UNIVERSITY OF PETROLEUM & ENERGY STUDIES

(ISO 9001:2015 Certified)

B.TECH

(MECHANICAL ENGINEERING)

(w.e.f. 2022)

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Program Outcomes (POs)

PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	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.
PO 5	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.
PO 6	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.
PO 7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	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.
PO 11	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.
PO 12	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.

Program Specific Outcomes (PSOs)

PSO1	Apply the knowledge of thermal engineering, design and manufacturing technology in developing mechanical products and systems.
PSO2	Apply advanced modern techniques such as lean manufacturing, Rapid Prototyping etc., and Software tools such as Catia, NASTRAN, PATRAN, etc. in designing mechanical products.

B. Tech- Mechanical Engineering 2022					
SEMESTER I			**SEMESTER II**		
Subject Code	**Subject**	**Credits**	**Subject Code**	**Subject**	**Credits**
MATH1049	Engineering Mathematics I	4	CHEM 1013	Chemistry	3
PHYS1002	Physics	4	MATH 1051	Engineering Mathematics II	4
CSEG 1008	Object Oriented Programming	3	MEPD 1003	Workshop Practices	2
ECEG 1004	Basic Electrical and Electronics Engineering	3	MECH 1001	Engineering Graphics	2
CSEG 1108	Object Oriented Programming Lab	1	MECH 1011	Introduction to Mechancial Engineering	2
ECEG 1104	Basic Electrical and Electronics Engg Lab	1	MECH 1002	Engineering Mechanics	4
PHYS1102	Physics Lab	1	SLLS 0103	Leadership and Teamwork	2
SLLS 0101	Living Conversations	2	SLSG 0101	Critical Thinking and Writing	3
SLLS 0102	Learning how to learn	2			
	TOTAL	**21**		**TOTAL**	**22**
SEMESTER III			**SEMESTER IV**		
Subject Code	**Subject**	**Credits**	**Subject Code**	**Subject**	**Credits**
	Exploratory 1	3		Exploratory 2	3
MEMA 2001	Material Science	3	MECH 2057	Fluid Machinery	3
MEPD 2006	Thermodynamics and Heat Engines	3	MECH 2058	Heat Transfer	3
MECH 2023	Fluid Mechanics	3	MECH 2018	Strength of Materials	3
MATH 2053	Applied Numerical Methods	3	ECEG 2041	Instrumentation & Control	3
MECH 2046	Manufacturing Processes	3	MEMA 2102	Material Science & Material Testing Lab	1
MECH 2123	Fluid Mechanics Lab	1	MECH 2158	Heat transfer lab	1
MECH 2157	Computer Aided Design and Drafting LAB	1	MECH 2159	CADD application in Assembly Drawing LAB	1
SLLS 2001	Social Internship	0	SLLS 0202	Working with Data	2
	TOTAL	**22**		**TOTAL**	**23**
SEMESTER V			**SEMESTER VI**		
Subject Code	**Subject**	**Credits**	**Subject Code**	**Subject**	**Credits**
	Exploratory 3	3		Exploratory 4	3

MECH 3059	Applied Machine Learning	3	MECH 3010	Refrigeration & air-conditioning	3
MECH 3060	Theory of Machines	3	MECH 3156	Thermal and RAC lab	1
MEPD 3010	Manufacturing Technology	3	MEPD 3024	Mechanical Measurement and Metrology	3
MEPD 3110	Manufacturing Technology lab	1	MEPD 3124	Measurement and Metrology LAB	1
MECH 3155	Machine Learning Lab	1		Specialization Course I	3
MECH 3024	Design of Machine Elements	3		Specialization Course II	3
PROJ 3108	Project I	1	PROJ 3121	Project II	2
SLLS 0301	Persuasive Presence	2	INDT 3105	Industrial Visit	0
	TOTAL	**23**		**TOTAL**	**22**
SEMESTER VII			**SEMESTER VIII**		
Subject Code	**Subject**	**Credits**	**Subject Code**	**Subject**	**Credits**
	Exploratory 5	3		Exploratory 6*	3*
MEPD 4018	Industrial engineering & management	3	MECH 4046	Quality control, reliability & maintenance engineering	3
MEAD 4031	Vehicle Technology	2		Specialization Course V	3
	Specialization Course III	3	PROJ 4120	Project IV	4
	Specialization Course IV	3	**Signature 6**	**Choose Anyone**	**3**
INDT 4101	Industrial Internship	0	SLSG 0401P	India and Its Place in the Contemporary World	
PROJ 4119	Project III	2	SLSG 0402P	Theory of Everything	
Signature 5	**Choose Anyone**	3	SLSG 0403P	Digital Transformation	
SLSG 0302P	Solving Complex Problems		SLSG 0404P	Finding your Purpose in Life	
SLSG 0303P	Technologies of the Future		SLSG 0405P	Contemporary World	
SLSG 0304P	Future Casting				
SLSG 0305P	Managing Relationships and Being Happy				
	TOTAL	**19**		**TOTAL**	**13**
Specialization in Smart Manufacturing			**Specialization in Energy Engineering**		
MECH 3049P	Rapid Prototyping and Tooling	Splz 1	EPEG 3048P	Wind and small hydro energy system	Splz 1
MECH 3050P	CAD and Digital Manufacturing	Splz 2	EPEG 3049P	Solar Energy Systems	Splz 2
MECH 4044P	Micro machining technology	Splz 3	EPEG 4045P	Waste to Energy	Splz 3
MECH 4049P	Reverse Engineering	Splz 4	EPEG 4042P	Energy Storage Systems	Splz 4

MECH 4060P	Automation in Manufacturing	Splz 5	EPEG 4043P	Optimization of energy storage	Splz 5
Total Credits of B. Tech Mechanical Engineering 2022					**165**

SEMESTER I

SLICL 001	Learning How To Learn	L	T	P	C
		2	0	0	2
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives:

The objectives of this course are:

• To facilitate the process of inquiry through a need to know and explore a wide variety of subject matter that may or may not be linked to the learners chosen specialism or area of interest.

• To analyze and understand how learning takes place using both cognitive and motor skills.

• To appreciate that the learning process is as important as the content.

• To develop the knowledge and skills of becoming a competent learner

Course Outcomes:

Knowledge & Understanding:

After completing this course, you will be able to:

CO1. **Define** the basic qualities of a life-long learner.

CO2. **Understand** the process and elements of inquiry-based learning.

CO3. **Identify, contextualize and discuss** the learning tools needed to be a lifelong learner of diverse subjects and self-driven goal-oriented learning.

CO4. **Respond** to new learning content and develop concepts using the understanding of the learning process and tools

Skills and Attributes:

CO5: Use a range of basic inquiry-based techniques to draw on appropriate sources in the development of a response to a problem.

CO6: Choose and employ appropriate practice tools in the execution of a project/coursework.

CO7: Critique and articulate responses to project work undertaken by self and by others.

Catalog Description:

This course explores and attempts to equip learners to become conscious about the learning process beyond the cognitive functions of knowledge, understanding and application of subject content. It aims at enabling students to consciously use curiosity, deductive reasoning, inquiry, perspective and argument in exploring a variety of diverse subjects and theories thereby developing a lifelong learning habit.

Course Content

1. **Learning through inquiry** **8 hours**

    a. Elements of inquiry based learning: question, investigate, use evidence (to describe, explain, and predict), evaluation and response/findings.

    b. Types of inquiry: Confirmation inquiry, Structure enquiry, Guided inquiry and Open inquiry

2. **The learning process** **6 hours**

    a. Interactive components of the learning process: attention, memory, language, processing and organizing, writing and synthesizing.

3. **Learning tools** **6 hours**

    a. Basic tools that help learning: reading, writing/annotating, exploring, experiencing, experimenting, applying, practicing, memorizing.

    b. Exploring learning tools: Focused modes of thinking, Chunking, Recall, Pomodoro Technique, Journaling

4. **Collaborative learning** **6 hours**

Learning through peer and self-exploration of diverse and challenging subject

    a. Developing the lifelong learner

    b. Self-driven goal oriented learning

5. **PROJECT and E- portfolio Submission** **4 hours**

Text Books / Reference Books:

Textbooks

- Stanley, J. (2011). ***Know How*.** Oxford University Press. ISBN: 9780199695362**.**
- Oakley, B. (2017). ***Mindshift: Break Through Obstacles to Learning and Discover Your Hidden Potential.*** TarcherPerigee (Amazon/Kindle Ed.)

Reference Books

- Kosslyn, S.M., & Rosenberg, R.S. (2007). **Psychology in Context**. Pearson. ISBN: 9780205507573
- Minskey, M. (1986). **The Society of the Mind.** Simon & Schuster. ISBN: 978-0671657130

JOURNALS AND ARTICLES (Will be uploaded on LMS)

https://www.emeraldgrouppublishing.com/sites/default/files/2020-01/ejournal-subject-brochure-HRLOS_0.pdf

WEB SOURCES

TED Talks:

- The Life Long Learner – Bernie Dunlap
- The Nerd's Guide to Learning Everything Online – John Green

How to learn a new language: 7 secrets from TED Translators

Modes of Evaluation: Quiz +e-portfolio + project

Examination Scheme:

Components	QUIZ	E-PORTFOLIO	PROJECT	Total
Weightage (%)	20%	30%	50%	100

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1						-			-			3			
CO2						3			3			3			
CO3						3			3			3			
CO4						3			3			3			
CO5						3			3			3			
CO6						3			3			3			
CO7						3			3			3			
Average						2.6			2.6			3			

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

SLICL 002	Living Conversations	L	T	P	C
		2	0	0	2
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives:

The objectives of this course are:

1. Encourage critical self-reflection to develop empathy and clarity of expression for exchange of individual and organizational ideas and information.
2. Enable qualities of deep listening and clear and concise communication skills.
3. Apply and practice varied platforms and tools of communication both formal and informal.
4. Appreciate and practice collaborative communication in a given environment and context.

Course Outcomes:

Knowledge & Understanding:

After completing this course, you will be able to:

CO1. **Understand** the importance of being empathetic and the role of clarity in the expression.

CO2. **Identify** appropriate strategies to improve one's ability to express, listen and to understand people in a given situation and context.

CO3. **Use** speaking, writing and listening skills to create more effective and productive professional and personal relationships

CO4. **Build** collaborative relationships that emphasize cross cultural understanding.

Skills and Attributes:

CO5: **Use** a range of basic and advanced communication skills, both verbal and non-verbal to engage, inquire, ideate, collaborate and co-create.

CO6: **Choose and employ** appropriate practice tools in the execution of a project/coursework.

CO7: **Critique and articulate** responses to group and individual work undertaken by self and by others.

Catalog Description:

Living Conversations is a life skill course that empowers and enables learners to exchange, empathize, express, ideate, create and collaborate in any given situation - professional or personal. It aims at enabling students to converse confidently and participate in a variety of discussions appropriately in different situational and cultural contexts, making them an

influential communicator.

Course Content

Basics of Communication **6 hours**

Introduction to the course, Importance, use and its application in life (personal as well as professional), Basics of Communication with Practical Examples (need – principles - process – model), Introducing Types of Communication (Verbal & non-verbal), Types of non-verbal communication & its importance in overall communication.

Setting Communication Goals & Avoiding Breakdowns **4 hours**

Communication goals, creating value in conversations, Internal & external factors impacting our conversations, Communication breakdowns and how to address them.

Communication Styles **4 hours**

Recognizing your style and the styles of others, closing communication gaps, being flexible without compromising one's identity.

Listening for Improved Understanding **4 hours**

Importance, Active & Passive listening, Barriers, Benefits, Features & Examples of Active Listening, Verbal and non-verbal signs of active listening skills, Tools & Tips for Practicing Active Listening.

Emoting, Enunciating & Expressing **4 hours**

Intonation, Enunciation & clarity, Expressions – verbal and written), Calibrating the variance between what you want and what you express, Speaking through silence.

Cross-cultural Communication: navigating beyond boundaries **4 hours**

Developing greater sensitivity to cultural differences, Building greater accountability and trust on virtual teams, Uncovering hidden assumptions, Recognizing filters in oneself and others.

PROJECT and E- portfolio Submission **4 hours**

Text Books / Reference Books:

Textbooks

- Hargie, Owen (ed.) (2018). The Handbook of Communication Skills. Routledge. London.
- Anderson, Peter & Guerrero, Laura. Handbook of Communication and Emotion. 1st Edition. Elsevier.
- Bordia Crossman, Bretag. Communication Skills. Tata Macgraw Hill.
- Tuhovsky, Ian. The Science of Effective Communication.
- Murphy, Herta, Thomas, Jane P. Effective Business Communication. Tata McGraw Hill

JOURNALS AND ARTICLES (Will be uploaded on LMS)

- Patterson, Kerry et.al. (2011) Crucial Conversations Tools for Talking When Stakes Are High. MacMillan. Switzerland.
- A Theory of Goal Oriented Communication: https://www.researchgate.net/publication/220138297_A_Theory_of_Goal-Oriented_Communication

WEB SOURCES

1) Effective Communication http://www.free-management-ebooks.com/dldebk/dlcm-effective.htm

2) Active Listening http://www.free-management-ebooks.com/dldebk/dlcm-active.htm

TED Talks:

https://www.ted.com/playlists/211/the_art_of_meaningful_conversa

Modes of Evaluation: Project + E-Portfolio + Mega Quiz

Examination Scheme:

Components	PROJECT	E-PORTFOLIO	MEGA QUIZ	Total
Weightage (%)	50%	30%	20%	100

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1															
CO2															
CO3															
CO4															
CO5															
CO6															
CO7															
Average															

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

CSEG1008	Object Oriented Programming	L	T	P	C
		3	-	-	3
Pre-requisites/Exposure	Basic Knowledge of Computers such as fundamentals & logic for solving programs				
Co-requisites	--				

Course Objectives

1. To enable students to analyze a real time problem and develop the structures to map into programming objects and develop algorithms to solve.
2. To enable students to develop a program and find mistakes in the program and correct them.
3. To enable students to design a class that serves as a program module or package.
4. To enable students to understand and demonstrate the concepts of object-oriented design, polymorphism, information hiding, and inheritance.

Course Outcomes

On completion of this course, the students will be able to
CO1: Comprehend the fundamentals of Programming and concepts of algorithm, flowcharts and develop efficient algorithms for solving a problem.
CO2: Identify the various OOPS concepts in CPP Programming
CO3: Apply OOPS concepts inheritance, polymorphism to resolve mathematical problems.
CO4: Analyze the real life problem and write a program in 'CPP' language to solve the problem.

Catalog Description

This course covers object-oriented programming principles and techniques using C++. Topics include pointers, classes, overloading, data abstraction, information hiding, encapsulation, inheritance, polymorphism, file processing, templates, exceptions, container classes, and low-level language features. This course also covers basic concepts for software design and reuse.

Course Content

Unit 1 – Introduction – 12 Lectures

Evolution of Programming methodologies – Generation of Programming Languages - Introduction to Structured programming and Object Oriented Programming methodologies, difference between the two methodologies, Basic Concepts of structured programing and Object Oriented Programming. Software development steps -Problem Solving Techniques – Algorithm, Pseudocode, Flowchart.

What is C++?, Applications and structure of C++ program, Different Data types, Variables, Different Operators, expressions, and control structures ,loops and decisions - Function in C++ , Function prototyping.

Unit 2 – Classes and Objects – 11 Lectures

Object Oriented Concepts - – Data Abstraction - Creating classes – Classes objects, data members, member functions - Access Specifiers - Functions in class - Passing arguments to Functions - this Pointer, Friends, Friend Functions, Friend Classes, Friend Scope, and Static Functions.

Unit 3 – Inheritance and Polymorphism – 11 Lectures

Constructors and Destructors, Static variables, Inheritance in C++, Types of Inheritance, Single, Multilevel, Multiple, Hierarchical and Hybrid inheritance. Pointers, Objects and Pointers. Polymorphism, Virtual Functions, Abstract classes. Function and Operator overloading. Operator overloading, Unary and Binary operator overloading.

Unit 4 – Templates and Exception Handling – 11 Lectures

Class templates: Implementing a class template, implementing class template member functions, using a class template, Function templates, and Implementing function templates.

Exception handling: Throwing an exception, catching an exception: The try block, Exception handlers.

Text Books / Reference Books

1. E. Balagurusamy – Object Oriented Programming with C++, Fifth edition, Tata McGraw Education Hill , 2011.

2. Ashok N. Kamthane, Object oriented Programming with ANSI & Turbo C++, First Edition, Pearson India.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1			1										
CO2			1		1										
CO3			1	1											
CO4	1	2													

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

CSEG1108	Object Oriented Programming Lab	L	T	P	C
		-	-	1	1
Pre-requisites/Exposure	Basic Knowledge of Computers such as fundamentals & logic for solving programs				
Co-requisites	--				

Course Objectives

- To help the students to learn the basics of C++ programming language and enable them to contrast procedural and object-oriented approaches of problem solving.
- To make students aware about the object-oriented concepts.
- To enable students to develop programming skills using C++.
- Utilize the flexibility and modularity provided by OOPs using C++.

Course Outcomes

At the end of this course student should be able to

CO1. Demonstrate a clear understanding of the C++ programming environment and basic concepts.

CO2. Apply the concepts of class, method, constructor, instance, data abstraction, function abstraction, overriding, and overloading.

CO3. Design solutions using the concepts of Inheritance and Polymorphism in object-oriented programming.

CO4. Exhibit a clear understanding of Generic Programming, and Exception Handling.

Catalog Description

This course introduces C++ programming language with object-oriented programming principles. The course aims to utilize object-oriented programming paradigm, focusing on the definition and use of classes along with the fundamentals of object-oriented design. Further, emphasis is placed on implementation of generic programming and exception handling.

List of Experiments

Experiment No: 01 Algorithm and Flowchart

To design the various problems using the various problem solving techniques algorithm and flowchart.

Experiment No: 02 Decision and Loops

To develop simple C++ programs to implement control structures like decisions and loops.

Experiment No: 03 Classes and Objects

To develop simple programs using input and output statements, functions, functions with default arguments and Passing Arguments.

Experiment No: 04 Classes and Objects

To develop simple programs to understand objects, member functions with Access Specifiers.

Experiment No: 05 Types of Function

To develop simple programs to understand this Pointer, Friend Functions, Inline Function, and Static Functions.

Experiment No: 06 Constructor and Destructors

To develop simple programs to understand the concepts of Constructors and Destructors.

Experiment No: 07 Inheritance

To develop simple programs to understand the concept of types of Inheritance, Single, Multilevel, Multiple, Hierarchical and Hybrid inheritance.

Experiment No: 08 Compile Time Polymorphism

To develop simple programs to understand the concept compile time polymorphism by implementing operator and function overloading.

Experiment No: 09 Run Time Polymorphism

To develop simple programs to understand the concept run time polymorphism by implementing virtual functions and virtual base class.

Experiment No: 10 Templates & Exception Handling

To develop simple programs to understand the template function and classes, exception handling with the various exception handlers.

