Autonomous Program Structure

Second Year B. Tech.
Forth Semester (Mechanical Engineering)
Academic Year: 2024-25 Onwards

Course Code	Course Title	Teaching Scheme Hours / Week			Cr	Examination Scheme			Total Marks
		L	T	P		ISE	ESE	Pr/Or	
23PCME401	Kinematics of Machinery	2	1	0	3	50	50	0	100
23PCME402	Fluid Mechanics	3	0	0	3	50	50	0	100
23PCME403	Mechanics of Machining and Tool Design	3	0	0	3	50	50	0	100
23PCME404L	Kinematics and Dynamics of Machinery Laboratory	0	0	2	1	25	0	25	50
23PCME405L	Fluid Mechanics and Machines Laboratory	0	0	2	1	25	0	25	50
23MmME401	Statistics and Probability for Data science	3	0	0	3	50	50	0	100
23VSECME401L	Rapid Prototyping and Manufacturing Laboratory	0	0	4	2	25	0	25	50
23EEM401	Entrepreneurship Development	3	1	0	4	50	50	0	100
23CEP401	Community Engagement Project	1	0	2	2	50	0	0	50
	Total =	**15**	**02**	**10**	**22**	**400**	**275**	**75**	**700**

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Secretary Academic Council
MKSSS's Cummins College of Engineering
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Course Code 23PCME401	Kinematics of Machinery	L	T	P
		2	1	-
Pre-requisites	Engineering Mechanics, Engineering Mathematics			

Course Objectives: To make students

1. Understand the fundamentals of Mechanisms
2. Understand the analysis of mechanisms
3. Understand the dimensional synthesis of mechanisms
4. Understand the relationship between input parameters and the resulting motion of mechanisms.
5. Understand the kinematics of Gear and Gear Trains.

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

1. Identify the nature of kinematic pairs, links, and chains and will be able to analyze the mobility of the Mechanism.
2. Analyze the velocity and acceleration of the Simple mechanism.
3. Perform dimensional synthesis of mechanisms.
4. Analyze and predict the position, orientation, and motion of various links and joints of a mechanism.
5. Evaluate the Speed ratio and Torque for the Epicyclic Gear train.

Unit: 1	**Fundamentals and Types of Mechanisms**

Kinematic Link, types of links, kinematic pair, types of constrained motion, types of kinematic Chains, types of joints, mechanism, machine, degree of freedom, Kutzbach criterion, Grubler's criterion, Grashoff's law, four bar chain and its inversion, Slider crank and its inversion, double slider crank and its inversion, straight-line mechanism, Steering Gear Mechanism, Condition for correct steering, Davis and Ackermann Steering Gear Mechanism.

Unit: 2	**Analysis of Mechanisms**

Analysis Velocity and acceleration for four bar and slider crank mechanisms using analytical and graphical methods.

Unit : 3	**Dimensional Synthesis of Mechanism**

Introduction to Synthesis of Mechanism-Type, number, and dimensional synthesis, the task of dimensional synthesis, path, function and motion generation(body guidance), precision positions, Chebychev spacing, Mechanical and structural errors. Three position synthesis of four bar mechanism using Freudenstein's Equation.

Unit: 4	**Forward and Inverse Kinematics of Mechanisms**

Position Analysis, Matrix representation, Homogeneous Transformation matrices, Inverse of Transformation Matrix.

Unit: 5	**Kinematics of Gear and Gear Train**

Gear Terminology, the law of gearing, forms of teeth, Classification of Gears, Kinematics of helical and Spiral gear, Bevel Gear, Worm and Worm gear.Gear Train classification, Analysis of Epicyclic Gear Train.

