NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

CURRICULUM OF

BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

2023 ONWARD UNDERGRADUATE ADMISSION BATCH

V0:

First Year Curriculum Recommended by members of UGAC	19.08.2023
First Year Curriculum Approved by the Chairman, Senate	19.08.2023
First Year Curriculum & Syllabus ratified in the 71st Senate meeting (Item No. 71.5(b))	18.12.2023
Entire Curriculum and Syllabus Recommended by UGAC	09.12.2024
Entire Curriculum and Syllabus Approved by the 73rd Senate (Item No. 73.8)	23.03.2025

DEPARTMENT OF MECHANICAL ENGINEERING

Program Name: Bachelor of Technology in Mechanical Engineering

DETAILED CURRICULUM

CURRICULUM OF 2023 ONWARD UNDERGRADUATE ADMISSION BATCH FOR MECHANICAL ENGINEERING- B.TECH.

L= Lecture hour/ week; T= Tutorial hour/ week; S= Sessional/ practical hour/ week

C= Subject credit point; H= Subject contact hour/ week.

GROUP I:

Semester - I

Sl. No	Code	Subject	L	T	S	C	H
1	MAC01	Mathematics - I	3	1	0	4	4
2	CSC01	Computer Programming	2	1	0	3	3
3	XEC01	Engineering Mechanics	2	1	0	3	3
4	XEC02	Basic Electrical and Electronics Engineering	3	0	0	3	3
5	ESC01	Ecology and Environment	2	0	0	2	2
6	CYC01	Engineering Chemistry	3	0	0	3	3
7	CSS51	Computer Programming Laboratory	0	0	3	2	3
8	XES52	Basic Electrical and Electronics Engineering Laboratory	0	0	3	2	3
9	CYS51	Engineering Chemistry Laboratory	0	0	2	1	2
		TOTAL	**15**	**3**	**8**	**23**	**26**

Semester – II

Sl. No	Code	Subject	L	T	S	C	H
1	MAC02	Mathematics - II	3	1	0	4	4
2	CSC02	Data Structure and Algorithms	2	1	0	3	3
3	PHC01	Engineering Physics	2	1	0	3	3
4	HSC01	Professional Communication	2	0	2	3	4
5	CSS52	Data Structure and Algorithms Laboratory	0	0	3	2	3
6	XES51	Engineering Graphics	0	1	3	3	4
7	PHS51	Engineering Physics Laboratory	0	0	2	1	2
8	XXS51	Extra Academic Activities	0	0	2	1	2
		TOTAL	9	4	12	20	25

GROUP II

Semester – I

Sl. No	Code	Subject	L	T	S	C	H
1	MAC01	Mathematics - I	3	1	0	4	4
2	CSC01	Computer Programming	2	1	0	3	3
3	XEC01	Engineering Mechanics	2	1	0	3	3
4	PHC01	Engineering Physics	2	1	0	3	3
5	HSC01	Professional Communication	2	0	2	3	4
6	CSS51	Computer Programming Laboratory	0	0	3	2	3

7	XES51	Engineering Graphics	0	1	3	3	4
8	PHS51	Engineering Physics Laboratory	0	0	2	1	2
9	XXS51	Extra Academic Activities	0	0	2	1	2
		TOTAL	**11**	**5**	**12**	**23**	**28**

Semester – II

Sl. No	Code	Subject	L	T	S	C	H
1	MAC02	Mathematics - II	3	1	0	4	4
2	CSC02	Data Structure and Algorithms	2	1	0	3	3
3	XEC02	Basic Electrical and Electronics Engineering	3	0	0	3	3
4	ESC01	Ecology and Environment	2	0	0	2	2
5	CYC01	Engineering Chemistry	3	0	0	3	3
6	CYS51	Engineering Chemistry Laboratory	0	0	2	1	2
7	CSS52	Data Structure and Algorithms Laboratory	0	0	3	2	3
8	XES52	Basic Electrical and Electronics Engineering Laboratory	0	0	3	2	3
		TOTAL	**13**	**2**	**8**	**20**	**23**

Semester–III							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC331	Mathematics - III	3	1	0	4	4
2	MEC301	Solid Mechanics	3	1	0	4	4
3	MEC302	Theory of Machines and Mechanisms	3	1	0	4	4
4	MEC303	Fluid Mechanics	3	1	0	4	4
5	MEC304	Engineering Thermodynamics	3	1	0	4	4
6	MES351	Machine Drawing & Solid Modeling	0	0	3	2	3
7	MES352	Fluid Mechanics Lab	0	0	3	2	3
8	WSS381	Workshop Practice-I	0	0	3	2	3
9	XXS381	Co-curricular Activities - III (Optional)	0	0	0	0	0
		TOTAL	15	5	9	26	29

Semester – IV							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MEC401	Design of Machine Elements-I	3	1	0	4	4
2	MEC402	Casting, Forming and Welding	3	1	0	4	4
3	MEC403	Heat & Mass Transfer	3	1	0	4	4
4	MEC404	Dynamics of Machines	3	0	0	3	3
5	MEC405	Fluid Machines	3	0	0	3	3
6	MES451	Solid Mechanics Lab	0	0	3	2	3
7	MES452	Mechanism Lab	0	0	3	2	3
8	WSS481	Workshop Practice-II	0	0	3	2	3
9	XXS481	Co-curricular Activities - IV (Optional)	0	0	0	0	0
		TOTAL	**15**	**2**	**9**	**24**	**27**

Semester –V							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MEC501	Machining and Machine Tools	3	1	0	4	4
2	MEC502	IC Engine & Gas Turbine	3	0	0	3	3
3	MEC503	Design of Machine Elements-II	3	1	0	4	4
4	MEC504	Computer Aided Manufacturing &Robotics	3	1	0	4	4
6	MEE510-MEE519	Depth Elective -- 1	3	0	0	3	3
7	MES551	Hydraulic Machines Laboratory	0	0	3	2	3
8	MES552	Heat Transfer Laboratory	0	0	3	2	3
9	MES553	Robotics, AI & Mechatronics Lab.	0	0	3	2	3
10	XXS581	Co-curricular Activities - V (Optional)	0		0	0	0
		TOTAL	**15**	**2**	**9**	**24**	**27**

Semester – VI							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MEC601	Power Generation Technologies	3	0	0	3	3
2	HSC631	Economics and Management Accountancy	3	0	0	3	3
3	CSCXXX	AI & ML	3	0	2	4	5
4	MEE610-MEE619	Depth Elective -- 2	3	0	0	3	3
5	MEE620–MEE629	Depth Elective -- 3	3	0	0	3	3
6	MES651	Power Generation Laboratory	0	0	3	2	3
7	MES652	Machine Design Sessional	0	0	3	2	3
8	MES653	Manufacturing Laboratory	0	0	3	2	3
9	XXS681	Co-curricular Activities - VI (Optional)	0	0	0	0	0
10	XXS481	Co-curricular Activities - IV (Optional)	0	0	0	0	0
		TOTAL	**15**	**0**	**11**	**22**	**26**

Semester-VII							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MSC731	Principle of Management	3	0	0	3	3
2	MEC701	Industrial Engineering & Engineering Measurement	3	1	0	4	4
3	MEE710-MEE719	Depth Elective -- 4	3	0	0	3	3
4	MEE720-MEE729	Depth Elective -- 5	3	0	0	3	3
5	YYO74*	Open Elective – 1	3	0	0	3	3
6	MES751	Machine Dynamics Laboratory	0	0	3	2	3
7	MES752	Engineering Measurement Laboratory	0	0	3	2	3
8	MES753	Summer Internship and Seminar	0	0	2	1	2
9	MES754	Project - I	0	0	3	1	3
		TOTAL	**15**	**1**	**11**	**22**	**27**

Semester-VIII							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MES851	Project – II / Industry Internship	0	0	14	6	14
2	MES852	Comprehensive Viva-Voce	0	0	0	1	
		TOTAL	**0**	**0**	**14**	**7**	**14**
DepartmentalCore:15		**Non-departmentalCore:05(IncludingAI& ML)**					
DepartmentalElectives:05		**OpenElectives:01**					

CREDIT UNIT OF THE PROGRAM:

Semester	**I + II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**TOTAL**

Credit Unit	43	26	24	24	22	22	7	**168**

DEPTH ELECTIVE COURSE BASKETS

THE STUDENTS PRIMARILY WILL OPT FROM THE DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY HIS/ HER OWN DEPARTMENT. HOWEVER, A STUDENT CAN OPT FOR DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED BY OTHER DEPARTMENT IN A PARTICULAR SEMESTER, WITH THE PERMISSION/ CONSENT FROM HIS/ HER HEAD OF THE DEPARTMENT AND THE CONCERNED TEACHER OF THAT SUBJECT.

5thSemester

DEPARTMENT OF MECHANICAL ENGINEERING	
MEE510	Convective Heat and Mass Transfer
MEE511	Advanced Solid Mechanics
MEE512	Multi-Phase Flow and Heat Transfer
MEE513	Tribology
MEE514	Material Science and Engineering
MEE515	Operation Research
MEE516	Mechatronics
MEE517	Advanced Foundry Engineering
MEE518	Engineering Optimization

6thSemester

DEPARTMENT OF MECHANICAL ENGINEERING	
MEE610	Non-Conventional Machining
MEE611	Design and Optimization of Thermal Systems
MEE612	Control Systems
MEE613	Fundamentals of Combustion
MEE614	Modelling and Simulation of Dynamic Systems
MEE615	Non-Linear Vibration
MEE616	Mechanics of complex fluids
MEE620	Automobile Engineering
MEE621	Gas Dynamics and Propulsion
MEE622	Mechanics of Composite and Functionally Graded Materials
MEE623	Finite Element Methods
MEE624	Additive Manufacturing
MEE625	Mechanics of Forming and Press Working
MEE626	Advanced Welding Technology
MEE627	Computer Aided Design

7th Semester

DEPARTMENT OF MECHANICAL ENGINEERING	
MEE710	Machine Tool Engineering and Automation
MEE711	Fracture Mechanics
MEE712	Micro and Nano Manufacturing

MEE713	Aerospace Engineering
MEE714	Advanced Mechanical Vibration
MEE715	Solar Energy
MEE720	Advanced Machining and Surface Engineering
MEE721	Microfluidics
MEE722	Refrigeration and Air Conditioning
MEE723	Computational Fluid Dynamics and Heat Transfer
MEE724	Theory of Plates
MEE725	Energy Conversion Systems
MEE726	Advanced Robotics

LISTOF*OPENELECTIVE*SUBJECTS::ADMISSIONBATCH2023&ONWARDS

7th Sem	**DEPARTMENT OF MECHANICAL ENGINEERING**
MEO741	Product Development and Value Engineering
MEO742	Energy Management and Auditing
MEO743	Dynamical Systems Theory
XEO744	Design Thinking, Innovation and Entrepreneurship

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC01	MATHEMATICS - I	PCR	3	1	0	4	4
Pre-requisites		Basic concepts of function, limit, differentiation and integration.					
Course Outcomes	• CO1: learn the fundamentals of differential calculus of single and several variables. • CO2: learn the basic concepts of convergence of infinite series. • CO3: understand the basic concepts of integral calculus along with its various applications. • CO4: acquire the theoretical knowledge of vector calculus and its engineering applications.						
Topics Covered	**Functions of Single Variable:** Review of limit, continuity and differentiability. Mean value theorems: Rolle's Theorem, Lagrange's Mean Value Theorem (MVT), Cauchy's MVT, Taylor's theorem, Taylor's and Maclaurin's series. (8) **Functions of several variables:** Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, derivatives of composite and implicit functions, derivatives of higher order and their commutativity, Homogeneous function, Euler's theorem and its converse, Exact differential, Jacobian, Taylor's &Maclaurin's series, Maxima and Minima, Necessary and sufficient condition for maxima and minima (no proof). (11) **Sequences and Series:** Real sequences and their convergence, Series of positive terms, Necessary and sufficient condition for convergence, p-series, geometric series, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6) **Integral Calculus:** Review of the idea of integration as a limit of a sum, Mean value theorems of integral calculus, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms, Improper integrals and their convergence, Beta and Gamma functions. (12) **Multiple Integrals:** Evaluation of double and triple integrals, Change of order of integration, Change to better coordinates, Area and volume by double integration, Volume by triple integration. (10) **Vector Calculus:** Vector valued functions and its differentiability, Line integral,						

	Surface integral, Volume integral, Gradient, Curl, Divergence, Green's theorem in the plane (including vector form), Stokes' theorem, Gauss's divergence theorem and their engineering applications. (9)
Text Books, and/or reference material	**Text Books:** 1. Kreyszig, E., Advanced Engineering Mathematics: 10th edition, Wiley India Edition, 2010. 2. Murray, D.A., Differential and Integral Calculus, FB & C Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2014. 4. Murray Spiegel, Schaum's Outline of Vector Analysis, Tata McGraw Hill .1980 ,Education **Reference Books:** 1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011. 2. Thomas and Finny: Calculus and Analytic Geometry, 11th Edition, Addison Wesley.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC01	CO1	2	3	2	3	1	1	-	-	1	1	1	2
	CO2	2	3	2	3	-	1	-	-	1	1	2	2
	CO3	2	3	2	3	-	1	1	-	-	2	2	2
	CO4	3	3	2	3	1	1	-	1	-	2	1	2

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC01	**COMPUTER PROGRAMMING**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Basic knowledge of computer.		CT+MT+EA					
Course Outcomes	• CO1: To understand basics of computer programming, program flow, and programming constructs. • CO2: Develop concepts on basic and complex data types, conditional and iterative statements. • CO3: Exercise the concepts of user defined functions to solve real time problems. • CO4: Inscribe C programs that use Pointers to access arrays, strings and functions. • CO5: Exercise user defined data types including structures and unions to solve problems.						
Topics Covered	**Introduction to C**: Phases of developing a running computer program in C. (2L) Data types, size and values. Char, Unsigned and Signed data types. Number systems and representations. Constants, Overflow. (3L) Data concepts in C: Constants, Variables, Expressions, Operators, and operator precedence in C. (2L)						

	Statements: Declarations, Input-Output Statements, Compound statements, Selection Statements. (2L) Conditions, Logical operators, Precedences. Repetitive statements, While construct, Do-while Construct, For construct. (3L) Arrays. Strings. Multidimensional arrays and matrices. (3L) **Pointers:** Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Examples. Accessing arrays through pointers. Pointer types, Pointers and strings. String operations in C. (6L) Dynamic memory allocation. (2L) **Modular Programming:** Functions: The prototype declaration, Function definition. (3L) Function call: Passing arguments to a function, by value, by reference. Scope of variable names. Recursive function calls, Tail recursion. (4L) Sorting problem: Sorting in arrays with an example of Bubble sort. Sorting in strings. (3L) Search problem: Linear search and binary search. (2L) **More Data-types in C:** Structures in C: Motivation, examples, declaration, and use. Operations on structures. Passing structures as function arguments. type defining structures. (4L) File input-output in C. Streams. Input, output and error streams. Opening, closing and reading from files. Programming for command line arguments. (3L)
Text Books, and/or reference material	**Text Books:** 1. P. Deitel, H. Deitel. C How to Program. Pearson Education India, 7th Ed. 2. B. W. Kernighan, Dennis M. Ritchie. The C Programming. Prentice Hall Software Series, 2nd Ed. **Reference Books:** 1. P. Dey and M. Ghosh. Computer fundamentals and programming in C. Oxford press, 2013. 1. Y. Kanetkar. Let Us C. BPB Publications, Sixteenth edition, 2017.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC01	CO1	2	2	1	-	1	2	-	-	-	-	-	-
	CO2	3	2	1	-	1	1	1	-	-	-	-	-
	CO3	2	2	1	-	-	2	-	-	-	-	-	-
	CO4	3	2	2	-	-	1	-	-	-	-	-	-
	CO5	3	1	2	-	1	2	-	-	-	-	-	-

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
XEC01	**ENGINEERING MECHANICS**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	• CO1: Acquire knowledge of mechanics and ability to draw free body diagrams. • CO2: Apply knowledge of mechanics for solving special problems like truss and frame analysis. • CO3: Ability to calculate centroid, moments of inertia for various shapes. • CO4: Learn momentum and energy principles. • CO5: Knowledge on virtual Work Principle and its application						

Topics Covered	Engineering Mechanics; measurement and SI units. [1] Vectors and force as a vector; Resultant of a system of forces on a particle; free body diagram and conditions of equilibrium of a particle; problems on particles; equilibrium of particles in space. [2] Resultant of a system of forces and couples on a rigid body; conditions of equilibrium of a rigid body; free body diagrams of rigid bodies subjected to different types of constraints; simple space problems of rigid bodies. [4] Coefficients of static and kinetic friction; problems involving friction; theories of friction on square threaded power screw and flat belt. [5] Simple trusses; analysis of trusses by method of joints and method of sections. [5] Centre of gravity and centre of mass; centroids of lines, curves and areas; first moment of area; second moment of area; polar moment of inertia; radius of gyration of an area; parallel axis theorem; mass moment of inertia. [4] Path, velocity, acceleration; rectilinear and curvilinear motion; motion of system of particles; introduction to the concept of plane kinematics of rigid bodies. [6] Newton's second law of motion; dynamic equilibrium and D'Alembert's principle; linear momentum; angular momentum; rectilinear and curvilinear motion; principles of work–energy and impulse–momentum; impact of system of particles; introduction to the concept of plane kinetics of rigid bodies. [12] Principle of Virtual Work, Solution of Problems on Mechanics using Principle of Virtual Work [3]
Text Books, and/or reference material	1) S P Timoshenko and D H Young, Engineering Mechanics, 5th Edition 2) J L Meriam and L G Kraige, Engineering Mechanics, 5th Edition, Wiley India 3) F P Beer and E R Johnston, Vector Mechanics for Engineers 4) I H Shames, Engineering Mechanics

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XEC01	CO1	1	-	-	-	-	-	-	-	-	-	-	1
	CO2	1	1	1	1	-	-	-	-	-	-	-	1
	CO3	1	1	-	-	-	-	-	-	-	-	-	1
	CO4	1	2	-	-	-	-	-	-	-	-	-	1
	CO5	-	2	2	2	2	1	-	-	-	1	-	1

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
PHC01	**Engineering Physics**	**PCR**	**2**	**1**	**0**	**3**	**3**
Pre-requisites:		Course Assessment methods: (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	• CO1: To realize and apply the fundamental concepts of physics such as superposition principle, simple harmonic motion to real world problems. • CO2: Learn about the quantum phenomenon of subatomic particles and its applications to the practical field. • CO3: Gain an integrative overview and applications of fundamental optical phenomena such as interference, diffraction and polarization. • CO4: Acquire basic knowledge related to the working mechanism of lasers and signal propagation through optical fibers.						

Topics Covered	**Harmonic Oscillations** - Linear superposition principle, Superposition of two perpendicular oscillations having same and different frequencies and phases, Free, Damped and Forced vibrations, Equation of motion, Amplitude resonance, Velocity resonance, Quality factor, sharpness of resonance, [8] **Wave Motion**: Longitudinal waves, Transverse waves, Wave equation, phase velocity and group velocity, Maxwell's equations, Electro-magnetic waves in free space. [3] **Introductory Quantum Mechanics** - Inadequacy of classical mechanics, Blackbody radiation, Planck's quantum hypothesis, de Broglie's hypothesis, Heisenberg's uncertainty principle and applications, Schrodinger's wave equation and applications to simple problems: Particle in a one-dimensional box, Simple harmonic oscillator, Tunnelling effect. [8] **Interference & Diffraction** - Huygens' principle, Young's experiment, Superposition of waves, Conditions of sustained Interference, Concepts of coherent sources, Interference by division of wavefront, Interference by division of amplitude with examples, The Michelson interferometer and some problems; Fraunhofer diffraction, Single slit, Multiple slits, Resolving power of grating. [13] **Polarisation** - Polarisation, Qualitative discussion on Plane, Circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction (birefringence) - Ordinary and extra-ordinary rays, Optic axis etc.; Polaroid, Nicol prism, Retardation plates and analysis of polarized lights. [5] **Laser and Optical Fiber** - Spontaneous and stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient, Optical resonator and pumping methods, He-Ne laser. Optical Fibre– Core and cladding, Total internal reflection, Calculation of numerical aperture and acceptance angle, Applications. [5]
Text Books, and/or reference material	**TEXT BOOKS**: 1. The Physics of Vibrations and Waves, H. John Pain, Willy and Sons 2. A Text Book of Oscillations and Waves, M. Goswami and S. Sahoo, Scitech Publications 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **REFERENCE BOOKS**: 1. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 2. Quantum Physics, R. Eisberg and R. Resnick, John Wiley and Sons 3. Fundamental of Optics, Jankins and White, McGraw-Hill 4. Optics, A. K. Ghatak, Tata McGraw-Hill 5. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 6. Lasers and Non-linear Optics, B. B. Laud, New Age International Pvt Lt

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHC01	CO1	3	2	1	1	1	-	-	1	-	-	-	1
	CO2	3	2	-	2	-	-	-	-	-	-	-	1
	CO3	3	2	2	2	1	1	1	1	1	-	1	1
	CO4	3	2	2	2	1	1	1	-	1	-	1	1

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC01	**Engineering Chemistry**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					

Course Outcomes	• CO1: Students will get the knowledge of fundamentals as well industrial applications of polymer, petroleum products, organometallic compounds and others. • CO2: Students will be able to elucidate the structure of different organic compounds and to analyze the structure-property correlation. • CO3: Students will be aware on the role played by different metals in biological systems and also the ecological impact of metals. • CO4: Students will be able to understand and analyzethermodynamical, kinetic as well as electrochemical aspects of chemical systems and apply the understanding in the technical field.
Topics Covered	**ORGANIC CHEMISTRY** i. **Polymer chemistry and polymer engineering:** Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber and plastic materials; vulcanization, structure-property correlation: Concept of Molecular weight of polymer, Glass transition temperature. Engineered polymer: Thermally stable, flame retardant, Conducting polymer. (5L) ii. **Petroleum Engineering and oil refinery:** Origin of petroleum, separation principle and techniques of distillation of crude oil, thermal and catalytic cracking of petroleum, uses of different fractions, knocking, anti-knock compounds, octane number and cetane number. High octane and Aviation fuel. Bio-diesel. (3L) iii. **Structure elucidation of organic compounds by modern spectroscopic methods:** Application of UV-Visible (Lambert-Beers law), concept of chromophore, auxochrome, hypso-, hyper-, bathochromic, red shift. FT-IR spectroscopy and Mass spectroscopy (including instrumentation). (4L) **INORGANIC CHEMISTRY** i. **Coordination Chemistry:** Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, LMCT, MLCT, IVCT. Isomerism and stereochemistry.(5L) ii. **Bioinorganic Chemistry:** Metal ions in biological systems: Fe, Cu (2L) iii. **Industrial applicationof Organometallic complexes:** π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes, Various catalytic cycles of industrial importance. (4L) iv. **Environmental Chemistry:** Metal toxicity (As, Hg, Pb and Cd) and its remediation (1L) **PHYSICAL CHEMISTRY** i. **Chemical Thermodynamics:** 2nd law of thermodynamics: Concept of thermodynamic engine (Carnotand reverse Carnot cycle), entropy, free energy. Temperature and pressure dependence of entropy and free energy. Change in phase: phase diagram of single component system. Cryogenics: Joule Thomson experiment. (5L) ii. **Chemical Kinetics:**Rate expression of Reversible reaction, parallel reaction,and Consecutive reaction with proper examples. Temp effect on reaction rate.(3L) iii. **Catalysis:** Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis.(2L) iv. **Electrochemistry:**EMF, Nernst Equation, Application of electrochemistry in chemical processes. Electrochemical cell, Fuel cell, Li-ion battery(3L).
Text Books, and/or reference material	Suggested Text Books: (i) Physical Chemistry by P. Atkins, Oxford (ii) A guidebook to mechanism in Organic chemistry: Peter Sykes; Pearson Edu. (iii) Inorganic Chemistry Part-I & II, R. L. Dutta, The new book stall Suggested Reference Books: **Organic Chemistry**: (i) Basic stereochemistry of organic molecules: S. Sengupta; Oxford University press

	(ii) Engineering Chemistry: Wiley (iii) Elementary Organic Spectroscopy: William Kemp, ELBS with Macmillan **Inorganic Chemistry:** (i) Inorganic Chemistry: Principle structure and reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, Pearson Education (ii) Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life: An Introductionand Guide, 2nd Edition, Wolfgang Kaim, Brigitte Schwederski, Axel Klein. (iii) Inorganic Chemistry Fourth Edition, Shriver & Atkins, Oxford **Physical Chemistry:** (i) Physical Chemistry by G.W Castellan (ii) Physical Chemistry by P. C. Rakshit

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYC 01	CO1	1	2	-	-	-	-	-	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	1	2	1	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	-	2	-	1	-	-	-	-	-

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
ESC01	**Ecology and Environment**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	• CO1: Understand the importance of environment and ecosystem. • CO2: Understand the fundamental aspect of pollutant tracking and its implementation in natural and anthropogenic pollution of air and water system. • CO3: Understand the scientific basis of local and as well as global issues. • CO4: Apply of knowledge to develop sustainable solution.						
Topics Covered	**UNIT – I: INTRODUCTION (2)** Multidisciplinary nature of Environmental Studies: Definition, Scope, and Importance. **UNIT–II: FUNDAMENTALS OF ECOLOGY (9)** Definition, Components of Environment; Fundamentals of Ecology and Ecosystem; Components and Classification of Ecosystem; Energy flow in Ecosystem: Tropic level, Food Chain, Food Web, Ecological Pyramid; Biogeochemical cycles: Carbon, Nitrogen, Sulphur, Phosphorus, and Water Cycle; Biosphere and Biodiversity; Conservation. **UNIT–III: FUNDAMENTALS OF ENVIRONMENT (10)** **Environmental Pollution:** Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Solid Wastes, and Natural hazards: Floods, earthquakes, cyclones, and landslides. **Environmental Issues:** Climate change and global warming; acid rain; and ozone						

	layer depletion. **Environment Quality:** Ambient air quality standards, Water quality parameters and standards: pH, Turbidity, Hardness, Sulphate, Phosphates, Iron, Dissolved Oxygen, BOD, and COD. **UNIT– IV: NATURAL RESOURCES (3)** Mineral Resources, Energy Resources: Conventional and Non-Conventional. **UNIT- V- GREEN TECHNOLOGY & ENVIRONMENTAL ETHICS (4)** Sustainability: Carbon Sequestration, Green building practices, Green computing; Carrying capacity; and Environment Protection Acts/laws.
Text Books, and/or reference material	1. A Basic Course in Environmental Studies. Deswal&Deswal. Pub. DhanpatRai& Sons 2. Ecology. Odum. Pub. Oxford & IBH 3. Environmental Engineering. Peany et.al. Pub. McGraw Hill 4. A Text Book of Environmental Engg. VenugpalRao. Pub. PHI 5. A Basic Course in Environmental Studies. Deswal&Deswal. Pub. DhanpatRai& Sons 6. Environmental Studies. Bharucha. Pub. University of Press 7. Environmental Chemistry and Pollution, S. S. Dara& D. D. Mishra, S. Chand Publishing

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ESC01	CO1	3	-	-	-	-	-	2	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	2	-	-	-	-	-	2	-	-	-	-	-
	CO4	1	-	3	-	-	2	1	-	-	-	-	-

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
HSC01	**Professional Communication**	PCR	2	0	2	4	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: Learners will acquire linguistic proficiency in terms of improvement in their listening, speaking, reading, and writing skills. • CO2: Learners will acquire better communicative ability. • CO3: The course will help learners improve their social connectivity skill.						
Topics Covered	Vocabulary 1. Word Formation, Use of Prefixes and Suffixes (1) 2. Synonyms, Antonyms (1) 3. Prefixes and Suffixes from Foreign Languages, Words from Foreign Languages (1) 4. Abbreviations and Acronyms (1) 5. Technical Vocabulary (1) Grammar						

	1. Identifying Common Errors in Articles and Prepositions (1) 2. Common Errors in Noun-Pronoun Agreement and Subject-Verb Agreement (1) 3. Misplaced Modifiers and Tenses (1) 4. Redundancies and Clichés (1) Reading 1. Reading and Its Importance, Techniques of Effective Reading (1) 2. Improving Comprehension Skills, Techniques for Good Comprehension (1) 3. Skimming and Scanning (1) 4. Comprehension, Intensive and Extensive Reading (2) Writing 1. Sentence Structures, Phrases and Clauses, Punctuation (2) 2. Organising Principles of Paragraphs (2) 3. Formal Letters, Letters of Complaint, Requisition Letters, Job Application, and Résumé (2) 4. Nature and Style of Sensible Writing, Defining, Describing, Classifying, Providing Examples and Evidence (2) 5. Essay Writing (2) 6. Précis Writing (2) 7. Report Writing (2) Oral Communication 1. Listening Comprehension (4) 2. Pronunciation, Intonation, Stress, and Rhythm (4) 3. Communication at the Workplace (4) 4. Everyday Conversation (4) 5. Group Discussion (4) 6. Interviews (4) 7. Formal Presentations (4)
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana&Savitha (Cambridge UP) **Reference Books:** 2. *English*—Kulbhushan Kumar (Khanna Book Publishing) 3. *Remedial English Grammar*—F. T. Wood (Macmillan)

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HSC01	**CO1**	1	--	--	1	--	1	--	1	2	3	1	--
	CO2	1	--	--	1	--	2	--	2	2	3	2	--
	CO3	--	--	--	1	--	3	--	3	3	3	2	--

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC02	**MATHEMATICS - II**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Basic concepts of set theory, differential equations, and probability.		CT+MT+EA					
Course Outcomes	• CO1: learn the basic concepts of linear algebra and be able to apply the same to solve various engineering problems.						