Text Books / Reference Books

1. E. Balagurusamy – Object Oriented Programming with C++, Fifth edition, Tata McGraw Education Hill , 2011.
2. Ashok N. Kamthane, Object oriented Programming with ANSI & Turbo C++, First Edition, Pearson India.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1			1										
CO2			1		1										
CO3			1	1											
CO4	1	2													

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

ECEG-1001	Basic Electrical & Electronics	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Understand the characteristics of the basic electronic components like diode and transistor
2. Develop the application-based circuits like switch, Rectifier by using Diode and transistor and by logic gates.
3. Design DC-Power supply by using Rectifiers and Adders& Subtractors by using Logic Gates.
4. Apply laws to solve the DC & AC Circuits.
5. Study the Constructional features, operation and characteristics of Electrical Machines

Course Outcomes

On completion of this course, the students will be able to

CO 1	Employ electronic and electrical components and devices to solve the Engineering problems.
CO 2	Analyze and make simple circuits and systems of Electrical and Electronics Engineering.
CO 3	Design the electrical system with discrete components and to understand the specifications of industrial equipment.
CO4	Design the electronics system with discrete components and to understand the specifications of industrial equipment.

Catalog Description

Electrical & Electronics is the integral part of life. The basic circuits used in day-to-day life are studied in this course. In this course, the main focus will be on the designing of basic electrical and electronics circuits like AC to DC converter by using diode, half adder, full adder etc. in Electronics and three phase system circuits in electrical. Students will learn how to use diode, transistor, Integrated circuit, AC machine and DC Machine in real time and develop circuits buy using them. Classroom activities will be designed to encourage students to play an active role in the construction of their own knowledge and in the design of their own learning strategies. We will combine traditional lectures with other active teaching

methodologies, such as practical sessions, group discussions, and cooperative group solving problems. Class participation is a fundamental aspect of this course. Students will be encouraged to actively take part in all practical sessions to apply the devices and design the basic circuits.

Course Content

Unit I: **7 Lecture Hours**

Fundamental Characteristics of diode: Formation of P-N junction, I-V characteristics, half-wave rectifier circuits, full-wave rectifier circuits Zener and Avalanche breakdown; diode applications in voltage regulation clipper and clamper.

Unit II: **7 Lecture Hours**

Resistance, inductance and capacitance, open circuit and short circuit, electrical power and energy; Voltage and current sources, Kirchhoff current and voltage laws, analysis of simple circuits with DC excitation. Superposition Thevenin and Maximum Power Transfer theorem.

Switch Fuse Unit (SFU), MCB, ELCB, MCCB; Types of Wires and Cables, Earthing; Elementary calculations for energy consumption, and battery backup.

Unit III: **8 Lecture Hours**

Construction and operation, Transistor amplifying action, Amplification factors; Limits of operation, Applications of transistor DC-Biasing: Fixed bias DC-Biasing: Emitter bias, Voltage divider bias

Unit IV: **7 Lecture Hours**

Representation of sinusoidal waveforms, peak and RMS values, phasor representation. Elementary analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations. Real power, reactive power, apparent power, power factor. Resonance Three-phase balanced circuits, voltage and current relations in star and delta connections.

Unit V: **8 Lecture Hours**

Number system and codes Minimization techniques: Boolean logic operations, Basic laws of Boolean algebra De Morgan’s Theorems; Logic gates: AND, OR, NAND, NOR. Adder and subtractor.

Unit VI: **8 Lecture Hours**

Construction, Working Principle and Classification; Ideal and practical transformer, losses in transformers & efficiency; Classification of motors (AC), Classification of motors (DC), characteristics & applications of DC Motors

Text Books

1. Electrical & Electronics Engineering by K R Niazi, Genius Publication.ISBN:9788188870137
2. Basic Electrical and Electronics Engineering, by J B Gupta S K Kataria and Sons.3rd Ed.

Reference Books

1. Basic Electrical Engineering by Chakrabarti, Tata McGraw Hill. ISBN: 9781259083365
2. Basic Electrical Engineering byU.A.Bakshi, V.U.Bakshi, ISBN: 9788184316940
3. A Text Book of Electrical Machines by Rajput, L P Publications. ISBN: 9788131804469
4. Basic Electronics By Santiram Kal,(2013): PHI
5. Digital Circuits & Logic Design By Salivahanan: Vikas Publishing House. ISBN 978-9325960411
6. Electronics Devices and Circuits By Boylestad & Nashelsky 10th ED : PEARSON: ISBN 978-8131727003

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**IA**	**MID SEM**	**End Sem**	**Total**
Weightage (%)	**30**	**20**	**50**	**100**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO 1	2	2	3	1	-	-	-	-	-	-	-	1	2	1
CO 2	2	2	2	1	1	-	-	-	-	-	-	1	1	2
CO 3	3	3	2	-	1	-	-	-	-	-	-	1	1	3
CO4	3	3	2	-	1	-	-	-	-	-	-	1	1	3
Average	2.5	2.5	2.25	1	1	0	0	0	0	0	0	1	1.25	2.25

ECEG1104	Basic Electrical and Electronics Engg. Lab	L	T	P	C
		0	0	2	1
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Understand the characteristics of the basic electronic components like diode and transistor
2. Develop the application based circuits like switch, Rectifier by using Diode and transistor and also by logic gates.
3. Design DC-Power supply by using Rectifiers and Adders& Subtractors by using Logic Gates.
4. Apply laws to solve the DC & AC Circuits.
5. Study the Constructional features, operation and characteristics of Electrical Machines

Course Outcomes

CO1 Experimentally verify the basic circuit theorems

CO2 Study the characteristics of different components, semiconductor devices and circuits used in electrical and electronics engineering applications.

CO3 Create resonance condition in R-L-C series and parallel circuit and learn how to draw phasor diagram for the circuit.

CO4 Develop the logic using digital circuits

Catalog Description

Electrical & Electronics is the integral part of life. The basic circuits used in day-to-day life are studied in this course. In this course, the focus will be on the designing of basic electrical and electronics circuits like AC to DC converter by using diode, half adder, full adder etc. in Electronics and single phase system circuits analysis in electrical. Students will learn how to use semiconductor devices like diodes and transistors and apply their knowledge in finding the applications of all devices. Class participation is a fundamental aspect of this course. Students will be encouraged to participate actively in all practical sessions to apply the devices and design the basic circuits. .

List of Experiment

Virtual Experiments

Experiment No: 01 Resistor Color Code (CO2)

To study Resistor Color Code and measure the values using multimeter and ammeter voltmeter connection in simple electrical circuit.

Link: https://www.allaboutcircuits.com/tools/resistor-color-code-calculator/

Experiment No: 02 Verifying Circuit Theorem (CO1)

To verify Thevenin's Theorem.

Link: http://vlabs.iitb.ac.in/vlabs-dev/labs_local/network_lab/labs/exp2/index.php

Experiment No: 03 Verifying Circuit Theorem (CO1)

To verify Superposition Theorem

Link: http://vlabs.iitb.ac.in/vlabs-dev/labs_local/network_lab/labs/exp1/index.php

Experiment No: 04 Verifying Circuit Theorem (CO1)

To verify the Maximum Power Transfer Theorem

Link: http://vlabs.iitb.ac.in/vlabs-dev/labs_local/network_lab/labs/exp3/index.php

Experiment No: 05 Single Phase Circuit analysis (CO3)

To study the phenomenon of resonance in L-C-R series circuit

Link: https://vlab.amrita.edu/?sub=1&brch=75&sim=330&cnt=1

Experiment No: 06 Single Phase Circuit analysis (CO3)

To study the phenomenon of resonance in LCR parallel circuits.

Link: https://vlab.amrita.edu/?sub=1&brch=75&sim=325&cnt=1

Experiment No: 07 Electronics Components (CO2)

To study various electronic components (diode, resistor, transistor, capacitors, ICs, etc).

Link:

1. http://vlabs.iitkgp.ernet.in/be/exp1/index.html
2. http://vlabs.iitkgp.ernet.in/be/exp2/index.html
3. http://vlabs.iitkgp.ernet.in/be/exp3/index.html
4. http://vlabs.iitkgp.ernet.in/be/exp4/index.html

Experiment No: 08 Electronics Components (CO2)

To plot V-I characteristics of PN junction diode.

Link: http://vlabs.iitkgp.ernet.in/be/exp5/index.html

Experiment No: 09 Electronics Circuits (CO2)

To study half-wave and full-wave rectifier circuit.

Link: http://vlabs.iitkgp.ernet.in/be/exp6/index.html

Experiment No: 10 Electronics Components (CO2)

To study the characteristics of NPN transistor in CE configuration.

Link: http://vlabs.iitkgp.ernet.in/be/exp11/index.html

Experiment No: 11 Electronics Components (CO2)

To study the characteristics of NPN transistor in CB configuration.

Link: http://vlabs.iitkgp.ernet.in/be/exp12/index.html

Experiment No: 12 Digital Circuits (CO4)

Implementation of Half and Full Adder digital circuits.

Link : http://hecoep.vlabs.ac.in/Experiment1/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab

Text Books:

[T1] Electrical & Electronics Engineering by K R Niazi, Genius Publication.ISBN:9788188870137

[T2} Basic Electrical and Electronics Engineering, by J B Gupta S K Kataria and Sons.3rd Ed.

Reference Books:

[R1] William H. Hayt, Jr. Jack E. Kemmerly, "Engineering Circuit Analysis" McGraw Hill Publication.

[R2] N.C. Jagan, "Network Analysis", BS Publication, Hyderabad, Second Edition.

[R3] Basic Electronics By Santiram Kal,(2013): PHI

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**Continuous Evaluation**
Weightage (%)	**100**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	2	-	-	-	-	-	-	-	-	-	-
CO2	-	-	2	2	-	-	-	-	-	-	-	-	3	-
CO3	-	-	3	1	-	-	-	-	-	-	-	-	-	-
CO4	-	-	3	2	-	-	-	-	-	-	-	-	3	-
Average	-	-	2.75	1.75	-	-	-	-	-	-	-	-	3	-

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

MATH 1026	Engineering Mathematics I	L	T	P	C
		3	1	0	4
Pre-requisites/Exposure	Mathematics up to class XII				
Co-requisites	--				

Course Objectives

1. To enable students to apply matrix theory in engineering problems.
2. To help the students understand the technique to expand functions of one and two variables and to trace the curves.
3. To develop students' skills to calculate the area, volume, mass, centroid and moments of inertia of plane and solid regions using the principles of multiple integration.
4. To enable students to compute Fourier series of periodic functions.

Course Outcomes

On completion of this course, the students will be able to

CO1. Find the Eigen values, Eigen vectors and solution of system of linear algebraic equations using the techniques of matrix theory.

CO2. Apply the principles of differentiation to the problems related to extreme values, curve tracing and expansion of functions.

CO3. Calculate the area, volume, mass, centroid and moment of inertia of plane and solid regions using the principles of multiple integration.

CO4. Represent periodic functions of a single variable as Fourier series.

Catalog Description

Mathematics is a necessary subject to a clear and complete understanding of virtually all phenomena. It helps us to develop logical thinking and to find the right way to solve problems. This course covers Matrix theory, Differential calculus, Multiple integrals and Fourier series. This course is designed in such a way that it enables the students to cope confidently with the mathematics needed in their future subjects and the curriculum aims at developing student's

ability to conceptualize, reason and to use mathematics to formulate and solve problems in their core subjects.

Course Content

Unit I: Matrices **13 lecture hours**

Introduction: Revision of Prerequisites, Elementary Row and Column Transformations(Reduction of a Matrices into Echelon and Normal form), Linear Dependence of Columns and Rows, Rank of a Matrix, Consistency of System of Linear Equations and its Solution, Characteristic Equation, Eigen values and Eigenvectors, Applications of Cayley-Hamilton Theorem, Diagonalisation.

Unit II: Differential Calculus **23 lecture hours**

Higher order derivatives, Successive Differentiation, Leibnitz Theorem, Maclaurin's and Taylor's Theorem, Expansion of Functions of one variable, Partial Differentiation, Euler's Theorem and its Applications, Jacobian, Expansion of Functions of two variables, Extrema of Functions of two variables, Asymptotes, Curve Tracing (Cartesian, Polar & Parametric Curves).

Unit III: Multiple Integrals **14 lecture hours**

Double and Triple Integrals, Change of Order of Integration, Change of Variable, Beta and Gamma Functions, Applications of I (Area, Volume, Center of Gravity & Moment of Inertia).

Unit IV: Fourier Series **10 lecture hours**

Introduction to Periodic Functions, Fourier Series Expansion of Functions of Period 2π, Change of Interval, Half Range Sine and Cosine series.

Text Books

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publications. ISBN: 9788184875607.
2. E. Kreyszig, Advanced Engineering Mathematics, Wiley Publications. ISBN: 9788126531356.
3. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill. ISBN: 9780071070089.

Reference Books

1. M. D. Greenberg, Advanced Engineering Mathematics, Pearson Education, India. ISBN: 9788177585469.
2. S. Narayan, Differential Calculus, Shyamlal Charitable Trust, New Delhi. ISBN: 9788121904711.
3. N. Piskunov, Differential and Integral Calculus, CBS, New Delhi, India. ISBN: 8123904932.
4. J. Stewart, Essential Calculus: Early Transcendentals, Cengage Learning India Pvt. Ltd. ISBN: 8131503453.
5. D. G. Zill, Advanced Engineering Mathematics, Jones & Bartlett, India. ISBN: 9789384323271.

Modes of Evaluation: Class tests/Assignment/Tutorial Assessment/Written Examination

Examination Scheme:

Components	**Tutorial/Faculty Assessment**	**Class Tests**	**MSE**	**ESE**
Weightage (%)	**15**	**15**	**20**	**50**

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	2	-	-	-	-	-	-		-	-
CO3	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	2	-	-	-	-	-	-	-	-	-
Average	3	2	-	-	2	-	-	-	-	-	-	-	-	-

1=weakly mapped 2= moderately mapped 3=strongly mapped

PHYS- 1020	Physics-I	L	T	P	C
		3	1	0	4
Pre-requisites/Exposure	12^{th} Level Physics				
Co-requisites	12^{th} Level Mathematics				

Course Objectives

1. Explore Fiber optics and Lasers' fundamentals and their applications to modern communication systems.
2. Comprehend the effect of electric and magnetic field in materials and apply Maxwell's equations to understand EM wave propagation
3. Familiarize with the basics of solar photovoltaics and their applications in solar industries.
4. Construct a quantum mechanical model to explain the behavior of a system at the microscopic level.
5. Understand the fundamentals of crystal structure and X-rays diffraction.

Course Outcomes

CO1. Learn the principles of physical optics, lasers and fiber optics and their applications in various devices

CO2. Comprehend the properties of dielectric and magnetic materials under the influence of electric and magnetic fields.

CO3. Employ photovoltaics fundamentals in understanding the functioning of various devices used in electronics and solar photovoltaics industries.

CO4. Understand the behavior of microscopic objects using fundamentals of Quantum Mechanics.

CO5. Explore different types of crystals structures and use X-ray diffraction technique to understand their details.

Catalog Description

Almost all disciplines of engineering and technology have origins in the basic principles of Physics. In this course, we will systematically build the foundation of the students by teaching them introductory quantum mechanics, solid-state physics, electromagnetics, and optics. These topics will help the students in understanding their respective engineering content better. The

theoretical development of wave mechanics, its limitations and contributions in revolutionizing the modern world will be covered in the first unit. In the second unit, the focus will be on different types of crystal structures and how X-ray diffraction may be utilized in understanding various attributes of a crystal structure. The third unit deals with very important class of engineering materials namely di-electric and magnetic materials along with their wide range of applications; understanding EM waves propagation with the help of Maxwell's equations will also be covered in this unit. In the remaining units, the students will be apprised of physical optics and its applications in various optical devices and measurements; lasers and optical fibres will be introduced thereafter with an objective to teach sufficient details to the students so that they should be able to understand modern day communications systems. A short unit on solar photovoltaics at the end has been provided to provide enough details so that the students could make themselves familiar with the PV technology applied nowadays for clean energy generation.

Course Content

Unit I: Physical Optics, Lasers & Fiber optics **14 lecture hours**

Introduction to interference and examples; concept of diffraction, Fraunhoffer and Fresnel diffraction, diffraction grating and its characteristics.

Polarization: Introduction, polarization by reflection, polarization by double refraction, circular and elliptical polarization, optical activity.

Fibre Optics: Introduction, total internal reflection, numerical aperture and various optical fibre parameters, step and graded index fibres, losses in optical fibres.

Lasers: Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping; types and applications of lasers, He-Ne laser.

Unit II: Electromagnetics **17 lecture hours**

Overview of Electrostatics and Magnetostatics, electric current and the continuity equation, laws of magnetism. Ampere's & Faraday's laws. Maxwell's equations, Electromagnetic waves and Poynting Vector in free space.

Electric Polarization, permeability and dielectric constant, internal fields, Clausius-Mossotti equation, applications of dielectrics.

Magnetization, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

Unit III: Quantum Mechanics **15 lecture hours**

Introduction to Quantum Mechanics, photoelectric effect, Compton Effect, Pair production & Annihilation, De-Broglie waves, phase and group velocities, Uncertainty principle and its applications, Wave function and its interpretation, Normalization, Linearity and superposition, expectation values, operators, Eigen values & Eigen functions, Schrodinger time independent & dependent wave equations, Particle in a 1-D box

Unit IV: Solid State Physics & Photovoltaics **14 lecture hours**

Introduction to Solid State Physics, single crystals and polycrystalline forms, Lattice, Basis and crystal structure, Translational symmetry and basis Vectors, Unit Cell (primitive and non-primitive), Bravais lattices, Miller indices, sc, bcc, and sodium chloride structures, closed packed structures(fcc and hcp), Reciprocal lattice, X-ray diffraction, Bragg's law.

Photovoltaic effect, irradiance, solar radiation and spectrum of sun, solar cells, basic structure and characteristics, solar cell arrays, PV modules.

Text Books

1. Malik H.K, Singh A.K. (2011) Engineering Physics, TMH, New Delhi. ISBN: 9780070671539

2. Beiser A. (2002) Concepts of Modern Physics, McGraw Hill Education. ISBN: 9780070495531

3. Sadiku M.N.O. (2007) Elements of Electromagnetics, Oxford University Press. ISBN: 0195300483

4. Pillai S.O. (2015) Solid State Physics, New Age International Pvt Ltd. ISBN: 978-8122436976

Reference Books

1. Griffith D.J. (2012) Introduction to Electromagnetics, PHI Learning, 4th edition, ISBN: 9780138053260.
2. Kittel C. (2012) Introduction to Solid State Physics, Willey. ISBN: 978-8126535187.

Modes of Evaluation: Class tests/Assignment/Tutorial Assessment/Written Examination

Examination Scheme:

Components	**IA**	**MSE**	**ESE**
Weightage (%)	**30**	**20**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	-	-	-	-	-	-	1	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	1	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	1	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Average	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

PHYS-1120	PHYSICS LAB	L	T	P	C
		0	0	2	1
Pre-requisites/Exposure	Basic knowledge on practical Physics (12th level) for understanding and performing experiments.				
Co-requisites	Data interpretation and basic knowledge on graphical analysis.				