Books:

1.	S.S.Rattan, Theory of Machines, Tata McGraw Hill
2.	Ashok Kumar Mallik, Amitabha Ghosh, and Gunter Dittrich. Kinematic analysis and synthesis of mechanisms. CRC Press, 1994.
3.	Thomas Bevan, „Theory of Machines" CBS Publisher and Distributors, Delhi
4	Shiley J. E. and Uicker J.J. , „Theory of Machines and Mechanism", McGraw Hill Inc
5	Wilson C.E., Sandler J.P. „Kinematics and Dynamics of Machinery", Pearson Education
6	Erdman A.G. and Sandor G. N. „Mechanism Design, Analysis and Synthesis Vol-I, Prentice Hall
7	Hartenberg, Richard Scheunemann, and Jacques Denavit. „Kinematic Synthesis of linkages". McGraw-Hill, 1964.
8	S.K.Saha, "Introduction to Robotics", 2nd edition, TataMcGraw Hill Publication
9	John J. Craig, "Introduction to Robotics: Mechanics & Control", 3rd edition, Pearson Education.

Course Code 23PCME402	Fluid Mechanics	L	T	P-
		3	-	-
Pre-requisites	Engineering Physics, Engineering Mathematics			

Course Objectives: To make students

1. Explain the effects of fluid acceleration on flow behavior.
2. Utilize Bernoulli's equation to solve practical engineering problems in various fluid flow scenarios.
3. Differentiate between laminar and turbulent flow characteristics in pipes.
4. Apply the Darcy-Weisbach equation to quantify head loss due to friction in piping systems.
5. Apply boundary layer analysis techniques to predict drag and lift forces on immersed bodies.

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

1. Evaluate fluid motion characteristics, distinguishing between different flow types and assessing their impact on flow behavior.
2. Apply Bernoulli's equation to handle engineering problems in diverse fluid flow scenarios.
3. Deduce governing equations for simple fluid mechanical systems using the Navier-Stokes equations.
4. Analyze the distinctions between laminar and turbulent flow in pipes and utilize the Darcy-Weisbach equation to quantify the friction-induced head loss.
5. Apply boundary layer analysis techniques to predict drag and lift forces exerted on immersed bodies.

Unit : 1	Introduction

Definition and classification of fluids (ideal, real, Newtonian, non-Newtonian), fluid properties (density, viscosity, kinematic viscosity, surface tension), pressure, Pascal's Law, hydrostatic pressure distribution, buoyancy and Archimedes' Principle, applications of fluid statics (manometers, dams, buoyancy in fluids), forces on submerged bodies (center of pressure)., Flow visualization techniques (streamlines, streaklines, pathlines), Description of fluid motion (steady, unsteady, uniform, non-uniform), Continuity equation (derivation and applications in steady incompressible flow) Fluid Acceleration (Concept of total derivative).

Unit : 2	Reynolds Transport Theorem

Derivation and physical interpretation of the RTT, derivation of Bernoulli's equation from RTT (steady, incompressible, inviscid flow), applications of Bernoulli's equation (idealized flow in pipes, venturi meter, orifice meter, pitot tube), limitations of Bernoulli's equation (viscous effects, compressibility).

Unit : 3	Dimensional Analysis

Introduction to dimensional analysis and its importance, understanding dimensions, units, and dimensional homogeneity, statement and application of the Buckingham Pi theorem, determination of dimensionless groups for fluid mechanics problems, real-world applications of dimensional analysis in fluid mechanics.	
Unit : 4	**Pipe Flow**
Derivation of Hagen-Poiseuille equation (viscous flow in circular pipes), Laminar flow characteristics (velocity profile, shear stress distribution), Head loss due to viscous friction Characteristics of turbulent flow (fluctuations, Reynolds number), Introduction to pipe roughness and Moody diagram Darcy-Weisbach equation for head loss in pipes due to friction, Comparison of laminar and turbulent flow behaviour	
Unit : 5	**Boundary Layer Theory**
Concept of boundary layer (development, types), Boundary layer equations (simplified forms) Importance of boundary layer analysis in fluid mechanics (drag, lift)	
Text Books	
1	Hibbeler R C , 'Fluid Mechanics', 2nd Edition, Pearson.
2	Munson, Okiishi, Young, 'Fluid Mechanics', 7th Ed, Wiley, 2016.
Reference Books	
1	Cengel, Y. A., & Cimbala, J. M. (2017). Fluid mechanics: Fundamentals and applications (4th ed.). McGraw-Hill Education.
2	Robert W. Fox, Alan T. McDonald, John W. Mitchell, Fox and McDonald's Introduction to Fluid Mechanics, 10ed, Wiley India, 2021

