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. 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-III													
23BTMEL201 23BTMEP201	Fluid Mechanics & Machinery	PCC 2	3	-	2	5	4	10	15	50	25	-	100
23BTMEL202 23BTMEP202	Machining Process	PCC 3	3	-	2	5	4	10	15	50	25	-	100
23BTMEL203	Multidisciplinary Minor-I	MDM 1	2	-	-	2	2	10	15	50	-	-	75
23BTMEL204	Open Elective –I	OE 1	4	-	-	4	4	10	15	50	-	-	75
23BTMBL202ME	Entrepreneurship Development Practices	EEMC 1	2	-	-	2	2	10	15	50	-	-	75
23BTSHL20X	Humanities Elective	VEC 1	2	-	-	2	2	10	15	50	-	-	75
23BTMEP205	Minor Project	CEP	-	-	4	4	2	-	-	-	50	-	50
TOTAL			**16**	**-**	**8**	**24**	**20**						**550**

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-IV													
23BTMEL206	Engineering Thermodynamics	PCC 4	4	-	-	4	4	10	15	50	-	-	75
23BTMEL207	Strength of Materials	PCC 5	3	1	-	4	4	10	15	50	-	-	75
23BTMEL208	Open Elective-II	OE 2	2	-	-	2	2	10	15	50	-	-	75
23BTMEL2XX 23BTMEP2XX	Vocational and Skill Enhancement Elective -III	VSEC 3	1	-	2	3	2	10	15	-	25	-	50
23BTSHL231ME 23BTSHP231ME	Aptitude and Employability Skills	AEC 2	1	-	2	3	2	10	15	-	25	-	50
23BTMEL212	Multidisciplinary Minor-II	MDM 2	2	-	-	2	2	10	15	50	-	-	75
23BTMEL213	Operation Research and Management	EEMC 2	2	-	-	2	2	10	15	50	-	-	75
23BTSHL233ME	Universal Human Values 2:Understanding Harmony	VEC 2	2	-	-	2	2	10	15	50	-	-	75
TOTAL			**17**	**1**	**4**	**22**	**20**						**550**

UG Scheme-2023 (NEP-2020)
B. Tech. in Mechanical Engineering
Vocational and Skill Enhancement Courses

Skill Enhancement Elective-III (IV sem)		
Sr. No.	**Code**	**Course**
1.	23BTMEL209 23BTMEP209	CNC Programming
2.	23BTMEL210 23BTMEP210	Product Design
3.	23BTMEL211 23BTMEP211	Electric Vehicles

Humanity Elective (III sem)		
Sr. No.	**Code**	**Course**
1.	23BTSHL20X	Applied life skills for Progressive Excellence
2.	23BTSHL20X	Content designing and Media Fundamentals
3.	23BTSHL20X	Foreign Language: Japanese
4.	23BTSHL20X	Foreign Language: French
5.	23BTSHL20X	Foreign Language: Spanish
6.	23BTSHL20X	Foreign Language: German

B. Tech. Mechanical Engineering

3rd Semester Syllabus

Course Title: Fluid Mechanics & Machinery										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 2	3 Hrs.	--	2 Hrs.	4	10	15	50	25	-
Course Code	23BTMEL201 23BTMEP201									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2.5 Hrs					100				

Course Objectives	To understand the basic fluid properties like density, specific gravity, viscosity, etc.
	To understand kinematics and dynamics of fluid flow.
	To study various techniques of dimensional analysis
	To understand the momentum principle and its application to various fluid machineries.
	To learn model testing of hydraulic pumps and turbines.
Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO1: Understand the fluid properties and apply hydrostatic laws on submerged surfaces.
	CO2: Evaluate the fluid flow kinematics and the basic principles of fluid dynamics.
	CO3: Evaluate head losses for flow through pipe for given hydraulic systems and apply dimensional technique to fluid flow problems.
	CO4: Evaluate the performance parameters of impulse and reaction turbines.
	CO5: Design and evaluate performance characteristics of centrifugal and reciprocating pump.

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	PS O 1	PS O 2	PSO3
CO1	3	3	3	2	--	--	--	2	--	2	--	3	3	3	3
CO2	3	3	3	2	--	--	--	2	--	3	--	3	3	3	3
CO3	3	3	3	3	--	--	--	2	--	2	--	3	3	3	3
CO4	3	3	3	3	--	--	--	2	--	3	--	3	3	3	3
CO5	3	3	3	3	--	--	--	2	--	2	--	3	3	3	3

Course Contents:

Unit	Contents	Hours
I	**Fluid Properties and Hydrostatic Forces** Introduction to Fluid Mechanics: Properties of fluids, Newton's law of viscosity and its Applications, Fluid pressure & its Measurement, Manometers, Concept of total pressure & center of pressure on plane immersed bodies, buoyancy and floatation, metacenter, metacentric height.	8

II	**Kinematics & Dynamics of fluid flows** Kinematics of Fluid Flow: Types of flow. Continuity equation in Cartesian Coordinates, Velocity and Acceleration at a point. Stream function & Velocity potential function. Dynamics of Fluid Flow: Linear Momentum Equation. Euler's equation, Bernoulli's equation. Applications of Bernoulli's equation: Venturimeter, Orifice, Pitot tube.	8
III	**Flow through Pipes** Flow Through Pipes: Losses in pipes. Pipes in series and parallel. Power Transmission Through Pipe. Siphon tube, Hydraulic gradient line and total energy line, Dimensional analysis: Dimensional homogeneity, Buckingham's π- theorem.	8
IV	**Turbines** Impact of jets, Components and construction of Impulse and reaction turbines – Pelton Wheel, Francis and Kaplan Turbines. Velocity triangles. Specific speed and performance characteristics. Cavitation in hydraulic turbines. Geometric similarity of hydraulic turbines.	8
V	**Pumps** Centrifugal Pumps: Classification, working principle. Characteristic curves. Velocity triangles. Pump performance parameters, performance curves. Cavitations, NPSH and specific speed. Reciprocating pumps: Classification, working principle, discharge, performance parameters. indicator diagrams	8