Course Objectives

1. To impart hand-on skills in performing experiments, data acquisition and interpretation of the data.
2. To design the circuits and study about various experimental procedures involved.
3. To understand and verify theoretical formulation and prediction.
4. To develop curiosity and creative ability through experimentation and investigation based on the virtual experiments.

Course Outcomes

At the end of this course student should be able to

CO1: Demonstrate the dual nature of light by verifying the various phenomena associated with it

CO2: Apply the concepts of electromagnetics to study the various electrical and magnetic properties of Materials.

CO3: Evaluate and compare the universal constants by using the principle of modern physics.

CO4: Design virtual Physics based experiments to illustrate the Photoelectric Effect.

CO5: Inculcate good presentation skills.

Catalog Description

The laboratory practice has been an important part of professional and engineering undergraduate education, an ideal platform for active learning. The purpose of the Physics practical sessions are to give students hands-on experience with the experimental basis of engineering physics and, in the process, to deepen their understanding of the relations between experiment and theory. The focus of this course is to improve the skills of the students in collecting, analyzing, interpreting and presenting findings and data.

Sonometer is a useful apparatus for investigating the vibration of a string or wire under tension. The student will able to measure the AC mains frequency using sonometer and electromagnet in the lab. The experiment allows the change in length of the string in accordance with the variation in the tension. The student will demonstrate the Hall's effect in the laboratory, finds Hall's coefficient and apply this to calculate carrier density in the given semiconductor material. Hall Effect experiment is extremely useful in determining the carrier density, mobility of carriers in the semiconductor, which is a precursor of semiconductor electronic devices. There are numerous industrial applications of Hall's effect in IC switches, ignition sensors, automotive industry for level/tilt measurement sensor, aerospace industry in temperature and pressure sensor, magnetic card reader, and semiconductor industry so on. Experiments based on electromagnetic theory focusses on the applications of the well-defined laws e.g. Faraday's Law, in studying the induced emf produced due to change in the velocity of the magnet. In Stewart-Gee coil experiment, the variation of magnetic field along the axis of a circular coil is demonstrated. The virtual labs develop a curiosity and creative ability through experimentation and investigation on the photoelectric effect experiment. Additionally, the virtual lab experiment provides an insight to use the simulator to understand the photoelectric effect. The virtual experiment on photoelectric effect explains the basic interaction of light and matter. The Newton's Rings experiment determines the wavelength of the given light source by utilizing the phenomenon of interference. The diffraction grating experiment composed of a spectrometer, diffraction grating and mercury vapor lamp explores the wavelengths of spectra lines of different orders by arranging the spectrometer in the normal incidence position. The solar cell trainer is a typical setup, which converts light energy to electrical power. A solar cell or photovoltaic cell is used to converts light energy into electrical energy, basing on the principle of the photovoltaic effect. The student will analyze the characteristics of solar cell and its efficiency in the laboratory. The device has wide application in sensor applications. Solar cells diverged from the silicon technology is used for terrestrial panels, the spacecraft application and a power source. The experiment on Planck's constant using LEDs determines the Planck's constant, which is very useful in explaining about the radiation and correlates the photon energy with wavelength. The particle nature of light will be demonstrated using light emitting diodes (LEDs) by observing the reverse photoelectric effect and find the value of Planck's constant.

List of Experiments:

Experiment No: 01

To determine the frequency of AC mains by using a sonometer.

Experiment No: 2

To study the Hall effect and hence determine the Hall coefficient (R_h) and carrier density (n) of a given semiconductor material.

Experiment No: 3

(**a**) To study the induced emf as a function of velocity of the magnet passing through the coil (Faraday's Law).

(**b**) To study the charge delivered due to electromagnetic induction.

Experiment No: 4.

To study the variation of magnetic field with distance along the axis of a current carrying circular coil and hence estimate the radius of the coil.

Experiment No: 5.

To study the variation of magnetic field with distance along the axis of a current carrying circular coil and hence estimate the radius of the coil.

Experiment No: 6

To determine the wavelength of a given light by forming Newton's Rings.

Experiment No: 7

To determine the wavelength of a given light by using a Diffraction grating in its normal incidence position.

Experiment No: 8

Study of both the current - voltage characteristic and the power curve to find the maximum power point (MPP) and efficiency of a solar cell.

Experiment No: 9

To find the Planck's constant by using LEDs.

Experiment No: 10

Presentation related to any science concept.

Text Books

4. H. Singh, Practical Physics, S. Chand & Company LTD., ISBN: 8121904692.
5. S. L. Kakani, S. Kakani, Applied Physics-Theory & Practicals, Viva Books, ISBN: 9788130924892.
6. C. L. Arora, Practical Physics, S. Chand & Company LTD., ISBN: 9788121909099, 8121909090.

Reference Books

6. Gupta, Kumar, Practical Physics, Pragati Prakashan, ISBN: 9789386633569.
7. I. Prakash, R. Krishna, A. K. Jha, Practical Physics, Kitab Mahal, ISBN: 8122504167, 9788122504163
8. P. R. Sasi Kumar, Practical Physics, Prentice Hall of India Pvt Ltd, ISBN: 9788920344341

Modes of Evaluation: File /Viva-voce/ presentation/ Comprehensive viva-voce

Examination Scheme: Continuous Evaluation

Components	Continuous Evaluation
Weightage (%)	100

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Average	-	**3**	**3**	**3**	**2**	-		-	-	**3**	**0**	**1**	-	-	-

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

2022-26 Batch

SEMESTER II

Course Code	Course name	L	T	P	C
SLICS 01	Critical Thinking and Writing	3	0	0	3
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

The objectives of this course are:

- To introduce the essential tools and approaches of critical thinking.
- To realize how the fallacies and biases hinder the process of critical thinking and how to overcome them.
- To understand and the various components and conventions of critical writing and create appropriate documents.

Course Outcomes

On completeing this module, the student should be able to:

CO 1 identify, understand and define the various arguments in different contexts
CO 2 to draw logical conclusions
CO 3 introspect and reflect on their thought processes
CO 4 identify the errors in reasoning
CO 5 listen, read and write critically

Catalog Description

The ability to think clearly and rationally is important in whatever we choose to do. **Critical thinking is the ability to think clearly and rationally about what to do or what to believe a**nd includes the ability to engage in reflective and independent thinking. Critical Thinking and Writing skills are important to help the one progress in their professional and personal life effectively. This course aims to introduce the various tools and methods available to develop their critical thinking. It will equip students to utilize critical thinking concepts and strategies in learning, and apply those skills for effective written communication, thus developing the ability to think critically and communicate effectively

Course Content

Unit 1 – Heading – 0 Lectures

Module-1 Understanding the process of critical thinking

- What is critical thinking: definition and theories
- Importance of Critical Thinking
- Critical thinking Structures
- Metacognitive skills; understanding our minds

Unit 2 – Heading – 0 Lectures

Module-2 Barriers to critical thinking

- The critical thinking model
- Information Literacy

- Cognitive Biases
- Logical Fallacies

Unit-3

Module-3 Approaches for Critical Thinking

- Arguments and Rationality
- Reasoning and Persuasion
- Six Thinking hats
- Simplification

Unit-4

Module-4 Critical thinking and writing

- Critical thinking and clear writing
- Presenting and communicating ideas

Text Books / **Reference Books**

- Lewis Vaughn, The power of critical thinking, effective reasoning about ordinary and extraordinary claims, second edition, Oxford University Press
- Walter Sinnott Armstrong and Robert Fogelin, Understanding Arguments: An Introduction to Informal Logic. 8th Ed., Wadsworth Cengage Learning.
- Edward de Bono, Six Thinking Hats, ISBN 0-316-17831-4
- Richard Paul and Linda Elder, The miniature guide to critical thinking, concepts and tools, the foundation for critical thinking
- Encourage critical thinking with 3 questions: https://www.youtube.com/watch?v=0hoE8mtUS1E
- Wile E Coyote Into- Introduction to critical thinking: https://www.youtube.com/watch?v=xOjl3jm-GrA
- Psychologist Diane Halpern on Critical Thinking: https://www.youtube.com/watch?v=rn_7aJP5BTw

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	QUIZ	E-PORTFOLIO	PROJECT	Total
Weightage (%)	20%	30%	50%	100

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO12
CO1									2	2		3
CO2									2	2		3
CO3									2	2		3
CO4									2	2		3
CO5									2	3		3
CO6												
CO7												
Average									2	2.5		3

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

SLICL 003	LEADEARSHIP AND TEAMWORK	L	T	P	C
		2	0	0	2
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives:

The objectives of this course are:

• Formulate and articulate a personal point of view about the meaning of leadership and teamwork, and why they are important.
• Explore and appreciate the scope of leadership and teamwork in one's day to day life.
• Understand the concepts of effective leadership and teamwork in organizations.
• Identify and assess the skills and motivations associated with effective leadership and teamwork.
• Improve effective communications in groups and manage team conflict to resolve issues.
• Learn how to perform in teams to achieve results on personal and professional levels.

Course Outcomes:

Knowledge & Understanding:

After completing this course, you will be able to:

CO1. **Understand** the importance of being an empathetic leader and a collaborative team member.

CO2. **Understand** the skills of leadership and teamwork – including analysis of leadership and teamwork theory, as well as how they are assessed in the professional and social process.

CO3. **Build** collaborative relationships that emphasize team building and problem solving.

Skills and Attributes:

CO4: **Use** a range of basic reflective practice techniques, to evaluate their own teamwork and leadership skills.
CO5: **Use** leadership and teamwork skills to create more effective and productive professional and personal relationships.

CO6: **Choose and employ** appropriate practice tools in the execution of a project/coursework.

CO7: **Critique and articulate** responses to group and individual work undertaken by self and by others.

Catalog Description: Leadership and teamwork are the essence of community living both social and professional. The aim of this course is to explore and appreciate the scope of both these attributes in varied aspects of one's day to day working. When taking this course, you will raise your own self-awareness and gain self-confidence for a better leadership.

Course Content

1. **Leadership: Introduction, Self Awareness & Leadership Examples** **5 hours**
   Introduction to the Course, Importance and Its Application in Life, Self Awareness and Leadership Examples from Different Walks of Life, Personality Assessment through (i) BIG 5, (ii) MBTI.

2. **Defining Leaders and Leadership** **3 hours**
   Defining Leaders and Leadership, Historical Perspective, Contemporary Perspective, Types of Leaders and Leadership Styles.

3. **Leadership Toolkit** **6 hours**
   Leadership Tools - Locus of Control, Goal Setting, Time Management, Interpersonal Relationship, Role of Perception, Powerful First Impression, Body Language, Elevator Pitch, Small Talk, Constructive Criticism, Assertiveness Skills, Dealing with Difficult People.

4. **What is a Team?** **6 hours**
   What is a Team? Why is a Team needed? 4 Phase Model of Team Formation, What to Do as a Leader and What to Do as a Team Member in Each Phase? Effective Teams and Solving Problems as a Team – Brief Introduction to The Six Thinking Hats

5. **Positive Leadership & Team Building Activity** **6 hours**
   Positive Leadership - Communication, Appreciation, Empathy, Feedback, Leaders and Teams: Working Effectively towards Common Goals, Team Building Activity.

6. **PROJECT and E- portfolio Submission** **4 hours**

Text Books / Reference Books:

Textbooks

- Carroll, John, and Sachi Hatakenaka. "Driving Organizational Change in the Midst of Crisis." *MIT Sloan Management Review* 42, no. 3 (Spring 2001): 70-79.

- *Senge, Peter M., Art Kleiner, Charlotte Roberts, Rick Ross, and Bryan Smith. "The Ladder of Inference." In The Fifth Discipline Fieldbook. New York, NY: Currency Publishers, pp. 242-250. ISBN: 0385472560.*
- Organizational Behavior, Stephen P. Robbins, Timothi A. Judge and Seema Sanghi, 12th ed, Prentice Hall India.
- Organizational behavior-Human behavior at work by John W Newstrom, 12th edition, McGrawHill

Additional Reading/Viewing:

- Stephen R. Covey, The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change
- Katie Shonk (2018, June 19). 3 Types of Conflict and How to Address Them. Harvard Law School. climerconsulting.com/episode-23-how-conflict-impacts-team-creativity
- Charas, S. (2013, February 27). Boardroom conflict: Productive or not? Business Insider.

businessinsider.com/boardroom-conflict-productive-or-not-2013-3?r=AU&IR=T

- Mitchell, R. (2014, January 21). Team innovation and success: Why we should fight at work. The Conversation

theconversation.com/team-innovation-and-success-why-we-should-fight-at-work-20651

WEB SOURCES:

- NACE Job Outlook Report, 2020
- https://www.stjohns.edu/sites/default/files/2020-05/nace_job_outlook_0.pdf
- Ten Leadership Theories in Five Minutes
- https://courses.lumenlearning.com/wmopen-organizationalbehavior/chapter/the-history-of-leadership-theories/
- https://toughnickel.com/business/The-History-of-Leadership-Studies-and-Evolution-of-Leadership-Theories
- https://courses.lumenlearning.com/principlesmanagement/chapter/10-5-contemporary-approaches-to-leadership/
- https://www.bumc.bu.edu/facdev-medicine/files/2010/10/Leadership-Matrix-Self-Assessment-Questionnaire.pdf
- https://www.tuw.edu/business/what-kind-of-leader-are-you/

- https://www.thebalancesmb.com/smart-goal-examples-2951827
- https://examples.yourdictionary.com/examples-of-measurable-goals-and-objectives.html
- https://www.youtube.com/watch?v=0Mi9_XEXQqc
- https://www.youtube.com/watch?v=zc8zCSQxBhM
- https://www.youtube.com/watch?v=vlpKyLklDDY&t=296s

Modes of Evaluation: Project + E-Portfolio + Mega Quiz

Examination Scheme:

Components	PROJECT	E-PORTFOLIO	MEGA QUIZ	Total
Weightage (%)	50%	30%	20%	100

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1															
CO2															
CO3															
CO4															
CO5															
CO6															
CO7															
Average															

1 = weakly mapped 2 = moderately mapped, 3 = strongly mapped

MEPD1002	Workshop Practices	L	T	P	C
		1	0	2	2
Pre-requisites/Exposure	Workshop practice theory course				
Co-requisites					

Course Objectives

1. To impart knowledge and skill of components in the field of basic workshop practices.
2. To deal with different hand and machine tools required for manufacturing simple components.
3. To impart the knowledge regarding the various basic manufacturing processes required in day-to-day life.
4. To familiarize the students with the properties and selection of different engineering material.
5. To impart knowledge of dimensional tolerances with different manufacturing processes.

Course Outcomes:

CO1: Understand the basics of manufacturing processes used in engineering workshop.

CO2: Identify basic workshop hand & machine tools

CO3: Fabricate simple models by using different Manufacturing processes.

CO4: Compare conventional and advance manufacturing processes.

Catalog Description

Workshop technology is the backbone of the real industrial environment that helps to develop and enhance relevant technical hand skills required by the engineers working in the various engineering industries and workshops. This course intends to impart basic knowledge of various hand tools

and their use in different sections of manufacturing. Irrespective of branch, the use of workshop practices in day-to-day industrial as well domestic life helps to solve the problems. The workshop experiences would help to build the understanding of the complexity of the industrial job, along with time and skills requirements of the job. The students are advised to undergo each skill experience with remembrance, understanding and application with special emphasis on attitude of enquiry to know why and how for the various instructions and practices imparted to them in each shop.

Course content:

UNIT 1 **4 LECTURE HOURS**

Manufacturing Methods, Forming process –hot working and cold working processes – types. Machining Advanced manufacturing processes- introduction to non-conventional machining processes and its needs.

UNIT 2: **2 LECTURE HOURS**

Fitting operations & power tools , limits, fits and tolerance. Types of power tools.

UNIT 3 : **2 LECTURE HOURS**

Metal casting patterns-types, allowances, molding sand-its properties, types of molds and cores, melting equipment.

UNIT 4 **3 LECTURE HOURS**

Welding (arc welding & gas welding), brazing, Gas welding.

UNIT 5 **1 LECTURE HOURS**

Carpentry Types of woods,defects of wood, seasoning of wood, types of carpentry tools. Additive manufacturing –additive v/s subtractive manufacturing, need, advantages and applications of additive manufacturing, introduction to 3 D printing

List of Experiments:

Experiment No: 01

Prepare lab layout of the workshop with layout of all shops: carpentry, fitting, machine, welding, smithy, sheet metal and foundry shop.

Experiment No: 02

To fabricate a T-lap joint of given dimensions using common carpentry tools.

Experiment No: 03

To fabricate a cross lap joint of given dimensions using common carpentry tools.

Experiment No: 04

To develop a square fitting model of given dimensions by using fitting tools.

Experiment No: 05

To learn lathe operation and develop a step turning model of given dimensions by using lathe machine.

Experiment No: 06

To develop a model of given dimension by using facing, turning, grooving, parting and knurling operations.

Experiment No: 07

To learn welding operation and develop a T- joint, V-butt joint and Lap joint using electric arc welding process.

Experiment No: 08

To develop a rectangular tray in sheet metal shop using various hand tools for working with sheet metal

Experiment No: 09

To develop a chisel using common smithy hand tools.

Experiment No: 10

To develop a cope and drag mould in foundry shop

Text Books / Reference Books

1. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers.

2. Engineering Practices Lab Manual, Jeyapoovan, SaravanaPandian, Vikas publishers

3. Dictionary of Mechanical Engineering, GHF Nayler, Jaico Publishing House.

Modes of Evaluation: Class tests/Assignment/Tutorial Assessment/Written Examination

Examination Scheme:

Components	Quizzes/Tests, Assignments	Lab Evaluation	ESE
Weightage (%)	35	35	30

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/ CO	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
CO 1	1	-	1	-	-	-	1	-	-	-	-	-	-	-
CO 2	1	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	3	-	-	-	2	-	-	2	-	-
CO 4	1	-	-	-	2	-	-	-	-	-	-	-	-	-
Average	1	-	1	-	2.5	-	1	-	2	-	-	2	-	-

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

CHEM 1011	Chemistry	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure	12th level Chemistry				
Co-requisites	--				

Course Objectives

Objectives of the course are:

1. To make students familiar with the fundamental concepts of chemistry.
2. To make the students understand the various basic chemical reactions, related calculations and reasoning.
3. To prepare the students for studying advanced subjects with required knowledge of chemistry.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Explain the basic concepts of chemistry w.r.t thermochemical reactions, reaction dynamics, organic reaction, electrolysis, electrochemical reactions, polymers and Nanomaterials

CO2. Explain preparation, properties, mechanism and case-based reasoning in various chemical reactions and compounds/materials

CO3. Apply the concepts of chemistry in reaction dynamics, corrosion related problems and selecting suitable fuel for various domestic/industrial applications

CO4. Analyse the results of various analytical/chemical procedures

Catalogue Description

Chemistry is present everywhere around us. It is existing in everything we see, feel or imagine. It is one of the very fundamental basics behind every structure, building, bridge, refinery and industry. In this course, focus will be on firming the basic knowledge of students about chemistry. Students will learn how to use the concepts correctly through prescribed syllabus. They will be taught various types of fuels. Different processes used to improve the quality of fuels in refineries will also be discussed. Combustion calculations related to oxygen or air required will help them to get an effective fuel: O_2 ratio to result in proper and complete combustion. Kinetics will help them to understand the mechanism of reaction. This knowledge will make them able to control the factors to move the reaction in desired direction. Corrosion is based on electrochemical cells. For any engineer, it is quite mandatory to have an understanding to select the suitable metal and the methods to protect it from decaying. They will also be discussed about various types of polymers and nanomaterials so that they can correlate their properties to their various application areas. Course delivery will be made by classroom teaching, Blackboard, presentations, videos and tutorial classes.