Course Code 23PCME403	Mechanics of Machining and Tool Design	L3	T	P-
		3	-	-
Pre-requisites	Manufacturing Processes and Technology			

Course Objectives: To make students

1. To discuss the theory of metal cutting and select the appropriate tool and design a single or multi-point cutting tool.
2. To explain the principles of design and operations of jigs and fixtures.
3. To explain the working and roll of abrasive machining and finishing processes.
4. To discuss various semiconductor manufacturing technologies.

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

1. Evaluate cutting force, power, tool life, and surface finish for machining operations, considering the economics of machining-based parameters.
2. Design an appropriate single or multipoint cutting tool for the given machining process.
3. Design jigs and fixtures for the given industrial component.
4. Analyze different finishing and super finishing processes for a given industrial component.
5. Select manufacturing processes for the given semiconductor device manufacturing.

Unit: 1	**Fundamentals of Machining**

Mechanics of machining, tool geometry, and materials, tool life and wear, the economics of machining, design of single point cutting tool and form-tool.

Unit: 2	**Multi-point cutting tool design**

Design of milling cutters, drills, reamers, screwing taps, and broaching tools.

Unit : 3	**Jigs and fixtures design**

Fundamental concepts, basic principles of design and construction, types of jigs and fixtures, location in jigs and fixtures, clamping and indexing in jigs and fixtures, design fixtures for lathe, drilling, and milling operation.

Unit: 4	**Abrasive machining and finishing processes**

Introduction, abrasive and bonded abrasives, fundamentals of the grinding process, operations, and machines. Design considerations for grinding. Advanced finishing operations, deburring operations, the economics of abrasive machining, and finishing operations.

Unit: 5	**Manufacturing of semiconductor devices**

Elements of semiconductor devices, manufacture of silicon wafers, device fabrication, thick-film, and thin-film technologies.	
Books:	
1.	Serope Kalpakjian and Stephen Schmid, "Manufacturing, Engineering and Technology", SI Edition, Pearson Education, ISBN: 978-9332587908
2.	Ghosh and Mallik, "Manufacturing Science", East- West Press
3.	P. N. Rao, "Manufacturing Technology", Tata McGraw Hill Publishing Co. Ltd., Volume I&II, New Delhi, ISBN: Volume I-978-1259062575, Volume II-978- 9353160524.
4	Milton C Shaw, "Metal Cutting Principles", Oxford University Press, ISBN: 978- 0198086116.
5	Yusuf Altintas, "Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design", Cambridge University Press, ISBN: 978-0521172479.

Course Code 23PCME404L	Kinematics and Dynamics of Machinery Lab	L-	T	P
		-	-	2
Pre-requisite	Engineering Mechanics, Engineering Mathematics, Computer Programming			

Course Objectives: To make students

1. Conduct experiments on various experimental setups to verify mechanical engineering principles.
2. Determine un-balance rotating masses, utilize analytical techniques and problem-solving techniques to verify experimentally the rotatory balancing of mechanical systems.
3. Understand mechanisms for determining position, velocity, and acceleration characteristics through mathematical modeling and computer programing.
4. Understand dimensional synthesis techniques to design mechanisms meeting specified performance criteria.
5. Understand forward and reverse kinematics for robotic manipulators.

