University of Engineering & Management

Institute of Engineering & Management, Salt Lake Campus

Institute of Engineering & Management, Newtown Campus

University of Engineering & Management Jaipur

New Syllabus Outline Structure

For
4th SEMESTER (B.Tech in Mechanical Engineering)

Effective for Admission Year 2026-2027

DEPARTMENT OF MECHANICAL ENGINEERING

B.Tech ME 4th SEMESTER

Sl. No.	Category	Code	Course Title	Hours per week			Contact hours	Credits
Theory Papers				L	T	P		
1	BSC	BSM401	Mathematics- IV	3	0	0	3	3
2	PCC	PCCME401	Fluid Mechanics & Fluid Machines	3	1	0	4	4
3	PCC	PCCME402	Kinematics & Dynamics of Machines	2	1	0	3	3
4	PCC	PCCME403	Internal Combustion Engine & Gas Turbine	2	1	0	3	3
5	PCC	PCCME404	Measurements & Metrology	2	1	0	3	3
6	HSMC	ESP401	Essentials Studies for Professionals – IV	2	0	0	2	0.5
Practical / Sessional Papers								
7	MC	MCC471	Sustainability, Climate Action & Environmental Science	0	1	2	3	2
8	PCC	PCCME491	Mechanical Engg Lab IIIA (Fluid Mechanics)	0	0	2	2	1
9	PCC	PCCME492	Mechanical Engg Lab IIIB (IC Engine)	0	0	2	2	1
10	PCC	PCCME493	Mechanical Engg Lab IIB (Measurements & Metrology)	0	0	2	2	1
11	ESC	ESCME481	Object Oriented Programming	0	0	2	2	1
12	PRJ	PRJME481	Project II (Research Methodology)	0	0	2	2	1
13	HSMC	SDP481	Skill Development for Professionals -IV	0	0	2	2	0.5
TOTAL							**33**	**24**
For B.Tech with Minor Degree (Robotics/ Sustainable Energy Engineering/ Artificial intelligence and Machine learning/Additive manufacturing)								
14	MD	MINOR401R	Mechanics of Robots	3	0	0	3	3
15	MD	MINOR401S	Climate Change Understanding & Observations	1	1	2	3	3
16	MD	MINOR401A	Introduction to Data Analytics	3	0	2	5	4
17	MD	MINOR401M	Design for Additive Manufacturing	3	0	2	5	4
Mandatory Courses								
18	IFC	IFC	Industry and Foreign Certification (IFC)	0	0	0	0	0
19	MAR	MAR	Mandatory Additional Requirements (MAR)	0	0	0	0	0
For B.Tech Honours Degree								
20	MOOCs	MOOCS	MOOCs Certificate Courses (NPTEL/SWAYAM)	-	-	-		

Subject Name: Mathematics-IV

Subject Code: BSM401 **Credit: 3** **Lecture Hours: 36**

CO	Course Outcomes
CO1	Identify different tools for differentiation and integration of functions of a complex variable that are used with various other techniques for solving engineering problems.
CO2	Appraise the notions of Fourier Series and Transform to solve advanced engineering problems.
CO3	Apprehend the concept of Laplace Transform together with its applications in evaluating integrals and solving ordinary differential equations.
CO4	Relate the use of Z-Transform for discrete functions and solve difference equations using Z-Transform technique.

Detail syllabus

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Mapping with Text book	Lecture Hours	Corresponding Lab Assignment
1	**Calculus of Complex Functions**	Complex function, Limit, Continuity and Differentiation; Analytic functions, Cauchy-Riemann equations (statement only); Harmonic functions, Harmonic Conjugate; construction of Analytic functions; elementary Analytic functions (exponential, trigonometric, logarithm) and their properties.	***International Academia:***erp.iitkgp.ac.in https://syllabus.stanford.edu/syllabus/#/mainSyllabus/MATH 117 ***AICTE-prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_ECE/EE/EEE/ME/BSC104/pg 43.pdf) ***Industry Mapping:***Analysis of AC circuit, physical problems involving ideal fluid flow , steady state heat and current flow can be solved using the theory.	Text book Chapter 19 & Chapter 20	8	**Associated Lab using MATLAB:** 1.Evaluation of contour integrals using **MATLAB** 2.Calculation of residues at the poles using **MATLAB**
2	**Fourier Series & Transfor**	*Fourier Series*: Even function, Odd function. Periodic function, Euler's formula,	**International Standards** :) https://syllabus.stanford.edu/syllabus/#/mainSyllabus/MATH 53	Fourier Series: Text book	12	**Associated Lab using MATLAB:** 1.Perform fourier

	m	Dirichlet's conditions; Sum of the Fourier series at the point of discontinuity and end points of an interval; Half Range Sine and Cosine Series; Parseval's Theorem. *Fourier Transforms*: Fourier Transform and its properties; Fourier Sine and Cosine Transforms, Fourier Transform of derivatives (statement only); Inverse Fourier Transform (statement only); Convolution theorem (statement only), related problems.	***Industry Mapping:***1. Designing and analysing electrical and electronic communication systems. 2.Fourier coefficients are used to analyse and predict signals and images. 3. In medical science, CT scan, ECG, EEG, X-ray are analysed using fourier transform.	Chapter 10 Fourier Transform: Text book Chapter 22		sine and cosine transforms using **MATLAB** 2. Write fourier series for some elementary functions using **MATLAB**
3	**Laplace Transform**	Laplace Transform and its properties; First and Second Shifting theorems; Laplace Transform of Periodic functions; Inversion of Laplace Transform by different methods, Convolution theorem; evaluation of integrals by Laplace Transform; solving ODEs by Laplace Transform method. .	***International Standards:*** https://web.stanford.edu/~boyd/ee102/laplace.pdf/Lecture 3 & 7 ***AICTE prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_ECE/EE/EEE/ME/BSC104/mOD 4/pg 211.pdf ***Industry Mapping:*** 1. In the circuit with inductor and capacitor connected to a generator, the charge, and the supply voltage may be estimated. Differential-Difference equations, Intrigo-differential equations often obtained during solving non-linear problems which is difficult otherwise.	Text book Chapter 21	10	**Associated Lab using MATLAB:** **1.** Perform Laplace transform of some elementary functions using **MATLAB** **2.** Perform inverse Laplace transform using **MATLAB**
4	**Z-Transfor**	Sequence, representation of sequence, Z-Transform and its	***International Standards:*** ***https://ccrma.stanford.edu/~jos/fp/***	Text book Chapter 23	6	**Associated Lab using MATLAB:**

	m	properties, Shifting theorems, Inverse Z-transform, Convolution theorem, region of convergence, concept of difference equation and their solution by Z-Transform method.	***Z_Transform.html*** ***AICTE prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_ECE/EE/EEE/ME/BSC104/mOD 4/pg 211.pdf ***Industry Mapping:*** *1. To find the current in the n-th loop for the ladder network.* *2.The principle of a controller design for process control.*			**1.** Compute z-transform of some elementary of some functions using **MATLAB** 2. Solve linear difference equation with constant coefficients using MATLAB

Text Book:

- **B. S. Grewal**, "Higher Engineering Mathematics", 44th Edition (2021), Khanna Publishers. (Chapter 10,19,20,21,22,23)

Reference Books:

1. **Biswadip Basu Mallik & Krishanu Deyasi,** "Engineering Mathematics" – Vol. 2B, 1st Edition (2020), Cengage Learning.
2. **B. K. Pal & K. Das,** "Engineering Mathematics" - Vol. IIB, 13th Edition (2019), Vol. IIIB, 8th Edition (2019), U. N. Dhur & Sons.
3. **Erwin Kreyszig,** "Advanced Engineering Mathematics", 10th Edition (2017), John Wiley & Sons.
4. **R. K. Jain and S. R. K. Iyengar,** "Advanced Engineering Mathematics", 5th Edition (2016), Narosa Publication House.
5. **B. V. Ramana,** "Higher Engineering Mathematics", 11th Reprint (2017), Tata McGraw Hill.

CO-PO Mapping:

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

Subject Name: Fluid Mechanics & Fluid Machines

Subject Code: PCCME401 **Credit: 4** **Lecture Hours: 48**

Prerequisite: No

Relevant link: **STUDY MATERIALS** **NPTEL** **COURSERA**

Course Objective(s):

The purpose of learning of this course is to:

1. To learn about the application of mass and momentum conservation laws for fluid flows
2. To understand the importance of dimensional analysis
3. To obtain the velocity and pressure variations in various types of simple flows
4. To analyze the flow in water pumps and turbines.

Module No.	Topic	Sub-topics	Mapping with Industry and International Academia	Mapping with Textbook & Chapter	Lecture Hours	Corresponding Lab Assignments
1	Basic Concepts and Properties of Fluid	definition, distinction between solid and fluid - Modules and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapor pressure, capillary, and surface tension. Fluid statics concept of fluid static pressure, absolute and gauge pressures – pressure measurements by manometers and pressure gauges. Hydrostatic forces on submerged surfaces, Stability of floating bodies.	***International Academia:*** (https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/pages/syllabus/) ***AICTE-prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf) ***Industry Mapping***: CFD, Open FOAM Software, ANSYS	*Text Book, RK Bansal, Chap – 1,2,3,4*	10	1.To explore the principles of fluid mechanics, including Stokes' law, Bernoulli's theorem, and hydraulic coefficients, and apply them to real-world scenarios using analytical, computational, and AI-based approaches s.
	Fluid	Fluid Kinematics - Flow visualization	***International Academia:***	*Text Book, RK Bansal*		Designing and Analyzing Flow

2	Kinematics and Fluid Dynamics	- lines of flow - types of flow - velocity field and acceleration - continuity equation (one- and three-dimensional differential forms)- Equation of streamline - stream function - velocity potential function - circulation - flow net. Fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli'sequation, applications - Venturi meter, Orifice meter, Pitot tube. Dimensional analysis - Buckingham's Pei theorem- applications - similarity laws and models.	(https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/pages/syllabus/) ***AICTE-prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf) ***Industry Mapping***: CFD, Open FOAM Software, ANSYS	*Chap – 5, 6, 12*	10	Through Notches Using AI Tools
3	Incompressible Fluid Flow-Viscous flow	Navier - Stoke's equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes. (Hagen Poiseulle's equation). Hydraulic and energy gradient - flow through pipes - Darcy - Weisback's equation – pipe roughness -friction factor- Moody's diagram- minor losses - flow through pipes in series and in parallel - power transmission. Boundary layer flows, boundary layer thickness and boundary layer separation. Drag and lift coefficients	***International Academia:*** (https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/pages/syllabus/) ***AICTE-prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf) ***Industry Mapping***: CFD, Open FOAM Software, ANSYS	*Text Book, RK Bansal Chap – 9, 10, 11, 12,13*	8	Analyzing Friction in Pipes Using Reynolds Apparatus with AI/GenAI
	Rotody	Euler's equation – theory of Roto	***International Academia:***	*Text Book,*		Assignment:

4	namic machin es - Pumps	dynamic machines – various losses and efficiencies. Centrifugal pumps - working principle, work done by the impeller, velocity triangle at the entry and exit, specific speed, multi-staging, NPSH, cavitation in pumps, performance curves. Reciprocating pump – working principle, indicator diagram and airvessel.	(https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/pages/syllabus/) ***AICTE-prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf) ***Industry Mapping***: CFD, Open FOAM Software, ANSYS	*RK Bansal Chap – 17, 19, 20*	10	Performance Characteristics of a Centrifugal Pump Using AI/GenAI. 1. Cavitation phenomena in centrifugal pump. 2. Centrifugal Pump Experiment (Series and paralleloperation)
5	Water Turbi ne	Classification, working principle, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, draft tube, Specific speed, unit Quantities, performance curves for turbines – governing ofturbines.	***International Academia:*** (https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/pages/syllabus/) ***AICTE-prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf) ***Industry Mapping***: CFD, Open FOAM Software, ANSYS	*Text Book, RK Bansal Chap - 18*	10	Assignment: Enhancing Water Turbine Design and Analysis Using AI and Generative AI
		Total			48	

Course Outcomes (s) (COs):

After completion of this course, the learner will be able to

1. Upon completion of this course, students will be able to analyze simple flow situations mathematically
2. They will be able to evaluate the performance of pumps and turbines.
3. Analyse the model and the prototype.
4. Find the dependent and independent parameters for a model of fluid flow.