	• CO2: understand fundamentals of ordinary differential equations and their applications. • CO3: acquire the theoretical knowledge of Fourier Series, Fourier & Laplace transforms, and learn about their applications. • CO4: learn the basic concepts of probability theory.
Topics Covered	**Introduction to Algebraic structures:** Group, subgroup, ring, subring, integral domain, and field. (3) **Linear Algebra:** Vector spaces over field, linear dependence and independence of vectors, linear span of a set of vectors, basis and dimension of finite dimensional vector space, elementary row/column operations, rank of a matrix, solutions of system of linear (homogeneous and non-homogeneous) equations, eigenvalues and eigenvectors, characteristic polynomials, Cayley-Hamilton theorem (without proof), Diagonalization of matrices. (15)
	Ordinary Differential Equations (ODE): Review of first order ODE, Picard's theorem (Statement Only), ODE of first order and of the first degree (exact ODE, rules for finding integrating factors), ODE of first order and of the higher degree (ODE solvable for x, solvable for y; Clairaut's equation, singular solution), homogeneous and non-homogeneous linear ODE with constant coefficients and variable coefficients (Euler–Cauchy type), linear dependence of solutions, Wronskian determinant, Solution of simultaneous ODEs $(dx/P = dy/Q = dz/R;\ dx/dt = ax + by,\ dy/dt = cx + dy)$, properties of nonlinear ODEs, phase plane analysis. (18) **Fourier series:** Piecewise smooth and periodic functions, Fourier series of a function in an interval, Dirichlet conditions, Convergence of Fourier series, Fourier sine and cosine series, Complex form of Fourier series. (4) **Fourier Transforms:** Fourier Integral Theorem (statement only), Different forms of Fourier Integrals, Fourier Transform and its inversion formula, Properties of Fourier Transform, Convolution. (7) **Laplace Transforms:** Laplace transforms and its Properties, Inverse Laplace transforms, Convolution theorem, Applications to ODE. (4) **Probability:** Random variables and probability distributions (discrete and continuous), Binomial, Poisson, Uniform and Normal distributions. (5)
Text Books, and/or reference material	**Text Books:** 1. Kreyszig, E., Advanced Engineering Mathematics: 10th edition, Wiley India Edition (2010). 2. Strang, G., Linear algebra and its applications (4th Edition), Thomson (2006). 3. Murray, D.A., Introductory Course in Differential Equations, Khosla Publishing House (2021). 4. Debnath, L., Integral Transforms and Their Applications, CRC Press (1995). 5. Baisnab, A.P., Jas, M., Elements of Probability and Statistics, McGraw Hill Education (2017). **Reference Books:** 1. Kumaresan, S., Linear algebra - A Geometric approach, ChaukhambaAuriyantaliya (2017). 2. Ross, S.L., Differential Equations, 3rd Edition, Wiley Student Edition (2017). 3. Shivamoggi, A., Integral Transforms for Engineers, PHI (2003). 4. Grinstead, C.M., Snell, J.L., Introduction to probability, American Mathematical Society (2012).

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC02	CO1	3	3	2	1	2	-	2	-	-	-	1	2
	CO2	3	3	2	2	2	-	2	-	-	1	-	2

	CO3	3	3	2	2	3	1	1	-	1	1	1	2
	CO4	3	2	1	3	2	1	1	1	1	-	-	2

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC02	Data Structure and Algorithms	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
CSC01 (Computer Programming)		CA+ MT + ET **[**CA: 15%, MT: 25%, ET: 60%**]**					

Course Outcomes	• CO1: Understanding the fundamental concepts of abstract data types, data structures, algorithms and time complexity analysis of algorithms. • CO2: Implementation of different abstract data types (array, linked list, stack, queue, tree, graph). • CO3: Implementation of different sorting and searching techniques along with their performance evaluation. • CO4: Analysis of the suitability/compatibility of different data structures based on the types of applications. • CO5: Design and development of algorithms for real-life applications.
Topics Covered	**Introduction:** Abstract Data Type (ADT), Data Structures, Concept of static and dynamic memory allocation, Algorithm, Analysis of time and space complexity of algorithms, Asymptotic notations: Big Oh, Big Omega and Big Theta notations, Impact of data structure on the performance of an algorithm. (6L) **Array:** Array as an ADT, Single and multi-dimensional array, Memory representation (row major and column major) of array, Address calculation for array elements. (2L)
	Linked list: Linked list as an ADT, Memory allocation and deallocation for a linked list, Linked list versus array, Types of linked lists: singly linked list, doubly linked list and circular linked list, Operations on linked list: creation, display, insertion and deletion (in different positions), Concatenation, Searching, Sorting, Applications of linked list: Representations and operations on polynomials, sparse matrices, etc., Array vs. Linked List. (6L)
	Stack: Stack as an ADT, Push and pop operations on stacks, Array implementation of stack, Linked list implementation of stack, Applications of stack: Recursion, Function call, Evaluation of postfix expression using stack, Conversion of infix to postfix using stack. (5L) **Queue:** Queue as an ADT, Enqueue and dequeue operations, Array implementation of queue, Limitation of array implementation, Circular queue, Linked list implementation of queue, Priority queue. (4L) **Binary Tree:** Binary Tree, Definition and properties, Representation of binary tree in memory: linked representation, array representation, Binary tree traversal (Preorder, Inorder and Postorder), Binary search tree, Heap (8L) **Searching Algorithms:** Linear search and binary search. (2L) Sorting Algorithms: Selection sort, Insertion sort, Quick sort, and Merge sort. (5L) **Graphs Algorithms:** Graph representation using Adjacency matrix and Adjacency list, Breadth First Search and Depth First Search algorithms. (4L)
Text Books, and/or reference material	**Text Books:** 1. R. F. Gilberg and B. A. Forouzan, "Data Structures: A pseudocode approach with C", 2nd Edition, CENGAGE Learning. 2. A. V. Aho, J. D. Ullman and J. E. Hopcroft, “Data Structures and Algorithms”,

	Addition Wesley. 3. Lipschutz, "Data Structures (Schaum's Outline Series)", Tata Mcgraw Hill. 4. E. Horowitz, S. Sahni, S. Anderson-Freed, "Fundamentals of Data Structures in C", Universities Press; Second edition (2008). **Reference Books:** 1. Y. Langsam, M. J. Augenstein and A. N. Tanenbaum, "Data Structures using C and C++", Pearson, 2006. 2. Knuth, Donald E. The Art of Computer Programming. 3rd ed. Vols 1&2. Reading, MA: Addison-Wesley, 1997. ISBN: 0201896834. ISBN: 0201896842. ISBN: 0201896850. 3. Kleinberg and Eva Tardos. Algorithm Design. Addison-Wesley 2005 ISBN-13: 978-0321295354.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC02	CO1	3	-	1	1	1	-	-	-	-	-	-	-
	CO2	3	2	1	2	2	-	-	-	-	-	-	1
	CO3	3	2	1	2	2	-	-	-	-	-	-	1
	CO4	3	3	2	3	3	-	-	-	-	-	-	1
	CO5	3	3	3	3	3	-	-	-	-	-	-	2

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XEC02	**Basic Electrical and Electronics Engineering**	PCR	3	0	0	3	3
Pre-requisites			Course Assessment methods				
(10+2) level mathematics and physics			CT+MT+EA				
Course Outcomes	CO1: Learn the fundamentals of electric circuits and analyze the circuits using laws and network theorems. CO2: Gain the knowledge about magnetic circuits, electromagnetism and the basics of generation of alternating voltage. CO3: Understand the behaviour of single phase and poly-phase AC circuits. CO4: Understand the fundamentals of semiconductor devices. CO5: Analyze the design and characteristics of transistor-based electronic circuits. CO6: Evaluate operational amplifier-based circuits and logic gates.						
Topics Covered	1. Introduction to Electrical systems, Fundamentals of Electric Circuits: Ohm's laws, Kirchhoff's laws, Independent and Dependent sources, Analysis of simple circuits. (4) 2. Network theorems (DC): Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem. (5) 3. Magnetic circuits: Review of fundamental laws of electromagnetic induction, Self and mutual inductances, Solution of magnetic circuits. (3) 4. Generation of alternating voltage and current, E.M.F. equation, Average and R.M.S. value, Phase and phase difference, Phasor representation of alternating quantity, Behaviour of AC circuits, Resonance in series and parallel R-L-C circuits. (6) 5. Poly-phase system, Advantages of 3-phase system, Generation of 3-phase voltages, Voltage, current and power in a star and delta connected systems,						

	3-phase balanced and unbalanced circuits. (3) 6. Semiconductor Devices: Construction, working and V-I characteristics of diode, Zener diode, Zener diode as a voltage regulator, LED. (6) 7. Transistors:Introduction to BJT, FET, MOSFET; CMOS, working principle, and V-I characteristics of Transistors, biasing of BJT circuits-fixed bias, emitter bias, feedback bias, voltage divider bias, transistor as an amplifier. (8) 8. Operational amplifier:Introduction, applications: inverting, non-inverting amplifier, unity follower, integrator, differentiator, summing circuit .(4) 9. Introduction of logic gates, memory: ROM, RAM. (3)
Text Books, and/or reference material	**TEXT BOOKS** 1. Electrical & Electronic Technology by Hughes, Pearson Education India. 2. Introduction Electronic Devices & Circuit Theory, 11/e, 2012, Pearson: Boylestad&Nashelsky. 3. Electronics: Fundamentals and Applications By D. Chattopadhyay, P. C. Rakshit; New Age Int. Publication. **REFERENCE BOOKS** 1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd. 2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Edu. India. 3. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill. 4. Electronics - Circuits and Systems, Fourth Edition by Owen Bishop. 5. Electronics Fundamentals: Circuits, Devices & Applications (8e) by Thomas L. Floyd & David M. Buchla.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XEC02	CO1	3	3	3	3	3	1	1	1	1	1	1	1
	CO2	3	3	3	3	2	1	2	1	1	1	1	1
	CO3	3	3	3	3	3	2	2	1	1	1	1	1
	CO4	2	3	2	2	-	1	-	-	-	-	-	1
	CO5	3	2	1	2	2	1	-	-	2	-	-	1
	CO6	3	2	2	2	3	-	-	-	2	-	-	1

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS51	**COMPUTER PROGRAMMING LABORATORY**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	CO1: To understand the principle of operators, loops and branching statements. CO2: Implementation of function, recursion, arrays, and pointers based several types of assignments. CO3: To detail out the operations of strings. CO4: To understand structure and union. CO5: Application of C-programming to solve various types of problems.						
Topics Covered	**List of Experiments:** 1. Programs on expression evaluation. 2. Programs on conditional statements and branching 3. Programs on iterations/loops. 4. Applications of Arrays 5. Programs on basics of functions and pointers.						

	6. Programs on string using array and pointers. 7. Programs on recursion. 8. Programs on structures, union. 9. Programs on File Operations. 10. Case Studies.
Text Books, and/or reference material	**Text Books:** 1. Y. Kanetkar, "Let Us C", BPB Publications, Sixteenth edition, 2017. 2. B. S. Gottfried, "Programming with C", McGraw Hill Education, 4th Ed., 2018. 3. E. Balagurusamy, "Computing Fundamentals and C Programming", McGraw Hill Education; Second edition, 2017. **Reference Books:** 1. P. Dey and M. Ghosh, “Computer fundamentals and programming in C”, Oxford press, 2013. 2. R. Thareja, “Computer fundamentals and programming in C”, Oxford press, 2013. 3. Schaum’s Outline, Programming with C.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS51	CO1	3	3	2	-	-	2	-	-	-	-	-	-
	CO2	2	2	1	-	-	1	-	-	-	-	-	-
	CO3	3	2	2	-	-	1	-	-	-	-	-	-
	CO4	2	3	2	-	-	2	1	-	-	-	-	-
	CO5	3	3	3	-	1	2	1	-	-	-	-	-

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

Course Code	**Title of the course**	Program Core (PCR) / Electives (PEL)	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PHS51	**Physics Laboratory**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					
Course Outcomes		CO1: To realize and apply different techniques for measuring refractive indices of different materials. CO2: To realize different types of waveforms in electrical signals using CRO. CO3: To understand charging and discharging mechanism of a capacitor. CO4: To understand interference, diffraction and polarization related optical phenomena. CO5: To acquire basic knowledge of light propagation through fibers.					
Topics Covered		1. Find the refractive index of a liquid by a travelling microscope. 2. Determine the refractive index of the material of prism using spectrometer. 3. Determination of amplitude and frequency of electrical signals by oscilloscope. 4. To study the characteristics of RC circuits. 5. To study Brewster’s law/Malus’ law using laser light. 6. To study the diffraction of light by a grating. 7. To study the interference of light by Newton’s ring apparatus. 8. To determine numerical aperture of optical fiber. 9. Determination of Planck constant.					

Text and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Mazumdar and B. Ghosh 2) Practical Physics – Worsnop and Flint

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHS51	CO1	3	2	1	-	-	-	-	-	2	1	-	1
	CO2	3	2	1	-	-	1	-	-	2	1	-	1
	CO3	3	1	-	-	-	-	-	-	2	1	-	1
	CO4	3	2	-	1	-	1	1	-	2	1	-	1
	CO5	3	2	1	-	1	1	1	-	2	1	-	1

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS51	**CHEMISTRY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					
Course Outcomes	• CO1: To learn basic analytical techniques useful for engg applications. • CO2: Synthesis and characterization methods of few organic, inorganic and polymer compounds of industrial importance. • CO3: Learn chromatographic separation methods. • CO4: Applications of spectroscopic measurements.						
Topics Covered	1. Experiments based on pH metry: Determination of dissociation constant of weak acids by pH meter. 2. Experiments based on conductivity measurement: Determination of amount of HCl by conductometric titration with NaOH. 3. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry 4. Estimation of metal ion: Determ. of total hardness of water by EDTA titration. 5. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, $Fe(acac)_3$, cis-bis(glycinato)copper (II) monohydrate and their characterization by m. p. , FTIR etc. 6. Synthesis and charact. of organic compounds: e.g.Dibenzylideneacetone. 7. Synthesis of polymer: polymethylmethacrylate 8. Verification of Beer-Lamberts law and determination of amount of iron present in a supplied solution. 9. Chromatography: Separation of two amino acids by paper chromatography 10. Determination of saponification value of fat/ vegetable oil						
	Suggested Text Books: 1. Vogel's Quantitative Chemical Analysis (6th Edition) Prentice Hall 2. Advanced Physical Chemistry Experiments: By Gurtu&Gurtu 3. Comprehensive Practical Organic Chemistry: Qualitative Analysis By V. K. Ahluwalia and S. Dhingra Suggested Reference Books: 1. Practical Chemistry By R.C. Bhattacharya 2. Selected experiments in Physical Chemistry By N. G. Mukherjee						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYS51	CO1	2	1	-	1	-	-	-	-	-	-	-	-
	CO2	-	1	-	1	1	2	-	-	-	-	-	-
	CO3	2	-	-	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	1	1	-	-	-	-	-	-	-

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES51	**ENGINEERING GRAPHICS**	PCR	1	0	3	4	2.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Ability of mental visualization of different objects • CO2: Theoretical knowledge of orthographic projection to solve problems on one/two/three dimensional objects • CO3: Able to read/interpret industrial drawing and to communicate with relevant people						
Topics Covered	Graphics as language of communication; technical drawing tools and their up-keep; types of lines; construction of geometrical figures; lettering and dimensioning. [6] Construction and use of scales; construction of curves of engineering importance such as curves of conic section; spirals, cycloids, involutes and different loci of points; use of equations for drawing some curves. [9] Descriptive geometry: necessity and importance of orthographic projection; horizontal and vertical reference planes; coordinate of points; orthographic projection of points and lines situated in different quadrants, viz. 1^{st}, 2^{nd}, 3^{rd} and 4^{th} quadrants; traces of lines. First angle and third angle projection of lines and planes; views from top, front and left (or right); true length and true inclination of lines with planes of projections; primary auxiliary projection of points, lines and planes; auxiliary plan and auxiliary elevation. [9] Projection of simple regular solids, viz. prisms, cubes, cylinders, pyramids, cones, tetrahedrons, spheres, hemi-spheres etc. [6] Section of solids; section by perpendicular planes; sectional views; true shapes of sections. [6] Dimensional techniques; international and national standards (ISO and BIS). [3] Freehand graphics. [3]						
Text and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… Engineering Drawing – N D Bhat 3)… Practical Geometry and Engineering Graphics – W Abbott						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

XES51	CO1	1	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	1	-	-	-	-	-	-	-	-	-	-
	CO3	1	-	1	-	-	-	-	-	-	-	-	-

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES52	**Basic Electrical and Electronics Laboratory**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	CO1: Learn to analyse the electric circuits using network theorems. CO2: Understand the characteristics of fluorescent lamp and compact fluorescent lamp. CO3: Analyze the behaviour of single phase and three phase AC circuits. CO4: Understand the application of electronics components, diode circuits as rectifier circuits and voltage regulators. CO5: Evaluate and study the performance of the transistor as a switch. CO6: Create inverting and non-inverting amplifier circuits using Op-Amp.
Labs Conducted.	1. Verification of the network theorems (DC). 2. Study of the characteristics of fluorescent and compact fluorescent lamp. 3. Analysis of the three phase system for star and delta connected load. 4. Study of the series and parallel R-L-C circuit. 5. Identify and understand the use of different electronic and electrical instruments, various electronic components. 6. Study of half-wave and full-wave (bridge) rectifier with and without capacitor filter circuit. Zener diode as a voltage regulator. 7. Study the performance of a transistor as a switch through NOT gate. 8. Realization of Inverting and Non-inverting amplifier using Op-Amp.
Text Books, and/or reference material	**TEXT BOOK** 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru , J M Chuma, H U Ezea. 2. Experiments Manual for use with Electronic Principles (Engineering Technologies and the Trades) by Albert Paul MalvinoDr., David J. Bates, et al. **REFERENCE BOOKS** 1. Laboratory Courses in Electrical Engineering (5th Edition) by S. G. Tarnekar, P. K. Kharbanda, S. B. Bodhke, S. D. Naik, D. J. Dahigaonkar (S. Chand Publications). 2. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill. 3. Electronic Principles, by Albert Paul MalvinoDr. and David J. Bate.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES52	CO1	3	3	3	3	3	1	1	1	2	2	2	3
	CO2	3	3	2	3	3	3	1	1	2	2	2	3
	CO3	3	3	2	3	3	2	1	1	2	2	2	3
	CO4	3	3	3	3	3	1	1	1	2	2	2	3
	CO5	3	2	1	2	2	1	-	-	2	-	-	-
	CO6	3	2	2	2	3	-	-	-	2	-	-	-

	CO7	3	3	2	2	-	-	-	-	2	-	-	-

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS52	**DATA STRUCTURES AND ALGORITHMS LABORATORY**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	CO1: Understanding the suitability and compatibility of array and linked list implementations for different application problems. CO2: Understanding the concept of abstract data types from real-life scenarios and their implementation in computing system. CO3: Identify, design and implementation of stack, queue, binary tree, and graph as applicable for given problem. CO4: Implementation of different searching and sorting techniques using appropriate data structures and perform efficiency analysis. CO5: Create efficient algorithms for real-life applications.
Topics Covered	**List of Experiments:** 1. Application of arrays using dynamic memory allocation. 2. Implementation and Applications of linked lists. 3. Implementation of stack, and applications of stack. 4. Implementation of queue, applications of queue: Priority queue. 5. Implementation of Binary tree, Binary tree traversal: Preorder, Inorder and Postorder traversal. 6. Implementation of binary search tree and operations on it. 7. Implementation of linear search, binary search (recursive, non-recursive). 8. Implementation of different sorting algorithms. 9. Implementation of graph algorithms: Breadth first search, Depth first search. 10. Case Studies.
Text Books, and/or reference material	**Text Books:** 1. S. Lipschutz, “Data Structures (Schaum’s Outline Series)”, McGraw Hill Education; First edition (2017). 2. E. Horowitz, S. Sahni, S. Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press; Second edition (2008). 3. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education India Private Limited, Seventh edition (2017). **Reference Books:** 1. B. S. Gottfried, "Programming with C", McGraw Hill Education, 4thEd. (2018).

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS52	CO1	-	1	1	1	-	-	-	-	-	-	-	-
	CO2	-	1	1	3	-	-	-	-	-	-	-	-
	CO3	2	2	3	2	1	-	-	-	-	-	-	-
	CO4	2	2	2	1	1	-	-	-	-	-	-	-
	CO5	3	3	3	3	3	-	1	1	-	-	1	2

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

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XXS51	**Extra Academic Activities**	PCR	**0**	**0**	**2**	**2**	**1**

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA))
NIL	CT+EA

Course Outcomes	• CO1: Social Interaction through the medium of sports • CO2: Team building and self defence
Topics Covered	**YOGA** • Introduction of Yoga- Suryanamaskar. 1L • Sitting Posture / Asanas – Padmasana, Vajrasana, ArdhaKurmasana, Ustrasana, Janusirshasana, Gomukhasana, Bhadrasana. 7L • Mudra- Gyana Mudra, Chin Mudra. 1L • Laying Posture/ Asana-PavanaMukhtasana, UttanaPadasana, Sarpasana, Bhujangasana (Cobra Pose), EkaPadaSalabhasana, Dhanurasana, Chakrasana, Viparitkarani, ArdhaHalasana (Half Plough Pose), Naukasana (Boat Posture), Shavasana (Relaxing Pose) , Makarasana. 7L • Meditation-Om Chant.1L • Standing Posture / Asana-Tadasana (Mountain Pose), Vrikshana (Tree Pose), ArdhaChandrasana, Padahastasana, ArdhaChakrasana (Half Wheel Posture). 5L • Pranayama-Deep Breathing, AnulomVilom, Shitali, Bhramari. 5L • Kriya- Kapalbhati 1L **TAEKWONDO** • Introduction About Taekwondo- Meaning Of Taekwondo, Korean Language Of Dress, Fighting Area, Punch, Block, Kicks Etc. 1L • Stance- Ready Stance, Walking Stance, Front Stance, Back Stance. 2L • Punch Technique- Front Fist Punch, Double Fist Punch, With Stance Etc. Blocks- Upper Blocks, Middle Block, Side Block, Suto Etc. 4L • Foot Technique- Standing Kick, Front Kick, Doliyo, Back Kick Etc. 6L • Poomsae (Forms)- Jang, Yi Jang. 6L • Self Defense Technique- Self Defense from Arms, Fist and Punch. 4L • Sparring (Kyorugi)- One Step Sparring 2L • Combination Technique- Combined Kick And Punch. 2L • Project Work 1L

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS51	CO1	-	-	-	-	-	2	-	-	2	-	-	1
	CO2	-	-	-	-	-	-	-	2	3	-	-	1

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

THIRD SEMESTER

<table>
<tr><td colspan="8">DepartmentofMathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleofthecourse</td><td rowspan="2">Program Core(PCR)/ Electives (PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MAC331</td><td>MATHEMATICS-III</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)andend assessment(EA))</td></tr>
<tr><td colspan="2">Basicknowledgeoftopics includedinMAC01&MAC02</td><td colspan="6"></td></tr>
<tr><td>CourseOut comes</td><td colspan="7">• CO1:Acquiretheidea aboutmathematicalformulations ofphenomenainphysicsandengineering.
• CO2: Tounderstandthe common numericalmethodsto obtaintheapproximatesolutions fortheintractablemathematicalproblems.
• CO3:Tounderstandthebasicsofcomplexanalysisanditsroleinmodernmathematics andappliedcontexts.
• CO4:To understand the optimization methodsandalgorithmsdevelopedforsolvingvarioustypesofoptimizationproblems.</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">PartialDifferentialEquations(PDE):
FormationofPDEs;Lagrangemethodforsolutionoffirstorderquasilinear PDE;Charpitmethodforfirstordernonlinear PDE;Homogenous and Nonhomogeneous linear PDE with constant coefficients:ComplimentaryFunction,Particularintegral;Classificationofsecondorderlinear PDEandcanonicalforms;Initial&BoundaryValueProblemsinvolvingonedimensionalwaveequation, one dimensionalheat equation and two dimensionalLaplace equation. [14]NumericalMethods:Significantdigits,Errors;Differenceoperators;Newton'sForward,BackwardandLagrange’sinterpolationformulae;Numericalsolutionsofnonlinearalgebraic/transcendentalequationsbyBisectionandNewton-Raphsonmethods;TrapezoidalandSimpson’s1/3rulefornumericalintegration;Euler’smethodandmodifiedEular'smethodsforsolvingfirstorderdifferentialequations. [14]
ComplexAnalysis:Functionsofcomplexvariable,Limit,ContinuityandDerivative;Analyticfunction;Harmonicfunction;ConformaltransformationandBilineartransformation;Complexintegration;Cauchy’sintegraltheorem;Cauchy’sintegralformula;Taylor’stheorem,Laurent’stheorem(Statementonly);Singularpointsandresidues;Cauchy’sresiduetheorem. [17]
Optimization:
MathematicalPreliminaries:HyperplanesandLinearVarieties;ConvexSets,PolytopesandPolyhedra. [2]
LinearProgrammingProblem(LPP):Introduction;Formulationoflinearprogramming problem (LPP); Graphical method for its solution; Standard form of</td></tr>
</table>

	LPP;BasicfeasiblesolutionsSimplexMethodforsolvingLPP. [9]
Text Books,and/or referencematerial	**TextBooks:** 1. AnElementaryCourseinPartialDifferentialEquations-T.Amarnath 2. NumericalMethodsforscientific&EngineeringComputation-M.K.Jain, S.R.K.Iyengar&R.K.Jain. 3. FoundationsofComplexAnalysis-S.Ponnuswami 4. OperationsResearchPrinciplesandPractices-Ravindran,Phillips,Solberg 5. AdvancedEngineeringMathematics-E.Kreyszig **ReferenceBooks:** 1. ComplexAnalysis-L.V.Ahfors 2. Elementsofpartialdifferentialequations-I.N.Sneddon 3. OperationsResearch-H.A.Taha

<table>
<tr><th colspan="8">DepartmentofMechanicalEngineering</th></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of thecours e</td><td rowspan="2">Program Core(PCR) / Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MEC301</td><td>Solid Mechanics</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)andEndAssessment (EA))</td></tr>
<tr><td colspan="2">EngineeringMechanics</td><td colspan="6">CA:CT +EA</td></tr>
<tr><td>CourseOu tcomes</td><td colspan="7">CO1:Basicunderstandingaboutelasticpropertiesofmaterials,analysisofstressandstrains,strainene rgyinsolidbodies.
CO2:Exposuretowardsstructuralmemberssubjectedtotensile,shear,bendingandtorsionalloads.
CO3:Ideaaboutanalyzingfordeflectionofbeams.
CO4:Evaluatefailurecriteriaofstructuralmembersundervariouscombinedloadingconditions.
CO5:Acquirethefundamentalsaboutstructuralmemberssubjectedtocompressiveloads,internalor externalpressure.</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">SimpleStressandStrain 04
Introductiontostressandstrains,GeneralizedHooke’sLaw,Relationshipamongdifferentelasticcoe fficients.
AnalysisofBeams 24
Theoryofbending,ShearingforcesandBendingmomentsinbeams,SFandBMDiagrams.Bending and Shear stresses in Beams, Flexural rigidity, Section modulus. Deflection ofBeams:Double-Integrationmethod,Area-Momentmethod.Staticallyindeterminatebeam problems.
ComplexStressandStrain 08
Transformations of stress and strain using analytical and graphical methods, Mohr’sCirclefora2-Dstateofstress,Stress,strainanddisplacementrelationship,Strainrosette.TorsionofCircularMembers 05
TorsionaldeformationsofacircularC/Smember,Shaftsinseriesandparallelconnection,TDD, Statically indeterminate shafts, Strain energy in torsion and pure shear, Design oftransmissionshafts, Stressconcentrationsintorsion.
TheoriesofFailures 05
Combinedloadingcasesandassociatedstresses,Theoriesoffailureforductileandbrittlematerials.
Columns 04
Fundamental concepts of buckling and stability of column using Euler’s theory, Criticalload,bucklingshape,andcriticalstressforvariouscolumns,LimitationofEuler’sformula.ThinPressureVessels 04
Stresses in thin cylinder, Deformation analysis of thin cylinder, Design of thin cylindricalshells.
EnergyMethod 02
Elasticstrainenergy,Castigliano’sTheoremsanditsapplications.</td></tr>
<tr><td rowspan="2">TextBook s,and/orre ferencema terial</td><td colspan="7">TextBooks:
1. Mechanics of Materials by F.P. Beer, E.R. Johnston, J.T. DeWolf, D.F. Mazurek, McGraw-HillEducation.
2. EngineeringMechanicsofSolidsbyE.P.Popov,PrenticeHall.
3. MechanicsofMaterialsbyB.J.GoodnoandJ.M.Gere,CengageLearning.</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. ATextbookofStrengthofMaterialsbyD.GhoshandK.Dutta,NewAgeInternationalPublishers.
2. StrengthofMaterials:PartI,IIbyS.Timoshenko,CBSPublishers.
3. StrengthofMaterialsbyS.S.Rattan,McGraw-HillEducation.
4. IntroductiontoSolidMechanics,I.H.Shames andJ.M.Pittariesi,PHI.</td></tr>
</table>

Department of Mechanical Engineering							
Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEC302	**Theory ofMachines andMechanisms**	PCR)	3	1	0	4	4
Pre-requisites		CourseAssessmentmethods					
XEC01		Continuous(CT)+MidTerm(MT)+EndTermassessment(EA)					
CourseOutcomes	CO1Understandtheprinciplesofdifferentlowerandhigherkinematicpairsandmechanisms CO2Analyze the mechanisms forposition,velocityandacceleration CO3AnalyzethedynamicsofICengineanditscomponents CO4 Synthesize planar four bar, slider crank mechanisms and cam profile for specified designrequirements						
Topics	**IntroductiontoMechanisms** Kinematiclinks,pairs,chains,mechanismsandinversions;degreesoffreedom,Gruebler'scriterion;Four barmechanismsandslidercrankmechanisms,SpatialMechanisms,Micro-mechanisms, Compliantmechanisms						**3**
	KinematicAnalysisofPlanarMechanisms Displacementanalysis,Velocityanalysis,Accelerationanalysis,ComputerAidedKinematic analysis						**5**
	KinematicAnalysisofSpatialMechanisms Displacement analysis, Velocity analysis, Acceleration analysis of mechanisms withopenkinematicchains						**5**
	KinematicSynthesisofPlanarLinkages Type,numberanddimensionalsynthesisforfunctiongeneration,Analyticallinkagesynthesis						**4**
	Gears&Geartrains Classification,Gearterminology,fundamentallawofgearing,formofteeth,velocityratio,pathofcontact, arcofcontact,KinematicanalysisofGeartrains:simple, compoundandepicyclicgeartrains						**4**
	CamMechanisms Camterminology,kinematicsanalysisoffollower,graphicallayoutofcamprofile						**3**
	ReviewofKinetics ofRigidBodies in3DPlanemotionofrigidbodies:						**4**
	DynamicAnalysisofLinkages Dynamic force analysis for slider crank mechanism; inertia forces in reciprocatingparts; primary and secondary inertia forces; simple engine mechanism –gas force,piston effort, gudgeon pin load,crankeffortorturningmoment;singleanddoubleactingengine;inertiaforceanalysisconsideringmassoftheconnectingrod;force analysisforafourbarmechanism						**7**
	Flywheels: Turningmomentdiagram,indicatordiagrams– meaneffectivepressuresforsuction,compression,expansionandexhauststrokes;overallmeaneffective pressureforthecycle;meanresistingtorque;fluctuationofenergyandspeed.						**5**
	GovernorMechanisms: Types,characteristicsofcentrifugalgovernors;conicalpendulumtypegovernors–Watt,Porter,andProell;Springloadedtypeof governors–Hartnell;controllingforce,effort,power,sensitiveness,isochronism,stabilityandhuntingof governors						**8**
TextBooks,and/orreferencematerial	**TextBooks:** 1. TheoryofMachines andMechanisms,UickerJ.J.,PennockG.R.,ShigleyJ.E. 2. TheoryofMechanismsandMachines,GhoshA.,MallikA.K.						
	ReferenceBooks: 1.IntroductiontothemechanicsofmachinesMorrisonJ.L.M.,CrosslandB.						