Course Outcomes: Students will be able to

1. Measurement of various parameters and verification of mechanical engineering principles based on experimentation.
2. Analyze and implement methods for balancing rotating masses.
3. Analyze mechanisms for position, velocity, and acceleration.
4. Design mechanism using Dimensional Synthesis approach.
5. Perform forward and reverse kinematics of Robot Manipulator.

Lab Work

1.	Analysis of Epicyclic Gear Train to Measure Holding Torque.
2.	Measurement of Angle of Precession for Gyroscopic Couple.
3.	Verification of the Law of Steering.
4.	Performance Analysis of Dynamometer-Eddy Current dynamometer, Prony Brake dynamometer.
5.	Dynamic Balancing of Rotating masses.
6.	Implementation of Forward Kinematics of Robot Manipulator.
7.	Implementation of Reverse Kinematics of Robot Manipulator.
8	Computer Programming on Analysis and Synthesis of Mechanisms
9.	Computer Programming on Synthesis of Mechanisms

Books:

1.	S.S.Rattan, Theory of Machines, Tata McGraw Hill
2.	Ashok Kumar Mallik, Amitabha Ghosh, and Gunter Dittrich. Kinematic analysis and synthesis of mechanisms. CRC Press, 1994.
3	Thomas Bevan, „Theory of Machines" CBS Publisher and Distributors, Delhi
4	Thomas Bevan, „Theory of Machines" CBS Publisher and Distributors, Delhi
5	Shiley J. E. and Uicker J.J. , „Theory of Machines and Mechanism", McGraw Hill Inc
6	Wilson C.E., Sandler J.P. „Kinematics and Dynamics of Machinery", Pearson Education
7	S.K.Saha, "Introduction to Robotics", 2nd edition, TataMcGraw Hill Publication

Course Code 23PCME405L	Fluid Mechanics and Machines Lab	L	T	P
		0	0	2
Pre-requisite	-			

Course Objectives: To make students

1. proficiencient in applying theoretical concepts of fluid mechanics to practical scenarios through hands-on experimentation in the laboratory.
2. Equip with the skills to effectively operate and utilize various laboratory equipment to measure and analyze fluid properties, flow rates, and pressure distributions accurately.
3. systematically collect experimental data, utilize statistical methods for analysis, and draw meaningful conclusions regarding fluid behavior and characteristics.
4. enhance their ability to communicate experimental procedures, results, and conclusions clearly and concisely through written reports and oral presentations,

Course Outcomes: Students will be able to

1. Understand the fundamental principles of fluid mechanics, including viscosity, density, and pressure, through hands-on experimentation and analysis.
2. Develop proficiency in using laboratory equipment to accurately measure and analyze fluid properties, flow rates, and pressure distributions.
3. Develop proficiency in using laboratory equipment to accurately measure and analyze fluid properties, flow rates, and pressure distributions.
4. Communicate experimental procedures, results, and conclusions clearly and concisely in both written reports and oral presentations.

Lab Work

1	To study the variation of viscosity with temperature using Redwood Viscometer
2	To determine the coefficients of velocity and discharge of small orifices
3	To verify Bernoulli's theorem by measuring the pressure changes along a converging-diverging section
4	To measure the flow rate of fluid using a Venturi meter and calibrate it against known flow rates.
5	To investigate and observe different flow regimes and transition phenomena using Reynolds apparatus.
6	To Measure the coefficient of friction in pipes of different materials
7	Investigation of Momentum Transfer and Jet Impact on Flat and Curved Surfaces
8	To plot the characteristic curves of the centrifugal pump
9	To plot the constant characteristic curves of Pelton Wheel
10	To plot characteristic curves of Francis Turbine/ Kaplan Turbine

Course Code 23MmME401	**Statistics and Probability for Data Science**	L	T	P
		3	-	-
Prerequisite	Engineering Mathematics			

Course Objectives:

The students will

1. Understand data types and description
2. Learn various statistical measures and their importance
3. Understand role of probability data analysis
4. Appreciate use of random variables and distributions
5. Learn to draw conclusions from given data