Text Books	1.	Fluid Mechanics and Fluid Machines, R.K. Bansal, 7th Edition; Laxmi Publications, 2002.
	2.	A Textbook of Fluid Mechanics and Hydraulic Machines, Dr. R. K. Bansal, 9th Edition, Laxmi Publications, New Delhi, , 2017
	3.	Hydraulics and Fluid Mechanics Including Hydraulics Machines, Dr. P.N. Modi & S.M. Seth, 18th Edition, Standard Book House, New Delhi, 2011.
	4.	Fluid Mechanics and Fluid Machines, D.S. Kumar, 4th Edition; S. K. Kataria& Sons, 1992.
E--Books	1.	Fluid Mechanics and Machinery, C.P.Kothandaraman & R. Rudramoorthy, 2nd Edition, New Age International, 2007.
Reference Books	1.	A Text book of Fluid Mechanics and Hydraulic Machines, R. K. Rajput, 4th Edition, S. Chand Publications, 2013.
	2.	Fluid Mechanics & Fluid Machinery, Modi & Seth, Standard Book House, 2002
	3.	Fluid Mechanics, F. M. White, 6th Edition, McGraw Hill Publications, 2011
Online TL Material	1.	Fluid Mechanics Prof.S.K.Som, IIT Kharagpur, NPTEL https://nptel.ac.in/courses/112105171/01.
	2.	Fundamentals of Fluid Power James D. Van De Ven University of Minnesota courser https://www.coursera.org/learn/fluid-power
	3.	Fluid Machinery - Prof. Gautam Biswas, S.Sarkar, S.K.Som IIT Kanpur NPTEL:- https://nptel.ac.in/courses/112104117/06.

Sr. No.	Name of Experiments / Mini Projects/ Case Studies
1	To verify Bernoulli's theorem.
2	To determine the coefficient of discharge of Venturimeter.
3	To determine the coefficient of discharge of Orifice meter.
4	To identify the laminar, transition and turbulent flow regimes in pipe flow using Reynolds experiment
5	To verify the impulse momentum equation using impact of jet on vane.
6	To determine the Darcy-Weisbach friction factor for given pipes of different materials.
7	To determine the performance characteristics of Pelton wheel.
8	To determine the performance characteristics of Francis Turbine.
9	To determine the performance characteristics of Centrifugal Pump.
10	To determine the performance characteristics of Reciprocating pump.
Open Ended Experiments	
1	To calculate minor losses of various pipe joints.
Details of on line Laboratory Resource Material Instruction / Operating Manuals	
1.	Virtual Labs: Hydraulics and Fluid Mechanics Lab, https://eerc03iiith.vlabs.ac.in/List%20of%20experiments.html?domain=Civil%20Engineering
2.	Virtual Labs: Fluid Mechanics Lab http://fm-nitk.vlabs.ac.in/#

Course Title: Machining Process										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC3	3 Hrs.	---	2 Hrs.	4	10	15	50	25	--
Course Code	23BTMEL202 23BTMEP202									
Teaching Mode	Offline	5 Hrs			Total	75			25	
Duration of ESE	2.5 Hrs					100				

Course Objectives	To develop an insight of metal cutting principles.
	To provide details of machine tools & its processes.
	To demonstrate surface finishing operation.
Course Outcomes	Upon the successful completion of course, the student shall be able to
	CO1: Select cutting tool based on the material and desirable properties.
	CO2: Demonstrate Lathe machine and its operations.
	CO3: Make use of milling cutter and its operations.
	CO4: Classify various drilling, broaching and finishing operations.
	CO5: Explain different grinding operations.

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	PS O 1	PS O 2	PS O3
CO1	3	2	2	3	-	-	-	-	-	-	-	-	3	1	1
CO2	3	2	2	3	-	-	-	-	-	-	-	-	3	1	1
CO3	3	2	1	2	-	-	-	-	-	-	-	-	3	1	1
CO4	3	2	1	2	-	-	-	-	-	-	-	-	3	1	1
CO5	3	2	1	2	-	-	-	-	-	-	-	-	3	1	1

Course Contents:

Unit	Contents	Hours
I	**Introduction to Machining Parameters** Introduction to machining process, tool materials and their properties nomenclature and tools geometry of single point cutting tool, Cutting fluids and lubricants. Cutting parameters, cutting force, Merchant's circle, tool wear and tool failure, tool wear mechanism, Tool life equation, Chip morphology, Heat generation and friction in metal, Machining Economics.	8
II	**Turning** Introduction, type, construction of simple lathe, mechanism and attachments for various operations, machine specifications, basis for selection of cutting speed, feed and depth of cut, time estimation for turning operations such as facing, step turning, taper turning, threading, knurling.	8
III	**Milling** Introduction, specifications, types, column and knee type milling machine, fixed bed type milling machines, production milling machines, special purpose milling machines such as thread milling machines, profile milling machine, Gear Milling / Hobbing machines. Mechanisms and Attachments for Milling. Cutting parameters, Types of milling operations, Types of cutting tools, Tool geometry and their specifications. Introduction to shaper and planar machines.	8
IV	**Drilling & Finishing Operation** Drilling, Types of Drilling machine, Drill Nomenclature, Broaching and its types Super finishing processes such as honing, lapping, polishing, buffing and Burnishing. Jigs and Fixtures.	8
V	**Grinding** Grinding operations, grinding wheel, specifications and selection of grinding wheel, cylindrical and centreless, grinding operation, surface grinding, tool and cutter grinding, time estimation for grinding operations, Glazing, loading, truing, dressing and selection of grinding wheel. Advanced topic	8

Text Books	1.	Manufacturing Technology (Metal Cutting and Machine Tools) – by P.N. Rao TMH education, 2006.
	2.	Manufacturing Science by Ghosh and Malik, East west publication, 2007.
	3.	Workshop Technology (Volume I & II) – By H S Bawa, TMH Publications, 2017.
E-Books	1.	Multi-mode machining by T. Liu, Intech open publications.
	2.	Manufacturing Processes, M Begman, Intech open publications.
Reference Books	1.	Advanced Machining Processes – Nontraditional and Hybrid Machining Processes by Hassan Abdel-Gaward El-Hofy, McGraw-Hill.
	2.	Advanced Machining Processes, by Hassan El-Hofy, McGraw-Hill.
	3.	Manufacturing Processes and Materials: Exercises© 2010 Miltiadis A. Boboulos & Ventus Publishing.