Course Content

Unit I: Fuels & Thermochemistry **08 lecture hours**

Prerequisite: Enthalpy of formation, Enthalpy of neutralization and Enthalpy of combustion, Hess's law of constant heat summation and its application, bond energy

Contents: Kirchoff's equation, Fuels - Introduction, Classification and Characteristics, Important properties of a good fuels, Distillation of crude oil and petroleum composition, Important reactions for petroleum industries (isomerization, dimerization, aromatization, cracking), Calorific value, Determination of calorific value by Bomb calorimeter and Boys gas calorimeter, Combustion and its calculations, Flue gas calculations, Analysis of coal- proximate, Ultimate analysis, Octane number, cetane number

Unit II: Reaction Dynamics **09 lecture hours**

Prerequisite: Rate of reaction and rate constant, factors affecting rate of a reaction, order and molecularity of a reaction, Rate expression for zero and first order

Contents: Second (2A & A+B) and third (3A) order reaction, Methods of determining order of a reaction, Effect of temperature on reaction rate, Steady state approximation, Concept of activation energy and energy barrier, Collision theory, Kinetics of complex reactions- reversible, parallel, consecutive and chain reaction, Equilibrium and rate of reaction, Kinetics of polymerization reactions (step growth, chain growth, cationic, anionic and free radical polymerization)

Unit III: Electrochemistry and Corrosion **07 lecture hours**

Prerequisite: Galvanic cell, Single electrode potential, Nernst equation, ECS and its applications

Contents: Conductance and its types, Variation of conductance with dilution, Transport number (determination by Hittorf method & moving boundary method and application in batteries), application of electrochemistry in corrosion (Introduction, dry theory, Wet theory, acid theory, types, Factors, prevention)

Unit IV: Organic Chemistry **09 lecture hours**

Prerequisite: Inductive effect, Electromeric effect, Resonance and Hyperconjugation, Types of fission, Reactive intermediates Carbonium ion, Carbanions, Free radicals

Contents: Types of organic reactions, Aliphatic nucleophilic substitution-SN1 and SN2, stereochemistry, Electrophilic substitution with energy profile- Halogenation, Nitration, sulphonation and Friedel craft reaction (comparison also), Addition reactions – electrophilic and nucleophilic, Elimination- E1 and E2, Elimination vs. substitution, mechanism of isomerization, Wolf-Kischner reduction and Clemmenson reduction, Fischer Trophs Synthesis.

Unit V: Polymers **07 lecture hours**

Prerequisite: Introduction

Contents: History, Classification, Physical properties, Types of polymerization, Copolymers, mechanism of polymerization (cationic, anionic and free radical), vulcanization, average molecular weight of polymers (end group analysis and osmotic pressure), biopolymers, conducting polymers, Polymeric electrolyte plastic hazards, plastic used in daily life applications

Unit VI: Nanomaterials **05 lecture hours**

Contents: Introduction, Methods of preparation, Effect on important properties, Application areas, BET Surface area, XRD

Text Books

1. Bapna, Renu, Engineering Chemistry - New Delhi MacMillan 2010 – 431, ISBN:0230330762.
2. Text book of Engineering Chemistry, By: Chawla, Shashi, **BookPublisher: Delhi:** Dhanpat Rai, **2014. ISBN 13: 123456755036.**
3. Engineering Chemistry, By: Krishnamoorty, P, Publisher: New Delhi: McGraw Hill, 2012, Edition: 1.ISBN: 9780071328753.

Reference Books

1. Encyclopedic dictionary of organic chemistry, By Milton, Jules K., Publisher: New Delhi Pentagon Press 2004 Description: 208p. ISBN: 818274167--X; 9788182741676.
2. Crude oil chemistry, By: Simanzhenkov, Vasily, **BookPublisher: New York:** Marcel Dekker, **2003 Description: 409p.ISBN: 082474098.**
3. Atkins' physical chemistry, By: Atkins, Peter, Paula, Julio De, BookPublisher: New Delhi Oxford University Press 2014, Edition: 10th. ISBN: 9780198728726; 0198728727.
4. Essentials of Physical Chemistry by Bahl & Tuli, Publisher: S.Chand & Co., ISBN 13: 978-8121929783.
5. Organic Chemistry for engineers, By: Mallick, Abhijit, Book Publisher: New Delhi: Viva Books, 2012, ISBN: 9788130920580.

Modes of Evaluation: Quiz/Assignment/ Common Class Tests/ Tutorial classes/ Written Examination

Scheme:

Components	**MSE I**	**IA (30)**		**ESE**
		CCTs	**Tutorials/Assignment/ etc.**	
Weightage (%)	**20**	**15**	**15**	**50**

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	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
CO1	3	2	-	-	-	-	1	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	1	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	1	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	1	-	-	-	-	-	-	-
Average	3	2	-	-	-	-	1	-	-	-	-	-	-	-

1=Weakly mapped 2=Moderately mapped 3=Strongly mapped

MATH 1027	Engineering Mathematics II	L	T	P	C
		3	1	0	4
Pre-requisites/Exposure	Mathematics up to B. Tech 1st semester.				
Co-requisites	--				

Course Objectives

1. To help the students to solve the differential equations.
2. To enable the students to understand the basic concepts of Laplace transforms
3. To enable the students to understand the basic knowledge of vector calculus.
4. To make the students to develop the basic knowledge of probability and statistics.

Course Outcomes

On completion of this course, the students will be able to

CO1. Solve the linear ordinary differential equations.

CO2. Apply Laplace transform for the solution of linear ordinary differential equations and understand the basic properties of Fourier transform.

CO3. Apply vector calculus techniques to evaluate line, surface and volume integrals.

CO4. Interpret the engineering and scientific data using fundamental statistical techniques.

Catalog Description

Mathematics is necessary subject to a clear and complete understanding of virtually all phenomena. Its precision, depth, and generality support the development of critical thinking and problem-solving skills. This course provides a detailed knowledge of various methods to solve ordinary differential equations of constant as well as variable coefficients. This course also introduces the study of Laplace transform of various important functions. The students will also get insight into the solutions of boundary value problems using Laplace transform. In addition, this course will introduce the calculus of vector-valued

functions. The evaluation of line, surface and volume integrals has also been given in this course. The students will also get the basic knowledge of probability and statistics, which is useful in engineering.

Course Content

Unit I: Ordinary Differential Equations **14 lecture hours**

Linear Differential Equations with Constant Coefficients, Cauchy-Euler Differential Equations, Solution of Second Order Differential Equations (when a part of complementary function is known, by reduction to Normal Form, by changing the independent Variable and by Variation of Parameters)

Unit II: Integral Transform **16 lecture hours**

Laplace Transform, Unit Step Function and Dirac-Delta Function, Periodic Functions, Differentiation and Integration of Laplace Transform, Inverse Laplace Transform, Convolution Theorem, and Solution of Linear Differential Equations, Fourier Transform.

Unit III: Vectors **13 lecture hours**

Differentiation of vector valued functions and applications, Gradient, Divergence, Curl, and Integration of vector valued functions: Line, Surface and Volume Integrals, Applications of Green's, Gauss divergence and Stokes Theorems.

Unit IV: Statistics **17 lecture hours**

Random Variable: Discrete and Continuous, Probability mass and Probability density Functions, Moments, Skewness and Kurtosis, Moment Generating Functions and their properties, Binomial, Poisson and Normal Distributions, Correlation: Karl-Pearson coefficient and Spearman Brown's Rank correlation, Linear Regression and Chi Square Test.

Text Books

1. J R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publications. ISBN: 9788184875607.
2. E. Kreyszig, Advanced Engineering Mathematics, Wiley Publications. ISBN: 9788126531356.
3. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill. ISBN: 9780071070089.

Reference Books

1. J. Stewart, Essential Calculus: Early Transcendentals, Cengage Learning India Pvt. Ltd. ISBN: 8131503453.

2. A. Jeffery, Advanced Engineering Mathematics, Academic Press, ISBN: 9780080522968.

3. M. D. Greenberg, Advanced Engineering Mathematics, Pearson Education, India. ISBN: 9788177585469.

Modes of Evaluation: Class tests/Assignment/Tutorial Assessment/Written Examination

Examination Scheme:

Components	**Tutorial/Faculty Assessment**	**Class Tests**	**MSE**	**ESE**
Weightage (%)	**15**	**15**	**20**	**50**

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	2	-	-	-	-	-	-	-	-	-
Average	3	2	-	-	2	-	-	-	-	-	-	-	-	-

1=weakly mapped 2= Moderately mapped 3=Strongly mapped

MECH1004	Engineering Graphics	L	T	P	C
		1	0	2	2
Pre-requisites/Exposure	The knowledge of simple geometrical theorem and procedures is essential.				
Co-requisites	--				

Course Objectives:

1. Introduction to engineering design and its place in society.
2. Exposure to the visual aspects of engineering design.
3. Exposure to engineering graphics standards.
4. Exposure to solid modelling.
5. Exposure to computer-aided geometric design.
6. Exposure to creating working drawings.
7. Exposure to engineering communication.

Course Outcomes:

At the end of this course student should be able to

CO1: Remember the conventions of engineering graphics such as types of lines, dimensioning, method of projection etc.

CO2: Demonstrate understanding of fundamental concepts of engineering graphics.

CO3: Apply knowledge of orthographic and isometric projections to solve problems related to points, lines, planes and solids.

CO4: Develop and model basic mechanical components.

Catalog Description:

Engineering graphics builds the foundation of analytical capabilities for solving a great variety of engineering problems involving diagrams. It also has numerous real time application in almost all branches of engineering. This subject helps the student to enhance their knowledge, imagination and drawing skill. The purpose of the study of the engineering graphics is to develop the ability to visualize an object with physical and dimensional configurations. With its extensive coverage, the step-by-step approach and handy drawing tips. The subject support for students to draw the accurate and precise line drawing.

Course Content

UNIT I: INTRODUCTION OF ENGINEERING DRAWING, LINES, and LETTERING AND DIMENSIONING 01 lecture hours

Introduction, Drawing instruments, Drawing sheet, pencils, Sheet layout, Title Block, Configurations of lines, drafting of lines, Types of lines and their applications, Order of priority of coinciding lines, Lettering, Dimensioning, terminology and method of execution, placing and general rule of dimensioning.

UNIT II: ORTHOGRAPHIC PROJECTIONS 01 lecture hours

Projection, Pictorial view and Multi view, Orthographic Projection, Multi View Projection, Terminologies, First-Angle Projection, Third angle Projection, Second angle and Fourth angle Projection, Symbols of Orthographic Projection

UNIT III: PROJECTION OF POINT 01 lecture hours

Introduction, Conventional Representation, A point situated in first quadrant (above HP and in front of VP), A point situated in second quadrant (above HP and behind VP), Point in the third quadrant (below HP and behind VP), Point in the Fourth quadrant (below HP and in front of VP). Problems

UNIT IV: PROJECTION OF LINES 02 lecture hours

Orientations of straight lines, lines parallel to one or both the planes, line contained by one or both the planes, Line perpendicular to either of the RPs, line inclined to one RP and parallel to other, line inclined to both the RPs, Traces of a line, Methods of determining traces of line.

UNIT V: PROJECTION OF PLANES **02 lecture hours**

Introduction, Position of Planes, Terms used in projection of planes, Planes parallel to an RP, Plane inclined to one RP and perpendicular to the other RP, plane perpendicular to both the RPs, Plane inclined to both the RPs, Suspended planes, Traces of planes,

UNIT VI: PROJECTION OF SOLIDS **02 lecture hours**

Introduction, Basic solids, Frustums and Truncated Solids, position of the solids, solids with Axis perpendicular to an RP, Solid with Axis inclined to one RP and parallel to the other, solid with axis inclined to both the RPs, solid with axis parallel to both the RPs, Rules for deciding the Hidden Lines

UNIT VII: SECTION OF SOLIDS **02 lecture hours**

Section planes, Sections, True shape of a section, Section of prisms: section plane parallel to VP, Section plane parallel to the HP, Section plane perpendicular to HP and inclined to the VP, Section plane perpendicular to the VP and inclined to the HP. Sections of Pyramids, Sections of cylinders, sections of cones etc.

UNIT VIII: ISOMETRIC PROJECTION **01 lecture hour**

Introduction, Principle of Isometric Projection, Terminology, Isometric Scale, Isometric Projections and Isometric Views.

List of Exercises:

S.No.	Exercise no.	Content
1	Exercise-1	Introduction to CATIA and user interface
2	Exercise-2	Introduction to engineering Graphics, sheet layout and sketching.
3	Exercise-3	Drawing of Lines, Lettering.
4	Exercise-4	Dimensioning
5	Exercise-5	Projection of points situated in 1st, 2nd, 3rd and 4th quadrant

6	Exercise-6	Projection of Line parallel to one or both the planes, line perpendicular to one plane and parallel to other
7	Exercise-7	Line inclined to one of the planes
8	Exercise-8	Line inclined to both the planes
9	Exercise-9	Line inclined to both the planes
10	Exercise-10	Projection of planes parallel to one of the references
11	Exercise-11	Projections of planes inclined to one of the reference plane and perpendicular to the other
12	Exercise-12	Projections of planes inclined to one of the reference plane and perpendicular to the other
13	Exercise-13	Introduction and types of solid, Projections of solids, Projections of solids in simple positions.
14	Exercise-14	Projections of solids Inclined to one plane.
15	Exercise-15	Projections of solids Inclined to one planes.
16	Exercise-16	Section of Prisms, Pyramids
17	Exercise-17	Section of Cylinder, Cones
18	Exercise-18	Introduction of isometric axes, lines and planes.
19	Exercise-19	Isometric drawing of different objects
20	Exercise-20	Isometric drawing of different objects
21	Exercise-21	Methods of development, Developments of lateral surfaces
22	Exercise-22	Methods of development, Developments of lateral surfaces
23	Exercise-23	Principle of perspective projections
24	Exercise-24	Principle of perspective projections

Text Books

1. Bhatt, N. D. (2014) *"Engineering Drawing"*, Charol Publication
2. Gill, P. S. (2009) *"Engineering Drawing"*, Kataria Publication
3. Dhawan, R. K. (2011) *"Engineering Drawing"*, S Chand

Reference Books

1. Morling, K. *"Geometric and Engineering Drawing"*, Third Edition, Elsevier 32 Jamestown Road London NW1 7BY 30 Corporate Drive, Suite 400, Burlington, MA 01803, USA

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	Lab	End Sem	Total
Weightage (%)	35	35	30	100

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	-	-	-	-	2	-	1	-	3
CO2	3	3	3	2	3	-	-	-	-	2	-	1	-	3
CO3	3	3	3	2	3	-	-	1	-	2	-	1	-	3
CO4	3	3	3	2	3	-	-	1	2	2	-	1	-	3
Average	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**1**	**2**	**2**	**-**	**1**	**-**	**3**

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

2022-26

MECH 2019	Engineering Mechanics	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure					
Co-requisites					

Course objectives:

1. Confidently tackle equilibrium equations, moments and inertia problems.
2. Master calculator/computing basic skills to use to advantage in solving mechanics problems.
3. Gain a firm foundation in Engineering Mechanics for furthering the career in Engineering

Course outcomes:

On completion of this course, the students will be able to

CO1. Understand the basic concepts of statics and dynamics of rigid bodies.
CO2. Apply the concepts of Engineering Mechanics in solving Engineering problems.
CO3. Analyze forces, motion, work and energy problems and their relationship to engineering applications.

Course description:

The course covers the fundamental background in the statics and dynamics of rigid bodies, with a special emphasis on ***applications of laws of rigid body mechanics***, as relevant to engineering sciences in general and automotive engineering in particular. The course begins with a description of basic laws of mechanics, resultant of system of forces and equilibrium of system. The aim is to develop in the engineering student the ability to analyze any problem in a simple and logical manner and to apply to its solution a few, well understood, basic principles. The application of concepts of mechanics further is elaborated in analysis of pinned joint structure and dynamics of bodies. Students will learn to understand the concepts of dealing problems with friction like belt, wedge and ladder friction. The understanding of center of gravity and moment of inertia and its calculations are also explored in this course. Further, being a rigorous course on problem-solving, it will acquaint students with engineering problem-solving approaches and the effective use of commercial software packages to answer engineering questions.

Course content:

Unit 1 Introduction to Engineering Mechanics

Force Systems, Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and

Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy

Unit 2 Friction

Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack;

Unit 3 Basic Structural Analysis

Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines;

Unit 4 Centroid and Centre of Gravity

Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

Unit 5 Virtual Work and Energy Method

Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

Unit 6 Review of particle dynamics

Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).

Unit 7 Introduction to Kinetics of Rigid Bodies

Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation;

Unit 8 Mechanical Vibrations covering

Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums;

Suggested Text/Reference Books:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R. C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson

Education

7. Reddy Vijaykumar K. and K. Suresh Kumar (2010), Singer's Engineering Mechanics
8. Bansal R.K. (2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	3	3	2	-	3	-	-	3	-	-	2	-	2	-
CO2	3	3	2	-	3	-	-	3	-	-	2	-	2	-
CO3	3	3	2	-	3	-	-	3	-	-	2	-	2	-
Average	3	3	2	-	3	-	-	2	-	-	2	-	2	-

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

SEMESTER III

B. Tech- Mechanical Engineering

UNIVERSITY OF PETROLEUM & ENERGY STUDIES

2022-26

MEPD 2006	**Thermodynamics and Heat Engines**	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure	Basic knowledge of physics and mathematics				
Co-requisites					

Course objectives:

1. Help the students to understand the fundamentals and relevance of thermodynamics in thebroader context of engineering sciences
2. Able to use the laws of thermodynamics to estimate the potential for thermo-mechanical energyconversion and their application.
3. Empower the students with the knowledge of fundamental concepts that is required to translatea novel engineering idea to reality through thermodynamic relations and power cycles.
4. To expose students to a wide variety of research areas and concerns in and around thermodynamics

Course outcomes:

CO1. Comprehend the thermodynamic systems, properties and laws of thermodynamics.CO2. Apply laws of thermodynamics to flow and non-flow processes.

CO3. Analyze the performance of various thermodynamic systems and cycles.CO4. Evaluate various thermodynamic systems.

Course description:

Thermodynamics are important in many scientific and technological problems and can be applied to any discipline, technology, applications or the processes. Thermodynamic is used to understand many energy exchanges accompanying a wide range of mechanical and chemical processes. In thermodynamic we study mainly interactions between the thermodynamic system and surroundingin the form of heat and work. Due to interaction between system and surrounding properties of thesystem will change and we can study all qualitative and quantitative changes within the system by laws of thermodynamics.