Course Outcomes:

Students will be able to

1. Describe and identify data types
2. Perform statistical measures on a given data
3. Apply probability and Bayes theorem for data analysis
4. Analyze distribution functions of discrete and continuous data
5. Perform hypothesis testing and parameter estimation and draw inferences

Unit :- 1	**Introduction and type of data**

Types of data, Descriptive and Inferential statistics, Scales of measurement, Describing categorical data Frequency distribution of categorical data, Best practices for graphing categorical data, Mode and median for categorical variable, Describing numerical data Frequency tables for numerical data

Unit :- 2	**Statistical Measures**

Measures of central tendency - Mean, median and mode, Quartiles and percentiles, Measures of dispersion - Range, variance, standard deviation and IQR, Five number summary, Association between two variables - Association between two categorical variables - Using relative frequencies in contingency tables, Association between two numerical variables - Scatterplot, covariance, Pearson correlation coefficient, Point bi-serial correlation coefficient

Unit :- 3	**Probability**

Permutations and combinations, Basic definitions of probability, Events, Properties of probability, Conditional probability - Multiplication rule, Independence, Law of total probability, Bayes' theorem, Applications of probability

Unit :- 4	**Random Variables**

Random experiment, sample space and random variable, Discrete and continuous random variable, Probability mass function, Cumulative density function, Expectation of a discrete random variable, Variance and standard deviation of a discrete random variable, Bernoulli trials, Independent and identically distributed random variable, Binomial random variable, Expectation and variance of a binomial random variable, Poisson distribution, continuous random variables, Area under the curve, Properties of pdf, Exponential distribution	
Unit :- 5	**Estimation, Inference and Hypothesis Testing:**
Maximum Likelihood, Bayesian Estimation, EM Algorithm. Z-test, T-test, Chi-square test, real life applications and use cases.	
Text Books:	
1.	Probability and Statistics for Engineers and Scientists, Walpole, Pearson
2.	A First Course in Probability, Sheldon Ross, Pearson
3.	Probability and Statistics for Engineering and the Sciences, J. L. Devore, Cengage
Reference Books:	
1.	Statistics for Data Scientists, Maurits Kaptein , Heuvel, Springer
2.	Probability and Statistics for Data Science, Norman, Matloff, CRC

Course Code 23VSECME401L	Rapid Prototyping and Manufacturing Laboratory	L	T	P
		-	-	4
Pre-requisite	Engineering Graphics, Manufacturing Processes and Technology			

Course Objectives: This course will

1. Enable students to identify the engineering problem and find the preliminary solution
2. Enables students to use Computer Aided Design (CAD) for additive manufacturing and its applications.
3. Provide students with experience in modern rapid prototyping of mechanical components and subsystems, essential in the construction of mechanical systems.
4. Enable students to design of jigs and fixtures.
5. Enable students to manufacture assembly using various machine tools.

Course Outcomes: Students will be able to

1. Identify the engineering problem and articulate a hand-sketched conceptual design.
2. Build a three-dimensional computer model of a mechanical system.
3. Create the prototype/device using rapid prototyping technique.
4. Manufacture assembly by using tolerances for industrial application.
5. Design of jigs and fixtures for a given component.

Lab Work

1. Design and Manufacturing of product/assembly using rapid prototyping
2. To manufacture assembly of a minimum 6 number of components such as press tool, Oldham coupling, and wheel support assembly. Which involves the use of various machine tools such as lathe, milling, drilling, CNC, and manufacturing processes such as abrasive machining and finishing processes.
3. Design of Jig and Fixture for Engineering Component.