Online TL Material	1.	Advanced machining Processes, Prof. Manas Das IIT Guwahati, nptel, https://nptel.ac.in/courses/112103202/
	2.	Introduction to machining and machining fluids, Prof. MamillaraviSankar, IIT Guwahati, nptel, https://nptel.ac.in/courses/112103245
	3.	Mechanics of Machining, Prof. Uday S. Dixit, IIT Guwahati, nptel: https://nptel.ac.in/ courses/ 112103248/

Sr. No.	**Name of Experiments / Mini Projects/ Case Studies**
1	Study of single point cutting tool
2	Tools for left hand and right hand turning
3	Tools for external and internal turning (Boring)
4	Study of cutting tool manual (any one)
5	Study of mechanisms in Lathe
6	Study of mechanism in drilling
7	Study of grinding operations
8	Study of mechanism in milling
9	Practical on turning involving facing, step turning, taper turning, boring, boring with internal steps and taper, drilling (on lathe), internal and external threading
10	Practical on grinding
11	Practical on Milling machine – Gear Milling
12	Practical on use of drilling machines
	Open Ended Experiments
1	Shaper machine operation and maintenance
2	Power Saw machine operation and maintenance
3	Capstan Turret lathe operation and maintenance
4	Study of Flexible Manufacturing System
	Details of on line Laboratory Resource Material Instruction / Operating Manuals
1.	Virtual Lab.: Micromachining laboratory! http://mm-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Mechanical%20Engineering
2.	To study various thermal models for EDM
3.	To study influence of process parameters on the Wire EDM
4	Study of Electrochemical machining process
5	Instruction / Operating Manuals for each Central workshop

Course Title: Minor Project										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	CEP	--	--	4 Hrs.	2	--	--	--	50	--
Course Code	23BTMEP205									
Teaching Mode	Offline	4 Hrs.			Total	--			50	

DEPARTMENT OF MECHANICAL ENGINEERING

Course Objectives	1. To learn the basics concepts of mechanical engineering components or systems
	2. To identify the components of basic mechanical system.
	3. To develop the basic mechanical system for specific application.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1. Define the fundamentals of mechanical systems
	CO2. Associate the basic parameters or components of mechanical systems
	CO3. Choose the require parameters or components of mechanical systems
	CO4. Validate the concept of mechanical systems
	CO5. Develop working model or system for various applications

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	Program Outcomes														
	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	3	-	1	-	-	-	-	-	-	3	-	1
CO2	3	-	1	2	1	-	-	-	-	-	2	-	3	-	1
CO3	3	2	2	2	2	1	1	-	2	-	3	1	3	-	2
CO4	3	3	3	3	2	1	2	1	2	-	3	-	3	-	3
CO5	3	3	3	3	3	2	2	1	3	1	3	2	3	-	3

Introduction:

A group of students is required to carry out the minor project work related to Mechanical Engineering applications under the guidance of a faculty.

Groups shall take up a suitable minor project including interdisciplinary project. The scope of the project shall be such as to complete it within the prescribed duration of one semester. Term work shall consist of:

- Fabrication of models, machines, prototypes based on new ideas, robots and machine small experimental set-up, fabrication of testing equipment, modification of machines, etc.
- Above work shall be taken up in a group of max 4 students.
- The group must show progress in each practical class and finally submit a working model for demonstration with report for evaluation.
- Maximum presentations to be conducted shall not be more than 3 including final presentations.
- A detailed report on the work done shall include project specifications, drawings, components used, assembly and fabrication procedures etc. Minor project shall be based on the following types.

1. Manufacturing/Fabrication of a prototype machine including selection, concept, materials, manufacturing of the components, assembly of components
2. Improvement of existing machine / equipment / process.
3. Problems related to productivity improvements/value engineering/material handling systems.
4. Simple mechanical system integrated with electronic components
5. Low-cost automation in manufacturing.
6. Time and motion study, job evaluation and merit rating.
7. Ergonomics and safety aspects under industrial environment.

G H RAISONI INSTITUTE OF ENGINEERING & TECHNOLOGY

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Department of Mechanical Engineering

Syllabus (Open Elective-I)

3rd Semester

Course Title: Open Elective - I (Total Quality Management)										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	OE 1	4 Hrs.	---	---	4	10	15	50	--	--
Course Code	23BTMEL204									
Teaching Mode	Offline	4 Hrs			Total	75			--	
Duration of ESE	2 Hrs					75				

Course Objectives	**1.** To facilitate the understanding of Quality Management principles and process.
	2. To infer the customer perception of quality.
	3. To train them with various tools and techniques of Quality Management.
	4. To inculcate the importance of Quality in an organization.
	5. To make understood about the ISO Quality systems.
Course Outcomes	**CO1.** Apply knowledge to demonstrate the tools utilization for quality improvement.
	CO2. Analyze customer needs and perceptions to design feedback systems.
	CO3. Analyze total quality management principles and process.
	CO4. Apply the various quality systems in implementation of Total quality management.
	CO5. Analyze the various types of techniques are used to measure quality.

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	2	3	-	-	-	-	-	-	-	-	3	1	1
CO2	3	2	2	3	-	-	-	-	-	-	-	-	3	1	1
CO3	3	2	1	2	-	-	-	-	-	-	-	-	3	1	1
CO4	3	2	1	2	-	-	-	-	-	-	-	-	3	1	1
CO5	3	2	1	2	-	-	-	-	-	-	-	-	3	1	1

Course Contents:

Unit	Contents	Hours
I	**INTRODUCTION** Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM, Economics of quality value and contribution.	9
II	**TQM PRINCIPLES** Leadership – Strategic quality planning, Quality statements - Customer focus, orientation, satisfaction, complaints, experience and advocacy, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5S, Principles of kaizen, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating., Case Studies	10
III	**TQM TOOLS & TECHNIQUES I** The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking –Reason to bench mark, Bench marking process – FMEA – Stages, Types, Case Studies.	10
IV	**TQM TOOLS & TECHNIQUES II** Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – Total Productive Maintenance, Steps in introduction of TPM in an organization, Quality by Design (QbD): Definition, Key components of QbD, Benefits and Challenges of QbD. Cost of Quality – Performance measures.	9
V	**QUALITY SYSTEMS** Quality systems, Need for ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.	10

Text Books	1. Dale H. Besterfiled, et at., “Total Quality Management”, Pearson Education Asia, Third Edition, Indian Reprint (2006).
	2. Total Quality Management, V. Jayakumar, Lakshmi Publications.(reprint 2005)
Reference Books	1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6 th Edition, South-Western (Thomson Learning), 2005
	2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
On-line TL Material	https://nptel.ac.in/courses/110/104/110104080/ The NPTEL course the “Total Quality Management-I” by PROF. RAGHU NANDAN SENGUPTA, IIT Kanpur

G H RAISONI INSTITUTE OF ENGINEERING & TECHNOLOGY

(Approved by AICTE, New Delhi and Recognized by DTE, Maharashtra)
An Autonomous Institute Affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
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DEPARTMENT OF MECHANICAL ENGINEERING