Course content:

Unit 1	**Introduction: Thermodynamics**	**5 Lectures**
Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work		
Unit 2	**Energy conversion and energy analysis**	**3 Lectures**

Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy		
Unit 3	**Pure Substances**	**9 Lectures**
Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steamtables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.		
Unit 4	**First law of thermodynamics for flow processes**	**9 Lectures**
First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.		
Unit 5	**Heat Engine, Entropy and Second Law of Thermodynamics**	**13 Lectures**
Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale; Clausius inequality; Definitionof entropy; Demonstration that entropy 'S' is a property; evaluation of entropy for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in T-s coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis		
Unit 7	**Power Cycle**	**6 Lectures**
Power Cycle- Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.		

Suggested Text/Reference Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, *Fundamentals of Thermodynamics*, John Wiley and Sons.

2. Jones, J. B. and Duggan, R. E., 1996, *Engineering Thermodynamics*, Prentice-Hall ofIndia

3. Moran, M. J. and Shapiro, H. N., 1999, *Fundamentals of Engineering Thermodynamics*,John Wiley and Sons.
4. Nag, P.K, 1995, *Engineering Thermodynamics*, Tata McGraw-Hill Publishing Co. Ltd.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written ExaminationExamination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs /Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	2	-	-	-	-	1	3	-	-
CO2	3	3	1	-	-	-		-	-	-	-	1	3	-	-
CO3	3	3	2	1	-	-		-	-	-	-	1	3	-	-
CO4	3	3	2	3	2	-	2	-	-	-	-	1	3	-	-
Avg.	**3**	**2.7**	**1.6**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**

1=weakly mapped 2= moderately mapped 3=strongly mapped

2022-26

MEMA 2003	Materials Science	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure					
Co-requisites					

Course objectives:

1. Understanding correlation between the internal structure of materials, their mechanical properties, and various methods to quantify their mechanical integrity and failure criteria.

2. Providing a detailed interpretation of equilibrium phase diagrams.

3. Understanding different phases and heat treatment methods to control the properties of steels.

Course outcomes:

CO1. Demonstrate the understanding of structure and properties of engineering materials.

CO2. Apply the basic concepts of crystallography and phase diagrams to analyse structure and properties of various alloy systems

CO3. Apply the concepts of phase transformation and heat treatment for optimizing the properties of steels.

CO4. Understand and evaluate the applications of various ferrous and non-ferrous engineering materials based upon their properties.

Course description:

Materials from the basic building block of any engineering system and find application in every industrial environment viz. automotive, aerospace, manufacturing, chemical, construction etc. In different applications, materials experience a variety of environment like heat, stress, moisture, chemicals, radiation, etc, and thus it is imperative to study the behavior of a material when exposed to these environments. Students will be expected to develop a basic understanding of different types of engineering materials along with their structures and properties. This course would also develop upon how these properties are measured and how they can be modified through phase transformations using heat treatment.

Course content:

Unit 1 **6 Lectures**

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems critically resolved shear stress.

Unit 2 **6 Lectures**

Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength.

Unit 3 **6 Lectures**

Static failure theories: Ductile and brittle failure mechanisms, Tresca's, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Introduction to non-destructive testing (NDT)

Unit 4 **6 Lectures**

Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of leduburite, austenite, ferrite, and cementite, cast iron

Unit 5 **6 Lectures**

Heat treatment of Steel: Nucleation and Growth, Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

Unit 6 **6 Lectures**

Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys

Suggested Text/Reference Books:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.

2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.

3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.

4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	2	2	2	2	1	-
CO2	3	2	2	1	1	-	-	-	2	2	2	2	1	-
CO3	3	2	3	2	1	-	-	-	2	2	2	2	1	-
C04	3	2	2	2	1	1	1	-	3	2	2	2	1	-
Avg.	3	1.75	2	1.25	0.75	0.25	0.25	-	2.25	2	2	2	1	-

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

MECH 2107	Fluid Mechanics Lab	L	T	P	C
		0	0	2	1
Pre-requisites/Exposure	Fluid mechanics				
Co-requisites	--				

Course Objectives

1. To help the students understand the fundamentals and relevance of fluid mechanics in the broader context of engineering sciences in general, and automotive engineering in particular
2. To enable students to understand fluid properties and apply laws of fluid mechanics and analyse fluid flows through different configurations along with the measurement of flow parameters.
3. To empower students with the expertise of experimentation, simulation and the fundamental concepts that are required to translate a novel engineering idea to reality through dimensional analysis and similitude.
4. To expose students to a wide variety of research areas and concerns in and around fluid mechanics such as energy, health etc. across multidisciplinary domains.
5. To equip students with necessary engineering skills such as solving engineering problems in a professional way, using commercial software packages such as MATLAB for data analysis and presentation, numerical simulations etc.

Course Outcomes

On completion of this course, the students will be able to

CO1 Understand the objective of the experiment and experimental set-up/procedure

CO2 Compute the results of the experiments based on different process parameters obtained during the experimentation.

CO3 Analyze the data obtained during experiments of fluid mechanics experiments

Catalog Description

Fluid flows are important in many scientific and technological problems including automotive design, atmospheric and oceanic circulation, renewable energy generation, and energy production by chemical or nuclear combustion in engines and stars, energy utilization in vehicles, buildings and industrial processes, and biological processes such as the flow of blood. The highly

multidisciplinary nature of the subject can be gauged from the fact that it is taught across multiple disciplines ranging from Mechanical, Aerospace, Civil, and Chemical to Environmental Engineering. The current course covers the fundamental background in the statics and dynamics of fluids, with a special emphasis on applications of fluid mechanics, as relevant to engineering sciences in general and automotive engineering in particular. The course begins with a description of different fluid properties and covers the basic conservation laws of mass, momentum and energy. The students will learn the fundamental laws of fluid dynamics and then apply it to two distinct type of flows commonly found in real life: internal
flows and external flows. The students will thus get an adequate exposure to internal flows such as pipe flows in industry, or external flows viz. flow over an aircraft wing. The student will also learn the art of engineering approximations, and the fundamental concepts of dimensional analysis, similitude and experimentation, that are involved in translating a novel idea to a real-world application. Further, being a rigorous course on problem-solving, it will acquaint students with engineering problem solving approaches and the effective use of commercial software packages to answer engineering questions.

List of Experiments

Exp. 1	To verify the Bernoulli's theorem experimentally	CO's
Exp.2	Viscosity measurement using Stokes theorem	CO1-3
Exp. 3	Study the laminar and turbulent flow in pipes in Reynold's apparatus	CO1-3
Exp. 4	Calculated the center of pressure by experiment and comparison with theoretical value	CO1-3
Exp. 5	Determination of discharge co-efficient for V-notch and rectangular notch	CO1-3
Exp. 6	To calibrate a Venturimeter and Orifice meter to study the variation of coefficient of discharge with the Reynolds number.	CO1-3
Exp. 7	To study the variation of friction factor, 'f' for turbulent flow in rough and smooth commercial pipes.	CO1-3
Exp. 8	To determine the minor head loss coefficient for different pipe fittings.	CO1-3
Exp 9	To determine the coefficient of discharge Cd, coefficient of velocity Cv and coefficient of contraction Cc for various types of orifice and mouthpieces.	CO1-3
Exp 10	To verify Darcy's law and to find out the coefficient of permeability of the given medium.	CO1-3

Text Book :

1. Introduction to fluid mechanics and machinery by S K Som ,Gautam Biswas & Chakorbarty

Reference Book:

1. Fluid Mechanics and Hydraulic Machines by S.C. Gupta
2. Fluid Mechanics by Pijush K. Kundu, Ira M. Cohen and David R. Dowling kohen
3. Fluid mechanics by Frank M. White

Modes of Evaluation: continuous evaluation system

Students will be continuously evaluated based on following 2 stages.
Experiment Evaluation - 50%
viva voce / Quiz - 50%

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-			-	-				-		1	2
CO2	3	2				-					-	1	1	2
CO3	2	3											1	2
Aveg	3	2											1	2

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

UNIVERSITY OF PETROLEUM & ENERGY STUDIES

2022-26

SEMESTER IV

B. Tech- Mechanical Engineering

2022-26

MECH 3003	Heat Transfer	L	T	P	C
		3	1	0	4
Pre-requisites/Exposure	Fluid Mechanics, Thermodynamics.				
Co-requisites					

Course objectives:

1. The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
2. Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
3. The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Course outcomes:

1. Formulate and analyze a heat transfer problem involving any of the three modes of heat transfer
2. Obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical
3. Evaluate the rate of heat transfer by correlations
4. Design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.

Course description:

Heat transfer has broad applications such as automotive industry, aerospace, chemical process industry, energy, refrigeration and air-conditioning, domestic and biomedical. The current course covers fundamentals of heat and mass transfer. In term of heat transfer, three modes of heat transfer: conduction, convection and radiation. Conduction covers for planar, cylindrical and spherical geometries as well as extended surface. Convection heat transfer covers for laminar and turbulent flow regimes. Radiation heat transfer covers general characteristics of radiation as well as the properties of radiating surfaces. Types of heat exchanger and heat exchangers design. Fundamentals of mass transfer.

Course content:

Unit 1 **14 Lectures**

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one-dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts

10 Lectures

Unit 2

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.

10 Lectures

Unit 3

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method

6 Lectures

Unit 4

Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε- NTU methods

4 Lectures

Unit 5

Boiling and Condensation heat transfer, Pool boiling curve

4 Lectures

Unit 6

Introduction mass transfer, Similarity between heat and mass transfer

Suggested Text/Reference Books:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P. Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002
5. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs /COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	-	-	1	1	1	2	-
CO2	3	2	3	1	1	-	-	-	-	1	1	1	2	-
CO3	2	3	2	2	1	-	-	-	-	1	1	1	3	-
C04	3	3	3	1	1	-	-	-	-	1	1	1	3	-
Avg.	3	2.5	2.5	1.25	1	-	-	-	-	1	1	1	2.5	-

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

2022-26

MECH 2012	Strength of Materials	L	T	P	C
		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course objectives:

1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
2. To calculate the elastic deformation occurring in various simple geometries for different types of loading

Course outcomes:

CO1. Understand the basic principles of stress and strain in solid bodies.
CO2. Apply stress-strain relationships in single and compound members subjected to different types of loading such as tension, compression, shear, bending, torsion etc.
CO3. Analyze Engineering problems using basic principles of stress and strain.
CO4. Evaluate failure of structural and mechanical components under various loading conditions.

Course description:

This subject deals with the behavior of solid objects (rigid bodies as well as deformable bodies) under various loadings. The subject helps in understanding the distribution of stresses and strains under various loadings and boundary conditions. In one-dimensional and two-dimensional structures/ components there can be various types of loads acting. It can be axial forces of either type, tensile as well as compressive, shear force, bending moment, torsion or forces developed due to temperature difference. Starting with one-dimensional or two- dimensional problems, results are obtained for various conditions and then generalized for three-dimensional problems.
How do beams, columns or shafts behave under axial loads, shear loads, bending moment or torsion? This subject enables us to answer such questions. In response to various forces/ moments, these structural members/components show deformation. The deformation can be elastic as well as plastic. In case the loads are more than a certain value, the mechanical deformations become more than acceptable working values. This condition is also called the breakdown of the component/structure. In this subject, we learn how to calculate the resulting stresses due to various effects. These stresses are considered along with material properties such as modulus of elasticity, modulus of rigidity, bulk modulus, yield strength, ultimate tensile strength and Poisson's ratio. Geometrical constraints like notches, holes, sharp corners etc. also play an important role in failure of a component. Depending on the nature of material, appropriate failure criterion is selected and the values of forces can be calculated for which the component fails.

Course content:

Unit 1 **10 Lectures**

Deformation in solids, Hooke's law, Stress and strain - tension, compression and shear stresses, Thermal, Elastic constants and their relations- volumetric, linear and shear strains, Principal stresses and principal planes- Mohr's circle.

Unit 2 **9 Lectures**

Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Moment of inertia about an axis.

Unit 3 **9 Lectures**

Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads, Deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems

Unit 4 **9 Lectures**

Polar moment of inertia, Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.

Unit 5 **8 Lectures**

Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure

Suggested Text/Reference Books:

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata McGraw Hill Publishing Co. Ltd., New Delhi 2005.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs /COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	2	-	-	-	-	1	-	-
CO2	3	3	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	3	2	1	-	-	-	-	-	-	-	1	3	-
CO4	3	3	2	3	2	-	2	-	-	-	-	1	3	-
Average	3.00	2.75	1.67	2.00	2.00	-	2.00	-	-	-	-	1.00	2.67	-

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

MEMA 2102	Material Science & Material Testing lab	L	T	P	C
		0	0	2	1
Pre-requisites/Exposure	Knowledge of mechanics of materials and material science				
Co-requisites					

Course Objectives

1. Exposure on experimental methods to determine the various mechanical properties of engineering materials.
2. Exposure on experimental methods for characterization of various ferrous and nonferrous materials.
3. To gain experience to advanced computerized machines in material testing and material science lab.

Course Outcomes

CO1: Interpret and quantitatively determine the basic mechanical properties using tensile, compression, shear, torsion and impact tests.
CO2: Compare different scales of hardness through Rockwell, Brinell and Vickers's tests.
CO3: Determine the physical properties of a helical spring.
CO4: Characterize the composition and microstructures of different ferrous and non-ferrous metals.

Catalog Description

This lab deals with the testing of various engineering materials under various loadings. Basic tests like tension, compression, shear, torsion, impact are done to establish the mechanical properties. Other tests include spring test and hardness tests on different machines. The main goal is to understand the behavior of materials and the failure criterions. The second phase of the lab is focused on material characterization. Various ferrous and non-ferrous materials will be taken to experiment on microstructure.

List of Experiments

Exp. 1	To find the Rockwell and Brinell hardness of the given specimen using hardness testing machines.	CO2
Exp. 2	To find the Spring Constant and Modulus of Rigidity of a given spring using Spring Testing Machine.	CO3
Exp. 3	To determine tensile properties through Tensile test on a UTM.	CO1
Exp. 4	To conduct Torsion test on Mild steel or cast-iron specimen to find out modulus of rigidity	CO1

Exp. 5	To Conduct the Izod Impact test on Impact testing machine and find the impact strength and modulus of rupture of a given specimen.	CO1
Exp. 6	To determine impact strength and modulus of rupture using Charpy Impact test.	CO1
Exp. 7	To analyze the performance of given specimen by shear test on UTM	CO1
Exp. 8	To conduct the compression test on a UTM and determine the ultimate compressive strength for a given specimen (C.I, Brick, wooden)	CO1
Exp. 9	To characterize the microstructure of plain carbon steel/CI/MS (ferrous metals)	CO4
Exp. 10	To characterize the microstructure of non-ferrous metals like Cu/Brass/Al.	CO4
Exp. 11	To the chemical composition of metal alloy systems using optical emission spectroscopy.	CO4
Exp. 12	To find the Vickers hardness of the given specimen using Micro Vickers hardness testing machine.	CO2

Text Books / **Reference Books**

1. An Introduction to Materials Engineering and Science by Brain S. Mitchel
2. Material Science and Engineering Hand Book by James F Shackelford
3. Mechanical Behaviour of Materials by Thomas Courteny
4. Strength of Materials by U C Jindal

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Lab will run in continuous evaluation mode

Experiment evaluation	50%
Viva-Voice/Test	50%

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-	1	-

1 = Weakly mapped, 2 = Moderately mapped, 3 = Strongly mapped

UNIVERSITY OF PETROLEUM & ENERGY STUDIES

2022-26

SEMESTER V

B. Tech- Mechanical Engineering

2022-26

MEPD3010	Manufacturing Technology	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure	Workshop Technology, Engineering Mathematics				
Co-requisites					

Course objectives:

1. To help the students understand the fundamentals and relevance of manufacturing processes in the broader context of engineering sciences.
2. To apply basic mathematical tools for analytical solution of manufacturing problems.
3. To empower students with the expertise of experimentation, prototyping and the fundamental concepts that are required to ensure quality products in primary manufacturing operations.
4. To expose students to a wide variety of research areas and concerns in and around advanced manufacturing techniques across multidisciplinary domains.
5. To equip students with necessary engineering skills such as solving engineering problems in a professional way, using commercial software packages for casting simulation and weldment design.

Course outcomes:

CO1. Understand principles of different manufacturing processes such as metal casting, welding, machining, non-traditional machining etc.

CO2. Solve problems related to gating system design, metal cutting, welding process parameters, rapid prototyping, CNC technology and non-traditional machining processes.

CO3. Analyze various manufacturing processes based upon their controlling parameters and effects.

CO4: Create and assemble prototypes/models using various manufacturing processes.

Course description:

Manufacturing technology provides the productive tools that power a growing, stable economy and a rising standard of living. These tools create the means to provide an effective national defence. They make possible modern communications, affordable agricultural products, efficient transportation, innovative medical procedures, space exploration and the everyday conveniences we take for granted.

Production tools include machine tools and other related equipment and their accessories and tooling. Machine tools are non-portable, power-driven manufacturing machinery and systems used to perform specific operations on man-made materials to produce durable goods or components. Related technologies include Computer Aided Design, Rapid Prototyping and Powder Metallurgy (P/M) as well as assembly and test systems to create a final product or sub-assembly.

Course content:

Conventional Manufacturing Processes

Unit 1 **5 Lectures**

Casting and molding: Metal casting processes and equipment, Heat transfer and solidification, shrinkage, riser design, casting defects and residual stresses.

Unit 2 **5 Lectures**

Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming (forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy

Unit 3 **9 Lectures**

Metal cutting: Single and multi-point cutting; Orthogonal cutting, various force components: Chip formation, Tool wear and tool life, Surface finish and integrity, Machinability, cutting tool materials, cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining

Unit 4 **3 Lectures**

Additive manufacturing: Rapid prototyping and rapid tooling

Unit 5 **5 Lectures**

Joining/fastening processes: Physics of welding, brazing and soldering; design considerations in welding, Solid and liquid state joining processes; Adhesive bonding

Unit 6 Unconventional Manufacturing Processes **3 Lectures**

Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters

Unit 7 **3 Lectures**

Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant &maskant, process parameters, MRR and surface finish

Unit 8 **3 Lectures**

Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining

Suggested Text/Reference Books:

1. Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition)- Pearson India, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems.
3. Degarmo, Black & Kohser, Materials and Processes in Manufacturing
4. Gary F. Benedict, Non-traditional Manufacturing Processes, CRC press, 1987

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs /COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2	1	3	-	-	-	-	2	2	2	3	1
CO3	3	3	2	1	2	-	1	-	-	2	2	2	3	1
CO4	3	3	2	-	2	-	-	-	-	1	2	2	3	1
Avg.	3	3	2	1	2		1			2	2	2	3	1

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

2022-26

MECH 2006	Theory of Machines	L	T	P	C
		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course objectives:

1. To understand the kinematics and rigid- body dynamics of kinematically driven machine components.
2. To understand the motion of linked mechanisms in terms of the displacement, velocity and acceleration at any point in a rigid link.
3. To be able to design some linkage mechanisms and systems to generate specified output motion.
4. To understand the kinematics of gear trains

Course outcomes:

CO1. Understand the kinematics and dynamics of different mechanisms and drives.
CO2. Apply the concepts of position, velocity and acceleration analyses for various mechanisms.
CO3. Analyze problems related to kinematic behavior and dynamic behavior of drives, mechanisms and machines.
CO4. Evaluate the characteristics of various drives.