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<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleofthecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEC303</td><td>FluidMechanics</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td colspan="3">Nil</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1FundamentalofEngineeringfluidmechanics</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">I. Introduction: 08
Definition of fluid; Concept of continuum and Knudsen number; Concept of velocity,pressure and stressfields;Stresstensor;Fluidproperties;Slipandno-slip;Compressibilityandbulkmodulus; Vapour pressure; Surface tension; Capillary riseanddepression.
II. Kinematics of flowandflowmeasurements: 08
Definitionofflowfield;LagrangianandEuleriandescriptionoffluidmotion;Substantialderivative; Reynold’s Transport Theorem; Integral form of conservation equations offluid motion; Acceleration field;Pathline,streamsline,streakline,timelineandstreamtube;Puretranslation,rotationand linear and angular deformation of fluidelement;angularvelocity;vorticityand circulation;Freeandforcedvortexflows;Euler’sequationalongstreamline;Bernoulli’sEquation; Static,stagnationanddynamicpressures:ApplicationofBernoulli’s Equation.
III. Differentialanalysis of fluidmotions:Differentialcontrolvolume: 08
Conservationofmass;conservationofmomentum;Stokes’shypothesis;Navier-Stokesequation; Euler’sequationofmotionofanidealfluid;ExactsolutionsofNSequationsforsteady incompressible flow: plane Poiseuille flow, Couette Flow,fallingfilmflow,.
IV. IncompressibleFlowthroughpipesandducts: 06
Hagen-Poiseuilleflow,DarcyWesibachEquation,Majorandminorlosses,Surgecontrol;
V. DimensionalAnalysis: 04
Measurementanddimension;Variablesandfunctions;Dimensionalhomogeneity;PiTheorem;Dimensionlessparameters;Scalingrules,dimensionlessnumbers;Similitude;Similaritysolutions andtransformations;Geometricanddynamicsimilitude.
VI. Boundarylayer flows: 06
Boundarylayerconcepts;Prandtl’sboundarylayerequations;BlasiusEquationforflowover a flat plate; Momentum integral equations for boundary layers; Wall shear stress;Separationofboundarylayers;Fluidflows aboutimmersedbodies.
VII. Potentialflow: 06
Irrotational flow; Velocity potential and stream function; Stream function for two-dimensional incompressibleflow;Laplaceequation;Methodofsolution;Complexpotential for fundamental flows; Superposition of elementary flows; Flow about a halfbody; Uniform flow past a source and a sink, a doublet, and a cylinder with circulation;Aerofoiltheory.
VIII. Compressibleflow: 06
Propagationofsoundwave;Typesofflowregimes:Machcone;Stagnationand criticalstates;Isentropicflowofanidealgas:areavariation;Isentropicflowinconvergingandconverging-divergingnozzle;normal shock.</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. IntroductiontoFluidMechanics:Fox
2. FluidMechanics:MunsonandOkiish
3. FluidMechanics:RobertGranger</td></tr>
<tr><td></td><td colspan="7">ReferenceBooks:
1. FluidMechanics:FrankM.White
2. MechanicsofFluids:B.S.Massey</td></tr>
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<table>
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<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleofthecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEC304</td><td>EngineeringThermodynamics</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods{Continuous(CT)andendassessment (EA)}</td></tr>
<tr><td colspan="2">Nil</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1 To gain knowledge of thermodynamic systemsCO2TolearntheLawsofthermodynamics
CO3 To solve problems using the properties and relationships of thermodynamic systemsCO4Toanalyseairstandardcycles,vapourpowercycles,Compressors,refrigerationand air-conditioningsystems</td></tr>
<tr><td>TopicsCovered(Total Hours50)</td><td colspan="7">Basic definitions - microscopic and macroscopic approaches, engineering thermodynamicsystems.
Thermodynamic properties - definition and units, intensive, extensive properties, specificproperties.Thermodynamicstate-statepoint,statediagram,pathandprocess,quasi-staticprocess,cyclicandnon-cyclicprocesses.Thermodynamicequilibrium;definition,mechanicalequilibrium,thermalequilibrium,chemicalequilibrium,Zerothlawofthermodynamicsandtheconceptoftemperature.Measurementoftemperature.Thermodynamicdefinitionofworkandheat,signconvention.Displacementwork-expressionsthroughp-vdiagrams.Shaftwork;Electricalwork.Othertypesofwork.4L
Joule’s experiment and the first law of thermodynamics for cyclic and non-cyclic processes.Energy - modes. First law of thermodynamics for control volumes - steady flow energyequation(SFEE)andapplications.Limitationsoffirstlawofthermodynamicsandintroduction to the second law of thermodynamics. Heat engine – concept of efficiency.Concept of refrigerator and heat pump – coefficient of performance. Statements of secondlawandtheirequivalence-PMMIandPMMII. Carnotcycle. 6L
Definitions of a reversible process and irreversible process - reversible heat engine. Causesofirreversibility.UncheckedexpansionofCarnot’sengine.Internalandexternalreversibility.Definitionofthethermodynamictemperaturescale.Entropy-Clasiusinequality, change of entropy, entropy as a quantitative test for irreversibility, principle ofincrease in entropy, entropy as a coordinate. Available (Exergy) and Unavailable energy.Exergyanalysis.Irreversibilityandsecondlawefficiency. 4L
AirStandardCycles:Carnot,Otto,Diesel,DualCycles,Joule-Brayton,Reversed Carnot,ReversedJoule-BraytonCycles 5L
PropertiesofPureSubstances:SteamTables,MollierDiagram,P-hChart 6LVapourPowerCycles:Rankine,Reheat,RegenerativeCycles,BinaryVapourCycles 8LReciprocatingAirCompressor:SingleStageAirCompressor,IsothermalEfficiency,VolumetricEfficiency,TwoStageandMultistageCompression,Intercooler,IndicatorDiagram,MeanEffectivePressure, MechanicalEfficiency 4LRotaryCompressor:RootsBlower,VaneTypeBlower,RotaryDynamicCompressor,CentrifugalCompressor,MomentumPrinciples,Euler'sEquationforEnergyTransfer,StaticandTotalHeadQuantities,VelocityDiagrams 3LRefrigerationandAirConditioningBasics,VCRS,Refrigerants:Types,Properties,EnvironmentalImpact,GasReforming,PsychometricChart:BasicandApplications,Vapour AbsorptionRefrigerationSystem(VARS):PrinciplesandComponents,ComponentDesign</td></tr>
</table>

	andWorkinginRefrigerationandAirConditioningSystems,DesignofComponents:Compressors, Condensers, Evaporators, Design of Components: Compressors, Condensers,Evaporators10L
TextBooks,and/orreferencematerial	**TextBooks:** 1. M.J.Moran,H.N.Shapiro,FundamentalsofEngineeringThermodynamics,Wiley. 2. R. E. Sonntag, C. Borgnakke, G. J. Van Wylen, Fundamentals of Thermodynamics,Wiley. 3. P.K.Nag,EngineeringThermodynamics,McGraw-Hill. 4. Arora.C.P.,RefrigerationandAirConditioning,TataMcGrawHill **ReferenceBooks:** 1.Engineering Thermodynamics: Work and Heat Transfer by Gordon FrederickCrichtonRogers, YonRichardMayhew

DepartmentofMechanicalEngineering							
Course Code	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MES351	**Machine DrawingandSolidModeling**	PCR	0	0	3	3	2
Pre-requisites		CourseAssessmentmethods					
NIL		Continuous(CT)+EndTermassessment(EA)					
CourseOutcomes	CO1Todeveloptheabilityofmentalvisualizationofdifferentobjects CO2 To impart knowledge regarding standard conventions on lettering, dimensioning,symbols etc CO3Tointroducewiththetheoryoforthographicprojectiontosolveproblemsonone/two/threedimensional objects CO4Topreparefortheheighersemesterdepartmentaldrawings CO5Togiveexposuretoread/interpretindustrialdrawingandtocommunicatewithrelevantpeople						
TopicsCovered	**Part-I:** 1. Elevation,PlanandsideviewsandIsometricview. 2. Differenttypesofauxiliaryprojection. 3. Dimensionmethods anddifferentnotationsanddifferentrulesofdimensioning. 4. Differentsystems ofsectionaldrawing–sectionplanes,sectionlinesandconventions. 5. Conventionsusedinmachinedrawingtorepresentsomespecificaspectsmachineelements with theirdimensioninglikegears, shafts,threadsetc. 6. Conceptoftruesizeandtrueshape. 7. Conceptofmissinglines andmissingviews. 8. Assemblydrawingofamachinecomponentandpartdrawingofdifferentpartsofmachinecomponent –theirrelative positions andspacing. 9. Selectionofsuitablerepresentativescales. 10. Nameplateandbillofmaterials. **Part-II:** a. PartmodelingusingCADsoftware b. AssemblymodelingusingCADsoftware c. AutomaticdraftingusingCADsoftware						
Text Books,and/orreferencematerial	1. EngineeringDrawingandGraphics–KVenugopal 2. EngineeringDrawing–ND Bhat						

DepartmentofMechanicalEngineering							
Course Code	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MES352	**FluidMechanics Laboratory**	PCR	**0**	**0**	**3**	**3**	**2**
Pre-requisites		CourseAssessmentmethods(Continuous(CT)andend assessment(EA))					
FluidMechanics(MEC303)		CT+EA					
CourseOut comes	CO1:To impart knowledge on how the flow energy of one form is transformed intootherformfollowingBernoullie's principle. CO2:To impart expertise in calibration and efficient application of several devicesforflowmeasurementthroughclosed conduits aswellasopenchannels. CO3:To give basic knowledge on how to estimate the loss of flow energy over acertainlengthof pipe andacrossa pipe-bend. CO4:To give the idea of the extent of impulsive force of a fluid jet which can beutilizedfor hydro-power generation. CO5:Toenhanceskillandknowledgetodealwiththeissues inengineeringorindustrialflowapplication.						
TopicsC overed	1. VerificationofBernoullie'sTheorem. (CO1,CO5) 2. CalibrationofVenturimeter. (CO2,CO5) 3. CalibrationofOrificemeter. (CO2,CO5) 4. CalibrationofV-notch. (CO2,CO5) 5. Determinationoffrictionfactorinflowthroughpipes. (CO3,CO5) 6. Determinationofcoefficientofbendlossinflowthroughpipe.(CO3,CO5) 7. ExperimentonImpactofjet. (CO4,CO5)						
Text Books,and/o rreferencem aterial	**TextBooks:** *1.* MechanicsofFluids:Massey,B.S. *2.* FluidMechanics–J.F.Douglas,J.M.Gasiorek,J.A.Swaffied,L.B.Jack *3.* IntroductiontoFluidMechanicsandFluidMachines-S.K.Som,*et*al. *4.* HydraulicMachinery-JagdishLal						
	ReferenceBooks: FluidMechanics—F.M.White						

DepartmentofMechanicalEngineering							
Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
WSS381	**Workshop PracticeI**	PCR	**0**	**0**	**3**	**3**	**2**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
		CT+EA					
CourseOut comes	CO1: - Understand different manufacturing techniques and identify their uses.CO2: - Apply the different welding technique to produce joining effect betweendifferentparts. CO3: - Understand the foundry and forging techniques and use them to produceparts. CO4:-Selectcarpentryandfittingprocess tomakedifferentproducts.						
TopicsC overed	WeldingShop 2×3=6hrs • Introductiontoequipment&tools,electrode,weldingprocess(GTAW,SMAW,MIG,GasWelding),differentweldingjointsandweldingsymbols. • ElectricArcformation. • Demonstrationandformationofweldbeadby SMAWonmildsteelflat.						

	• Constructionofdiagrams&recordingtheprocedureindocument. • Safety precautions needed at Welding shop.FoundryShop 2×3=6hrs • IntroductiontoFoundryTechnology. • IntroductiontoPatternanditsallowances,ingredientsofmouldingsand. • Foundrytoolsandtheirpurposes. • Preparationofgreensandmouldusingsolidpattern. • Preparationofgreensandcore usingsplitcorebox. • Aluminiumcastingoftheabovemould. • SafetyprecautionsneededatFoundryshop. BlacksmithyShop 3×3=9hrs • IntroductiontoSmithy&Forging–Tools,Machines,Furnaces&itsaccessories. • Forgeabilityofvariousmetals&alloys • Making of bars of different cross-sections and measuring of temperatureusingdigitalpyrometer. • Safety precautions needed at Blacksmithy shop.CarpentryShop 2×3=6hrs • Introductiontowoods-types,structure,disease&defectsofwood. • Introductiontowoodworkingmachinesandtools. • Makingofdovetailjoint. • Makingofbridlejoint. • Safety precautions needed at Carpentry shop.FittingShop 2×3=6hrs • Introduction&demonstrationtohandmetalcuttingtoolswithspecifications andmaterials used,nomenclatureandtheiruse. • UseofDigitalmeasuringtools andconventionaltools. • Fittingofdifferenttypesofjointsusingmildsteelflats. • SafetyprecautionsneededatFittingshop. VivaVoce 1X3=3hrs.
Text Books,and/orreferencematerial	**TextBooks:**ReferenceBooks: 1. The Elements of Workshop Technology - Vol I & II, S.K. HajraChoudhury, A.K.Hajra 2. ManufacturingScience--A.Ghosh,A.K.Mallik 3. Principles ofFoundryTechnology--P.L.Jain
	ReferenceBooks:

DepartmentofMechanicalEngineering							
Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
XXS381	**Co-curricularActivity-III**	Optional	**0**	**0**	**0**		**0**
Pre-requisites							
CourseOutcomes							
TopicsCovered							
Text Books, and/or referencematerial		**TextBooks:** ReferenceBooks:					

FOURTH SEMESTER

CourseCode	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEC401	**Design ofMachineElements-I**	PCR	3	1	0	4	4
Pre-requisites		CourseAssessmentmethods					
MEC301(SolidMechanics)		Continuous(CT)+MidTerm(MT)+EndTermassessment(EA)					
CourseOutcomes	CO1:Tounderstandthebasicprinciplesofdeignofmachineelements CO2:Tounderstandthefundamentalsofmaterialselectionandmanufacturingconsiderationsindesign CO3:ToAnalyzesteadyandvariablestressesinducedinmachineelementsfordifferentapplications CO4:ToApplytheprinciplesandskillsforthedesignofvariousmachineelementslike shaft,keys,keyway,coupling,threadedfasteners,helicalandleafspringetc.forspecificapplications.						
TopicsCovered	Introduction:Reviewofstressanalysis,Theoriesoffailure,MachineDesignincontinuationo f strengthof materials.						2
	GeneralPrinciplesandProceduresofdesignofmachineelements,FactorofsafetyandServic e Factor						2
	ReviewofmechanicalpropertiesofEngineeringMaterials						1
	DesignunderStaticload:C-frames andCranehooks						3
	Designforvariableloading						6
	DesignofHelicalspringsandLeafsprings						7
	DesignofShaftunderstaticloads&fatigueload.						6
	DesignofKeys,Rigidandflexiblecouplings						4
	Designofnon-permanentjoint-Boltedjoints						5
	Designofpermanentjoints-RivetedandWeldedjoints						5
	Designofthickcylindersandpressurevessels						4
	Designofconnectingrods.						3
Text Books,and/orreferencematerial	**TextBooks:** Mechanical Engineering Design – J.E. ShigleyDesign of Machine Elements – V.B. BhandariDesignofMachineElements– M.F.Spotts MachineComponentDesign-Juvinall&Marshek						
	ReferenceBooks: MachineDesign–BlackandAdams MachineDesign:AnIntegratedApproach-Norton						

<table>
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEC402</td><td>Casting,Forming andWelding</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1.Learndifferent typesofcastingprocess.
CO2.Selectsuitablemanufacturingprocessfortypicalcomponents.CO3.Lea rnthe various weldingprocess.
CO4.Explaintheconceptofforging,rollingprocessanddrawing.</td></tr>
<tr><td>Topics Covered</td><td colspan="7"><u>Casting</u> (20 hrs)
Foundry:foundrymaterials-mouldingandcoresand-binders–additives;sand preparation-sandcontroltests 2
patternandpatternmaking 3
mouldandcoremaking, expendableandnon-expendablemoulds, 3
mouldassembly;solidificationofpure metals andalloys,graingrowth. 1
Castingprocesses-sandcasting,shellmoulding,investmentcasting,slushcasting, gravityandpressurediecasting,centrifugalcasting;continuous casting 5
castingdesign, gatewaysystemdesign, riser design 3
castingdefects-inspection, testing-destructiveandnon-destructive. 3
<u>Welding</u> (18 hrs)
Metaljoining- classification, weldingheatsources, 1
arcweldingmachines,arcproduction,arccharacteristics,metaltransfer, weldingelectrode, 5
resistancewelding, thermitwelding,solderingandbrazing, 2
gas welding, 3
Weldingmetallurgy,weldabilityofferrousandnonferrousmetals, 1
Weldingdefects,testingof welded joints 3
Othernonconventionalweldingmethodslike,ultrasonicwelding,electronbeam welding,laser beamweldingetc. 3
<u>Forming</u> (18 hrs)
Metalforming-cold,warmandhotworking.
Forging:processesanditsclassification-dropforgingandpressforging,opendie, impressiondie,closeddieandprecisionforgingprocesses.
grainflowinaforged product, 4
Specificforgingoperationslike,coining,piercing,hubbing,heading,Swaging,roll forging,orbitalforging, incrementalandisothermalforging. 2
Forgingdefects. 1
Rolling:Striprolling-recrystallisationandprocessdetails,Rollingmills,ringrolling, gearandthreadrolling,various rolledsections,defectsinrolledproducts. 5
Drawing:drawingterms andtheirdefinitions,circulardrawingdie,rodandwire andtube drawing. 4
Extrusion:processes-directandindirectextrusion,impactandhydrostaticextrusion, metalextrusionpractice,metalflowduringextrusion. 2</td></tr>
<tr><td rowspan="2">Text Books,and/o rreferencem aterial</td><td colspan="7">TextBooks:
1. ManufacturingProcessesforEngg.Materials-Kalpakjian
2. ProductionTechnology(volI&II)—R.K.JainandS.C.Gupta
3. ManufacturingProcesses:H.S.Shan,Vol.1
4.Atextbookof ProductionTechnology –P.C. Sharma</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. ManufacturingScience--A.Ghosh,A.K.Mallik
2. Principles ofFoundryTechnology--P.L.Jain</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEC403</td><td>HeatandMass Transfer</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td>Nil</td><td></td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1 Understand the relation between thermodynamics and heat transferCO2 Analyze problems involving steady and unsteady heat conductionCO3Estimateheattransferfornaturalandforced Convection CO4Analyseradiationproblemindifferentconfigurations CO5Solveengineeringproblems ofHeatandmasstransferequipment</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">Introduction,basicconceptsandmodes;relationshiptothermodynamics. 1
Conduction: Mechanism; Fourier law of heat conduction in 3-D, 1-D steady stateconductionwithheatgeneration,compositeplanewall,cylindersandspheres,thermalresistance network. Critical thickness of insulation; Use of analytical, numerical andgraphicalmethods,thermaldiffusivity,HeatTransferfromextendedsurface,Fineffectiveness and fin efficiency, Transient conduction, Lumped capacitance method,Fouriernumber 16
Conservation principles: various conservation equations, Relation between systemandcontrolvolumeapproach:MomentumTheorem,Entropygenerationminimizationas a general heat transfer objective, Basic convective configurations, Fluid flow andheat transfer aspect of internal flow, Fluid flow and heat transfer aspect of externalflow,Visualizationofconvection,Flowoveraflatplate,Conceptofthermalandhydrodynamicboundarylayers,Laminarandturbulentboundarylayers,Scalinganalysis, Natural, forced, mixed and turbulent convection, Dimensional analysis incorrelations for convective heat transfer, Relation between fluid friction and heattransfer,Analysis ofheatexchanger:LMTD,effectiveness-NTUmethod. 15
Radiation:physicalmechanism,radiationproperties,blackbodyradiation,greybody,spectral dependence of radiation properties, Wien’s displacement law, Kirchoff’s law.Shapefactor,heatexchangebetweeninfiniteparallelplanes,andGraybodies;radiationshields,networkrepresentation. 8
Mass Transfer: Diffusive and Convective mass transfer, Evaporation process in theatmosphere,Basicconceptofboilingandcondensation,Fick’slawanditsapplications. 8</td></tr>
<tr><td rowspan="2">Text Books,and/o rreferencem aterial</td><td colspan="7">TextBooks:
1. F. P. Incropera, D. P. Dewitt, T. L. Bergman, A. S. Lavine, Incropera's Principles ofHeatandMassTransfer,Wiley.
2. J.P.Holman,S.Bhattacharyya,HeatTransfer,McGrawHillEducation
3. Y. A. Cengel, A.J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications,McGrawHill.
4. J.H.LienhardV,J.H.LienhardIV,AHeatTransferTextBook,Dover.
5. A.Bejan,HeatTransfer:Evolution,DesignandPerformance,Wiley.</td></tr>
<tr><td colspan="7">ReferenceBooks:
1.S.Kakac,Y.Yener,C. P.Naveira-Cotta, HeatConduction,CRC Press.
2. U. Grigull, H. Sandner, Heat Conduction, International Series of Heat and MassTransfer.
3. T.Cebeci,P.Bradshaw,PhysicalandComputationalAspectsofConvectiveHeatTransfer ,Springer.
4. A.Bejan,ConvectionHeat Transfer,Wiley.
5. M.F.Modest,S.Mazumder,RadiativeHeatTransfer,AcademicPress.
6. E.R.G.Eckert,R.M.Drake,AnalysisofHeatandMassTransfer,McGrawHill.</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEC404</td><td>Dynamics ofMachines</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="2">Theory of Machines andMechanisms(MEC302)</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1Analysethegyroscopiceffectsonmechanicalsystems
CO2Minimiseunbalanceofrotatingandreciprocatingmachines
CO3 Introduction of single and two body lumped mass system with compliantelements anditsapplicationindesignofmechanicalsystems.</td></tr>
<tr><td></td><td colspan="7">TheoryComponent</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Gyroscope
Spinning,precessionandgyroscopiccouple;gyroscopiceffectonautomobiles,shipsandaeroplane;ApplicationofGyroscope 10
Balancing
Internal and external balancing; Balancing of rotating masses -single plane balancingand two plane balancing, Balancing of reciprocating masses – single cylinder engine,Veecylinderengine,andmulti-cylinderinlineengine. 10
Vibration
Longitudinal vibration, free vibration, damped vibration, and forced damped vibrationof SDOF system; Torsional vibration, free vibration of rotor system and torsionalequivalent shaft; Introduction to 2 DOF systems, vibration absorbers. Critical speed ofshaft with single rotor with and without damping. Whirling of shaft, Critical speed ofshaft having multiple rotor. Free vibration of elastic bodies, Vibration of strings,Longitudinal vibration of bars, Transverse vibration of beam, Torsional vibration ofshaft. 22</td></tr>
<tr><td rowspan="2">Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. TheoryofMachines andMechanisms,UickerJ.J.,PennockG
2. TheoryofMechanismsandMachines,GhoshA.,MallikA.K.
3. MechanismandMachineTheory,J.S.RaoandR.V.Dukkipati,</td></tr>
<tr><td colspan="7">ReferenceBooks:
1.Dynamicsofmachinery:Holowenko, AlfredR</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEC405</td><td>FluidMachines</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">MEC 303</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1: To acquire an in depth knowledge of hydraulic machines used in the IndustryCO2:Tolearnthebasic designprocedurefordifferenthydraulic machines</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">PrinciplesofSimilarity,SpecificSpeedandUnitQuantities(4)
Generalclassificationofhydraulicmachines-basicprinciples,torque,powerandefficiency.(2)</td></tr>
<tr><td></td><td colspan="7">A Brief introduction of 2 D Cascade Theory for Rotodynamic Machines (4)Hydraulic Turbines:(12)
ClassificationandtypesofTurbines.ImpulseTurbine:-PeltonWheel;.ReactionTurbine:-
Francis, Propeller and Kaplan turbines; Effective head, Available head andefficiency; Force, Torque, Power, Efficiency and Operation of Turbines; Principles ofsimilarity; Specific speed; Cavitation; Setting of turbines; Draft tubes; Penstocks; Surgetanks; Performance characteristics curves; Selection of types and speeds of turbines;Governingof turbines.
Pumps:(12)
Pumps:Classification;Rotodynamicpumps:-CentrifugalandAxialflowpumps;Torque, Power, Efficiency and Operation; Performance Characteristics; Principles ofSimilarity and Specific speed; Energy losses in pumps; Cavitation; Priming; Powerrequirements;Homologousoperation;SeriesandParalleloperation;Multistagepumps;Selectionandinstallationofpumpsofvariousduties;Testingofpumps.Cavitationandsettingheightofturbomachines
Reciprocatingpumps:-
Types;Workingprinciple;Instantaneousdischargeandaveragedischarge;Slip;Negativeslip,Coefficient of discharge and volumetric efficiency; Work done and overall efficiency;Indicatordiagram:-
effectofinertiaandfrictiononsuctionanddeliverypipes;Separationhead;Effectofbendondeliverypipe;Airvessels;Powersavedbyairvesselsinovercomingpipefriction;Dischargeinandoutofairvessel.Hydrauliccoupling;
Torqueconverter(2)</td></tr>
<tr><td>Text Books,and/or referencem aterial</td><td colspan="7">TextBooks:
1. MechanicsofFluids:Massey,B.S.
2. IntroductiontoFluidMechanicsandFluidMachines-S.K.Som,etal.
3. HydraulicMachinery-JagdishLal</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MES451</td><td>Solid MechanicsLaboratory</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>2</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">Engineering Mechanics(XEC01),Solid Mechanics (MEC301)</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: Graphical and experimental verification of the solid Mechanics andEngineeringmechanics</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">• Mohr’sCircleonstrainRosette-GraphicalSolution.
• Mohr’sCircleonMomentofInertia -GraphicalSolution.
• MechanicaltestingofEngineeringMaterials.
• Experimentsontheprinciplesofstrengthofmaterials.
• Instrumentationformeasurementofdeflectionunderloading.</td></tr>
<tr><td rowspan="2">Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1.StrengthofMaterials–A.PytelandF.L.Singer
2.</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. ElementsofStrengthofMaterials–S.P.TimoshenkoandD.H.Young
2. StrengthofMaterials–S.S.Rattan</td></tr>
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DepartmentofMechanicalEngineering							
Course Code	Titleofthecourse	Program Core(PCR) / Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T	Practical (P)	Total Hours	
MES452	**Mechanism Laboratory**	PCR	**0**	**0**	**3**	**3**	**2**
Pre-requisites		CourseAssessmentmethods(Continuous(CT)andendassessment (EA))					
EngineeringMechanics (XEC01)		CT+EA					
CourseOut comes	CO1: Students will be able to solve kinematics of mechanism by graphical methodCO2:Students willbeabletoanalyzemechanism bycomputeraidedtools CO3: Students will be able to solve mechanism synthesis problems usingcomputeraided tools CO4:Studentswillbeabletodemonstratemodeloffewplanarmechanisms						
TopicsC overed	• Determination of velocity and acceleration of various mechanisms by semigraphicalmethods. • Analysisofinertiaforces. • ComputerAidedKinematicAnalysisofplanarmechanisms • ComputerAidedMechanismSynthesisofplanarmechanisms • Modeling&simulationofmechanismsusingComputerAidedTools • Modelmaking						
Text Books,and/o rreferencem aterial	**TextBooks:** 1. Theoryofmachines andmechanisms–Uicker,PenrockandShigley 2. Theoryofmechanismsandmachines---Ghosh&Mallick 3. Theoryofmachines–SSRattan						
	ReferenceBooks: 1. Theoryofmachines –Thomas Bevan 2. Introductiontothemechanicsofmachines–MorrisonandCrossland						

DepartmentofMechanicalEngineering							
Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
WSS481	**Workshop PracticeII**	PCR	**0**	**0**	**3**	**3**	**2**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
		CT+EA					
CourseOut comes	CO1:- Understandmachiningprocessinconventionalmachinetoolslikelathe,shaper,millinget c. CO2:- Applytheconventionalmachiningprocessliketurning,facing,milling,chamferingetc to produce simple parts. CO3:-IdentifyCNCmillingmachineanddescribeit's working. CO4: - Execute G code and M code in CNC milling machine programming to producesimplejobs. CO5:-Demonstratedifferentelectricalequipmentandidentifytheiruses.						