Syllabus (Multidisciplinary Minor-I)
3rd Semester

Course Title: Introduction to 3D Printing (Multidisciplinary Minor- I)										
Semester	III	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Odd	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	MDM 1	2 Hrs.	--	--	2	10	15	50	--	--
Course Code	23BTMEL203									
Teaching Mode	Offline	2 Hrs.			Total	75			--	
Duration of ESE	2.5 Hrs.					75				

Course Objectives	1. Understand the fundamentals of 3D printing
	2. Develop proficiency in 3D modeling
	3. Gain practical knowledge of 3D printer operation
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO 1. Gain a comprehensive understanding of the principles, processes, and techniques involved in 3D printing
	CO 2. Develop skills in 3D modeling software to create and design 3D printable models.
	CO 3. Have practical experience operating 3D printers.
	CO 4. Learn about different materials used in 3D printing, their properties, and their suitability for various applications.
	CO 5. Familiarized with post-processing techniques for 3D printed objects.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	**Program 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
CO1	3	2	3	2	1		2	-	3	-	-	-
CO2	3	2	2	1	2	1	2	-	2	-	-	-
CO3	3	2	3	2	3	3	2	-	2	-	-	-
CO4	2	2	2	2	2	2	2	-	2	-	-	-
CO5	3	3	3	3	3	3	3	-	3	-	-	-

Course Contents:

Module	Contents	Hours
I	**Introduction to 3D Printing** • Overview of 3D printing technologies • History and current applications of 3D printing • Introduction to 3D modeling software	4
II	**3D Modeling for 3D Printing** • Basics of 3D modeling • Design considerations for 3D printing • Creating 3D models using CAD software	4
III	**Preparing 3D Models for Printing** • Introduction to slicing software • Importing and manipulating 3D models • Configuring print settings	4
IV	**3D Printing Materials** • Overview of common 3D printing materials • Properties and characteristics of different materials • Selecting the right material for a specific application	4
V	**Operating 3D Printers** • Components of a 3D printer • Setting up and calibrating a 3D printer • Troubleshooting common issues	4
VI	**Advanced 3D Printing Techniques** • Multi-material printing • Support structures and rafts • Post-processing techniques (sanding, painting, etc.)	4
VII	**Project Work** • Design and print a complex 3D object • Iterative design process • Presentation and evaluation of final projects	4

Text Books	1.	The Role of Digital Fabrication in Today's Society Tandra Lea Tyler-Wood Source Title: Research Anthology on Makerspaces and 3D Printing in Education DOI: 10.4018/978-1-6684-6295-9.ch002
	2.	Fundamentals of Digital Manufacturing Science, Zude Zhou, Shane (Shengquan) Xie Dejun Chen ISSN 1860-5168 ISBN 978-0-85729-563-7 e-ISBN 978-0-85729-564-4 DOI 10.1007/978-0-85729-564-4 Springer London Dordrecht Heidelberg New York
Online NPTEL Material	1.	Rapid Manufacturing https://onlinecourses.nptel.ac.in/noc23_me82/preview
	2.	Metal Additive Manufacturing https://onlinecourses.nptel.ac.in/noc23_me92/preview

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DEPARTMENT OF MECHANICAL ENGINEERING

B. Tech. Mechanical Engineering
4th Semester Syllabus

Course Title: Engineering Thermodynamics										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 4	4 Hrs	--	--	4	10	15	50	-	-
Course Code	23BTMEL206									
Teaching Mode	Offline	4 Hrs			Total	75			-	
Duration of ESE	2.5 Hrs					75				

Course Objectives	To understand mass and energy interaction in a system.
	To use various laws of thermodynamics for analysis of systems.
	To familiarize with various thermodynamic power cycles
Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO1:Enlist the different terminologies and laws for thermodynamic systems and processes
	CO2: Analyze the thermodynamic system using first law.
	CO3: Identify the reversible and irreversible processes using entropy principle.
	CO4: Determine the quality of steam in steam power applications
	CO5: Assess the gas and steam power cycles.

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	3	--	--	--	--	1	--	--	--	2	2	3	1
CO2	3	3	3	--	--	--	--	1	--	--	--	2	2	3	1
CO3	3	3	3	--	--	--	--	1	--	--	--	2	2	3	1
CO4	3	3	3	--	--	--	--	1	--	--	--	2	2	3	1
CO5	3	3	3	--	--	--	--	1	--	--	--	2	2	3	1

Course Contents:

Unit	Contents	Hours
I	**Basic concepts and properties:** Introduction, thermodynamic system, control volume, macroscopic and microscopic approaches, properties and state of a system, point and path functions, thermodynamic equilibrium, process and cycle, quasi-static process, intensive and extensive properties, Zeroth law of thermodynamics, temperature scales. Thermodynamic heat and work. Ideal gas, Equation of state, universal gas constant, Enthalpy, Specific heat at constant volume and constant pressure, change in internal energy. P-V diagrams.	10
II	**First Law of Thermodynamics:** Law of conservation of energy, First law applied to closed system undergoing a cycle, Joule's experiment, First law applied to non-cyclic process. Energy-a property of system, internal energy: a function of temperature, heat & work transfer during various non-flow processes. First law applied to flow processes: steady-state steady flow process, mass balance and energy balance in steady flow process, steady flow energy	10

	equation and its application to nozzles and diffusers, throttling valve, turbines and compressors, pumps, heat exchangers etc.	
III	**Second Law of Thermodynamics:** Limitations of First Law, Thermal reservoirs, Kelvin-Plank & Clausius statements, Heat engines, Refrigerator & Heat pump, Perpetual motion machines, Reversible & Irreversible processes, Carnot cycle, Thermodynamic temperature scale. **Entropy:** The Clausius inequality, Principle of increase of entropy, Change in entropy for Closed & Steady flow open systems.	10
IV	**Properties of steam**: Phase change process of pure substance, Sensible heat and latent heat, specific volume and entropy of steam, dryness fraction of steam, throttling of steam, steam tables and their use, *T-s* and *h-s* diagrams, determination of dryness fraction using calorimeters.	10
V	**Vapor power cycles:** Rankine and modified Rankine cycle, work done and efficiency, specific steam consumption, comparison of Rankine and Carnot cycle, representation on *P-v*, *T-s* and *h-s* diagram. **Gas power cycles:** Otto cycle, Diesel cycle, Semi-Diesel, Sterling cycles, their efficiency, work done and mean effective pressure calculations, Brayton cycle. Advance Topic	10