Text Book:

1. Introduction to Fluid Mechanics and Hydraulic Machines, Dr. R.K.Bansal, Laxmi Publication. (Chap-1,2,3,4,5,6,9,10, 11,12,17,18,19,20)
2. A Text book of Fluid Mechanics and Hydraulic Machines, Dr. R.K.Rajput, S Chand Publishing

Reference Books

1. Introduction to Fluid Mechanics & Fluid Machines, Som and Biswas,TMH.
2. A Textbook on Fluid Mechanics and Machines, S.Pati,McGrawHill.
3. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press,2010.
4. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard BookHouse.

CO-PO Mapping:

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

Subject Name: Fluid Mechanics & Fluid Machines Lab

Subject Code: PCCME491 Credit: 1 Lecture Hours: 24

Objectives:

1. To understand the principles and performance characteristics and application of flow devices.
2. To know about the measurement of the fluid properties
3. To understand about rotodynamic machines

Contents

Details of Experiments	Industry Application	Mapping	Software
1. Pressure measurement instrument used in many i.e HVAC industry as Digital manometer	It detects gas leaks as well as faults in air conditioning systems. Other uses include maintenance of HVAC systems, monitoring gas pressure in piping and compressor systems, measuring fluid flow and blood pressure, etc.	***International Academia:*** (https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/pages/syllabus/)	***Quick analyser*** is a powerful software that allows to connect any PC in an easy and efficient way to all AEP transducers instrumentations with serial or USB
2. Total energy of fluid at a given section remains constant, validated through Bernoulli's Apparatus.	It is useful in 1) Dynamic lift of aeroplane. 2) Hydraulic press. the flow of water through small places like pipes, the way blood moves in our bodies, and how car carburetor's function. Some applications of Bernoulli's equation include Bunsen burners, flow sensors, ejectors, carburetors, aircraft wings, and spoilers on cars.	(https://ocw.mit.edu/courses/2-672-project-laboratory-spring-2009/pages/syllabus/)	**Cadence's Fidelity and Fidelity Pointwise:** CFD simulation tools use numerical methods to solve the equations governing fluid flow, to analyze flow behavior, calculate energy and flow rate
3. Viscosity of any fluid measured through Stoke's Law Apparatus	Applications of Stokes' law, such as testing the viscosities of fluid,	***AICTE-prescribed syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf	**Interactive simulation of Stokes' law:** An open-source interactive simulation of Stokes' Law is available on **Stoke's Law** is used to determine the terminal velocity of any object. This law also works in explaining the working of parachutes. Autodesk hydraulic modeling software CFD software can be used to analyze and design venturimeters for industrial application.

4. Finding different flow ratios used in model analysis in the form of hydraulic coefficients. 5. Controlling fluid flow through V notch and of Rectangular notches in dam. 6. Measuring fluid flow in piping industry through Venturimeter Apparatus 7. Industries using different softwares for laminar or turbulent flow mearured by Reynolt's apparatus. 8. One of the major parameters which lead to major loss in manufacturing sector is Friction In pipes 9. Performance characteristic, Cavitation	studying fog and rain, and industrial applications, such as separating particulates from drilling mud and separating oil from wastewater. Estimating model parameters to minimize the difference between model results and actual observations. To measure seepage of water through, around or under a dam in earth as well as concrete dams. Measuring, controlling, monitoring airflow, measuring sewage discharge in pipes of water treatment plant, refinery etc The Reynolds number is a fundamental parameter used in many industrial software applications, including: CFD, System design, HVAC etc. It identifies the type of flow. Designing and optimizing hydraulic systems, calculating pressure drop, Calculating flow rate etc. Industrial applications: Water	) ***Industry Mapping***: CFD, Open FOAM Software, ANSYS (https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/pages/syllabus/) (https://ocw.mit.edu/courses/2-672-project-laboratory-spring-2009/pages/syllabus/) (https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/pages/syllabus/) (https://ocw.mit.edu/courses/2-672-project-laboratory-spring-2009/pages/syllabus/)	CFD software is used in industrial applications of the Reynolds apparatus to simulate fluid flow and heat transfer through **Ansys fluent, Ansys CFX, Omnis, Pointwis**e. AioFlo calculates pipe sizes (diameter), fluid flow rates and pressure drops for compressible and incompressible fluids. AFT Fathom is used to calculate pressure drop and flow distribution in liquid and low-velocity gas piping and ducting systems. I **Edibon** Computer Controlled Fluid Friction in Pipes, with Hydraulics Bench **AFTC** is designed to determine the friction coefficient in pipes Many software options for piping design **Bentley:** comprehensive piping and vessel design and analysis software **AutoPIPE:** comprehensive piping and vessel design and analysis software, **CADWorx**: a powerful and versatile solution that redefines plant design and automation. CAESES, CFD for pump system design. cosmetic, agriculture, wine-making, dairy, mining, petroleum, food-processing, chemical, power

phenomena, multi-staging of Centrifugal Pump Experiment. 10. Study of Pelton Turbine	treatment, Oil refineries, Dairy: etc. Wastewater treatment, Hydroelectric power generation, Water supply and irrigation, Marine propulsion		**RITAL, CFturbo, software** can be used to design axial, radial and mixed-flow pumps, fans, blowers, compressors, and turbines, as well as for diffusers, **Ansys**

Course Outcome

1. Understand hands on experience in flow measurements using different devices.
2. Understand the working principle and performance of centrifugal pump and Turbine.
3. Know, how to calculate and draw characteristics curves for various experiments related to fluid mechanics.
4. Understand the energy flow pattern through the hydraulic turbines and pumps.

Text Book:

1. Introduction to Fluid Mechanics and Hydraulic Machines, Dr. R.K.Bansal, LaxmiPublication.
2. A Text book of Fluid Mechanics and Hydraulic Machines, Dr. R.K.Rajput, S Chand Publishing

Reference Books

3. Introduction to Fluid Mechanics & Fluid Machines, Som and Biswas,TMH.
4. A Textbook on Fluid Mechanics and Machines, S.Pati, McGrawHill.
5. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press,2010.
6. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard BookHouse.

CO-PO Mapping:

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

Subject Name: Kinematics and Theory of Machines
Subject Code: PCCME402 **Credit: 3** **Lecture Hours: 36**

Pre-requisite: Engineering Mechanics (Statics), Engineering Mechanics (Dynamics)

Relevant Link: STUDY MATERIAL **NPTEL** **COURSERA (1 & 2)**

Module No.	Topic	Sub-topics	Textbook & Chapter No.	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignment
1	**Mechanisms**	Definition and types of joints; Lower and higher pairs; Classification of mechanisms based on function and constraints; Common mechanisms such as slider crank and 4-bar mechanisms and their inversions; Quick return mechanism, Straight line generators, rocker mechanisms, universal joints, steering mechanisms, etc.	Theory of machine, S S Rattan, Chapter 1	***National Standards:*** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf ***International Standards:*** https://ocw.mit.edu/courses/2-12-introduction-to-robotics-fall-2005/resources/chapter4/ ***Industry Mapping:*** MATLAB, SIMULINK, SIMSCAPE	6	1. Analyze and simulate the kinematics of a four-bar mechanism in MATLAB by formulating and implementing displacement, velocity, and acceleration analysis.
2	**Basic Kinematic Concepts and Definitions**	Degree of freedom and Grübler's formula; Grashof's rule and rotatability limits; Mechanical advantage; Transmission angle; Limit positions.	Theory of machine, S S Rattan, Chapter 1	***National Standards:*** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf ***International Standards:*** https://ocw.mit.edu/courses/2-12-	5	2. Create and analyze the dynamic behavior of a slider-crank mechanism in MATLAB-SIMULINK, formulating the system's equations of motion and generating

				introduction-to-robotics-fall-2005/resources/chapter4/ ***Industry Mapping:*** MATLAB, SIMULINK, SIMSCAPE		simulations under varying input conditions. 3. Develop a MATLAB-SIMSCAPE model for a quick return mechanism, to generate motion dynamics and force analysis to evaluate the mechanical advantage across different configurations.
3	**Kinematic Analysis of Simple Mechanisms**	Displacement, velocity, and acceleration analysis; Velocity analysis using instantaneous centers; Position, velocity and acceleration analysis using loop closure equations; Coincident points; Coriolis component of acceleration.	Theory of machine, S S Rattan, Chapters 2, 3	***National Standards:*** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf ***Industry Mapping:*** SOLIDWORKS Motion Simulation	8	
4	**Static & Dynamic Force analysis of Simple Mechanisms**	Two & three force members; Force & moment equilibrium; Inertial forces; Equations of motion for force-bar and slider-crank mechanisms.	Theory of machine, S S Rattan, Chapter 12, 13	***National Standards:*** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf ***International Standards*** : https://ocw.mit.edu/courses/2-003sc-engineering-dynamics-fall-2011/resources/mit2_003scf11_rec6notes1/ ***Industry Mapping:*** MATLAB, SIMULINK, SIMSCAPE	6	4. Simulate and optimize the motion of a cam and follower system in SOLIDWORKS, analyzing displacement, velocity, and acceleration profiles, and formulating both graphical and analytical solutions for the follower's motion.
5	**Cams and Followers**	Classification and terminology; Displacement, velocity, acceleration and jerk	Theory of machine, S S Rattan, Chapter 7	***National Standards:*** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.	5	5. Create an ADAMS model for an epicyclic gear train,

		diagrams; Uniform velocity, parabolic, simple harmonic and cycloidal motions; Derivatives of follower motions; Circular and tangent cams; Pressure angle and undercutting; Graphical and analytical disc cam profile synthesis for roller and flat face followers.		pdf ***International Standards:*** https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-12-rotations-and-translation-rolling/#Deep_Dive ***Industry Mapping:*** 1. Physical inspection of cam-follower mechanisms in machines 2. Hexagon ADAMS Simulation 3. SOLIDWORKS motion analysis		generating simulations to analyze kinematic behavior, force transmission, efficiency, transmission angle, and conjugate action under various load conditions.
6	**Gears**	Involute profiles; gear parameters; Fundamental law of gearing and conjugate action, Force analysis Spur gear, helical gear; Epicyclic and regular gear train kinematics	Theory of machine, S S Rattan, Chapters 10, 11	***National Standards:*** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf ***International Standards:*** https://ocw.mit.edu/courses/2-003sc-engineering-dynamics-fall-2011/pages/mechanical-vibration/ ***Industry Mapping:*** Hexagon ADAMS Simulation	6	6. Create a MATLAB library function to automate the graphical synthesis of a crank-rocker mechanism for path and motion generation. The function should accept input parameters (link lengths, input angles) and output the corresponding motion paths and kinematic results, enabling black-box type analysis.

Course Outcomes:

After completing this course, the students should be able to -

1. Comprehend the kinematics and rigid-body dynamics of machine components driven by kinematic inputs, focusing on their motion

behavior.

2. Analyze the motion of interconnected mechanisms by determining the displacement, velocity, and acceleration of any point on a rigid link.
3. Design and develop linkage mechanisms and cam systems to achieve desired output motion, based on specified design criteria.
4. Master the kinematics of gear trains, understanding their operation and behavior in various configurations.

