

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UNIT:3 [12 Hours]
Design of Keys, Shaft and Couplings: Classification of keys and pins, Design of keys and pins, Design of shafts: based on strength, torsional rigidity and fluctuating load. Design of couplings: Rigid coupling muff, split muff and flange coupling, Flexible coupling

UNIT:4 [10 Hours]
Design of Lever: Classification, Design of levers, Cranked lever, Lever of safety valve, Power screw, design with square thread such as screw jack

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill, 3rd edition, 2010.
2. Mechanical Engineering Design, J.E.Shigley, R.G.Budynas and K.J.Nisbett, TMH, 10th edition, 2014

Ref. Books:

1. Machine Design, P.Kanaiah, Sciotech Publications, 2nd edition, 2010
2. Fundamentals of Machine Component Design by R.C.Juvinall and K.M.Marshek, John Wiley & Sons, 5th edition, 2012.
3. Machine Design: An Integrated Approach, Norton, R. L., Pearson, 5th edition 2014

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	MANUFACTURING SCIENCE - II	3	0	0	3	A

Pre -Requisite: Engineering workshop, Mechanics

Course Educational Objectives

CEO1	To know the basics of metal machining and mechanics of metal machining
CEO2	To study the different cutting tool materials and types & geometry of cutting tools
CEO3	To acquire knowledge on various machining processes and its working principle
CEO4	To select the best suitable non conventional manufacturing process for processing of various hard, brittle and heat sensitive materials employed in modern manufacturing industries.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Describe the concepts in tool geometry and develop relations for different physical quantities using appropriate technique during orthogonal cutting.
CO2	Discuss the working principle of conventional machines and the application of production machine tools
CO3	Explain the various mechanisms involved in conventional machines and interpret the concept of economics of metal cutting
CO4	Classify the knowledge of Non-conventional machining processes with its advantages, limitations and application.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	3												
CO2	3	1												
CO3	3	2												
CO4	3	1												
Avg.	2.75	1.75												

SYLLABUS

UNIT:1

[12 Hours]

Classification of various tool and tool geometry, various tool angles of a single point cutting tool, ASA and ORS, Conversion of ASA to ORS and vice versa, Mechanics of chip formation, Effect of Geometrical parameters on cutting force and surface finish, Merchant's theory, Force relationship and velocity relationship, Cutting tool materials, Types of Tool Wear: Flank wear, Crater wear, Wear measurement, Cutting fluid and its effect; Machinability Criteria, Tool life and Taylor's equation, Effect of variables on tool life and surface finish.

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UNIT:2 [12 Hours]
Conventional machining process and machine tools – Turning, Drilling, Shaping, Planning, Milling, Grinding. Machine tools used for these processes, their specifications and various techniques used.
Production Machine tools – Capstan and turret lathes, single spindle and multi spindle semiautomatics, Gear shaper and Gear hobbing machines

UNIT:3 [12 Hours]
Principles of machine tools: Kinematics of machine tools, speed transmission from motor to spindle, speed reversal mechanism, mechanism for feed motion, Tool holding and job holding methods in different Machine tools, Indexing mechanism and thread cutting mechanism, Quick return mechanism.
Calculation of Machining time for various machining process, Economics of machining.

UNIT:4 [12 Hours]
Non-traditional Machining processes: Need of non-conventional machining, Comparison of conventional and non-conventional machining, Working principle of Ultrasonic Machining, Laser Beam Machining, Plasma Arc Machining, Electro Chemical Machining, Electro Discharge Machining, Electron Beam Machining, Abrasive Jet Machining, Application, Advantage and limitation of various non conventional machining processes.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Fundamentals of Machining and Machine Tools, G.Boothroyd and W.A.Knight, CRC Press
2. Metal Cutting Principles, M.C.Shaw, Oxford University Press
3. A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co

Ref. Books:

1. Manufacturing Technology – by P.N.Rao, Tata McGraw Hill publication.
2. Modern Manufacturing Processes, P.C.Pandey, H.S.Shan, Tata McGraw Hill
3. Manufacturing Science, Ghosh and Mallik, East West Press.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	INTERNAL COMBUSTION ENGINES	3	1	0	4	A

Pre -Requisite: Engineering Thermodynamics

Course Educational Objectives

CEO1	Understand the thermodynamic cycle (Otto, Diesel) and know the working principle of reciprocating internal combustion engine.
CEO2	Understand the concept of atomization of fuel in carburetor and spray formation in injector.
CEO3	Understand the mechanism of ignition, injection, combustion, supercharging, scavenging, knocking and detonation phenomena.
CEO4	Understand the engine performance in terms of power, efficiency, exhaust emission and control.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Illustrate working and performance of IC Engines through thermodynamic cycles, and various systems of IC engine.
CO2	Classify atomization ,spray formation and combustion phenomena related to SI and CI engines and factors influencing combustion chamber design.
CO3	Analyze exhaust gas emission formation mechanism of IC engines and its effects and the legislation standards.
CO4	Design IC Engine with use of super charger and turbo charger according to alternate fuels.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3												3
CO2	3	2												3
CO3	3	3	2											3
CO4	3	2	2											3
Avg.	2.5	2.5	1											3

SYLLABUS

UNIT:1 Fundamentals of I.C.Engines [10 Hours]
Introduction, Classification of I.C. Engines. Fundamental difference between SI and CI engines, Comparison of two stroke and four stroke engines. Valve timing diagram, Properties and rating of IC engine, fuels, Additives and non-petroleum fuels.
Gas power cycles: Air standard cycles- Otto, Diesel, Dual Combustion and Brayton cycles, The Brayton cycle with non-isentropic flow in compressors and turbines, The Brayton cycle with regeneration, reheating and intercooling, Ideal jet propulsion cycle.
Introduction to Alternative Fuels: LPG, LNG, CNG, Alcohol, Hydrogen, Vegetable oils and Biogas.

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UNIT:2	[14 Hours]
Carburetion and Fuel injection: Function of carburetors, Description and principle of simple carburettor and its drawback, petrol injections. Requirements of diesel injections system. Types of injection systems, Fuel pumps and nozzles, types of fuel injections, Spray formation, penetration and direction.	
Combustion of Fuels: Stages of SI engine combustion, Effect of engine variables on ignition lag and flame propagation, fuel knock, control of knock. SI engine combustion chamber stage of diesel combustion, variables affecting delay period. Diesel knock and methods of control. CI engine combustion chambers	
UNIT:3	[10 Hours]
Supercharging and scavenging: Thermodynamic cycle with supercharging and its effect. Efficiency of supercharging engines Methods of supercharging and scavenging of two stroke engines. Turbo charging: Methods of turbo charging, effects of turbo charging on performance	
UNIT:4	[12 Hours]
Testing and Performance: Fuel air and power measurement methods. Performance of SI and CI engines, Characteristic curves, Governing of speed.	
Engine Emission and Control: Engine Emissions and its harmful effects, Gasoline and Diesel emission: Methods of measuring pollutants controlling of engine emission.	
Cooling Lubrication and ignition systems: Air cooling and water cooling systems effects of cooling on power output and efficiency. Properties of lubricants additives lubricating systems. Battery, Magnet ignition systems ignition timing.	
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert	
Text Books:	
2. IC Engines, V Ganeshan, TMH, 4th edition	
3. IC Engines, H N Gupta, PHI Publication, 3 rd edition.	
Ref. Books:	
1. IC Engines, Mathur and Sharma, Dhanpat Rai & Sons, 4 th edition.	
2. IC Engines, Gill and Smith, OXFORD & IBH, 4 th edition.	
3. IC Engines Fundamentals, John B. Heywood, TMH, 3 rd edition.	

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	ADVANCED MECHANICS OF SOLID	3	0	0	3	A

Pre -Requisite: Fundamentals in mathematics, Engg. Mechanics and Material science

Course Educational Objectives

CEO1	Explain the students of different types of mechanical elements, structural bodies and their application
CEO2	By Appling different types of theories of failure, strength of the machine elements, structural bodies can be determined
CEO3	Summarize the social need of the particular elements and their cost effective design satisfying for the need of society.
CEO4	Make use of the concept of stress and strain in different types of beam, structure analysis, and design in machine elements.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Develop principles of elasticity theory to determine stresses and strains
CO2	Apply theory of elasticity and formulate plane stress and plane strain problems
CO3	Estimate stresses and deflection of beams under unsymmetrical bending and to locate shear Centre of thin wall beams.
CO4	Analyze solid mechanics problem using classical methods and energy methods.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2											1	
CO2	2	3												1
CO3	1	3												
CO4	2	3											0.25	0.25
Avg.	2	2.75												

SYLLABUS

UNIT:1

[14 Hours]

Analysis of stress:-

Introduction to stress analysis in elastic solids - stress at a point - stress tensor - stress components in rectangular coordinate system - Cauchy's equations - stress transformation - principal stresses and planes -stress invariants - hydrostatic and deviatoric stress components, octahedral shear stress -differential equations of equilibrium, plane stress, Mohr's circle for 3D state of stress.

Analysis of strain:-

Engineering strain - strain tensor (basics only) - analogy between stress and strain tensors - strain-displacement relations (small-strain only) - stress compatibility equation, Airy's stress function and Bi-harmonic equation

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UNIT:2	[12 Hours]
Axisymmetric problems - governing equations - application to thick cylinders, compound cylinder, shrink fit, Bending of Curved Beam, stress distribution in beam with rectangular, circular & trapezoidal section. Stresses in crane hook, ring and chain link Unsymmetrical bending of straight beams, Deflection of unsymmetrical bending.	
UNIT:3	[12 Hours]
Strain energy of deformation - special cases of a body subjected to concentrated loads, moment or torque - reciprocal relation - strain energy of a bar subjected to axial force, shear force, bending moment and torque. Maxwell reciprocal theorem - Castigliano's first and second theorems - virtual work principle - minimum potential energy theorem.	
UNIT:4	[10 Hours]
Torsion of non-circular bars: Saint Venant's theory - solutions for circular and elliptical cross-sections Prandtl's method - solutions for circular and elliptical cross-sections - membrane analogy. Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections Variable stresses - reversed cyclic stress, fluctuating stress, alternating stress, stress concentration, stress concentration factor, notch sensitivity	
Teaching Methods: Chalk& Board	
Text Books:	
1. Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill	
2. Advanced Mechanics of Materials : Boresi and Schmidt, Willey	
Ref. Books:	
1. Advanced Mechanics of Materials : Siley and Smith	
2. Strength of Materials Vol.II, by S.Timoshenko	
3. Mechanical Metallurgy by Dieter	

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	AUTOMOBILE ENGINEERING	3	0	0	3	A

Pre -Requisite: Internal Combustion Engine, Kinematics and Dynamics of Machines

Course Educational Objectives

CEO1	To impart practical and theoretical knowledge in both practically by covering the various types of power-driven vehicles
CEO2	To familiarize the students with the fundamentals of Automotive Engine System, Chassis and suspension system, braking and transmission system, and cooling system
CEO3	To make the students acquainted with the operation, maintenance and repairs of all components of the various transportation vehicles
CEO4	To make the students aware of the various electrical vehicles and electrical system of automobiles

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	List out the different components and systems of an automobile.
CO2	Illustrate the constructional designs and working principles involved in vehicle design.
CO3	Utilize steering geometry, principle of gear box design and braking system for effective power transmission of vehicles
CO4	Develop electrical vehicles considering environmental safety

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													3
CO2	3	2	1											3
CO3	3	3	2											3
CO4	3		2				3							3
Avg.	3	1.25	1.25				0.75							3

SYLLABUS

UNIT:1

[14 Hours]

Introduction:

Main units of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act.

Power for Propulsion: Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Braking systems: Hydraulic braking system, braking of vehicles when applied to rear, front and all four wheels, theory of internal shoe brake, design of brake lining and brake

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drum, different arrangement of brake shoes, servo and power brakes.

[12 Hours]

UNIT:2

Transmission Systems: Layout of the transmission system, main function of the different components of the transmission system, transmission system for two wheels and four wheels drives. Hotchkiss and torque tube drives.

Gear box :

Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission. Hooke's joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, three quarter floating and full floating types.

[10 Hours]

UNIT:3

Front wheel Geometry and steering systems : Camber, castor, kingpin inclination, toe-in and toe-out, centre point steering condition for true rolling, components of steering mechanism, power steering (Hydraulic & Pneumatic).

Ignition System: Requirements of an ignition system, conventional ignition system (Battery and Magneto), Modern ignition system (TCI, CDI), Spark advance mechanism.