Text Books	1.	Basic and Applied Thermodynamics, Nag P. K., 4th Edition, Tata McGraw-Hill, 2014.
	2.	Thermal Engineering, Mahesh Rathore, 5th Edition, Tata McGraw-Hill, 2010.
E-Books	1.	Fundamentals of Thermodynamics, Richard E. Sontag, Claus Borgnakke and Gordon J. Van Wylen, 8th Edition, John Wiley and Sons, Inc.2013
	2.	Fundamentals of Engineering Thermodynamics, Moran M.S. and Shapiro H.N., 7th Edition, John Wiley and Sons, 2011
Reference Books	1.	Thermodynamics: An Engineering Approach, Yunus Cengel and Michael Boles, 5th Edition, 2014.
	2.	Fundamental of Engineering Thermodynamics, R. Yadav, 7th Edition, Central Publication House, 2012.
	3.	Engineering Thermodynamics, Jones J.B. and Hawkins G.A., 2nd Edition, John Wiley and Sons.
on line TL Material (course)	1.	Basic Thermodynamics Prof. S. K. Som IIT, Kharagpur, NPTEL- https://nptel.ac.in/courses/112/105/112105123/
	2.	Basic Thermodynamics Prof. Gautam Biswas, Prof. Y.V.C. Rao, IIT Kanpur https://nptel.ac.in/courses/112/104/112104113/

Course Title: Strength of Materials										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	PCC 5	3 Hrs.	1 Hr.	--	4	10	15	50	--	-
Course Code	23BTMEL207									
Teaching Mode	Offline	4 Hrs			Total	75			--	
Duration of ESE	2.5 Hrs					75				

Course Objectives	To teach the fundamentals of stresses and strains.
	To imbibe concept of shear force and bending moment with Practical applications.
	To facilitate the concept of bending and its theoretical analysis
Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO1: Understand the concepts of various stresses and strains and their relative effects in context to engineering applications.
	CO2: Effectively use the concepts of shear force and bending moment diagrams in design of machine elements.
	CO3: Estimate the slope and deflection of beams.
	CO4: Resolve the stresses induced in shafts.
	CO5: Evaluate the strain energy stored in a body subjected to various types of loading.

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	2	-	-	-	-	-	-	1	2	1	1
CO2	2	2	3	2	1	-	-	-	-	-	-	1	2	1	1
CO3	2	3	3	2	2	-	-	-	-	-	-	2	2	1	1
CO4	2	3	3	2	2	-	-	-	-	-	-	1	2	1	1
CO5	2	3	3	2	2	-	-	-	-	-	-	1	2	1	1

Course Contents:

Unit	Contents	Hours
I	**Concept of simple stresses and strains** Introduction, stress, strain, types of stresses, stress – strain diagram for brittle and ductile material, elastic limit, Hooks law, modulus of elasticity. modulus of rigidity, factor of safety. Analysis of composite section, longitudinal strain and stress, lateral stresses and strains, Poisson's ratio, volumetric stress and strain. Bulk modulus, relation between elastic constants, Mohr's Circle, Thermal Stresses, Principal Stresses and Strains. Theories of Failure.	8
II	**Shear force and bending moment** Types of beam (cantilever beam, simply supported beam, overhanging beam etc.). Types of loads (Concentrated and UDL), shear force and bending moment diagrams for different types of beams subjected to different types of loads, sign conventions for bending moment and shear force.	8
III	**Deflection of beams** Derivation of differential equation of elastic curve with the assumptions made in it. Deflection and slope of cantilever, simply supported, subjected to concentrated load, UDL, relation between slope, deflection and radius of curvature, Macaulay's method & Double integration method.	8
IV	**Torsion of circular shafts** Derivation of torsion equation with the assumptions made in it. Torsional shear stress induced in the shaft. Strength and rigidity criteria for design of shaft. Torque transmitted by solid and hollow circular shaft.	8

V	**Strain energy and impact loading:** Definition of strain energy, strain energy stored in a body when it is subjected to gradually applied load, suddenly applied loads and impact loads. Strain energy stored in shear and torsion, Castigliano's theorem. Advanced topic	8

Text Books	1.	Strength of Materials, by S. P. Timoshenko, East West Press, 5th edition, 2011.
	2.	Strength of Materials, Surendra Singh, S.K.Kataria & Sons. Reprint 2012.
	3.	Strength of Materials, by R. K. Rajput, S. Chand Publisher, 4th edition, 2015.
E-Books	1.	Strength of Materials, by R.K. Bansal, 2003 4th Edition.
	2.	Strength of Materials, by B.K. Sarkar, 2003.
Reference Books	1.	Strength of Materials, by F. L. Singer, Harper Pollins Publisher, 4th edition.
	2.	Strength of Materials, by S.Ramamurtham, Dhanpat Rai Publishing Co. 2008.
	3.	Engineering Mechanics of Solids by Egor popov, Prentice Hall, 2010
Online TL Material	1.	Mechanics of Materials II: Thin-Walled Pressure Vessels and Torsion Dr. Wayne Whiteman, PE, Woodruff School of Mechanical Engineering (COURSERA) https://www.coursera.org/learn/mechanics2
	2.	Mechanics of Materials III: Beam Bending Dr. Wayne Whiteman, PE, Woodruff School of Mechanical Engineering (COURSERA) https://www.coursera.org/learn/beam-bending
	3.	Mechanics of Materials IV: Deflection , Buckling Woodruff School of Mechanical Engineering (COURSERA) https://www.coursera.org/learn/materials-structures

Course Title: **CNC Programming (Vocational and Skill Enhancement Elective –III)**										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	VSEC 3	1	-	2	2	10	15	-	25	-
Course Code	23BTMEL209 23BTMEP209									
Teaching Mode	Offline	3 Hrs			Total	25			25	
Duration of ESE	-					50				

Course Objectives	1.	To study CNC fundamentals.
	2.	To generate efficient and accurate CNC programs that meets industry standards and specifications.
	3.	To identify and troubleshoot common issues that may arise during CNC machining processes.
Course Outcomes	Upon successful completion of this course, student will be able to:	
	CO 1.	Understand the CNC fundamentals.
	CO 2.	Develop CNC programs for different machining operations.
	CO 3.	Select appropriate cutting tools and apply CAM software to optimize machining processes.
	CO 4.	Apply tolerances, surface finishes, and dimensional accuracy in manufacturing.
	CO 5.	Adapt safety protocols of CNC.

