G H Raisoni College of Engineering and Management, Nagpur

(An Autonomous Institute affiliated to RTM Nagpur University, Nagpur)

Department of Mechanical Engineering

B. Tech. in Mechanical Engineering with Multidisciplinary Minor

UG Scheme & Curriculum - 2023 (NEP 2020)

Institute Vision and Mission

Vision

To achieve excellent standards of quality education by keeping pace with rapidly changing technologies and to create technical manpower of global standards with capabilities of accepting new challenges.

Mission

- Our efforts are dedicated to impart quality and value based education to raise satisfaction level of all stakeholders.
- Our Strength is directed to create competent professionals.
- Our endeavor is to provide all possible support to promote research and development activities.

Department Vision and Mission

Vision

To create excellence in the field of Mechanical Engineering by imparting quality education so as to develop our students to be capable of facing technology challenges.

Mission

- To adopt strict teaching learning monitoring system.
- Provide high quality, innovative and responsive education.

B. Tech. in Mechanical Engineering

Program Educational Objectives

PEO1	**Preparation:** To prepare students to succeed in employment/profession and/or to pursue post graduate and research educations in Mechanical Engineering discipline in particular and allied Engineering discipline in general.
PEO2	**Core Competence:** To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to formulate, analyze and solve engineering problems requiring knowledge of Mechanical Engineering.
PEO3	**Breadth:** To prepare students with engineering breadth to innovate, design, and develop software products and to contribute in providing solutions related to multidisciplinary real life problems.
PEO4	**Professionalism:** To inculcate in students professional and ethical attitude, effective communication skills and team work to become a successful professional.
PEO5	**Learning Environment:** To provide students with an academic environment that makes them aware of excellence and lifelong learning in emerging technologies.

Program Specific Outcomes

PSO1	Apply knowledge in the field of Machine Design, Thermal and Manufacturing Engineering to solve engineering problems by utilizing advanced technology.
PSO2	Prepare students for successful careers in industry that meets the needs of Industries.
PSO3	Respond to the demand of the society by engaging in lifelong learning.

Program Outcomes

PO1	**Engineering knowledge:** Apply knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

UG Scheme-2023 (NEP-2020)
B. Tech. Mechanical Engineering

Scheme Summary

Semester	Credits	Hours	Marks	No. of Theory Heads	No. of Practical Heads	Total Heads
I	20	28	525	6	6	12
II	20	28	650	7	6	13
III	20	24	550	6	3	9
IV	20	22	550	8	2	10
V	22	30	625	6	6	12
VI	22	27	550	6	4	10
VII	22	29	575	5	4	9
VIII	16	28	375	1	1	2
Total	**162**	**216**	**4400**	**45**	**32**	**77**

Course Category Credits Summary

Semester		**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total Credits**
Basic Science Course	BSC/ESC	6	8	--	--	--	--	--	--	14
Engineering Science Course		8	4	--	--	--	--	--	--	12
Programme Core Course (PCC)	Program Courses	--	2	8	8	10	8	10	--	46
Programme Elective Course (PEC)		--	--	--	--	4	8	4	4	20
Multidisciplinary Minor (MDM)	Multidisciplinary courses	--	--	2	2	4	2	4	--	14
Open Elective (OE) Other than a particular program		--	--	4	2	2	--	--	--	8
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	2	2	--	2	--	2	--	--	8
Ability Enhancement Course (AEC-01, AEC-02)	Humanities Social Science and Management (HSSM)	2	--	--	2	--	--	--	--	4
Entrepreneurship/Economics/ Management Courses		--	--	2	2	--	--	--	--	4
Indian Knowledge System (IKS)		--	2	--	--	--	--	--	--	2
Value Education Course (VEC)		--	--	2	2	--	--	--	--	4
Research Methodology	Experiential Learning Courses	--	--	--	--	2	2	--	--	4
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	2	--	--	--	--	--	2
Project		--	--	--	--	--	--	4	--	4
Internship/ OJT		--	---	--	--	--	--	--	12	12
Co-curricular Courses (CC)	Liberal Learning Courses	2	2	--	--	--	--	--	--	4
Total Credits (Major)		**20**	**20**	**20**	**20**	**22**	**22**	**22**	**16**	**162**

UG Scheme-2023 (NEP-2020)
B. Tech. in Mechanical Engineering

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	Marks
SEMESTER-V													
23BTMEL301 23BTMEP301	Heat Transfer	PCC 6	2	-	2	4	3	10	15	50	25	-	100
23BTMEL302 23BTMEP302	Metrology and Quality Control	PCC 7	2	-	2	4	3	10	15	50	25	-	100
23BTMEP303	Computer Aided Machine Drawing	PCC 8	-	-	4	4	2	-	-	-	50	-	50
23BTMEL304	Design of Machine Elements	PCC 9	2	-	-	2	2	10	15	50	-	-	75
23BTMEL305 23BTMEP305- 23BTMEL309 23BTMEP309	Program Elective- I	PEC 1	3	-	2	5	4	10	15	50	25	-	100
23BTMEL310 23BTMEP310	Multidisciplinary Minor-III	MDM 3	3	-	2	5	4	10	15	50	25	-	100
23BTMEL311	Open Elective - III	OE 3	2	-	-	2	2	10	15	50	-	-	75
23BTSHP301	Research Methodology	RM	-	-	4	4	2	-	-	-	25	-	25
TOTAL			**14**	**-**	**16**	**30**	**22**						**625**

Course Code	Name of Course	Course Category	Teaching Scheme				Credits	Evaluation Scheme					
								Theory			Practical		Total
			L	T	P	Total Hours		TAE	CAE	ESE	INT	EXT	Marks
SEMESTER-VI													
23BTMEL312	Energy Conversion	PCC 10	4		-	4	4	10	15	50	-	-	75
23BTMEL313 23BTMEP313	Theory of Machines	PCC 11	3		2	5	4	10	15	50	25	25	125
23BTMEL314 23BTMEP314- 23BTMEL318 23BTMEP318	Program Elective - II	PEC 2	3	-	2	5	4	10	15	50	25	-	100
23BTMEL319- 23BTMEL323	Program Elective - III	PEC 3	4	-	-	4	4	10	15	50	-	-	75
23BTMEL324	Multidisciplinary Minor- IV	MDM 4	2	-	-	2	2	10	15	50	-	-	75
23BTMEL32X 23BTMEP32X	Vocational and Skill Enhancement Elective- IV	VSEC 4	1	-	2	3	2	10	15	-	25	-	50
23BTSHP302	Research Ethics & Technical Writing	RM	-	-	4	4	2	-	-	-	50	-	50
TOTAL			**17**	**-**	**10**	**27**	**22**						**550**

UG Scheme-2023 (NEP-2020)
B. Tech. in Mechanical Engineering

Vocational and Skill Enhancement Courses

Skill Enhancement Elective-IV (VI sem)		
Sr. No.	**Code**	**Course**
1.	23BTMEL325 23BTMEP325	Fuel Cell
2.	23BTMEL326 23BTMEP326	Aircraft and Glider Design
3.	23BTMEL327 23BTMEP327	Introduction to Drone