[10 Hours]

UNIT:4

Electrical system of an automobile : Starting system, charging system, other electrical system. Electrical vehicles: History, electrical vehicles and the environment pollution, description of electric vehicle, Operational advantages, present EV performance and applications, battery for EV, Battery types and fuel cells, Solar powered vehicles, hybrid vehicles.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Models

Text Books:

1. Automobile Mechanics , N.K.Giri, Khanna publishers, 3rd edition
2. Automobile Engineering, K.M. Gupta, Vol I & II, Umesh Publication, 4th edition
3. Automobile engineering, kripal singh vol I & II Standard Publishers Distributors, 3rd edition

Ref. Books:

1. Automotive mechanics: William h. Crouse and Donald L. Anglin, TMH, 5th edition
2. Automobile Mechanics, J. Heitner, East West Press, 8th edition.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	MODERN MANUFACTURING PROCESSES	3	0	0	3	A

Pre -Requisite: Basic Manufacturing process, Machining science and technology

Course Educational Objectives

CEO1	To learn the concepts of material removal using various advanced machining operations
CEO2	To develop competency in understanding of machine tools and mechanism involved in machining operations
CEO3	To apply fundamentals principles of electro chemical, laser and plasma machining
CEO4	To be able to control surface finish, material removal rate and accurate dimensions by applying different machining operations

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand requirements to achieve maximum material removal rate and best quality of machined surface while machining various industrial engineering materials.
CO2	Analyze the machining process parameters, and mechanism involved in material removal process in various non conventional machining.
CO3	Interpret contemporary issues in material removal process using advanced techniques, skills and modern engineering tools necessary for engineering practice.
CO4	Apply the concept of concurrent, reversed engineering and rapid prototyping in various industrial applications.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												
CO2	3	1												
CO3	2	2			1									2
CO4	3	1												
Avg.	2.75	1.5			0.25									0.5

SYLLABUS

UNIT:1

[14 Hours]

ULTRASONIC MACHINING (USM): Introduction, equipment, tool materials & tool size, abrasive slurry, cutting tool system design:-Modelling for finding MRR, Effect of parameters on Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM. Numerical on MRR

ABRASIVE JET MACHINING (AJM): Introduction, Equipment, Variables in AJM: Carrier

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

Gas, Type of abrasive work material, standoff distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Modelling for finding MRR. Applications, advantages & Disadvantages of AJM. Numerical on MRR.

Water Jet Machining: Principle, Equipment, Operation, Application, Advantages and limitations of Water Jet machining.

UNIT:2

[12 Hours]
ELECTROCHEMICAL MACHINING (ECM): Introduction, study of ECM machine, elements of ECM process: ECM Process characteristics - Material removal rate, Accuracy, surface finish, Applications, Electrochemical turning, Grinding, Honing, deburring, Advantages, Limitations. Numerical on MRR

CHEMICAL MACHINING (CHM): Introduction, elements of process, chemical blanking process, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.

ELECTRICAL DISCHARGE MACHINING (EDM): Introduction, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, EDM process characteristics: metal removal rate, accuracy, surface finish, Heat Affected Zone. Machine tool selection, Application, electrical discharge grinding, wire EDM

UNIT:3

[12 Hours]
PLASMA ARC MACHINING (PAM): Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Applications, Advantages and limitations.

LASER BEAM MACHINING (LBM): Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

ELECTRON BEAM MACHINING (EBM): Principles, equipment, operations, applications, advantages and limitation of EBM

UNIT:4

[10 Hours]
Introduction to Surface engineering, High speed machining and grinding: Application of advanced coatings in high performance modern cutting tools and high performance super-abrasive grinding wheels, Micro and nano machining of glasses and ceramics. Theory and application of chemical processing: Chemical Machining, Coating and Electro-less forming, PVD and CVD; Introduction to Reverse Engineering, Concurrent Engineering and Rapid prototyping: Solid based, liquid and powder based rapid prototyping methods.

Teaching Methods: Chalk& Board/ PPT/ Lecture by Industry Expert

Text Books:

1. Modern machining process, Pandey and Shan, Tata McGraw Hill 2000
2. Manufacturing Engg. & Technology, Kalpakjian, Pearson Education

Ref. Books:

1. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	ADVANCED FLUID MECHANICS	3	0	0	3	A

Pre -Requisite: Mathematics, Basics of Mechanics and Fluid Mechanics and Hydraulic Machines

Course Educational Objectives

CEO1	To understand the basic tools for the analysis and solution of different types of flows
CEO2	To derive the partial differential equations governing the conservation of mass, momentum, and energy of an incompressible Newtonian fluid
CEO3	To obtain dimensionless form of the governing equations and extract the dimensionless parameters from them to determine the flow field.
CEO4	To derive the boundary layer equations and show how to obtain exact and approximate integral solutions.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Demonstrate the concept of fluid mechanics like statics, kinematics and dynamics, including concepts of mass, momentum and energy conservation equation.
CO2	Apply the principles of high and low Reynolds number flows to fluid flow systems.
CO3	Review the concepts of boundary layer and flow in transition.
CO4	Apply the fundamentals of one dimensional isentropic flow to variable area duct and principles of compressible flow to constant area duct subjected to friction or heat transfer

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1												
CO2	2	3												
CO3	2	2												
CO4	2	3												
Avg.	2.25	2.25												

SYLLABUS

UNIT:1

[14 Hours]

Basic Concepts and Fundamentals; Definition and properties of Fluids, Fluid as continuum, Lagrangian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics. Potential Flows: Revisit of fluid kinematics, Stream and

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2. Surface Wear Analysis, Treatment & Prevention - ASM International, Materials Park, OH, U.S.A., 1st Ed. 1995
3. Production Technology, HMT, Tata McGraw Hill. 2001

Ph

Raj

B. S. Sanyal

Y. S. Sanyal

N. S. Sanyal

S. S. Sanyal

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Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Flow past a circular cylinder, Concept of lift and drag

UNIT:2 [12 Hours]

Governing Equations of Fluid Motion, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler's equation, Bernoulli's Equation. Exact solutions of Navier-Stokes Equations: Poiseuille flows.

UNIT:3 [10 Hours]

Laminar Boundary Layers; Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations,

Turbulent Flow; Introduction, General equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer

UNIT:4 [10 Hours]

Compressible Flows; Speed of sound and Mach number, Basic equations for one dimensional flows, Isentropic relations, Normal-shock wave, Fanno curve.

Introduction to Computational Fluid Dynamics; Boundary conditions, Basic discretization - Finite difference method, Finite volume method and Finite element method

Teaching Methods: Chalk& Board

Text Books:

1. Fluid Mechanics by A K Mohanty, TMH Publication
2. Fluid Mechanics by S K Som, TMH Publication

Ref. Books:

1. Fluid Mechanics by F M White, TMH Publication
2. Fundamentals of Fluid Mechanics, Schlitching
3. Fluid Mechnics:Cengel and Cimbala, TMH Publication

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	COURSE TITLE	L	T	P	C	QP
	DYNAMICS OF MACHINERY LABORATORY	0	0	2	1	

Pre -Requisite: Theory of Machines

Course Educational Objectives

CEO1	Understand the principles of dynamics applied in Theory of machinery
CEO2	To verify the gyroscopic principle under dynamic loadings.
CEO3	To conduct experimentation to find the damping co-efficient for natural and forced frequencies.
CEO4	To analyze the static and dynamic balancing of different components.

Course Outcomes: Upon successful completion of this course, students should be

CO1	Define the gyroscopic effects in ships, aero planes and road vehicles
CO2	Analyze and design centrifugal governors.
CO3	Analyze balancing forces in rotating and reciprocating machine components.
CO4	Determine co-efficient of damping for free and forced vibrations of single degree freedom systems.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1			2						1				
CO2	1	2		2						2				
CO3	1			3						2				
CO4	1			3						2				
Avg	1	0.5		2.5						1.75				

LIST OF EXPERIMENTS

List of Experiment: (Minimum 8 Experiments)

1. Design of any one working model related to Mechanisms and Machines i.e., Module I and II.
2. Design of any one working model related to Mechanisms and Machines i.e., Module III and IV.
3. Determination of gyroscopic couple using gyroscopic test rig.
4. Performance characteristics of a spring loaded governor
5. Determination of critical speed of rotating shaft
6. Experiment on static and dynamic balancing apparatus
7. Determination of natural frequencies of un-damped as well as damped vibrating systems.
8. Study of interference and undercutting for gear drives
9. Experiment on Cam Analysis Apparatus.
10. Experiment on evaluation of damping in a vibrating system

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT	COURSE TITLE	L	T	P	C	QP
	MANUFACTURING SCIENCE -II LABORATORY	0	0	2	1	

Pre -Requisite: Engineering Workshop, Mathematics

Course Educational Objectives

CEO1	To provide the student with personal, hands-on experience in the operation of standard machine tools
CEO2	To provide to the students an understanding and appreciation of the abrasive metal cutting processes.
CEO3	To provide a proper insight about the importance of lubrication and wear problems.
CEO4	To provide the students with a proper understanding of nontraditional machining processes.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Classify the basic principle and techniques of lathe, shaper and planner, drilling, milling and grinding machines.
CO2	Evaluate different cutting force acts during machining by lathe tool dynamometer
CO3	Define the concept and applications of modern machining processes.
CO4	Develop the design of job with proper dimension using CNC Lathe and milling.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	1			2						1				
CO2	1			2						2				
CO3	1			2						2				
CO4	1			3						2				
Avg	1			2.25						1.75				

LIST OF EXPERIMENTS

LIST OF EXPERIMENTS: (Minimum 7 experiments)

1. Job on lathe with taper turning, thread cutting, knurling and groove cutting
2. Gear cutting (with index head) on milling machine
3. Working with shaper, Planner and slotting machine.
4. Working with surface and cylindrical grinding.
5. Determination of cutting force using Lathe tool dynamometer.
6. Determination of cutting force in drilling using drill tool dynamometer.
7. Study of Non-traditional machining processes.(USM, AJM, EDM, ECM)
8. Study of CNC Lathe and demonstration of making job in CNC lathe.
9. Study of CNC Milling machine and demonstration of making job in CNC Milling machine.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

COURSE CODE	COURSE TITLE	L	T	P	C	QP
	INTERNAL COMBUSTION ENGINES LABORATORY	0	0	2	1	

Pre -Requisite: Basic Knowledge of Thermodynamic cycle and Mathematics

Course Educational Objectives

CEO1	Understand thermodynamic cycle, valve timing diagram, function of different components and its working principle.
CEO2	Understand the mechanism of carburetion, injection and know the working principle of carburetor, injector, fuel pump, air filter.
CEO3	Understand different types of cooling system, lubrication, analysis of exhaust gas emission.
CEO4	Understand load test analysis, performance analysis of single cylinder/ multi cylinder SI and CI engine.

Course Outcomes: Upon successful completion of this course, students should be

CO1	Classify the concept of valve timing diagram of both SI and CI engine.
CO2	Develop the concept of carburetion, atomization, spray formation and injection technique.
CO3	Compare lubrication and cooling phenomena related to SI and CI engines and factor influencing them.
CO4	Measure load test analysis and prepare heat balance sheet on four stroke multi cylinder SI and CI engine.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2			2										2
CO2	1			3										2
CO3	1			2										2
CO4	1			2										2
Avg	1.25			2.25										2

LIST OF EXPERIMENTS

List of Experiment: (Minimum 8 Experiments)

1. Valve timing diagram of an IC engine
2. Study of a modern carburetor (e.g. Solex Carburetor)
3. Study of fuel injection system of a diesel engine
4. Analysis of exhaust gas of automobile (Orsat apparatus)
5. Study of different cooling systems in automobiles (Air cooling and water cooling).
6. Study of lubrication systems in automobiles.
7. Load test on 4-stroke single cylinder C.I. engine.
8. Load test on 4-stroke single cylinder S.I. engine.
9. Morse Test on multi-cylinder S.I. or C.I. engine
10. Load test on variable compression ratio S.I. engine
11. Load test and Heat balance on 2 stroke S.I. Engine

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VI Semester [Third Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Core Courses	BPCME6010/ BPCME6110	Heat Transfer	4	0	2	5
2	Professional Core Courses	BPCME6020/ BPCME6120	Machine Design-II	4	0	2	5
3	Professional Core Courses	BPCME6030	Production And Operations Management	3	0	0	3
4	Professional Elective Courses	BPEME6040	Product Design & Product Tooling	3	0	0	3
		BPEME6041	CAD / CAM				
		BPEME6042	Fatigue, Creep and Fracture				
		BPEME6043	Refrigeration & Air Conditioning				
5	Professional Elective Courses	BPEME6050	Additive Manufacturing	3	0	0	3
		BPEME6051	Computational fluid Dynamics				
		BPEME6052	Vibrational and Structural Dynamics				
		BPEME6053	Hydraulics and Pneumatics				
6	Open Elective Courses	BOEME6060	Internet Of Things	3	0	0	3
		BOEME6061	Corrosion Engineering				
		BOEME6062	Renewable Energy Sources				
		BOEME6063	Industrial Instrumentation				
7	Project	BPCME6180	Mini Project	0	0	2	1
8	Engineering Courses	BMCHS6070	Dietetics and Nutrition	3	0	0	3
Total Credits:				23	0	6	26

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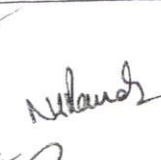
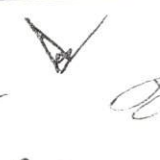
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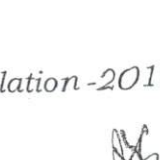
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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE		TITLE OF THE SUBJECT										L	T	P	C	QP
		HEAT TRANSFER										3	1	0	3	A
Pre -Requisite: Basics of thermodynamics, fluid mechanics																
Course Educational Objectives																
CEO1	To understand the basic concept of mode of heat transfer.															
CEO2	To analyze the 1D and 2D heat conduction in form transient and with heat generation mode.															
CEO3	To study the thermal boundary layer, during convective heat transfer over a pipe or flat surface.															
CEO4	To Understand the effect of radiative heat transfer.															
Course Outcomes: Upon successful completion of this course, students should be able to:																
CO1	Recall the thermodynamics correlations and understand the fundamental modes of heat transfer like conduction, convection and radiation.															
CO2	Evaluate the temperature distribution in steady state and unsteady state heat conduction.															
CO3	Interpret and analyze convective heat transfer by using empirical correlations of external and internal, forced and free convection.															
CO4	Design the heat exchanger with using LMTD and NTU methods.															
CO-PO & PSO Mapping																
COs	PROGRAMME OUTCOMES												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
CO1	3	2												2		
CO2	3	3												2		
CO3	3	3												2		
CO4	2	3	2											3		
Avg.	2.75	2.75	0.5											2.25		
SYLLABUS																
UNIT:1														[15 Hours]		
Introduction to heat transfer:																
Modes of heat transfer: conduction, convection, and radiation ,Mechanism & basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity, Thermal conductance &Thermal resistance, Contact resistance, convective heat transfer coefficient, radiation heat transfer coefficient , Electrical analogy, combined modes of heat transfer.																
Heat conduction:																
The General heat conduction in Cartesian, polar-cylindrical and polar-spherical co-ordinates, Simplification of the general equation for one and two dimensional steady/transient conduction with constant/ variable thermal conductivity with / without heat generation.																
Solution of the one dimensional steady state heat conduction problem in case of plane																






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walls, cylinders and spheres for simple and composite cases. Critical insulation thickness, Heat transfer in extended surfaces (pin fins) without heat generation, Long fin, short fin with insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and fin effectiveness.
Conduction in solids with negligible internal temperature gradient (Lumped heat analysis)

UNIT:2

[15 Hours]

Convective heat transfer: Introduction to convective flow - forced and free, Physical significance of Grashoff, Reynolds, Prandtl, Nusselt and Stanton numbers. Conservation equations for mass, momentum and energy for 2-dimensional convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Critical Reynolds number; general expressions for drag coefficient and drag force Reynolds-Colbourn analogy. Thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer Coefficient; Nusselt number. Use of empirical relations for solving turbulent conditions for external and internal flow. Mechanism of heat transfer during natural convection, Experimental heat transfer correlations for natural convection in the following cases (a) Vertical and horizontal plates

(b) Inside and outside flows in case of tubes

UNIT:3

[10 Hours]

Radiative heat exchange: Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity, reflectivity & transmissivity. Emissive power & emissivity, Kirchhoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Radiation shields.

UNIT:4

[8 Hours]

Heat Exchangers: Introduction, Types of heat exchanger, the overall heat transfer coefficient and fouling factors, LMTD and E-NTU analysis of heat exchangers.
Heat transfer for boiling liquids and condensing vapours: Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling. Numericals.

Teaching Methods: Chalk & Board

Text Books

1. Heat Transfer : R.K.Rajput, Laxmi Publications, 3RD EDITION.
2. Fundamentals of Engineering Heat and Mass Transfer: R.C.Sachdeva, New Age International, 2ND Edition.
3. Heat and Mass Transfer by Yonus A Cengel, TMH, 6TH Edition.

Ref. Books:

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DEPARTMENT OF MECHANICAL ENGINEERING

- 1 Heat Transfer: P.S.Ghosdastidar, Oxford University Press, 3RD EDITION
2. Heat Transfer by P.K. Nag, TMH 3RD EDITION.
3. Heat Transfer by S.P. Sukhatme, TMH, 3RD EDITION.
4. Heat Transfer Tenth Edition. J.P. Holman, 4TH EDITION.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	MACHINE DESIGN -II	3	0	0	3	A

Pre Requisite: Fundamentals in mathematics, Engg. Mechanics, TOM, MOS and Drawing.

Course Educational Objectives

CEO1	This course is intended to introduce the mechanical engineering students to the basic components of machinery, and how to select and size these components to achieve design goals in the construction of mechanical system
CEO2	To familiarize the various steps involved in the Design Process and to understand the principles involved in evaluating the shape and dimensions of a component
CEO3	To satisfy functional and strength requirements and learn to use standard practices and standard data of machine components.
CEO4	To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice and obtaining design solutions to open ended problems through a systematic design process

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Classify the types of Bearing, application and material of bearing.
CO2	Design the pressure vessels and belt drive.
CO3	Analyze the design of spring and gears.
CO4	Design of Flywheel and I.C engine Components.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1												1
CO2	1	3	2											1
CO3	2	1	3											1
CO4	1	2	3											
Avg.														

SYLLABUS

UNIT:1

BEARINGS: Classification of bearings applications, types of journal bearings - lubrication - bearing modulus - full and partial bearings - clearance ratio - heat dissipation of bearings, bearing materials - journal bearing design - ball and roller bearings - static loading of ball & roller bearings, bearing life.

[16 Hours]

UNIT:2

Design of Pressure vessels: Thin pressure vessels: cylindrical and spherical vessels, Design of end Closures, Thick cylindrical shells.

[12 Hours]

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

Design of belt drive : Design of belt drive and pulley.

UNIT:3

[12 Hours]

MECHANICAL SPRINGS: Stresses and deflections of helical springs – extension compression springs – springs for fatigue loading, energy storage capacity – helical torsion springs – co axial springs, leaf springs

Gears: Design of Spur, Helical, bevel and worm gears.

UNIT:4

(12 Hours)

Flywheel: Design of Flywheel.

Design of I.C. Engine components: Design of Cylinder, Piston, Connecting Rod, Crank Shaft.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill
2. Design of Machine Elements by C. S. Sharma and K. Purohit, PHI

Ref. Books

1. Mechanical Engineering Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH
2. Machine Design, P.Kanaiah, Sciotech Publications
3. Fundamentals of Machine Component Design by R.C.Juvinall and K.M.Marshek, John Wiley & Sons

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	Q P
	PRODUCTION AND OPERATION MANAGEMENT	3	0	0	3	A

Pre -Requisite:

Course Educational Objectives

CEO1	To educate basics of various Productions, operation and management system in various industry.
CEO2	To develop an idea of safe work system design and selection of appropriate method for a process.
CEO3	To build up an entrepreneurial skill through the topics like layout design, forecasting and inventory control.
CEO4	To impart current advanced trends of different industries.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Outline the concept of operation function, product design and process technology and correlate the factors affecting productivity of industries.
CO2	Apply different techniques for better work system design and to understand the concept of location and various forecasting technique.
CO3	To understand the concept of inventory control and analyze the data collected from different sections of organization for planning and control.
CO4	Illustrate the concept of Sequencing and Scheduling, Project Management and modern trends in manufacturing.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2												
CO2	1	2	2											
CO3	2	3	2											
CO4	1	3	2											
Avg.	1.5	2.5	1.5											

SYLLABUS

UNIT:1

Introduction: Operations Function in an Organization, Manufacturing VS Service Operations, System view of Operations; Designing Products and Processes: New Product Design- Product Life Cycle, Product Development Process, Process Technology: Project, Job shop, Batch, Assembly Line, Continuous Manufacturing; Concepts of productivity and concurrent engineering.
Work Study: Methods Study- Techniques of Analysis, recording, improvement and standardization; Work Measurement : Work Measurement Principles using Stopwatch Time Study, Predetermined Motion Time Standards and Work Sampling, Standard

[10 Hours]

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Time Estimation.

UNIT:2 [11 Hours]
Location and Layout: Factor Influencing Plant, Facility Location Procedure and Models: Qualitative Models, Breakeven Analysis, location Model, centroid method. Layout Types: Process Layout, Product Layout, Fixed Position Layout; Concept of GT. Forecasting: Principles and Method, Moving Average, weighted Moving Average, Exponential Smoothing, Linear regression, Delphi method, Forecasting Error.

UNIT:3 [10Hours]
Inventory Control: Relevant Costs, Basic EOQ Model, Model with Quantity discount, Economic Batch Quantity, Periodic and Continuous Review Systems, Safety Stock, Reorder Point and Order Quantity Calculations. ABC Analysis.

Manufacturing Planning and Control: The Framework and Components: Aggregate Planning, Master Production Scheduling, Rough-cut-Capacity Planning, Material Requirements Planning, Capacity Requirements Planning.

UNIT:4 [14 Hours]
Sequencing and Scheduling: Single Machine Sequencing: Basics and Performance Evaluation Criteria, Methods for Minimizing Mean Flow Time, Flowshop sequencing: 2 and 3 machines cases: Johnson's Rule, CDS heuristic and Jobshop Scheduling: Priority dispatching Rules.
Project Management: Introduction, phases, guidelines for network construction; Critical Path Method (CPM), project evaluation and review technique (PERT), Crashing of project network.
Modern Trends in Manufacturing: Just in Time (JIT) System, FMS, Total Quality Management, Total Productive Maintenance, Lean Manufacturing, Supply Chain Management, and ERP.

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Ref. Books:

1. S.N.Chary, "Production and Operations Management", Tata McGraw Hill.
2. R. Paneerselvam, "Production and Operations Management, Prentice Hall of India.
3. Aswathappa & Bhatt - Production & Operations Management, HPH.
4. Gaither & Frazier - Operations Management, Cengage Publication
5. Russell & Taylor - Operations Management, PHI Publication
6. Chase, Aquilanno, Jacob & Agarwal - Operations Management, TMH Publication.
7. E.E. Adam and R.J. Ebert "Production and Operations Management", Prentice Hall of India
8. Buffa ES, Sarin RK. Modern Production: Operations Management, John Wiley and Sons Ltd.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT											L	T	P	C	QP
	PRODUCT DESIGN & PRODUCT TOOLING											3	0	0	3	A
Pre -Requisite: Basic Manufacturing, Manufacturing science Technology, Project Management																
Course Educational Objectives																
CEO1	To study the basic concepts of product design and development process.															
CEO2	To study the applicability of product design and development in industrial applications.															
CEO3	To design dies for different forging operation and sheet metal working.															
CEO4	To study various locating and clamping methods as well as design jigs and fixtures															
Course Outcomes: Upon successful completion of this course, students should be able to:																
CO1	Interpret the concept of product design and product development.															
CO2	Apply principles of locating and clamping systems for designing jigs and fixtures.															
CO3	Select and design forging dies as well as progressive, compound or combination dies for sheet metal workings.															
CO4	Design Single point cutting tool, form tools and tooling for turret lathe and automats															
CO-PO & PSO Mapping																
COs	PROGRAMME OUTCOMES												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2		
CO1	2	1	3													
CO2	1	1	2													
CO3	1	2	3											1		
CO4	1	2	3											0.5		
Avg.	1.25	1.5	2.75													
SYLLABUS																
UNIT:1 [12 Hours]																
Product design, product design considerations, product development, product life cycle, value analysis and value engineering, product specification. Role of computer in product design. Process Planning – selection of processes, Design of sequence of operations, Time & cost estimation																
UNIT:2 [14 Hours]																
Forging design: allowances, die design for drop forging, upset forging die design, design of flash and gutter. Sheet metal working: Design consideration for shearing, blanking																

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piercing, deep drawing operation, progressive and compound die, strippers , stops, strip layout.

UNIT:3

[10 Hours]

Design of jigs and fixtures, principle of location and clamping, clamping methods, locating methods, Drill Jig bushing, Indexing type drilling Jig.

UNIT:4

[10 Hours]

Design of single point cutting tool, broach and form tool design. Tooling design for turret lathe and automats

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Guest Lecture

Text Books:

1. Manufacturing Technology, P.N. Rao , Tata McGraw Hill
2. A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co

Ref. Books:

1. Product Design & Manufacturing, A K Chitale, R C Gupta, Eastern Economy Edition, PHI.
2. Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill
3. Jigs & Fixture Design, Edwrd G Hoffman, Cengae Learning

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	REFRIGERATION AND AIR CONDITIONING	3	0	0	3	A

Pre -Requisite: Basic of thermodynamics, Heat transfer

Course Educational Objectives

CEO1	Explain how thermodynamic principles are applied within the refrigeration and Air conditioning, methods of lowering the temperature in single compression system.
CEO2	Summarize about various system components and accessories of air-craft refrigeration system, VCRS, VARS and different air-conditioning system.
CEO3	Apply knowledge of principles of producing low temperatures by using multi compressor, multi-evaporator systems and cascade systems.
CEO4	Illustrate the different types and classification of refrigerant with its properties, To carry-out cooling load calculations for different applications.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Recall the basic principle of thermodynamics and understand various refrigeration systems like air refrigeration, vapor compression and absorption refrigeration etc.
CO2	Evaluate and explain various terminologies involved in psychometric process.
CO3	Estimate cooling load calculations for various air-conditioning systems.
CO4	Design human comfort air conditioning systems related to cooling load estimations.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2						3						
CO2	2	3												
CO3	2	3												
CO4	2	2	3											
Avg.	2.25	2.25	0.75					0.75						

SYLLABUS

UNIT:1

[12 Hours]

Air Refrigeration System: Introduction, Unit of refrigeration, Coefficient of performance, Reversed Carnot Cycle, Temperature limitations, maximum COP, Bell Coleman air cycle, Simple Air Cycle System for Air-craft with problems.
Vapour Compression System: Analysis of theoretical vapour compression cycle, Representation of cycle on T - S and p - h diagram, Simple saturation cycle, sub-cooled cycle and super-heated cycle, Effect of suction and discharge pressure on performance, Actual vapour compression cycle. Problem illustration and solution

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UNIT:2

[10 Hours]

Multi-stage compression and Multi-evaporator systems: Different arrangements of compressors and inter-cooling, Multistage compression with inter-cooling, Multi-evaporator system, Dual compression system. Simple problems

UNIT:3

[10 Hours]

Vapour Absorption System: Simple Ammonia - absorption system, Improved absorption system, Electrolux/Three fluid system, Lithium-bromide-water vapour absorption system, comparison of absorption system with vapour compression system. Simple Problems and solution. Thermoelectric Refrigeration, Magnetic Refrigeration.

Refrigerants: Classification of refrigerants and its designation - Halocarbon (compounds, Hydrocarbons, Inorganic compounds, Azeotropes, Properties of refrigerants, comparison of common refrigerants, uses of important refrigerants, Brines. Alternative refrigerants (Organic and inorganic compounds).

UNIT:4

[13 Hours]

Psychrometrics: Properties of air-vapour mixture, Law of water vapour-air mixture, Enthalpy of moisture, Psychrometric chart, simple heating and cooling, Humidification, De-humidification, Mixture of air streams. Review question and discussions.

Requirements of comfort air conditioning: Oxygen supply, Heat removal, moisture removal, air motion, purity of air, Thermodynamics of human body, comfort and comfort chart.

Teaching Methods: Chalk& Board/ PPT/Video Lectures

Text Books:

1. Refrigeration and Air Conditioning by R.S. Khurmi, 3rd edition
2. Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpat Rai & Sons, 4th edition.

Ref. Books:

1. Refrigeration and Air conditioning by P.L. Balloney, Khanna Publishers, 3rd edition.
2. Refrigeration and Air conditioning by C.P. Arora, Tata McGraw Hill, 4th edition.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	FATIGUE, CREEP & FRACTURE	3	0	0	3	A

Pre -Requisite:

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Be familiar with the fatigue development and Influence of stress concentration under fatigue strength.
CO2	Understand and able to analyze Mechanism of creep and it effects in design components.
CO3	Interface various modes of fracture under different Theories.
CO4	Ability to conduct an experimental analysis on different materials subjected to creep, fatigue and fracture mechanisms.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3												
CO2	3	3												
CO3	2	2												
CO4	2	2												
Avg.	2.5	2.5												

SYLLABUS

UNIT:1	(12 Hours)
Fatigue: Types of fatigue loading and failure, Fatigue test, endurance limit; Fatigue under combine stresses; Influence of stress concentration on fatigue strength, Notch sensitivity, Factors influencing fatigue behaviour.	
UNIT:2	(10 Hours)
Phase in fatigue life – Crack initiation – Crack growth – Final fracture – Dislocations – Fatigue fracture surfaces.	
UNIT:3	(12 Hours)
Creep: Creep-stress-time temperature relations, Mechanics of creep in tension, bending, torsion, creep buckling. Members subjected to creep and combined stresses.	
UNIT:4	(12 Hours)
Fracture: Basic modes of fracture, Griffith of brittle fracture, Irwin's theory of fracture inelastic-plastic materials. Theories of linear elastic fracture mechanics, stress intensity factors, fracture toughness testing.	

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Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert.

Text Books

1. . Mechanical Metallurgy - G. E. Dieter, Mc-Graw Hill Book Co., 2017.
2. Mechanical Behaviour of Engineering Materials - Joseph Marin, PHI.
3. Fatigue Testing and Analysis - Y. Lee, J.Pam, R.B. Hathaway & M.E. Barkey Elsevier Press,
4. Engineering Fracture Mechanics - S. A. Meguid, Elsevier Press, 2004.

Ref. Books

1. Strength and Resistance of Metals - J. M. Lessels, John Wiley and Sons, Inc..
2. Mechanical Behaviour of Materials - N. E. Dowling, PHI, 2018.
3. Introduction to Fracture Mechanics - Kare Hellan, Mc-Graw Hill Book Co., 2005.
4. The Practical Use of Fracture Mechanics - David Broek, MN Publishers, 2015.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT										L	T	P	C	Q P
	CAD / CAM										3	0	0	3	A
Pre -Requisite :Design and Drafting, Simulation															
Course Educational Objectives															
CEO1	To understand the Design process, Creating the Manufacturing Database.														
CEO2	To develop the Configuration, Graphics Packages, Database structure and content, Wire frame and solid modeling.														
CEO3	Classify Manual and Computer Aided programming, studying Problems with conventional NC, NC technology: CNC, DNC, Combined DNC/ CNC system.														
CEO4	To learn the Data exchange formats, Finite element analysis, Rapid prototyping.														
Course Outcomes: Upon successful completion of this course, students should be able to:															
CO1	Understand the basic fundamentals of computer aided design and manufacturing and to learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc.														
CO2	Categorize different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc.														
CO3	Explain the part programming, importance of group technology; computer aided process planning, computer aided quality control.														
CO4	Compile the overall configuration and elements of computer integrated manufacturing systems.														
CO-PO & PSO Mapping															
COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	3	2													
CO2	2	2													
CO3	3	1													
CO4	2	2													
Avg.	2.5	1.75													
SYLLABUS															
UNIT:1 (14 Hours) Fundamentals of CAD: Design process, Applications of computer for design, Creating the Manufacturing Database, The Design workstation, Graphical Terminal, Operator input Devices, Plotters and other devices, Central Processing Unit, Memory types															
UNIT:2 (14 Hours) Computer graphics Software and Database: Configuration, Graphics Packages,															

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Constructing the Geometry, Transformations of geometry, Database structure and content, Wire frame versus solid modeling, Constraint- Based modeling, Geometric commands, Display control commands, Editing

UNIT:3

(14 Hours)

CAM - Numerical Control and NC Part Programming: Numerical Control, Numerical Control elements, NC Coordinate system, NC motion control system, Manual and Computer Aided programming, the APT language, Miscellaneous Functions, M, Advanced part-programming methods. Problems with conventional NC, NC technology: CNC, DNC, Combined DNC/ CNC system, Adaptive control manufacturing systems, Computer Integrated Manufacturing system, Machine Tools and related equipment, Materials Handling system: AGV, Robots, Lean manufacturing.

UNIT:4

(10 Hours)

Data Exchange Formats and Applications: Data exchange formats, Finite element analysis, Rapid prototyping. Robotics: Anatomy & configuration of robot, Characteristics of robots, Grippers, Application of robots in manufacturing, Robot programming. Group Technology: Introduction to Group technology,

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Guest Lectures

Text Books

1. CAD/CAM Computer Aided Design and Manufacturing, M.P.Goover and E.W.Zimmers, Jr., Pearson.
2. CAD & CAM, J Srinivas, Oxford University Press

Ref. Books

1. CAD/CAM Theory and Practice, Zeid and Subramanian, TMH
2. CAD/CAM Principles, Practice and Manufacturing Management, McMahon and Browne, Pearson Education
3. CAD/CAM Concepts and Applications, C.R.Alavala, PHI

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3	A

Pre -Requisite: Fluid Mechanics, Heat transfer, Finite element methods

Course Educational Objectives

CEO1	To introduce the basics of CFD through FVM, FDM and FEM to students
CEO2	To teach different discretization scheme to formulate the governing equations.
CEO3	To make the students understand about fluid flow problem through numerical method (staggering and discretization method).
CEO4	To make the students familiar with transient heat transfer problems through finite volume method

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Develop mathematical models for solving fluid flow problems, through one dimensional geometry.
CO2	Analyze the behavior of fluid flow through discretization using, finite volume method.
CO3	Illustrate and Solve the unsteady heat conduction examples using finite volume method.
CO4	Evaluate the transient convection -diffusion problems using different discretization scheme.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3		2										
CO2	3	2		2										
CO3	2	3		2										
CO4	2	3		2										
Avg.	2.5	2.75		2										

SYLLABUS

UNIT:1

Basics of Computational Fluid Dynamics (CFD)- Introduction to One dimensional computation: Finite difference methods (FDM)-Finite element method(FEM)-Finite volume method(FVM). Solution of Discretised Equations:
The tri-diagonal matrix algorithm (Thomas Algorithm for one dimensional case) The Finite Volume Method for Diffusion Problems-Introduction -Finite volume method for onedimensional steady state diffusion -Worked examples: one-dimensional steady state Diffusion

[12 Hours]

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UNIT:2 [12 Hours]
The Finite Volume Method for Convection-Diffusion Problems - Introduction - Steady onedimensional convection and diffusion - The central differencing scheme - Assessment of the central differencing scheme for convection-diffusion problems - The upwind differencing scheme - Assessment of the upwind differencing scheme - The hybrid differencing scheme - Assessment of the hybrid differencing scheme - The power-law scheme - Higher order differencing schemes for convection-diffusion problems - Quadratic upwind differencing scheme: the QUICK scheme.

UNIT:3 [10 Hours]
The Finite Volume Method for Unsteady Flows - Introduction - One-dimensional unsteady heat conduction - Explicit scheme - Crank-Nicolson scheme - The fully implicit scheme - Illustrative examples

UNIT:4 [10 Hours]
Implicit method for two- and three-dimensional problems - Discretisation of transient convection-diffusion equation - Worked example of transient convection-diffusion using QUICK differencing..

Teaching Methods: Chalk& Board/Video Lectures

Text Books

1. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis, ISBN-10
2. John C. Tannehill, Dale A. Anderson and Richard H. Fletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis
3. Versteeg, H. K., Malalasekera W, An Introduction to Computational Fluid Dynamics- The Finite Volume Method, Longman Scientific & Technical.

Ref. Books:

1. Jr. D. A. Anderson, Computational Fluid Mechanics and Heat Transfer by McGraw-Hill Education
2. Muralidhar, K. and Sundararajan, T., Computational Fluid Flow and Heat Transfer,

Norosa Publishing House, N. Delhi

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	ADDITIVE MANUFACTURING	3	0	0	3	A

Pre -Requisite: Basic of Manufacturing processes

Course Educational Objectives

CEO1	To teach how to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies, such as traditional machining
CEO2	To make the students learn the manufacturing of highly complex parts can be an economically viable alternative to conventional manufacturing technologies
CEO3	To teach type of material used, the deposition technique or by the way the material is fused or solidified
CEO4	To expose the students to the mathematical models for AM to describe the transport phenomena such as heat/mass transfer and fluid flow

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Explain the importance of AM in Manufacturing
CO2	Able to compare different method and discuss the effects of the Additive Manufacturing technologies
CO3	Analyze the characteristics of the different materials in Additive Manufacturing for social applications
CO4	Elaborate to design a component with Additive Manufacturing technique in the application of Automobile, Aerospace, and Bio-medical etc as well optimize material utilization and elevate the performance.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													
CO2	2													
CO3	2	3				2								
CO4	3		2			2								
Avg.	2.5	0.75	0.5			1								

SYLLABUS

UNIT:1 (12 Hours)
Overview – History - Need-Classification -Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology – Tooling - Applications

UNIT:2 (12 Hours)
Basic Concept – Digitization techniques – Model Reconstruction – Data Processing for Additive Manufacturing Technology: CAD model preparation – Part Orientation and support generation – Model Slicing –Tool path Generation – Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.

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UNIT:3 (10 Hours)

LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS

Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system –Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing

UNIT:4 (11 Hours)

POWDER BASED ADDITIVE MANUFACTURING SYSTEMS

Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications- Laser Engineered Net Shaping (LENS), Electron Beam Melting

Teaching Methods: Chalk & Talk/ PPT/Video Lectures/Lecture by Industry Expert.

Text Books

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.

Ref. Books

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	VIBRATION AND STRUCTURAL DYNAMICS	3	0	0	3	A

Pre -Requisite: DOF, SHM, Laplace Transformation

Course Educational Objectives

CEO1	To teach the importance of vibrations in mechanical design of machine parts that operates in vibratory conditions.
CEO2	To teach linear vibratory models of dynamic systems with changing complexities (S-DOF and M-DOF).
CEO3	To derive the differential equation of motion of vibratory systems.
CEO4	To train the students to analyze on free and forced (harmonic, periodic, non-periodic) vibration system of single and multi degree of freedom linear systems.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Identify the causes and effects of vibration in mechanical systems.
CO2	Develop schematic models for physical systems and formulate governing equations of motion.
CO3	Explain the role of damping, stiffness and inertia in mechanical systems.
CO4	Analyze rotating and reciprocating systems and compute critical speeds.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	3												2
CO2	3	1	2		1									1
CO3	2	1												2
CO4	1	2												1.25
Avg.	2	1.75	0.5		0.25									

SYLLABUS

UNIT:1 (10 Hours)
Introduction to Mechanical Vibration, Types of Vibration, Simple Harmonic Motion (S.H.M.), Principle of superposition applied to S.H.M., Beats, Fourier analysis, Degree of freedom, Equations of motions, general solution of free vibration.
Undamped free vibration of single degree freedom systems: Modeling of Vibrating Systems, Evaluation of natural frequency – differential equation, Equivalent systems.

UNIT:2 (14 Hours)
Damped free vibration of single degree freedom systems, Different types of damping, Equivalent viscous damping and Structural damping. Study of vibration response of viscous damped systems for cases of under damping, critical damping and over damping, Logarithmic decrement.

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Forced vibration of single degree freedom systems, Steady state solution with viscous damping due to harmonic force, reciprocating and rotating unbalance mass, vibration isolation and transmissibility due to harmonic force excitation and support motion.

UNIT:3 (10 Hours)
Vibration measuring instruments, Concept of critical speed and its effect on the rotating shaft.

Undamped vibration of two degree freedom systems, Free vibration of spring coupled and mass coupled systems, Longitudinal, Torsional and transverse vibration of two degree freedom systems, influence coefficient technique

UNIT:4 (12 Hours)
Transverse vibration of strings, longitudinal vibrations of bars, Lateral vibration of beams, Torsional vibration of circular shafts, whirling of shafts.
Introduction, Method of Laplace transformation and response to an impulsive output, response to step-input, pulse-input, and phase plane method

Teaching Methods: Chalk & Board

Text Books:

1. Mechanical Vibrations: V.P. Singh, Dhanpat Rai & company Pvt. Ltd. 3 rd ed., 2006
2. Introductory Course on theory and Practice of Mechanical Vibrations. J.S. Rao & K. Gupta, New Age International Publication, New Delhi, 2007

Ref. Books:

1. Mechanical vibration - By G.K. Grover; Nemchand Chand and Sons
2. Mechanical Vibration - By Thomson; Prentice Hall
3. Mechanical Vibration - By Den Hartog; Mc Graw Hill

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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	HYDRAULICS & PNEUMATICS	3	0	0	3	A

Pre -Requisite: Engineering Thermodynamics, Fluid Mechanics

Course Educational Objectives

CEO1	Students will able to Identify hydraulic and pneumatic components used in a real application
CEO2	Students will able to Summarize the features and functions of Hydraulic motors, actuators and Flow control valves
CEO3	Students will able to Explain the working of different pneumatic circuits and systems
CEO4	Students will able to design hydraulic and pneumatic circuits.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand the Fluid power and operation of different types of pumps, Hydraulic circuits and systems.
CO2	Summarize the features and functions of Hydraulic motors, actuators and Flow control valves.
CO3	Elaborate the working of different pneumatic circuits and systems.
CO4	Design the various trouble shooting methods and applications of hydraulic and pneumatic systems.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	2											
CO2	2	3	2											
CO3	2	3	2											
CO4	2	3	2											
Avg.	2.25	3	2											

SYLLABUS

Unit-1: Introduction to Hydraulic Power:

(14 hours)

Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law. The source of Hydraulic Power: Pumps Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps.

Hydraulic Actuators and Motors Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of

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Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors).

Unit-2: Control Components in Hydraulic Systems

(12 hours)

Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types.

Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. Maintenance of Hydraulic System Hydraulic Oils - Desirable properties, general type of Fluids, Sealing Devices, Reservoir System, Filters and Strainers, wear of Moving Parts due to solid -particle Contamination, temperature control (heat exchangers), Pressure switches, trouble shooting.

Unit-3: Introduction to Pneumatic Control Pneumatic Actuators:

(10 hours)

Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit. Pneumatic Actuators: Linear cylinder - Types, Conventional type of cylinder- working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols.

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. Simple Pneumatic Control direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling. Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications.

Unit-4

(10 hours)

Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams. Signal elimination methods, Cascading method- principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves). Electro- Pneumatic Control: Principles - signal input and output, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application. Compressed Air: Production of compressed air- Compressors Preparation of compressed air-Driers, Filters, Regulators, Lubricators, Distribution of compressed air Piping layout.

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Teaching Methods: Chalk& Board/ Presentation/Video Lectures/Lecture by Industry Expert/Industrial tour

Text Books:

1. Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw- Hill, 2001.

Ref. Books:

1. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill, 2001
3. Majumdar, S.R., "Pneumatic Systems - Principles and Maintenance", Tata McGraw Hill, 2007.
4. Micheal J, Pinches and Ashby, J.G., "Power Hydraulics", Prentice Hall, 1989.
5. Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
6. Srinivasan. R, "Hydraulic and Pneumatic Control", IInd Edition, Tata McGraw - Hill Education,

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	COURSE TITLE	L	T	P	C	QP
	HEAT TRANSFER LABORATORY	0	0	2	1	

Pre -Requisite: Basics of Thermodynamics, Heat transfer

Course Educational Objectives

CEO1	To study the thermal boundary layer, during convective heat transfer over a pipe or flat surface.
CEO2	To experimentally measure the effectiveness of heat exchangers.
CEO3	To experimentally determine thermal conductivity and heat transfer coefficient through various materials.
CEO4	To study the thermal boundary layer, during convective heat transfer over a pipe or flat surface.

Course Outcomes: Upon successful completion of this course, students should be

CO1	Demonstrate and organize the thermal conductivity of composite slab by testing
CO2	Define and find the heat transfer coefficient in natural/forced convection by a particular equipment
CO3	Relate the performance of heat exchanger types of parallel flow and counter flow
CO4	Explain and Interpret the effectiveness of natural and forced convection through fins, the advantage of fins in heat transfer

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2		3						2				2
CO2	3	2		2						2				2
CO3	3	2		2						2				2
CO4	2	2		2						2				2
Avg	2.75	2		2.25						2				2

LIST OF EXPERIMENTS

List of Experiment: (Minimum 6 Experiments)

1. Determination of Thermal conductivity of composite slab
2. Determination of heat transfer coefficient in natural or forced convection.
3. Determination of surface emissivity
4. Performance test on parallel flow and counter flow heat exchanger
5. Determination the efficiency and effectiveness of fins by natural convection.
6. Determination of Fin Efficiency and Effectiveness by forced convection.
7. Determination of Critical heat flux during boiling heat transfer.
8. Verification of Stefan Boltzman's law.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT	COURSE TITLE	L	T	P	C	QP
	MACHINE DESIGN -II LAB	0	0	2	1	

Pre -Requisite: None

Course Educational Objectives

CEO1	To draft and capture for theories of failure for a system.
CEO2	To familiar with mechanism and application of clutches through design and drafting.
CEO	To understand the effect of inertia by design and drafting piston and
CEO4	To explain the importance of gears through design of straight and helical gear.

Course Outcomes: Upon successful completion of this course, students should be

CO1	Build the knowledge on basic machine elements used in machine design
CO2	Judge and quantify failure of pressure vessels.
CO3	Analyze the stress and strain on mechanical components.
CO4	Apply the techniques, skills necessary for engineering practice

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1		2	2							1				
CO2		2	2							2			2	
CO3		2	3							2			2	
CO4		2		1						2			1	
Avg		2	1.75	0.25						1.75			1.25	

LIST OF EXPERIMENTS

List of Experiment: (Minimum 6 Experiments)

1. Design of thin/ thick cylindrical shells under internal fluid pressure
2. Design of lever
3. Design of Journal Bearing
4. Design of straight/ helical gears
5. Design of piston
6. Design of connecting rod
7. Design of crank shaft
8. Design of fly wheel

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VII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses	BPEME7011	Advanced Welding Technology	3	0	0	3
		BPEME7012	Gas Dynamics and Jet Propulsion				
		BPEME7013	Finite Element Method				
		BPEME7014	Tribology				
2	Professional Elective Courses	BPEME7021	Fire and Safety Engineering	3	0	0	3
		BPEME7022	Design and Analysis of Heat Exchanger				
		BPEME7023	Non-Destructive Evaluation and Testing				
		BPEME7024	Nano Science				
3	Open Elective Courses	BOEME7031	Intellectual Property Rights Industrial Robotics	3	0	0	3
		BOEME7032	Green Technology				
		BOEME7033	Industrial Robotics				
		BOEME7034	Industrial Automation & Control				
4	Humanities and Social Sciences including Management Courses	BHSMS7040	Entrepreneurship Development	2	0	0	2
		BHSMS7041	Engineering Economics and Costing				
		BHSMS7042	Marketing Management				
		BHSMS7043	Human Resource Management				
5	Project	BPCTP7170	Summer Industry Internship	-	-	2	1
6	Project	BPCTP7180	Project Work-I	0	0	8	4
Total Credits:				11	0	10	16

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	Q P
	FINITE ELEMENT METHODS	3	0	0	3	G

Pre -Requisite: Basic Mathematics, Mechanics of solid

Course Educational Objectives

CEO1	To teach the basic principles, design and modeling considerations in using finite element Method.
CEO2	Make the students to develop stiffness matrices for spring, truss, beam, plane stress problems and three dimensional problems.
CEO3	To teach the finite element method to solve structural, fluid flow and thermal problem.
CEO4	To teach the basics of FEM to solve various engineering problems.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Explain the application and characteristics of FEM for the elements such as bars, beams, plane, isoperimetric elements, and 3-D element.
CO2	Apply the concepts behind variational methods and weighted residual methods in FEM
CO3	Analyze the element characteristic equation procedure and generation of global stiffness equation will be applied.
CO4	Select the finite element method to solve problems involving axisymmetric solids subjected to axisymmetric loadings, fluid flow and heat conduction.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	2												
CO2	2	2												
CO3	3	2												
CO4	2	2												
Avg.	2.25	2												

SYLLABUS

UNIT:1 [06 Hours]
FEM fundamental concepts, Difference between classical method and FEM and FDM, Application of FEM, Advantages and limitation of FEM, Commercial softwares used for FEM. Preprocessing, processing and post processing.

UNIT:2 [08 Hours]
Variational principles, Rayleigh Ritz and Galerkin Methods, Elimination and penalty approaches, Finite Element Modeling of one dimensional problems. Finite Element Analysis of 2-D framed structures.

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UNIT:3	[13 Hours]
FEM formulation of 2-D and 3-D stress analysis problems. Jacobian matrix, Axisymmetric solids subjected to axisymmetric loadings. Two-dimensional isoparametric elements	
UNIT:4	[10 Hours]
Finite element modeling of fluid flow and heat conduction problems. Exposure to commercial FE codes in ANSYS	
Teaching Methods: Chalk & Board	
Text Books:	
1. Finite Elements in Engineering, T.R.Chandraputla and A.D.Belegundu, PHI.	
2. A First Course in the Finite Element Method, D.L.Logan, Cengage Learning	
Ref. Books:	
1. Introduction to Finite Element Method, J.N.Reddy, Tata McGraw Hill.	
2. The Finite Element Method in Engineering, S.S.Rao, Elsevier	
3. Fundamentals of Finite Element Analysis, David V. Hutton, Tata McGraw Hill.	