DEPARTMENT OF MECHANICAL ENGINEERING

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	PS O1	PSO 2	PSO 3
CO1	3	3	3	-	-	-	-	-	-	-	-	-	3	1	1
CO2	3	3	3	-	3	-	-	-	-	-	-	-	3	1	1
CO3	3	3	3	-	3	-	-	-	-	-	-	-	3	1	1
CO4	3	3	3	-	-	-	-	-	-	-	-	-	3	1	1
CO5	3	3	3	-	-	-	-	3	-	-	-	-	3	1	1

Course Contents:

Unit	Contents	Hours
I	**Introduction to CNC Technology and Fundamentals:** Overview of NC, CNC and DNC, Comparison of conventional machining vs CNC machining, Basic components of CNC machines, Types of CNC machines and their configurations, Concept of Axis of CNC Machine.	7
II	**Proficiency in CNC Programming Skills:** Basics of CNC programming, G Codes & M Codes, Syntax and structure of CNC programs, Coordinate Systems: Absolute vs. Incremental programming, Linear and circular interpolations, Tool compensation, CNC lathe operations, CNC milling operations, Introduction to APT.	7
III	**Tools and CAM software:** Cutting tools for CNC machining, Overview of CAM software, Creating 3D models and tool paths, Simulation and post-processing.	7
IV	**Precision and Accuracy in CNC Machining:** Interpretation of Engineering Drawings**,** Dimensions and tolerances, Importance of tolerances and surface finishes.	7
V	**Troubleshooting and Problem-Solving:** Common issues and challenges in CNC programming, Strategies for troubleshooting and resolving problems, Understanding safety protocols in CNC machining, Maintenance of CNC Machines-Preventive Maintenance Programs.	7

Text Books	1.	CNC Machines, B. S. Pabla, M. Adithan, New Age International Publication, ISBN 81-224-0669-6.
	2.	CNC Technology And Programming, , Katson Publishing House, 2012
E books	1.	Programming of CNC Machines, Ken Evans, ISBN-13, Edition 4, Industrial Press, Inc., 2016, https://www.amazon.in/Programming-CNC-Machines-Ken-Evans-ebook/dp/B01C5RYQ4G
Reference Books	1.	CNC Programming Made Easy, Jha B., Vikas Publication House, 2014
	2.	Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson, ISBN-10, Edition 4, 2016
NPTEL	1.	Computer numerical control of machine tools and processes, https://archive.nptel.ac.in/courses/112/105/112105211/#

Sr. No.	List of Experiments
1.	Simulation of different part-programs on CNC lathe.
2.	Simulation of different part-programs on CNC mill.
3.	Setting up of workpiece zero position and machining in CNC Turning machine.
4.	Setting up of workpiece zero position and machining in CNC Milling machine.
5.	Writing and execution of CNC Lathe operation (Facing cycle).

6.	Writing and execution of CNC Lathe operation (Turning and step turning cycle)
7.	Writing and execution of CNC milling operation (Linear and circular interpolation)
8.	Writing and execution of CNC milling operation (Pocketing operation)
9.	Open ended experiment
10.	Virtual lab experiment

Course Title: **Product Design (Vocational and Skill Enhancement Elective –III)**										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	VSEC 3	1	-	2	2	10	15	-	25	-
Course Code	23BTMEL210 23BTMEP210									
Teaching Mode	Offline	3 Hrs.			Total	25			25	
Duration of ESE	-					50				

Course Objectives	To impart knowledge on product design and development.
	To understand the concepts of different types of product architectures.
	To explore product quality and functionality in applications.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1: Understand the need for product development considering customer needs.
	CO2: Analyze an appropriate standardization method.
	CO3: Develop product by ergonomic and aesthetic consideration
	CO4: Evaluate the product using CAD tools.
	CO5: Create new mechanical product and method to minimize product development cost.

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	PS O1	PS O2	PS O3
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	1	1
CO2	2	3	3	3	3	-	-	-	-	-	-	-	3	1	1
CO3	3	3	3	3	3	-	-	-	-	-	-	-	3	1	1
CO4	3	3	3	3	-	-	-	-	-	-	-	-	2	1	1
CO5	3	3	3	3	-	-	-	3	-	-	-	-	3	1	1

Course Contents:

Unit	**Contents**	**Hours**
I	**Introduction to Product Design** Need for development of products, Importance of engineering design, Types of design, Various phases of product development, Planning for products, Modern product development process. Innovative thinking. Morphology of design.	7

II	**Concept Generation, Selection and Idea Screening** Plan and establish product specifications, Task structured approaches, Clarification, Product change, Component standardization, product performance, manufacturability, concept testing methodologies, fish bone diagram.	7
III	**Product Architecture and Industrial Design:** Product development management, establishing the architecture, clustering, geometric layout development, Ergonomics/Aesthetics: Gross human autonomy. Anthropometry. Man-Machine interaction. Concepts of size and texture, colour. Comfort criteria. Psychological & Physiological considerations.	7
IV	**Tools for Product Design** Introduction of CAD Model and Drafting / Modeling software. Rapid prototyping, Creativity Techniques: Creative thinking, Conceptualization, Brain storming, Primary design, drawing, Simulation, Detailed design	7
V	**Prototype and Design for Manufacturing:** Prototype basics, Principles of prototype, Types of prototypes, planning for prototypes, rapid prototyping technology driven products, estimation of manufacturing costs. Design for Manufacturing& Assembly: Methods of designing for manufacturing& Assembly, Designs for Maintainability. Designs for Environment.	7

Text Books	1.	Karl T Ulrich, Steven D, Eppinger, Maria C. Young, Product Design and Development, Tata McGraw-Hill Education ,7th Edition, 2020.
	2.	Kevin Otto, Kristin Wood, Product Design, Indian Reprint, Pearson Education, 2018.
Reference Books	1.	Yousef Haik, T. M. M. Shahin, Engineering Design Process, 4th Edition Reprint, Cengage,2020.
	2.	Clive L. Dym, Patrick, Little Engineering Design: A Project-based Introduction, Sixth Edition, Wiley,2017.
NPTEL	1.	NPTEL Couse on Product Design and Development by Dr. Indirdeep Singh, IIT Roorkee https://onlinecourses.nptel.ac.in/noc21_me83/preview
Udemy	1.	Udemy course on Product Design: https://www.udemy.com/course/designing-engaging-user-experiences/

Sr. No.	List of Experiments
1.	Introduction of innovative product
2.	Concept generation, idea generation and sketch preparation of proposed product
3.	New product design and development and product tree
4.	Ergonomic and aesthetes' consideration for the product
5.	Preparation of geometrical model of propose product with the help of CAD
6.	Prototype development of propose innovative product
7.	Presentation of product with specification
8.	Introduction of innovative vehicle accessories
9.	Virtual lab experiment