B. Tech. Mechanical Engineering

5th Semester Syllabus

Course Title: Heat Transfer										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 6	2 Hrs.	--	2 Hrs.	3	10	15	50	25	--
Course Code	23BTMEL301 23BTMEP301									
Teaching Mode	Offline	4 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	To provide a general knowledge on the basic mechanisms of heat transfer.
	To understand the heat transfer processes in practical applications.
	To learn the design principles of heat exchangers.
Course Outcomes	Upon the successful completion of course, the student shall be able to:
	CO1: Illustrate basic laws of heat transfer to solve real time heat conduction problem.
	CO2: Develop solutions for unsteady state heat conduction in simple geometries.
	CO3: Estimate the heat transfer coefficients and heat transfer rate for forced and natural convection.
	CO4: Analyze the performance of heat exchanger by using LMTD and NTU methods.
	CO5: Understand & evaluate the radiation heat transfer between various surfaces.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3	1	2	--	1	1	--	--	2	2	3	--
CO2	3	3	3	3	1	2	--	1	3	--	1	2	2	3	--
CO3	3	3	3	3	1	2	--	1	2	--	--	2	2	3	--
CO4	3	3	3	3	2	2	--	1	3	--	1	2	2	3	1
CO5	3	3	3	3	1	2	--	1	1	--	--	2	2	3	--

Course Contents:

Unit	Contents	Hours
I	**One Dimensional Steady State Heat Conduction Without Heat Generation:** Introduction. Basic modes of heat transfer, conduction, convection and radiation. Laws of heat transfer. General heat conduction equation in Cartesian Cylindrical coordinates. Thermal conductivity and diffusivity. One dimensional steady state conduction equation for the plane wall, cylinder. Thermal resistance of composite structures, contact resistance, overall heat transfer coefficient, critical thickness of insulation**.**	6
II	**Conduction with Internal Heat Generation:** Internal heat generation for plane wall, Cylinder. **Extended Surfaces:** Types of fins. Fins of uniform cross section area, temperature distribution and heat transfer rate, fins efficiency and effectiveness. **Unsteady state heat transfer:** Unsteady state heat transfer, lumped heat capacity analysis.	6
III	**Forced Convection:** Physical signification of non-dimensional parameters. Flow of high, moderate & low prandtl number, fluid over a flat surface. Concept of velocity & thermal boundary layer, local and average heat transfer coefficients. **Free or Natural Convection:** Grashoff Number, Rayleigh Number for Horizontal and Vertical Plate. **Heat Transfer with Phase Change**: Pool boiling curve. Film & drop wise condensation	6
IV	**Heat Exchanger:** Classification, Overall Heat Transfer Coefficient, Fouling Factor, LMTD Method of Heat Exchanger, Analysis for Parallel, Counter Flow & Cross Flow Arrangement. Effectiveness, Heat Exchanger Analysis by NTU Method, Design Aspects of Heat Exchangers.	6
V	**Radiation:** Nature of thermal radiation, black body radiation, radiation intensity, laws of radiation – Kirchoffs, Planks, Weins displacement, Stefan Boltzmann & Lamberts co-sine law. Emissivity, absorptivity, transmissivity, reflectivity, radiosity, emissive power, irradiation. Radiation network, radiation exchange between surfaces, concept of shape factor. Radiation shields, Advanced Topic	6

Text Books	1.	A Textbook of Heat and Mass Transfer, R. K. Rajput, 7th edition, S Chand Publishing, 2018.
	2.	Heat and Mass Transfer – Fundamentals & Applications, Y. A. Cengel & A. J. Ghajar,5thedition, McGraw Hill Education, New York, 2015.
E-Books	1.	Engineering Heat and Mass Transfer, Mahesh M. Rathore, 3rd Edition, University Science Press, New Delhi, 2015.
	2.	Fundamentals of Heat and Mass Transfer, Incropera & Dewitt, 7th edition, John Wiley and Sons, New York, 2011.
Reference Books	1.	Heat and Mass Transfer – Fundamentals & Applications, Y. A. Cengel & A. J. Ghajar,5th edition, McGraw Hill Education, New York, 2015.
	2.	Heat Transfer, J.P.Holman, 9th edition, Tata Mcgraw Hill, New Delhi, 2008.
	3.	Heat Transfer, Y.V.C Rao, University Press, Hyderabad, 2001.
Data Book	1.	Heat and Mass Transfer Data Book, C P Kothandaraman and S. Subramanyan, 9th Edition, New Age International Publishers, 2019.
Online TL	1.	Heat and Mass Transfer, Prof. S. P. Sukhatme, IIT Bombay

Material (course)		NPTEL: https://nptel.ac.in/courses/112/101/112101097/
	2.	Conduction and Convection heat transfer, Prof. S. Chakraborty, NPTEL: https://nptel.ac.in/courses/112/105/112105271/

Sr. No.	Name of Experiments
1	To determine thermal conductivity & total thermal resistance of composite Wall
2	To determine heat flow rate through the lagged pipe and compare it with the heater for known value of thermal conductivity of lagging material.
3	To determine thermal conductivity of an insulating material in powder form.
4	To determine free convective heat transfer coefficient for air flow over a vertical Cylinder.
5	To determine temperature distribution and heat transfer rate from a fin under. a) Free Convection b) Forced Convection Conditions
6	To estimate the film heat transfer coefficient in unsteady state heat transfer.
7	To find out the emissivity of non - black surface.
8	To find the Stefan Boltzmann constant.
9	To determine overall heat transfer coefficient and Effectiveness of Cross flow heat exchanger
Open Ended Experiments	
1	Experimental investigation of convection heat transfer enhancement using nano fluids in circular tube
2.	Measurement of output power from solar PV module
Details of online Laboratory Resource Material Instruction / Operating Manuals	
1.	Heat and Thermodynamics Virtual Lab http://htv-au.vlabs.ac.in/
2.	Heat and Mass Transfer Data Book, C P Kothandaraman and S. Subramanyan, 9th Edition, New Age International Publishers, 2019.

Course Title: Metrology & Quality Control										
Semester	**V**	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 7	2 Hrs.	--	2 Hrs.	3	10	15	50	25	--
Course Code	23BTMEL302 23BTMEP302									
Teaching Mode	Offline	4 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs					100				

Course Objectives	To provide understanding of dimensional measurement.
	To get acquainted with measuring instruments and methods.
	To introduce the concept of quality control.
Course Outcomes	Upon the successful completion of course, the student shall be able to:
	CO1: Define production drawing and planning sheet.
	CO2: Demonstrate comparators and gauges.
	CO3: Evaluate surface flatness and gear profile.
	CO4: Analyze and measure quality of samples.
	CO5: Apply sampling and inspection techniques & Adapt ISO and BIS standards.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	3	2	3	3	-	-	-	-	1	-	2	-	3	-	-
CO2	3	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO3	3	-	-	-	3	-	-	-	-	-	-	-	2	-	-
CO4	3	3	3	3	3	3	2	-	3	-	3	-	3	-	-
CO5	3	3	2	2	3	1	-	-	-	-	-	-	3	-	-

Course Contents:

Unit	Contents	Hours
I	**Introduction to Metrology** Fundamental principles and definitions, measurement standards, Interpretation of Production Drawing, Break-Even Analysis, Tolerance Analysis. Limits & Fits, Types Of Fits, Shaft Basis System, Hole Basis System, Selective Assembly, Allowances, IS Specifications. Design of Limit Gauges Process Planning Sheet and Tolerance Chart Preparation.	6
II	**Measurement Methods 1 (Comparators and Screw thread):** Comparators – Mechanical, Electrical and Electronic Comparators, pneumatic comparators and their uses in mass production. Screw thread Measurement. Element of measurement, measurement of effective diameter, angle of thread and thread pitch, profile thread gauges.	6
III	**Measurement Methods 2 (Flat Surface and Gear):** Flat Surface Measurement: Instruments used, straight edges. surface plates. optical flat and auto collimator. Gear Measurement. Gear measuring instruments, Gear tooth profile measurement. Measurement of diameter, pitch pressure angle and tooth thickness. Coordinate Measuring Machines. Types of CMM, and Applications of CMM	6
IV	**Quality Control 1:** Definition, Function, Objectives, Characteristics, Quality, Quality Of Design, Quality Of Conformance, Process Control Charts And Process Capability Statistical Quality Control,7 Quality control tools.	6