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DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	GAS DYNAMICS AND JET PROPULSION	3	0	0	3	A

Pre -Requisite: Thermodynamics ,fluid mechanics and Mathematics

Course Educational Objectives

CEO1	To teach gas turbine cycle (Brayton) and know the working principle of each component of gas turbine engine
CEO2	To make the students about the application of shaft power in gas dynamics , compressibility effects, normal shock wave and oblique shock wave
CEO3	To teach about the design of combustion chamber and performance characteristics curve
CEO4	To aware the students about the application of axial flow turbine ,turbojet, turbo prop, turbo fan, ram jet, pulse jet engine

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand the concept of Brayton cycle, compressors, one and three dimensional flow, combustion theory, turbo machines etc.
CO2	Solve problems on Brayton cycle, one /three dimensional flow, gas dynamics, combustion chamber, centrifugal and axial compressors/turbines.
CO3	Design and evaluate the performance of turbine blades, combustion chamber, turbine stages
CO4	Develop turbo machineries with high performance.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												2
CO2	3	3												2
CO3	3	2	3											2
CO4	3	2	3											2
Avg.	3	2.25	1.5											2

SYLLABUS

UNIT:1

[10 Hours]

Bray ton cycle, regeneration and reheating cycle analysis , Axial flow fans and compressors, Elementary theory, degree of reaction , three dimensional flow, simple design methods, blade design, calculation of stage performance, overall performance.

UNIT:2

[12 Hours]

Introduction of gas dynamics - Compressibility effect, steady state one dimensional compressible flow of a perfect gas in a duct, isentropic flow in a constant area duct with friction, normal shock waves, oblique shock wave, supersonic expansion and compression.

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UNIT:3	[10 Hours]
Combustion: Performance characteristics. Combustion system, Form of combustion, important factors affecting combustion chamber design, combustion processes, combustion chamber performance, practical problem	
UNIT:4	[14 Hours]
Axial flow turbines, construction of centrifugal and axial flow turbine, Analysis of Turbo Jet, Turbo Prop, Turbo Fan, Ram Jet, Pulse Jet Engine. Centrifugal fans Blowers and Compressors, Principle of operations, work done and pressure rise, slip factor, surging, chocking, Stalling	
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert	
Text Books:	
1. Rarefied Gas Dynamics: From Basic Concepts to Actual Calculations Volume 21 of Cambridge Texts in Applied Mathematics Rarefied Gas Dynamics: From Basic Concepts to Actual Calculations Carlo Cercignani, 4 TH EDITION	
2. Fundamentals of Gas Turbine by V.Ganeshan, Tata McGraw Hill, 3 RD EDITION	
3. Internal Combustion Engine, R K Rajput, Laxmi Publication, 3 RD EDITION	
Ref. Books:	
1. J.E Lee, Theory and design of stream and gas turbine, TMH Publication, 8 TH EDITION	
2. Gas Turbines, Cohen & Rogers, Longmans Green Publisher, 4 TH EDITION	

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DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	Q P
	ADVANCED WELDING TECHNOLOGY	3	0	0	3	A

Pre -Requisite: Basics of manufacturing process and materials.

Course Educational Objectives

CEO1	To impart knowledge regarding various advanced welding practices in industries
CEO2	To understand the various parameters and requirements for welding processes
CEO3	To apply the right kind of welding technique suitable for different materials
CEO4	To evaluate the characteristics and properties of various metals and the related chemical, physical and mechanical properties

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Relate the theoretical aspects of welding technology in depth.
CO2	Describe the basic metallurgy of the melted and heat-affected zone of a metal or alloy.
CO3	Select the suitable welding power sources and determine the mechanism of metal transfer in welding
CO4	Evaluate the basic principle of advanced welding techniques and the appropriate welding process for a particular application

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	1											3	
CO2	2	2												2
CO3	2	2												3
CO4	2	2												
Avg.	2.25	1.75											0.75	1.25

SYLLABUS

UNIT:1

[13 Hours]

WELDING ARC: Definition of Arc, Structure and characteristics, Arc efficiency, arc blow, Electrical Characteristics of arc, Types of Welding Arcs, mechanism of arc initiation and maintenance, role of electrode polarity on arc behavior and arc stability, analysis of the arc. Arc length regulation in mechanized welding processes.

WELDING METALLURGY: Introduction, Weld Metal Zone, Theory of solidification of metals and alloys, Homogeneous Nucleation, Heterogeneous Nucleation, Freezing of alloys, Epitaxial Solidification; Effect of Welding speed on Grain structure, Fusion boundary zone, Heat affected zone, Under bead zone, Grain Refined Zone, Partial transformed zone, Properties of HAZ.

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UNIT:2	[10 Hours]
WELDING POWER SOURCES: Requirement of an Arc welding power sources, basic characteristics of power sources for various arc welding processes, duty cycles, Selection of a static Volt-Ampere characteristic for a welding process, AC/DC welding power source, DC rectifiers thyristor controlled rectifiers, transistorized units, inverter systems, Mathematical Problems on Static volt ampere characteristics	
UNIT:3	[08 Hours]
COATED ELECTRODES: Electrode coatings, classification of coatings of electrodes for SMAW, SAW fluxes, role of flux ingredients and shielding gases, classification of solid and flux code wires. METAL TRANSFER & MELTING RATE: Mechanism and types of metal transfer, forces affecting metal transfer, modes of metal transfer, metal transfer in various welding processes, effective of polarity on metal transfer and melting rate	
UNIT:4	[13 Hours]
SOLID STATE WELDING: Theory and mechanism of solid state welding. Techniques and scope of friction welding, diffusion welding, cold pressure welding and ultrasonic welding. High energy rate welding. Analysis of the Process. WELDING TECHNIQUES: Technique, scope and application of the electron beam and laser welding processes. Under water welding-process & problem.	
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert	
Text Books: 1. R.S.Parmar, "Welding processes & Technology", Khanna Publishers. 2.S.V. Nandkarni, "Modern Arc Welding Technology", Oxford & IDH publishing Co	
Ref. Books: 1. L.M.Gourd, "Principles of Welding Technology", ELBS/ Edward Arnold. 2. Richard L. Little, "Welding & Welding Technology", Mc-Graw Hill. 3.Rossi, "Welding Technology", Mc-Graw Hill	

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	TRIBOLOGY	3	0	0	3	F

Pre -Requisite: Fluid mechanics

Course Educational Objectives

CEO1	To expose the student to different types of bearings, bearing materials,
CEO2	To understand friction characteristics and power losses in journal bearings.
CEO3	To learn theory and concepts about different types of lubrication.
CEO4	To learn concept of loss of materials on surfaces and its effects
CEO5	To design a tribological system with better efficiency

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Rephrase friction characteristics in the field of Tribology
CO2	Summarize about different theories of lubrication to reduce friction and wear
CO3	Analyze the tribological issues in the design of machine components and braking systems
CO4	Evaluate the design a tribological system and estimate optimal performance to develop technical project reports as well technical presentations.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1												
CO2	2	2												
CO3	2	3												
CO4		2	3											
Avg.	1.5	2	0.75											

SYLLABUS

UNIT:1

(12 Hours)

Introduction to Tribology and Factors influencing Tribological phenomena, Properties of materials relevant to friction and wear. Study of various parameters: Viscosity, flow of fluids, viscosity and its variation, absolute and kinematic viscosity, temperature variation, viscosity index, determination of viscosity, different viscometers used.

Hydrostatic lubrication: Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing

UNIT:2

(12 Hours)

Surfaces, Friction and Wear: Surfaces, Friction and Wear: Engineering surfaces - Surface characterization, Contact of engineering surfaces: Hertzian and nonhertzian contact, Contact pressure and deformation in non-conformal contacts. Causes of friction, Stick-slip friction behaviour and friction instability, sliding and rolling friction, frictional heating and temperature rise, Friction measurement techniques. Wear and

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wear types, Mechanisms of wear, Wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear measurement and controlling techniques.

UNIT:3

(8 Hours)

Lubrication: Hydrodynamic theory of lubrication: Various theories of lubrication, petroffs equation, Reynold's equation in two dimensions -Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro-dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl anti - friction bearing

UNIT:4

(8 Hours)

Design of Tribological Elements: Tribological consideration in design, Mechanisms of tribological failures in machines, Design Hydrodynamic bearings, and Performance analysis of gears, seals, piston rings, machine tool slide ways, cams and follower. Surface Engineering for Wear and Corrosion resistance: Diffusion, coating, electro and electro-less plating, hot deep coating, metal spraying, cladded coating, crystallizing coating, selection of coating for wear and corrosion resistance, potential properties and parameters of coating

Teaching Methods: Chalk& Talk/ PPT/Video Lectures/Lecture by Industry Expert

Text Books

1. Fundamentals of Tribology, Basu, SenGupta and Ahuja/PHI
2. Tribology in Industry : Sushil Kumar Srivatsava, S. Chand &Co

Ref. Books

1. Tribology – B.C. Majumdar, Tata McGraw Hill Co Ltd
2. Lubrication - Raymono O. Gunther; Bailey, Bros & Swinfan Ltd.
3. Bearing Systems - Principles and Practice, PT Barwill
4. Dowson D, History of Tribology, Longman London, 1979.
5. Stachowiak G N, Batchelor A W and Stachowick G B "Experimental methods in Tribology", Tribology Series 44, Editor D Dowson, 2004.

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	DESIGN AND ANALYSIS OF HEAT EXCHANGER	3	0	0	3	A

Pre -Requisite: Thermodynamics, Heat Transfer, Design of machine elements

Course Educational Objectives

CEO1	To know common heat exchanger types, their advantages and limitations.
CEO2	To learn how to handle rating and sizing problems in heat exchanger design
CEO3	To analyze various types of heat exchangers providing heat transfer between two or more fluids and acquiring necessary information for the design of heat exchangers.
CEO4	To examine how to consider fouling of surfaces, incorporate fouling in designs, and handle fouling during heat exchanger operation.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand different types of flow, heat exchanger & mechanism of heat exchange.
CO2	Analyze the effectiveness of LMTD approach over AMTD approach based on different factors.
CO3	Evaluate the effectiveness of different heat exchangers
CO4	Design and develop Heat Exchangers with different applications along with allied equipments.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1	2											1
CO2	2	3	2											
CO3	2	3	2											
CO4	2	2	2											2
Avg.	2	2.25	2											0.75

SYLLABUS

UNIT:1 (12 Hours)
Heat exchanger types, constructional details, Nature of heat exchange, Parallel flow, Counter flow, Cross flow, Concentric tube, Shell and tube, Multiple shell and tube, Compact heat exchanger, Condenser, Evaporator, Regenerator, Recuperator . Overall heat transfer coefficient, Thermal resistance, Efficiency. Temperature Distribution and its implications

UNIT:2 (12 Hours)
LMTD, effectiveness, Overall Heat transfer coefficients, Fouling factor, Scaling factor, Correction factor, NTU method, Flow Distribution, Friction Factor, Pressure Loss, Pumping power, Orifice, Flow nozzle, Diffusers, Bends, Baffles, Effect of Channel

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Divergence, Manifolds.
UNIT:3 (14 Hours) Heat exchanger fabrication, Tubular versus flat plate, Tube to header joint, Finned surface, Design of Liquid to Liquid heat exchanger, Plate and Frame heat exchanger, Design of Gas to Gas heat exchanger, Tubular regenerators for gas turbine, Regenerator for mobile gas turbine, Recuperators for heat pipe, Design of Liquid to gas heat exchanger, Comparison of fin geometric, Design of fin matrices, Design of automotive radiators.
UNIT:4 (10 Hours) Stress in tubes, Headers sets and Pressure vessels: Differential Thermal Expansion, Thermal stresses, Shear stresses, Thermal sleeves, Vibration, Noise, types of failures. Design Aspects: Heat transfer and pressure loss flow configuration effect of baffles. Effect of deviations from ideality. Design of cooling towers. Types of cooling tower, Wind loads, Dry cooling tower.
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Guest Lectures by Industry Expert & Academia
Text Books 1. Heat and Mass Transfer by P.K. Nag, TMH, 3rd Ed., 2. A.P. Frass and M.N.Ozisik, Heat Exchanger Design', John Wiley & Sons Inc, 1965.
Ref. Books 1. W.M. Kays and A.L. London. Compact Heat Exchangers', 3rd Ed., TMH, 1984. 2. G.Walker, Industrial Heat Exchangers', A basic guide, TMH V Book Co. 3rd Ed., 1980.