Books:

1	Kenneth G. Cooper, “Rapid Prototyping Technology Selection and Application”, Marcel Dekker, Inc.
2	N. D. Bhat, “Machine Drawing”, Charotor publishing house, Bombay.
3	R. K. Dhavan, “Machine Drawing”, S. Chand and Company.
4	Serope Kalpakjian and Stephen Schmid, “Manufacturing, Engineering and Technology”, SI Edition, Pearson Education, ISBN: 978-9332587908
5	Ghosh and Mallik, “Manufacturing Science”, East- West Press

Course Code	Entrepreneurship Development	L	T	P
23EEM401		3	1	-
Pre-requisite	---			

Course Objectives: Students will be able to

1.Understand the fit between individual entrepreneurial ambitions and select a problem worth solving

2.Identify customers and create value proposition

3.Identify direct and indirect competitors and prepare business model

4.Build and demonstrate an MVP (Minimum Viable product) and financial plan

5.Identify appropriate GTM Channels

6.Prepare growth plan along with possible funding options

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

1.Identify entrepreneurial opportunities and develop entrepreneurial skills

2.Analyze the customer segments and create a compelling value proposition for solution

3.Develop Business Model along with Minimum Viable Product for testing

4.Create a Pitch deck with effective presentation

Unit I:	**Entrepreneurship foundation**

Entrepreneurship and Intrapreneurship, why startup fails, Mindset, skillset, entrepreneurial styles, discover yourself, Principles of Effectuation, problem identification and opportunity discovery, problem worth solving analysis and validation, idea validation.

Unit II:	**Value proposition**

Customer segments, market identification and sizing, primary and secondary research, customer journey mapping, market validation, brainstorming ideas, innovative solution, Problem- solution fit, compelling value proposition, sustainable differentiation, competition analysis, pricing models, competitive advantage.

Unit III:	**Business model canvas**

Lean business model, test assumptions, identify risks, risk mitigation strategy, MVP and testing MVP, refining MVP, business plan: financial, sales, people. unit economics, identify matrix that matters, feasibility analysis.

Unit IV:	**Goto market strategy**

Channel identification, key partnerships, marketing strategy, Pricing strategy, Effective marketing plan, digital marketing. building traction, feedback, refining MVP, Product-market fit, refining business model and strategy

Unit V:	**Support systems and business regulations**

business entities, organization structure and functional requirements, agreements, regulations and permissions, business ethics, startup ecosystem, incubation centers and accelerators, Government initiatives, local initiatives,

IPR strategy, role of technology	
Unit VI:	**Pitch deck and growth plan**
Effective pitch deck, contents of presentation, growth plan, scaling strategy, 5 years plan, creating pitch deck, Sources of funds, term sheet and contracts, equity, execution plan, team building, time management and work delegation, business partner and employee dilemma, acquisition, and mergers	
Textbooks:	
1.	"Entrepreneurship Journey from Idea to Startup" by Dr. Makarand Ramesh Velankar, Dr. Megha Sunil Borse, Dr. Anjali Milind Naik Techknowledge Publications, 2024
2.	Course contents will be available on https://wadhwanifoundation.org/programs/ignite/
Reference Books:	
1.	Harvard business review entrepreneur's handbook
2.	Traction: A Startup Guide to Getting Customers by Gabriel Weinberg and Justin Mares
Online Resources:	
1	https://wadhwanifoundation.org/programs/ignite/

Course Code 23CEP401	Community Engagement Project	L	T	P
		1	-	2
Pre-requisite	---			

Course Objectives: This course will

1. define problem statement for identified community,
2. select method for data collection,
3. analyze the collected data,
4. communicate overall learning from the project.

Course Outcomes: Students will be able to

1. to define problem statement for identified community,
2. to select method for data collection,
3. to analyze the collected data,
4. to communicate overall learning from the project.

Course Work

In this course, students will identify a significant challenge/problem faced by a certain community, apply a systematic approach to investigate the problem, conduct field visits to collect relevant data, analyze the collected data, summarize their findings and compile a detailed report about their study. This report may be presented to the stakeholders.

Pedagogy:

1. In-class activity: Group discussions, interaction with faculty mentor
2. Out-of-the-class activity: Field visits, interaction with community, data collection