V	**Quality Control 2:** Acceptance Sampling Techniques, O.C Curves, AQL, LTPD, Concept of AOQL, Sampling Plans Single, Double and Sequential Sampling, Inspection Types and Objectives. Introduction to TQM Concepts, Quality Assurance, Quality Audit, Quality Circles, Shainin,6 sigma, BOB & WOW techniques. Advanced Topic: such as 2D & 3D Profilers	6

Text Books	1.	Engineering Metrology-R K Jain, Khanna Publishers, 2012
	2.	Textbook of Engineering Metrology- I C Gupta, Dhanpat Rai Publications (p) Ltd,2012
	3.	Juran's Quality Handbook- Joseph M juran, Tata Mcgraw Hill Publishing Co Ltd ,2010.
E-Books	1.	https://www.researchgate.net/publication/328314868_15ME402_Metrology_and_Quality_Control_Unit_1-5
	2.	*https://books.google.co.in/books?id=pDMfEAAAQBAJ&printsec=copyright&redir_esc=y#v=onepage&q&f=false*
Reference Books	1.	*Grant, E.L., Statistical Quality Control, McGraw-Hill, 2004.*
	2.	Engineering Metrology, I.C. Gupta, Dhanpat Rai Publications, 2018
Online TL Material	1.	NPTEL https://swayam.gov.in/nd1_noc20_me94/preview.
	2.	*https://archive.nptel.ac.in/courses/112/104/112104250/*
	3.	*https://nptel.ac.in/courses/112106179*

List of Experiment:

Sr. No.	Name of Experiment
1	To understand construction of Vernier Caliper and calculate its least count.
2	To understand construction of outside micrometer and calculate its least count
3	Vernier Height gauge, Digital Height gauge and Vernier Depth gauge.
4	Direct and indirect measuring instruments like Screw pitch gauge, radius gauge, small hole gauge, Telescopic gauge and Feeler gauge.
5	To find unknown angle of a given component using Sine Bar.
6	Gear Teeth Measurement
7	Micrometer calibration by Slip Gauges
8	Study of Tool Maker's Microscope.
9	Study of Surfaces using optical flat.
10	Study on Statistical Quality Control and types of inspection
Open Ended Experiments	
1	Dimensional Gauge Calibration; Case Study
2	Analysis of Software Measures Using Metrology Concepts; Case Study
Virtual Lab	
1	Fault Detection Lab; http://vlabs.iitkgp.ac.in/mbfd/
2	Metrology and Quality Control Lab; https://sites.google.com/site/profparagmarathe/products-services/metrology--quality- control-lab
3	Vernier Caliper; https://www.youtube.com/watch?v=TWsRQy-j3f8
4	Surface finish measuring equipment; https://www.youtube.com/watch?v=CYqQfWr2MKc

DEPARTMENT OF MECHANICAL ENGINEERING

Course Title: Computer Aided Machine Drawing										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	Th	Tu	Pr	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 8	-	-	4 Hrs.	2	-	-	-	50	-
Course Code	23BTMEP303									
Teaching Mode	Online	4 Hrs			2	-			50	
Duration of ESE	-					50				

Course Objectives	To develop ability to create solid models of machine components.
	To develop an ability to create assembly of 3D models.
	To know application of geometrical dimensioning & tolerances in drafting.
Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO1: Define basics of engineering drawing and its applications.
	CO2: Demonstrate various commands for generation of geometrical model.
	CO3: Build 3D geometrical model from 2D parametric drawing.
	CO4: Generate the assembly using 3D Components considering fits and tolerances.
	CO5: Justify the production drawing using GD&T symbols.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O 2	PS O3
CO1	3	2	2	2	3	-	-	-	-	2	-	2	1	-	1
CO2	3	2	2	2	3	-	-	-	-	2	-	2	1	-	2
CO3	3	2	2	2	3	-	-	-	-	2	-	2	1	-	2
CO4	3	2	3	3	3	-	-	-	-	2	-	2	1	-	2
CO5	3	2	3	3	3	-	-	-	-	3	-	2	2	-	2

Course Contents:

Sr. No.	Contents	Hours
I	**Drawing Standards** Introduction of CAD, Importance of CAD in solid modeling. Graphic user Interface of any Solid modeling CAD software. Creation of Parametric sketching, introduction of entities like circle, rectangle etc.	10
II	**Creation of 2D parametric drawing by operation tools** Creating object (2D) Using Draw command and modification of 2D entites, operation on entites like apply constraints, modify, basic dimensioning, editing dimentions, dimention style etc. Alignment & Dimentioning.	10
III	**Parametric solid modeling of mechanical components** Conversion of 2D sketches into 3D solid geometrical model. Prepartion of 3D pectorial view of mechanical component by using 3D modeling tools.	10
IV	**Assembling Modeling & Creation of Assembling by using Fits and Tolerence** Creation of 3D Geometrical mechanical component by using advanced modeling tool in	10

	CAD software, Introduction to Unit Assembly Step involve in preparation of assembly drawing, Introduction about Geometrical Dimensioning & Tolerance, surface roughness symbol, welding symbol and other as per ASME Y14.5 -2009	
V	**Production Drawing** Generation of 2D drawing from parts and assembly 3D model, with tolerance, machining symbol, welding symbol, manufacturing methods surface finish symbols, indicating on drawing of position Elements of production drawing Information (Plates, Part list, Formats) Types of assembly drawing, Part Drawing for Catalogus and instruction manuals. Advance Topic.	10

Text Books	1.	Dr. K L Narayana, Dr. P. Kannaih, K. Venkata Reddy, Machine Drawing, New Age International (P) Ltd. 4th Edition year of publication 2012.
	2.	Ajeet Singh, Machine Drawing, Tata McGraw-Hill Education and Publication 2nd Edition 2012.
E--Books	1.	CATIA V5 Design Fundamentals. A Step by Step Guide, Author: JaecheolKoh Publisher: ONSIA Inc. (www.e-onsia.com)
Referenc e Books	1.	Sham Tickoo Professor Department of Mechanical Engineering Technology Purdue University Calumet, Hammond, Indiana, USA, CATIA V5 - R2014 for Designer, CAD-CIM Technologies525 St Andrews Drive Schererville, Indiana 46375
	2.	Designer, CAD-CIM Technologies 525 St Andrews Drive Schererville, Indiana 46375
Online TL Material	1.	ASME Y14.5 -2009 Handbook

Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	Basic introduction of CAD software, application and introduction of various Icon, shortcut keys and practices.
2	To prepare 2-D geometrical model using profile tool bar like circle, line, rectangle etc.
3	To prepare 2-D geometrical model in given sheet by using operation and transform tool bar.
4	To prepare 2-D geometrical model using drawing constraints.
5	Instruction on PART modeling icon: To prepare 3D geometrical model using all constraint sketches based on feature tool bar like, pad, pocket & revolve.
6	To prepare 3D geometrical model using all constraints like create, dress up feature on existing drawing by using dress up tool bar like, shell, draft, chamfer & fillet operation**.**
7	To prepare 3D geometrical model using all constraints like transformation tool bar, like array, symmetry, hole, etc.
8	To prepare any two components with sectional view by using part modeling commands.
9	Introduction to Assembly by using various tool bar like manipulation, smart move, coincident, offset, angle, constraint, reuse pattern and practices.
10	Preparation of Assembly by considering all parameters. (problem with three components)
11	To prepare assembly of any mechanical component i) Tool post ii) C-clamp iii) Screw jack iv) Coupling v) Pipe clamp
12	Introduction of Geometrical Dimensioning and tolerances by ASME Y14.5 – 2009.
13	Preparation of production drawing of any mechanical components and assembly by using GD&T and symbol.
Open Ended Experiments / New Experiments	
1	Creation of CAR body by using Surface design feature
2	Creation of water mug by Surface design feature