Text Book -

5. "Theory of Machine" by S S Ratan, McGraw Hill Education India Private Limited (Chapters – 1,2,3,7,10,11,12,13)

Reference books:

1. A. Ghosh and A.K. Mallick, Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd., New Delhi, 1988.
2. T. Bevan, Theory of Machines, 3rd Edition, CBS Publishers & Distributors, 2005.
3. W.L. Cleghorn, Mechanisms of Machines, Oxford University Press, 2005.
4. R.L. Norton, Kinematics and Dynamics of Machinery, 1st Edition, McGraw Hill India, 2010.

CO-PO Mapping:

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

Subject Name: IC Engine & Gas Turbine

Subject Code: PCCME403 **Credit: 3** **Lecture Hours: 36**

Prerequisites: Thermodynamics

Relevant Links: **STUDY MATERIAL** **NPTEL**

COURSE OBJECTIVES:

1. To acquire knowledge about the IC engine cycles, classification, and working principles and to measure performance parameters along with the heat balance sheet.
2. To provide complete knowledge of combustion phenomena in IC Engines, the type of fuels used, and the fuel supply systems.
3. To explain the effects of exhaust emissions on human health, the environment, and various pollution norms.
4. To explain the Gas Turbine with various operating cycles (ideal and real).

Module No	Topic	Sub-topics	Textbook & Chapter No.	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignment
1	**Introduction**	Internal and external combustion engines, classification and nomenclature of I.C. Engines, air standard Otto, Diesel and Dual combustion cycles, deviation of actual engine cycle from ideal cycle, fuel air cycle analysis, real cycles, valve timing diagram.	I.C. Engines, V. Ganesan, Chapter 1, 2 and 3	***International Standard:*** (https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/calendar/) ***AICTE-prescribed syllabus/IIT Syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-1/ug-vol1.pdf) / https://people.iitism.ac.in/~academics/assets/course_structure/new/cat/mech/MEC307.pdf) ***Industry Mapping:*** SolidWorks/ ANSYS/ MATLAB	6	1. Disassembly and assembly of Engine Model. 2. Modeling an Engine using Matlab 3. IC Engine valve motion

						analysis using SolidWorks
2	**Carburetors & Fuel Injection**	Mixture requirements for various operating conditions in S.I. Engines, elementary carburetor, single-point and multi-point fuel injection systems, diesel injection system, calculation of air-fuel ratio for a simple carburetor, electronic fuel injection in S.I. engine, requirements of diesel injection system, types of injection systems - port fuel injection, direct injection, common rail injection, gasoline direct injection system, fuel pumps, Variable Valve Technology.	I.C. Engines, V. Ganesan, Chapter 7, 8 and 9	***International Standard:*** (https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/calendar/) ***AICTE-prescribed syllabus/IIT Syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-1/ug-vol1.pdf) / https://people.iitism.ac.in/~academics/assets/course_structure/new/cat/mech/MEC307.pdf) ***Industry Mapping:*** SolidWorks/ ANSYS/ MATLAB	6	1. Study of MPFI (multipoint fuel injection) system. 2. Study of valve timing diagram of diesel engine. 3. Analysis of fuel injector using ANSYS
3	**Ignition systems**	Types of ignition systems - Battery and Magneto ignition system, electronic ignition system, ignition timing, spark plugs, spark advance, ignition delay.	I.C. Engines, V. Ganesan, Chapter 10	***International Standard***: (https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/calendar/) ***AICTE-prescribed syllabus/IIT Syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-1/ug-vol1.pdf) / https://people.iitism.ac.in/~academics/assets/course_structure/new/cat/mech/MEC307.	3	1. Modeling engine timing using triggered subsystems

				pdf) ***Industry Mapping:*** SolidWorks/ ANSYS/ MATLAB		
4	**Combustion in I.C. Engines**	Stages of combustion in S.I. & CI Engines, factors influencing the combustion phenomenon, combustion chambers and abnormal combustion - detonation and knocking, influence of engine variables on detonation, pre-ignition, delay period, variables affecting delay period, lubrication and cooling systems.	I.C. Engines, V. Ganesan, Chapter 11, 12 and 13	***International Standard***: (https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/calendar/) ***AICTE-prescribed syllabus/IIT Syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-1/ug-vol1.pdf) / https://people.iitism.ac.in/~academics/assets/course_structure/new/cat/mech/MEC307.pdf) ***Industry Mapping:*** SolidWorks/ ANSYS/ MATLAB	5	1. Comprehensive IC engine flow & combustion simulation using ANSYS 2. Modeling an engine cooling system using MATLAB
5	**Engine Testing and Performance**	Measurement of various engine performance parameters, heat balance, Morse tests.	I.C. Engines, V. Ganesan, Chapter 15 and 16	***International Standard***: (https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/calendar/) ***AICTE-prescribed syllabus/IIT Syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-1/ug-vol1.pdf) / https://people.iitism.ac.in/~academics/assets/course_structure/new/cat/mech/MEC307.pdf) ***Industry Mapping:*** ANSYS/ MATLAB	4	1. Performance Test of an I.C. Engine using electric (eddy current) dynamometer. 2. Calculating efficiency of Otto cycle by MATLAB Simulink
6	**Turbocharging and Supercha**	Objectives of supercharging, its advantages and	I.C. Engines, V.	***International Standard***: (https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-	3	1. Computational fluid dynamics

	ging	applications; turbocharging and supercharging of SI and CI Engines; limitations of supercharging.	Ganesan, Chapter 18	2017/pages/calendar/) ***AICTE-prescribed syllabus/IIT Syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-1/ug-vol1.pdf) / https://people.iitism.ac.in/~academics/assets/course_structure/new/cat/mech/MEC307.pdf) ***Industry Mapping:*** ANSYS/ MATLAB		(CFD) analysis of turbocharger 2. Computational fluid dynamics (CFD) analysis of supercharger
7	**Emissions & Alternate Fuels for IC Engines**	Fuels and rating of fuels for internal combustion engine. Engine emission and control, NOx formation, carbon monoxide and unburned hydrocarbon emissions, particulate emissions, exhaust gas treatment, catalytic converters, emission standards. Basic overview of alternative fuels, environmental pollution from vehicles, its measurement and control, biogas and hydrogen in engines.	I.C. Engines, V. Ganesan, Chapter 6 and 14	***International Standard***: (https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/calendar/) ***AICTE-prescribed syllabus/NIT Syllabus:*** (https://www.aicte-india.org/sites/default/files/Model_Curriculum/UG-1/ug-vol1.pdf) / https://website.nitrkl.ac.in/Academics/AcademicDepartments/SyllabiDetails.aspx?d=TUU6TWVjaGFuaWNhbCBFbmdpbmVlcmluZw==-muzHrU86jFw=&di=MTY=-/NBtEwG4h0k=&c=TWVjaGFuaWNhbCBFbmdpbmVlcmluZyAoQi5UZWNoLiAtIDR5cnMp-ZQC9+Ctqefk=&t=VUc=-/CGGPdtU1IU=&s=NzA2Ng%3d%3d-9pPKosm5Tm8%3d) ***Industry Mapping:*** ANSYS/ MATLAB	3	1. Experimental study of exhaust gases of an IC engine. 2. Use of catalytic converters and their effect on flue gas of an I.C. Engine. 3. Determination of calorific value of a fuel by Bomb calorimeter.
8	**Gas Turbines**	Brayton cycle, open and closed gas turbine plants, improvements of the basic gas turbine cycle, reheating and regeneration, applications of gas	Gas Turbines, V. Ganesan, Chapter 4 and 5	***International Standard***: (https://ocw.mit.edu/courses/2-60j-fundamentals-of-advanced-energy-conversion-spring-2020/resources/mit2_60s20_lec15/) ***AICTE-prescribed syllabus/NIT Syllabus:***	6	1. Performing calculation of a gas turbine thermodynamic cycle using MATLAB

		turbines, requirements of a gas turbine.		(https://people.iitism.ac.in/~academics/assets/course_structure/new/cat/mech/MEC307.pdf) ***Industry Mapping:*** SolidWorks/ANSYS/ MATLAB		

COURSE OUTCOMES:

CO1: To explain the operating characteristics and thermodynamic analysis of common internal combustion engine cycles.
CO2: To understand about the combustion phenomenon of SI and CI engines, engine emissions and exhaust treatment models.
CO3: To assess the performance of IC engines, efficiency enhancement methods and the importance of alternate fuels.
CO4: To identify the essential components of gas turbines along with their performance-improving methods.

TEXT BOOKS:

1. V. Ganesan, I.C. Engines, McGraw Hill, 2017. (Chapters – 1,2,3,6,7,8,9,10,11,12,13,14,15,16,18)
2. V. Ganesan, Gas Turbines, McGraw Hill, 2004. (Chapters – 4,5)

REFERENCE BOOKS:

1. C.R. Ferguson and A.T. Kirkpatrick, Internal Combustion Engines, Wiley, 2015.
2. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI, 2012.
3. H. Cohen, H.I.H. Saravanamuttoo, G.F.C. Rogers, P. Straznicky and A.C. Nix, Gas Turbine Theory, Pearson, 2019.
4. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Co., 1988.

CO-PO Mapping:

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

Subject Name: Mechanical Engg Lab IIIB (IC Engine)

Subject Code: PCCME492 **Credit:1** **Lecture Hours: 24**

Prerequisites: Engineering Thermodynamics

COURSE OBJECTIVES:

1. To understand the function and different components of an I.C. Engine.
2. To know about the fundamentals of I.C. Engines operations and their performance characteristics, efficiency, fuel requirements, and environmental impact.

COURSE CONTENT:

Experiments	Mapping with Industry and International Academia	Corresponding Lab Assignment
1. Disassembly and assembly of a working 4-stroke 3-cylinder SI Engine and finding faults for maintenance work.	***AICTE prescribed syllabus:*** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf ***International Standards:*** https://ocw.mit.edu/courses/2-61-internal-combustion-engines-spring-2017/pages/labs/ ***Industry Mapping:*** SolidWorks, ANSYS, MATLAB	Create a mathematical model of a 4-stroke S.I. Engine in MATLAB.
2. Analysis of the MPFI (multipoint fuel injection) system and developing an Arduino based injection control module with optimized code and testing of the same.		Analyse the heat and fluid flow of the fuel through a fuel injector using ANSYS.
		Using SolidWorks, analyse the valve motion for the inlet and outlet valves of a diesel engine.
3. Performance Testing of a 4- stoke 4-cylinder SI Engine using an Eddy Current Dynamometer: Analysis of brake power, efficiencies, and fuel consumption to formulate the heat balance sheet to understand the engine's performance under different fuel blend condition.		Calculate the efficiency of a 2-stroke IC Engine using MATLAB Simulink.
4. Experimental analysis of exhaust gases from an Internal Combustion Engine and findings the emission characteristics and environmental impact with different blending of biodiesel/ethanol and modifying the catalytic converters.		Make a model of the exhaust system of a 4-stroke S.I. engine and analyse the heat release from the system in ANSYS using transient conditions.

		Conduct a CFD analysis of the flow rate and heat transfer involved with the flow of flue gases from the exhaust pipe of an automobile in ANSYS.
5. Determination of Calorific Value of solid/liquid fuels as per ASTM standards using a microprocessor based automated bomb calorimeter: Energy Analysis to study the direct influence of a fuel's calorific value on engine performance and efficiency.		Model the heat release and temperature distribution during the combustion of a fuel inside a bomb calorimeter using ANSYS.
Mini Project: Create a MATLAB script titled "ICEPerformanceSimulator.m" that simulates the performance of a 4-stroke S. I. engine that uses input parameters like engine displacement, compression ratio, fuel type, and operating conditions (load, R.P.M.), and the script calculates key outputs like power, torque, specific fuel consumption and thermal efficiency. The tool should also help visualize the performance curves of the engine.		

COURSE OUTCOMES:

CO1: Study the working of different engine terminology and different components of I.C. Engines.
CO2: Understand the various losses, stages of combustion and performance parameters in I.C. Engines.
CO3: Apply knowledge of thermodynamics and measure performance characteristics of I.C. Engines.
CO4: Evaluation of engines emission and their effect on environment.

Learning Resources:

Richard Van Basshuysen, Fred Schaefer, Internal Combustion Engine Handbook, 2nd English Edition, SAE International, 2016

CO-PO Mapping:

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

Subject Name: Measurements & Metrology
Subject Code: PCCME404 **Credit: 3** **Lecture Hours: 36**

Pre-requisite: Physics

Relevant Link: **STUDY MATERIAL** **NPTEL (1 & 2)** **Coursera (1, 2)**

Objectives:

1. To discuss suitable methods and devices for dimensional, geometrical, and surface roughness measurements, and designing the limit gauges.
2. To interpret the characteristics of measuring instruments and apply suitable methods of measurement for physical quantities such as force, pressure, temperature, velocity, torque, vibration, etc.
3. To identify and estimate measurement errors and suggest suitable techniques to minimize them.
4. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.

COURSE CONTENT:

Module number	Topic & Sub-topics	Mapping with Industry and International Academia	Mapping with Text Book	Lecture Hours	Corresponding Lab Assignment
I	**Measurement Purpose and Parameters:** Parameters–geometry (straightness, flatness, roundness, etc.), displacement, force, speed, torque, flow, level, pressure, temperature, acceleration, etc.; Definitions: Accuracy, precision, range, resolution, uncertainly and error sources; Regression analysis.	**International Academia:** https://meche.mit.edu/featured-classes/measurement-and-instrumentation **IITTP:** https://www.iittp.ac.in/pdfs/syllabus/2022_NewCourses/ME/ME213L.pdf **AICTE-prescribed syllabus:** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf **Industry Mapping:** Stress/Strain/Force Measurements Equipment/Devices/Sensors	A K Bewoor, V A Kulkarni: Metrology & Measurement Chapter 4 Jain R.K. "Engineering Metrology Chapter 7	**5**	1. Develop a MATLAB program to simulate the output of a load cell, calculate the force based on the sensor's sensitivity and excitation voltage, and visualize the results with a plot. 2. Write a MATLAB script to simulate the output of a torque sensor, calculate the corresponding torque using given calibration parameters, and plot the torque values. 3. Create a MATLAB script

					to simulate circularity measurement by introducing deviations to an ideal circle, calculate the measured radius, and visualize the ideal and measured profiles using polar plots.
II	**Measurement Principles:** Structure and examples of measurement systems; Calibration principles; Linear and angular measurements; Comparators; Gauge design; Interferometry.	**International Academia:** https://meche.mit.edu/featured-classes/measurement-and-instrumentation IIT: https://www.iittp.ac.in/pdfs/syllabus/2022_NewCourses/ME/ME213L.pdf **AICTE-prescribed syllabus:** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf **Industry Mapping:** sine bar, sine center, bevel protractor, tool makers microscope, AutoCAD	A K Bewoor, V A Kulkarni: Metrology & Measurement Chapter 3,7,8 & 9 Jain R.K. "Engineering Metrology Chapter 2, 4, 5, 6, 8	**4**	1. With a neat diagram explain the working of AC laser interferometer and show its industrial application. 2. Measurement angle using sine bar/ sine center/ bevel protractor/ tool makers microscope 3. Measurement of Cutting Tool Angles by Tool Maker's MicroScope 4. Calibration of Micrometer using slip gauges
III	**Limits, Fit, and Tolerances:** Definitions; Tolerance zone and grades, Hole and shaft system, Geometric tolerances, Tylor's principle of gauging, Design of tolerances for various applications; Tolerance analysis in manufacturing and assembly; Role of metrology in Design of Manufacturing.	**International Academia:** https://meche.mit.edu/featured-classes/measurement-and-instrumentation **AICTE-prescribed syllabus:** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf **Industry Mapping:** Gears/Screw Threads Measurements Equipment/Devices/Sensors gear tool micrometer, different industrial gauges	A K Bewoor, V A Kulkarni: Metrology & Measurement Chapter 6 Jain R.K. "Engineering Metrology Chapter 4, 10	**6**	1. Measurement of Screw Thread using Floating Carriage Micrometer/ 2 wire/3 Wire Thread Measuring Systems 2. Measurement of Gear Tooth Thickness by Gear Tooth vernier caliper/Constant Chord /Span Micrometer.
IV	**Mechanical Measurements**	**International Academia:**	A K Bewoor,	**7**	1. How gear tooth Vernier

	and Equipment: *Dimensional metrology* – Vernier, micrometers, LVDT; *Form metrology* – form tester, surface profiler, CMM, 3D scanning; *Surface metrology*– optical microscopes, Laser scanning microscopes, electron microscopy (SEM/TEM), x-ray microscopy, Raman spectroscopy; Tool wear, workpiece quality, and process metrology.	https://mitocw.ups.edu.ec/courses/biological-engineering/20-309-biological-engineering-ii-instrumentation-and-measurement-fall-2006/ **AICTE-prescribed syllabus:** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf **Industry Mapping:** imageJ software, Talysurf surface analyser, profile projector,	V A Kulkarni: Metrology & Measurement Chapter 14 &16 Jain R.K. "Engineering Metrology Chapter 11, 17		caliper can be used for measuring tooth thickness? 2. measure the surface roughness of a given specimen.
V	**Thermal and Flow Measurement**: Measurement of temperature, thermal conductivity and diffusivity; Flow obstruction methods; Magnetic flow meters.	**International Academia:** https://meche.mit.edu/featured-classes/measurement-and-instrumentation **AICTE-prescribed syllabus:** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf **Industry Mapping:** Thermocouples, Thermistor	A K Bewoor, V A Kulkarni: Metrology & Measurement Chapter 20 &22	**4**	1. Measurement of temperature using Thermocouple trainer (Thermocouples, Resistance Temperature Detectors, Thermistor)
VI	**Electrical Measurements and Instruments:** Signal generators and analysis; Wave analyzer; Spectrum analyzer; *Frequency counters* – measurement errors, extending the frequency range; *Transducers* – types, strain gages, displacement transducers; *Digital data acquisition system* - interfacing	**International Academia:** https://ocw.mit.edu/courses/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/pages/syllabus/ **AICTE-prescribed syllabus:** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf **Industry Mapping:** MATLAB, Labview, PLC	A K Bewoor, V A Kulkarni: Metrology & Measurement Chapter 1 6 &17 E.O Doebelin and Dhanesh Manik, "Measurement Systems	**6**	1. Simulate any two-measurement systems using LAB VIEW. 2. Design various transducer circuits systems for measuring different non-electrical quantities. 3. design a required waveform using arbitrary waveform generator and measure various parameters using DSO

	transducers to electronics control and measuring system; Instrumentation amplifier; Isolation amplifier; Computer-controlled test systems.		Chapter 3,4,5,6		
VII	**Design of Experiments and Statistical Analysis:** DOE techniques; orthogonal arrays; Data acquisition, signal processing, and conditioning; Error reduction techniques using AI/ML; Quality control and assurance in industry.	**International Academia:** https://professional.mit.edu/course-catalog/design-and-analysis-experiments **IITTP:** https://www.iittp.ac.in/pdfs/syllabus/2022_NewCourses/ME/ME213L.pdf **AICTE-prescribed syllabus:** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf **Industry Mapping:** Design expert, Minitab, Statpro	A Kulkarni: Metrology & Measurement Chapter 4	**4**	1. Create a Design of experiment in mintab/designexpert. 2. ANOVA, Regression Analysis, and Interaction Effects of any experimental set from journal paper. Prepare a predictive modelling using AI.

Text Books:

1. A K Bewoor, V A Kulkarni: Metrology & Measurement, McGraw Hill Education, 2009 (Chapter 3,4,6,7,8,9,14,16,20,22)
2. Jain R.K. "Engineering Metrology", Khanna Publishers, 2009. (Chapter 2,4,5,6,7,8,10,11,17)
3. E.O Doebelin and Dhanesh Manik, "Measurement Systems", McGraw Hill,2017

Reference Books:

1. Doebelin E O, Measurement Systems: Application and Design, 4th Edition, McGraw Hill Higher Education (1989).
2. Shotbolt C S and Galyer J, Metrology for Engineers, Cassell Publications, 5th Edition (1990).
3. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.
4. D. James, and S, Meadow, "Geometric Dimensioning and Tolerancing", Marcel Dekker, 1995
5. Madhav S. Phadke, Quality Engineering using Robust Design, Prentice Hall,1989
6. Beckwith G and Thomas G, Mechanical Measurements, 6th Edition, Pearson Education (2013).
7. Smith G T, Industrial Metrology, Springer (2002).

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Basic knowledge about measurement systems and their components
2. Various instruments used for measurement of mechanical and electrical parameters
3. Integrate measurement systems for process monitoring and control
4. Design of limits, fits, and tolerances for given applications

CO-PO Mapping:

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

Subject Name: Mechanical Engg Lab IIB (Measurements & Metrology)

Subject Code: PCCME493 **Credit: 1** **Lecture Hours: 24**

Pre-requisite: No

Objectives:

1. To understand the proper use and maintenance of important instruments, such as Vernier callipers, autocollimators, slip gauges, and pyrometers
2. To identify the techniques for the quality assurance of the products and the optimality of the process in terms of resources and time management.
3. To experiment with measuring equipment used for linear and angular measurements.
4. To find common types of errors in measurement equipment.
5. To experiment with different types of sensors, transducers, and strain gauges equipment.
6. To make use of thermocouples for measurement of temperature.

Course Content:

It should include about 14 experiments as outlined below:

Module number	Topic & Sub-topics	Mapping with Industry and International Academia	Corresponding Lab Assignment
	1. Use of straight edge and sprit level in finding the flatness of surface plate. Ensuring flatness of jigs, fixtures, and machine bases for precision machining. 2. Measurement of linear, angles, tapered objects using comparator, bevel vernier protractor, and Sine Bar, respectively. Inspecting any machine parts to ensure precision and adherence to design specifications. 3. Measurement of threads using two-wire/three-wire method assuring	**International Academia:** https://mitocw.ups.edu.ec/courses/biological-engineering/20-309-biological-engineering-ii-instrumentation-and-measurement-fall-2006/ **AICTE-prescribed**	Develop a MATLAB Simulation and Analysis Tool for Measuring Surface Flatness Using Straight Edge and Spirit Level: Ensuring Precision in Jigs, Fixtures, and Machine Bases

quality in the production of fasteners, threaded shafts, and screws for industries, ensuring proper fit and strength. 4. Use gear teeth Vernier calipers and check the Gear tooth thickness and chordal addendum of spur gear. Inspection and validation of gear dimensions in the production of automotive transmissions, industrial gearboxes, and heavy machinery to ensure smooth operation and durability. 5. Use profile projector/ tool makers microscope to inspect small and complex components such as cutting tools, and micro-electronic parts, ensuring they meet precise tolerances. 6. Measurement of bore diameter using micrometer and gauges (Bore gauge/ telescopic gauge). Validating bore dimensions of engine cylinders, pistons, or pumps during the production process to ensure fit and functionality. 7. Practicing different gauges to assess angles, thread, internal and external radius, etc. Check quality of sheet metal products/ turbine blades/ engine parts to verify dimensional accuracy. 8. Measurement of surface roughness by Talysurf instrument. Ensuring the required surface finish for parts like bearings/ seals, where surface quality impacts performance and longevity. 9. Statistical process control system to apply to measured dimension of samples to monitor dimensional consistency to reduce defects and improve process capability. 10. Calibration of transducer or thermocouple for temperature measurement ensure accurate temperature control in manufacturing processes such as	**syllabus:** https://www.aicte-india.org/sites/default/files/Model_Curriculum/Final_Mechanical%20Engg.pdf **Industry Mapping:** imageJ software, SolidWorks Inspection Taylor Hobson TalyMap MATLAB, Labview, PLC Design expert, Minitab, Statpro	Taylor Hobson TalyMap Software for analyzing roughness and texture of bearing materials and check with catalog. Varying process parameter do experiments on any machine. Measure roughness Do statistical analysis of response data and process control using MiniTab. Using SolidWorks Inspection verify gauge readings and assessments. Analyze the microscopic image using ImageJ software. CATIA Measurement Modules for angle and surface analysis/ taper analysis in design. NI LabVIEW for interfacing with sensors to automate flatness measurements. LabVIEW for creating

heat treatment, plastic molding, and metal casting for product quality assurance. 11. Calibration of LVDT transducer for displacement measurement verify precise displacement in CNC machines and robotic systems used in advanced manufacturing and assembly processes. 12. Calibration of capacitive transducer for monitoring angular positions in rotating machinery such as robotic arms/ indexing tables/ spindle heads in manufacturing systems. 13. Determination of modulus of elasticity of a mild steel specimen using strain gauges and ensure they meet load-bearing and deformation criteria. 14. Study and use of a Seismic pickup for the measurement of vibration amplitude of an engine bed/ CNC machines/ rotary systems at various loads.		custom LVDT calibration systems.

Text /Reference Books:

1. Bewoor & Kulkarni, "Metrology & Measurement" Tata McGraw Hill, 2009.
2. E.O Doebelin and Dhanesh Manik, "Measurement Systems", McGraw Hill,2017
3. D. James, and S, Meadow, "Geometric Dimensioning and Tolerancing", Marcel Dekker, 1995
4. Madhav S. Phadke, Quality Engineering using Robust Design, Prentice Hall,1989

Online Resources:

1. Mechanical Measurements and Metrology by Prof. S P Venkateshan (IIT Madras), NPTEL Course (Link:https://nptel.ac.in/courses/112/106/112106138/).
2. Principles of Mechanical Measurement by Prof. Dipankar N Basu (IIT Guwahati), NPTEL Course (Link:https://nptel.ac.in/courses/112/103/112103261/).

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Basic knowledge about measurement systems and their components
2. Various instruments used for the measurement of mechanical and electrical parameters
3. Integrate measurement systems for process monitoring and control
4. Conduct different machine alignment tests.

Virtual Lab:

1. To use Vernier Callipers for the measurement of the dimensions of a given object.
   https://amrita.olabs.edu.in/?sub=1&brch=5&sim=16&cnt=4
2. To use Micrometer Screw Gauge for the measurement of dimensions (Length, Thickness, Diameter) of a given object.
   https://amrita.olabs.edu.in/?sub=1&brch=5&sim=156&cnt=4
3. To calculate Young's modulus of elasticity of steel wire by Vernier method
   https://amrita.olabs.edu.in/?sub=1&brch=5&sim=155&cnt=4
4. Electron Microscopy
   https://emb-iitk.vlabs.ac.in/Introduction.html
5. Characterize the LVDT
   https://sl-coep.vlabs.ac.in/exp/lvdt/index.html
6. Characterize the Strain gauge sensor
   https://sl-coep.vlabs.ac.in/exp/strain-gauge-sensor/procedure.html
7. Measurement of Torque using Torque Sensor
   https://kcgcollege.ac.in/Virtual-Lab/Mechanical/simulation.html
8. Surface Roughness Measurement
   https://kcgcollege.ac.in/Virtual-Lab/Mechanical/Exp-3/

CO-PO Mapping:

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

University of Engineering and Management

Institute of Engineering & Management, Salt Lake Campus
Institute of Engineering & Management, New Town Campus
Institute of Engineering & Management, Jaipur

Subject Name: Object Oriented Programming **Credit: 1**

Subject Code: ESCME481 **Lecture Hours: 36**

Pre-requisite: Basic knowledge of computer fundamentals, programming in C/C++, logical and mathematical reasoning, and basic understanding of algorithms and problem-solving concepts.

Objectives:
To develop the ability to efficiently organize, manage, and process data using appropriate data structures and algorithms through programming.

Contents

Module & Topic	Sub-topics	Mapping with Industry and International Academia
Module I: Introduction to Object Oriented Programming Paradigms	Introduction to various programming paradigms, advantages of OOP, comparison of OOP with Procedural Paradigm, Classes and Objects: Prototyping, Referencing the variables in functions, Inline function, static and friend functions, Memory allocation for classes and objects, Arrays of objects, Constructors	**NPTEL** https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs34 **Linkedin** 1. https://www.linkedin.com/learning/programming-foundations-object-oriented-design-3/learn-object-oriented-design-principles?u=229219690 2. https://www.linkedin.com/learning/python-object-oriented-programming-22888296/python-object-oriented-programming?u=229219690 **Coursera** https://www.coursera.org/projects/object-oriented-programming-in-python

Module II: Polymorphism & Inheritance	Introduction to Polymorphism, Polymorphism with a Function and Objects, Overriding Methods, Type conversions from basic data types to user defined and vice versa, Base classes and Derived classes, Types of inheritance, Various types of classes, Invocation of Constructors and Destructors in Inheritance, Aggregation, composition, Classification hierarchies, Meta class/abstract classes, Unit Testing and Exceptions.	**NPTEL** https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs34 **Linkedin** 1. https://www.linkedin.com/learning/programming-foundations-object-oriented-design-3/learn-object-oriented-design-principles?u=229219690 2. https://www.linkedin.com/learning/python-object-oriented-programming-22888296/python-object-oriented-programming?u=229219690 **Coursera** https://www.coursera.org/projects/object-oriented-programming-in-python
Module III: Python libraries	Basics of open-source libraries for data preprocessing, Data Analysis with python, Data Analysis libraries, Data Modelling, Type of an object, Special Methods for Data Modelling in Python, Data Visualization, Data Visualization in Python using Matplotlib, Data Visualization in Python using Seaborn, Data Visualization in Python using Plotly	**NPTEL** https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs34 **Linkedin** 1. https://www.linkedin.com/learning/programming-foundations-object-oriented-design-3/learn-object-oriented-design-principles?u=229219690 2. https://www.linkedin.com/learning/python-object-oriented-programming-22888296/python-object-oriented-programming?u=229219690 **Coursera** https://www.coursera.org/projects/object-oriented-programming-in-python

Module IV: Using Python to Access Web Data	Regular Expressions, Regular Expression Functions, Extracting Data, Sockets, Socket methods, Using the Developer Console to Explore HTTP, Retrieving Web Page, Parsing Web Pages	**NPTEL** https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs34 **Linkedin** 1. https://www.linkedin.com/learning/programming-foundations-object-oriented-design-3/learn-object-oriented-design-principles?u=229219690 2. https://www.linkedin.com/learning/python-object-oriented-programming-22888296/python-object-oriented-programming?u=229219690 **Coursera** https://www.coursera.org/projects/object-oriented-programming-in-python
Module V: Using Databases with Python	Using Databases, Single Table CRUD, Designing a Data Model, Representing a Data Model, Inserting Relational Data, Reconstructing Data with JOIN, Many to Many Relationships.	**NPTEL** https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs34 **Linkedin** 1. https://www.linkedin.com/learning/programming-foundations-object-oriented-design-3/learn-object-oriented-design-principles?u=229219690 2. https://www.linkedin.com/learning/python-object-oriented-programming-22888296/python-object-oriented-programming?u=229219690 **Coursera** https://www.coursera.org/projects/object-oriented-programming-in-python

Text Books:

1. Python Object-Oriented Programming by Dusty Phillips and Steven F. Lott., 2021.

2. Dietel H.M, Dietel P.J, "Java: How to Program", Prentice-Hall, 7th Edition, 2006.
3. Flanagan D, "Java in a Nutshell", O'Reilly Media, Inc., 5th Edition. 2005.
4. Eckel B, "Thinking in Java", Prentice-Hall. 1998.
5. Gosling J, Joy B, Steele G., Bracha G., "The Java Language Specification", Prentice-Hall, 2nd Edition, 2000.
6. Xavier C, "Java Programming - A Practical Approach", Tata McGraw-Hill, 2011.
7. Bloch J., "Effective Java", Addison-Wesley, 3rd Edition, 2018

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Compare programming paradigms and implement core OOP concepts using classes, objects, and specialized functions.

CO2: Design scalable software architectures using inheritance, polymorphism, abstract classes, and exception handling.

CO3: Preprocess, model, and visually analyze complex datasets using modern Python open-source libraries.

CO4: Extract text using regular expressions and develop networked applications capable of retrieving and parsing web data.

CO5: Design relational data models and manipulate database tables using CRUD operations and complex SQL JOINs.

CO-PO Mapping:

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

Subject Name: Sustainability, Climate Actions & Environmental Sciences

Subject Code: MCC471 **Credit: 2** **Lecture Hours: 24**

Study Material LinkedIn NPTEL Coursera

Course Outcomes:

The concepts developed in this course will help the students in their higher studies. The course will enable the student to

CO1: Understand fundamental concepts of environmental systems, sustainability, United Nations Sustainable Development Goals (UNSDGs) and their interrelationship with human society.

CO2: Apply knowledge of sustainable practices, different technical tools and existing frameworks to address environmental and societal challenges.

CO3: Analyze the challenges and strategies associated with climate change mitigation, sustainable cities, and waste management within the context of international agreements and frameworks.

CO4: Evaluate and design innovative approaches to energy, water, and waste management, considering the principles of the circular economy and global SDG progress reports.

Module Number	Topic	Sub-topics	Mapping with Industry and International Academia	Lecture Hours	Corresponding Lab Assignment
I	**Overview - United Nations Sustainable Development Goals (UNSDGs)**	Basic ideas of environment, basic concepts: man, society & environment, their interrelationship. Significance of sustainability in today's world. 17 United Nations Sustainable Development Goals (UNSDGs) - background, significance, interconnectedness of goals, global challenges and recent progress. Climate change and mitigation. Explain and evaluate the evidence for human-caused climate change, in the context of historical climate change, as well as the relevant scientific uncertainties and possible evidence to the contrary.	***International Academia:*** *https://unccelearn.org/course/view.php?id=170&page=overview* *https://unccelearn.org/course/view.php?id=181&page=overview* ***Industry Mapping:***	4	Assess the college campus alignment with the United Nations Sustainable Development Goals (SDGs) and rank the performance across selected goals mentioning the actionable strategies for improvement.
II	**Sustainable Management**	Sustainable management of water and sanitation- introduction, key components, challenges and innovative approaches. Ensure access to affordable, reliable, sustainable, and modern energy- introduction, importance, key targets, challenges and strategies. Sustainable Cities and Communities- Definition of sustainable cities, current challenges, strategies, innovative solution, smart city	***International Academia:*** *https://ocw.mit.edu/courses/res-env-006-teaching-with-sustainability-january-iap-2022/* ***Industry Mapping:***	4	Design and propose innovative, sustainable solutions for managing water, energy, and urban systems, inspired by the principles of SDG 6, SDG 7 and SDG 11.
III	**Climate Action**	Climate change and its consequences, international agreements on climate change, strategies and actionable step, Life Below Water- Importance of water bodies and marine ecosystem, strategies for protecting aquatic life and water bodies, Life on Land- importance of biodiversity, carbon sequestration, Food security, Strategies for Conservation and Restoration of Ecosystems, Sustainable Land Management, Biodiversity	***International Academia:*** *https://unccelearn.org/course/view.php?id=7&page=overview&lang=en* *https://unccelearn.org/course/view.php?id=145&page=overview* *https://unccelearn.org/course/view.php?id=48&page=overview*	4	Using data analytics and modeling tools - evaluate climate change impacts, assess ecosystem health, and propose technical solutions for mitigation and conservation efforts.

		Conservation, Accountable steps for life on land. The successes and failures of past national and international efforts to address climate change, and evaluate prospects for future management of climate change. Provisions of the United Nations Framework Convention on Climate Change, Paris Agreement	*https://ocw.mit.edu/courses/res-env-001-climate-action-hands-on-harnessing-science-with-communities-to-cut-carbon-january-iap-2017/* ***Industry Mapping:***		
IV	**UN-call for Action**	Focus on **annual SDG Goals Report** and the **United Nations Secretary-General's calls for action** to accelerate the progress on the Sustainable Development Goals (SDGs). Examine the global progress trends, challenges highlighted in recent reports, and key priorities proposed by the Secretary-General to achieve the 2030 Agenda.	***International Academia:*** *https://unccelearn.org/course/view.php?id=175&page=overview* ***Industry Mapping:***	4	Using quantitative analysis, strategic planning, and innovative approaches, evaluate the global progress on the Sustainable Development Goals (SDGs) as highlighted in the annual SDG Goals Report.
V	**Environmental Systems Analysis**	Environmental impact assessment - lifecycle assessment (LCA), Using of LCA software tools – OpenLCA, Environmental, social, and governance (ESG), Integrated Impact Assessment of ESG, Carbon Management, Green Hydrogen, Importance of green building (LEED, IGBC etc.) certification. Environmental Management System (EMS) in industry - ISO 14001.	***International Academia:*** https://www.lse.ac.uk/united-states/Assets/Documents/Syllabus-Hub-PDFs/Michael-Carbajales-Dale-Clemson-Environmental-Systems-Analysis.PDF https://www.igmpi.ac.in/environmental-social-governance?gad_source=1 https://www.iso.org/standard/60857.html#:~:text=ISO%2014001%20is%20the%20internationally,continually%20improve%20their%20environmental%20performance. ***Industry Mapping:***	4	Life Cycle Assessment of a college building using OpenLCA software.
VI	**Waste Management**	Waste Management Rules - Hazardous Waste, E-waste, Municipal Solid Waste, Bio-medical waste, Plastic Waste & Construction and Demolition Waste. Management of different waste streams – collection, transportation, treatment,	***International Academia:*** *https://cpcb.nic.in/rules-6/* *https://ocw.mit.edu/courses/ec-716-d-lab-waste-fall-2015/* *https://unccelearn.org/course/view.php?i*	5	Mapping the supply chain of different waste management system and finding the issues & challenges.

		storage and disposal. Basel Convention, Extended producer responsibility (EPR) Energy & Resource Recovery - Incineration, Co-processing, Composting, Bio-methanation, Management of solar photo-voltaic modules or panels or cells, Battery Waste Management Rules, Circular Economy	*d=131&page=overview* *https://unccelearn.org/course/view.php?id=87&page=overview* ***Industry Mapping:***		

Field works will be assigned for each and every student/ group of students, on completion of which they have to give a presentation alongwith a model display if possible.

Learning Resources:

Text Books:

This syllabus has been designed on the United Nations Sustainability Development Goals, so there is no prescribed text books. Please refer to the study material and online courses.

Subject Name: Essential Studies for Professionals-IV

Subject Code: ESP401 **Credit: 0.5** **Lecture Hours: 48**

Pre-requisite: No

Module number	Topic	Subtopics	Mapping with International/National/ State Level Exams	Lecture Hours	Corresponding Assignment
1	**Constitution of India**	Central Legislative System of India, State Legislative System of India, Constitutional Amendments.	***National Exams:*** ***1. UPSC Civil Services Exam*** (https://upsc.gov.in/sites/defau lt/files/Notif-CSP-23-engl- 010223.pdf), pg 25-26 ***2.UPSC Combined Defence Services (https://upsc.gov.in/sites/defa ult/files/Notif-CDS-I-Exam- 2023-Engl-211222.pdf), pg 20-21*** ***3.Combined Graduate Level conducted by SSC (https://ssc.nic.in/SSCFileServer/PortalManagement/Uploa dedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22*** ***4. Intelligence Bureau ACIO (https://www.pw.live/exams/wp-content/uploads/2023/11/IB-ACIO-Recruitment-2023-Notification-Emp-News.pdf) State Level Exams:*** ***1. Civil Services Executive Exam (WBCS) (https://wbpsc.gov.in/Download?param1=20230225142430_Syl labus.pdf&param2=advertisem ent), pg 1*** ***2.*** **Miscellaneous Services Recruitment Examination** (*file:///C:/Users/UEMK/Downl oads/2707970_2019.pdf) pg 1*	10	Assignment: Evolution of the Indian Parliament: A Historical Overview Discuss the powers, responsibilities, and challenges faced by the Speaker of the Lok Sabha in maintaining order and impartiality. Discussion: Anti-defection Law: Impact on Indian Politics Debate: The Efficacy of Parliamentary Sessions: Quality vs. Quantity ** All the assignments are in line of GS Paper I of UPSC CSE Mains Examination

2	**History**	Islam and Early Muslim Invaders, Delhi Sultanate, Rise of the Mughals (Till Akbar)	***National Exams:*** ***1. UPSC Civil Services Exam*** (https://upsc.gov.in/sites/defau lt/files/Notif-CSP-23-engl- 010223.pdf), pg 25-26 ***2.UPSC Combined Defence Services*** *(https://upsc.gov.in/sites/defa ult/files/Notif-CDS-I-Exam- 2023-Engl-211222.pdf , pg 20-21)* ***3.Combined Graduate Level conducted by SSC*** *(https://ssc.nic.in/SSCFileServer/PortalManagement/Uploa dedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22* ***4. Intelligence Bureau ACIO*** *(https://www.pw.live/exams/wp-content/uploads/2023/11/IB- ACIO-Recruitment-2023- Notification-Emp-News.pdf* ***State Level Exams: 1.Civil Services Executive Exam (WBCS)*** *(https://wbpsc.gov.in/Download?param1=20230225142430 _Syllabus.pdf&param2=adver tisement, pg 1* ***2.*** **Miscellaneous Services Recruitment Examination** (*file:///C:/Users/UEMK/Downloads/2707970_2019.pdf), pg 1*	12	Islam and Early Muslim Invaders: Assignment: "Cultural and Social Changes in India with the Advent of Islam: A Comparative Analysis." Delhi Sultanate: Discussion: "From Slave Dynasty to Tughlaq Dynasty: Analyzing Military Tactics and Strategies." Rise of the Mughals: Debate: "Babur's Conquest: Was it Driven by Ambition or Necessity?" ** All the assignments are in line of GS Paper I of UPSC CSE Mains Examination.
3	**Geography**	Rivers of India, Multipurpose River Valley Projects, Thermal Power Projects.	***National Exams:*** ***1. UPSC Civil Services Exam*** (https://upsc.gov.in/sites/defau lt/files/Notif-CSP-23-engl- 010223.pdf), pg 25-26 ***2.UPSC Combined Defence Services*** ***(****https://upsc.gov.in/sites/defa ult/files/Notif-CDS-I-Exam- 2023-Engl-211222.pdf* ***), pg 20-21*** ***3.Combined Graduate Level conducted by SSC*** *(https://ssc.nic.in/SSCFileServer/PortalManagement/Uploa dedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22*	12	1. Rivers of India Assignment: Major rivers of India. creating a detailed itinerary, documenting key geographical features, historical landmarks, and ecological zones along the river. 2. Multipurpose River Valley Projects Essay writing on "Pros and Cons of a constructing

			4. Intelligence Bureau ACIO ***(https://www.pw.live/exams/wp-content/uploads/2023/11/IB- ACIO-Recruitment-2023- Notification-Emp-News.pdf)*** ***State Level Exams: 1.Civil Services Executive Exam (WBCS)*** *(https://wbpsc.gov.in/Download?param1=20230225142430_Syllabus.pdf&param2=advertisement, pg 1* ***2.*** **Miscellaneous Services Recruitment Examination** (*file:///C:/Users/UEMK/Downloads/2707970_2019.pdf) pg1*		multipurpose river valley project in-terms of ecological, social impacts." 3. Thermal Power Projects.. Debate on Future of Thermal Power: ** All the assignments are in line of GS Paper I of UPSC CSE Mains Examination.
4	**Economics**	Tax System of India, Balance of Payment, Industrial Reforms, NITI Aayog and its relationship with 5 year plan, Sustainable Development Goals	***National Exams:*** ***1. UPSC Civil Services Exam*** (https://upsc.gov.in/sites/default/files/Notif-CSP-23-engl-010223.pdf), pg 25-26 ***2.UPSC Combined Defence Services (https://upsc.gov.in/sites/default/files/Notif-CDS-I-Exam-2023-Engl-211222.pdf), pg 20-21*** ***3.Combined Graduate Level conducted by SSC (https://ssc.nic.in/SSCFileServer/PortalManagement/UploadedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22*** ***4. Intelligence Bureau ACIO (https://www.pw.live/exams/wp-content/uploads/2023/11/IB- ACIO-Recruitment-2023- Notification-Emp-News.pdf)*** ***State Level Exams: 1.Civil Services Executive Exam (WBCS) (https://wbpsc.gov.in/Download?param1=20230225142430_Syllabus.pdf&param2=advertisement), pg 1*** ***2.*** **Miscellaneous Services Recruitment**	09	1. Tax System of India Assignment on "how different tax policies impact various socio-economic groups and propose measures to enhance fairness and inclusivity". 2. Balance of Payment, Debate on "Impact of trade policies on the balance of payments" 3. Industrial Reforms Brainstorming session on "Digital Industry Transformation" 4. NITI Aayog and its relationship with 5 year plan Policy Debate: NITI Aayog vs. Five-Year Plans 5. Sustainable Development Goals Building of Sustainable Business plan aligned with one or more SDGs. They should consider environmental, social,

			Examination (***file:///C:/Users/UEMK/Downloads/2707970_2019.pdf*** ***) pg1***		and economic aspects, outlining how their business would contribute positively to the goals.
5	**Current affairs and Static GK:**	National News, International News, MOU's and agreements, Summits and Conclaves, Obituaries, Awards and Events, Sports, Important Days, Banking and Economic Awareness	***National Exams:*** ***1. UPSC Civil Services Exam*** (https://upsc.gov.in/sites/defau lt/files/Notif-CSP-23-engl- 010223.pdf), pg 25-26 ***2. UPSC Combined Defence Services*** *(https://upsc.gov.in/sites/defa ult/files/Notif-CDS-I-Exam- 2023-Engl-211222.pdf), pg 20-21* ***3. RBI Grade B*** *(https://rbidocs.rbi.org.in/rdocs/Content/PDFs/DADVTGRB09052023FA65E4FB1C2CF473396B4FD7E5F69CDDE.PDF), pg 22-23* ***4. IBPS Probationary officer*** *(https://www.ibps.in/w p-content/uploads/Detailed-Advt.-CRP-PO-XII.pdf) , Pg 7.* ***5. Combined Graduate Level conducted by SSC*** *(https://ssc.nic.in/SSCFileServer/PortalManagement/UploadedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22* ***6. Intelligence Bureau ACIO*** *(https://www.pw.live/exams/wp-content/uploads/2023/11/IB-ACIO-Recruitment-2023- Notification-Emp-News.pdf)* ***State Level Exams:*** ***1.Civil Services Executive Exam (WBCS)*** *(https://wbpsc.gov.in/Download?param1=20230225142430_Syllabus.pdf&param2=advertisement, pg 1* ***2.*** **Miscellaneous Services Recruitment Examination** (*file:///C:/Users/UEMK/Down*	5	1. Discussion on National and International affairs 2. Discussion on MOU's and agreements, Summits and Conclaves 3. Discussion on recent Awards and Events, Sports. 4. Discussion on Economic Awareness

			loads/2707970_2019.pdf), pg1		

Subject Name: Skill Development for Professionals-IV

Subject Code: SDP481 **Credit: 0.5** **Lecture Hours: 48**

Pre-requisite: No

Module number	Topic	Sub- topics	Mapping with International/ National/ State Level Exams	Lecture Hours	Corresponding Assignment
1	**Quantitative Aptitude**	Permutation & Combination: Numbers, Alphabets, Linear arrangement, Circular arrangement, Repetition, Selection based Probability: Coins, Dices, Drawing of balls, Cards, Numbers, Miscellaneous. Mensuration – Rectangle, Square, Triangle, Rhombus, Parallelogram, Cylinder, Cone, Sphere, Hemisphere Geometry-. Lines, Angles, Triangles, Quadrilateral and circles.	***International Exams 1.GRE (https://www.ets.org/pdfs/gre/g re-math-review.pdf)*** ***2. GMAT (https://downloads.mba.com/downloads/gmat-handbook.pdf)*** ***National Exams:*** ***1. UPSC Civil Services Exam*** (https://upsc.gov.in/sites/default/files/Notif-CSP-23-engl- 010223.pdf), pg 25-26 ***2. UPSC Combined Defence Services (https://upsc.gov.in/sites/default/files/Notif-CDS-I-Exam- 2023-Engl-211222.pdf), pg 20-21*** ***3. RBI Grade B (https://rbidocs.rbi.org.in/rdocs/Content/PDFs/DADVTGRB09052023FA65E4FB1C2CF473396B4FD7E5F69CDDE.PDF), pg 22-23*** ***4. IBPS Probationary officer(https://www.ibps.in/wp-content/uploads/Detailed- Advt.-CRP-***	12	1. Permutation & Combination a. How to arrange different numbers in different sequences. b. Questions based on Alphabet arrangements. c. Problems based on linear and circular arrangements. d. Problems based on garlands and Necklaces. e. Problems based on selection of things and persons. 2. Probability a. Problems based on different numbers of coin tossed. b. Problems based on rolling dices. c. Problems based on forming of committees based on selection. d. Problems based on drawing of cards

			PO-XII.pdf) , Pg 7. ***5. Combined Graduate Level conducted by SSC (https://ssc.nic.in/SSCFileServer/PortalManagement/UploadedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22*** ***6. Intelligence Bureau ACIO (https://www.pw.live/exams/wp-content/uploads/2023/11/IB- ACIO-Recruitment-2023- Notification-Emp-News.pdf)*** ***7. XAT (https://xat.org.in/xat-syllabus/)*** ***8. GATE (https://gate2024.iisc.ac.in/pap ers-and-syllabus/)*** ***9. CAT https://iimcat.ac.in/per/g01/pub/756/ASM/WebPortal/1/index.html?756@@1@@1*** ***State Level Exams: 1.Civil Services Executive Exam (WBCS) (https://wbpsc.gov.in/Download?param1=20230225142430_Syllabus.pdf&param2=advertisement, pg 1*** ***2.* Miscellaneous Services Recruitment Examination (file:///C:/Users/UEMK/Downloads/2707970_2019.pdf), pg 1***		3. Mensuration. a. Problems based on 2D and 3D shapes. b. Finding area based on mixed shapes. c. Finding the volume based on different shapes. d. Problems based on Prism Pyramid. 4. Geometry: a. Problems based on Lines and Angles. b. Problems based on complementary, supplementary, corresponding, alternative angles. c. Problems based on acute, right, obtuse, scalene, equilateral, isosceles triangles. d. Basis problems based on Quadrilaterals. e. Basic Problems based on chords and tangents. ** All the assignments are in line of GS Paper I of UPSC CSE Mains Examination
2	**Logical Reasoning**	1) Calendar 2) Analogy &	***National Exams:***	12	1. Calendar a. Problems based basic

		Classification 3) Dice & Cube, Puzzles and Sitting Arrangement	*1. UPSC Civil Services Exam* (https://upsc.gov.in/sites/default/files/Notif-CSP-23-engl- 010223.pdf), pg 25-26 ***2. UPSC Combined Defence Services (https://upsc.gov.in/sites/default/files/Notif-CDS-I-Exam- 2023-Engl-211222.pdf , pg 20-21)*** ***3. Combined Graduate Level conducted by SSC (https://ssc.nic.in/SSCFileServer/PortalManagement/UploadedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22*** ***4. Intelligence Bureau ACIO (https://www.pw.live/exams/wp-content/uploads/2023/11/IB- ACIO-Recruitment-2023- Notification-Emp-News.pdf*** ***State Level Exams: 1. Civil Services Executive Exam (WBCS) (https://wbpsc.gov.in/Download?param1=20230225142430_Syllabus.pdf&param2=advertisement, pg 1*** ***2.* Miscellaneous Services Recruitment Examination (*file:///C:/Users/UEMK/Downloads/2707970_2019.pdf), pg 1***		structure of a calendar and a concept of an odd day. b. Problems based on leap year in centuries. c. Problems based on exact day and comparison of day. d. Finding the day when another day is given or not given. 2. Analogy & Classification a. Problems based on letter or word based analogy. b. Problems based on Number based analogy. c. Problems based on Mixed analogy. d. Problems based on image analogy. 3. Dice & Cube a. Problems based on standard dice and ordinary dice. b. Problems based on single dice. c. Problems based on two or more dices.
3	**Objective English-2**	1) Application of Adverbs 2) Active Passive Voice 3) Direct and	***International Exams*** ***1. GRE (https://www.ets.org/gre/test-takers/general-test/prepare/content/verbal-***	12	1. Application of Adverbs Practice set based on Spotting the Error.

		Indirect Speech 4) Reading Comprehension 5) Technical Report Writing	***reasoning.html#accordion- 9f58105fc6-item-88093eca37)*** ***National Exams:*** ***1. UPSC Civil Services Exam*** (https://upsc.gov.in/sites/default/files/Notif-CSP-23-engl- 010223.pdf), pg 25-26 ***2.UPSC Combined Defence Services (https://upsc.gov.in/sites/default/files/Notif-CDS-I-Exam- 2023-Engl-211222.pdf), pg 20-21*** ***3.Combined Graduate Level conducted by SSC (https://ssc.nic.in/SSCFileServer/PortalManagement/UploadedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22*** ***4. Intelligence Bureau ACIO (https://www.pw.live/exams/wp-content/uploads/2023/11/IB- ACIO-Recruitment-2023- Notification-Emp-News.pdf)*** ***State Level Exams: 1.Civil Services Executive Exam (WBCS) (https://wbpsc.gov.in/Download?param1=20230225142430_Syllabus.pdf&param2=advertisement, pg 1*** ***2.* Miscellaneous Services Recruitment Examination (file:///C:/Users/UEMK/Downloads/2707970_2019.pdf) pg 1***		2. Active Passive Voice Practice set based on conversion of active sentences to passive and vice-versa 3. Direct and Indirect Speech Practice set based on conversion of direct speech to indirect speech and vice-versa 4. Reading Comprehension Reading unseen passages and answering questions based on the same 5. Technical Report Writing Need to submit assignment with one report written on each type oftechnical report namely White paper, Case Studies, Technical Proposals, SDK Documentation
4	**Data**		***International Exams***	12	1. Problems based on mixed

	Interpretation level-II		***1. GRE (https://www.ets.org/gre/test-takers/general-test/prepare/content/quantitativ e-reasoning.html#accordion-eb7b696bc8-item-f763480e0e) National Exams:*** ***1. UPSC Civil Services Exam*** (https://upsc.gov.in/sites/default/files/Notif-CSP-23-engl- 010223.pdf), pg 25-26 ***2. UPSC Combined Defence Services (https://upsc.gov.in/sites/default/files/Notif-CDS-I-Exam- 2023-Engl-211222.pdf), pg 20-21*** ***3. Combined Graduate Level conducted by SSC (https://ssc.nic.in/SSCFileServer/PortalManagement/UploadedFiles/notice_CGLE_0304 2023.pdf) pg. 20-22*** ***Intelligence Bureau ACIO(https://www.pw.live/exams/wp-content/uploads/2023/11/IB- ACIO-Recruitment-2023- Notification-Emp-News.pdf)*** ***State Level Exams: 1.Civil Services Executive Exam (WBCS) (https://wbpsc.gov.in/Download?param1=20230225142430 _Syllabus.pdf&param2=advertisement), pg 1*** ***2.* Miscellaneous Services Recruitment Examination**		diagrams. 2. Problems based on Profit and loss. 3. Problems based on Simple and compound interest 4. Problems based on time series.

			(file:///C:/Users/UEMK/Downloads/2707970_2019.pdf) pg 1		

Subject Name: Project II (Research Methodology)

Subject Code: PRJME481 Credit: 1 Lecture Hours: 24

Pre-Requisites: Project – I (CAD Based)

Course Objective(s):

The purpose of learning of this course is to:

1. To be familiar with literature survey, problem identification & formulation.
2. To carry out experiments independently to achieve planned objectives.
3. To compile and analyze the data.
4. To develop or simulate an experimental model.
5. To present the project work in the form of dissertation.

Course Content.

Sl. No.	Contents	Hours
1	Understanding the language of research – concept, construct, definition, variable research process, literature review	2
2	Problem identification & formulation of research, development of hypothesis, testing of hypothesis – logic & importance	2
3	Research design concept and importance in research, concept of qualitative and quantitative research.	2
4	Data analysis and data preparation, interpretation of data and paper writing – layout of a research paper, ethical issues related to publishing, plagiarism and self-plagiarism, Use of tools / techniques for Research, Reference Management Software	4
5.	Dissertation submission based on analysis/simulation/experimental trial	1
6.	Presentation of the Project work	1

Course Outcome:

CO1: Understand and comprehend the basics of research methodology and apply them in research/ project work.
CO2: Apply knowledge and design experiments to obtain statistically significant data.
CO3: Systematically analyze to provide meaningful interpretation and present simulated/experimental data.
CO4: Understand the importance of teamwork to obtain any project goal.

Learning Resources:

1.Kothari, C.R, and Garg, G., (2019), Research Methodology - Methods and Techniques, 4th Edition, New Age International Publishers.
2.Catherine Dawson, (2019), Introduction to Research Methods by, 5th Edition, Robinson

3.Bordens, K. S. and Abbott, B. B. (2013) Research Design and Methods – A Process Approach. 9th Edition, McGraw-Hill.

CO-PO Mapping:

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

Minor Degree in Robotics

Course Title	Mechanics of Robots
Course Code	MINOR401R
Number of Credits	3 (L: 3; T: 0; P: 0)

Course Objective: This course aims to inculcate thorough understanding about basic knowledge of mathematics, kinematics and dynamics required for understanding motion programming and operational / control functionality in robotics.

Course Contents:

Module No	Topic	Sub- topics
Module 1:	**Mathematical Preliminaries of Robotics:**	Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.
Module 2:	**Robot Kinematics:**	Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Homogeneous Transformation Matrix, Forward Kinematics. Inverse Kinematics, Geometric and analytical approach.
Module 3:	**Velocities & Statics**:	Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, , Jacobian Jv / Jw, Jacobian in a Frame, Jacobian in Frame {0}, Kinematic Singularity, Kinematics redundancy, Force balance equation, Forces, Velocity/Force Duality, Virtual Work, Force ellipsoid, Jacobian, Kinematic Singularity, Kinematics redundancy,

		Mechanical Design of robot linkages,
Module 4:	**Robot Dynamics:**	Introduction to Dynamics, Velocity Kinematics, Acceleration of rigid body, mass distribution Newton's equation, Euler's equation, Iterative Newton –Euler's dynamic formulation, closed dynamic, Lagrangian formulation of manipulator dynamics, dynamic simulation, computational consideration.

Text Books/References:

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014).
2. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
3. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
4. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, (2005).
5. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, AddisonWesley (2003).

Alternative SWAYAM/NPTEL Course:

NPTEL Course Name	Instructor	Host Institute
Robotics	Prof. Dilip Kumar Pratihar	IIT Kharagpur
Robotics	Prof. P. Seshu, Prof. P.S. Gandhi, Prof. K. Kurien Issac, Prof. B. Seth, Prof. C. Amarnath	IIT Bombay

Course Outcomes: After completion of course, students would be able:

1. To understand terminologies related to Kinematics and Dynamics of Robotics.
2. To apply mathematics for manipulator positioning and motion planning.
3. To analyse basics of motion programming as per kinematics.
4. To estimate the force/torque required to drive a robot.

Minor Degree in Sustainable Energy Engineering (SEE) - ME Program
Climate Change: Understanding & Observation

Course Code: **MINOR401S**
Course Title: **Climate Change Understanding & Observations**
Number of credits: **3[Lecture (14hours), Practical (10hours), Social(15hours)]**

Course category: **Minor**

Prerequisite: **None**

Course Description:

Climate Change poses an increasing threat to the stability of Earth's systems. If we want to protect our planet from dangerous and unprecedented change, first we must understand the science behind climate change. This course will help in looking back across understanding the dynamics of climate change, its causes, and consequences, and learning the difference between 'natural' from 'human' induced climate change; looking to the present to see how the impacts of climate change are already being felt; finally looking to the future to see what it might hold for our planet.

Course Objective:

This course will offer

- Understanding of climate change, the difference between climate and weather
- Understanding the causes, consequences of climate change
- Evidence of the climate change - frequency and intensity of the erratic climatic events
- Comprehending the future of fossil fuels in a carbon-constrained world
- Understanding the past climate agreements
- Understanding the pledges of COP26
- Future scenarios of climate action
- Up-scaling renewable energy

Course Content

A. Theoretical Learning

Each lecture is assumed to be for one hour. In the content column, if possible breakdown the content of 1 hour in sub-topics

1	**Understanding the climate and weather:** discussion on what is climate, weather, the difference between the two, and defining climate change, understanding the relevance of 1.5 degrees and 2-degree Celsius warming.
2	**Science of climate change:** In-depth understanding of the causes climate change, human contribution to climate change, anthropogenic drivers of climate change,
3	**Understanding the depletion of natural elements:** What would be the impacts of these changes in climate for human well-being and the natural world? Understanding the consequences of climate change on the depletion of the two natural resources - **water and soil changes,** amount of changes, reasons behind, what are future trends
4	**Understanding the depletion of natural elements: change:** An understanding and analysis of the consequences of the climate change of two parameters - **temperature and precipitation change,** amount of changes, reasons behind, what are future trends
5	**Understanding the depletion of natural elements**: An understanding and analysis of the consequences of the climate change of two parameters - droughts & heatwaves and hurricanes, amount of changes, reasons behind, what are future trends
6	**Understanding the depletion of natural elements:** An understanding and analysis of the consequences of the climate change of two parameters - sea **levels and glacier melting,** amount of changes, reasons behind, what are future trends
7	**The future of fossil fuels in a carbon-constrained world:** Understanding the fossil fuels and how they will be earmarked in the future of the energy generation and consumption, how we can move towards the decarbonized world
8	**Climate Change Agreements:** Understanding the evolution of the climate agreements, UNFCCC, Kyoto protocol, the defining agreements of Paris and COP
9	**The pledges of C0P26:** What is C0P26?, participating organizations, Understanding the synopsis of the current climate agreement of C0P26 and how the countries have committed to marking their progress with the initial commitment
10	**Future scenarios of climate action:** In-depth study of two scenarios - one with the world wherein the consumption of fossil fuels remain the same, then what will happen to our ecosystems and the second scenario, where in we move towards a decarbonized world, what will be the impact on our ecosystems
11	**Mitigation and Adaptation Strategies (Part-1):**Understanding the what are roles of individuals, countries, and the global community in adapting to climate change and policies for up scaling renewable energy

12	**Mitigation and Adaptation Strategies (Part-2):**Understanding the what are roles of individuals, countries, and the global community in adapting to climate change and policies for up scaling renewable energy
13	**Case Study**-1:**Climatechange mitigation and adaptation**
14	**Case Study-2:Climate change mitigation and adaptation**

B. Practical Learning

Each experiment can be for 4 to 6 hours. In contents please provide as detailed a title of the experiments as possible, also break down experiments in sub experiments to give a clear indication on what are the concepts/observations students are expected to learn in each experiment.

Exp. No	Contents
Note	Conduct any of the five experiments listed below
1	Find out the records (measurements from meteorology stations) of average temperature changes of the past 20-30 years in your region. Observe the patterns of temperature change and make critical comments on patterns and reasons behind.
2	Find out the records (measurements from meteorology stations) of average precipitation of the past 20-30 years in your region. Observe the patterns of temperature change and make critical comments on patterns and reasons behind.
3	Prepare a report on the possible role of your institutions in the mitigation of climate change. Do this based on discussion with people in society. Frame a set off 5to6 questions, interview people and based on the interview prepare a report.
4	Estimate the carbon footprint of your institute based on energy consumption of the institute. Also make an estimate of carbon emission of your institute (even if it is very approximate) that includes travelling by students and staff, carbon footprint due to residents, etc.

C. Social Learning

This activity would be most crucial and needs careful design. This includes activities outside the classroom and outside the laboratory. Students must do something to apply their knowledge. This can also be exercised to apply the knowledge learned in the classroom and laboratory and gather more information/data from society on a topic.

Social experiment No.	Contents
Note	Conduct any of the three experiments/exercises
1	Prepare a report on the possible role of individuals in the mitigation of climate change. Prepare this report based on discussion with people in society. Frame a set of 5 to 6 questions, interview people and based on the interview prepare a report.
2	Visit a nearby river / pond /forest, discuss with people living around it and figure out the changes people have observed since the last 20-30 years. Prepare a report.
3	Prepare a report on what is your and your family's possible role in contribution to climate change and its mitigation. As far as possible quantify the contributions.
4	Prepare a report on newspaper coverage of climate change and related happenings of your region and country since last one year. Make your remarks on newspaper coverage.

Text books and other references

1. University of Cambridge (2013).Climate Change: Action, Trends and Implications for Business. Available at: https://www.cisl.cam.ac.uk/system/files/documents/ScienceReportBriefingWEBEN.pdf
2. IISD,UNITAR&UNEP(2009).IEA Training Material: Vulnerability and Climate Change Impact Assessment for Adaptation .Available at: https://www.iisd.org/system/files/publications/iea_training_vol2via.pdf
3. IPCC(2021).ClimateChange2021.ThePhysical Science Basis-Summary for Policymakers Available at https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6 WGISPMfinal.pdf
4. OECD(2009):Guidance on Integrating Climate Change Adaptation into Development Co-operation. Available at: https://www.oecd.org/env/cc/44887764.pdf
5. UNEP (2009). Climate Change Science Compendium. Available at: https://www.unep.org/resources/report/climate-change-science-compendium-2009
6. UNEP(2009).ClimateinPeril,aPopularGuidetotheLatestIPCCReport. Available at httDS://www.uneD.org/resources/reoort/climate-Deril-ooDular-guide-latest-ipcc-reports
7. UNEP&UNDP(2011).MainstreamingClimateChangeAdaptationintoDevelopment Planning: A Guide for Practitioners. Available at https://www.undp.org/sites/g/files/zskgke326/files/publications/Guide%20Mainstreaming%20C1imate%20Change%20Adaptati

on%202011.pdf
8. UNFCCC. CGE Climate Change Training Materials. Available at https://unfccc.int/Drocess-and-meetings/bodies/constituted-bodies/consultative-grouD-of-exDerts/cge-training-materials/coe-training-materials-for-the-preparation-of-national-communications
9. UNFCCC(2008).CompendiumonMethodsandToolstoEvaluateImpactsof,and Vulnerabilityand Adaptation to, Climate Change. Available at https://unfccc.int/files/adaptation/nairobi_workprogramme/compendiumonmethodstools/application/pdf/20080307compendiumm_t_complete.pdf
10. UNFCCC(2006).UNFCCC Handbook.Availableat cc.int/resource/docs/publications/handbook.pdf
11. UNFCCC&UNEP(2002).Climate Change Information Kit. Available at https://unfccc.int/resource/iuckit/cckit2001en.pdf
12. World Bank Report(2012).Turn Down the Heat .Available at https://documents1.wor1dbank.org/curated/en/865571468149107611/pdf/NonAsciiFi1eName0.pdf
13. WorldMeteorologicalOrganization(2012).GreenhouseGasBulletins.Availableat https://library.wmo.int/docnum.php?explnumid=10100
14. O.P.Gupta,ElementsofEnvironmentalPollutionControl,KhannaBookPublishing.
15. O.P.Gupta,EnergyTechnology,KhannaPublishingHouse,NewDelhi,2020.
16. Khandelwal,K.C.andMahdi,BiogasTechnology-APracticalHandBook,TataMcGraw.
17. A.Chakrabarti, Energy Engineering and Management, PHI.

The expected outcome of course:

The possible outcomes of course are:

- Ability to describe the key principles of climate change
- Ability to identify the causes and consequences of climate change
- Ability to identify signs of climate change
- Understand the impacts on the current ecosystems
- Understanding the future projections and what the future may hold for Earth

Course Title	Introduction to Data Analytics
Course Code	MINOR401A
Number of Credits	4 (L: 3; T: 0; P: 2)
Course Category	AIML
Pre- Requisite	Basic Statistics

Course Objective:

- Provide you with the knowledge and expertise to become a pro icient data scientist
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science;
- Produce Python code to statistically analyse a dataset;
- Critically evaluate data visualisations based on their design and use for communicating stories from data;

Course Contents:

Module 1: [Duration: 7 Lectures]
Introduction to Data Science, Different Sectors using Data science, Purpose and Components of Python in Data Science.

Module 2: [Duration: 7 Lectures]
Data Analytics Process, Knowledge Check, Exploratory Data Analysis (EDA), EDAQuantitative technique, EDA- Graphical Technique, Data Analytics Conclusion and Predictions.

Module 3: [Duration: 11 Lectures]
Feature Generation and Feature Selection (Extracting Meaning from Data)- Motivating application: user (customer) retention- Feature Generation (brainstorming, role of domain expertise, and place for imagination)- Feature Selection algorithms.

Module 4: [Duration: 10 Lectures]
Data Visualization- Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects- Exercise: create your own visualization of a complex dataset.

Module 5: [Duration: 7 Lectures]
Applications of Data Science, Data Science and Ethical Issues- Discussions on privacy, security, ethics- A look back at Data Science- Nextgeneration data scientists.

Lab Work:

1. Python Environment setup and Essentials.

2. Mathematical computing with Python (NumPy).
3. Scienti ic Computing with Python (SciPy).
4. Data Manipulation with Pandas.
5. Prediction using Scikit-Learn
6. Data Visualization in python using matplotlib

Text Books/References:

1. Joel Grus, Data Science from Scratch, Shroff Publisher Publisher /O'Reilly Publisher Media
2. V.K. Jain, Data Sciences & Analytics, Khanna Publishing House
3. Annalyn Ng, Kenneth Soo, Numsense! Data Science for the Layman, Shroff Publisher Publisher
4. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly Publisher Media.
5. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

Corresponding Online Resources:

1. Data Analytics, https://onlinecourses.swayam2.ac.in/ntr24_ed70/preview

Course Outcomes: After completion of course, students would be able to:

1. Explain how data is collected, managed and stored for data science;
2. Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists;
3. Implement data collection and management scripts using MongoDB.

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