TopicsCovered	**M/CShop** **5X3= 15 hrs.** • Introductiontovariousmachinetools-Lathe,Shaper,Milling,SurfaceGrinder,Planner, Radial Drillingetc. • Conceptofcuttingtoolmovementandjob position. • Conceptof differentoperationinacentre lathe. • Conceptofsimpleindexinginamillingmachine.
	• Jobinacentrelatheusingmildsteelcylindricalbarcomprisedoffacing,parallelturning &chamfering. • Jobina millingmachineusingcastirontoprepareaspur gear. • Jobina shaper machine. • Safetyprecautions neededatm/cshop. **CNCShop** **3×3=9hrs** • IntroductionofCNCmillingmachinesalongwithitsadvantages/disadvantagesoverconventional machines. • Introduction to various parts of CNC milling machine andkey/button/switch/modeof operatingsystems. • IntroductiontoG-codes(G00,G01,G02,G03,G04,G17,G18,G19,G54TOG59,G70,G71, G90,G91)andM-codes (M01,MO3,M04,M05,M08,M09,M30). • Zerooffsetsetting. • Programming andjoboperationonplainsurface milling/slotcutting byfacemillingcutter/endmillingcutter. **ElectricalShop** **3×3=9hrs** • Introduction & Demonstration regarding Procedure, Use, Hazards & Safetyprecautions of House Wiring system, Earthing System, Testing System / DOlStarter / Automatic Star Delta Starter / Soldering along with Tools, Materials &Instruments used. • Individually Practiced 3 types of connections of House Wiring, following thedrawncircuitsofbelowgivenproblemsbyusingtools &materials. Problem-1:Controllingalamp,afanandatwo pinplugsocket separately by using required switches placed in a board in PVC Conduit Wiringsystem. Problem-2: Controlling a lamp independently from two different places by usingrequiredswitchesinPVC CasingCappingwiringsystem. Problem-3:Controllingacallingbellplacedinsidetheapartmentalongwith IN&OUT marked two indicating lampsplacedoutsideofthat apartment for theinformation regarding house owner's presence by using required switches inConduitWiringsystem.Providedthatanyonelampwillglowonlywhenthe visitorwillpressthepushswitch.Nolampswillglow24hours.Callingbellshouldbeconnected justifiably.
Text Books,and/orreferencematerial	**TextBooks:**ReferenceBooks: 1. The Elements of Workshop Technology - Vol I & II, S.K. HajraChoudhury, A.K.Hajra 2. ManufacturingScience--A.Ghosh,A.K.Mallik 3. Principlesof FoundryTechnology--P.L. Jain
	ReferenceBooks:

DepartmentofMechanicalEngineering							
Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
XXS481	**Co-curricularActivity-IV**	Optional	**0**	**0**	**0**		**0**
Pre-requisites							
CourseOutcomes							
TopicsCovered							
Text Books, and/or referencematerial		**TextBooks:**ReferenceBooks:					
		ReferenceBooks:					

FIFTH SEMESTER

<table>
<tr><td colspan="8">DepartmentofMechanicalEngineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleofthecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEC501</td><td>Machining andMachineTo ols</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1:Knowledgeoffundamentalmachiningprocessesandtheunderlyingsciencesofmachiningand the related processes
CO2:Variousmachinetools,theiroperationsandthemechanismsinmachinetools</td></tr>
<tr><td>TopicsC overed</td><td colspan="7"><u>Machining</u> (28 hrs)
Introduction to Manufacturing processes and Metal cutting, Types of basic motions,Speed, feed and depth of cut, Shapes produced by different combination of motions,representationof chipformationin3D. 2
Cutting Tools: Single point, Multi point, Left hand and Right hand cutting tool.Singlepoint cutting tool nomenclature and representation in 3D, Tool geometry in ASA andORSsystems, Effectoftoolgeometryonperformance. 2
Experimentalobservationsin metalcutting-chipthickness,widthofcut,primarydeformationzone,shear angleconcept,Piispanen’smodel,typesofchipsandtheconditionsoftheirformation,strainhardening,heatgenerationanddissipation,cuttingfluid.OrthogonalandObliquecutting-2Dand3Drepresentation,effectonchipformation and on mechanics of chip formation. Concept of undeformed chip thickness,chip reduction coefficient determination-experimentally from chip length.Analyticaldeterminationofshearangleandshearstrainfromsimplegeometryofchipformation.
4
Forces in Metal cutting: Free body diagram and mechanics of chip formation, directionand Representation of forces on basic plane and orthogonal plane, 3D representationofforcesoncuttingtool,Merchant’sCircleDiagramrepresentationofforces,transformation offorces, kinematiccoefficient of friction, total work doneand itsdistribution, different specific energies, power estimation, Merchant’s first shear anglerelationshipanditsdeviationfromexperimentalobservations. 4
Tool life: Different way of tool failure, types of tool wear- their causes and remedies,features of flank and face wear, characteristic of wear growth, definition of tool life,factorsaffectingtoollife,Taylor’stoollifeequation,effectsoftoolgeometryontoollife.
4
Grinding- Machines and processes, Transverse grinding and plunge grinding, creep-feed grinding, centreless grinding, truing and dressing of grinding wheels, balancing ofgrindingwheels,Detailsofgrindingwheels-Manufacturingandspecifications,grindingwheelwear, grindingtemperature. 6
Nonconventional machining processes: Working principles, processes and mechanicsofprocessparameters andapplications.ECM, EDM,AJM,USM 6

<u>Machinetools</u> (28 hours)
Fundamentalof Machinetools, Machine toolelements. 1
General feature of construction and working of Lathe, Different parts of a Lathe, TypesofLatheandspecification.Backgeararrangement,Workholdingdevices.Screw cutting,Taperturning,Formturningandvariousotheroperationsperformedbya Lathe.Feed,speed, depthof cutandmachiningtime calculation. 6</td></tr>
</table>

	General feature of construction and working of Drilling machine, Different parts of aDrillingmachine,TypesofDrillingmachineandSpecification.Reaming,Threadingandvarious other operations performed by a Drilling machine.Types of Drill bits.Feed,speedandmachiningtimecalculation. 4 General feature of construction and working of Milling machine, Different parts of aMillingmachine,TypesofMillingmachineandSpecification.DividingheadandIndexingmethod.Upmilling,Downmilling,Spiralmillingandotheroperationsperformed by a Milling machine.Types and choice of Milling cutter. Machining timecalculation. 6 GeneralfeatureofconstructionandworkingofShapingmachineandSlottingmachine.Quick return mechanism. Whitworth mechanism, Feed mechanism.Types of tools.Machiningtimecalculation. 4 Gearmanufacture-milling,hobbingandshaping,Gearfinishingprocesses 4 Turret and Capstan Lathe: Types, parts, equipments and tools for use on turret andcapstanlathe,operationalplanningandturrettoollayout. 4
Text Books,and/or referencematerial	**TextBooks:** 1. MachiningandMachineTools –A.B.Chattopadhyay 2. Theoryofmetalcutting–G.Kuppuswamy 3. ManufacturingProcesses–H.S.Shan,Vol.2 4. AtextbookofProductionEngineering–P.C.Sharma 5. ProductionEngineeringSciences –PandeyandSingh
	ReferenceBooks: 1. ManufacturingScience–A.Ghosh,A.K.Mallik 2. Theoryofmetalcutting–SenandBhattacharya

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Course Code	Titleofthecourse	Program Core (PCR) / Elective(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T	Practical (P)	Total Hours	
MEC502	**IC Engine andGasTurbines**	PCR	**3**	**0**	**0**	**3**	**3**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
MEC304,MEC403		CT+EA					
CourseOutcomes	CO1: Explain the fundamental concepts (basic structure and operating principles) of ICengines. CO2: Understand the working principle of different types of gas turbines, Jetpropulsiveengines,andRockets. CO3: Evaluate the performance of IC engines based on conventional and alternative fuels.CO4:Analyze thecombustionphenomenoninSI andCI engines.						
TopicsCovered	**Introduction:** Basic Engine components and terminology, Classification of engines, Theworking principle ofengines, Comparison of2-stroke and 4-stroke engines; CIand SIEngines,Idealandactualworkingcycles andtheiranalysis,Valvetimingdiagram. 4 **ThermochemistryandFuels:**Combustionreaction,Stoichiometric,leanandrichcombustion, Engine exhaust analysis, Chemical structure of hydrocarbon fuels, Propertiesof SI and CI Engine fuels, Self-ignition and ignition delay, Fuel Ratings; Octane Number,CetaneNumber, Alternative fuelsforI.C. Engines. 8 **AirandFuelInduction**:Partsofintakesystem,Intakemanifold,Intakevalve,Fuelinjectors,Carburetor,Factorsaffectingvolumetricefficiency,Supercharging, Turbocharging,stratifiedchargedengine,Intakefortwo-strokeengine,scavenging,InductioninCI engine. 6						

	Combustion: Combustion in SI and CI Engines, Engine operating characteristics, Normaland Abnormal Combustion in SI and CI Engines, Stages of Combustion, Detonation andKnocking. 4 **EnginePerformance**:TestingofICengines,EnginePower,EngineEfficiencies,Performance Characteristics, Variables Affecting Performance Characteristics, Methods ofImprovingEnginePerformance,HeatBalance,Superchargingandturbocharging.5 **Engine friction and lubrication**: Engine friction, effect of engine parameters on enginefriction,determinationofenginefriction,propertiesoflubricants,typesoflubricants,lubrication systems. 3 **Engine cooling**: Necessity of engine cooling, cooling systems, and components of liquidcoolingsystems. 3 **Emission and Air Pollution**: Exhaust of IC engines, Composition of exhaust gases, Causesof HC, CO, NOx emission, Particulate matter and other emissions. After treatment: Thermalconverter,Catalyticconverter,Particulatetrap,EGR,Non-exhaustemission. 3 **GasTurbineandJetPropulsion**:IntroductiontoGasTurbines,Classification,andApplication of Gas Turbines, Ideal and Actual Cycles; Effect of Inter cooling, Reheating,Regeneration,Combinedcycle,andCogeneration.Criteriaofperformance,Intake,andpropellingnozzleefficiencies,SimpleTurbojetCycle,turbopropengine,Thrust augmentation,Gasturbinecombustionsystems,Combustionchamberdesigns,GasTurbineEmissions,Rocketengine. 6
TextBooks,and/orreferencematerial	**TextBooks:** 1. InternalCombustionEngine–VGanesan 2. I.C.EngineFundamentals–Heywood 3. EngineeringFundamentalsofICEngine—W.W.Pulkrabek
	ReferenceBooks: 1. I.C.Engines--P.W.Gill,Smith,Zury 2. I.C.EngineFundamentals--Obert

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Course Code	Titleofthecourse	Program Core(PCR)/Electives (PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEC503	**Design of MachineElements-II**	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and endassessment(EA))					
Theory of Machines andMechanisms(MEC302),Design ofMachineElementI(MEC401)		CT+EA					
CourseOutcomes	CO1Detailanalysisofmembersunderfatigueloads CO2 Design procedures for some machine elements used in mechanical drivesCO3Exposedtotheimportanceofengineeringtolerances andits use CO4 Introduction to different types of bearings and lubricationsCO5To understandthebasics of gearmechanics						

TopicsCovered	ManufacturingconsiderationsinDesign:FitsandTolerances. 4 Beltdrives:Flatbelts andV-belts. 5 Power screw 5 Bearings:Slidingcontactbearing;Rollingcontactbearings-Construction,Typesandselection,Constructionaldetails,Typesoflubrication. 7 ToothedGearDrive:Spurgear-Contactforces,Materials,StaticdesignbyLewisequation. 7 Dynamicloadsongears– Buckingham'smethod.Types,Terminology, Geometricalproportions,Analysisofcontact,Materials,AnalysisofForce,andDesignofHelical,
	BevelandWormgears.Checkfordynamicloadandwearstrength. Designofgearboxes. 15 Brakes:BandbrakesandShoe brakes 5 Clutch:FrictionclutchesandJawclutches. 4
Text Books,and/orreferencematerial	**TextBooks:** 1. MechanicalEngineeringDesign–J.E.Shigley 2. DesignofMachineElements–M.F.Spotts 3. DesignofMachineElements–V.B.Bhandari
	ReferenceBooks: 1.MachineDesign–BlackandAdams

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			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEC504	**ComputerAided Manufacturing andRobotics**	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and endassessment(EA))					
Machining, Machine Tools,KnowledgeonMechanisms		CT+EA					
CourseOutcomes	CO1Knowledgeoffundamentals ofNCandCNCmachines CO2Variousmachinetools,theiroperationsandthemechanismsinmachinetoolsprocesses CO3CNCprogrammingforcarryingoutDrilling,Millingandturning. CO5:Studentswillbeabletoanalyseandsolveproblemsonkinematicsand dynamicsofindustrial robots, jointtrajectoryformotionplanning. CO6:Studentswillbeabletodescribeandcomparevariousrobotsensorsandactuators						

TopicsCovered	**NCandCNCmachinesFundamentals(20hours)** CAM - concept and definition, NC (Numerical Control), CNC (Computerized NumericalControl)andDNC(DirectNumericalControl)-concept,featuresanddifferences.,Advantages andlimitations ofCNC.,SelectioncriteriaforCNCmachines.**:5** OverviewofAutomation:Definition,application,advantagesanddisadvantages,Introduction to Automation of different manufacturing processes, need of automationandcomponents.Typesofautomation:fixedautomation(automaticmachines,transferdevices and semi-automatics), Programmable automation (NC, CNC and machiningcenters,DNC,adaptivecontrolmachines,Industrialrobots,CAD/CAM,CIM)andflexibleautomation(FMS)**.: 7** NCandCNCTechnology:Types,Classification,Specificationandcomponents,ConstructionDetails,Controllers,SensorsandActuators,CNChardware:Recirculatingball screw, anti-friction slides, step/servo motors. Axis designation, NC/CNC toolingElementsofCNCmachines-Types,sketch,workingandimportanceof-i.Slideways.ii.Re-circulatingballscrew.iii.Feedbackdevices(transducers,encoders).iv.Automatictoolchanger (ATC). v. Automat:**8** **CNCProgramming(16Hours)** FundamentalsofPartprogrammingTypesofformat,ISOGandMcodesforturningandmilling-meaningandapplicationsofimportantcodes.**:5** SimplepartprogrammingforturningusingISOformathavingstraightturning,taperturning (linear interpolation) and convex/concave turning (circular interpolation) **:3**Partprogrammingfor–Drilling,Milling,Turning;Importance,types,applicationsandformatfor:i.Cannedcycles. ii. Macro.iii. Loops. iv.Subroutine :**8**

	FutureTrendsinCAM(6Hours) InterfacingstandardsforCAD/CAM-Typesandapplications,Adaptivecontrol-definition, meaning, block diagram, sources of variability and applications. FlexibleManufacturing System (FMS) - concept, evaluation, main elements and their functions,layoutanditsimportance,applications.**:3** ComputerIntegratedManufacturing(CIM)- Concept,definition,areascovered,benefits.Robotics- definition,terminology,classificationandtypes,elementsandapplications.Rapidprototyping- Conceptandapplication**:3** **<u>Robotics (14Hours)</u>** IntroductiontoRobotics:Basicstructure,classification,applicationsofrobots, Fundamentalsofindustry4.0andRoboticadditivemanufacturing(2hrs) Robot Arm Kinematics: Forward and Inverse kinematics, velocity and accelerationanalysisofserialmanipulator(5hrs) TrajectoryPlanningofManipulator:Jointspace scheme,Cartesianspacescheme (2hrs) IntroductiontoDynamicsofSerialManipulators:Lagrange-Eulerformulation(3hrs) Robot Sensorsandactuators(2hrs)
Text Books,and/or referencematerial	**TextBooks:** 1. CNC Machines, Pabla B.S., Adithan M., New Age International, NewDelhi,2014(reprint). 2. CAD/CAM,PrinciplesandApplications–PNRao,McGrawHill,2010 3. ComputerAidedManufacturing-Rao,Tewari,Kundra,McGrawHill,1993 **TextBooks(forRobotics):** 4.Saha,S.K.,IntroductiontoRobotics,TMHPublishingCompanyLtd.,NewDelhi,2008. 5.Pratihar,D.K.,FundamentalsofRobotics,NarosaPublishingHouse,India,2017
	ReferenceBooks: 1. ComputerNumericalControl,QuesadaRobert,PrenticeHall2014. 2. CAD/CAM: computer aided design and manufacturing. GrooverMikell P, ZimmeredWEmory, Prentice Hall 2011 **ReferenceBooks(forRobotics):** 3.Ghosal,A.,Robotics:FundamentalConceptsandAnalysis,OxfordUniversityPress, 2ndreprint, 2008.

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Course Code	Titleofthecourse	ProgramCore(PCR) / Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	TotalHours	
MES551	**HydraulicMachines Laboratory**	PCR	**0**	**0**	**3**	**3**	**2**
Pre-requisites		Course Assessment methods (Continuous (CT) and endassessment(EA))					
FluidMechanics(MEC303)FluidMachines(MEC504)		CT+EA					
CourseOutcomes	CO1:To experience and gain knowledge on the working principle ofrotodynamic andpositivedisplacementmachines. CO2:To impart expertise in operation and performance evaluation ofcentrifugalandreciprocatingpump. CO3:To give basic knowledge on working principle and operationalcharacteristics of impulsehydro-turbine. CO4:Toimpartexpertiseinworkingwiththereactionturbinesandunderstandtheirperformance characteristics. CO5: To enhance skill and knowledge to deal with the issues in hydraulicmachines for hydro-electric power generationapplication.						
TopicsCovered	1. Centrifugalpump. (CO1,CO2,CO5) 2. Reciprocatingpump. (CO1,CO2,CO5) 3. PerformancetestofPeltonwheelturbine. (CO1,CO3,CO5) 4. PerformancetestofFranciswheelturbine. (CO1,CO4,CO5) 5. PerformancetestofKaplanturbine. (CO1,CO4,CO5)						
Text Books,and/orreferencematerial	**TextBooks:** *5.* MechanicsofFluids:Massey,B.S. *6.* FluidMechanics–J.F.Douglas,J.M.Gasiorek,J.A.Swaffied,L.B.Jack *7.* IntroductiontoFluidMechanicsandFluidMachines-S.K.Som,*et*al. *8.* HydraulicMachinery-JagdishLal						
	ReferenceBooks: FluidMechanics—F.M.White						

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Course Code	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MES552	**HeatTransfer Laboratory**	PCR	**0**	**0**	**3**	**3**	**2**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
EngineeringThermodynamics (MEC304), Heat and MassTransfer(MEC403)		CT+EA					
CourseOutcomes	CO1: Fundamental concepts of Temperature measurement systemsCO2:Testonheat transferringapparatus CO3:Knowledge on conduction heat transferCO4:Knowledge on convection heat transferCO3:Knowledge onRadiationheattransfer						

TopicsCovered	Various types of temperature measuring and controlling instruments. Thermocouples,Thermostats etc. Fundamental concept and function of Multi-channel temperature indicator,Experiments on- Determinationofforcedconvectionheattransfercoefficientthroughpinfinforvariableflowratesof fluidat differentinlettemperature. DeterminationofLMTDandeffectivenessforparallelandcounterflowheatexchanger.Verificatio nofthelaws ofradiationwith thehelpofradiationlaboratoryunit. `
Text Books,and/orreferencematerial	**TextBooks:** 1. HeatTransfer--J.P.Holman 2. ACourseinHeatandMassTransfer--S.Domkundwar 3. ACourseinInternalCombustionEngines--R.P.Sharma,M.L.Mathur 4. I.C.Engines--P.W.Gill,Smith,Zury

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Course Code	Titleofthecourse	Program Core(PCR)/ Electives (PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MES553	**Robotics,AIand Mechatronics Laboratory**	PCR	0	0	3	3	2
Pre-requisites		CourseAssessmentmethods{Continuous(CT)andendassessment(EA)}					
Basic understanding of electronics,mechanicalengineeringprinciples, andcontrolsystems.		CT+EA					
CourseOutcomes	CO1TounderstandandanalyzeRobotics&MechatronicSystems: CO2 To design, assemble, and program a basic mechatronic system, integrating sensors,actuators,andcontrol algorithms						
TopicsCovered()	Fundamentals of robotic andmechatronic systemsInterfacingmechanical,electrical,andcomputersystemsOverviewofsensorsandactuators Buildingsimpleroboticandmechatronicsystems Closed loop PID (Proportional Integral Derivative) response of step inputAutonomous systemsusingembeddedcontrollers DemonstrationofRoboAnalyzersoftware ProgrammingusingPLC(ProgrammableLogicController)						
TextBooks,and/orreferencematerial	**TextBooks:** 1. De Silva, Clarence W., et al., eds. ***Mechatronics: fundamentals and applications***.CRC Press,2015						
	ReferenceBooks:						
TextBooks,and/orreference material	**TextBooks:** 2. De Silva, Clarence W., et al., eds. ***Mechatronics: fundamentals and applications***.CRC Press,2015						
	ReferenceBooks:						

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Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
XXS581	**Co-curricularActivity-V**	Optional	**0**	**0**	**0**		**0**
Pre-requisites							
CourseOutcomes							
TopicsCovered							
Text Books,and/orreferencematerial	**TextBooks:**ReferenceBooks:						
	ReferenceBooks:						

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE510</td><td>ConvectiveHeatandMass Transfer</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td colspan="2">EngineeringThermodynamics (MEC304), Heat and MassTransfer(MEC403)</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: Acquire an idea about convective transport mechanismCO2:To learnthebasicsof heatandmasstransfer
CO3: To learn about forced and natural convections and heat transfer in phasechange.
CO4:Introducedtophysicsofthermalsystemdesign.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Fundamentalprinciples:Basiclawsoffluidmechanicsandthermodynamics,scaleanalysis. 4
Laminar Boundary Layer: Concept of velocity and temperature boundary layers,integralsolutions,similaritysolutions,differentwallheatingconditions. 5
LaminarDuctFlow:Heattransfertodevelopedanddevelopingductflows. 5
Externalnaturalconvection. 4
Internalnaturalconvection. 4
Transitiontoturbulence. 2
Turbulentboundarylayerflowandductflow. 4
Freeturbulentflows:shearlayer,jets andplumes. 4
Convectionwithchangeofphase. 4
Mass transfer. 6</td></tr>
<tr><td rowspan="2">Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. ConvectionHeatTransfer–A.Bejan
2. ConvectiveHeatTransfer--L.C.Burmeister
3. PrinciplesofConvectiveHeatTransfer–M.Kaviany</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. ConvectiveHeatandMassTransfer –KaysandCrawford
2. ConvectiveHeatandMassTransfer–S.M.Ghiaasiaan
3. HeatConvection–L.M.Jiji</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MEE511</td><td>Advanced SolidMechanics</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">CourseAssessmentmethods(Continuous(CT)andEndAssessment(EA))</td></tr>
<tr><td colspan="3">SolidMechanics</td><td colspan="5">CA+ EA</td></tr>
<tr><td colspan="3">CourseOutcomes</td><td colspan="5">CO1: To recall the 2-d state of stress and to learn the 3-d state of stress and strainproblems.
CO2: Use/utilized the concept of 3-D stress and strain to formulate the mathematicalmodel of thick pressure vessels, unsymmetrical bending, curved beams and torsion ofnon-circularbar.
CO3: To employ energy methods to formulate mathematical models for different solidmechanics problems.
CO4: To solve the thick pressure vessels, curved beams and unsymmetrical bending ofbeam problems.
CO5:Toanalysistheabovementionedstructuralmembers</td></tr>
<tr><td colspan="3">TopicsCovered</td><td colspan="5">1. Three dimensional state of stress analysis: Concept of tensor, Rectangular StressComponents, Stress Components on an arbitrary plane, Equality of cross shear, PrincipalStresses,Stressinvariants,Mohr’sCircles,Maximum,octahedralshearandnormalstress,The state of pure shear, Plane state of stress, Equations of equilibrium, Equations ofequilibriumincylindricalcoordinatesystem.Axisymmetricandplanestress problem.8
2. Three dimensional state of strain analysis:Rectangular Strain Components, Straindisplacement relation for Cartesian coordinate system, Cauchy strain tensor, Principalstrains,Straininvariants,Planestateofstrain,Compatabilityconditions 6
3. Energy Methods: Work done by different type of loading and Elastic Strain Energy fordifferent type of loading, Superposition of Elastic strain energy, Theorem of virtual work,Derivation of equations of equilibrium and thin beam equation from Principal of virtualwork theorem, First theorem of Castigliano’s, Second theorem of Castigliano’s, Staticallyindeterminantproblem,Fictitiousloadmethod. 8
4. Analysis of axisymmetric Problems: Thick-walled cylinder subjected to internal andexternal pressures-Lame’s Problem, Stresses in composite tubes-Shrink fit, rotating discofuniformthickness. 7
5. Unsymmetricalbending ofbeams. 5
6. BendingofCurvedBeams 4
7. Torsion ofnon-circularbar 4</td></tr>
<tr><td colspan="3" rowspan="2">TextBooks,and/orreference material</td><td colspan="5">TextBooks:
1. AdvancedSolidMechanicsByL.S.Srinath
2. AdvancedStrengthofMaterialsByD.Ghosh</td></tr>
<tr><td colspan="5">ReferenceBooks:
1. AtextbookofStrengthofMaterials ByD.GhoshandA.K.Dutta
2. EngineeringMechanicsofSolidsByPopov</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE512</td><td>Multi-PhaseFlowand Heat Transfer</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="2">FluidMechanics(MEC303), HeatandMassTransfer (MEC403)</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1:Leadsstudentstowardaclearunderstandingandfirmgraspofthebasicprinciples ofmultiphase flowandheat transfer.
CO2:Understandsthefluid-dynamicinvolvedinconvectionandmulti-phaseheattransfer.
CO3:Performselementaryanalysisofmostgas-liquidtwo-phasesystemsandpreparestousemore advanced models.
CO4: Equips the student with the analytical model to apply the fundamentals to a widevarietyofcomplexengineeringproblems,formulatethemandinterprettheresults.
CO5: Student can analyze Hydrodynamics of three phase flows and compare twophaseflowsituations.</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">Introduction,FlowRegimes, 5
HomogeneousFlow,SeparatedFlow 4
Condensation, 2
Onedimensionalsteadyseparated flowmodel, 6
Flowinwhichinertiaeffectsdominate,energyequations, 3
Theseparatedflowmodelforstratifiedandannularflow, 2
Generaltheoryof driftfluxmodel, 3
Applicationofdriftfluxmodeltobubblyandslugflow, 4
Hydrodynamicsofsolid-liquidandgas-solidflow, 4
Anintroductiontothree phaseflow, 3
Fluid-Population Balance Technique, Volume of Fluid Method, Lattice BoltzmannModel. 6</td></tr>
<tr><td>Text Books,and/o rreferencem aterial</td><td colspan="7">TextBooks:
1. Ghiaasiaan, S. M., Two-Phase flow, Boiling, and Condensation, CambridgeUniversityPress.
2. Brennen, C.E., Fundamentals of Multiphase Flow, Cambridge University PressCollier, J. G. and Thome, J. R., Convective Boiling and Condensation, 3rd ed.,OxfordUniversityPress
3. Wallis,G.B.,OneDimensionalTwoPhaseFlow,McGrawHillHigherEducation.
4. Hewitt,G.F.,MeasurementofTwoPhaseFlowParameters.
5. Govier,G.W.,andAziz,k.,FlowofComplexMixtures.
6. Hetsroni,G.,HandbookofMultiphasesystems.</td></tr>
</table>

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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE513</td><td>Tribology</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">Solid Mechanics (MEC301),FluidMechanics(MEC303)</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1: Understand the basic knowledge of surface topography and contact betweenengineeringsurfaces.
CO2:Understand the basic theory and application of friction and wear for differentmaterials
CO3: Understand about lubricants and lubrication for different bearingsCO4:ApplyMicro-NanotribologyforMEMS applications
CO5:ApplyBio-tribologyforhumanjoints</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">Surfacetopography:Measurementofsurfacetopography;Quantifyingsurfaceroughness;The topographyof engineeringsurfaces. 3
Contactbetweensurfaces:Hertziancontact–sphereonspherecontactandcylinderoncylindercontact;Contactbetweenroughsurfaces. 6
FrictionandWearofcontactsurfaces:LawsandTheoriesoffrictionandwear;FrictionandWearofdifferentmaterials;Applicationtofrictionmaterials. 12
Lubricantandlubrication:Viscosityoflubricants;Compositionandpropertiesofoilsandgreases;Reynoldsequation;Typeoflubrications-Hydrostaticlubrication, Hydrodynamiclubrication;Elastohydrodynamiclubrication;Boundarylubrication,andapplicationtobearings. 12
Micro-Nanotribology:Surfaceforcesandadhesion;Atomicforcemicroscopy(AFM);Friction,wearand lubricationonatomiclevel;ApplicationstoMEMS 7
Biotribology:Naturalhumanjoints;Structureandpropertiesofarticularcartilage;Mechanismof synoviallubrication:Mechanism of articularcartilagedamage;Artificial jointreplacements 8</td></tr>
<tr><td>Text Books,and/o rreferencem aterial</td><td colspan="7">TextBooks:
1. EngineeringTribology-Dr.PrasantaSahoo
2. IntroductiontoTribologyofBearings--B.C.Majumder
3. Principles ofTribology--J.Halling
4. BasicLubricationTheory-AlastairCameron</td></tr>
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<tr><td colspan="8">DepartmentofMechanicalEngineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of thecourse</td><td rowspan="2">ProgramCore (PCR) / Electives (PEL)</td><td colspan="4">TotalNumberof contacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE514</td><td>MaterialsScienceand Engineering</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods (Continuous(CT)andend assessment (EA))</td></tr>
<tr><td colspan="2">EngineeringPhysics, EngineeringChemistry.</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">• CO1:COMPAREcrystal structureandCORRELATEimperfectionsincrystalwithmechanical behavior ofmaterials.
• CO2: IDENTIFY&ESTIMATEdifferentparametersofthesystemsviz.phases,variables,component, grains andgrain boundaryetc.
• CO3:ANALYSEheattreatmentonpropertiesofmaterials.
• CO4:SELECTappropriatematerialsforvariousapplications.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">HistoricalDevelopment and ClassificationofEngineeringMaterials: IntroductiontoMaterialsScienceandEngineering,RelationshipbetweenProcessing-Structure-Properties-Performance,ChallengesandFactorsAidinginMaterialSelection,ClassificationofMaterials,AdvancedMaterialsandModernMaterialsNeeds. (03)AtomicStructureandBonding,CrystalStructureandDefectsinSolids:AtomicStructure,AtomicBondinginSolids,CrystalStructure:Unit cells,Metalliccrystalstructures,PolymorphismandAllotropy,CrystallographicPoints,Directions,andPlanes,MillerIndices,CrystallineandNon-crystallineMaterials,Anisotropy.DefectsinCrystallineMaterials:Theoreticalyieldstrength,Point(0-D)defects,Line(1-D)defectsorDislocations,InterfacialDefects,BulkorVolume(2-D)Defects,AtomicVibrations. (08)
PhasediagramandIronCarbondiagram:
SolidSolutions:-Introduction,Types,Humerotheryruleforsubstitutionalsolidsolution (03)
Solidification:-Nucleationandcrystalgrowth,Solidificationofpuremetal,solidificationofalloys. (02)
Phasediagram:-Coolingcurves,types ofphasediagrams,Gibbs phaserules. (03)IronCarbonDiagram:-Iron-carbonequilibriumdiagramsindetailwithemphasisininvariantreactions. (03)
HeatTreatments:
Austenitetransformationinsteel:-Timetemperaturetransformationdiagrams,Continuouscoolingtransformationdiagram. (04)
HeatTreatmentProcesses:-Introduction,Annealing(Fullannealing,Processannealing,Spheroidiseannealing,isothermalannealing,stressreliefannealing)Normalising, Hardening,Tempering,Austempering,Martempering,Sub-zerotreatment,Hadenability. (04)
SurfaceHardening:-Classification,Flamehardening,Inductionhardening,Carburising,Nitriding,Cabonitriding. (02)
Properties, Applications and Processing of Materials: Mechanical Properties ofMetals. Applications and Processing of Metallic Alloys. Structures,Properties, ApplicationsandProcessingofCeramics.Structures,Characteristics,Applications, and</td></tr>
</table>

	Processing of Polymers. Composite materials. Electrical Properties.ThermalProperties.MagneticProperties.OpticalProperties. **(10)**
Text Books,and/ orreference material	**TextBooks:** • Material Science & Metallurgy for Engineers :- DR. V. D. Kodgire& S. V.Kodgire • MaterialsScienceandEngineeringIntroduction:-WilliamD.Callister • MaterialsScience&Engineering:-RaghvanV.
	ReferenceBooks: • MechanicalBehaviour&TestingofMaterials:- A.K.Bhargava,C.P.Sharma • ManufacturingEngineeringandTechnology:-SeropeKalpakjian, Steven R.Schmid

DepartmentofMechanicalEngineering							
Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MEE515	**Operations Research**	PEL	**3**	**0**	**0**	**3**	**3**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
NIL		CT+EA					
CourseOutcomes	CO1:Studentswillbeabletodiscussthehistory,concepts,formulationsandapplicationsofoperations research. CO2:Studentswillbeabletoanalyzeandsolveconflictingproblemsonconstrainedlinearoptimization problemshavingsingleandmultipleobjectives. CO3: Students will be able to apply integer, dynamic programming methods for solvingrelevantproblems.						
TopicsCovered	Origin,growth,definition,methodologyandapplicationofOR. 2 LinearProgramming,MathematicalModelling,GraphicalMethodofSolution,SensitivityAnalysis. 8 SimplexMethod,BigMand2-PhaseMethods,DualityinLP. 7 Transportationproblem. 3 AssignmentProblem 3 Sequencingproblem. 2 QueuingmodelandSimulation. 3 CompetitiveDecisionMaking,GameTheory. 4 DualityTheoryandSensitivityAnalysis. 3 IntegerProgramming,BinaryIntegerProgramming. 4 DynamicProgramming. 3						
TextBooks,and/orreferencematerial	**TextBooks:** **1.** Hillier,FredrickS.andLieberman,GeraldJ.,IntroductiontoOperationsResearch,7thEdition,TMH,2001. **2.** Basu,S.K.,Pal,D.K.,Bagchi,H.,OperationResearchforEngineers,2nd Edition,Oxford&IBHPublishingCo. Pvt.Ltd.,1998 **3.** Taha,H.A.,OperationResearch,McMillanPublishingCo.,London,1982.						
	ReferenceBooks: **1.** Churchman,C.M.,Ackoff,R.L.,Arnoff,E.L.,IntroductiontoOperationResearch,AsiaPublishingo.,1962 **2.** Hanssmann,F.,OperationsResearchinProductionandInventoryControl,JohnWiley&Sons, Inc., London, 1962.						

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<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of thecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE516</td><td>Mechatronics</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">MEC301,MEC504</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1:Studentswillbeabletoidentifytheimportanceofamalgamationbetweentheelectronics andelectro-mechanical systems.
CO2:Studentswillbeabletoformulateandevaluatebehavioroflineartimecontinuous control systems.
CO3:Studentswillbeabletoformulatetheprocedureforconvertinganalogsignalstodigitalforma ndvice-versa.
CO4:Studentswillbeabletodescribesignalsanditsprocessingbymodernelectronicmethods.
CO5: Students will be able to identify and critically evaluate current developmentsandemergingtrends withinthe field ofmechatronicsystems.</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">MechatronicSystems:Introduction,ApplicationofMechatronics. 2
SensorsandTransducers-Briefreview,Simpleelectronicelements&OperationalAmplifiers. 4
Actuators:Pneumatic,Hydraulic,Electrical&Mechanicalactuationsystem,Micro-actuators.3
ModellingandSimulationofPhysicalSystem:Systemmodels,Dynamicresponsesofthesystem,S ystem transferfunctions. 4
Digitallogic:Numbersystems,Booleanalgebra,Logicgates-Applicationgate,Designoflogicofdigitallogicgates. 5
Microprocessors and Micro-Controllers: Introduction, Microprocessor Architecture,Instructioncodes,Generalrequirements forimplementationissues,Examples.6
ProgrammableLogicControllers:Basicstructure,I/Oprocessing,Programming,Timer,Interrela ys andCounters. 6
Signal conditioning & Digital communication system: Basics of signal conditioning,Filtering, Data acquisition and Digital signal processing, Digital communication andCommunicationinterface. 6
MechatronicSystems,CaseStudies. 6</td></tr>
<tr><td rowspan="2">Text Books,and/o rreferencem aterial</td><td colspan="7">TextBooks:
1. Alciatore, D. G. and Histand, M. B., Introduction to Mechatronics and MeasurementSystems,McGrawHillPublications, 4th Edition,2012.
2. Bolton,W.,Mechatronics,PearsonEducationIndia,2008.
3. Gaonkar,R.S.,MicroprocessorArchitecture,ProgrammingandApplicationswith8085,Pen ramPublishersIndia, 6thEdition,2013.</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. Malvino, A. P., and Bates, D. J., Electronic Principles, TMH Publishing Company Ltd.,NewDelhi, 8thEdition,2016.
2. Nise, N. N., Control Systems Engineering, 6thEdition, John Wiley & Sons, Inc., USA,2011.</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE517</td><td>Advanced FoundryEngineering</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and endassessment(EA))</td></tr>
<tr><td colspan="2">MEC402(Casting,FormingandWelding)</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">• CO1 At the end of the course student will be able to get the knowledge aboutvariousaspectsofcastingprocesses andtheunderlyingscience
• CO2:various typesofcastingmethods
• CO3:Applicationfieldsofvariouscastingprocesses</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">CastingProcesses:Classification,characteristicsofsandcastingprocesses,metalmould casting process, Pattern materials, types of patterns, Mould and core makingmaterialsandtheircharacteristics. (12)
Solidification of metals: Nucleation and grain growth, solidification of pure metals,shortandlongfreezingrangealloys,Rateofsolidification,macrostructureandmicrostructure.SolidificationContraction,Grainrefinement (6)
SandCastingDesign:Gatingandriseringdesigncalculations,Fluidityanditsmeasurement. (6)
Investment casting, shell moulding, squeeze casting, vacuum casting, counter-gravityflow-pressurecasting,Directionalandmonocrystalsolidification,squeezecasting,semisolidmetalcasting,rheocasting. (8)
Familyofcastiron–DuctileIron,MalleableCastIron, (3)
Casting defects- inspection and testing , analysis of casting defects, nondestructivetestingofcasting-dyepenetranttesting,magneticflawdetection,radiography,ultrasonictesting,etc. (4)
Near net shape casting processes, Modern foundry practices and special castingmethod.Continuouscasting (3)</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. JohnCampbell,“CastingPractice”ElsevierSciencePublishingCo.,2004
2. ScropeKalpakjian, “Manufacturing processes for Engineering Materials”,Addision,Wesley,1997.
3. P.C.Mukherjee,Fundamentalsofmetalcastingtechnology-OxfordandIBH
4. Beely,FoundryTechnology,Newnes-Butterworths,1979
ReferenceBooks:
1. Castingpropertiesofmetalsandalloys-V.Korolkove.
2. ASMHandBook“Casting”,ASMInternational1998.</td></tr>
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<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of thecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE518</td><td>Engineering Optimization</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="6">CO1:Studentswillbeabletodescribeandformulateoptimizationproblems
CO2: Students will be able to apply knowledge of different optimization methods forsolvingengineeringproblems
CO3: Students will be able to differentiate between optimization methods and suggestasuitabletechniqueapplicablefora specificproblem.</td></tr>
<tr><td>TopicsC overed</td><td colspan="6">Introduction:EngineeringApplication,StatementandClassificationoftheOptimizationProblem ,Classification, formulationprocedures. 4
Classical Methods: Single Variable Optimization; Multivariable Optimization withoutany Constraints with Equality and Inequality Constraints, Kuhn–Tucker Conditions;LinearOptimizationMethods,One-DimensionalMinimizationMethod.UnimodalFunction. 6
EliminationMethods:Exhaustivesearch, Fibonocci andGoldenMethod. 3
InterpolationMethod–Quadratic andCubicInterpolationMethod. 2
UnconstrainedMinimizationMethod--Univariate,ConjugateDirections,SteepestDescent(Cauchy)Method,Newton’sMethod,MarquardtMethod,Quasi-NewtonMethod. 6
ConstrainedMinimizationMethod,RandomSearchMethods,SequentialQuadraticProgramming.BasicApproachofthePenaltyFunctionMethod,InteriorPenaltyFunctionMethod, ExteriorPenaltyFunctionMethod. 5
Non-traditional Optimization Techniques - Genetic Algorithms. Simulated annealing.Particleswarm optimization.AntColonyOptimization.Tabusearch. 11
Reductionofsizeofanoptimizationproblem.Scalingofdesignvariablesandconstraints. 3
IntroductiontooptimizationToolboxinMATLAB. 2</td></tr>
<tr><td rowspan="2">Text Books,and/o rreferencem aterial</td><td colspan="6">TextBooks:
1. S.S.Rao,EngineeringOptimization,TheoryandPractics,3rdEnlargedEdition,NewAgeInternational Publishers,NewDelhi, 2010.
2. Ashok D. Belegundu and Tirupathi R Chandrupatla, Optimization Concepts andApplicationsinEngineering,PearsonEducation1999,FirstIndiaReprint,2002.</td></tr>
<tr><td colspan="6">ReferenceBooks:
1. G.N.Vanderplaats,NumericalOptimizationTechniquesforEngineeringDesignwithApplications,McGraw-Hill, NewYork, 1984.
2. R. L. Fox, Optimization Methods for Engineering Design, Addison- Wesley, Reading,Mass,1971.</td></tr>
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SIXTH SEMESTER