DEPARTMENT OF MECHANICAL ENGINEERING

Course Title: Electric Vehicles (Vocational and Skill Enhancement Elective –III)										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	VSEC 3	1	-	2	2	10	15	-	25	-
Course Code	23BTMEL211 23BTMEP211									
Teaching Mode	Offline	3 Hrs			Total	25			25	
Duration of ESE	-					50				

Course Objectives	To design components of EV.
	To Test various EV performance.
	To identify and troubleshoot common issues of EV.
Course Outcomes	Upon successful completion of this course, student will be able to:
	CO1. Understand the EV fundamentals.
	CO2. Develop EV for different Electric Vehicle Architecture
	CO3. Select appropriate sizing of Electric Vehicle components
	CO4. Calculate torque for motor sizing
	CO5. Choose proper energy storage system for EV.

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	PS O1	PS O2	PS O3
CO1	3	3	3	-	-	-	3	-	-	-	-	-	3	1	1
CO2	3	3	3	-	-	-	3	-	-	-	-	-	3	1	1
CO3	3	3	3	-	-	-	3	-	-	-	-	-	3	1	1
CO4	3	3	3	-		-	3	-	-	-	-	-	3	1	1
CO5	3	3	3	-	-	-	3	-	-	-	-	-	3	1	1

Course Contents:

Unit	Contents	Hours
I	**Introduction to Electric Vehicle** Introduction to Internal combustion Engine Technology, Comparison with Internal combustion Engine: Benefits and Challenges, EV classification and their electrification levels. Components of Electric Vehicle, EV Terminology	7
II	**Calculations of Motor Torque for Electric Vehicle**, Calculating the Rolling Resistance, the grade resistance, the Acceleration Force, finding the total tractive effort, Torque required on the drive wheel	7
III	**Electric Vehicle Architecture Design,** Types of Electric Vehicle and components, Electrical protection and system requirement Battery electric vehicle, Plug-in hybrid vehicle,	7
IV	**Electric Drive and controller**, Types of Motors, Selection and sizing of Motor, RPM Motor Controllers Component sizing Physical locations Mechanical connection of motor Electrical connection of motor, Function of control unit. Introduction to AC/DC, DC/AC, AC/AC, DC/DC converters, four quadrant operation of converters	7
V	**Energy Storage Solutions and Battery Management System** Cell Types (Lead Acid/Li/NiMH), Battery charging and discharging calculation, Cell Selection	7

	and sizing, Battery lay outing design, Battery Pack Configuration, Battery Pack Construction, Battery selection criteria, Need of BMS	

Text Books	1.	Ali Emadi, “Advanced Electric Drive Vehicles”, CRC Press, 2015.
	2.	A.K. Babu, Electric & Hybrid Vehicles, Khanna Publishing House, New Delhi (Ed. 2018)
E books	1.	Electric Vehicles Technology, Policy and Commercial Development, By Joao Vitor Fernandes Serra,2012, ISBN 9781138374973, Routledge
Reference Books	1.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, and Ali Emadi, CRC Press 2005
	2.	Enge, Per, Nick Enge, and Stephen Zoepf. 2021. Electric Vehicle Engineering. 1st ed. New York: McGraw Hill https://www.accessengineeringlibrary.com/content/book/9781260464
NPTEL	1.	https://archive.nptel.ac.in/courses/108/106/108106170/
	2	https://nptel.ac.in/courses/108103009

Sr. No.	**List of Experiments**
1.	Overview of Electric Vehicles
2.	Determine the motor capacity
3.	Trouble shooting of EV.
4.	Connecting various components of EV.
5.	To study battery characteristics
6.	EV Motor Test Bench
7.	Study of electrical vehicle at load condition
8.	Study of electrical vehicle at no load condition
9.	Open ended experiment
10.	Virtual lab experiment

Course Title: **Operation Research and Management**										
Semester	**IV**	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	EEMC 2	2 Hrs.	--	--	2	10	15	50	--	--
Course Code	23BTMEL213									
Teaching Mode	Offline	2 Hrs.			Total	75			--	
Duration of ESE	2.5 Hrs.					75				

Course Objectives	To study the importance of Operations Research.
	To study the optimization techniques for linear programming, transportation, assignment problems.
	To learn various inventory management techniques.

Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO1: Define real world problem into a mathematical form and generate solutions.
	CO2: Evaluate real world Assignment and Transportation Models for feasible solution.
	CO3: Analyze the various inventory control and simulation techniques.
	CO4: Apply Game theory to real-life problems.
	CO5: Understand the concept and knowledge of project management to achieve the project goals.

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	PS O 1	PS O 2	PS O3
CO1	-	3	3	2	2	1	-	-	2	-	3	-	3	1	1
CO2	1	3	3	2	2	1	-	-	-	-	3	-	3	1	1
CO3	1	3	3	2	2	1	-	-	-	-	3	-	3	1	1
CO4	-	3	3	2	2	-	-	-	3	2	3	-	3	1	1
CO5	2	3	3	2	2	1	-	-	3	-	3	-	3	1	1

Course Contents:

Unit	Contents	Hours
I	**Linear Programming:** Introduction and methodology of Operation Research, Linear Programming- Definition, mathematical formulation, standard form, solution space, solution – feasible, basic feasible, optimal, infeasible, multiple, optimal, Redundancy, Degeneracy. Graphical and simplex methods	6
II	**Transportation & Assignment Problems:** Formulation of transportation model, Basic feasible solution using different methods (North-West corner, Vogel's Approximation Method) Optimality Methods, Unbalanced transportation problem, Variants in Transportation Problems, Applications of Transportation problems. Formulation of the Assignment problem, unbalanced assignment problem, typical assignment & formulation of travelling salesman problem**.**	6
III	**Inventory Control & Simulation:** Inventory control models including both deterministic and stochastic models, Simulation, introduction to simulation, Random number generation, Monte Carlo Simulation.	6
IV	**Game Theory:** Introduction, Characteristics of Games, Types of Game models, Rules for Game Theory, Rectangular games, Saddle point, Minimax (maximum) method of optimal strategies, Graphical solution of 2xn or mx2 games, Game with mixed strategies, Limitations of Game theory.	6
V	**Project Planning & Management:** Introduction to Project Management, Project planning tools, CPM & PERT, Probability of completion of project, crashing of project, Resource levelling, Cost analysis of project, Sequencing model. Advanced Topic:	6