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	Q P
	FIRE AND SAFETY ENGINEERING	3	0	0	3	A

Pre -Requisite: Basics on Fire Safety

Course Educational Objectives

CEO1 Practice fire protection engineering technology regionally, nationally, and internationally in a broad range of modern professional settings.

CEO2 Actively participate in the development of engineering technology decisions on societal, environmental, economical, and safety issues at the local or global levels.

CEO3 Learn various uses of fire protective equipments in industries.

CEO4 Identify various risks and hazards to develop safe work systems.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1 Discuss fire dynamics, fire initiation, Combustion effects and classification of various fire fighting equipments.

CO2 Examine building regulations and fire engineering principles and their application to fire engineered alternative solutions.

CO3 Explain active and passive fire safety systems and their application.

CO4 Apply knowledge of the practical design process adopted by the industry

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2						2							1
CO2			2			2								
CO3	1					1								2
CO4			2				2							1
Avg.	0.75		1			0.75	1							1

SYLLABUS

UNIT1: [13 Hours]
Basic Physics and chemistry related to fire, Anatomy of Fire, Classification of Fire & Extinguishers, Pumps and primers, Foam and foam making equipments

UNIT 2 : [10 Hours]
Hose and hose fittings, Water relay systems, breathing apparatus, Small gears

UNIT3: [12 Hours]
Fire protective clothing, Ladders, Ropes and lines, bends & hitches, Fire prevention, Special appliances, Fire fighting codes and standards, Electrical fire hazards, Structures under Fire.

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UNIT 4:	[12 Hours]
Safety goals and objectives, Monitoring safety progress, Identifying hazards and risks, Safety and financial benefits, Safety and the balanced scorecard, Setting targets and ensuring commitment, Developing safe work systems, Policies and procedures, Safety values and Principles	
Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert	
Text Books:	
1. Principles of Fire Safety Engineering: Understanding Fire and Fire Protection: Akhil Kumar Das, PHI learning private limited 2014	
2. A Guide to Fire Safety Engineering: S. D. Christian, BSI British Standards Institution, 2010.	
Ref. Books:	
1. Fire from First Principles: A Design Guide to Building Fire Safety: John Abrahams, Dr Paul Stollard, Paul Stollard	
2. Fire Risk: Fire Safety Law and Its Practical Application: Allan Grice Thorogood Publishing, 2009.	

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	Q
BOEME7031	INTELLECTUAL PROPERTY RIGHTS	3	0	0	3	P
Pre -Requisite:						A

Course Educational Objectives

CEO1	Understand the basics of intellectual property, including copyrights, trademarks, patents, and trade secrets.
CEO2	Recognize the purpose, scope, and limitations of each type of intellectual property.
CEO3	Analyze national and international intellectual property laws and regulations.
CEO4	Evaluate the impact of intellectual property on innovation, creativity, and economic growth.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Gain a comprehensive understanding of intellectual property laws, including copyrights, trademarks, patents, and trade secrets.
CO2	Apply intellectual property concepts to analyze and evaluate real-world scenarios related to intellectual property rights.
CO3	Identify and assess potential infringement or violation of intellectual property rights, and propose appropriate legal measures for protection and enforcement.
CO4	Recognize the impact of intellectual property on innovation, creativity, and economic growth in various industries and sectors.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1								2				2		
CO2										2		3		
CO3								1		2				
CO4								2				2		
Avg.								1.66		2		2.33		

SYLLABUS

UNIT:1

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights. [10 Hours]

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting and evaluating trade mark, trade mark registration processes



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UNIT:2

[9 Hours]

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT:3

[9 Hours]

Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secret litigation.

Unfair competition: Misappropriation right of publicity, False advertising. .

UNIT:4

[10 Hours]

New development of intellectual property: New developments in trade mark law; copy right law, patent law, intellectual property audits.

International overview on intellectual property, international - trade mark law, copy right law, international patent law and international development in trade secrets law.

Teaching Methods: Chalk& Talk, Ppt ,video lecture.

Text Books:

1. Intellectual property right, Deborah, E. Bouchoux, Cengage learning.
2. Intellectual property right - Unleashing the knowledge economy, PrabuddhaGanguli, Tata Mc

Reference Book:

1. "Intellectual Property Law", Authors: Lionel Bently, Brad Sherman, and Dev S. Gangjee, Oxford University Press
2. "Global Intellectual Property Law", Authors: Graeme B. Dinwoodie and Rochelle C. Dreyfuss, Publisher: Edward Elgar Publishing

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	NON DESTRUCTIVE EVALUATION AND TESTING	3	0	0	3	A

Pre -Requisite: Machining Science Technology

Course Educational Objectives

CEO1	To provide students with a strong knowledge of terms, concepts, principles etc. involved in non-destructive testing.
CEO2	To provide practical training in handling and testing the non-destructive testing equipments.
CEO3	To develop knowledge and skills for interpretation and evaluation of the results.
CEO4	To offer environment to enhance team essential skills for effective careers in the inspection profession

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Understand the basic theory and principles of NDT methods.
CO2	Use of appropriate measurement techniques and tools to collect data.
CO3	Interpret the results and investigate the possible artifacts.
CO4	Show confidence to take responsibility for on the job training and guidance of trainees and NDT level I personnel.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2													1
CO2	1	2			2									1
CO3	2	2												1
CO4	1				2									2
Avg.	1.5	1			1									1.25

SYLLABUS

UNIT:1 Introduction to NDT, Comparison between destructive and NDT, [6 Hours]
Importance of NDT, Scope of NDT, difficulties of NDT, future progress in NDT, economics aspects of NDT.

Various physical characteristics of materials and their applications in NDT,
Visual inspection – tools, applications and limitations -Fundamentals of visual testing: vision, lighting, material attributes, environmental factors.

UNIT:2 [9 Hours]
Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, Developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials, Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism

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UNIT:3

[14 Hours]

Principles of MPI, basic physics of magnetism, permeability, flux density, cohesive force, Magnetizing force, retivity, residual magnetism, Methods of magnetization, magnetization techniques, Interpretation of MPI, indications, advantage and limitation of MPI. Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique -Principle, AE parameters, Applications

UNIT:4

[11 Hours]

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetra meters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

Teaching Methods: Chalk& Board/ PPT/Video Lectures/Lecture by Industry Expert

Text Books:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

Ref. Books:

1. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005
3. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	Q P
	NANO SCIENCE	3	0	0	3	A

Pre -Requisite: Engineering Physics, Engg. Chemistry, IPMEM.

Course Educational Objectives

CEO1	To learn the basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.
CEO2	To teach a knowledge on the state-of-the-art of nano-fabrication methods
CEO3	To know the fundamental principles of nanoscience and its application to engineering.
CEO4	To demonstrate the use of various testing tools that are used in production/synthesis and research/analysis of nano-structured materials.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Define the basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nano materials.
CO2	Demonstrate a comprehensive understanding of state-of-the-art on nano-fabrication methods.
CO3	Analyze the characterization of nano materials by using different testing tools.
CO4	Discuss various applications of Nano materials in societal field.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	2	1												
CO2	2	2												
CO3	2	2			1									
CO4	3						2							
Avg.	2.25	1.25			0.25		0.5							

SYLLABUS

UNIT:1

[9 Hours]

Introduction: History and Scope, Implications for Physics, Chemistry, Biology and Engineering , Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilm-multilayered materials, Applications of Nanomaterials.

Effect of Nano-dimensions on Materials Behavior: Mechanical properties, Melting Point, Diffusivity, Grain growth characteristics, Enhanced solid solubility, Optical, Magnetic Properties.

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UNIT:2	[12 Hours]
Synthesis Routes: Bottom up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol-gel method, Self assembly, Top down approaches: Mechanical alloying, Nano-lithography, Consolidation of Nanopowders: Shock wave consolidation, Hot isostatic pressing and Cold isostatic pressing Spark plasma sintering.	
UNIT:3	[12 Hours]
Tools to Characterize nanomaterials: X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunneling Microscope (STM), Field Ion Microscope (FEM). Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.	
UNIT:4	[12 Hours]
Applications of Nanomaterials: Information storage- nanocomputer, molecular switch, super chip, Nano-electronics, Micro- and Nano-electro-mechanical systems (MEMS/NEMS), Nanosensors, Nanocatalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water- Treatment and the environment, Textiles, Paints, Energy, Defence and Space Applications, Photostat, printing, solar cell, battery.	
Teaching Methods: Chalk& Talk, Ppt, video lecture.	
Text Books:	
1. Nano: The Essentials by T.Pradeep, Mc Graw- Hill Education. 2. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.	
Ref. Books:	
1. N John Dinardo, "Nanoscale charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000 2. Akhlesh Lakhtakia (Editor), "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, New Delhi, 2007. 3. Transport in Nano structures- David Ferry, Cambridge University press 2000.	

N. Pradeep

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

VIII Semester [Fourth Year]

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits
				L	T	P	
1	Professional Elective Courses	BPEME8011	Composite Materials	3	0	0	3
		BPEME8012	Power Plant Engineering				
		BPEME8013	Mechatronics				
		BPEME8014	Cryogenics				
2	Open Elective Courses	BOEME8021	Reverse Engineering	2	0	0	2
		BOEME8022	Artificial Intelligence And Expert Systems				
		BOEME8023	Disaster Management				
4	Project	BPCTP8180	Project Work-II &Dissertation	0	0	10	5
5	Project	BPCTP8170	Seminar and Comprehensive Viva-Voce	0	0	2	1
Total Credits:				5	0	12	11

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	COMPOSITE MATERIALS	3	0	0	3	A

Pre -Requisite: Introduction to Physical Metallurgy

Course Educational Objectives

CEO1	To teach basic concept of composites and their classification
CEO2	To extend a knowledge of applications and selection of different composites in consideration of the properties and characteristics to students
CEO3	To teach the manufacturing processes of reinforcement fibers and volume fraction effect on matrices of composites
CEO4	To teach the concept of tailored design philosophy

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Illustrate the concept of composite and Predict elastic properties of long fiber and short fiber composites.
CO2	Explain fundamental fabrication processes for polymer matrix, metal matrix, and ceramic matrix composites
CO3	Analyze the strengthening mechanism and structural effect on properties of composite materials for societal application
CO4	Design different types of composite by apply the micromechanics principles.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3												2	
CO2	2												3	
CO3	2					2							2	
CO4	1		3										1	
Avg.	2		0.75			0.5							2	

SYLLABUS

UNIT:1

[16 Hours]

Introduction: definitions and classifications; natural composites; role of matrix and reinforcement; factors which determine properties; the benefits of composites.

Reinforcements and the reinforcement matrix interface: natural fibers; synthetic organic fibers – aramid, polyethylene; and synthetic inorganic fibers – glass, alumina, boron, carbon, silicon based fibers; particulate and whisker reinforcements, reinforcement-matrix interface – wettability, interfacial bonding, and methods for measuring bond strength

UNIT:2

[12 Hours]

Metal matrix composites: Introduction, important metallic matrices; metal matrix composite processing: solid state processing – diffusion bonding, powder metallurgy; liquid state processing – melt stirring, compocasting (rheocasting), squeeze casting,

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liquid infiltration under gas pressure; deposition – spray co-deposition and other deposition techniques like CVD and PVD; in situ processes. Interface reactions. Properties of MMCs – physical properties; mechanical properties like elastic properties, room temperature strength and ductility, properties at elevated temperatures, fatigue resistance. Processing, structure of multi-filamentary superconductors, properties of aluminium reinforced with silicon carbide particles.

UNIT:3

[12 Hours]

Ceramic matrix composites: Introduction; processing and structure of monolithic materials – technical ceramics, glass-ceramics. Processing of ceramics: conventional mixing and pressing – cold pressing and sintering, hot pressing, reaction bonding processes, techniques involving slurries, liquid state processing – matrix transfer moulding, liquid infiltration, sol-gel processing, vapour deposition techniques like CVD, CVI, liquid phase sintering, lanxide process and in situ processes. Processing, properties and applications of alumina matrix composites – SiC whisker reinforced, zirconia toughened alumina; Glass-ceramic matrix composites; Carbon-carbon composites – porous carbon-

UNIT:4

[10 Hours]

Polymer matrix composites: Introduction; polymer matrices – thermosetting, thermoplastic, rubbers. Processing of PMCs, Processing, properties and applications of fibre-reinforced epoxies, PEEK matrix composites, rubber matrix composites. Damping characteristics. Environmental effects in polymer matrix composites. Recycling of PMCs. Micromechanics of unidirectional composites: micromechanics models for stiffness – longitudinal stiffness, transverse stiffness, shear modulus, poisson's ratio.