DEPARTMENT OF MECHANICAL ENGINEERING

Course Title: Design of Machine Elements										
Semester	**V**	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 9	2 Hrs.	--	--	2	10	15	50	--	--
Course Code	23BTMEL304									
Teaching Mode	Offline	2 Hrs.			Total	75			--	
Duration of ESE	2.5 Hrs.					75				

Course Objectives	To make students conversant with fundamental aspects of design and develop competency in design of joints.
	To develop competency in designing a mechanical system.
	To make students conversant with tools for designing pressure vessel and transmission shafts.
Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO1: Define basic concepts of design, selection of materials in the design of a project and joints for various components.
	CO2: Apply the design principles of power screw, helical & leaf spring in the design of suspension system.
	CO3: Analyze the design principles of clutches and brakes for various applications.
	CO4: Evaluate the design principles of pressure vessel in various industrial applications.
	CO5: Understand the design of the shafts for various power transmission systems.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	**Program Outcomes and Program Specific Outcomes**														
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	3	3	3	2	1	2	--	--	--	--	1	2	3	--	1
CO2	3	3	3	2	2	2	--	--	--	--	1	2	3	--	2
CO3	3	3	3	2	2	2	--	--	--	--	1	2	3	--	2
CO4	3	3	3	2	2	2	--	--	--	--	1	2	3	--	2
CO5	3	3	3	2	2	2	--	--	--	--	1	2	3	--	2

Course Contents:

Unit	Contents	Hours
I	**Introduction of Design:** Definition of design, types of design, design process, manufacturing considerations in design, mechanical properties of engineering materials, selection of materials. **Design of Joints:** Classification, riveted and bolted joints, Cotter and Knuckle joint.	6
II	**Design of Power Screw**: Screw jack, Lead screw of lathe machine. **Design of Spring:** Helical spring and leaf spring	6
III	**Design of Clutch:** Friction clutch - Single plate & multiple plates **Design of Brake:** Shoe brake & band brake.	6
IV	**Classification of Thin and Thick Cylindrical Pressure Vessel**: Stresses in thin and thick cylindrical pressure vessels, ASME code of pressure vessel, expression for circumferential and longitudinal stresses, design of pressure vessel, heads and cover plate.	6
V	**Design of Transmission Shafts:** On the basis of strength and rigidity, ASME code for shaft design. Case Studies based on above topics Advanced topic	6

Text Books	1.	"Design of Machine Elements", V. B. Bhandari, Tata McGraw-Hill Education, Third Edition, First Reprint 2010.
	2.	"Mechanical Engg. Design", J. E. Shigley, Charles R. Mischke, Richard G. Budynas, McGraw-Hill, Tenth Edition, 2014.
	3.	Design Data for Machine Elements, B.D. Shiwalkar, Benett & Co Publishing Division, Revised Edition, 2015.
E-Books	1.	Norton, R.L., Design of Machinery –An introduction to Synthesis and Analysis of Mechanisms and Machines, McGraw Hill International Editions, New York, Edition II, 2002.
	2.	Paul H Black and O. E. Adams, P., Machine Design, 3/e, McGraw Hill Book Company, Inc., New York, USA., 2007.
	3.	Design of Machine Components authorized by Kannaiah, P., Machine Design, 2/e, Scitech Publication Pvt. Ltd., 2009.
Reference Books	1.	"Mechanical Design of Machine", Martin J. Siegel, Vladimir L. Maleev, James Busse Hartman, Pennysilveria, International Textbook Co, Fourth Edition, 1972.
	2.	"Machine Design-I & II" authorized by P.H. Black, McGraw-Hill, Third Edition, 1983.
Online TL Material	1.	Machine Design Part 1 Dr. Kathryn Wingate, Academic Professional Georgia Institute of Technology (COURSERA). https://www.coursera.org/learn/machine-design1
	2.	Engineering Design Process with Autodesk Fusion 360 Autodesk Coursera, https://www.coursera.org/learn/engineering-design-process-fusion-360.
	3.	Basic 3D animation using Blender Sameer S Sahasrabudhe IIT, B (mooc) https://www.iitbombayx.in/courses/basic-3d-animation-using-blender-1

DEPARTMENT OF MECHANICAL ENGINEERING

Course Title: Automobile Engineering (Program Elective-I)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 1	3 Hrs.	--	2 Hrs.	4	10	15	50	25	--
Course Code	23BTMEL305 23BTMEP305									
Teaching Mode	Offline	5 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	1. To make the student conversant with Fundamentals of Automotive systems.
	2. To develop competencies of students in vehicle performance and safety
	3. To make the student conversant with automotive electrical system and vehicle maintenance.
	4. To understand the emerging trends of electric vehicles, hybrid electric vehicles and solar vehicles.
Course Outcomes	Upon the successful completion of course, the student shall be able to:
	CO1. Compare and select the proper automotive parts and system for the vehicle.
	CO2. Analyze the performance and safety aspects of the vehicle.
	CO3. Diagnose the faults of automotive vehicles.
	CO4. Apply the knowledge of Electric vehicles, hybrid electric vehicles and solar vehicles for further development.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3	1	2	--	1	1	--	--	2	2	3	--
CO2	3	3	3	3	1	2	--	1	3	--	1	2	2	3	--
CO3	3	3	3	3	1	2	--	1	2	--	--	2	2	3	--
CO4	3	3	3	3	2	2	--	1	3	--	1	2	2	3	1

Course Contents:

Unit	Contents	Hours
I	**Current Scenario and Drive Train** **Introduction:** Current scenario in Indian auto/ancillary industries, vehicle specifications and classification. **Chassis and Frames**: Types of chassis layout with reference to power plant locations and drive, various types of frames, constructional details. **Drive Train**: Types of transmission system, necessity and selection of clutch, necessity of gear box and different types, fluid flywheel, torque	8

	convertor, continuous variable transmission, overdrive and differential.	
II	**Axles, Wheels and Tyres, Steering System** **Axles:** Purpose, requirement and types of front and rear axle, loads acting on rear axles. **Wheels and Tyre:** Wheel construction, alloy wheel, wheel balancing, type of tyre, tyre construction, tyre materials, factors affecting tyre life. **Steering system:** Steering mechanism, steering geometry, cornering force, slip angle, scrub radius, steering characteristics, steering linkages and gearbox, power steering, collapsible steering, reversibility of steering, four wheel steering, wheel alignment.	8
III	**Suspension and Brake System** **Suspension:** Types of suspension linkages, types of suspension springs-leaf, coil, air springs, hydro gas, rubber suspension, interconnected suspension, self-leveling suspension (active suspension), shock absorbers (hydraulic and air). **Brake systems**: Drum, disc, mechanical, hydraulic, air brakes, vacuum, power assisted brakes, hand brake, Antilock braking system (ABS), Electronic Brake Distribution (EBD).	8
IV	**Vehicle Performance and Safety** **Vehicle performance:** Parameters, vehicle resistances, traction and tractive effort, power requirement for propulsion, road performance curves (numerical), stability of vehicles, vehicle testing on chassis dynamometer, maintenance, different BS norms **Vehicle safety:** Types of active and passive safety, vehicle interior and ergonomics, NVH in automobiles. Study of various performance and safety Test. **Batteries:** Electrical safety accessories **ADAS** (Automated Driver Assisted System)	8
V	**Electric and Hybrid Electric Vehicles** **Introduction:** Concept and environmental importance of Electric vehicles, Hybrid electric and solar vehicles. **Electric vehicles:** Layout, construction and working, study of charging system. **Hybrid electric vehicles:** Types, layout, hybridization factor, plug in hybrid electric vehicles, fuel efficiency analysis. Challenges and future scope of Electric and Hybrid Electric Vehicles.	8