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<tr><th colspan="8">DepartmentofMechanicalEngineering</th></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleofthecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEC601</td><td>Power GenerationTechnologies</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods {Continuous (CT) and end assessment(EA)}</td></tr>
<tr><td colspan="2">MEC304,MEC403</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1 To remember the basics of power generation cyclesCO2Tounderstandthedifferentenergysources
CO3 To analyse and evaluate the performance of different power generation technologiesCO4To designthe differentcomponentsof power generationsystems</td></tr>
<tr><td>TopicsCovered(Totalhours39)</td><td colspan="7">Primary and Secondary Sources of Energy, Global trends for per capita consumption ofenergy, Demand for energy and future availability in usable form, Recent developments intherenovationof energysources 2
Analysis of Steam Cycles: Steam power plant outline, Effect of steam conditions on thermalefficiency,Regenerativefeedheating,feedwaterheaters,andoptimumdegreeofregeneration, Deaerator,co-generationofpowerandprocessheat 9
Fuelsand Combustion:Coalrankingandanalysis,fueloil,naturalandpetroleumgas,Combustion reactions, Combustion Equipment, and Firing Methods: Fuel bed combustion,Pulverizedcoalfiring,Cyclonefurnace 7
Fluidizedbedcombustion:CirculatingFluidizedBedandBubblingFluidizedBed 2
Gasification:Coalandbiomassgasification 2
SteamGenerators:High-pressureboilers,subcriticalandsupercriticalboilers,Calculationoneconomizer,superheater,reheater, andairpreheater 4
Draughtsystems:ForcedDraught(FD),InducedDraught(ID),andbalanceddraught,calculationoffanpower 2
Circulation:naturalandforced,circulationratio,performance ratingofboilers 1
FlowThroughNozzlesandDiffusers,shocks,super-saturationofsteamthroughnozzleflow4
SteamTurbines:Machinesworkingonimpulseandreactionprinciples,Turbineblading,velocitytriangles,bladespeedratio,Velocityand pressurecompounding,stageand overall efficiencies,degreeofreaction 6</td></tr>
<tr><td rowspan="2">TextBooks,and/orreferencematerial</td><td colspan="7">TextBooks:
1. PowerPlantEngineering-P.K.Nag
2. PowerPlantTechnology-M.M.El.Wakil</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. PowerPlantEngineering-F.T.Morse
2. SteamTurbineDesignandPractice-Kareton
3. PowerPlantEngineering-BlackandVeatch
4. ACourseinPowerPlantEngineering-S.Domkundwar,S.C.Arora.</td></tr>
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<tr><td colspan="7">DepartmentofHumanitiesandSocialSciences(offeredforall)</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of thecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>HSC631</td><td>Economicsand Management Accountancy</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5"></td></tr>
<tr><td colspan="2">CourseOutcomes</td><td colspan="5">• Learnerswillbeabletoreviewbasiceconomicprinciples.
• Learners will be introduced to the basic capital appraisal methods used forcarrying out economic analysis of different alternatives of engineeringprojectsor works.
• Learnerswillgainagoodknowledgeoffinancialaccounting,enabli ngthemprepare,analyseandinterpretfinancialstatementsfortakin ginformed
decisions.</td></tr>
<tr><td colspan="2">TopicsCovered</td><td colspan="5"><u>PART1:Economics</u>
GroupA: Microeconomics
Unit 1: Economics: Basic Concepts, Unit 2: Theory of Consumer Behaviour, Unit 3:Theory of Production, Cost and Firms, Unit 4: Analyses of Market Structures: PerfectCompetitionUnit5:MonopolyMarket,Unit6:GeneralEquilibrium &Welfare
Economics
GroupB:Macroeconomics
Unit 1: Introduction to Macroeconomic Theory; Unit 2: National Income AccountingUnit 3: Determination of Equilibrium Level of Income; Unit 4: Money, Interest andIncome; Unit 5: Inflation and Unemployment; Unit 6: Output, Price and Employment<u>PART2:ManagementAccountancy</u>
Unit1: IntroductiontoAccounting: 3L
Accounting Environment of Business; Objectives of Unit 1: Accounting; AccountingEquationsforFinancialStatements.BooksofAccounting:Journa l,Ledger,Cashbook.
Unit2:FinancialStatementPreparation andAnalysis: 5L
Preparation of Trial Balance, Trading, Profit & Loss, account and Balance Sheet. Casestudydiscussion.
Unit3:FinancialRatioAnalysis: 4L
CommonSizeStatements;ComputationofFinancialRatios;Interpretationa ndanalysis of FinancialRatioswiththehelpof casestudies.</td></tr>
<tr><td colspan="2">Text Books,and/orreferencemateria l</td><td colspan="5">TextBooks:
Part1:GroupA:Microeconomics
1. Koutsoyiannis:ModernMicroeconomics
2. MaddalaandMiller:Microeconomics
3. AnindyaSen:Microeconomics:TheoryandApplications
4. Pindyck&Rubenfeld:Microeconomics
Part1:GroupB:Microeconomics
1. W.H.Branson:Macroeconomics–TheoryandPolicy(2nded)
2. N.G.Mankiw:Macroeconomics,WorthPublishers
3. DornbushandFisher:MacroeconomicTheory
4. SoumyenSikder:PrinciplesofMacroeconomics
PART2:ManagementAccountancy
1. Gupta,R.L.andRadhaswamy,M:FinancialAccounting;S.Chand&Sons
2. AshokeBanerjee:FinancialAccounting;ExcelBooks
3. Maheshwari:IntroductiontoAccounting;VikasPublishing
4. Shukla,MC,GrewalTSandGupta,SC:AdvancedAccounts;S.Chand&Co.</td></tr>
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<tr><td colspan="7">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSC6XX</td><td>Artificial Intelligence and Machine Learning</td><td>PCR</td><td>3</td><td>0</td><td>2</td><td>5</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="4">Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic Concepts of Probability and Statistics, Knowledge of Algorithm analysis</td><td colspan="4">CE+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1: Identify problems where artificial intelligence (AI) techniques are applicable
• CO2: Understand to apply search strategies to solve the problems.
• CO3: Principal models used in machine learning and Apply them in machine learning to appropriate problems
• CO4: Formulate valid solutions for problems involving uncertain inputs or outcomes by using decision making techniques.
• CO5: Understanding different supevised and unsupervised learning methods.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Introduction to Artificial Intelligence (AI): What is Intelligence, Reasoning and Planning,Learning and Adaptation, and interaction with the real world,A brief history of AI, Application areas of AI, State of the art. (2)
Problem solving by search: Problem types, Illustrative search problems; Search Space, Search tree; BFS, DFS, UCS; Local search; Hill climbing; Heuristics; A* search (6)
Knowledge Representation: Propositional,predicate logic, first order logic, resolution and unification(5)
Reasoning under Uncertainty:Conditonal independence representation, exact inference through variableelimination, and approximate inference through sampling. (5)
Introduction to Machine Learning:Basic concepts, bias-variance trade off, evaluation metrics etc. (2)
Supervised Learning:Simple linearregression, multiple linear regression, logistic regression, support vector machine, decision trees, Introduction to artificial neural network. (14)
Unsupervised Learning:Clusteringalgorithms, k-means/k-medoid, hierarchical clustering (6)
Dimensionality reduction:Principal component analysis. (2)
Sessional experiments: Study of PROLOG programming language to implement different search techniques, Implementation of different machine learming techniques (linear and logistic regression; Decision Trees; Support Vector Machine; artificial neural network; Clustering techniques) by programming in Python</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">Text Books:
1.Artificial intelligence : A Modern Approach- Stuart Russell, Peter Norvig, Prentice Hall, Fourth edition, 2020
2. Tom M. Mitchell, “Machine Learning”, McGraw Hill Education, International Edition, 2010
Reference Books:
1. Elaine Rich, Kevin Knight and Shivashankar B Nair, “Artificial Intelligence”, Tata McGraw Hill, 3rd Edition 2017.
2. EthemAlpaydin, “Introduction to Machine Learning”, Third Edition, , MIT Press, 2014</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MES651</td><td>Power Generation Laboratory</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>2</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">Engineering Thermodynamics(MEC304), Heat and MassTransfer(MEC403),ICEngine andGasTurbine(MEC502)</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1:Experimentation of refrigerating systemsCO2:Experimentation on steam generatorsCO3:Studyof steamturbines
CO4:Testondieselengine
CO5:Experimentationonsteam nozzle</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Refrigeration and air-conditioning: Specification, performance test and loading ofrefrigerators.Concept of air conditioning.Types of air conditioning systems andtheirapplication.
Steam generators:Fundamental concept, types, application and performance data.Useofsteamforpowergeneration.
FundamentalconceptandfunctionofTurbines.
Studyof-
• Constructionoffiretubeandwatertubeboiler.
• Startingandloadingoffiretubeboiler.
• Constructionofvapourcompressionrefrigeratorunit.</td></tr>
<tr><td></td><td colspan="7">Experimentson-
• Determinationofdryness fractionofsteam.
• Efficiencytestofaboiler.
• Performance test of diesel engine using mechanical type dynamometer undervariablespeedconditions.
• Determinationofcriticalpressureratioofasteamnozzle.
• Effect of humidity and outside air temperature on cooling load of airconditioningmachine.
• Determinationofoutputandback-workratioofagasturbineunitundervariableload condition.</td></tr>
<tr><td rowspan="2">Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. RefrigerationandAir-conditioning--W.F.Stoecker,J.W.Jones
2. RefrigerationandAir-conditioning--C.P.Arora
3. PowerPlantEngineering--P.K.Nag
4. PowerPlantEngineering--F.T.Morse
5. SteamTurbineDesignandPractice--Kaerton</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. JeffreyMGordon,Kim ChoonNg,CoolThermodynamics,VivaBooks,2008.
2. RefrigerationandAir-conditioning--R.C.Jordon,G.B.Priester
3. Modern Air-conditioning, Heating and Ventilation-- W. H. Carrier, R. E.Cherne</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MES652</td><td>Machine DesignSessional</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="2">MEC401,MEC503</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1: Acquire basic idea about making the design and production drawingforsimple andcommonmechanicalassembly.
CO2:Tounderstandthemethodofimplementationofengineeringtolerances.
CO3: To identify the importance of using the standards and use ofcataloguesinmakingthedesign.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">DesignandmanufacturingDrawingofScrewJackusingCAD
DesignandmanufacturingDrawingofgearboxusingCADProductDesignrelatedproject.</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. DesignofMachineElements–V.B.Bhandari
2. DesignofMachineElements–M.F.Spotts
3. DesignDataBook–P.S.G.CollegeofTechnology,Coimbatore.</td></tr>
<tr><td></td><td colspan="7">ReferenceBooks:
1. MechanicalEngineeringDesign–J.E.Shigley
2. FundamentalsofMechanicalDesign–R.M.Phelan</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MES653</td><td>Manufacturing Laboratory</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>2</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="2">Casting, Forming and Welding(MEC402)</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1:-Analyzethemoldingsandpropertyusedinfoundryindustrybydifferentsandtechnique.
CO2: -Apply the concept of machining in different machine tools like milling, radialdrilling,grindingmachineetc.
CO3:-Demonstratethedifferentweldingproceduretoproducethejoiningeffect.CO4:-Analyzethelaserandhotembossingprocedureforsamplepreparation.
CO5:-Performphoto-chemicalmachiningandcontactanglegoniometerexperiment.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">ListofExperiments:-
Foundry:-
Experiment 1: To determine the amount of moisture content in sand sample used forcastingusingrapidmoisture tellermachine.
Experiment 2: To determine the particle size and grain fineness number (GFN) of moldingsandused incasting
Experiment 3: To Study the sand properties and sand casting procedure for foundryindustry.
Machining:-
Experiment 4: To perform grinding operation on specimen using surface grindingmachine.
Experiment 5: To perform drilling operation on sample using radial drilling machine.Experiment 6: To prepare specimen of face milling operation on MS plate in a VerticalMillingMachine
Welding:-
Experiment 7: To perform SAW welding on MS specimen for joint preparation.Experiment 8: To perform GTAW welding on MS specimen for joint preparation.Experiment 9: To perform GMAW welding on MS specimen for joint preparation.AdvancedManufacturing Techniques:-
Experiment 10: To develop micro pattern using fiber laser engraving machine.Experiment11:To studyandperform thehotembossingprocess.
Experiment 12: To study the wettability of a substrate using Contact Angle Goniometer.Experiment 13:Fabrication of micro-sized complex patterns by using Photo ChemicalMachining(PCM)</td></tr>
<tr><td rowspan="2">TextBooks,and/orreferencematerial</td><td colspan="7">TextBooks:
1. ManufacturingProcessesforEngg.Materials—Kalpakjian
2. ProductionTechnology(volI&II)—R.K.JainandS.C.Gupta
3. ACourseinWorkshopTechnology(volI&II)—B.S.Raghuwanshi</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. ManufacturingScience—A.Ghosh,A.K.Mallik
2. PrinciplesofFoundryTechnology—P.L.Jain</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE610</td><td>Nonconventional Machining</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)andend assessment(EA))</td></tr>
<tr><td colspan="2">Casting,FormingandWelding (MEC402)</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: Cutting edge technology for nonconventional/ precision machining.CO2:Emergingtrendofmetal removalprocess</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Introduction 1
ECM:WorkingPrinciple;ECMMachineTool;Processperformances;Advantages,limitations and applications; ECG- Working Principles; ECG Machine Tool; Processperformances; Advantages, limitations and applications; Electrochemical Debarring(ECDe),ShapedTubeElectrolyticMachining(STEM). 8
AJM,WaterJetMachiningandAbrasiveWaterJetMachining 8
USM:WorkingPrinciples,USMMachineTool,Mechanicsofcutting,Processcapabilities,Advantages,limitationsandapplications. 4
FIB: Working Principles, Machine Tool , Mechanism of material removal and surfacemodification 4
EDM:WorkingPrinciples,EDMMachineTool– PowerSupply,DielectricSystem,Electrodes,Servo-system,PulsegeneratingCircuitsandanalysis,ProcessVariablesandProcessCharacteristics;ElectricalDischargeGrinding. 4
Wire-cut EDM: Working Principles, EDM Machine Tool, Process Variables and ProcessCharacteristics. 4
LBM:ProductionofLASERs,WorkingPrinciplesofLBM,TypesofLASERs,Processcharacteristics,Advantages,LimitationsandApplications. 3
EBM:ProductionofElectronBeam,WorkingPrinciplesofEBM,Focusingandcontrolof electron beam, Process characteristics, Advantages, Limitations and Applications.3ChemicalMachining,MicrofabricationandMicromachining 3</td></tr>
<tr><td rowspan="2">Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. Non-conventionalMachiningProcess:P.K.Mishra
2. Non-conventionalMachiningProcess:V.K.Jain</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. ManufacturingScience:Ghoshandmallik
2. ModernMachiningProcesses:PandeyandShan</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE611</td><td>Designand Optimization ofThermalSystems</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods (Continuous(CT)andend assessment(EA))</td></tr>
<tr><td colspan="2">MEC304,MEC403,MEC502</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1:Latestmethodologies forthedesignofthermalsystem
CO2: Use of economics, system simulation and optimization method for thermalsystem
CO3:Willlearnexergyanalysisanditsapplicationforthermalsystem
CO4: Use of thermo-ecological parameters to assess various thermal systemCO5:Modelingof energysystem</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">1. IntroductiontoThermalSystemDesign
Introduction, Life cycle design, Thermal system design aspects, Computer aidedthermalsystemdesign
2. Thermodynamics,Modelling,andDesignAnalysis
Basic concepts and definition, Control volume aspects, Property relations, Reactingmixtures andcombustion,Modellinganddesignof pipingsystems
3. ThermodynamicModellingofPolygenerationSystem
Modelling of Power Generation, Modelling of Cogeneration, Modelling ofPolygeneration
4. ExergyAnalysis
Why exergy and energy analysis, Balances for mass, energy and entropy, Physicalexergy, Chemical exergy, Exergy for systems and flows, Exergy balance, Referenceenvironment,Applications
5. ApplicationswithThermodynamicsandHeatandFluidFlow
Heat transfer, Heat exchangers, Trade-off between thermal and fluid flowirreversibility,Applicationtopower generationandrefrigeration
6. EconomicAnalysis
Estimation of capital investment, Principles of economic evaluation, Cost of utility,Profitabilityevaluation
7. ThermoeconomicAnalysisandEvaluation
Fundamental of thermoeconomics, Thermoeconomic variable for component,evaluation,Costingconsiderations
8. ProblemFormulationandMethodforOptimization
Introduction, Optimization method, Optimization of thermal systems, Practicalaspects
9. ThermoeconomicOptimization
Introduction to optimization, Cost optimal exergetic efficiency, Optimization of heatexchangernetworks,Enhancedsystemoptimization
10. ExergyMethod:EcologicalApplications
Cumulativeexergyconsumption,Thermo-ecologicalcost,Applications</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. BejanA.,TsatsaronisG.,MoranM.;Thermaldesignandoptimization.Wiley.
2. JaluriaY.,Designandoptimizationofthermalsystem.CRCPress.
3. SzargutJ.,Exergymethod:Technicalandecologicalapplications.WITPress.
4. Dincer I., Rosen MA., Exergy: Energy, environment and sustainable development.Elsevier.</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE612</td><td>Control Systems</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">MEC302,MEC502</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1:Willgetexposuretotheblockdiagrambasedformulations,behavioroflineartimecontinuous control systems.
CO2:Abilitytoanalyzethesystemperformanceandrelativestabilityinformation.
CO3:Understandtherelevanceofcharacteristicrootsinthebehaviorofvariousdynamic systems.
CO4:Abilitytodesignsimplecontrollersforanalogsystems.
CO5: To study and analyze state space methods, controllability and observability ofcontrolsystems.</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">Introduction to Control, Systems and Elements, Transducers, Feedbacks,
Classificationofsystems 3
Mathematicalmodelling,BlockDiagramandTransferFunctions 4
AnalysisofResponseofsimplefeedbackcontrolsystems 5
StructureofControlsystemsandControlLaws 4
Rootlocusplotandanalysis 5
Stabilityanalysisbyfrequencyresponsemethods–NyquistandBodediagrams 5
State-spacerepresentations 5
PIDcontrollers –Analysisanddesign 5
DigitalControlMethods. 2
DesignofControlSystemsinMatlabSimulinkEnvironment. 2
ExamplesofControlSystems,LaboratoryExercises. 2</td></tr>
<tr><td rowspan="2">Text Books,and/o rreferencem aterial</td><td colspan="7">TextBooks:
1. Kuo,B.C.,AutomaticControlSystem,3rdEdition,PrenticeHallInc.,NewJarsey,1975.
2. Nise, N. N., Control Systems Engineering, 6thEdition, John Wiley & Sons, Inc., USA,2011.</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. Raven, F. H., Automatic Control Engineering, McGraw Hill Book Company PrivateLtd.,USA, 1961.</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE613</td><td>Fundamentalso fCombustion</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td colspan="2">MEC304,MEC403,MEC405</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="6">CO1: Understand Combustion FundamentalsCO2:Analyze CombustionReactions
CO3: Apply Thermodynamic and Chemical Kinetic ModelsCO4:SolveEnergyandMassBalanceProblemsinCombustio n</td></tr>
<tr><td>TopicsC overed</td><td colspan="6">ReviewofThermodynamics:CombustionTerminology,MatterandItsproperties,Microscopic overview of thermodynamics, Conservation of mass and energy, First LawandSecondlawof thermodynamics. 4
Stoichiometry and Thermochemistry of Reacting Systems: Overall reactions, Gasanalysis,GlobalConservationequationsforreactingsystems,Thermochemistry:Enthalpyof Formation,ApplicationofThermochemistry 6
ReactionDirectionandEquilibrium:ChemicalEquilibrium,ChemicalEquilibriumRelations,V antHoffequation,AdiabaticflametemperaturewithChemicalEquilibrium4
Fuels:GaseousFuels,LiquidFuels,SolidFuels,OtherFuels,SizeDistributionofSolidandLiquidFu els 4
Chemical Kinetics:Reactionrates,Elementaryreactionsand Molecularity,MultipleReactionTypes,ChainReactionandReactionMechanism,GlobalMechanis msForReactions, The Arrhenius Law, Global and Backward Reactions, The partial Equilibrium,TimeScale for Reactions,Solid-Gas Reactions 8
MassTransfer:HeatTransferandFourier’slaw,MasstransferandFick’sLaw,MolecularTheory,G eneralized formFourier’s andFick’sLaw 4
FirstLawApplications:GeneralizedrelationsinMolarForm,ClosedsystemCombustion,Opensy stemcombustion:PlugFlowReactor,Perfectlystirredreactor,SolidCarbonCombustion,Droplet Burning 7
Conservation Relations: Simple Diffusive Transport Constitutive Relations, ConservationEquations,GeneralizedTransport,SimplifiedBoundary-Layer-TypeProblems,Shvab–Zeldovich Formulation,TurbulentFlows 5</td></tr>
<tr><td rowspan="2">TextBook s,and/orre ferencema terial</td><td colspan="6">TextBooks:
4. CombustionScienceandEngineering–K.Annamalai andI.K.Puri
5. FundamentalsofCombustionEngineering–A.MukhopadhyayandS.Sen</td></tr>
<tr><td colspan="6">ReferenceBooks:
3.AnIntroductiontoCombustion-S.R.Turns</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE614</td><td>Modeling andSimulatio n ofDynamic Systems</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="2">EngineeringMechanics, StrengthofMaterial,Dynamicsof Machine.</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="6">CO1By theendof thecoursestudentsareabletoknowthefundamentalof modelingandsimulationandits usefulness.
CO2Overviewofvariousmodelingsoftwareanditsusefulnessindevelopmentofmathematicalm odel.
CO3Modelingconceptforelectro-mechanical,mechatronicssystemsandfeedbackcontrol.
CO4Interpretationofsimulationresultsanddiagnosisofsystems.</td></tr>
<tr><td>TopicsC overed</td><td colspan="6">Introductiontosystemmodeling 6
Introductiontomodelingwithexamples,introductiontosimulation,MATLABandSimulink,bond graph andAdamsmulti-bodysimulationtools.
Modelingof dynamicsystems 6
Introductiontodynamicsystemswithexamples,bondgraphmodeling,causality,generation of system equations, Methods of drawing bond graph models of electricalandmechanicalsystems.
Modelingof systems(fundamentalmodel) 8
Fundamentalmodelsofmechanical,electrical,hydraulic,pneumaticandthermalsystems, hydraulic and thermal system modeling, examples of fundamental systemssuchas two-tanksystem,thermaldamping,compressor-reservoirsystem,etc.
Modelingof systems(as acombinationofsubsystems) 10
Linearandnonlinearsystems,modelingofsystems:acombinationoftranslationalandrotationalsy stems,hydro-mechanicalsystemsandelectro-mechanicalsystems,modelingofmechatronicsystems andfeedbackcontrolof mechanicalsystems.
Simulationanditsapplications 10
SimulationusingSimulink,bondgraphandAdams,simulationofsimpleand compoundpendulum,simulationofplanarmechanisms,validationofsimulationresults with examples.</td></tr>
<tr><td rowspan="2">Text Books,and/o rreferencem aterial</td><td colspan="6">TextBooks:
1. Bond graph in modeling simulation and fault identification, AmalenduMukherjee,ArunKumarSamantaray,andRanjitKarmakar,CRCPr ess.
2. MATLABformechanicalengineers,RaoV.Dukkipati,NewageInternational.</td></tr>
<tr><td colspan="6">ReferenceBooks:
1. Measurements, Modelling and Simulation of Dynamic Systems, Edward Layer,KrzystofTomczyk,Springer-VerlagBerlinandHeidelbergGmbH&Co.KG.
2. Modelling and simulation Exploring Dynamic System Behavior, Louis G. Birta,GilbertArbez, Springer LondonLtd</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE615</td><td>Non-LinearVibration</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="2">MEC301,MEC302,MEC504</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: Understanding the various characteristics of nonlinear dynamic system.CO2:Developmentofsolutionproceduresemployingapproximatemethods.
CO3: Develop the concept of stability and different methods for stability andbifurcationanalysis.
CO4: Analysis of nonlinear system employing numerical techniques and comparingtheresultswithapproximate methods.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Introduction:
linear and nonlinear systems, conservative and non-conservative systems; potentialwell,Phaseplanes,typesofforcesandresponses,fixedpoints,periodic,quasi-periodicandchaoticresponses;Localandglobalstability;commonlyobservednonlinearphenomena:multipleresponse,bifurcations,jumpphenomena. 9
Analyticalsolutionmethods:
Harmonicbalance,perturbationtechniques(Linstedt-Poincare’,methodofMultipleScales,Averagingmethod) 6
Stabilityandbifurcationanalysis:
staticanddynamicbifurcationsoffixedpointandperiodicresponse,differentroutestochaoticresponse. 6
Numericaltechniques:
Timeresponse,phaseportrait,FFT,Poincare’maps,pointattractors,limitcyclesandtheirnumericalcomputation,strangeattractorsandchaos;Lyapunovexponentsand</td></tr>
<tr><td></td><td colspan="7">theirdetermination,basinofattraction:pointtopointmappingandcelltocellmapping,fractaldimension. 9
Applications:
Single degree of freedom systems: Free vibration-Duffing’s oscillator; primary-,secondary-and multiple- resonances; Forced oscillations: Van der Pol’s oscillator;parametric excitation: Mathieu’s and Hill’s equations, Floquet theory; effects ofdampingandnonlinearity.Multi degreeoffreedomandcontinuoussystems. 10</td></tr>
<tr><td rowspan="2">Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. Nayfeh,A.H.,andMook,D.T.,NonlinearOscillations,Wiley-Interscience,1979.
2. Hayashi,C.NonlinearOscillationsinPhysicalSystems,McGraw-Hill,1964.</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. NonlinearOrdinaryDifferentialEquations:AnIntroductionforScientistsandEngineers,D. JordonandP. Smith,Oxford
2. Evan-Ivanowski,R.M.,ResonanceOscillationsinMechanicalSystems,Elsevier.
3. Nayfeh,A.H.,andBalachandran,B.,AppliedNonlinearDynamics,Wiley.
4. Seydel,R.,FromEquilibriumtoChaos:PracticalBifurcationandStabilityAnalysis,Elsevier.</td></tr>
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<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of thecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE616</td><td>Mechanics ofComplexFluids</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites: MEC303,MEC304,MEC403,PHC01</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="2">MEE616</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: To acquire an in-depth knowledge of various constitutive models in viscous flowsCO2:To applythe constitutivemodels inmomentum conservationlaws
CO3: To learn the various types of complex fluid types and their source of nonlinearityCO4:Toundertakethesolutionprocess to simpleflowsofcomplexfluids
C05:Tolearntheconceptsofrheometryandcomplexfluids inindustrialsettings</td></tr>
<tr><td>Topics Covered</td><td colspan="7">IntroductiontoComplexFluidswithApplications. (1)
Review of required mathematics: Linear algebra and partial-differential equations. (2)MassandMomentumConservationLawsinHydrodynamics. (3)
TheCauchyStressTensorandtheNavier–StokesEquations.Examplesofviscousflows. (4)
MaterialfunctionsandGeneralizedNewtonianFluids:Shear-ThinningandShear-ThickeningandCarreau–YasudaModels. (8)
Linearviscoelastic theory,Oldroyd’stheoryandEricksen-Leslietheory(forliquid crystals):(PropertiesofViscoelasticFluids:relaxationtime,yieldstress,normalstress differences,shearthinningproperties). (7)
Basicintroduction to Differential Constitutive Equations, Integral Constitutive Equations,ContinuumMechanics,Stokesequations(Admissibleconstitutiveforms, differentialandintegralconstitutiveequations). (6)
RheologyofSuspensions(Colloidalfluids,EmulsionsandBlends):Suspensions Viscosity,Suspensionsofparticlesandmicroorganisms (7)
RheometryandApplicationofcomplexfluidsinindustrialsettings (4)</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1.“DynamicsofPolymerLiquids:Vol.1:FluidMechanics”byR.B.Bird,C.Armstrong, O.Hassager(Wiley),2ndEdn.,1987.
2.“APhysicalIntroductiontoSuspensionDynamics”byGuazzelliandMorris (CambridgeUniversityPress),2011.
3.“TheStructureandRheologyofComplexFluids”byR.G.Larson(Oxford),1999.</td></tr>
<tr><td></td><td colspan="7">ReferenceBooks:
1. ”Microhydrodynamics”byS.Kim andS.J.Karrila(DoverPublications),1991.
2. “Mathematical Modeling for Complex Fluids and Flows” by M. O. Deville and T. B.Gatski (Springer), 1st Edition,2012.</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)#</td><td>Total Hours</td></tr>
<tr><td>MEE620</td><td>Automobile Engineering</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">EngineeringThermodynamics (MEC304),HeatandMassTransfer (MEC403), IC Engine andGasTurbine(MEC502)</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: Classification and layouts of different vehiclesCO2:DifferenttypesofEnginesinuse
CO3:Differenttypes ofclutch,gearboxandtransmissionused
CO4:DifferenttypesofbrakesdrivelinesandwheelsandtyresCO4:Differenttypesofbrakes,drivelinesandwheelsandtyres.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Automotiveengine:Construction,operationandserviceofautomotiveengine. 8
Bearing,lubricationandcoolingsystem.
Fuelandexhaust,emissioncontrol. 6
Starting and charging system. Contact point and electronic ignition system.
Otheraccessories with electrical and electronic devices. Engine trouble diagnosis and tuneup. 10
Automotive power train: Transmission and transaxles, gear train, differentials anddriveaxles,drivelinesanduniversaljoints,clutchesandbrakes. 8
Automotive chassis: Springs and suspension system, steering system, wheels andtyres. 6
Automotiveventilationandairconditioningtechniques. 4</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">SuggestedTextBooks:
1. AutomobileEngineering--K.Singh
2. Automotive mechanics-- W. H. Crouse, D. L.
AnglinSuggestedReference Books:
1. Automotivemechanics--J.Heitner</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)#</td><td>Total Hours</td></tr>
<tr><td>MEE621</td><td>Gas DynamicsandPropulsion</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">FluidMechanics(MEC303)andEngineering Thermodynamics(MEC304)</td><td colspan="6">Course Assessment methods (Continuous evaluation (CE) and endassessment(EA))</td></tr>
<tr><td colspan="2">NIL</td><td colspan="6">CE+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: To learn compressible flows with constant entropy only, with friction only andwithheat transfer only.
CO2: To learn Normal shock, oblique Shock and Prandtl-Meyer Flow with real lifeapplications.
CO3: To learn Performance analysis of Air Breathing Engines (Ramjet, Turbojet(standard):FanexhaustedturbojetandFanmixedturbojetandTurboprop.)
CO4: To learn Performance analysis of Non Air Breathing Engines (Solid RocketMotors andLiquidRocketEngines).</td></tr>
<tr><td>TopicsCovered</td><td colspan="7"><u>Part-I:GasDynamics:</u>
Reviewofbasiccompressibleflowe.g.sonicvelocity,wavepropagation.Flowwith Variableareaductwithoutnormalshockandwithnormalshock.Fannoflowand Rayleighflow. Solutionofproblemsusinggastable. 7
MovingNormalshocksandObliqueshocks:Normalvelocitysuperpositionfor movingNormalshockandtangentialvelocitysuperpositionforobliqueshock, obliqueshockanalysisforperfectgas,obliqueshocktableandcharts.Problems. 7
Prandtl-Meyerflow:Isentropicturn(eitheraroundexpansionorcompression corner)frominfinitesimalshocks,Machwaves,Prandtl-Meyerflowanalysis, Prandtl-Meyerfunction,overexpandedandunderexpandednozzles,boundary conditionsforflowdirectionandpressure,shockdiamond,supersonicaerofoils, Workingofsupersonicwindtunnel. 4
Correlationof Fannoflow,Rayleigh flow,anda normalshock 2
<u>Part-II:JETPROPULSION</u>
AirBreathingEngines:Derivationofgeneralizedequation/expressionsforthrust, propulsionefficiency,thermalefficiencyandoverallefficiency.Relationbetween them,TSFC(Thrustspecificfuelconsumption);stoichiometry,equivalenceratio, massfraction,molefraction,partialpressure,massbalanceinchemicalequations, heatofreaction,heatbalanceinconstantvolumeandconstantpressureprocesses, fuelairratio,variationoftemperaturewithF/Oanditsstoichiometricvalue. Conditionformaximumefficiency.
Performanceanalysisofthefollowing:
(a)Ramjet,(b)Turbojet(standard):Fanexhaustedturbojet&Fanmixedturbojet (c)Turboprop.Effectofafterburneronalltheabove.Relatedproblems 12
Non-airbreathingengines:PerformanceofRocketvehiclessuchasThrust,specific Impulse(I_{sp}),vehicleacceleration,burningtime.TypeofchemicalRockets:Solid</td></tr>
</table>

	RocketMotorsandLiquidRocketEngines.Elementarytheoryandperformance characteristicsofbothtypes ofchemicalrockets.Relatedproblems. **10**
Text Books,and/or referencematerial	**TextBooks:** 1. Fundamentalsofgasdynamics-R.D.Zucker&OscarBiblarz. 2. Mechanicsandthermodynamicsofpropulsion:P.G.Hill&C.R.Peterson. **ReferenceBooks:** 1.TheDynamicsandThermodynamicsofCompressibleFluidFlowbyA.H.Shapiro. 2.AircraftPropulsion:V.Babu

DepartmentofMechanicalEngineering							
Course Code	Titleofthecourse	Program Core (PCR)/ Electives (PEL)	TotalNumberofcontacthours				Credit
			Lecture(L)	Tutorial (T)	Practical (P)	Total Hours	
MEE622	**Mechanics ofCompositesand FunctionallyGradedMaterials**	**PEL**	3	0	0	3	3
Pre-requisites		CourseAssessmentmethods(Continuous(CT)andEndAssessment (EA))					
SolidMechanics		CA+ EA					
CourseOutcomes	CO1: Learn about composite materials and their applications from large to small scales.CO2:UnderstandgeneralHooke'slawforcompositematerialsandcomputeitsengineeringconstants. CO3:Buildsuptheabilitytocalculatemicromechanicalparametersforlaminalevelanalysis.CO4: Builds up the ability to calculate macromechanical parameters for laminate levelanalysis. CO5: Basic understanding about functionally graded materials and its high temperatureapplications.						
Topics Covered	**IntroductiontoCompositeMaterials** **05** **Lectures** Definition,Classifications,Variousreinforcementandmatrixmaterials,Mechanicalbehavior, Manufacturingprocessandapplications,andBasicterminologies. **MacromechanicalAnalysis ofLamina** **15** **Lectures** Hook'slawanisotropic,orthotropic,transverselyisotropicandisotropicmaterial.Stress-strain relationandEngineeringconstantsforthismaterial.Stressandstraintransformation. **Micromechanical Analysis ofLamina** **05** **Lectures** Volumeandmass fraction,Densityandvoid content. EvaluationofElasticmodulii,Ultimatestrengthofunidirectionallamina. **MacromechanicalAnalysis ofLaminate** **10** **Lectures** Macromechanicalbehavioroflamina,Classicallaminationtheory,Laminatestiffnessofa fewcases,Stressstrainvariationinalaminate.Specialcasesoflaminates,symmetric,cross-ply,angleply,andantisymmetriclaminates. **FailureCriterionofComposites** **03** **Lectures** Failurecriteriaandfailuremodes. **IntroductiontoFGMs** **04** **Lectures** Historicalperspectiveandimportance,Gradedmicrostructures,Types,andApplications. ModelingandDesign:Rulesofmixtures,Variational,Micromechanical,Empirical,Mori–						

	Tanakaapproaches,Thermophysicalandmechanicalproperties,andmaterialgradationlaws.
Text Books,and/ orreference material	**TextBooks:** 1. Mechanicsof CompositeMaterialsbyRobertM.Jones, Taylor&Francis,USA. 2. Mechanicsof CompositeMaterialsbyAutarK.Kaw,CRCPress, BocaRaton. 3. FunctionallyGradedMaterialsbyR.M.MahamoodandE.T.Akinlabi,Springer.
	ReferenceBooks: 1. EngineeringMechanicsofCompositeMaterialsbyIsaacM.DanielandOriIshai,OxfordUniversityPress,NewYork. 2. AdvancesinFunctionallyGradedMaterialsandStructuresbyF.Ebrahimi(Editor), ExLi4EvA.

DepartmentofMechanicalEngineering							
Course Code	Title of thecourse	Program Core(PCR) / Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEE623	**Finite ElementMethods**	**PEL**	3	0	0	3	3
Pre-requisites		CourseAssessmentmethods(Continuous(CT)andEndAssessment(EA))					
SolidMechanics		CA+ EA					
CourseOutcomes	CO1:Implementtheknowledgeoftheoriesofelasticity,weightedresidualmethodsandenergymethods for FE formulation. CO2: FE formulation, solution and analysis of one dimensional static problemsCO3:FEformulation,solutionandanalysisoftwodimensionalstaticproblems CO4:FEformulation,solutionandanalysisofonedimensionalfreevibrationproblems CO5:FEanalysisofonedimensionalproblemsusingsoftwarepackage,andbycomputerprogramming						
TopicsCovered	1. Stresses and Equations of Equilibrium, Stress-strain relations, Strain-displacementrelations, Plane stress, Plane strain and axisymmetric problems. Potential energy,principleofminimumpotentialenergy,Rayleigh-RitzMethod. 6 2. Weighted residual methods, Week form, Solution using week form, Rayleigh-Ritzmetrhod. Steps in FE analysis, Elemental level equation, Assembly, Boundary conditions,solution,postprocessing. 5 3. Naturalcoordinates,Shapefunctions,LagrangeandSerendipityElements,NumericalIntegration,Derivationofelementallevelequationforonedimensionalbarusing Galerkin's method and principle of minimum potential energy methods. Plane trussProblems, One dimensional thermal stress problems. One dimensional conduction-convectionheattransferproblems.Torsionofcircularshaft. 12 4. Finite element analysis of 2-D problems. Palne stress, Plane strain and axisymmetricproblems. 4 5. FiniteElementAnalysisofbeamsusingCBTandTBT. 6 6. Freevibrationanalysisofbar,beamsandshaftusingFiniteElementMethods. 4 7. DiscussiononFEbasedpackageandcomputerprogrammingforFEanalysis. 5						
TextBooks,and/orreferencematerial	TextBooks: 1. TextbookofFiniteElementAnalysisbyP.Sesu(PHI) 2. Introduction to Finite Elements in Engineering by T. R. Chandrupatla, A. D. Belegundu(Prentice- Hall) 3. AnIntroductiontotheFiniteElementMethodbyJ.N.Reddy(TataMcGrawHill)						
	ReferenceBooks: 1.FiniteElementProcedures byK.J.Bathe(PrenticeHall) 2. Finite Element analysis Theory and Programming by C. S. Krishnamoorthy (TataMcGrawHill) 3. Conceptsandapplicationsoffiniteelementanalysisby R.D.Cook,D.S.Malkusetc.(Wiley)						

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE624</td><td>Additive Manufacturing</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td colspan="2">ManufacturingTechnology, Machining and Machine Tools(MEC501)</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOut comes</td><td colspan="7">CO1:Abletounderstandtheprinciplesofdifferentadditivemanufacturingprocesses
CO2:Abletolearnsoftware’sforadditive manufacturing
CO3: Able to expose materials for Additive Manufacturing and it’s selection
CO4:Abletoknowareasofusage,possibilitiesandlimitationsoftheadditive manufacturingtechnologies</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Introduction to Additive Manufacturing (AM),Overview, History,Need,Classification,AdditiveManufacturingTechnologyinproductdevelopment 2
CAD & Reverse Engineering, CAD model preparation – Part Orientation and supportgeneration, Model Slicing, Tool path Generation, Software’s for AdditiveManufacturing Technology , Model Reconstruction – Data Processing for AdditiveManufacturingTechnology,Reverseengineering 6
MaterialsforAdditiveManufacturingTechnology 4
DifferentAMprocesses andrelevantprocess physics,AMprocess chain 8
SheetLaminationProcesses 1
Photo-polymerizationProcesses 2
Extrusion-BasedSystems 1
PowderBedFusionProcesses 3
Binderjetting 1
Materialjetting 2
DirectedEnergyDepositionProcesses 3
Micro&Nanoadditivemanufacturingprocesses 4
DesignforAdditiveManufacturing 3
ApplicationsofAdditiveManufacturing 2</td></tr>
<tr><td rowspan="2">Text Books,and/or referencematerial</td><td colspan="7">TextBooks:
1. Ian Gibson, David W. Rosen and Brent Stucker, Additive manufacturingtechnologies:rapidprototypingtodirectdigitalmanufacturing,Springer.
2. C.K.Chua,K.F.LeongandC.S.Lim,3DPrintingandAdditiveManufacturing:Principles andApplications,WorldScientific.</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapidtooling,rapidmanufacturing, HanserPublishers.</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical(P)</td><td>Total Hours</td></tr>
<tr><td>MEE625</td><td>Mechanicsof Forming andPressWorking</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)andendassessment (EA))</td></tr>
<tr><td colspan="2">CastingFormingandWelding (MEC402)</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: Specialized techniques in forming practiced in industry.CO2:Detailedandindepthanalysisoftheformingprocesses</td></tr>
</table>

TopicsCovered	**Module1:** **Stress-strain relationship:** true stress true strain, elasticity, anelasticity, plasticity,workhardening,workdoneorstrainenergy.ComplexStressSystem,conceptofabsolute maximum shearing stress in a plane-stress system, three dimensional stresssystem andMohr'scirclefor the generalstateof stress(3-D). **Plastic Deformation and Yield Criteria:** maximum normal stress theory (Rankine'sTheory),Tresca'smaximumshearstresstheory,VonMises'maximumdistortionenergy theory, relation between tensile yield stress and shear yield stress, yieldingunderplanestrainGraphicalrepresentationofTresca'sandVonMises'theory. **Forging:** processes and its classification- drop forging and press forging, open die,impression die, closed die and precision forging processes. Grain flowin a forgedproduct. Forging die materials, lubrication, forging defects, forgeability of metals, die-manufacturingmethods.Analysisofforgingload:Lowfrictionorslidingfrictioncondition (as in cold forming); high friction condition; and, combined slipping andstickingfrictioncondition. **Rolling:**striprolling-recrystallizationandprocessdetails,conditionsforbiting,roleoffriction in rolling. Rolling mills, ring rolling, gear and thread rolling, various rolledsections,defectsinrolledproducts.Determinationofrollpressure:pressuredistribution in rolling, determination of neutral point, front tension and back tension,force and power calculation. Roll deflections and roll flattening, spreading, methods ofreductionof rollingforce,rollmaterials, various rolled sections. **Drawing:** drawing terms and their definitions, circular drawing die, drawing of wireand rod (homogeneous deformation), maximum possible reduction in a single pass,analysis of strip drawing, calculation of force and power, analysis of wire and roddrawing,calculationof force andpower. ***Extrusion:****processes-directandindirectextrusion,impactand*hydrostaticextrusion, *metalextrusionpractice,metalflowduringextrusion.* **Module2:** **Sheetmetalforming:**characteristics;parametersaffectingsheetmetalformingprocess such as, yield point elongation, anisotropy, grain size, residual stresses, springback,wrinkling, coated sheet. 1 **Shearing, punching and blanking:** punch force; shearing operations like, die cutting,fineblanking,slitting,steelrules,nibbling;Shearingdies:Punchanddieshapes,compound dies,progressivedies, transferdies,toolanddiematerials. 5 **Bending of sheets and plates:** minimum bend radius, factors affecting bendability,springback,compensationforspringback,commonbendingoperations. 3 **Deep drawing:** Characteristics of deep drawing, formability of sheet metal, designconsiderations **Miscellaneous forming processes:** stretch forming, bulging, hydroforming, variousspinningoperations. 3 **High energy rate forming:** Explosive forming, electrohydraulic forming, magneticpulseforming, superplasticformingetc. 3
Text Books,and/orreferencematerial	**TextBooks:** 1. ManufacturingProcessesforEngg.Materials-Kalpakjian 2. ProductionTechnology(volI&II)—R.K.JainandS.C.Gupta 3. ManufacturingProcesses:H.S.Shan,Vol.1 4. AtextbookofProductionEngineering–P.C.Sharma
	ReferenceBooks: 1)ManufacturingScience--A.Ghosh,A.K.Mallik

DepartmentofMechanicalEngineering

Course Code	Title of thecourse	Program Core(PCR)/ Electives (PEL)	TotalNumber ofcontacthours				Credit
			Lecture(L)	Tutorial(T)	Practical (P)	Total Hours	
MEE626	**Advanced**	PEL	3	0	0	3	3

	WeldingTechnology						

Pre-requisites	CourseAssessmentmethods(Continuous(CT)andendassessment (EA))
Casting, Forming and Welding(MEC402)	CT+EA
CourseOut comes	• CO1 : To get the knowledge about newly developed welding process and itsparameters • CO2:Tolearnvarious nonconventionalweldingmethods • CO3:Tolearnvariousapplicationfieldsofvariousweldingprocesses
TopicsC overed	**Welding :** Definition, requirements, Conditions for ideal weld, Classification ofweldingprocesses (1) **Arc Welding :** Arc Initiation, Arc Physics, Arc Maintenance, Power Sources, PowerFactor,DutyCycle,SMAW,GMAW,GTAW,SAW,ESW,EGW,PAW,AHW(10) **Electrodes :** Electrode Classification, Electrode Nomenclature, Electrode composition,Basicity Index, Role of different elements, Coating Factor, Selection of electrodes (3)**Welddesignandassociatedsymbols,Numericalproblemsinwelding** (5)**ShieldingGases:** Types, roles,features, Selection(1) **Weld Metallurgy**: Zones in a weld, HAZ and its calculation, Weld Decay, WeldDistortion,ResidualStresses–theircauses,identificationandremedy(3) **Solid State welding Processes** – Forge Welding, Cold Welding, Friction Welding,FrictionStirWelding(6) **Thermo-ChemicalWelding Processes**–Thermitewelding,etc(3) **RadiantEnergyweldingProcesses**–ElectronBeamWelding,LaserBeamWelding,Ultrasonic Welding(2) **WeldingatMicroandNanoScale**(2)
Text Books,and/o rreferencem aterial	TextBooks: 1) RichardL.Little,WeldingandWeldingTechnology,TataMcGrawHill,2004 2) J.F.Lancaster,Metallurgyofwelding,Allen&Unwin,London,1980 ReferenceBooks: 1)V.Tsegelsky,TheElectricWelder, MirPublishers,Moscow,1968

Course Code	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEE627	**Computer AidedDesign**	PEL	3	0	0	3	3

Pre-requisites	CourseAssessmentmethods
Machine Design, EngineeringMathematics	Continuous(CT)+MidTerm(MT)+EndTermassessment(EA)
CourseOut comes	CO1:AbletounderstandscopeandapplicationofCAD/CAMtoolsinindustry CO2: Able to learn geometric modelling and computer graphics concept in CAD toolsCO3:Abletounderstandthedifferentdesignanalysisandoptimizationtoolsin CAD.