Teaching Methods: Chalk& Board

Text Books:

1. Composite Materials: Engineering and Science, by Matthews and Rawlings, CRC Press.
2. Composite Materials Science and Engineering, K.K.Chawla, SpringerAn Introduction to composite material, by D.Hull and T.W. Clyne, Cambridge University press.
3. Metal Matrix Composites, Thermomechanical Behaviour by M.Taya, and R.J.Arsenault, Pergamon Press, Oxford.
4. Fundamentals of Metal Matrix Composites by S.Suresh, A.Martensen, and A.Needleman, Butterworth, Heinemann

Ref. Books:

1. An Introduction to composite material, by D.Hull and T.W. Clyne, Cambridge University press.
2. Metal Matrix Composites, Thermomechanical Behaviour by M.Taya, and R.J.Arsenault, Pergamon Press, Oxford.
3. Fundamentals of Metal Matrix Composites by S.Suresh, A.Martensen, and A.Needleman, Butterworth, Heinemann

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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT										L	T	P	C	Q P
	POWER PLANT ENGINEERING										3	0	0	3	A
Pre -Requisite: Engineering Thermodynamics, Fluid Mechanics															
Course Educational Objectives															
CEO1	To teach principles of thermodynamics, fluid mechanics, and heat transfer to the design and analysis of thermo dynamical systems by considering the environmental issues														
CEO2	To make the student aware of the relevance of environmental different power plants														
CEO3	To teach about the power plant overall issues on practical field														
CEO4	To teach the concept of sources of energy and their optimum utilization														
Course Outcomes: Upon successful completion of this course, students should be able to:															
CO1	Understand and analyze the working principle of the components of nuclear, thermal and oil based power plant.														
CO2	Evaluate the performance of nozzle, turbines and economics of power plant.														
CO3	Apply safety measures and pollution control technologies to coal and nuclear power plant														
CO4	Compare and solve power tariffs and costs.														
CO-PO & PSO Mapping															
COs	PROGRAMME OUTCOMES												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1	3	3													
CO2	2	3													
CO3	2	3					3								
CO4	2	3													
Avg.	2.25	3					0.75								
SYLLABUS															
UNIT:1 [10 Hours]															
Introduction to power plants and boilers Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine Power Plants Combined Power cycles – comparison and selection , Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidised Bed Boilers Fuel and ash handling , Combustion Equipment for burning coal, Mechanical Stokers. Pulveriser, Electrostatic Precipitator, Draught-Different Types, Condenser types, cooling Towers															
UNIT:2 [14 Hours]															
Flow Through Nozzles Types of nozzles and their area of application & related calculation, critical pressure & Choked flow, super saturated flow. Effect of friction and nozzle efficiency Steam turbines Turbine types, Variation of Pressure and Velocity in different types of turbines, Simple impulse Turbines, Flow through turbine															

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blades and velocity diagram, Pressure -compounded impulse turbines and Velocity compounded impulse turbines. Turbine power and related calculations.

UNIT:3 [12 Hours]

Nuclear power plants Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors : Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants

UNIT:4 [10 Hours]

Energy, economic and environmental issues of power plants Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, relative merits & demerits, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for Coal and Nuclear Power Plants

Teaching Methods: Chalk& Board/ Presentation/Video Lectures/Lecture by Industry Expert/Industrial tour

Text Books:

1. Power Plant Engineering, P K Nag. Tata McGraw- Hill ,2007, 3RD EDITION
2. EI-Wakil M.M ,Power "Plant Technology," Tata McGraw-Hill 1984,6TH EDITION

Ref. Books:

1. Power plant Engineering , R K Rajput, LAXMI Publication, 4TH EDITION
2. K.K.Ramalingam , " Power Plant Engineering ", Scitech Publications, 2002
3. G.R,Nagpal , "Power Plant Engineering", Khanna Publishers 1998, 3RD EDITION

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A. P. Singh
K. S. Singh
S. Singh
2/12/19



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SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
	MECHATRONICS	3	0	0	3	A

Pre -Requisite: Basics of Electronics

Course Educational Objective

CEO1	To impart the knowledge of Microprocessors, Microcontrollers, and PLCs' and its role in Mechatronic systems
CEO2	To introduce the students, the fundamentals of interdisciplinary engineering components and their integration in Mechatronic systems design approach
CEO3	Be able to do the complete design, building, interfacing and actuation of a mechatronic system for a set of specifications
CEO4	Relate various signal conditioning units, amplifiers, logic gates and their role in programmable logic controllers

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Model and analyze electrical and mechanical systems and their interconnection.
CO2	Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
CO3	Describe mechatronic systems and overview of control systems & actuators
CO4	Differentiate between various sensors, transducers and actuators and their applications

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3												
CO2	3	3	2											2
CO3	3	2												
CO4	2	1												1
Avg.	2.75	2.25	0.5											0.75

SYLLABUS

UNIT:1 (10 HOURS)
Evolution of Mechatronics, components of mechatronic system, types of mechatronic products,
Signal theory, signal analysis and processing, Laplace transformation, Z transformation modulation and de modulation. Electrical components and Electronic device -Resister, inductor and capacitor, reactance and impedance. Basic electronics devices junction diodes, Bipolar transistors

UNIT:2 (10 HOURS)
Basic Digital Technology : Digital number system, Binary number system, Hexadecimal

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SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	Q P
	CRYOGENICS	3	0	0	3	A

Pre -Requisite: Fundamentals of Thermodynamics, Physical Metallurgy & Refrigeration Engineering

Course Educational Objectives

CEO1	To familiar with the classification of physics properties of materials at cryogenics parameters.
CEO2	To make the student understand how to apply cryogenic treatments and cryogenic insulations in the technical application.
CEO3	To teach the design and analysis the Characterization of cryogenically processed materials.
CEO4	To familiar with the evaluation& preparation of cryogenic processing of materials for different applications in the real world with a consideration for environmental hazards.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	Summarize the physics properties of materials at cryogenics parameters and gas-liquefaction systems.
CO2	Apply cryogenic treatments and cryogenic insulations in the technical application.
CO3	Design and analyze the Characterization of cryogenically processed materials
CO4	Evaluate Cryogenic processing of materials for different applications in the real world with a consideration for environmental hazards.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2												
CO2	2	3												
CO3	2	2	3											
CO4	2	2												
Avg.	2.25	2.25	0.75											

SYLLABUS

UNIT:1

[10 Hours]

Properties of engineering materials at cryogenic temperatures, mechanical properties thermal properties, electric & magnetic properties, super conducting materials, thermo electric materials, composite materials, properties of cryogenic fluids, super fluidity of He3 & He4. Measurement systems for low temperatures:-Temperature measurements, pressure measurements, flow measurements, liquid level measurements, fluid quality measurements

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UNIT:2

[13 Hours]

Gas Liquefaction Systems:-Liquefaction systems for Air Simple Linde -Hampson System, Claude System, Heylndt System, Dual pressure, Claude. Liquefaction cycle Kapitza System. Comparison of Liquefaction Cycles Liquefaction cycle for hydrogen, helium and Neon, Critical components of liquefaction systems.

Gas Cycle Cryogenic Refrigeration Systems:-Classification of Cryo coolers Stirling cycle Cryo - refrigerators, Ideal cycle - working principle. Schmidt's analysis of Stirling cycle Various configurations of Stirling cycle refrigerators Integral piston Stirlingcryo-cooler, Free displacer split type StirlingCryo coolers, Gifford McMahonCryo- refrigerator, Pulse tube refrigerator, Solvay cycle refrigerator, Vuillimier refrigerator, Cryogenic regenerators.

UNIT:3

[12 Hours]

Cryogenic insulation&Vacuum Technology: -Fundamental principles. Production of high vacuum, Mechanical vacuum pumps, Diffusion pumps, Cryo-pumping, Measurement of high vacuum level. Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation Powder & Fibers Opacified powder insulation, Gas filled powders & Fibrous materials Multilayer super-insulation, Composite insulation.

Desirable qualities for materials used in cryogenic applications, History and applications of metallic / non-metallic materials, Understanding properties and fabrication processes of superconducting Nb3Sn wires, High temperature superconductors. Characterization of cryogenically processed materials

UNIT:4

[10 Hours]

Cryogenic processing of materials for Space applications, Superconductivity, Medical applications, Food Preservation-Individual Quick Freezing, Tool Industry, Automobiles etc.Hazards:-Physical hazards, Chemical hazards, Physiological hazards, combustion hazards, oxygen hazards.Safety in handling of cryogenics, care for storage of gaseous cylinders, accidents in cryogenic plants & prevention.

Teaching Methods: Chalk& Board, PPT, Video Lectures

Text Books:

- 1.Randall F. Barron, "Cryogenic Systems", McGraw-Hill, 1985, 3RD EDITION
- 2.William E. Bryson, "Cryogenics", HanserGardner Publications,1999, 3RD EDITION

Ref. Books:

1. Scott R. B., "Cryogenic Engineering", Van Nostrand and Co., 1962,5TH EDITION
2. Jha, A. R., "Cryogenic Technology and Applications", Butterworth-Heinemann, 2006. 6TH EDITION

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SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT CODE	TITLE OF THE SUBJECT	L	T	P	C	QP
BOEME8021	REVERSE ENGINEERING	2	0	0	2	B

Pre -Requisite: Basics of CAD and CAM

Course Educational Objectives

CEO1	To the basic fundamentals of CAD/ CAM, and CAD Designing for its applications in manufacturing systems.
CEO2	The History of Reverse Engineering, Scope and phases of reverse engineering.
CEO3	The various Methodologies and techniques of reverse engineering
CEO4	Rapid prototyping technique and the Project Implementation by Equipment's Involved for Reverse Engineering techniques.

Course Outcomes: Upon successful completion of this course, students should be able to:

CO1	List the principle's involved in manufacturing process by reverse engineering techniques.
CO2	Compare and exploit the capabilities of a particular data acquisition technique to generate accurate digital models
CO3	Analyze various Methodologies and techniques of reverse engineering.
CO4	Propose various rapid prototyping techniques and materials for Project Implementation.

CO-PO & PSO Mapping

COs	PROGRAMME OUTCOMES												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3													1
CO2	3	2												
CO3	2													
CO4	3	3												2
Avg.	2.75	1.25												0.75

SYLLABUS

UNIT:1

[10 Hours]

Fundamentals of Manufacturing; Types of production function in manufacturing; Fundamentals of CAD/ CAM, CAD Designing: Design process, Applications of computer for design, Creating the Manufacturing Database. Constructing the Geometry, Transformations of geometry, Database structure and content, Wire frame versus solid modeling, Constraint- Based modeling, Geometric commands, Display control commands, Editing, Model preparation, Slicing, Support structures and machine instructions

UNIT:2

[10 Hours]

History of Reverse Engineering, Scope and tasks of RE, Reverse engineering process- Three phases of reverse engineering-Phase I: Scanning, Phase II: Point processing, Phase



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III: Geometric model development, Technical Data Generation, Evaluation and Verification ,Case studies. STL Files: Process overviews, STL interface Specification, STL data generation, STL data Manipulation, Advantages and limitations of STL file format. STL file Generation, File Verification & Repair, Build File Creation, and Part Construction, STL file generation, Defects in STL files and repairing algorithms.

UNIT:3

[8 Hours]

Methodologies and techniques of reverse engineering: Computer aided reverse engineering, Computer vision and reverse engineering, Structured light range imaging, Scanner pipeline, case studies. Reverse engineering hardware, Reverse engineering software, Selection of a reverse engineering system, Case studies with implementation

UNIT:4

[12 Hours]

Introduction to rapid prototyping: Basic process, Current techniques and materials, Applications, Relationship between reverse engineering and rapid prototyping, Case studies with implementation. Project Implementation, Equipment Involved in the Reverse Engineering technique, Domain analysis- process of duplicating Applications and case studies. Cognitive approach to program understated, Integrating formal and structured methods in reverse engineering, Integrating reverse engineering, reuse and specification tool environments to Rapid Prototyping, Interdisciplinary Application of RP and RE

Teaching Methods: Chalk& Board/ Chalk& Board/PPT/Guest lecturers/NPTEL videos/Industry Experts

Text Books:

1. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corpn. July 1991
2. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology, 1994

Ref. Books:

1. Bjorke, Layer Manufacturing, Tapir Publisher.
2. Jacobs, PF (Ed), Rapid Prototyping and Manufacturing, Society of Manuf. Engrs, 1992
3. Burns, M., Automated Fabrication: Improving Productivity in Manufacturing, 1993