Course description:

Mechanisms have considerable fascination for most students of engineering as the theoretical principles involved have immediate applications to practical problems. The main objective of this course is to give a clear understanding of the concepts underlying engineering design. The course involves the kinematics and dynamics of machines. The focus is to empower the students with the theoretical and practical knowledge of mechanisms and machines to enable them to solve complex engineering problems.

Course content:

Unit 1 **10 Lectures**

Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashoff's law, Kinematic inversions of four bar chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker Mechanisms

Unit 2 **9 Lectures**

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coincident points- Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.

Unit 3 **8 Lectures**

Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers

Unit 4 **12 Lectures**

Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics

Unit 5 **9 Lectures**

Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes

Suggested Text/Reference Books:

1. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2005.
2. Cleghorn W. L., Mechanisms of Machines, Oxford University Press, 2005.
3. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill, 2009.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi, 1988.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					1	-	-
CO2	3	3	1									1	2	-
CO3	3	3	2	1								1	3	-
C04	3	3	2	3	2		2					1	3	-
Avg.	3.00	2.8	1.7	2	2		2					1	2.7	

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

2022-26

PROJ 3108	Project -1	L	T	P	C
		0	0	0	1
Pre-requisites/Exposure					
Co-requisites					

Course Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Course Outcomes:

1. To find state of the art and research gaps, and effectively communicate scientific results through presentations and report writing.
2. Apply knowledge of engineering and management principles to manage projects in multidisciplinary areas, think laterally and connect the dots from different areas with focus on industrial, social and environmental context.
3. To create new systems or innovate on existing engineering systems and make it better suited to emerging needs of society.
4. To work in teams with complementary functions to take the project to a logical and more holistic conclusions.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs /Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	-	2	1	2	-	2	1	2	-	-	-	2
CO2	2	-	2	2	2	2	1	-	1	1	3	1	3	2
CO3	1	-	3	1	2	1	3	-	1	1	1	1	2	2
C04	-	-	2	-	-	-	2	-	1	-	-	-	1	2
Avg.	1.3	3	2.3	1.7	1.7	1.7	2	2	1	1.3	2	1	2	2

1=Weakly mapped 2= Moderately ma

UNIVERSITY OF PETROLEUM & ENERGY STUDIES

2022-26

SEMESTER VI

B. Tech- Mechanical Engineering

MECH 3001	Design of Machine Elements	L	T	P	C
		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course objectives:

This course seeks to introduce the design of machine elements commonly encountered in mechanical engineering practice, through

1. A strong background in mechanics of materials-based failure criteria underpinning the safety- critical design of machine components.
2. An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations.
3. An overview of codes, standards and design guidelines for different elements.
4. An appreciation of parameter optimization and design iteration
5. An appreciation of the relationships between component level design and overall machine system design and performance

Course outcomes:

CO1. Understand various aspects and considerations in design of machine elements.
CO2. Design for static load & Fluctuating load.
CO3. Design of joints and power screws
CO4. Design of various power transmission elements.

Course description:

Machine design occupies a prominent position in the curriculum of Mechanical Engineering. It consists of applications of scientific principles, technical information and innovative ideas for the development of a new or improved machine. The task of a machine designer has never been easy, since he has to consider a number of factors, which are not always compatible with the present-day technology. In the context of today's technical and social climate, the designer's task has become increasingly difficult. Today's designer is required to account for many factors and considerations that are almost impossible for one individual to be thoroughly conversant with. At the same time, he cannot afford to play a role of something like that of a music director. He must have a special competence of his own and a reasonable knowledge of other 'instruments.

Course content:

Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure),

Design of shafts under static and fatigue loadings,

Analysis and design of sliding and rolling contact bearings,

Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives,

Design of springs: helical compression, tension, torsional and leaf springs,

Design of joints: threaded fasteners, pre-loaded bolts and welded joints,

Analysis and applications of power screws and couplings,

Analysis of clutches and brakes

Suggested Text/Reference Books:

1. Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
2. Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
3. Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
4. Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
5. R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs /COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					1	1	
CO2	3	3	1									1	3	1
CO3	3	3	2	1								1	3	1
C04	3	3	2	3	2		2					1	3	1
Avg	3	2.75	1.25	1	0.50	0	1	0	0	0	0	1	2.50	0.75

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

2022-26

PROJ 3109	Project -2	L	T	P	C
		0	0	0	3
Pre-requisites/Exposure					
Co-requisites					

Course Objectives:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Course Outcomes:

1. To find state of the art and research gaps, and effectively communicate scientific results through presentations and report writing.
2. Apply knowledge of engineering and management principles to manage projects in multidisciplinary areas, think laterally and connect the dots from different areas with focus on industrial, social and environmental context.
3. To create new systems or innovate on existing engineering systems and make it better suited to emerging needs of society.
4. To work in teams with complementary functions to take the project to a logical and more holistic conclusions.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs /Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	-	2	1	2	-	2	1	2	-	-	-	2
CO2	2	-	2	2	2	2	1	-	1	1	3	1	3	2
CO3	1	-	3	1	2	1	3	-	1	1	1	1	2	2
C04	-	-	2	-	-	-	2	-	1	-	-	-	1	2
Avg.	1.3	3	2.3	1.7	1.7	1.7	2	2	1	1.3	2	1	2	2

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

UNIVERSITY OF PETROLEUM & ENERGY STUDIES

2022-26

SEMESTER VII

B. Tech- Mechanical Engineering

2022-26

PROJ 4107	Project -III	L	T	P	C
		0	0	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of a mechanical device whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

Course Outcomes:

1. To find state of the art and research gaps, and effectively communicate scientific results through presentations and report writing.
2. Apply knowledge of engineering and management principles to manage projects in multidisciplinary areas, think laterally and connect the dots from different areas with focus on industrial, social and environmental context.
3. To create new systems or innovate on existing engineering systems and make it better suited to emerging needs of society.
4. To work in teams with complementary functions to take the project to a logical and more holistic conclusions.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

Os & PSOs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3	-	2	1	2	-	2	1	2	-	-	-	2
CO2	2	-	2	2	2	2	1	-	1	1	3	1	3	2
CO3	1	-	3	1	2	1	3	-	1	1	1	1	2	2
C04	-	-	2	-	-	-	2	-	1	-	-	-	1	2
Avg.	1.3	3	2.3	1.7	1.7	1.7	2	2	1	1.3	2	1	2	2

1=Weakly mapped 2= Moderately mapped 3=Strongly ma

2022-26

SIIB 4101	Summer internship	L	T	P	C
		0	0	0	2
Pre-requisites/Exposure	Basic Knowledge of mechanical engineering				
Co-requisites	--				

Course Objectives

1. To provide students the opportunity to test their interest in a particular career before permanent commitments are made.
2. To develop skills in the application of theory to practical work situations.
3. Internships will increase a student's sense of responsibility and good work habits.
4. To expose students to real work environment experience, gain knowledge in writing report in technical works/projects.
5. To build a good communication skill with group of workers and learn to learn proper behavior of corporate life in industrial sector.

Course Outcomes

CO 1: Develop good understanding about the organization and define the internship objectives.

CO 2: Apply technical knowledge and management principles

CO3: Demonstrate ethical principles and innovative way to accomplish assigned work

CO4: Illustrate presentation skills and report

CO5: Demonstrate ability to work effectively in a team and leadership skills

Catalog Description

The purpose of Industrial Training is to expose students to real work of environment experience and at the same time, to gain the knowledge through hands on observation and job execution. From the industrial training, the students will also develop skills in work ethics, communication, management and others. Moreover, this practical training program allows students to relate theoretical knowledge with its application in the manufacturing industry.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Student has to submit the internship certificate and feedback form from the organization. He has to present his work in front of specific panel made by the department after completion of the internship. Marks will be given to him on a specific annexure based on rubrics by the panel. Panel member will keep in mind about the feedback given by the industries.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1	1	1	-	1	-	-	1	1	1	3	3
CO2	2	1	-	-	2	3	2	-	-	-	-	-	3	3
CO3	1	1	1	-	1	1	2	3	-	-	2	-	-	-
CO4	-	-	-	-	-	-	-	-	1	3	2	-	3	-
CO5	-	-	-	-	-	-	-	-	3	2	3	1	-	-

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

SEMESTER VIII

B. Tech- Mechanical Engineering

2022-26

MEPD 4014	Automation in Manufacturing	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure					
Co-requisites					

Course objectives:

1. To understand the importance of automation in the of field machine tool-based manufacturing.
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics, and CNC.
3. To understand the basics of product design and the role of manufacturing automation
4. Illustrate adaptive control systems and automated inspection methods.
5. To use PLCs to apply computer control to an automation project.

Course outcomes:

1. Understand the concepts of automation, CAD, CAM and CIM, automated material handling.
2. Learn and apply the concepts of CAD/CAM, PLC's, microcontrollers etc. to automation.
3. Illustrate the concept of low cost automation into different mechanical systems.
4. Apply the concepts of modeling and simulation to industrial problems in manufacturing.

Course description:

Course introduces students to the basic control systems used to automate manufacturing processes. This course will develop specialized technical knowledge in automation and manufacturing systems, enabling students to apply engineering principles to understand, modify or control the manufacture, delivery and maintenance of technology components. It will give students the basic concepts needed to design manufacturing automation systems using both hard automation and robots used in a CIM cell high-end automation system.

Course content:

Unit 1 **Lectures**

Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers, NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing

Unit 2 **Lectures**

Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC- Adaptive Control

Unit 3 **Lectures**

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

Unit 4 **Lectures**

Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

Suggested Text/Reference Books:

1. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th Edition, Pearson
3. Yoram Koren, Computer control of manufacturing system, 1st edition
4. Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

Os & PSOs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	1	1	-	2	2	3
CO2	2	2	3	2	2	-	-	-	-	-	-	2	2	3
CO3	2	2	1	-	-	-	-	-	1	1	-	1	2	-
C04	2	3	3	2	3	-	-	-	-	-	-	2	2	2
Avg.	2	2.2	2	2	2.5	-	-	-	1	1	-	2.7	2	2.7

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

2022-26

MEPD 4001	CAD/CAM	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure					
Co-requisites					

Course objectives:

To provide an overview of how computers can be utilized in mechanical component design.

Course outcomes:

CO1: Understand the basic fundamentals of CAD/CAM.

CO2: Apply different geometric modeling techniques for feature based modeling.

Course description:

Over the past thirty years, engineering has changed from using mathematical tables, to slide rules, to pocket calculators, to personal computers. Interactive computer graphics and CAD technology has been impacting the drafting, design and manufacturing tools significantly. The purpose this subject is present CAD principles and tools in generic and basic forms with enough depth and breadth. These principles are supplemented with engineering and design applications as well as problems.

Course content:

Unit 1 **Lectures**

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation

Unit 2 **Lectures**

Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep

Unit 3 **Lectures**

Visual realism- hidden line-surface-solid removal algorithms, shading, coloring, computer animation

Unit 4 **Lectures**

Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations, mechanism simulation and interference checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics

Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc., Communication standards

Suggested Text/Reference Books:

1. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
2. C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
3. W. M. Neumann and R.F. Sproul, Principles of Computer Graphics, McGraw Hill, 1989.
4. D. Hearn and M.P Baker, Computer Graphics, Prentice Hall Inc., 1992

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					1	1	2
CO2	3	3	1									1	3	3
Avg.	3	2.5	1				2					1	2	2.5

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

MEPD4101	CAD/CAM Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Basics of C/C++ Programming, Basic workshop operations				
Co-requisites	CAD/CAM				

Course Objectives

- To impart the students with MATLAB programming.
- To introduce geometric modeling techniques and algorithms.
- To impart the students with the CNC programming using simulation software.
- To enable students with part programming by G & M Codes.

Course Outcomes

At the end of this course student should be able to

CO-1-Understand basic logical operation and Syntax of MATLAB.

CO2-Analyze various drawing algorithms on MATLAB

CO3- Create models of various manufacturing operations on CNC/VMC machine.

Catalog Description

This laboratory course introduces two most important areas- MATLAB programming for geometric modeling and part programming using simulation software. Machine tool, which cuts, mills, grinds, punches or turns raw stock into a finished part is to be studied which controlled through G and M Codes on numerically controlled machines (NC). Another applications include design of (optimum) cutting tools and modeling and design of fixtures for dies and molds.

MATLAB software enables students to learn various algorithms for line and circle drawing with other geometric transformation operations.

Course Content

Experiment No: 01 Basics of MATLAB

To study script files, functions, variable, nesting, matrices, array, algorithms, Input/output, relational expression, logical expression, plot etc.

Experiment No: 02 DDA Algorithms

MATLAB program to draw line using DDA Algorithms with function/ Script

Experiment No: 03 Bresenham's line Algorithms

MATLAB program to draw line using Bresenham's line Algorithms with function/ Script

Experiment No: 04 Bresenham's circle Algorithms

MATLAB program to draw circle using Bresenham's circle Algorithms with function/ Script

Experiment No: 05 Geometric Transformation

MATLAB program for various Geometric Transformation like Translation, scaling, shearing etc. with function/ Script

Experiment No: 06 Facing

To perform facing operations on CNC/ VMC machine

Experiment No: 07 Turning

To perform turning operations on CNC/ VMC machine

Experiment No: 08 Grooving

To perform grooving operations on CNC/ VMC machine.

Experiment No: 09 Drilling

To perform drilling operations on CNC/ VMC machine

Text Books

1. MATLAB A practical Approach by Stormy Attaway.
2. Ibrahim Zeid, R Sivasubramaniam, CAD/CAM-Theory and Practice, TATA McGraw hill.

Reference Books

NA

Modes of Evaluation: Class tests/Assignment/Tutorial Assessment/Written Examination

Examination Scheme:

Components	Lab Performance	Continuous Evaluation
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	3	-	-	1	1	-	-	2	-	-	-
CO2	1	1	-	1	3	-	-	1	1	-	-	2	-	-	-
CO3	1	-	-	1	3	-	-	1	1	-	-	2	-	-	-
Average	1	1	-	1	3	-	-	1	1	-	-	2	-	-	-

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

PROJ 4108	Project IV	L	T	P	C
		0	0	0	6
Pre-requisites/Exposure	Mechanical engineering subjects				
Co-requisites	Project specific software				

Course Objectives

1. Develop student's knowledge for solving technical problems through structured project research study in order to produce competent and sound engineers.
2. Provide the students with the opportunity to design undertake or conduct an independent research or study related to their degree course.
3. Identify and describe the problem and scope of project clearly, collect, analyze and present data into meaningful information using relevant tools
4. Select, plan and execute a proper methodology in problem solving, work independently and ethically
5. Present the results in written and oral format effectively and identify basic entrepreneurship skills in project management.

Course Outcomes

A/CO 1: Demonstrate methodology to achieve the objectives

A/CO 2: Analyze the results

A/CO3: Apply the professional ethics involved in projects

A/CO4: Illustrate presentation skills and report

A/CO5: Demonstrate ability to work effectively in a team and leadership skills

Catalog Description

In the modern world engineers and technicians are often involved fully or in part with identifying problems and finding suitable solutions. These engineering problems may range from a very large project, such as designing and building a hydroelectric power station, to smaller projects, such as designing and producing a paper clip to keep notes secure. No matter how large or small, these problems need to be project managed in order to find engineered solutions. This unit will provide learners with opportunities to present their own solutions to engineering projects and should enable them to feel confident in carrying out project work within their chosen engineering discipline at the

technician level. The unit aims to integrate the knowledge and skills learners have gained throughout their programme of study, into a major piece of work that reflects the type of performance expected of an engineering technician. The project is intended to develop the learner's ability to identify and plan a course of action and follow this through to produce a viable solution/outcome to an agreed specification and timescale. The end result of the project could be an engineering product, device, service or process or a modification to an existing process or product. As in the real world, the outcome of the project and its presentation are very important, although this project is also about developing the process skills necessary to carry out the project. Throughout the project learners will need to apply the technical skills developed in the other units in the qualification.

TYPES OF PROJECTS

Projects may be either one or a combination of the following categories of projects Experimental Research, Case study, Industrial applications, Analytical and Simulation. Here we will include the core area for different departments.

IDENTIFICATION AND ALLOTMENT OF PROJECTS AND SUPERVISORS

At the beginning of the semester, the Project coordinator/HOD meets with the students and explains to them about the project. Students are given a week to identify their project titles and send project title approval form to project coordinator. Depending on the project title, the student is allotted a supervisor.

RESPONSIBILITIES

Responsibilities of the Student

• The student should take responsibility for the design, methodology and presentation of the project.

• It is the responsibility of the student to edit their work, and ensure all information is accurate and complete.

• The student is responsible for presenting their research proposal to the Faculty for approval before embarking on the data collection.

• Students are reminded that their research project must be their own work and all quotations from other sources, whether published or unpublished, must be properly acknowledged. Plagiarism is a very serious offence and, where proven against a student, may result in disqualification from the examination of the project.

• The student should submit material in sufficient time to allow for comment and discussion before proceeding to the next stage.

• The student takes responsibility for maintaining regular contact with the supervisor.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Continuous monitoring and evaluation. Student will be evaluated twice in a semester by Mentor (50%) and Expert panel (50%). Marks earned will be compiled and converted to grades.

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	-	2	1	-	-	-	-	1	1	1	3	3
CO2	-	1	-	3	2	-	1	1	1	1	1	2	3	3
CO3	-	-	-	-	1	1	1	3	1	3	1	-	-	-
CO4	-	-	-	-	-	-	-	-	1	3	2	-	-	-
CO5	-	-	-	-	-	-	-	-	3	2	3	-	-	-

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

Specialization in Smart Manufacturing

Specialization I/II/III/IV/V

Specialization in Smart Manufacturing			
		Course	Credits
1	Splz 1	Rapid Prototyping and Tooling	3
2	Splz 2	CAD and Digital Manufacturing	3
3	Splz 3	Micro machining technology	3
4	Splz 4	Reverse Engineering	3
4	Splz 5	Automation in Manufacturing	3

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Course Code: MECH 3049	Course name : Rapid prototyping and tooling	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure	Manufacturing processes, manufacturing technology, CAD/CAM				
Co-requisites					

Course Objectives

1. To help the students understand the fundamentals and relevance of rapid prototyping in the broader context of manufacturing engineering.
2. To enable students to understand the principles and process parameters of different additive manufacturing techniques.
3. To expose students to a wide variety of research areas and concerns in and around rapid prototyping such as rapid tooling, biomedical application across multidisciplinary domains.
4. To equip students with necessary engineering skills such as solving engineering problems in a professional way, using commercial software packages for modelling and simulation.

Course Outcomes

On completion of this course, the students will be able to
CO1. Understand the principles and application of rapid prototyping techniques.
CO2. Calculate the design parameters for Fused Deposition Modeler.
CO3. Apply the knowledge of rapid prototyping to product development.
CO4. Understand the software processing and data formats for rapid prototyping.