TopicsCovered	Introduction:CurrenttrendsinDesign&Manufacturing,FundamentalconceptofCAD-CAM-CAE,ProductLife-cycle, OverviewofCAD-CAMsystem. (2) Computer Graphics: Fundamentals of Geometric transformations, Graphics standards,CAD-CAMData Exchange.(5) GeometricModeling: Types and Mathematical representation of curves, surface and solids, Solid modeling &concepts of B-rep and CSG representation scheme , Geometric Modeling Using PointClouds: Reverse Engineering and its Applications, Computer aided design for additivemanufacturing(10) Computer aided Mechanism and Machine element design, Modeling and simulation (5)Fundamentals of FiniteElementModeling(FEM) (10) Designoptimizationtools.(8) VirtualPrototyping&RapidPrototyping:IntroductiontoVirtualPrototypinganditsapplicationsin MechanicalEngineering.(2)
Text Books,and/orreferencematerial	**TextBooks:** 1. CAD/CAM:Theory&Practice byI.Zeid 2. CAD/CAMbyP.N.Rao 3. PrinciplesofComputer-AidedDesignandManufacturingbyFaridAmirouche 4. ComputerGraphicsbyRoyAPlastock
	ReferenceBooks: 1. MasteringCAD/CAMbyI.Zeid 2. FiniteElementMethodbyJ.N.Reddy

SEVENTH SEMESTER

<table>
<tr><td colspan="8">DepartmentofManagementStudies</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleofthecourse</td><td rowspan="2">Program Core(PCR) /Electives (PEL)</td><td colspan="4">TotalNumberofcontacthours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MSC731</td><td>PRINCIPLES OFMANAGEMENT</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">CourseAssessmentmethods(Continuousassessment(CA)andEndAssessment(EA))</td></tr>
<tr><td colspan="3"></td><td colspan="5">CA+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">• CO1:Tomakebuddingengineersawareofvariousmanagementfunctionsrequiredfor anyorganization
• CO2: To impart knowledge on various tools and techniques applied by theexecutivesof anorganization
• CO3: To make potential engineers aware of managerial function so that itwouldhelpfor theirprofessionalcareer
• CO4: To impart knowledge on organizational activities operational andstrategic bothinnature
• C05: To impart knowledge on each functional area of management likeMarketing,Finance,BehavioralScience,QuantitativeTechniquesand DecisionScience</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">UNITI:ManagementFunctionsandBusinessEnvironment:Businessenvironment-macro,Businessenvironment-micro;Porter’sfiveforces,Management functions – overview, Different levels and roles of management,Planning- Steps, Planning and environmental analysis with SWOT, Application ofBCGmatrixinorganization (12)
UNIT II: Quantitative tools and techniques used in management: Forecastingtechniques,Decisionanalysis(6)
UNIT III: Creating and delivering superior customer value: Basic understandingofmarketing,Consumerbehavior-fundamentals,Segmentation,Targeting&Positioning,ProductLifecycle.(8)
UNITIV:Behavioralmanagementofindividual:Motivation,Leadership,Perception,Learning. (8)
UNITV:Professionalethics:IntroductiontoProfessionalethics,Morals,valuesandEthics, EthicsinBusiness.(2)</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. MarketingManagement15thEdition,PhilipKotlerandKelvinKeller,PearsonIndia
2. Management Principles, Processes and practice, first edition, Anil BhatandArya Kumar, OxfordHigher education
3. Organizational Behavior,13 th edition, Stephen P Robbins, PearsonPrenticehall India
4. OperationsManagement,7thedition(Qualitycontrol,Forecasting),Buffa&Sarin, Willey
5. A.C.Fernando:BusinessEthics&CorporateGovernance,PearsonEducation
2ndedition</td></tr>
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DepartmentofMechanicalEngineering							
Course Code	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEC701	**IndustrialEngineering andEngineering Measurement**	PCR	**3**	**1**	**0**	**3**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
Basic knowledge ofEngineeringMechanics		CT+EA					
CourseOutcomes	CO1: Knowledge on the structures of Engineering Organization in general.CO2:Planningof manningandproductionline. CO3: Ability for material management.CO4:Indianstandardsofmeasurement. CO5:Techniquesofengineeringmeasurementswithitsapplication.						
TopicsCovered	Organization Structure: Classical principles, Different types of organization structure-Line,Staff,Lineandstaff,Committeeorganization,Casestudy. 3 Plant Location: Factors affecting plant location, Plant location theories- material indextheory,locationfactortheory,Dimensionaldecisionmakingmodel,Forceanalogymethod, Specificsiteselection. 4 Plantlayout:Differenttypesoflayout,Variousflowpatterns,Factorybuildingconstruction,Travel chart. 2 Job evaluation, Merit rating and Wage incentive schemes: Methods of job evaluation-Rankingmethod, Classification method, Point method, Factorcomparisonmethod.Meritrating-Pointratingscale,Employeecomparisonsystem.Differentwageincentiveschemes. 4 Work study:Operationprocesschart,Flowprocesschart, Flowdiagram, String diagram, Multiple activity chart- Man-machine chart, Man-machine-helper chart, Lefthand-right hand chart, Motion study, SIMO study, Cycle graph and chronocycle graph,Performancerating,Stopwatchtimestudy. 4 Operations Research : Fundamentals, Graphical Method, Simplex Method, 4 NetwrokTechniques :Fundamentals,Utility,GantChart 2 ProgramEvaluationandReviewtechnique 3 CriticalPathMethod 3 Generalisedmeasurementsystems-Calibration,Sensitivity,Damping,Characteristicsoffirstorderandsecondordersystems,Dynamicresponse,Harmonicanalysis. 5 Standardsoflinearmeasurements,Interferometricmeasurements. 2						
	Limit, Fit and Tolerances: Basis of a limit system, Unilateral and Bilateral systems.2Indian limit system IS 919:1993; Types of fits and selection of fits, IS 2709:19823DimensionchainandDimensionalanalysis,Designanduseoflimitgauges. 2 Errorofflatnessandstraightness:Conceptofmeantrueplane,Measurementofflatnesserrorusing BeamComparator,AutocollimatorandPrecisionBlockLevel. 3Dynamometersformeasuring2-componentand3-componentmachiningforces. 2 Surfaceroughnessmeasurement. 3						

<table>
<tr><td rowspan="2">Text Books,and/or referencematerial</td><td colspan="6">TextBooks:
1. IndustrialEngineeringandManagement--Dr.Ravishankar
2. IndustrialEngineeringandProductionManagement--M.Mahajan
3. ATextbookofEngineeringMetrology--I.C.Gupta
4. EngineeringDimentionalMetrology--L.Miller</td></tr>
<tr><td colspan="6">ReferenceBooks:
1. ManagementinIndustry--C.S.George
2. EngineeringTolerences--H.W.Conway</td></tr>
<tr><td colspan="7">DepartmentofMechanicalEngineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Titleofthecourse</td><td rowspan="2">Program Core(PCR)/ Electives(PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MES751</td><td>Machine DynamicsLaboratory</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>2</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and endassessment(EA))</td></tr>
<tr><td colspan="2">TheoryofMachinesand Mechanisms(MEC302)</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="6">CO1Analysethegyroscopiceffectsonmechanicalsystems
CO2Minimiseunbalanceofrotatingandreciprocatingmachines
CO3 Introduction of single and two body lumped mass system with compliantelements anditsapplicationindesignofmechanicalsystems.</td></tr>
<tr><td></td><td colspan="6">SoftwareRelated:
1.DemonstrationofSoftware(s)fordynamicanalysisofmechanism
HardwareRelated:
DataAcquisitionCard
Experimentalsetupfordemonstration
1. Estimationofcentrifugalforceindifferenttypesofgovernors.
2. Synthesisofcamprofile.
3. Kinematicanalysisofepicylicgeartrains;estimationofholdingtorque.
4. Estimationofgyroscopictorque.
5. Balancingofrotatingmachine.
6. FreeandforcedvibrationofSDOFsystem.
7. Determinationofcriticalspeedof shaft
8. JournalBearingapparatus
Tostudythepressureprofileoflubricatingoilatvariousconditionsofloadand speed.
9. CoriolisComponentofacceleration
Tofindoutthe Coriolisaccelerationofcomponentandthe speedratingatdifferent waterflowrate.</td></tr>
<tr><td rowspan="2">Text Books,and/or referencematerial</td><td colspan="6">TextBooks:
1. TheoryofMachines andMechanisms,UickerJ.J.,PennockG
2. TheoryofMechanismsandMachines,GhoshA., MallikA.K.
3. MechanismandMachineTheory,J.S.RaoandR.V.Dukkipati,</td></tr>
<tr><td colspan="6">ReferenceBooks:
1.Dynamicsofmachinery:Holowenko,AlfredR</td></tr>
</table>

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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MES752</td><td>EngineeringM easurement Laboratory</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)andEndAssessment(EA))</td></tr>
<tr><td colspan="2">IndustrialEngineeringand EngineeringMeasurement</td><td colspan="6">CA+ EA</td></tr>
<tr><td>CourseOu tcomes</td><td colspan="7">1) Learnhowtousebasicmechanicalmeasuringinstruments.
2) Toapplythetechniqueofengineeringmeasurements.
3)Torecognizeandemploytheprecautionandcareforprecisionengineeringmeasurement.
4) Interprettheexperimentalresults.
5) Topreparethereportinengineeringmeasurement.</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">Experiments
1. Measurementofasteppedshaft.
2. Measurementofchordalgeartooththickness.
3. Measurementofaplugscrewgauge.
4. Measurementofangleofanangleplategaugebysine-barmethod.
5. Measurementofanglesofasinglepointcuttingtool.
6. MeasurementofYoung’smodulusandPoission’sratioofagivenmaterialusingstraingauges.
7. Measurementofborediameter.
8. Measurement ofsurfaceroughnessandestablishing therelationshipbetweenfeedandsurfaceroughnessfor a turned cylindricalspecimen
9. Measurementofanexternaltapergauge.
10. Measurementofmodulusofresilanceandmodulusoftoughnessfromstress-straincurveusingplanimeter</td></tr>
<tr><td rowspan="2">TextBook s,and/orre ferencema terial</td><td colspan="7">TextBooks:
1. ATextbookofEngineeringMetrology--I.C.Gupta
2. EngineeringDimentionalMetrology--L.Miller</td></tr>
<tr><td colspan="7">ReferenceBooks:</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE710</td><td>MachineTool Engineering andAutomation</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">MEC501</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1:Indepthstudyofmechanicalmachinetoolsconstructionanddesign.CO2:Introduct iontomachinetoolsautomation.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">General principles of Machine Tool design, Machine Tool drives and mechanisms.2Design of speed and feed gear box, Optimum design principles for using double boundgears. 12
Design of Machine Tool structures: beds, slides and guides, selection of bearing formachinetools. 3
Hydrostatic and Hydrodynamic lubrication in Machine Tool slide ways and Guides, Stick-slipmotioninMachineToolslideways. 3
Machinetoolrigidity,systemcomplianceandprocesscapabilityofmachinetools. 4Mac hinetoolinspection,testingandmaintenance. 2
Overview on Automation: Definition, application, advantages and disadvantages. Types ofautomation: fixed automation (automatic machines, transfer devices and semi-automatics), Programmable automation (NC, CNC and machining centres, DNC, adaptivecontrolmachines,Industrialrobots,CAD/CAM,CIM)andflexibleautomation(FMS). 5
CNC Hardware: Constructional features, operational characteristics of CNC machine tools,Machinetooldrives,sensingdevices,openandcloseloopcontrol 3
CNCmachining,partprogramming,NCtoolpathgeneration. 8</td></tr>
<tr><td rowspan="2">TextBooks,and/orreferencematerial</td><td colspan="7">TextBooks:
1. PrinciplesofMachineTools –SenandBhattacharya
2. ComputerControlledofManufacturingSystems –Y.Koren</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. MachineToolEngineering–N.K.Mehta
2. NumericalControlandComputerAidedManufacturing–Kundra,RaoandTiwari</td></tr>
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<tr><td>Lecture(L)</td><td>Tutorial(T)</td><td>Practical(P)</td><td>Total Hours</td></tr>
<tr><td>MEE711</td><td>Fracture Mechanics</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessmentmethods(Continuous(CT)and EndAssessment(EA))</td></tr>
<tr><td colspan="2">StrengthofMaterial
Theory of Elasticity andPlasticity</td><td colspan="6">CA+ EA</td></tr>
<tr><td>CourseO utcomes</td><td colspan="7">CO1: Extend basic concept of strength of material, and theory of elasticity for fracturemechanicsandfatigue characteristicstounderstand,assessand overcomefailure.
CO2:Providebasicunderstandingbetweenstructuraldesignwithstrengthofmaterialsapproachand fracturemechanics approach,various historicalstructuresfail.
CO3:EvaluateSIFsfordifferentmodesoffractureundervariousloadingconditions.CO4: Applyfracture mechanicsparametersinfailure analysis.
CO5:Applyadvanceknowledgeforsolvingcomplexfractureandfatigueproblems.</td></tr>
<tr><td>TopicsC overed</td><td colspan="7">Introductionto Fracture 10
Lectures
Historical background of fracture mechanics and fatigue failure, Ductile and brittle fractures,Modes of fracture, Introduction to Griffith’s energy balance, Energy release rate, Irwin-Orowantheoryof almost brittle materials, R-curves,Criticalenergyreleaserate.
Linear ElasticFractureMechanics 26
Lectures
Stress intensity factors, Irwin’s SIFs, Westegaard’s and William’s stress functions, Relationshipbetween K and G, Critical SIFs, SIF of complex cases, Fracture toughness, Crack-tip plasticity,Effects of length and thickness on fracture toughness, Plastic zone shape for plane stress andplanestraincondition,Experimentalmethodsofdetermining SIFs,Mixedmodefracturemechanics.
Introduction to Fatigue 06
Lectures
Fatigueloading,Highandlowcyclefatigue,Mechanismoffatiguecrackinitiationandpropagation,Factorsinfluencingfatiguestrength,Fatiguedesignphilosophies(lifeprediction, preventionoffatiguefailures,fail-safedesigncriteria),Fatiguecrackgrowth.</td></tr>
<tr><td rowspan="2">TextBoo ks,and/or reference material</td><td colspan="7">TextBooks:
4. ElementsofFractureMechanicsbyPrashantKumar,McGraw Hill Education.
5. FractureMechanicsFundamentalsandApplicationsbyT.L.Anderson,Taylor&Francis.
6. FundamentalsofFractureMechanics byT.Kundu, CRCPress.
7. FatigueofMaterialsandStructures– FundamentalsbyC.Bathias,A.Pineau,(Eds.),JohnWiley&Sons.</td></tr>
<tr><td colspan="7">ReferenceBooks:
3. TheStressAnalysis ofCracksHandbookbyH.Tada, P.C.ParisandG.R.Irwin, DelResearchCorporation.
4. FractureMechanics: AnIntroductionbyE.E.Gdoutos,Springer.
5. FractureMechanicsFundamentalsandApplicationsbyS.K.Maiti,CambridgeUniversityPress.
6. FatigueofStructuresandMaterialsbyJ.Schijve,Springer.</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE712</td><td>MicroandNano Manufacturing</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">Casting, Forming and Welding(MEC402),Machining and MachineTools(MEC501)</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1:Tounderstandtheneedformicroandnanoscalefabrication
CO2:Togetacquaintedwithdifferentmicroandnanoscalefabricationtechniquesandtheircharacterization
CO3 : To be able to select a suitable micro or nano scale fabrication process baseduponthe requirement
CO4:Tocompareandunderstandthedifferences betweenmacroandnanoscale fabricationprocesses</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Need for Micro and Nano Scale Manufacturing Processes : Examples of micro and nanoscalepartsbeingusedinvariousapplications,Howtheperformancesofmicro/nano scalecomponents arebetterAFM,STM,SEM,TEM, XRD, 2</td></tr>
<tr><td></td><td colspan="7">Photo Lithography: Historical perspective, Overview, Electromagnetic SpectrumCleanRoom–Classes, Features
Photoresist:PositiveandNegativePhotoresists;GlassTransitionTemperature,Photoresist deposition: Spin coating, Spray coating, Electro-deposition; Baking, Masks,Exposure:ContactPrinting,ProjectionPrinting,ProximityPrinting,Development,CriticalDimension,OverallResolution,LineWidthMetrology,ResistProfiles,PhotolithographyResolutionEnhancementTechnology:throughImprovedResistPerformance,throughImprovedMaskTechnology, throughImprovedExposureTechnologyReducingtheminimumfeature dimensioninphotolithography
Examples 10
Dry Etching
Definitions, Plasma, Physics of plasma, Sputtering or Ion Etching, Ion Beam Milling,PlasmaEtching,DeepReactiveIonEtching(DRIE),ICP,Examples 3
WetEtching
Chemical Milling, Photochemical Milling, Wet Isotropic and Anisotropic Etching, EtchStopTechniques, 3
Moore’sLaw,Needforpushingthefeaturesizes tolowerlevels,
Next Generation Lithographic Techniques : EUV , XRL, LIGA, EBL : EBL Resists,electronemission, IonBeamLithography, Nano ImprintLithography,Lithographictechniquesstillinresearchanddevelopmentalstate Examples 10
Physical Vapor Deposition: Thermal evaporation, Sputtering– DC and RF Sputtering,PulsedLaserDeposition–Lasersputtering,AerosolDepositionExamples 4
Chemical VaporDeposition:Overview,description,PVDvsCVD,APCVD, LPCVD,PECVD,ALD,Examples 2
MicroandNanoScaleJoiningTechniques. 2</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. Fundamental of Microfabrication and Nanotechnology Volume 2, by Prof Marc JMadou,CRC Press, TaylorandFrancis Group
2. MicroandNanomanufacturing,MarkJJackson,Springerlink
3. MicroandNanomanufacturingVolume2,MarkJJackson,Springerlink</td></tr>
</table>

	ReferenceBooks: Micro/Nano Manufacturing, Hans Nørgaard Hansen and Guido Tosello, MDPIPublishing(for applicationexamples)

DepartmentofMechanicalEngineering							
CourseCode	Title of thecourse	Program Core(PCR)/ Electives(PEL)	ContactHours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	TotalHours	
MEE713	**Aerospace Engineering**	PEL	**3**	**0**	**0**	**3**	**3**
Pre-requisites		Course Assessment methods (Continuous (CA), Mid-term (MT) and End-termassessment(ET))					
MEC303,MEC403		CA+ MT+ EA					

CourseOutcomes

- CO1:UnderstandingfluidflowprinciplesandAerospacedesignbasics.
- CO2:Relatetheliftanddragforceassociatedwithairfoilshapes.
- CO3: Analyze how an aircraft is able to lift off the ground and get into the air before you use up alltherunwaylengths
- CO4: Understanding the concept of control when hit by gust of wind that momentarily pitches theairplaneup
- CO5:Examinethemodels ofawidevarietyofpropulsionsystems.

Chap No.	CourseContent
1	**BasicAerodynamics 7** Continuity Equation,Incompressibleand CompressibleFlow,MomentumEquation,DiscussionofCompressibility,IntroductiontoViscousFlow,Results for a Laminar Boundary Layer, Results for a Turbulent BoundaryLayer,FlowSeparation.
2	**Airfoilsand Wings 12** Introduction, Brief History of Aviation, Aircraft Component Nomenclature-Wings,Fuselage,Empennage,FlightControlSurfaces,HighLiftDevices,Airfoil Nomenclature, Lift, Drag, and Moment Coefficients, Infinite versusFiniteWings,PressureCoefficient,ObtainingLiftCoefficientfromC_P,Compressibility Correction for Lift Coefficient, Critical Mach Number andCritical Pressure Coefficient, Drag-Divergence Mach Number, Wave Drag (AtSupersonicSpeeds),SweptWings,AerodynamicsofAirfoils,HowLiftisProduced—SomeAlternative Explanations.
3	**PrinciplesofStabilityandControl 7** *Static Stability*, *Dynamic Stability*, *Control*, Absolute Angle of Attack, NeutralPoint, Criteria for Longitudinal Static Stability, Contribution of the Wing to*M*cg,ContributionoftheTailto*M*cg,NeutralPoint,StaticMargin,ConceptofStaticLongitudinalControl,CalculationofElevatorAngletoTrim,Stick-FixedVersusStick-FreeStaticStability.
4	**ElementsofAirplanePerformance 7** Introduction:TheDragPolar,EquationsofMotion,ThrustRequiredforLevel,UnacceleratedFlight,PowerAvailableandMaximumVelocity,AltitudeEffectsonPowerRequiredandAvailable,RateofClimb,GlidingFlight,AbsoluteandServiceCeilings,TimetoClimb,RangeandEndurance:Propeller-DrivenAirplane,RangeandEndurance:JetAirplane,TakeoffPerformance,LandingPerformance
5	**Propulsion 7** Introduction, Propeller, Reciprocating Engine, Jet Propulsion—The ThrustEquation, Turbojet Engine-Thrust Buildup for a Turbojet Engine, TurbofanEngine, Ramjet Engine, Scramjet Engine, Rocket Engine, Rocket Propellants,EngineEfficiency- PropulsiveEfficiency,Electric Propulsion

TextBook:
1.IntroductiontoFlight:J.D.Anderson,Jr.,McGraw-HillInternationalEditions.

ReferenceBooks:

1. Introduction to Aerospace Engineering with a Flight Test Perspective: Stephen Corda, John Wiley&Sons.
2. MechanicsofFlight:WarrenF.Phillips.JohnWileyandSons,Inc
3. Miele,A.,FlightMechanicsTheoryofFlightPaths,Vol.I,Addison-Wesley,Reading,MA.
4. AircraftDesign:AConceptualApproach,D.Raymer(4thEd.),AIAAPress,2006.
5. ElementsofGasDynamics:LeipmannandRoshko,JohnWileyandSons.
6. TheDynamicsandThermodynamicsofCompressibleFlows:A.HShapiro,JohnWileyandSons.

DepartmentofMechanicalEngineering							
			TotalNumber ofcontacthours				Credit
Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEE714	**Advanced Mechanical Vibration**	PEL	**3**	**0**	**0**	**3**	**3**
Pre-requisites		CourseAssessmentmethods(Continuous(CT)andendassessment (EA))					
MEC404		CT+EA					
CourseOutcomes	CO1:Understandingthefundamentalmaterialforamoderntreatmentofvibrations. CO2:ApplicationofLagrangeequationsforlumpedandcontinuoussystems CO3:Understandingfundamentalsofbeamtheory;extensional,torsional,andflexuralvibrations of beams. CO4:UnderstandingSelf-excitedvibration,nonlinearvibrationetc.						
TopicsCovered	Reviewof relevantmathematics:linearalgebra 3 Generalizedco-ordinates, Lagrange'sequations 3 Single-DOFandmulti-DOFvibration 7 VibrationAbsorber 2 Torsionalvibration 4 PeriodicexcitationandFourierseries, impulseandstepresponse 5 Vibrationincontinuoussystems 4 Self-excitedvibration,Criterionofstability;Effectoffriction 5 Introductionto nonlinearvibration 7						
Text Books,and/orreferencematerial	**TextBooks:** 1. MechanicalVibrations,S.S.Rao,PearsonEducationInc.(4thEd.),2007. 2. FundamentalofVibrationsLeonardMeirovitch,Mc-GrawHillInc.,2001 3. VibrationandControl,D.J.Inman,JohnWilley&Sons Inc,2002						
	ReferenceBooks: 1. MechanicalVibrations,S.Tamadonni& Graham S.Kelly,Schaum'sOutlineSeries,Mc-GrawHillInc, 1998. 2. VibrationConditionMonitoringofMachines,J.S.Rao,TataMc-GrawHill,2006.						

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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)#</td><td>Total Hours</td></tr>
<tr><td>MEE715</td><td>SOLARENERGY</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">MEC304,MEC403,MEC502</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1:Acquireknowledgeofsolarradiationprinciplesconcerningsolarenergyestimation
CO2:Estimatetheavailablesolarenergyinaparticularsite.
CO3:Suggestasuitableconversionmechanismforgeneratingpowerorthermalapplicationfromsolarenergy
CO4:DesignaSolarThermal/PVsystemforanyrequirement</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">SolarRadiationandMeasurements:</td></tr>
<tr><td></td><td colspan="7">Solarenergyoption-anoverview,Fundamentalsofsolarradiation,BasicEarth-sun-angles,Solar timeand equation oftime, Empiricalequations forpredicting theavailability of solar radiation, Computation of radiation on a surface, measurementsofsolar radiation-Pyranometer,Pyrheliometer,sunshine recorder.
LiquidFlatPlateCollectors:
Liquid flat plate collector design, Efficiency of flat plate collectors and performanceanalysis, Flat plate solar air heaters, Other types of solar air heaters, some noveldesigns,Performance analysis, andtestingprocedures.
SolarConcentricCollectors:
Cylindricalparaboliccollectors,Performanceanalysisofcylindricalparaboliccollectors, Compound parabolic concentrating collectors, Performance analysis ofcompoundparabolicconcentratingcollectors,Paraboloiddish collectors.
SolarThermalEnergyStoragesystem:
Needforthermalenergystorage,sizeanddurationofstorage,sensibleheatstorage,latentheatstorage, PCM,andThermochemical energystorage.
SolarThermalApplications:
Solarspaceheating,activesystems,passivesystem-Trombewall,Solarrefrigeration and air conditioning, Solar cookers, Solar desalination, Solar dryers,Solarpondsandtheirthermalperformance,Solarenergyforindustrialprocessheat
SolarThermo-MechanicalPowerGeneration:
Principles of solar engines, limitation of solar mechanical power conversion, Typesofsolarpowerplants,Solarchimney,Parabolicthroughpowerplants,Centralreceiverpowerplants.Solar furnaces.
SolarPhotovoltaicSystems:
Conversionofsolarenergyintoelectricity,photovoltaiceffects,photovoltaiccellandits working principle, different types of solar cells, series and parallel connections,photovoltaic applications, battery chargers, domestic lighting, street lighting andwaterpumping.</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">SuggestedTextBooks:
1. Sukhatme S. P., “Solar Energy: Principles of Thermal Collection and Storage,” 3rdEd.,Tata McGraw-HillPublishingCompanyLtd.
2. H. P. Garg and J. Prakash, Solar Energy: fundamentals and applications, 1stEd.,TataMcGraw-HillPublishingCompanyLtd.
SuggestedReferenceBooks:
1.SolarenergyProcess –DuffieandBeckman,JohnWiley</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEE720</td><td>AdvancedMachining andSurface Engineering</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">MEC501</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1:Tounderstandtheoryofmachining,orthogonalcutting
CO2:Tounderstandobliquecuttingmechanicsasappliedtodrillingandmilling
CO3: To study other important aspects in machining related to cutting toolsCO4:Tounderstandthesurfacemodificationprocessesandtechnology</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Module1:TheoryofMachining(27hours)
Introduction: Characteristics and development of tool materials, cutting tool insertsandits geometry,cuttingfluids 5
Mechanics of Metal Cutting, Shear angle relationships and Lee and Shaffer’s Theory,WorkhardeningandChipbreakers. 5
Stressdistributiononrakefaceofthetool 1
Thermalaspectsofmachining. 2
Mechanisms of tool wear, Surface Finish and Effects of cutting parameters and toolgeometryontool life. 4
Economicsofmachining. 1
Drilling:Geometryofdrillingtoolsandmechanicsofdrilling. 3
Milling:Geometryofmillingtoolsandmechanicsofplainmilling 6
Module2:SurfaceEngineering(15hours)
SurfacestructureandProperties, 2
Surfacetextureandroughness 2
Tribology:Friction,wearandlubrication, 5
Surfacetreatments,CoatingandCladding 6</td></tr>
<tr><td rowspan="2">Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
1. MachiningandMachineTools-A.B.Chattopadhyay
2. Theoryofmetalcutting–G.Kuppuswamy
3. ManufacturingProcesses-KalpakjianandSchmid
4. AtextbookofProductionEngineering –P.C.Sharma</td></tr>
<tr><td colspan="7">ReferenceBooks:
1.ManufacturingScience–A.Ghosh,A.K.Mallik</td></tr>
</table>

<table>
<tr><th colspan="8">DepartmentofMechanicalEngineering</th></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of thecourse</td><td rowspan="2">ProgramCore (PCR) /Electives (PEL)</td><td colspan="4">TotalNumber ofcontacthours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)#</td><td>Total Hours</td></tr>
<tr><td>MEE721</td><td>Microfluidics</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="3">MEC303, MEC304, MEC403,PHC01,CYC01, BTC01</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1: To learn the fundamentals of micro channel flows with heat transfer and the impactoflowReynolds numberhydrodynamicsonflowcharacteristics.
CO2:TolearnSurfaceTensionDrivenFlowswithreallifeapplications.
CO3: To learn the diverse flow actuation techniques using ElectrohydrodynamicsCO4:To acquaintwith various MicrofabricationTechniques
CO5:TolearnthebasicsofNanofluidicsandMolecularDynamicsSimulations</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">IntroductiontoMicrofluidics:Origin,Definition,Benefits,Challenges,Commercialactivities,Physics ofminiaturization,scaling laws,Intermolecularforces,Statesofmatter, Continuumassumption,Governingequations,Constitutiverelations.Microfluidics-SomeApplicationExamples:Drugdelivery, Diagnostics, Bio-sensing. 1
EquationsofConservation:Momentumconservation(NavierStokesEquation),EnergyEquation,SpeciesConservationEquation 5
Pressure–drivenMicroflows:Exactsolutions,Couetteflow,Poiseuilleflow 5
SomeExamplesofUnsteadyFlows:HydraulicresistanceandCircuitanalysis,Straight channelofdifferentcross-sections,Channelsinseriesandparallel.StokesDragonaSphere:Stokesdragonasphere,Time-dependentflows,Two-phase flows. 5
LubricationTheory 2
BoundaryConditioninFluidMechanics-SliporNo-slip:Gasandliquidflows,Boundaryconditions,Sliptheory,Transitiontoturbulence,LowReflows,Entranceeffects 2
SurfaceTensionDrivenFlows:Surfacetensionandinterfacialenergy,Young-Laplaceequation,Contactangle,Capillarylengthandcapillaryrise,Interfacialboundaryconditions,Marangonieffect 6
ThinFilmDynamics 4
Introduction to Micro-fabrication: Materials, Clean room, Silicon crystallography, Millerindices.Oxidation,photolithography-mask,spincoating,exposureanddevelopment,Etching, Bulk and Surface micromachining, Wafer bonding. Polymer micro fabrication,PMMA/COC/PDMSsubstrates,micromolding,hotembossing,fluidicinterconnections .
1
Electrokinetics: Electrohydrodynamics fundamentals. Electro-osmosis, Debye layer, ThinEDLlimit,Ideal electro-osmotic flow, IdealEOF withbackpressure,Cascade electro-osmoticmicropump,EOFofpower-lawfluids.Electrophoresisofparticles,Electrophoreticmobility, Electrophoretic velocity dependence on particle size. Dielectrophoresis, InducedpolarizationandDEP,Pointdipoleinadielectricfluid,DEPforceonadielectricsphere,DEPparticletrapping,ACDEPforceonadielectricsphere.Electro-capillaryeffects,Continuouselectro-wetting,Directelectro-wetting, Electro-wettingondielectric. 6
Dispersion,IntroductiontoNanofluidics,IntroductiontoMolecularDynamicsSimulations,Biomicrofluidics,NanofluidicEnergyConversion. 4</td></tr>
<tr><td>TextBooks,and/orreferencematerial</td><td colspan="7">TextBooks:
1) Microfluidics-StéphaneColin,Wiley-ISTE,2010.
2) Micro- and Nanoscale Fluid Mechanics, Transport in Microfluidic Devices by BrianKirby,Cambridge UniversityPress, 2010.</td></tr>
</table>

	ReferenceBooks: 1) TheoreticalMicrofluidics-HenrikBruus,OxfordUniversityPress,1st Ed.,2007. 2) Fundamentals and Applications of Microfluidics: Nam-Trung Nguyen and Steven T.Wereley,Artech House, Boston, 3rd Ed., 2018.

DepartmentofMechanicalEngineering							
Course Code	Title of thecours e	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEE722	**Refrigeration and AirCondition ing**	PEL	**3**	**0**	**0**	**3**	**3**
Pre-requisites		CourseAssessmentmethods(Continuous(CT)andEndAssessment(EA))					
Fluid Mechanics(MEC303), EngineeringThermodynam ics(MEC304),HeatandMas s Transfer(MEC403)		CA+ MT+ EA					
CourseOu tcomes		CO1: Understand the principles and applications of various refrigeration cycles.CO2:Knowledgeofdifferentrefrigerants anditsproperties. CO3:Abilitytounderstandthefundamentalsofpsychometric,andpsychometricprocesses.CO4:Anal yzeair-conditioningsystemusingtheprinciplesofpsychometric. CO5:Togainknowledgeaboutcomponentsofcoolingload,anditsestimation.					
TopicsCo vered		History and Methods of Refrigeration, Refrigeration and Second Law of Thermodynamics,Units of Refrigeration, Reversed Carnot Cycle. Its Practical Limitations, Bell-Coleman AirCycle, Standard Vapour Compression Refrigeration System and Its Performance Analysis.Effect of Evaporator and Condensing Pressure. Modifications, Its Effects, Actual VapourCompression Refrigeration Systems, Second Law Efficiency of Vapour Compression Cycle,MultistageVapourCompressionSystem,CascadeRefrigerationSystem.Cryogenics: Introductionandapplicationsofcryogenics. **[12]**					
		Desirable Properties of Refrigerants, Designation of Refrigerants, Secondary Refrigerant,Thermodynamicsanalysisofvapourabsorption System,Comparisonbetweenvapourabsorptionandvapourcompressionsystem,Aqua-AmmoniaandLithiumBromideabsorptionsystem.**[6]** Psychrometric properties, Psychrometers, Preparation of psychrometric charts, Enthalpydeviation, Psychrometric Processes - Mixing process, Sensible heating, Sensible cooling,Humidification,Dehumidification,CoolingandDehumidification,Heatingandhumidifica tion,Bypassfactor,Apparatusdewpoint,Sensibleheatfactor,Airwasher,Adiabatichumidification,E fficiencyofhumidification,SummerandWinterairconditioningsystem.**[10]** Factors affecting comfort air conditioning, Air conditioning system, Classification of airconditioning systems, Central air conditioning systems, Room sensible heat factor, Non-conventionalrefrigerationsystems:Vortexandpulsetuberefrigerationsystems;Thermoelectric refrigerationsystems.**[8]** Components of a cooling load, Heat gain from solar radiation, Metabolic rate, Heating loadcalculations,Ducts,Pressuredropinducts,EnergyefficiencyandSustainabletechnologies: Energy efficiency, Green buildings etc., Artificial intelligence models for refrigeration, airconditioningandheat pumpsystems.**[8]**					

TextBooks ,and/orreferencematerial	**TextBooks:** 1) RefrigerationandAirConditioningbyC.P.Arora,TataMcGraw-Hill. 2) RefrigerationandAirConditioningbyManoharPrasad,NewAgeInternationalPublishers. 3) RefrigerationandAirConditioningbyR.K.RajputKastonPublication.
	ReferenceBooks: 1) Refrigeration and Air Conditioning by W.F. Stoecker and J. W. Jones, Tata McGraw-Hill. 2) AroraS.C.andDomkundwarS.,"ACourseinRefrigerationandAirConditioning",Dhanpat Rai&Sons, 2006. 3) AnanthanarayananP.N.,"BasicRefrigerationandAirConditioning",TataMcGraw-Hill,2005. 4) ASHRAEHandbook.
	DataBooks: 1)Refrigerant and Psychrometric Properties - Tables and Charts [SI Units], M. L.Mathur,andF. S.Mehta, JainBrothers,2020 (RevisedEdition).

DepartmentofMechanicalEngineering							
Course Code	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEE723	**ComputationalFluid Dynamics and HeatTransfer**	PEL	**3**	**0**	**0**	**3**	**3**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment(EA))					
FluidMechanics(MEC303), Engineering Thermodynamics(MEC304)		CT+EA					
CourseOutcomes		CO1: To learn to model a physical Fluid Mechanical and Heat Transfer problem (bothLaminar&TurbulentFlow)mathematicallyintermsofPDEs. CO3: To learn discretization of the PDEs using Finite Difference and Finite VolumeMethods CO3:TolearnR-K4methodtosolveODEs andTechniquestosolvePDEs.					
		CO4: To learn to solve simple Heat transfer Problems and Viscous IncompressibleFluid Flow problems using MATLAB coding and checking the same bysimulationusingANSYS-Fluentsoftware.					
TopicsCovered		**Coservationequationsoffluidflowandheattransfer:** Mass, momentum (NS-equation), energy conservation equation and equation of state,Stream function- Vorticity method and Laminar Boundary layer equations for ViscousandThermalBoundarylayer.ClassificationofPDEs:Elliptical,ParabolicandHyperbolic PDEs, Initial and Boundary value problems, some examples. Numerical methods: (1)JacobiIteration,(2)PointGaussSiedeliteration(3),LineGaussSiedeliteration(4)PointSuccessiveover/underrelaxationmethodand(5)TDMAusingThomasAlgorithm.9 **Turbulence modeling:** (1) RANS equations with (a) Mixing length model, (b) The *k-ε*model and (c) *k-ω* model. (2) Large eddy Simulation (Concept only) and (3) DirectNumerical Simulation,DNS (Issues andconcepts). 5 **DiscretizationtechniquesofPDEs:** **Finite Difference Methods**: Central, Forward and Backward Differencing for bothuniformandnon-uniformgrids.Numericalerrorsandaccuracy;Consistency,Convergence and Stability of finite difference scheme. Grid generation, Discretizationand solution using Matlab coding of both Steady and Unsteady Diffusion problems andConvetion-Diffusionproblems. **FinitevolumeMethod**:Conservativeness,BoundednessandTransportiveness,Centraldifferen					

	cingschemes,Upwinddifferencingschemes,Hybriddifferencingschemes and Power law schemes, Quadratic Upstream Interpolation for ConvectiveKinetics(QUICK). 14
	NumericalmethodsforViscousIncompressibleFluidFlow: Runge-Kutta methods and its application to solve Viscous Boundary layer equations(Blasiusequationforflatplate)andThermalboundarylayerequations.Streamfunction-Vorticitymethod,MACalgorithm,SIPLE,SIMPLER,SIMPLECandPISOtosolveViscousincompressiblefluidflow. 14
Text Books,and/orreferencematerial	TextBooks: 1. PradipNeogy, S. K. Chakraborty and M. K. Laha:Introduction to ComputationalFluidDynamics; 2. H. K. Versteeg. and W. Malalasekera : An Introduction to Computational FluidDynamics:The FiniteVolume Method. 3. P.S.Ghoshdastidar:ComputationalFluidDynamicsandHeatTransfer. ReferenceBooks: 1. Tannehill,J.C.,Anderson,D.A.andPletcher,R.H.,ComputationalFluidMechanics andHeatTransfer,McGrawHill, 2002. Patankar,S.V.,NumericalHeatTransferandFluidFlow,AneBooks-NewDelhi,1980. 2. Blazek,J.,ComputationalFluidDynamics:PrinciplesandApplications,2ndEdition,ElsevierScience&Technology, 2006. 3. Chung,T.J.,ComputationalFluidDynamics,CambridgeUniversityPress,2003.

DepartmentofMechanicalEngineering							
Course Code	Title of thecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEE724	**Theoryof Plates**	PEL	**3**	**0**	**0**	**3**	**3**
Pre-requisites		CourseAssessmentmethods(Continuous(CT)andendassessment (EA))					
EngineeringMechanics, StrengthofMaterials		CT+EA					
CourseOutcomes	CO1:Conceptofvarious platetheory CO2: Derivation of governing equation using virtual displacement theoryCO3:Analysisof plates						
TopicsCovered	Stress strain relations, strain displacement relation, equations of equilibrium, virtualworkprinciple,Classicalplatetheory,FSDT,HSDT. 8 Pure bending and cylindrical bending of isotropic rectangular plates, Navier and Levysolutionsofrectangularplates. 8 Bendingofcircularplates. 6 Bendinganalysisoflaminatedcompositesplates. 8 Approximatesolutionmethodsforplateproblems. 6 DynamicsofPlates. 6						
Text Books,and/orreferencematerial	**TextBooks:** 1. TheoryofplatesByK.Chandrashekhara(UniversitiesPress) 2. TheoryandanalysisofelasticplatesandshellsByJ.N.Reddy(CRCPress) 3. Theory of plates and shells By S. P. Timoshenko and S. W. Krieger(TataMcgraw-Hill)						

	ReferenceBooks: 1.Theory and analysis of plates classical and numerical methods By R. Szilard(PrenticeHall)

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Course Code	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEE725	**Energy ConversionSystems**	PEL	**3**	**0**	**0**	**3**	**3**
Pre-requisites		Course Assessment methods (Continuous (CT) and endassessment(EA))					
MEC 601 (Power PlantEngineering)		CT+EA					
CourseOut comes	CO1:Acquireanideaaboutdifferentenergyconversiontechnologies CO2:To learn the energy efficient, economically viable, and environmental friendlypowergeneration technologies CO3: To learn about different conventional and non-conventional power generationsystems. CO4:Introducedtodifferentdirectenergyconversionsystems						
TopicsC overed	GlobalandIndianEnergyScenario 3 AdvancedCoalTechnologies 6 Advanced Power generation Cycles-Supercritical Power plant, Cogeneration,Combinedcyclepowerplants 7 Fluidizedbedcombustion 5 Gasification,IntegratedGasificationCombinedCycle(IGCC) 6 Direct Energy Conversion:Fuel Cells: Proton Exchange Membrane (PEM) Fuel cells,SolidOxideFuelCells(SOFC),Magneto-Hydro-Dynamic(MHD)Systems 7 Biomassbasedenergyconversion 3 NuclearPowergeneration 5						
Text Books,and/o rreferencem aterial	**TextBooks:** 1. PrinciplesofEnergyConversion-ArchieW.Culp 2. PowerPlantEngineering-P.K.Nag						
	ReferenceBooks: 1. FluidizedBedTechnology-J.R.Howard 2. PEMFuelCells:TheoryandPractice-FranoBarbir						

DepartmentofMechanicalEngineering							
CourseCode	Titleofthecourse	Program Core(PCR)/ Electives(PEL)	TotalNumber ofcontacthours				Credit
			Lecture (L)	Tutorial(T)	Practical (P)	Total Hours	
MEE726	**Advanced Robotics**	PEL	3	0	0	3	3
Pre-requisites		CourseAssessmentmethods					
KnowledgeonMechanisms		Continuous(CT)+MidTerm(MT)+EndTermassessment(EA)					
CourseOut comes	CO1Understandtheprinciplesofdifferentroboticmechanisms,sensors,actuatorsCO2 Analyse the serial robotic manipulators for position, velocity and accelerationCO3Analyse thedynamicsofserial roboticmanipulators CO4Analysethekinematicsofparallelmanipulator CO5Applyanalyticalformulationformodellingofleggedrobots						

TopicsCovered	Reviewofbasics ofRobotics(2) Mathematical representation of industrial robots : Denavit-Hartenberg convention (2)Kinematic analysis of serial robotic manipulators: Forward kinematics, Inversekinematics,velocityandaccelerationanalysis(8) Introduction to Dynamics of Serial Manipulators: Newton-Euler formulation, Lagrange-Eulerformulation(5) Trajectory Planning of Manipulator: Joint space scheme, Cartesian space scheme (4)Introductiontoparallelmanipulators(1) Kinematics of parallel manipulators (5)Modellingandanalysisofleggedrobots(4) Robot Sensors: Contact type, non-contact type, internal sensor, External sensor, Rangesensor, Proximity sensor, touch sensor, Force and torque sensor, Encoders, robotvisionetc(5) Robotactuators(1) Positionandforcecontrolofmanipulators(3) RobotOperatingSystem(ROS)andArtificialIntelligence(AI)inrobotics (2)
Text Books,and/orreferencematerial	**TextBooks:** 1. Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press,2ndreprint,2008. 2. Saha,S.K.,IntroductiontoRobotics,TMHPublishingCompanyLtd.,NewDelhi,2008. 3. Pratihar,D.K.,FundamentalsofRobotics,NarosaPublishingHouse,India,2017
	ReferenceBooks: 1. Spong,M.W.,Hutchison,S.,andVidyasagar,M.,RobotModelingandControl,WileyIndia,NewDelhi, 2006. 2. Fu,K.,Gonzalez,R.andLee,C.S.G.,Robotics:Control,Sensing,VisionandIntelligence¸ McGraw-Hill,1987.

OpenElectiveSubjectsofferedbyMechanicalEngineeringDepartment

<table>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEO741</td><td>ProductDevelopmentandValue Engineering</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">CourseAssessmentmethods(Continuous(CT)andendassessment(EA))</td></tr>
<tr><td colspan="2"></td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="6">• CO1:Understandtheprocessofproductdesignanddevelopment.
• CO2:Identifytheergonomics betweenhumanandmachines.
• CO3:Analyzetheconceptofvalueengineeringforproductorientation.
• CO4:Selecttheprocessforintroductionofproductforhumaninterface.</td></tr>
<tr><td>TopicsCovered</td><td colspan="6">1. ProductDevelopment: [15]
Productdesign,Typesofdesign,Phasesinproductdesign,Reasonforproductdevelopment,Factors affectingproductdevelopment,Characteristicsofsuccessfulproductdevelopment,Challengesofproductdevelopment,Productclassifications,Productdevelopmentprocesses,Conceptdevelopment,Brainstorming,Productdevelopment plan, Identifying customers need, Deciding product specifications, defectinvestigation, selection of materials, important engineering materials, new materials,process selectioncriteriaandprocess design.
2. Ergonomics: [12]
Scopeandobjectiveofergonomic,Humanphysicalcharacteristics,applicationofhumanfactorinengineering, Humanmachinesystems.
3. Valueengineering [15]
Introductionofvalueengineering,costreductiontechnique,Valueengineeringprogram,Advantages andapplications,problemrecognition,role ofcreativity,
Valueengineeringjobplan:-
orientationphase,informationphase,Functionphase,Evaluationfunction,Investigationphase,projectselectionandvaluestandard.
Fastdiagramandlifecyclecost:-
Useoffastdiagram,typesoffastdiagram,technicallyorientedfastdiagram, lifecyclecost</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="6">TextBooks:
• ProductDesignandDevelopment:KarlT.UlrichandStevenD.Eppinger
• HumanFactorsinErgonomicsandDesign:Sanders&Mccormick</td></tr>
<tr><td></td><td colspan="6">ReferenceBooks:
• Product design and manufacturing, A. C. Chitale and R C Gupta, Prentice HallNewDelhi
• ValueEngineering:AsystematicapproachbyArthurEMudge–McGrawHill</td></tr>
</table>

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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEO742</td><td>EnergyManagement andAuditing</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">CourseAssessment methods(Continuous(CT) and End Assessment(EA))</td></tr>
<tr><td colspan="2">Nil</td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1:Toacquiretheknowledgeaboutenergyconservation.
CO2:Knowledgeofenergyconversionefficiency.
CO3:Abilitytoevaluatetheperformanceofpumps,fans,blowers,andindustrialboilersetc.
CO4:Togainknowledgeabouttheenergyconservationopportunitiesinvariousindustrialprocesses.
CO5:Studentswillbeabletobecomeenergymanagerandenergyauditorindifferentindustries.</td></tr>
<tr><td>TopicsCovered</td><td colspan="7">Introduction: Importance of energy management, Role, Responsibilities and Duties ofEnergy manager and Energy Auditor, Energy Conservation Act and Calculation of energyconsumption,FundamentalcalculationinMechanical,Thermal&Electricalsystem,Thermal energy basis, Measurement and instruments used in energy audit, Performanceparametersforenergyaudit,BureauofEnergyEfficiency(BEE),PlantEnergyPerformance(PEP).(10)
MaterialandEnergyBalance,Energyanalysis,Sankeydiagram,FinancialManagementandanalysistechniques,ProjectManagement,Time-dependentenergyanalysis,Energyconversion efficiency, Capacity Factor (CF), Renewable energy sources, Non-renewableenergysources, andConversionefficiency.(8)
MechanicalandThermalsystem:GrossCalorificValue(GCV)andNetCalorificValue(NCV),Combustion,Boilerefficiencytesting,excessaircontrol,steamdistributionanduseofsteamtraps,condensaterecovery,flashsteamutilization,Furnaceefficiency,thermalinsulation,Cogeneration,Wasteheatrecovery,Energyconservationinpumps,fanandblower, Compressed air systems, Refrigeration and air conditioning systems.
(10)ElectricalSystem:Powerfactor,energyefficientmotors,lightinglevels,Illuminance,EnergyConservationincoolingtower,Wasteheatrecovery,Trigeneration,Energyconservationbuildingcode.(5)
EnergyAuditing:Introduction,Importanceofenergyaudit,usesofenergyaudit,Basic termsofenergyaudit,Typesofenergyaudit,Procedureforcarryingenergyaudit,Instruments used for energyaudit.(9)</td></tr>
<tr><td rowspan="2">TextBooks,and/orreferencematerial</td><td colspan="7">TextBooks:
1. EnergyManagementandConservationHandbook,FrankKreithandD.YogiGoswami;CRC Press, Taylor &FrancisGroup.
2. HandbookofEnergyEfficiencyandRenewableEnergy;FrankKreithandD.YogiGoswami; CRC Press, Taylor &FrancisGroup.
3. GuidetoEnergyManagement,SeventhEdition,BarneyL.Capehart,WayneC.Turner,William J. Kennedy;CRCPress, Taylor&FrancisGroup.
4. HandbookofEnergyAudits, NinthEdition,Albert Thumann, TerryNiehus, andWilliam J. Younger;CRC Press, Taylor&FrancisGroup.</td></tr>
<tr><td colspan="7">ReferenceBooks:
1. IntroductiontoPowerPlantEngineering -PKNag
2. EnergyManagementinBuildingsUsingPhotovoltaics,ElenaV.M.Papadopoulou;Springer.</td></tr>
</table>

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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>MEO743</td><td>DynamicalSystemsTheory</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and endassessment(EA))</td></tr>
<tr><td colspan="3">MAC02</td><td colspan="5">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">CO1:Understandthedynamicalbehaviourofnonlinearsystems.
CO2:Explaindifferentdynamicalstatesandtransition(Bifurcation)betweenthem</td></tr>
<tr><td></td><td colspan="7">CO3:EvaluateStabilityofdifferentdynamicalstates.
CO4:Analyzedifferentchaoticsystemsandtheiruniversality</td></tr>
<tr><td>Topics Covered</td><td colspan="7">DynamicsinStateSpace(in2and3dimension):StateSpace,1st orderdifferential equation,no-intersectiontheorem,dissipativesystemsandattractors,1Dstatespace, Taylorserieslinearizationnearfixedpoints,2DStatespace,Dynamicsandcomplex characteristicsvalues,Dissipationanddivergencetheorem,JacobianMatrix,Limit cycles,Poincaresection,Stabilityoflimitcycles,BifurcationTheory. 14
ThreeDimensionalStatespace:3DimensionaldynamicalSystems,Fixedpointsin 3D,LimitcyclesandPoincareSections,Quasi-periodicbehaviour,Routestochaos: Period-doublingroutetochaos,Quasi-periodicityroutetochaos,Intermittencyroute to chaos, Chaotic Transients and Homoclinic Orbits, Lyapunov exponents. 12
Chaoticsystems:AnonlinearElectricalSystem,PopulationGrowthModel,Lorenz Model:amodelofconvectingfluid,Determinism,UnpredictabilityandDivergenceof trajectories. 8
UniversalityofChaos:FeigenbaumNumbers,Convergenceratioofrealsystems,Self-Similarity,Otheruniversalfeatures. 4
IteratedMap:PoincaresectionandIteratedMap,BifurcationinIteratedMap,Tent Map,ShiftmapandSymbolicDynamics,2D IteratedMap 4</td></tr>
<tr><td rowspan="2">Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
6. ChaosandNonlinearDynamics–RobertC.Hilborn
7. NonlinearDynamicsandChaos –StevenH.Strogatz</td></tr>
<tr><td colspan="7">ReferenceBooks:

4.Dynamics forEngineers-SoumitroBanerjee</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial(T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>XEO744</td><td>DesignThinking, Innovation andEntrepreneurship</td><td>Openelective</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT) and end assessment(EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+EA</td></tr>
<tr><td>CourseOutcomes</td><td colspan="7">• CO1:Togettheknowledgeaboutproductdesignandconsumerthinking.
• CO2: Develop creative problem-solving skills and the ability to generate innovativesolutions.
• CO3:Tolearnaboutinnovationandits types.
• CO4:Tolearnvarious aspectsofentrepreneurshipanditssuccessfulexamples.</td></tr>
<tr><td rowspan="2">TopicsCovered</td><td colspan="7">Design Thinking: What is thinking? What is design thinking, Historical perspective,Importanceof designthinking,UserCentered Design(4)
Design Thinking Process: Five stages - Empathize, Define, Ideate, Prototype, Test,Tools and Techniques for Each Stage, Defining problem statements, Double diamondapproach,Applications(4)
Critical thinking for problem solving: Requirement, History, Fallacy, Standards ofCriticalThinking, Problemsolvingthrough criticalthinking(5)
Innovation:WhatisInnovation,InventionvsInnovation,Examples,Evolutionofproducts through innovation – case studies, Types of innovation – Based on idea, Basedonoutcome,Problemsolvingthroughinnovation–Casestudiesanddiscussion(11)
Entrepreneurship:Definition,examples,Need,ProductDevelopmentandMarketFit,</td></tr>
<tr><td colspan="7">Product ManagementLife cycle,TechnologyReadinessLevel,ManufacturingReadinessLevel,InvestmentReadiness Level,BusinessPlanDevelopment(8)
MarketResearch–Identifyingmarket,Segmentingthemarket,Buildingamarketingplan(2)
Businessplanning:Finances,Operations,Marketing(2)</td></tr>
<tr><td>Text Books,and/orreferencematerial</td><td colspan="7">TextBooks:
• "DesignThinkingforEntrepreneursandSmallBusinesses"byBeverlyRudkinIngle
• "ChangebyDesign"byTim Brown
• "CreativeConfidence"byTomKelleyandDavidKelley
• "Innovation and Entrepreneurship: Practice and Principles" by Peter F.Drucker
• "BlueOceanStrategy:HowtoCreateUncontestedMarketSpaceandMakettheCompetitionIrrelevant"byW.ChanKimandRenéeMauborgne
• "DisruptiveInnovation:TheChristensenCollection(TheInnovator'sDilemma,The Innovator's Solution, The Innovator's DNA, Harvard Business ReviewArticles)"byClaytonM.Christensen</td></tr>
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