Text Books	1.	Crouse W. and Anglin D., Automobile Mechanics, McGraw Hill Education; 10th edition 2017.
	2.	Kohali P. S., Automobile Electrical Equipment, McGraw Hill Education; 1st edition, 2017.
	3.	Narang G. B. S, “Automobile Engineering”, S. Chand and Company Ltd., 1989.
	4.	Singh Kirpal, “Automobile Engineering”, Volume 1 & 2, Standard Publishers distributors, 13th Edition 2012.
Reference Books	1.	Sclar D., “Auto repair for dummies, John Wiley & Sons Publication 2nd edition, 2019.
	2.	Gupta B K, Gupta R. B., Automobile Engineering, Satya Prakashan, 2016.
	3.	Heitner J., “Automotive Mechanics”, C.B.S Publishers, 2nd Edition, 2006.
Online	1.	Fundamentals of Automotive System, Prof. C.S.Shankar Ram, NPTEL,

DEPARTMENT OF MECHANICAL ENGINEERING

Material		https://archive.nptel.ac.in/courses/107/106/107106088/

Sr. No.	***Name of Experiments***
1	Dismantling and assembly of IC engine.
2	Performance on manual transmission system
3	Performance on CVT system
4	Study on automobile tyres
5	Study on various types of suspension system
6	Performance on Telescopic suspension system
7	Performance on bleeding of disc brakes
8	Performance on electrical circuits.
Open Ended Experiments	
1	Spark plug testing and cleaning
2	Fuel injection system cleaning and testing

Course Title: ADVANCED IC ENGINE (Program Elective-I)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 1	3 Hrs.	--	2 Hrs.	4	10	15	50	25	--
Course Code	23BTMEL306 23BTMEP306									
Teaching Mode	Offline	5 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	1.To understand the underlying principles of operation of different IC Engines and components.
	2.To provide knowledge on pollutant formation, control, alternate fuel etc.
	3.Learning about the fundamental concepts and principles that govern the design and operation of IC engines
	4. Performing thermodynamic and combustion analyses of IC engines
Course Outcomes	Upon the successful completion of course, the student shall be able to:
	CO1. Compare the operations of different IC Engine and components
	CO2. Evaluate the pollutant formation, control, and alternate fuel.
	CO3. Identify harmful IC engine emissions and use.
	CO4.Analyze the viable alternative fuels in engines.
	CO5.Analyze the pollutant formation and control.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3	1	2	--	1	1	--	--	2	2	3	--
CO2	3	3	3	3	1	2	--	1	3	--	1	2	2	3	--
CO3	3	3	3	3	1	2	--	1	2	--	--	2	2	3	--
CO4	3	3	3	3	2	2	--	1	3	--	1	2	2	3	1
CO5	3	3	3	3	2	2	--	1	3	--	1	2	2	3	1

Course Contents:

Unit	Contents	Hours
I	**Spark Ignition Engines** Mixture requirements – Fuel injection systems – Monopoint, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers.	8
II	**Compression Ignition Engines** Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock –	8

	Direct and Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Introduction to Turbocharging. Testing of Engine: SI &CI Engine	
III	**Emission Control** Pollutant – Sources – Formation of Carbon Monoxide, Un-burnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.	8
IV	**Alternative Fuels** Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - Engine Modifications.	8
V	**Recent Trends** Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NOx Adsorbers - Onboard Diagnostics, Camless Engine, variable valve control, quad & triple turbo engine.	8

Text Books	1.	Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2002.
	2.	Ganesan, "Internal Combustion Engines", II Edition, TMH, 2002.
	3.	IC Engines and Compressors by R.K. Singal
E-Books	1.	Stone, Richard (1992). Introduction to Internal Combustion Engines (2nd ed.). Macmillan. ISBN 978-0-333-55083-0.
	2.	Heywood, J. (2018). Internal Combustion Engine Fundamentals 2E. McGraw-Hill Education. ISBN 978-1-260-11611-3.
Reference Books	1.	Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines"., Dhanpat Rai & Sons 2007.
	2.	Duffy Smith, "Auto Fuel Systems", The Good Heart Willcox Company, Inc., 1987.
	3.	Eric Chowenitz, "Automobile Electronics", SAE Publications, 1995
Online Material	1.	I C Engine and Gas Turbine, Prof Pranb K Mandol aand Prof Vinayak Kulkarni – IIT Guwahati https://archive.nptel.ac.in/courses/112/103/112103262/

Sr. No.	*Name of Experiments*
1	Study of cut model of IC Engine (4- stroke petrol and diesel engine).
2	Study of cut model of IC Engine (2-stroke petrol and diesel engine).
3	Study of valve timing diagram of petrol engine.
4	Study of valve timing diagram of diesel engine.
5	Determine of flash point and fire point of sample oil.
6	Determine of calorific value of fuel by bomb calorimeter.
7	Performance test of an IC Engine using mechanical rope break dynamometer.
8	Performance test of an IC Engine using electrical break dynamometer.
9	Performance test of a multi cylinder petrol engine by Morse method.
Open Ended Experiments	
1	Prepare a heat balance sheet for a single cylinder two stroke petrol engine.
Details of online Laboratory Resource Material Instruction / Operating Manuals	
1.	Sectional light weight models of IC Engine, injection system and carburetor, sectional working model for 4 stroke petrol engine.
2.	Single Cylinder 4 stroke Multifuel VCR Engine

Course Title: Welding Technology (Program Elective-I)										
Semester	**V**	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 1	3 Hrs.	--	2 Hrs.	4	10	15	50	25	--
Course Code	23BTMEL307 23BTMEP307									
Teaching Mode	Offline	5 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	To identify the different sources of energy for welding.
	To understand different types of welding and its applications.
	To get acquainted with different weld testing methods.
Course Outcomes	Upon successful completion of the course, students shall be able to:
	CO1: Evaluate the concept of Arc welding and its working.
	CO2: Compare different welding methods.
	CO3: Analyze weldability of the metal.
	CO4: Apply various parameters for advance welding processes.
	CO5: Understand the nondestructive testing for welding.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	2	1	1	3	-	-	-	-	-	-	-	1	-	-
CO2	3	2	2	1	3	-	-	-	-	-	-	-	2	-	-
CO3	2	3	2	3	3	-	-	-	-	-	-	-	3	-	-
CO4	2	2	1	1	2	-	-	-	-	-	-	-	3	-	-
CO5	2	2	1	1	3	-	-	-	-	-	-	-	3	-	-

Course Contents:

Unit	Contents	Hours
I	**Introduction of Welding:** AWS Definition of welding, Classification of welding processes, Source of energy for welding, heat input, power density, Physics of Welding Arc; voltage distribution along the arc, polarities, theories of cathode and anode mechanism; arc characteristics and application of consumables.	8
II	**Fusion Welding Processes:** Selection of process and parameters - Gas welding, shielded metal arc welding (SMAW), Gas metal arc welding (GMAW), Gas tungsten arc welding (GTAW), Submerged arc welding (SAW), Plasma arc welding (PAW), Laser beam welding (LBW) and Electron beam welding (EBW). Various unconventional welding processes	8
III	**Welding Metallurgy:** Basics of Welding metallurgy, different zones in fusion welding, basics of weld metal solidification, welding defects, weldability; definition, factor affecting the weldability of steels.	8
IV	**Advanced Welding technique:** Solid state welding; parameters and tool selection for friction stir welding, cold metal transfer welding process, wire arc welding, laser- arc hybrid welding, impelled arc butt welding and explosive welding process, welding of non ferrous materials, weld overlay.	8
V	**Non-Destructive Testing of Weldments:** Ultrasonic inspection-principle of ultrasonic testing, N.D.T. Standard procedure for specification and qualification of welding procedure; Welding process sheet (WPS), Welding performance qualification (WPQ). Advanced Topic such as linear friction welding	8

Text Books	1.	Welding Fundamental, William A Bowditch A & Kevin A Bowditch, Good heart-Willcox, 1991.
	2.	Welding Metallurgy & Weldaility of Stainless Steel, John C Lippold, 2th Edition, 2014.
E-Books	1.	Welding Metallurgy, Sindo Kou, Wiley Publishers, 2016, 2nd edition.
	2	Welding Technology and Design, V.M. Radhakrishnan, New Age International (P) Limited, Pub., 2005.
Reference Books	1.	Metallurgy of Welding, J. F. Lancaster, William Andrew Publishing. 6th Edition,
	2.	Principles of Welding (Processes, Physics, Chemistry and Metallurgy), Robert

		W Messler, Wiley Publishers.
	3.	Welding Hand Book, Publisher: American Welding Society; 7th edition.
Online TL Material	1.	Fundamental of Welding Science and Technology, https://www.classcentral.com/course/swayam-fundamental-of-welding-science-and-technology-13016.
	2.	Source of Heat and Protection of Weld Pool, https://nptel.ac.in/courses/112107089/.
	3.	Physics of Welding arc, https://nptel.ac.in/courses/113106087/.

Sr. No.	***Name of Experiments***
1	Study of Welding Terms and Definitions
2	To prepare job by using tungsten Inert Gas Welding (TIG)
3	To determine the effect of welding parameters on weld bead by SMAW.
4	Study of different weld joint types and Selection of proper WEP for given condition
5	Study of different weld metal reactions
6	To prepare job by using Oxy-Acetylene Welding.
7	To determine the effect of microstructure of weld joint (CS)
8	Welding of a Test Coupon & Performance of Mechanical Testing
9	Study of Welding symbols
Open Ended Experiments	
1	Open ended experiment on Preparation of WPS & PQR
2	Flaw Detection by Ultrasonic Testing
Details of online Laboratory Resource Material Instruction / Operating Manuals	
1.	https://mm-coep.vlabs.ac.in/exp/welding-ndyag-laser/procedure.html
2.	Pipes Joint Welding Archived 2023-06-23 at the Wayback Machine

Course Title: COMPOSITE MATERIALS (Program Elective-I)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 1	3 Hrs.	--	2 Hrs.	4	10	15	50	25	--
Course Code	23BTMEL308 23BTMEP308									
Teaching Mode	Offline	5 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	1. Explain the behavior of constituents in the composite materials
	2. Enlighten the students in different types of reinforcement
	3. Develop the student's skills in understanding the different manufacturing methods available for composite material.
	4. Illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials.
Course Outcomes	CO1: Identify and understand the basic mechanical behavior of composite materials and make sound prediction on the likely behavior of new combinations of materials.
	CO2: Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.
	CO3: Compute the stresses and strains relation in composites materials
	CO4: Analyze the micromechanical properties of fibre reinforced composites.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3	1	2	--	1	1	--	--	2	2	3	--
CO2	3	3	3	3	1	2	--	1	3	--	1	2	2	3	--
CO3	3	3	3	3	1	2	--	1	2	--	--	2	2	3	--
CO4	3	3	3	3	2	2	--	1	3	--	1	2	2	3	1

Course Contents:

Unit	Contents	Hours
I	**Introduction** Introduction to Composites, function of the matrix and reinforcement in composites. Classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon-carbon composites, fiber reinforced composites, particulate reinforced composites and nature-made composites.	8
II	**Fibers, types, properties, and its applications** Glass fibers, Carbon fibers, Kevlar fibers, whiskers, and their properties, Introduction to natural fibers. Matrix Materials and its Properties: Polymer	8

	Matrix, Metal Matrix, Ceramic Matrix.	
III	**Micromechanics of Lamina** Introduction, Rule-of-mixtures – Mass and Volume fractions of composite, Four Elastic Constants of a Fibre Reinforced Composite under Iso– Strain condition, Iso–stress condition, Poisson's Ratio & Shear Modulus.	8
IV	**Manufacturing methods** **Manufacturing of Polymer matrix composites:** Wet/Hand layup and spray techniques, Filament winding Process, Pultrusion Process, Autoclave method, Resin Transfer Moulding. **Manufacturing of Metal Matrix Composites:** Casting or liquid infiltration, Squeeze casting or pressure infiltration, Centrifugal Casting, Solid State diffusion technique, Hot iso–static pressing. **Manufacturing of Ceramic Matrix Composites:** Liquid Metal Infiltration, Liquid phasesintering.	8
V	**Testing of Composites:** Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc. **Application developments:** Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.	8

Text Books	1.	Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall India, 2012
	2.	Introduction to Composite Materials Design" by Ever J. Barbero, CRC Press, ISBN 9781138196803, 2017
E-Books	1.	Introduction to Composite Materials Design | Ever J. Barbero https://sarrami.iut.ac.ir/sites/sarrami.iut.ac.ir/files/files_course/01-mechanics_of_composite_materials_sbookfi.org_.pdf
	2.	https://www.elsevier.com/books/compositematerialstechnology/klinghoffer/978-0-85709-011-9
Reference Books	1.	Matthews, F.L., and Rawlings, R.D, 'Composite Materials: Engineering and Science', Chapman & Hall, London 1994.
	2.	Clyne, T.W. and Withers, P.J., 'An Introduction to Metal Matrix Composites', Cambridge Univ. Press 1993.
	3.	Engineering Mechanics of Composite Materials, Daniel, I. M. and Ishai, O., Oxford University Press.
Online TL Material	1.	https://nptel.ac.in/courses/112/104/112104229/
	2.	https://nptel.ac.in/courses/112/104/112104168/

Sr. No.	*Name of Experiments*
1	Preparation of Polymer Matrix Composite Specimens with Thermoplastic and Thermoset Polymers
2	Preparation of Unidirectional/Continuous Fiber Reinforced Polymer Composites Using Hand-Lay-Up Technique
3	Preparation of Multi-Direction/Short Fiber Reinforced Polymer Composites Using Hand-Lay-Up Technique
4	Preparation of Particle Reinforced Polymer Composites Using Hand-Lay-Up Technique
5	Preparation of metal matrix composite by using casting methods
6	Study of mechanical properties of unidirectional/continuous fiber reinforced polymer composite materials.
7	Study of mechanical properties of multi direction/short fiber reinforced polymer composite materials.
8	Study of mechanical properties particle reinforced polymer composite materials.
Open Ended Experiments	
1	To investigate the moisture absorption behavior of composite materials and assess its impact on mechanical properties.
Details of online Laboratory Resource Material Instruction / Operating Manuals /Virtual experiment	
1.	To analyze and compare the vibration characteristics of different composite materials using Fast Fourier Transform (FFT) analysis.
2.	Mechanics of composite materials by Autar K. Kaw 2nd Edition, CRC-Press

Course Title: Computational Fluid Dynamics (Program Elective-I)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PEC 1	3 Hrs.	--	2 Hrs.	4	10	15	50	25	--
Course Code	23BTMEL309 23BTMEP309									
Teaching Mode	Offline	5 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	1.Model fluid / heat transfer problems and apply fundamental conservation principles.
	2.Discretize the governing equations by Finite Difference Method and Finite volume Method.
	3.Develop programming skills by in-house code development for conduction, convection and fluid dynamics problems.
	4.Solve basic convection and diffusion equations and understands the role in fluid flow and heat transfer.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1. Understand governing equations of conservation of mass, momentum and energy
	CO2. Generate high quality grids and interpret the correctness of numerical results with physics.
	CO3. Analyze and model fluid flow and heat transfer problems
	CO4. Evaluate fluid flow and heat transfer problems by using CFD tools

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3	1	2	--	1	1	--	--	2	2	3	--
CO2	3	3	3	3	1	2	--	1	3	--	1	2	2	3	--
CO3	3	3	3	3	1	2	--	1	2	--	--	2	2	3	--
CO4	3	3	3	3	2	2	--	1	3	--	1	2	2	3	1

Course Contents:

Unit	Contents	Hours
I	**Introduction to Computational Fluid Dynamics** Definition, steps in CFD, derivation and physical interpretation of governing equations (continuity, momentum, energy and species) in differential form, concept of substantial derivative, divergence and curl of velocity, mathematical behavior of governing equations and boundary conditions.	8

II	**Conduction Equation** Introduction to discretization methods: FEA, FDM and FVM, Solution of two dimensional steady and unsteady heat conduction equation using finite volume method (Implicit and Explicit) with Dirichlet, Neumann, Robbin boundary conditions, Stability Criteria.	8
III	**Advection Equation** Solution of two dimensional steady and unsteady heat advection equation using finite volume method (Implicit and Explicit) with Dirichlet BC, Stability Criteria, Introduction to first order up wind, CD, Second order upwind and QUICK convection schemes.	8
IV	**Convection-Diffusion Equation** Solution of two dimensional steady and unsteady heat convection-diffusion equation for slug flow using finite volume method (Implicit and Explicit), Stability Criteria, 1-D transient convection- diffusion system, Peclet Number	8
V	**Navier-Stokes Equation** Solution of Navier-Stoke‘s equation for incompressible flow using SIMPLE algorithms for lid driven cavity flow problem, Introduction to external flow simulation.	8

Text Books	1.	Anderson J. D., Computational Fluid Dynamics- The Basics with Applications, McGraw- Hill,1995.
	2.	Anil W. Date, Introduction to Computational Fluid Dynamics, cambridge university press, 2005.
	3.	Klaus A. Hoffmann and Steve T. Chiang, Computational Fluid Dynamics Vol 1, Edition 4, Engineering Education System 2000
	4.	Versteeg H., and Malalasekara W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Prentice Hall, 2nd edition, 2007.
E-Books	1.	Rainald Löhner, Applied Computational Fluid Dynamics Techniques: An Introduction Based on Finite Element Methods, WILEY, 14 March 2008
	2.	John F. Wendt, Computational Fluid Dynamics An Introduction, Springer link, 2009
Reference Books	1.	Wilcox D.C., Turbulence Modeling for CFD, D C W Industries; 3rd edition, 2006.
	2.	Chung T. J., Computational Fluid Dynamics, Cambridge University Press, 2002.
	3.	Tu J., Yeoh G.H. and Liu C., Computational Fluid Dynamics: A practical approach, Elsevier, 3 rd Edition 2018.
	4.	Schlichting H. and Gersten K., Boundary-Layer Theory, Springer, 2017.
Online Material	1.	Kolev, N. I., Multiphase Flow Dynamics. 1, Fundamentals, 2005, Berlin: Springer.
	2.	Sagaut, P., Large Eddy Simulation for Incompressible Flows, 2001, Heidelberg: Springer
	3.	http://www.ae.iitm.ac.in/~krishna/ecfd4tab.pdf

Sr. No.	Name of Experiments
1	Demonstrations of CFD software
2	2-D Modelling and meshing of fluid flow/ heat transfer problem
3	3-D Modelling and meshing of fluid flow/ heat transfer problem
4	Simulation of conductive steady state heat transfer 2-Dimensional
5	Simulation of conductive steady state heat transfer 3-Dimensional
6	Simulation of convective heat transfer 2-Dimensional
7	Simulation of convective heat transfer 3-Dimensional
8	Internal flow simulation
9	External flow simulation
10	Write codes for 1-D steady state conduction with and without source and do the post processing to verify with analytical results
Open Ended Experiments	
1	Modelling of real life problem in CFD
2	Analyze the internal flow of a centrifugal pump to study velocity and pressure variations
Details of online Laboratory Resource Material Instruction / Operating Manuals	
1	Virtual Labs: Computational Fluid Dynamics, https://cfd.direct/openfoam/computational-fluid-dynamics/
2	Virtual Labs: Computational Fluid Dynamics, https://www.flowthermolab.com/

Syllabus (Open Elective-III)
5th Semester

Course Title: Industry 4.0 (Open Elective-III)
Course Code: 23BTMEL311

Teaching Scheme				Credits	Continuous Evaluation Scheme						
					Theory				Practical		Total
L	T	P	Total Hours		TAE	CAE	ESE	Duration of ESE (Hrs)	Int	Ext	
2	-	-	2	2	10	15	50	2.5	-	-	75

Course Objectives	1. Understand IOT architecture and its building block
	2. Applications in the business world
	3. Introduction to different IOT platform
	4. Understanding technology and skill required in building IOT product
	5. Understand IOT application across various segment
Course Outcomes	On completion of the course, students will be able to
	1: Understand the drivers and enablers of Industry 4.0.
	2: Identify the smartness in smart factories, smart cities, smart products and smart services in industry.
	3: Apply the basic knowledge of Android, IOT and IIOT, Cloud Computing in an Industry.
	4: Compare and analyze different decision support systems and decision making models for Industry.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O 2	PS O3
CO1	3	3	2	-	-	-	2	-	-	-	-	1	2	2	1
CO2	3	3	2	-	-	-	2	-	-	-	-	1	2	2	1
CO3	3	3	2	-	-	-	2	-	-	-	-	1	2	1	1
CO4	3	2	3	-	-	-	1	-	-	-	-	1	3	3	1

Course Contents:

Unit	Contents	Hours
I	**Introduction to Industry 4.0** Industry 4.0: Definition, revolution and future view, benefits and applications. Key principles and strategies. Comparison of Industry 4.0 factory & today's factory, Security issues within Industry 4.0 networks, Challenges and risk.	6
II	**Industrial Automation** Introduction to Industrial Automation, Elements of automation, Types, Architecture of Industrial Automation Systems, Building blocks of Automation systems: LAN, Analog & Digital I/O Modules, SCADA System & RTU. Introduction to Sequence Control, the Hardware environment PLCs and Relay Ladder Logic and HMI	6
III	**Android, IOT and IIOT Application** Fundamentals and working principles, Learning the Language, Android OS Building Mobile Applications with Android Database Connectivity Applicability to Industrial Projects. Adriano applications. Introduction to IOT. Requirement of IOT. Applications and advantages. Introduction of Industrial IOT (IIOT) and its application.	6
IV	**Cyberphysical system** Introduction to Cyberphysical system, Use of sensors to capture data and further analysis to take decisions, Concept of Digital Twin.	6
V	**Data Management and Decision Support System** Management planning and control, decision making models, data bases, networks, decision theory, flow charting, smart logistics, smart factory management, man-machine-computer interfacing. Introduction, types and applications of Artificial Intelligence (AI) and Machine Learning (ML). Case Studies on Industry 4.0 Advanced Topic	6

Text Books	1. Ustundag A., and Cevikcan E. Industry 4.0: managing the digital transformation. Springer; 2017.
	2. Gilchrist A., Industry 4.0: the industrial internet of things. A press; 2016.
	3. Raj P, and Raman A.C. The Internet of Things: Enabling technologies, platforms, and use cases. Auerbach Publications; 2017.
	4. Schröder C., The challenges of industry 4.0 for small and medium-sized enterprises. Friedrich- Ebert-Stiftung: Bonn, Germany. 2016.
	5. Mukhopadhyay S., Sen S., and Deb A. K. Industrial Instrumentation, Control and Automation. Jaico Publishing House; 2013
	6. Bartodziej C.J., The concept industry 4.0. Springer Gabler, Wiesbaden.2017
Reference Books	1. Ogata K., Modern control engineering. Upper Saddle River, N J: Prentice hall; 2010.
	2. Burd B. Android application development all-in-one for dummies.

	John Wiley & Sons; 2015.
	3. Kuppusamy P, and Vyas U. AWS Development Essentials. Packt Publishing Ltd; 2014.
	4. Kurniawan A., Learning AWS IoT: Effectively manage connected devices on the AWS cloud using services such as AWS Greengrass, AWS button, predictive analytics and machine learning. Packt Publishing Ltd; 2018.
	5. Coronel C, Morris S, Rob P, Loney K, and Gennick J. Database Systems: Design, Implementation, and Management, 2012.
	6. Silberschatz A, Korth H.F., Sudarshan S. Database system concepts. New York: McGraw-Hill; 2002.
On-line TL Material	Industry 4.0, Prof. Sudip Misra, IIT Kharagpur, NPTEL, https://onlinecourses.nptel.ac.in/noc20_cs69/preview Industry 4.0, Prof. Janakranjan Ramkumar, Prof. Amandeep Singh Oberoi, IIT Kanpur, NPTEL https://onlinecourses.nptel.ac.in/noc23_me71/preview

Syllabus (Multidisciplinary Minor-III)
5th Semester

Course Title: Metrology & Quality Control (Multidisciplinary Minor- III)										
Semester	V	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	MDM 3	3 Hrs.	--	2 Hrs.	4	10	15	50	25	--
Course Code	23BTMEL310 23BTMEP310									
Teaching Mode	Offline	5 Hrs.			Total	75			25	
Duration of ESE	2.5 Hrs.					100				

Course Objectives	To provide understanding of dimensional measurement.
	To get acquainted with measuring instruments and methods.
	To introduce the concept of quality control.
Course Outcomes	Upon the successful completion of course, the student shall be able to:
	CO1: Define production drawing and planning sheet.
	CO2: Demonstrate comparators and gauges.
	CO3: Evaluate surface flatness and gear profile.
	CO4: Analyze and measure quality of samples.
	CO5: Apply sampling and inspection techniques & Adapt ISO and BIS standards.

Mapping of Course Outcomes with Program Outcomes and Program Specific Outcomes:

Course Outcomes	Program Outcomes and Program Specific Outcomes														
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	3	2	3	3	-	-	-	-	1	-	2	-	3	-	-
CO2	3	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO3	3	-	-	-	3	-	-	-	-	-	-	-	2	-	-
CO4	3	3	3	3	3	3	2	-	3	-	3	-	3	-	-
CO5	3	3	2	2	3	1	-	-	-	-	-	-	3	-	-

Course Contents:

Unit	Contents	Hours
I	**Introduction to Metrology** Fundamental principles and definitions, measurement standards, Interpretation of Production Drawing, Break-Even Analysis, Tolerance	8

	Analysis. Limits & Fits, Types Of Fits, Shaft Basis System, Hole Basis System, Selective Assembly, Allowances, IS Specifications. Design of Limit Gauges Process Planning Sheet and Tolerance Chart Preparation.	
II	**Measurement Methods 1 (Comparators and Screw thread):** Comparators – Mechanical, Electrical and Electronic Comparators, pneumatic comparators and their uses in mass production. Screw thread Measurement. Element of measurement, measurement of effectivediameter, angle of thread and thread pitch, profile thread gauges.	8
III	**Measurement Methods 2 (Flat Surface and Gear):** Flat Surface Measurement: Instruments used, straight edges. surface plates. optical flat and auto collimator. Gear Measurement. Gear measuring instruments, Gear tooth profile measurement. Measurement of diameter, pitch pressure angle and tooth thickness. Coordinate Measuring Machines. Types of CMM, and Applications of CMM	8
IV	**Quality Control 1:** Definition, Function, Objectives, Characteristics, Quality, Quality Of Design, Quality Of Conformance, Process Control Charts And Process Capability Statistical Quality Control,7 Quality control tools.	8
V	**Quality Control 2:** Acceptance Sampling Techniques, O.C Curves, AQL, LTPD, Concept of AOQL, Sampling Plans Single, Double and Sequential Sampling, Inspection Types and Objectives. Introduction to TQM Concepts, Quality Assurance, Quality Audit, Quality Circles, Shainin,6 sigma, BOB & WOW techniques. Advanced Topic:	8

Text Books	1.	Engineering Metrology-R K Jain, Khanna Publishers, 2012
	2.	Textbook of Engineering Metrology- I C Gupta, Dhanpat Rai Publications (p) Ltd,2012
	3.	Juran's Quality Handbook- Joseph M juran, Tata Mcgraw Hill Publishing Co Ltd ,2010.
E-Books	1.	https://www.researchgate.net/publication/328314868_15ME402_Metrology_and_Quality_Control_Unit_1-5
	2.	http://www.a-zshiksha.com/forum/viewtopic.php?f=148&t=61562.
Reference Books	1.	*Grant, E.L., Statistical Quality Control, McGraw-Hill, 2004.*
	2.	Engineering Metrology, I.C. Gupta, Dhanpat Rai Publications, 2018
Online TL Material	1.	NPTEL https://swayam.gov.in/nd1_noc20_me94/preview.
	2.	*https://archive.nptel.ac.in/courses/112/104/112104250/*
	3.	*https://nptel.ac.in/courses/112106179*

List of Experiment:

Sr. No.	Name of Experiment
1	To understand construction of Vernier Caliper and calculate its least count.
2	To understand construction of outside micrometer and calculate its least count
3	Vernier Height gauge, Digital Height gauge and Vernier Depth gauge.
4	Direct and indirect measuring instruments like Screw pitch gauge, radius gauge, small hole gauge, Telescopic gauge and Feeler gauge.
5	To find unknown angle of a given component using Sine Bar.
6	Gear Teeth Measurement
7	Micrometer calibration by Slip Gauges

8	Study of Tool Maker's Microscope.
9	Study of Surfaces using optical flat.
10	Study on Statistical Quality Control and types of inspection
Open Ended Experiments	
1	Dimensional Gauge Calibration; Case Study
2	Analysis of Software Measures Using Metrology Concepts; Case Study
Virtual Lab	
1	Fault Detection Lab; http://vlabs.iitkgp.ac.in/mbfd/
2	Metrology and Quality Control Lab;https://sites.google.com/site/profparagmarathe/products-services/metrology--quality- control-lab
3	Vernier Calliper ; https://www.youtube.com/watch?v=TWsRQy-j3f8
4	Surface finish measuring equipment; https://www.youtube.com/watch?v=CYqQfWr2MKc

UG Scheme-2023 (NEP-2020)
B. Tech. in Mechanical Engineering
Tracks for Professional Elective Courses

Electives	Course Code	XYZ	Course Code	XYZ	Course Code	XYZ	Course Code	XYZ	Course Code	XYZ
Track		**Track-I**		**Track-II**		**Track-III**		**Track-IV**		**Track -V**
Electives with Laboratory										
Programme Elective-I (Credits: 4) (Semester-V)	23BTMEL305 23BTMEP305	Automobile Engineering	23BTMEL306 23BTMEP306	Advanced IC Engine	23BTMEL307 23BTMEP307	Welding Technology	23BTMEL308 23BTMEP308	Composite Materials	23BTMEL309 23BTMEP309	Computational Fluid Dynamics