Catalog Description

Rapid Prototyping (RP) can be defined as a group of techniques used to quickly fabricate a scale model of a part or assembly using three-dimensional computer aided design (CAD) data. Rapid Prototyping has also been referred to as solid free-form manufacturing, computer automated manufacturing, and layered manufacturing. RP has obvious use as a vehicle for visualization. RP models can be used for testing, such as when an airfoil shape is put into a wind tunnel. RP models can be used to create male models for tooling, such as silicone rubber molds and investment casts. In some cases, the RP part can be the final part, but typically the RP material is not strong or accurate enough. When the RP material is suitable, highly convoluted shapes (including parts nested within parts) can be produced because of the nature of RP.

There is a multitude of experimental RP methodologies either in development or used by small groups of individuals. This section will focus on RP techniques that are currently commercially available, including Stereo lithography (SLA), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM), Solid Ground Curing (SGC), and Ink Jet printing techniques.

Course Content

Unit I: **10 lecture hours**

MANUFACTURING PROCESSES

Classification of Manufacturing Processes, Different Manufacturing Systems.

INTRODUCTION TO RAPID PROTOTYPING: Introduction to Rapid Prototyping (RP), Need of RP in Context of Batch Production, FMS and CIM and Its Application

Unit II: **8 lecture hours**

BASIC PRINCIPLES OF RAPID PROTOTYPING: Basic Principles of RP, Steps in RP, Process Chain in RP in Integrated CAD-CAM Environment, Advantages of RP

Unit III: **20 lecture hours**

RAPID PROTOTYPING TECHNIQUES

Classifications of Different RP Techniques; Based on Raw Material, Layering Technique (2D or 3D) and Energy Sources; Process Technology and Comparative Study of :- Stereo-Lithography (SL) with Photo-Polymerization, SL with Liquid Thermal Polymerization, Solid Foil Polymerization, Selective Laser Sintering, Selective Powder Binding, Ballastic Particle Manufacturing (2D and 3D), Fused Deposition Modeling, Shape Melting, Laminated Object Manufacturing, Solid Ground Curing, Repetitive Masking and Deposition, Beam Inference Solidification, Holographic Interference Solidification, Special Topic on RP Using Metallic Alloys

Unit IV: **7 lecture hours**

PROGRAMMING IN RAPID PROTOTYPING: Programming in RP, Modeling, Slicing, Internal Hatching, Surface Skin Fills, Support Structure.

Text Books

1. C K Chua, Rapid Prototyping: Principles and Applications, Cambridge University Press
2. Frank W Liou, Rapid Prototyping and Engineering Applications, CRC Press

Reference Books

1. James A. Rehg, Henry W. Kraebber, (2007) Computer Integrated Manufacturing, Pearson Education

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)/Program specific outcomes

PO, PSO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	1	-	-	-	2	-	-	2	-	-	2
CO2	3	3	-	-	1	-	-	-	2	-	-	2	-	-	2
CO3	3	3	-	-	1	-	-	-	-	-	-	2	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	-	2	-	-	2
Average	3	3	-	-	1	-	-	-	2	-	-	2	-	-	2

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Course Code: MECH 3050	Course name : CAD and Digital manufacturing	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure	CADD				
Co-requisites	Rapid prototyping				

Course Objectives: course is designed to accomplish the following objectives

1) To give knowledge about collaboration with Integrated design and manufacturing process
2) Summarize an understanding of digital manufacturing, principles of sustainable design, and manufacturing processes.
3) Explain and discuss how trends such as generative design and machine learning are influencing innovation, and how things are made.
4) Demonstrate knowledge of and apply job entry level skills in computer aided design, computer aided engineering (CAE) and computer aided manufacturing (CAM).

Course Outcomes: After completion of this course students will able to

1) Understand the fundamentals of digital CAD, CAM and digital manufacturing.
2) Explain new and immerging trends in the field digital manufacturing.
3) Create complete route of digital manufacturing starting from CAD to the product on the software platform.

Catalog Description

The future of making is here, bringing with it radical changes in the way things are designed, made, and used. And it's disrupting every industry. With the right knowledge and tools, this disruption is your opportunity—whether you're an entrepreneur, designer, or engineer.

Today's dominant technology trends—cloud computing, mobile technology, social connection, and collaboration—are driving businesses and consumers alike to explore profoundly different ways to design, make, and use things. This kind of industry transformation has happened before, but the pace of change is now much faster. In today's competitive landscape, anyone can be an innovator—and it's all about who innovates first.

Course Content

Unit 1. **Lecture: 8**

Conception and development of products Design processes and methods. CAD/CAM/CAE technologies and product lifecycle management (PLM). Concepts generation and embodiment. Expression of product design ideas using 2D sketches.

Unit 2. **Lecture: 8**

Computer Aided Design (CAD) 3D modeling. Parametric design. Assembly modeling. Render the appearance of a product. CAD and additive manufacturing.

Unit 3. **Lecture: 9**

Computer Aided Engineering (CAE) Finite Element Analysis (FEA) to validate functional performance: general stages of the process, solid and FEA models, materials definition, loading (loads, displacements constraints…), post-processing, results and verifications. Topology optimization in additive manufacturing.

Unit 4. **Lecture: 10**

Reverse engineering General methodology: point clouds, meshes (.stl), NURBS surface models and parametric CAD models. Digitizing methods and main technologies: applications and selection of reverse engineering systems. Hardware and software involved. Reverse engineering and additive manufacturing.

Unit 5. **Lecture: 10**

Additive manufacturing General methodology, stages and components of the process. Main technologies, principles and applications. Strengths, weaknesses, challenges, and limitations of additive manufacturing technologies. Main brands and suppliers available. Design for Additive Manufacturing (DFAM). Design for functionality and 3D printability. Planning and slicing additive manufacturing software.

Text Books

1. K. T. Ulrich and S. D. Eppinger, Product Design and Development, 6th Ed., McGraw-Hill Education, 2015. ISBN-13: 978-0-078-02906-6
2. Parametric Technology Corporation (PTC), Simulation using Creo Parametric user guides. § V. Raja and K. J. Fernandes (eds.),
3. Reverse Engineering. An Industrial Perspective, 1st Ed., Springer-Verlag London, 2008. ISBN-13: 978-1-849-96660-3

4. N. Hopkinson, R. J. M. Hague and P. M. Dickens (eds.), Rapid Manufacturing: An Industrial Revolution for the Digital Age, 1st Ed., John Wiley & Sons, 2005. ISBN-13: 978-0-470-01613-8

Reference Books

1. K. Otto and K. Wood, Product Design: Techniques in Reverse Engineering and New Product Development, 1st Ed., Prentice Hall, 2000. ISBN-13: 978-0-130-21271-9 §

2. Z. Zhou, S. Xie, and D. Chen, Fundamentals of Digital Manufacturing Science, 1st Ed., Springer-Verlag London, 2012. ISBN-13: 978-1-447-12714-7 §

3. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Springer-Verlag Boston, 2010. ISBN-13: 978-1-441-91119-3 §

4. C. K. Chua, K. F. Leong, and C. S. Lim, Rapid Prototyping: Principles and Applications, 3rd Ed., World Scientific, 2010. ISBN-13: 978-9-812-77898-7

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO12	PSO1	PSO2
CO1	1	-	1	-	3	-	-	-	-	-	1	2	1	3
CO2	2	-	1	-	3	-	-	-	-	--	1	2	3	3
CO3	2	-	1	-	3	-	-	-	-	-	1	2	3	3
Average	1.7	-	1	-	3	-	-	-	-	-	1	2	2.3	3

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

COURSE CODE	COURSE NAME	L	T	P	C
MECH4044P	Micro machining technology	3	0	0	0
Pre-requisites/Exposure	Material Science, Thermodynamics and kinetics of matrials				
Co-requisites					

Course objectives:

1. To give awareness of different techniques used in micro and nano machining/manufacturing.
2. To give in-depth idea of the conventional techniques used in micro machining/manufacturing.
3. To introduce Non-conventional micro-nano manufacturing and finishing approaches
4. To introduce Micro and Nanofabrication Techniques and other processing routes in Micro and nano machining/manufacturing.

Course Outcome

CO1: The student can identify different areas of Micro and Nano Machining
CO2: analyse the process to get the optimum output.
CO3: compare micromachining techniques on the basis of its industrial applications.

Course description:

The emergence of miniature and micro products / components has increased the demand of the production of micro components with feature size from a few millimeters to tens of micrometers. Mechanical micro machining is one of the key technologies to enable the realization of high accuracy complex micro products made from a variety of engineering materials. Mechanical micro machining is capable to machine metals, polymers, and ceramics in very less time as compared to lithographic processes and other micro machining processes such as EDM, ECM, LBM, etc. As a result, it has found strong base in a wide array of practical applications. Though the machine for micro cuttings are kinematically similar to conventional machines, there are many differences in terms of process mechanics, machine components, etc. Hence, understanding of machining at micro scale is very important to process any material to the desired dimensions.

Course content:

Unit 1		**10 Lectures**
Introduction: Introduction, Basic elements of molecular dynamics modelling, Design and requirements for state-of-the-art MD cutting process simulations, Capabilities of MD for nanoscale material removal process analysis, Advances and recent developments in material removal process simulation, Summary. Ductile Mode Cutting of Brittle Materials The mechanism of ductile mode cutting of brittle materials, The chip formation in cutting of brittle materials, Machined surfaces in relation to chip formation mode Diamond Tools in Micromachining Diamond technology, Preparation of substrate, Modified HFCVD process, Nucleation and diamond growth, Deposition on complex substrates, Diamond micromachining		

Unit 2	Conventional Processes: Micro-turning, Micro-drilling and Micro-milling Introduction, Micro-turning, Micro-drilling, Micro-milling, Product quality in micromachining Micro-grinding and Ultra-precision Processes Introduction, Micro and nanogrinding, Nanogrinding tools	**10 Lectures**
Unit 3		**9 Lectures**
Non-Conventional Processes: Laser Micromachining Introduction, Fundamentals of lasers, Laser microfabrication, Laser nanofabrication. Evaluation of Subsurface Damage in Nano and Micromachining Destructive evaluation technologies, Non-destructive evaluation technologies		
Unit 4		**8 Lectures**
Micro and Nano Finishing Processes Need for Nano finishing, Magnetic abrasive Finishing, Magnetorheological Finish, Elastic Emission Finishing, Magnetic Float Polishing, Ion Beam finishing.		
Unit 5		**8 Lectures**
Micro Joining Challenges, Micro Resistance welding, Ultrasonic welding, Micro TIG, Applications. Applications of Nano and Micromachining in Industry Typical machining methods, Applications in optical manufacturing, Semiconductor and electronics related applications. Case study.		

Suggested Text/Reference Books:

1. V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.

2. .J. Paulo Davim, Mark J. JacksonNano and Micromachining,John Wiley & Sons, 20132. Kasap, S.O.

3. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs/COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	-	-	-	-	1	-	-	3	3
CO2	1	2	-	-	-	-	-	-	-	1	-	-	3	3
CO3	1	2	-	-	-	-	-	-	-	1	-	-	3	3
Avg.	1	2	-	-	-	-	-	-	-	1	-	-	3	3

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Course Code: MECH 4049	Course name: Reverse Engineering	L	T	P	C
		2	0	0	2
Pre-requisites/Exposure	Manufacturing processes, CAD/CAM				
Co-requisites	--				

Course Objectives: Course is intended to fulfill following objective

1) Aware students about different approach of manufacturing.
2) To impart life long learning about advancements in manufacturing processes.
3) Students can apply the knowledge to the current industrial manufacturing need.
4) Give them the essence of relation between CAD/CAM and manufacturing.

Course Outcomes: After completion of the course students will able to

CO1. Understand the basic concepts of Reverse Engineering

CO2. Explain Methodologies and techniques of Reverse engineering

CO3. Demonstrate hardware and software of Reverse Engineering

Catalog Description

"Reverse engineering (RE) refers to creating a computer-aided design (CAD) model from an existing physical object, which can be used as a design tool for producing a copy of an object With globalization and trade liberalization, manufacturing companies face increasing competition from goods and services produced in lower wage economies. Countries in the West cannot compete against low wages and must therefore depend on raising innovation and best practices to create better products. In an attempt to compete in such a volatile environment, companies are looking to lean and agile strategies to compete and survive. Lean or world class manufacturing is principally aimed at reducing waste and controlling things that can be measured and controlled. On the other hand, agility deals with things that cannot be controlled. RE can be the best solution for the current industries

This course interested in RE from an industrial perspective. Several journal papers have to be discussed issues related to RE. This course is written for the benefit of the industrialist, who might not have the time to "scramble" through libraries and other sources to read journal papers. The main theme of the course is to get you started using RE as quickly as possible.

Course Content

- **Unit 1: INTRODUCTION TO REVERSE ENGINEERING: Lecturs-5**

  Introduction, what is reverse Engineering? Why use reverse Engineering?, Reverse Engineering – The generic process, scanning, point processing, application Geometric model development

- **Unit 2:- METHODOLOGIES AND TECHNIQUES FOR REVERSE ENGINEERING Lectures: 8**

  Computer aided reverse Engineering, what is not reverse Engineering, computer aided forward engineering, computer aided reverse Engineering, Computer vision and reverse Engineering – CMM, active illumination 3D stereo, benefits and drawbacks, structured light range imaging,

- **Unit 3 : REVERSE ENGINEERING – HARDWARE AND SOFTWARE: Lectures 5**

  Introduction, Reverse Engineering Hardware – Contact, non contact methods, destructive methods, RE software-classifications, phases, Engineering operations.

- **Unit: 4 REVERSE ENGINEERING SELECTION Lectures 8**

  Introduction, selection process- team formation, business opportunity and technical requirement, vendor information vendor shortlisting, vendor assessment, bench marking, evaluation of vendor,: point capture devices, triangulation approach , stereoscopic imaging systems, tracking systems, measurement systems,, destructive systems

- **Unit 5 RAPID PROTOTYPING AND RE Lectures 8**

  current techniques and methods, applications, relationship between rapid prototyping and RE APPLICATIONS :RE in Automotive Industry, Aerospace, medical device industry, Obstacles to adopt RE, REVERSE ENGINEERING: AN INDUSTRIAL PERSPECTIVE

Text Books

Vinesh Raja, Kiran J. Fernandes Springer Science & Business Media, 24-Oct-2007

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	IA	MID SEM	End Sem	Total
Weightage (%)	30	20	50	100

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO-12	PSO 1	PSO 2
CO1	3	3	2	-	1	1	1	-	-	-	1	1	-	1
CO2	2	2	1	-	-	-	-		-		-	1	-	1
CO3	2	2	2	-	-	-	-	-	-	-	-	2	-	1

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

2022-26

MECH4060P	Automation in Manufacturing	L	T	P	C
		3	0	0	3
Pre-requisites/Exposure	Manufacturing Technology				
Co-requisites					

Course objectives:

To understand the importance of automation in the field of machine tool-based manufacturing.

To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics, and CNC.

To understand the basics of product design and the role of manufacturing automation

Illustrate adaptive control systems and automated inspection methods.

To use PLCs to apply computer control to an automation project.

Course outcomes:

Understand the concepts of automation, CAD, CAM and CIM, automated material handling.

Learn and apply the concepts of CAD/CAM, PLC, microcontrollers etc. to the industry for automation.

Illustrate the concept of low cost automation into different mechanical systems.

Apply the concepts of modeling and simulation to industrial problems in manufacturing.

Course description:

This course will develop specialized technical knowledge in automation and manufacturing systems, enabling students to apply engineering principles to understand, modify or control the production, delivery and maintenance of technology components. It will give students the basic

concepts needed to design and manufacturing of automation systems using both hard automation and soft automation like robots used in a CIM cell high-end automation system.

Course content:

Course content:

Unit 1 **10 Lectures**

Why automation, Current trends, Reasons for and against automation, Automated systems, Types of automation, Rigid automation, Flexible automation, Automation Principle, Automation strategies, Automation Migration strategies, Production system and Automation, Product life cycle and automation, CAD/CAM and automation, Introduction to Manufacturing, influence of computers on Manufacturing environment. Part handling, Machine tools. Computer control of Machine Tools and Machining Centers,

Unit 2 **15 Lectures**

Computer Aided Manufacturing, Manufacturing support functions, ,Automation in Manufacturing Support Systems, Product Engineering, concurrent Engineering, Numerical Control(NC), Program of Instructions, NC procedures. NC coordinate System, Application of NC. Computer Control in NC, CNC technology, Direct Numerical Control(DNC), CNC-Adaptive Control, CNC Part Programming, Interpolations, Manual part programming, computer assisted part programming, CNC Codes letter, Automated Material handling. Assembly, Flexible Manufacturing, PLC, Micro-controllers,

Unit 3 **10 Lectures**

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies

Unit 4 **10 Lectures**

Introduction to Modeling and Simulation: Product design, process route modeling, Optimization techniques, Case studies & industrial applications.

Suggested Text/Reference Books:

Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.

Serope Kalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th Edition, Pearson

Yoram Koren, Computer control of manufacturing system, 1st edition

Ibrahim Zeid , CAD/CAM : Theory & Practice, 2nd edition

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs /COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	1	1	-	2	2	3
CO2	2	2	3	2	2	-	-	-	-	-	-	2	2	3
CO3	2	2	1	-	-	-	-	-	1	1	-	1	2	-
C04	2	3	3	2	3	-	-	-	-	-	-	2	2	2
Avg.	2	2.2	2	2	2.5	-	-	-	1	1	-	2.7	2	2.7

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

Specialization in Energy Engineering

Specialization I/II/III/IV/V

Specialization in Energy Engineering			
		Course	Credits
1	Splz 1	Wind and small hydro energy system	3
2	Splz 2	Solar Energy Systems	3
3	Splz 3	Waste to Energy	3
4	Splz 4	Energy Storage Systems	3
5	Splz 5	Optimization of energy storage	3

2022-26

EPEG3048P	**Wind and small hydro energy system**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic knowledge of wind and small hydro energy system				
Co-requisites	--				

Course Objectives:

This course will enable students:

1. To introduce the fundamental of wind and small hydro energy system.
2. To learn about selection and design criteria of wind and small hydro system.
3. To understand the concept of DPR and LCOE calculations
4. To impart the knowledge of different components of wind and small hydro energy system.

COURSE OUTCOMES

After successful completion of this course, students shall be able:

CO1: To understand about different components of the wind and small hydro energy system.
CO2: To analyse and design the different components of wind and small hydro energy systems.
CO3: To evaluate significance of existing potential of wind and small hydro energy in the country.
CO4: To learn about preparation of DPR and LCOE calculations.

Catalogue Description

This course provides a comprehensive description on wind and small hydro energy system. A detail description of historical developments of wind energy and small hydro energy plants and their components with different selection criteria of sites, types of setup and economical aspects are discussed in details.

Course Content

UNIT I:

Historical developments of Wind Energy, energy and power in wind, wind energy dynamics, power extracted, axial thrust on turbines, torque, maximum power and Betz coefficient, wind turbine operational characteristic, site selection. Wind energy conversion system, HAWT and VAWT constructions, basic rotor differences, relative merits and operational difficulties, lift and drag turbines, upwind and down wind machines.