Text Books	1.	'Operation Research', D.S. Hira & P.K Gupta, , S. Chand Co. 1998.
	2.	'Operation Research Problem and Solution', J.K. Sharma, Macmillan Publication, 2004.
	3.	Industrial Organization & Engineering Economics, T.R. Banga, S.C.Sharma, Khanna

		Publications, 2004.
E-Books	1.	Operations Research by Anand Sharma ISBN: 9788178668949
	2.	Handbook of Operation Management and Science, Financial Engineering, John Bhinge, Elesevier, 2007.
Reference Books	1.	'Quantitative Techniques in Management', N.D. Vohra, Tata McGraw Hill, 2001.
	2.	Principles of Management, Knootz, McGraw Hill, 2008.
	3.	'Operation Research an Introduction', H.A. Taha, PHI Publication, 1998.
Online TL Material	1.	NPTEL https://swayam.gov.in/nd1_noc20_ma45/preview
	2.	http://www.pondiuni.edu.in/storage/dde/downloads/mbaii_qt.pdf
	3.	https://www.classcentral.com/course/swayam-introduction-to-operations-research-7902.

Syllabus (Open Elective-II)
4th Semester

Course Title: Materials for Products Development (Open Elective-II)
Course Code: 23BTMEL208

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.** To introduce material, structure and properties
	2. To describe iron carbon equilibrium diagram and heat treatment
	3. To illustrate nano-material and its properties
	4. To make understood product design and development fundamentals.
Course Outcomes	**CO1.** Define crystallography & Properties of material
	CO2. Make use of heat treatment processes for enhancing the material properties.
	CO3. Analyze types of nano materials and its properties.
	CO4. Incorporate and select right Material and fundamentals for successfully developing new product designs.
	CO5. Use skills and knowledge gained to create new products

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	PO9	PO1 0	PO1 1	PO1 2	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
CO5	3	2	3	-	-	-	1	-	-	-	-	1	3	2	1

Course Contents:

Unit	Contents	Hours
I	**Introduction To Engineering Materials** Introduction to engineering materials, their classification, properties & application, Difference between metals & non-metals, Thermal, Mechanical, Chemical properties of Material, Macroscopic & microscopic examination, Mechanism of plastic deformation, slip, dislocation & twinning, Introduction to Basic Terms (System, Crystal Structure, Phase, Variables, Components etc.) related to equilibrium diagram	6
II	**Ferrous and Non-Ferrous Materials, Heat Treatment** Allotropy of Iron, Iron–Iron carbide equilibrium diagram, microstructure under equilibrium cooling condition. Different alloying elements and their effect on enhancing the different characteristics, designation of steels. Brief introduction to different nonferrous materials and study of the Aluminium and its alloy, Steel Alloys Introduction, importance of heat treatment, Basic heat treatments such as annealing, normalizing, hardening and tempering etc.	6
III	**Introduction To Nano Materials** Introduction to Nano Materials, Nano revolution of the XX century, Properties at nanoscale. Carbon based nano materials and other nano materials, Nano composites. Top-down, Bottom-up, Wet Deposition techniques, Self-assembly (Supra molecular approach), Molecular design. Microwave Synthesis of materials, TEM and SEM.	6
IV	**Product Design Fundamentals** Product design fundamentals and material selection, importance of product design, type of design, product definition, product specification, phases of production development: conceptual, embodiment and detailed design, product and technology development cycle, concept generation and evaluation methods, concepts of DFM and concurrent engineering.	6
V	**Essential Products & Developments in Nanotechnology** Product development cycle and importance of prototyping, types of prototypes, principles and advantages, different types of generative manufacturing process viz stereo lithography, FDM, SLS etc, factors concerning to RP, consideration for adoptions, advantages, accuracy and economic consideration. Carbon Nanotube Body Armor, Surface Protection Materials, Food Products and Packaging.	6

Text Books	1 Introduction to Engineering Materials, B. K. Agrawal, Tata McGraw-Hill
	2. Kevin Otto, Kristin Wood, ‘Product Design’, Pearson 2001
Reference Books	1. Materials Science, Willium Callister, John Wiley & Sons
	2. Material Science, Narula & Gupta, Tata Mc-Graw Hill
On-line TL Material	https://home.iitk.ac.in/~anandh/E-book.htm The NPTEL course the “Introduction to Materials” and Product Design & Development.

Syllabus (Multidisciplinary Minor-II)
4th Semester

Course Title: Operation Research and Management (Multidisciplinary Minor- II)										
Semester	IV	Teaching Scheme				Evaluation Scheme				
						Theory			Practical	
Term	Even	L	T	P	Credits	TAE	CAE	ESE	INT	EXT
Course Category	MDM 2	2 Hrs.	--	--	2	10	15	50	--	--
Course Code	23BTMEL212									
Teaching Mode	Offline	2 Hrs.			Total	75			--	
Duration of ESE	2.5 Hrs.					75				

Course Objectives	To study the importance of Operations Research.
	To study the optimization techniques for linear programming, transportation, assignment problems.
	To learn various inventory management techniques.
Course Outcomes	Upon successful completion of this course, student shall be able to:
	CO1: Define real world problem into a mathematical form and generate solutions.
	CO2: Evaluate real world Assignment and Transportation Models for feasible solution.
	CO3: Analyze the various inventory control and simulation techniques.
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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	2	2	1	-	-	2	-	3	-	3	1	1
CO2	1	3	3	2	2	1	-	-	-	-	3	-	3	1	1
CO3	1	3	3	2	2	1	-	-	-	-	3	-	3	1	1
CO4	-	3	3	2	2	-	-	-	3	2	3	-	3	1	1
CO5	2	3	3	2	2	1	-	-	3	-	3	-	3	1	1

Course Contents:

Unit	Contents	Hours
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	2.	'Operation Research Problem and Solution', J.K. Sharma, Macmillan Publication, 2004.
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	2.	Handbook of Operation Management and Science, Financial Engineering, John Bhinge, Elesevier, 2007.
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	2.	Principles of Management, Knootz, McGraw Hill, 2008.
	3.	'Operation Research an Introduction', H.A. Taha, PHI Publication, 1998.
Online TL Material	1.	NPTEL https://swayam.gov.in/nd1_noc20_ma45/preview
	2.	http://www.pondiuni.edu.in/storage/dde/downloads/mbaii_qt.pdf
	3.	https://www.classcentral.com/course/swayam-introduction-to-operations-research-7902.