Unit-II:

Wind turbine design considerations; Analysis of wind turbine characteristics; Introduction to reliability engineering, failure analysis of WECS. Basic components, fixed and variable speeds systems, type of generators, induction and synchronous machines; grid, standalone, and hybrid

schemes, Power electronics based controllers used with WECS, power quality, impact of constant and variable speed wind turbines on transient stability of power system, wind system economic components, economic analysis methods, cost of on-shore and off-shore wind turbines.

Unit-III:

Wind pumps: Performance analysis, design concept and testing methods; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy. Utilization of Wind Energy Preparing DPR including financial evaluation and LCOE calculations.

Unit-IV:

Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Classification and working principles of hydro turbines, different components of impulse and reaction turbines; Design concepts of hydro turbines, pump-as-turbine and other non-conventional hydro turbines; Characteristics of hydro turbines, geometric similarity, main characteristic and operating characteristic curves, hill curves; Governing of hydro turbines, mechanical and electro-mechanical governors, electronic load controller, mechanical drives, gear box, pulleys;

Unit-V:

Selection of hydro turbines based on specific speed and their optimal selection; Classification, components and selection of gates and valves; Model testing of hydro turbines, performance testing of turbines at site; Causes and impact of cavitation, silt erosion and their combined effect on operation of hydro turbines; Erection, commissioning, operation and maintenance of turbines. Site selection and civil works; Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies. Potential of small hydropower in hilly states of India. Wind and hydro based standalone hybrid power systems.

Textbooks:

1. V. Yaramasu and B.Wu, Model Predictive Control of Wind Energy Conversion Systems,Wiley-IEEE Press, 2016.
2. Clemen, D.M., “Hydro Plant Electrical Systems”, HCI Publication.

Reference Books

1. E. W. Golding, The Generation of Electricity by Wind farms, E & F. N. Spon Ltd, London, (U.K). 1976.
2. L. Gary, Johnson, Wind Energy System, Prentice Hall Inc. Englewood Cliffs. N. J. (USA) 1985.
3. Thomas Ackermann, Wind Power in Power System, John Wiley & Sons Ltd., 2005.
4. Brown, G., “Hydro-electric Engineering Practice”, Vol. I, II & III, CBS Publication.
5. Nigam, P.S., “Hand book of Hydroelectric Engineering”, Nem Chand and Brothers.

Modes of Evaluation: Class tests/Assignment/Tutorial Assessment/Written Examination

Examination Scheme:

Components	Tutorial /Assignments	Class Tests	MSE	ESE
Weightage (%)	15	15	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1						2			
CO2	3	2	2	2	1	1						2			
CO3	3	2	2	3	1	1					2	2			
CO4	2	2	2	3	1	1	1		2	2	2	2			
Average	**2.75**	**2**	**2**	**2.5**	**1**	**1**	**0**	**0**	**0.5**	**0.5**	**1**	**2**	**0**	**0**	**0**

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

2022-26

EPEG3049P	**Solar Energy System**	L	T	P		C
Version 1.0		3	0	0		3
Pre-requisites/Exposure	Thermodynamics & Heat transfer.					
Co-requisites	--					

Course Objectives

1. To familiarize students with the characteristics of solar radiation, its global distribution, and conversion methods of solar energy to heat and power.
2. To introduce the basic concepts and novel technologies in solar thermal systems.
3. To provide a balance between both frontier technology updates and existing solar thermal energy strategies, in both a quantitative and qualitative way.
4. To achieve extensive knowledge about solar thermal energy collector systems used for various applications with economical aspects
5. To develop skills to design, model, analyze and evaluate solar thermal systems.
6. To develop creative thinking and to deal with complex multidisciplinary solar thermal energy projects that involve the provision of effective and efficient solutions.
7. To provide students for practical training in the design of different solar thermal systems, such as water heating and control, solar collection, solar energy storage and system design.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand the basic concepts related to solar thermal system.

CO2. Apply concepts of solar thermal energy conversion and storage to simple and complex problems

CO3. Analyze the performance of solar thermal systems

CO4. Evaluate the performance of solar thermal systems

Catalog Description

This course covers the basic physics about solar energy, origin and related devices used to collect solar thermal energy, the design and operation of solar thermal systems. Foundational topics include solar radiation characteristics, solar materials, and heat transfer. Solar thermal systems include flat-plate collectors, concentrating collectors, solar water heating, solar space heating and cooling, and solar thermal power systems. Methods to predict long term system performance; Component models and Simulations, Software: TRNSYS, etc. Further, being a rigorous course on

problem-solving, it will acquaint students with engineering problem-solving approaches and the effective use of commercial software packages to answer engineering questions.

Course Content

Unit I: **10 lecture hours**

SOLAR RADIATION:

Introduction; Earth and solar constant; Extra-terrestrial radiation- spectral distribution, variation; Basic earth-sun angles; Solar time and solar constant; Diffuse radiation at ground; Average daily global radiation; Average daily diffuse radiation; hourly global and diffuse radiation; Angle of incidence on horizontal and inclined surfaces; Computation of radiation on inclines surfaces; Measuring instruments- pyrheliometer, pyrometer; Duration of sunshine hours.

Unit II: **10 lecture hours**

FLAT PLATE COLLECTORS:

Introduction; Components – absorber plate, insulation, cover plate; Efficiency of flat plate collectors; Overall heat loss coefficient- top, bottom and side heat loss coefficient, selective surfaces; Flat plate air heating collector- types, performance analysis, heat transfer and pressure drop; Testing of solar collectors- ASHARE standard, collector time constant, collector incident angle modifier, calculation of all day solar efficiency.

Unit III: **9 lecture hours**

SOLAR CONCENTRATING COLLECTORS:

Introduction; Classification; Thermodynamics limit to concentration; Performance analysis of cylindrical parabolic collector; Compound parabolic collector- tracking requirements, performance analysis; Point focusing solar concentrator- paraboloid of revolution, central power receiving systems, analysis of central receiver system; Material for solar concentrators.

Unit IV: **9 lecture hours**

HEATING APPLICATIONS OF SOLAR ENERGY:

Swimming pool heating; Solar water heaters- integrated collector storage system, natural circulation system, forced circulation system, performance prediction; Solar cookers- types, testing; Solar desalination- basics, materials, performance prediction; Solar drying of food- basics of drying, types of solar dryers, heat transfer in dryers

Unit V: **7 lecture hours**

SOLAR REFRIGERATION AND AIR CONDITIONING:

Introduction; Carnot refrigeration cycle; Absorption cooling - principle, basics of absorption cooling, lithium bromide water absorption system, intermittent absorption refrigeration system, desiccant cooling, Passive cooling of buildings- shading, ventilation,

Text Books

1. Duffie J.A., Beckman W.A. "Solar Engineering of Thermal Processes", 3rd ed., Wiley, 2006.
2. Garg H.P., Prakash J., "Solar Energy Fundamentals and Applications", Tata McGraw-Hill, 2005.

Reference Books:

1. Foster R., Ghassemi M., Cota A., "Solar Energy", CRC Press, 2010.
2. De Vos, A., "Thermodynamics of Solar Energy Conversion", WileyVCH, 2008.
3. Kalogirou S., "Solar Energy Engineering", Processes and Systems, Elsevier, 2009.
4. Petela, R., "Engineering Thermodynamics of Thermal Radiation for Solar Power", McGraw-Hill Co., 2010.
5. Yogi Goswami D., Frank Kreith, Jan F. Kreider, "Principles of Solar Engineering", Second Edition, Taylor & Francis, 2003.
6. Andrews J., Jelley N., "Energy Science", Oxford University Press, 2010.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Internal Assessment	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs):

POs & PSOs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2					1	2	
CO2	3	3	1									1	2	
CO3	3	3	2	1								1	3	
CO4	3	3	2	3	2		2					1	3	
Avg.	3	2.75	1.67	2	2		2					1	2.5	

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

UNIVERSITY OF PETROLEUM & ENERGY STUDIES

2022-26

EPEG4045P	**Waste to Energy**	L	T	P	C
Version 1.0		3	0	0	0
Pre-requisites/Exposure	Renewable and renewable energy				
Co-requisites	--				

Course Objectives

- To enable students to understand of the concept of Waste to Energy.
- To Understand he best available technologies for waste to energy.
- To link legal, technical and management principles for production of energy form waste.
- To facilitate the students in developing skills in the decision making process.
- To Analyze case studies for understanding success and failures.

Course Outcomes

On completion of this course, the students will be able to

CO1. Apply the knowledge about the operations of Waste to Energy Plants.

CO2. Analyze the various aspects of Waste to Energy Management Systems.

CO3. Carry out Techno-economic feasibility for Waste to Energy Plants.

CO4.Apply the knowledge in planning and operations of Waste to Energy plants.

Catalog Description

The objective of the course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. This course is designed to provide an understanding of the various aspects of Waste to Energy. The various sources of waste generation is analyzed with a focus on its potential for energy production. The need for characterization of wastes will be discussed along with the existing norms for waste utilization for alternate energy source. Various Technological options available for the production of energy form waste will delineated along with economics of using alternate sources. Case studies will be discussed to provide a better understanding of the concepts of "Waste to Energy" in the Indian context.

Course Content

Unit 1

Introduction **6 Hrs**

The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source**.**

Unit 2 **7 Hrs**

Waste Sources & Characterization

Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste

(hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria.

Unit 3 **7 Hrs**

Technologies for Waste to Energy

Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation. Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies.

Unit 4 **8 Hrs**

Waste to Energy Options

Landfill gas, collection and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets. Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers. Conversion of wastes to fuel resources for other useful energy applications. Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. Energy Recovery from wastes and optimization of its use, benchmarking and standardization. Energy Analysis

Unit 5 **6 Hrs**

Case Studies – Success/failures of waste to energy

Global Best Practices in Waste to energy production distribution and use. Indian Scenario on Waste to Energy production distribution and use in India. Success and Failures of Indian Waste to Energy plants. Role of the Government in promoting 'Waste to Energy'

Unit 6 **6 Hrs**

Centralized and Decentralized Waste to Energy Plants

Waste activities – collection, segregation, transportation and storage requirements. Location and Siting of 'Waste to Energy' plants. Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry. Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and its operations.

Unit 7 **5 Hrs**

Waste To Energy & Environmental Implications

Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms.

Text Books

- Industrial and Urban Waste Management in India, TERI Press.
- Wealth from Waste: Trends and Technologies by Banwari Lal and Patwardhan, TERI Press.
- Fundamentals of waste and Environmental Engineering, S.N Mukhopadhyay, TERIPress.
- Gazette Notification on Waste Management Rules 2016.
- CPCB Guidelines for Co-processing in Cement/Power/Steel Industry
- Waste-to-Energy in Austria – White Book – Figures, Data Facts, 2nd edition , May 2010
- Report of the task Force on Waste to Energy, Niti Ayog (Formerly Planning Commission) 2014.
- Municipal Solid Waste Management Manual, CPHEEO, 2016

Reference Books:

- Environmental and Resource Economics
- Environmental Monitoring and Assessment
- Journal of Environmental Assessment Policy and Management
- Reference papers and journals will also be given in class.

Modes of Evaluation: Quiz/Test/Assignment/ Written Examination

Examination Scheme:

Components	IA	MSE	ESE
Weightage (%)	30	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PSO 1	PSO 2
CO1	3	3	2	2	3	3	3	3	-	-	2	2	2	2
CO2	3	3	2	2	3	3	3	3	-	-	2	2	2	2
CO3	3	3	2	2	3	3	3	3	-	-	2	2	2	2
Average	3	3	2	2	3	3	3	2	-	-	2	2	2	2

1=Weakly mapped 2= Moderately mapped 3=Strongly mapped

UNIVERSITY OF PETROLEUM & ENERGY STUDIES

2022-26

EPEG4042P	**Energy Storage Systems**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Thermal Energy, Power Plant				
Co-requisites	--				

Course Objectives

1. To understand energy storage technologies for renewable and Non-Renewable sources of energy
2. To explore components of electrical and renewable energy storage systems
3. To understand the energy storage economics and its policies

Course Outcomes

On completion of this course, the students will be able to:
CO1: To understand the principle of energy storage technology, its policies, and economics in electrical and Renewable energy storage systems
CO2: To apply the knowledge of energy storage technologies in power systems
CO3: The analyze the performance of energy storage technologies for power systems

Catalog Description

This course provides a comprehensive description on energy storage technologies for renewable and electric energy storage systems. In addition students will able to design energy storage systems for various applications like heating, cooling and power systems.

Course Content

UNIT I: Introduction to Renewable Energy systems

Solar Energy Systems, Wind Energy Systems, Hydroelectric energy systems

UNIT II: Energy Storage Technologies

Thermal Energy Storage, Mechanical and Electrical Energy Storage, Electro-Chemical Energy Storage, Energy Storage efficiency

UNIT III Electrical Energy Storage:

Battery Storage, Superconducting Magnetic Energy Storage (SMES), Fuel Cells

UNIT IV Renewable Energy Storage Systems:

Solar, Wind, and Pumped energy storage systems, Fuel Cells, Energy storage in Micro-grid and Smart grid, Energy Management with storage systems, Battery SCADA, an increase of energy conversion efficiencies by introducing energy storage.

UNIT V Economics of Energy Storage:

Introduction to energy storage economics and Policy, Energy Demand, Energy Supply, Energy Market

Reference Books

- A.G.Ter-Gazarian, "Energy Storage for Power Systems", Second Edition, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN – 978-1-84919-219-4), 2011.
- Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.
- R. Pendse, "Energy Storage Science and Technology", SBS Publishers & Distributors Pvt. Ltd., New Delhi, (ISBN – 13:9789380090122), 2011.
- Electric Power Research Institute (USA), "Electricity Energy Storage Technology Options: A White Paper Primer on Applications, Costs, and Benefits" (1020676), December 2010.
- Paul Denholm, Erik Ela, Brendan Kirby and Michael Milligan, "The Role of Energy Storage with Renewable Electricity Generation", National Renewable Energy Laboratory (NREL) – A National Laboratory of the U.S. Department of Energy – Technical Report NREL/ TP6A2-47187, January 2010.

Modes of Evaluation: Class tests/Assignment/Tutorial Assessment/Written Examination

Examination Scheme:

Components	Tutorial /Assignments	Class Tests	MSE	ESE
Weightage (%)	15	15	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	1	1	1	1	2	2	3	2
CO2	3	3	3	3	3	1	1	1	1	1	1	2	3	2
CO3	3	3	3	3	3	1	1	1	1	2	1	2	3	2
Average	**3**	**3**	**3**	**3**	**3**	**1.3**	**1**	**1**	**1**	**1.3**	**1.3**	**2**	**3**	**2**

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

EPEG4043P	Optimization of energy storage	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic knowledge of different sources of energy				
Co-requisites	--				

Course Objectives:

1. To identify the importance of Energy storage & the energy of the modes that can be stored, corresponding to energy density and power density.
2. To explore the applications of thermal energy storage system
3. To understand the concept of mechanical energy storage
4. Study the basics of electromagnetic energy storage systems such as superconducting, Magnetic Energy storage and gain knowledge of super capacitors.

Course outcomes:

After successful completion of this course, students shall be able:

CO1: To evaluate the different energy storage systems.

CO2: To analyse different PCM-based energy storage systems, including latent and sensible heat storage systems.

CO3: To analyse the importance of chemical energy storage and hydrogen energy storage.

CO4: To acquire and apply the knowledge of compressed air energy storage and electrical and magnetic energy storage systems.

Catalogue Description

This course provides a comprehensive description on energy storage technique and optimization procedures. A detail description of thermal energy storage, PCM storage, mechanical energy storage, electric energy storage and electromagnetic energy storage and their optimization techniques are discussed.

Course Content

Unit I:

Need of energy storage and optimization; Different modes of Energy Storage, Mechanical Energy Storage and optimization technique: Pumped Hydro Energy Storage Systems (PHESSs), Elastic energy storage, Energy storage in Advanced Flywheels, Compressed air energy storage-numerical problems; Electrical and magnetic energy storage: Capacitors, Electromagnets storage systems and Battery storage systems such as primary, secondary, Lithium, Solid-state and Molten solvent batteries. Hydrogen storage methods and types (Metal hydrides, metallic alloy hydrides).

Unit II:

Thermal energy storage (TES) methods - Sensible heat storage (SHS) TES, Passive and active systems, Rock-bed storage systems. Energy conservation and optimization through Latent Heat TES (LHTES) systems; LHTES systems in refrigeration and Air-conditioning Systems, Phase Change Materials (PCMs) classification, properties and selection criteria, Main means of accumulation, Importance of thermal stratification, Strategies to enhance the thermal stratification - Cold TES - Seasonal TES - Characteristics of heat storage materials.

Design and operation of thermal storage systems - Performance characteristics, testing, safety, standards and system sizing, Energy conservation using TES - Energy and Exergy Analyses of TES Systems - Energy savings by TES, Case study/project.

Unit III:

Electrochemical energy conversion and storage: Introduction to batteries, elements and operation of electrochemical cells, battery classification, factors affecting battery performance, and batteries for the PV system. Electrochemical Energy Storage (ECES): lead acid battery, Li ion battery, Ni metal hydride battery, Flow Battery, Capacitor and Applications; Electrical Energy Storage (EES) Technologies and Considerations. Performance characteristics, testing, safety, standards and system sizing. Case study/project based on mechanical energy storage.

Unit IV:

Electromagnetic energy storage and optimization techniques: Superconducting Magnetic Energy Storage. Super capacitor: Basic components of super capacitors like types of electrodes like high surface area activated carbons, metal oxide and conducting polymers, and aqueous and organic electrolytes. Disadvantages and advantages of super capacitors over battery systems and their applications in aspects of energy density, power density, price and market.

Unit V:

Case studies and application of the thermal energy optimization in storage for space heating and cooling, green house heating, Solar power plant applications; Drying and heating for process industries, Food preservation; Waste heat recovery; Comparison of different energy storage technologies and future prospects.

Textbooks:

1. Johannes Jensen & Bent Sorensen, Fundamentals of Energy Storage, John Wiley & Sons, 1984
2. Kambo N. S., Mathematical programming techniques. Affiliated East-West Press, 2008.

Reference Books:

1. Kalaiselvam, S., and R. Parameshwaran. Thermal Energy Storage Technologies for Sustainability: Systems Design, Assessment and Applications. Elsevier.
2. Ataer, O. Ercan. Energy Storage Systems-Volume I (2009): 97, Encyclopaedia of Life Support Systems.
3. Fleischer, Amy S. Thermal Energy Storage Using Phase Change Material, Springer.

4. James Larminie, Fuel Cell Systems Explained, John Wiley & Sons, 2005.
5. Tetsuya Osaka, Energy Storage System for Electronics, Taylor & Francis Ltd., 2000.

Modes of Evaluation: Class tests/Assignment/Tutorial Assessment/Written Examination

Examination Scheme:

Components	Tutorial /Assignments	Class Tests	MSE	ESE
Weightage (%)	15	15	20	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	2					2			
CO2	3	3	2	2	1	1	2					2			
CO3	3	3	2	3	1	1	2					2			
CO4	3	3	3	3	1	1	2					2			
Average	**3**	**2.75**	**2.25**	**2.5**	**1**	**1**	**2**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**0**

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped