College of Engineering, Pune

(An Autonomous Institute of Govt. of Maharashtra, Permanently Affiliated to S.P. Pune University)

Department of Mechanical Engineering

Curriculum Structure & Detailed Syllabus (UG Program)

Third Year B. Tech.

(Effective from: A.Y. 2021-22)

Program Education Objectives (PEOs):

I. Cater to the needs of Indian as well as multinational industries

II. Be competent with strong technological background to analyze data, formulate and undertake industrial problems and obtain viable solutions

III. Make successful career in industry / research / higher Studies

IV. Be life-long learning and should be able to work on multi-disciplinary projects

V. Be Competent for effective communication, in management and in professional skills and ethics

Program Outcomes (POs):

On successful completion Graduates will demonstrate:

1. Engineering knowledge
2. Problem analysis
3. Design/development of solutions
4. Conduct investigations of complex problems
5. Modern tool usage
6. The engineer and society
7. Environment and sustainability
8. Ethics
9. Individual and team work
10. Communication
11. Project management and finance
12. Life-long learning

Correlation between the PEOs and the POs

PO→ PEO↓	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
I	✓		✓		✓	✓	✓				✓		✓		✓
II	✓	✓	✓		✓								✓		
III				✓		✓		✓	✓			✓		✓	✓
IV		✓	✓		✓					✓	✓	✓	✓	✓	✓
V						✓		✓	✓	✓	✓				✓

Programme Specific Objectives (PSOs):

I. Apply concepts of Design, Production and Thermal-fluid sciences to solve engineering problems utilizing advanced technology.

II. Use mechanical engineering software for the design and analysis of mechanical engineering systems/processes.

III. Extend and implement new thoughts on product design and development with the aids of modern CFD and CAD/CAM/CAE tools, while ensuring best manufacturing practices.

List of Abbreviations

Sr. No.	Abbreviation	Stands for:
1	BSC	Basic Science Course
2	DEC	Department Elective Course
3	HSMC	Humanities, Social Sciences including Management courses
4	IFC	Interdisciplinary Foundation Course
5	IOC	Interdisciplinary Open Course
6	LC	Laboratory Course
7	MLC	Mandatory Learning Course
8	PCC	Program Core Course
9	SBC	Skill Based Course

CURRICULUM STRUCTURE OF T. Y. B.TECH (Mechanical)

Effective from A. Y. 2021-2022

V-Semester:

Sr. No	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-21001	Probability and Statistics for Engineers	2	1	0	3
2	MLC	ML-21002	Environmental Studies	1	0	0	0
3	IFC	CT (IF)-21001	Interdisciplinary Foundation Course–III Data Analytics	1	0	2	2
4	HSMC	AS (HS)-	Humanities & Social Sciences Open Course -II	2	0	0	2
		21005	Industrial Psychology				
		21006	Personal Psychology				
		21007	Engineering Economics				
		21008	Finance for Engineers				
5	SBC	ME-21008	Skill Based Course of the Domain: Design of Machine Components	0	0	2	1
6	PCC	ME-21001	Fluid Machinery and Fluid Power	3	1	0	4
7	PCC	ME-21002	Metrology and Mechanical Measurements	3	0	0	3
8	PCC	ME-21003	Heat Transfer	3	0	0	3
9	PCC	ME-21004	Design of Machine Components	3	1	0	4
10	LC	ME-21005	Fluid Machinery and Fluid Power Lab	0	0	2	1
11	LC	ME-21006	Metrology and Mechanical Measurements Lab	0	0	2	1
12	LC	ME-21007	Heat Transfer Lab	0	0	2	1
			Total	**18**	**03**	**10**	**25**
			Total Academic Engagement and Credits	**31**			**25**

Minor and Honor courses (V-Semester)

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	Minor in Product Design and Optimization	ME (MI)-21001	Product Design	3	0	0	3
2	Honor in Hybrid and Electric vehicle	ME (HO)-21001	Automotive Engineering Systems	3	0	0	3
3	Honor in Thermal Stream	ME (HO)-21002	Fluid Dynamics	3	0	0	3
4	Honor in Design Stream	ME (HO)-21003	Comprehensive Design	3	0	0	3

VI-Semester:

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	MLC	ML-21001	Constitution of India	1	0	0	0
2	HSMC	AS (HS)-	Humanities & Social Sciences Open Course - I	2	0	0	2
		21001	English Proficiency Language				
		21002	German Language				
		21003	Japanese Language				
		21004	Spanish Language				
3	HSMC	HS-21001	Entrepreneurship Principles and Process	1	0	0	1
4	SBC	ME-21016	Mini Project ["D-S-P-T: Design-Simulate-Prototype-Test "]	0	0	4	2
5	IOC	Shown in IOC / DE list	Interdisciplinary Open Course-I	2	0	0	2
6	DEC		Department Elective-I/ Industry Floated Course / Co-Taught Course	3	0	0	3
7	PCC	ME-21009	Computational Methods & Programming	2	0	0	2
8	PCC	ME-21010	Theory and Design of Mechanical Systems	3	1	0	4
9	PCC	ME-21011	Steam and Gas Turbine	3	0	0	3
10	PCC	ME-21012	Fuels and Combustion	3	0	0	3
11	LC	ME-21013	Computational Methods & Programming Lab	0	0	2	1
12	LC	ME-21014	Theory and Design of Mechanical Systems Lab	0	0	2	1
13	LC	ME-21015	Steam & Gas Turbine And Combustion Lab	0	0	2	1
			Total	**20**	**1**	**10**	**25**
			Total Academic Engagement and Credits	**31**			**25**

Minor and Honor courses (VI Sem)

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	Minor: Product Design and Optimization	ME (MI)-21002	Engineering Design	3	0	0	3
2	Honors: Hybrid and Electric vehicle	ME (HO)-21004	Automotive Mechatronics	3	0	0	3
3	Honor in Thermal Stream	ME (HO)-21005	Micro fluidics	3	0	0	3
4	Honor in Design Stream	ME (HO)-21006	Fracture mechanics	3	0	0	3

List of Departmental Electives:

Sr. No.	Course Code	Elective Course	Sr. No.	Course Code	Elective Course
1	ME (DE)-21001	Computational Fluid Dynamics and Heat Transfer	5	ME (DE)-21005	Mathematical Modeling and Analysis of Thermal System
2	ME (DE)-21002	Steam Technology	6	ME (DE)-21006	Micro Electro Mechanical Systems
3	ME (DE)-21003	Advanced Manufacturing Technology	7	ME (DE)-21007	Finite Element Analysis
4	ME (DE)-21004	Operations Research			

Interdisciplinary Open Course-I (IOC)

Sr. No.	Course Code	Course Name
01	IOC-21005	Renewable Energy (Offered by Mechanical Engineering Department)

MA 21001 Probability and Statistics for Engineers

Teaching scheme
Lectures: 2 hrs/week
Tutorial: 1 hr/week

Examination Scheme
Internal Test 1: 20 Marks
Internal Test 2: 20 Marks
End – Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course student will be able to:

- Demonstrate number of methods of summarizing and visualizing data sets, evaluate probabilities of events.
- Make use of concepts of random variables and associated probability distributions to solve problems, illustrate the central limit theorem.
- Test for basic statistical inference (t-test, z-test, F-test, $\chi 2$ –test, confidence interval, non parametric tests).
- Explain basic principles of regression analysis and perform the same.
- Demonstrate use of R software for all the above.

Unit 1 **(5 hrs)**

Descriptive statistics: Measures of location and variation. Visualization of data: Frequency tables, bar diagrams, histograms, heat maps, other visualization tools. Review on introduction to combinatorics and probability theory.

Unit 2 **(5 hrs)**

Some of the basic probability distributions: Binomial, Poisson, Exponential, and Normal. Central limit theorem.

Unit 3 **(4 hrs)**

Introduction to 'R': Introductory R language fundamentals and basic syntax, major R data structures, Using R to perform data analysis, creating visualizations using R.

Unit 4 **(6 hrs)**

Basic statistical inference and hypothesis testing: Estimation, basic tests such as t-test, z-test, F-test, χ^2 –test, Non parametric tests: Sign test, Wilcoxon signed rank test.

Unit 5 **(4 hrs)**

Regression methods: Simple linear regression and multiple regression.

Unit 6 **(4 hrs)**

Engineering applications of statistics (Branch Specific (any 2)): Discussion on reliability and quality control. Introduction to random processes, stochastic processes, Markov chains. Machine learning and data science.

Text Books

- Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers and Scientists (8th Edition), Pearson Prentice Hall, 2007.
- Tilman M. Davies, The book of R: A first course in Programming and Statistics (1st Edition), No Starch Press, USA, 2016.

Reference Books

- Ross S.M., Introduction to probability and statistics for Engineers and Scientists (8th Edition), Elsevier Academic press, 2014.
- S. P. Gupta, Statistical Methods, S. Chand & Sons, 37th revised edition, 2008.
- Kishor S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications (2nd Edition), Wiley Student edition, 2008.
- Stephens L.J., Schaum's outline of statistics for Engineers, Latest edition, 2019.
- The practice of Business Statistics by Manish Sharma and Amit Gupta, Khanna Publishing Company Private Limited, New Delhi, 2014.

References for R Software

- Norman Matloff, The Art of R Programming - A Tour of Statistical Software Design, (1st Edition), No Starch Press, USA, 2011.
- Sudha Purohit, Sharad Gore, Shailaja Deshmukh, Statistics using R (2nd Edition), Narosa Publications, 2019.
- Randall Pruim, Foundations and Applications of Statistics - An introduction using R (2nd Edition), American Mathematical Society, 2018.
- Hadley Wickham and Garrett Grolemund, R for Data Science: Import, Tidy, transform, Visualize and Model Data, (1st Edition), O'Reilly Publications, 2017.

ML 21002 Environmental Studies

(Adopted from the 'Ability Enhancement of Compulsory Courses: Environmental Studies' as prescribed by the Expert Committee of University Grants Commission as per directives of Hon'ble Supreme Court)

Teaching scheme
Lectures: 1 hr/week

Examination Scheme
Periodic Assignment & Test
Assignment: 2 hrs/week

Course Outcomes (COs):
At the end of the course, student will be able to:

- Comprehend sustainable development goals for present generation
- Appreciate environmental resources, functioning of an ecosystem, significance of biodiversity and environmental challenges
- Analyze the current status of environment with respect to precautionary mechanisms and control measures
- Appreciate the role of an engineer for better tomorrow

Unit 1 **(2 hrs)**

Multidisciplinary nature of environmental studies:
Definition, scope and importance, Need for public awareness.

Unit 2 **(8 hrs)**

Natural resources: Renewable and non-renewable resources:
Natural resources and associated problems.
Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.Water resources : Use and over-utilization of surface and ground water,floods, drought, conflicts over water, dams-benefits and problems. Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies.Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification.Role of an individual in conservation of natural resources.Equitable use of resources for sustainable lifestyles.

Unit 3 **(6 hrs)**

Ecosystems:
Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and

decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem :-Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 4 **(8 hrs)**

Biodiversity and its conservation

Introduction– Definition: genetic, species and ecosystem diversity, Bio geographical classification of India, Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.

Unit 5 **(8 Hrs)**

Environmental pollution:

Definition, Cause, effects and control measures of :-Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards, Solid waste Management : Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management : floods, earthquake, cyclone and landslides.

Unit 6 **(7 hrs)**

Social issues and the environment:

From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case Studies, Environmental ethics : Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies, Wasteland reclamation, Consumerism and waste products. Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

Unit 7 **(6 Hrs)**

Human population and the environment:

Population growth, variation among nations, Population explosion – Family Welfare Programme, Environment and human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Case Studies.

Unit 8 **(5 Hrs)**

Field work:
Visit to a local area to document environmental assets river/ forest/grassland/hill/mountain Visit to a local polluted site-Urban/Rural/Industrial/Agricultural, Study of common plants, insects, birds, Study of simple ecosystems-pond, river, hill slopes, etc.

Reference Books:

- Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
- Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
- Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001,
- Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
- De A.K., Environmental Chemistry, Wiley Eastern Ltd.
- Down to Earth, Centre for Science and Environment (R)
- Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press. 473p
- Hawkins R.E., Encyclopedia of Indian Natural History, Bombay Natural History Society, Bombay (R)

CT (IF) 21001 Data Analytics

Teaching Scheme:
Lectures: 1 Hr/week
Laboratory: 2 Hrs/week

Examination Scheme:
Continuous Lab/Project Assessment: 40 marks
Mid-Sem Exam: 30 Marks
End-Sem Exam: 30 Marks

Course Outcomes (COs):
At the end of the course student will be able to:
- Examine and compare various datasets and features.
- Analyze the business issues that analytics can address and resolve.
- Apply the basic concepts and algorithms of data analytics.
- Interpret, analyse, and validate data using popular data analytics tools.

Unit 1 **(2 hrs)**

Fundamentals of data analytics:

Descriptive, Predictive, and Prescriptive Analytics, Data Types, Analytics Types, Data Analytics Steps: Data Pre-Processing, Data Cleaning, Data Transformation, and Data Visualization.

Unit 2 **(2hrs)**

Data analytics tools:
Data Analytics using Python: Statistical Procedures, NumPy, Pandas, SciPy, Matplotlib.

Unit 3 **(2hrs)**

Data Pre-processing:
Understanding the Data, Dealing with Missing Values, Data Formatting, Data Normalization, Data Binning, Importing and Exporting Data in Python**,** Turning categorical variables into quantitative variables in Python, Accessing Databases with Python.

Unit 4 **(2hrs)**

Data visualization:
Graphic representation of data, Characteristics and charts for effective graphical displays, Chart types- Single var: Dot plot, Jitter plot, Error bar plot , Box-and-whisker plot, Histogram, Two variable: Bar chart, Scatter plot, Line plot, Log-log plot, More than two variables: Stacked plots, Parallel coordinate plot.

Unit 5 **(2hrs)**

Descriptive and inferential statistics:
Probability distributions, Hypothesis testing, ANOVA, Regression

Unit 6 **(4hrs)**

Machine learning concepts:
Classification and Clustering, Bayes' classifier, Decision Tree, Apriori algorithm, K-Means Algorithm, Logistics regression, Support Vector Machines, Introduction to recommendation system.

Text Books

- Anil Maheshwari, "Data Analytics made accessible," Amazon Digital Publication, 2014.
- James R. Evans, "Business Analytics: Methods, Models, and Decisions", Pearson 2012
- Song, Peter X. K, "Correlated Data Analysis: Modeling, Analytics, and Applications", Springer-Verlag New York 2007.

Reference Books:

- Glenn J. Myatt, Wayne P. Johnson, "Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining", Wiley 2009.
- Thomas H. Davenport, Jeanne G. Harris and Robert Morison, "Analytics at Work: Smarter Decisions, Better Results", Harvard Business Press, 2010
- Rachel Schutt, Cathy O'Neil, "Doing Data Science", O'REILLY, 2006.
- Shamanth Kumar Fred Morstatter Huan Liu "Twitter Data Analytics", Springer-Verlag, 2014.

Data Analytics Lab

List of Assignments:

1. Write a NumPy program to generate an array of 15 random numbers from a standard normal distribution.
2. Write a NumPy program to create a two-dimensional array with shape (8, 5) of random numbers. Select random numbers from a normal distribution (200, 7).
3. Write a Pandas program to add, subtract, multiple and divide two Pandas Series. Sample Series: [2, 4, 6, 8, 10], [1, 3, 5, 7, 9]
4. Write a Pandas program to convert a NumPy array to a Pandas series.
5. Write a Pandas program to create the mean and standard deviation of the data of a given Series.
6. Write a Pandas program to compute the minimum, 25th percentile, median, 75th, and maximum of a given series.
7. Write a Pandas program to get the day of month, day of year, week number and day of week from a given series of date strings.
8. Consider Iris Dataset, load the iris data into a data frame and perform following basic operations on it:
    a. Print the shape of the data, type of the data and first 10 rows and get the number of observations, missing values and nan values.
    b. Use Scikit-learn to print the keys, number of rows-columns, feature names and the description of the Iris data.
    c. Create a 2-D array with ones on the diagonal and zeros elsewhere. Now convert the NumPy array to a SciPy sparse matrix in CSR format
    d. Basic statistical details like percentile, mean, std etc. of iris data.
    e. Write a Python program to drop Id column from a given Data frame and print the modified part. Call iris.csv to create the Data frame.
    f. create a plot to get a general Statistics of Iris data
9. Consider the same Iris Dataset and perform visualization on the same:
    a. Write a Python program to create a Bar plot and pie plot to get the frequency of the three species of the Iris data.

b. Write a Python program to create a graph to see how the length and width of Sepal Length, Sepal Width, Petal Length, Petal Width are distributed.
c. Write a Python program to create a joinplot to describe individual distributions on the same plot between Sepal length and Sepal width.
   Note: joinplot - Draw a plot of two variables with bivariate and univariate graphs.
d. Write a Python program to draw a scatterplot, then add a joint density estimate to describe individual distributions on the same plot between Sepal length and Sepal width.
e. Write a Python program using seaborn to Create a kde (Kernel Density Estimate) plot of sepal_length versus sepal width for setosa species of flower.
f. Write a Python program to create a box plot (or box-and-whisker plot) which shows the distribution of quantitative data in a way that facilitates comparisons between variables or across levels of a categorical variable of iris dataset. Use seaborn.
g. Write a Python program to create a Principal component analysis (PCA) of iris dataset.

10. Write a Python program using Scikit-learn to split the iris dataset into 80% train data and 20% test data. Train or fit the data into the model and using the K Nearest Neighbor Algorithm and create a plot of k values vs accuracy.
11. Build a decision tree model that predicts the species of iris from the petal and sepal width and length. Perform model evaluation.
12. Implementing Support Vector Machine(SVM) classifier in Python using the iris features from iris dataset and train an SVM classifier and use the trained SVM model to predict the Iris species type.

Mini Project: Write an application demonstrating your skills in defining a data science problem, writing down the requirements carefully, designing a modular solution with clear separation of data pre-processing and transformation, visualization ,model building and model evaluation. The application can use any dataset from Kaggle, UCI etc or a task defined after discussion with the instructor.

This list is a guideline. The instructor is expected to improve it continuously.

Humanities and Social Sciences Open Courses-II
AS (HS) 21005 Industrial Psychology

Teaching scheme
Lectures: 2 hrs/week

Examination Scheme
Assignment/Test: 40 Marks
Final assessment: 60 Marks
Field Visit/ Expert Lecture Report: 20 Marks
Mini-project Report: 40 Marks

Course Outcomes (COs):
At the end of the course, student will be able to:

- Determine the psychological factors that influence individual differences at work and appraise the role of research.
- Explain the concepts of motivation and job satisfaction at work and Utilize the elements of organizational culture for enhancing group/team behavior.
- Evaluate the relevance & functioning of leadership & diversity in workforce and acknowledge the multicultural factors influencing workplace behavior.
- Illustrate the process of recruitment & selection and Experiment with the information required to sustain employability.
- Interpret the nuances of Human Factors in Engineering and Analyze itsrole in their disciplines.
- Measure the behavioral findings from self-lead projects and Propose corrective actions to improve quality of workplace behaviour.

Unit 1 **(6 hrs)**

Basics of industrial psychology (IP):
Difference between IP & business programs; major fields & employment in IP, brief history- scientific management, time and motion study, Hawthorne studies, World war I & II, Research in social sciences, Individual differences at work: personality, intelligence, emotional intelligence, creativity & innovation, perception & attitudes.

Unit 2 **(8 hrs)**

People at work:
Motivation & job satisfaction- employee predisposition, expectations, goals, incentives & equity; job characteristic theory (diagnostic model), Understanding groups & teams- group dynamics, factors affecting group performance; understanding work teams, types of teams, team development, issues with teamwork, Leadership (co-teaching 4 hrs)- leader characteristics, leader & situation, leader & follower; specific leadership skills, Introduction to organizational development (OD), diversity- multiculturalism- Hofstede's theory, diversity dynamics.

Unit 3 **(8 hrs)**

Human factors engineering (HFE):
Introduction & brief history of HFE; essentials of HFE, person-machine systems- basic human factors: sensory systems, perception, cognition, information processing approach, memory, decision making, workspace designs- general principles, designing work areas; machine displays & controls; physical work environment & anthropometry; managing workplace strain through ergonomics (self-study), current trends in HFE- use of artificial intelligence, cognitive engineering, sociotechnical systems, etc.

Unit 4 **(6 hrs)**

Managing people at work:
Job analysis- brief background, types & importance; job description, recruitment & selection- overview, process, evaluation, gearing for selection- interviews & job search skills, performance appraisal (co-teaching 2 hrs): steps in the evaluation process; appraisal interview.

Text Books

- Aamodt, M.G. (2013). Industrial Psychology. Cengage Learning: Delhi.
- Wickens, C. D.; Lee, J. D., Liu, Y. & Gordon Becker, S. E. (2015). An Introduction to Human Factors Engineering. 2nd Edition. Pearson Education: New Delhi.
- Landy, F. J. & Conte, J. M. (2010). Work in the 21st Century: An Introduction to Industrial and Organizational Psychology. 2nd Edition. Wiley India: New Delhi.

References

- Matthewman, L., Rose, A. & Hetherington, A. (2009). Work Psychology. Oxford University Press: India.
- Schultz, D. & Schultz, S. E. (2013). Psychology and Work Today: An Introduction to Industrial and Organizational Psychology. 7th Edition. Pearson Education: New Delhi.
- Schultz, D. & Schultz, S. E. (2002). Psychology and Work Today. Pearson Education: New Delhi.

AS (HS) 21006 Personnel Psychology

Teaching Scheme
Lectures: 2 hrs/week

Examination Scheme
Total: 100 Marks
Assignment: 60 Marks
End Semester: 40 Marks

Course Outcomes (COs):
At the end of the course, student will be able to:
- Acquire organizational concepts and will recognize their own personality attributes suitable for corporate world.
- Realize the importance of motivation and apply motivational principles to their lives
- Experience group dynamics and apply those principles in their lives
- Grasp and apply different techniques to maintain mental health.

Unit 1 **(6 hrs)**

Introduction- Understanding own personality and corporate world:
Basic concepts in organizational set up and its importance, know own personality attributes, preparing for corporate world, work ethics, and self- management

Unit 2 **(6 hrs)**

Motivation:
Motivational theories for self- motivation and motivating others at work place, Approaches to work

Unit 3 **(8 hrs)**

Group dynamics:
Group behavior and leadership, Effective group behavior, leadership and management principles, virtual teams and performance appraisal

Unit 4 **(6 hrs)**

Mental health at work place:
Occupational stress and conflict and strategies for its management, emotional intelligence, spiritual intelligence

****The course contents different psychometric tests, case studies and classroom activities.**

Text Books

- Khana S.S.- (2016) Organizational Behaviour(Text and Cases) Chand and company Pvt.Ltd.Delhi.
- Rae Andr'e :- (2008) organizational behavior. Dorling Kindersley (India) Pvt. Ltd.
- Wallace H.and Masters L.- (2008) Personality development..Cengage Learning India Pvt. Ltd.

Reference Books

- Robbins S, JudgeA, Vohra N:- (2013)Organizational behavior.(15thed) Pearson Education, Inc.
- Singh Kavita:- (2010) Organizational behavior-Text and cases. Dorling Kindersley

AS (HS) 21007 Engineering Economics

Teaching scheme
Lectures: 2 hrs/week

Examination Scheme
Assignment/Test: 40 Marks
End Semester: 60 Marks

Course Outcomes (COs):
At the end of the course, student will be able to:

- Demonstrate understanding of economic theories and policies.
- Identify economic problems and solve it by applying acquired knowledge, facts and techniques in the available framework.

- Categorize, classify and compare economic situations and draw inferences and conclusions.
- Adapt to changing economic atmosphere and propose alternative solutions to the problems.

Unit 1 **(6 hrs)**

Introduction to economics:
Definitions, basic concepts of economics: cost, efficiency and scarcity, opportunity cost, types of economics: micro economics, macroeconomics and managerial economics, difference between micro economics and macroeconomics, application of managerial economics.

Unit 2 **(8 hrs)**

Micro economics analysis:
Demand analysis, supply analysis, theories of utility and consumers choice, cost analysis, competition and market structures, application of micro economics theories.

Unit 3 **(8 hrs)**

Macro-economic analysis:
Aggregate demand and supply, economic growth and business cycles, inflation, fiscal policy, national income, theory of consumption, savings and investments, commercial and central banking, use of macro-economic theories.

Unit 4 **(8 hrs)**

International economics:
Balance of trade and balance of payments, barriers to trade, benefits of trade/comparative advantage, foreign currency markets/exchange rates, monetary, fiscal and exchange rate policies, economic development, application of exchange rate policies.

Reference Books

- Macroeconomics: N. Gregory Mankiw, 2018
- Managerial Economics: Economic Tools for Today's Decision Makers: by Paul Keat (Author), Philip Young (Author) 2013
- Principles Of Macro Economics: Misra and Puri.2009, Himalaya publishing house, New Delhi.
- Modern Microeconomics, A. koutsoyiannis , Macmillan , London
- Microeconomics Robert S. Pindyck and daniel L. rubinfeld:,pearson education Inc. New Delhi
- Micro economics: K. N. Verma

AS (HS) 21008 Finance for Engineers

Teaching scheme
Lectures: 2 hrs/week

Examination Scheme
Assignment: 40 Marks
End Semester: 60 Marks

Course Outcomes (COs):
At the end of the course, student will be able to:

- Comprehend basics of accounting, cost concepts, will be able to read Financial statements of companies
- Enable them to understand critical financial principles and to enable them to integrate & analyze financial information necessary for Business Decision Making.
- Establish relationship between Risk & Return, time value of money, sources of finance & working capital
- Appreciate the digital platform of future finance, crypto-currency, the terms associated with Financial Markets such as money market, capital market, SEBI & other Regulatory authorities

Unit 1 **(6 hrs)**

Introduction to accounting & finance:
Basic elements of financial accounting, cost concepts, preparation of profit & loss account & balance sheet & concept of budgetary control.

Unit 2 **(6 hrs)**

Read & interpret financial statements:
As per Schedule III of companies Act 2013, financial statement analysis, concept of cash flow statement.

Unit 3 **(8 hrs)**

Break-even analysis, Risk & Return relationship, time value of money, sources of finance & working capital.

Unit 4 **(4 hrs)**

Digital platform such as net banking, crypto-currency, algorithm based stock exchange trading, basics of money market, capital market, commodities market, IPO & regulatory authorities.

****Pedagogy:** Lectures and PPTs, Use of basic Excel tools for preparation of final accounts, Annual Reports of companies.

Reference Books

- Accounting for Managers – C Rama Gopal (2012), Accounting for Management, New Age International Publishers

- Financial Management – Theory and Practice - Prasanna Chandra [Mc Graw Hill] publication

Skill Based Course of the Domain
ME 21008 Design of Machine Components

Teaching Scheme
Practical: 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes (COs):
At the end of the course students will be able to:

- Approach a design problem involving several mechanical components and take a decision when there is not a unique answer.
- Design and draw mechanical components.
- Use at least one drafting software.
- Use design data book.

Practical projects:
Term work shall consist of **"TWO"** design projects. Each project shall consist of two imperial size sheets – one involving assembly drawing with a parts list and overall dimensions and the other involving detailed drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified so as to make it a working drawing. Use software for analysis and design proficiently.

A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. Design project should be in the form of "Design of Machine components" comprising of various Machine elements covered in the syllabus. Design data book shall be used, wherever necessary, to select materials and standardized components. The drawings of one project shall be completed using design and drafting software.
The **ORAL** shall be based on Term Work.

ME 21001 Fluid Machinery & Fluid Power

Teaching scheme
Lectures: 3 hrs/week
Tutorial: 1 hr/week

Examination Scheme
Internal Test 1: 20 Marks
Internal Test 2: 20 Marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):
At the end of the course student will be able to:

- Design and evaluate performance of various Turbo Machines.
- Apply laws of fluid mechanics and governing equations for Turbo Machinery.
- Describe working of various components used for hydraulic & pneumatic systems.
- Design various hydraulic and pneumatic systems for industrial applications.

Unit 1 **(8 hrs)**

Momentum principle and its application:
Impulse- momentum principle, Calculation of force exerted on fixed plate, moving flat plates & curved vanes, Calculation force exerted on series of moving vanes, velocity diagrams & their analysis.

Unit 2 **(8 hrs)**

Turbines:
Classification, Various heads & efficiencies, Main components and constructional features of Pelton Wheel, Kaplan and Francis turbines, Velocity diagrams & analysis of Pelton, Francis turbines, Cavitation in water turbines, Governing mechanism, safety devices, Performance characteristics.

Unit 3 **(7 hrs)**

Centrifugal pumps:
Working principles, Construction, Types, Various heads, multistage pumps, Velocity triangles, Minimum starting speed, cavitation, Maximum permissible suction head (MPSH) and Net positive suction head (NPSH). Methods of priming, calculations of efficiencies, Discharge, Blade angles, Head, Power required Impeller dimensions etc. Specific speed and performance characteristics of pumps.

Unit 4 **(7 hrs)**

Fundamentals of fluid power:
Applications, advantages and dis-advantages of Hydraulic and Pneumatic systems. Various fluids used and their properties. Constructional details and Working of FRL unit. Drying of compressed air. Filters used in Hydraulic system.

Unit 5 **(7 hrs)**

Control valve & actuators :
Various types of Pressure, Direction & Flow control valves. Impulse valve, speed regulators, time delay valve, shuttle valve, twin pressure valve, solenoid operated valve. Constructional details and Working of various types of Actuators. Seals and Packing.

Unit 6 **(8 hrs)**

Hydraulic and pneumatic circuits:

Various symbols used. Basic Hydraulic and Pneumatic Circuits. Impulse operation, speed control, Actuation of pneumatic motor, sequencing of motion, use of roller operated valves, time delay circuit, Examples of Circuit design. Industrial Automation. Servo Mechanism.

Text Books

- Modi &Seth, Fluid Mechanics & Fluid Machinery, Standard Book House 2002.
- S.R. Majumdar, Pneumatic Systems Principles and Maintenance, Tata McGraw-Hill, N.Delhi, 2000.
- S.R. Majumdar, Oil Hydraulic Systems and Maintenance, Tata McGraw-Hill, N.Delhi, 2001.
- H.L. Stewart, Hydraulics and Pneumatics Power for Production, Industrial Press Inc. N.Y. USA, 2001.
- Andrew Parr, Butterworth and Heinemann, Hydraulics and Pneumatics, Oxford, UK, 1987.
- Espisito,Fluid Power with Application, Prentice Hall International,1998
- J.J.Pipenger ,Industrial Hydraulics, McGraw Hill, N.York, 1981.

Reference Books

- Industrial Hydraulics Manual-Vickers Sperry Rand Corporation, Technical Training Centre, N.York, 1988.
- Oil Hydraulics-P.Lal, International Literature, N.York, 1978.
- ISO-1219:1988 Fluid Systems and Components.
- Yeaple Franklin, Hydraulics and Pneumatics Power and Control, McGraw Hill Book. Co. N.York, 1966.
- R.K.Rajput,A Text book of Fluid Mechanics and Hydraulic Machines, S.Chand Co.Ltd.,2002

ME 21002 Metrology and Mechanical Measurements

Teaching scheme
Lectures: 3 hrs/week

Examination Scheme
Internal Test 1: 20 Marks
Internal Test 2: 20 Marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Apply knowledge of various tools and techniques used to determine geometry and dimensions of components in engineering applications.
- Design gauges to meet desired needs within realistic constraints.
- Perform experiments, as well as to analyze and interpret data.
- Apply the basic concepts of mechanical measurement for industrial applications.
- Describe methods of measurement for various quantities like force, torque, power, displacement, velocity/speed and acceleration.

Unit 1 **(8 hrs)**

Linear and angular measurements, **Interferometry, Measurement system analysis:**
A] Introduction: Meaning of Metrology, Precision, Accuracy, Methods and Errors in Measurement, Calibration.
B] Linear Measurement: Standards, Line Standards, End Standard, Wavelength Standard, Classification of Standards, Precision and Non -Precision Measuring instruments and their characteristics, Slip Gauges.
C] Interferometry: Introduction, Flatness testing by interferometry, NPL Flatness Interferometer. Study of Measuring Machines, Recent Trends in Engineering Metrology, use of interferometers for length, angle and surface roughness measurement.
D] Angle Measurement: Sine bars, Sine Centers, Uses of sine bars, angle gauges, Auto Collimator Angle Dekkor, Constant deviation prism.
E] Measurement System Analysis: Introduction, Influence of temperature, operator skills and the instrument errors etc. on the MSA.

Unit 2 **(6 hrs)**

Design of gauges, Interferometers and Comparators, Measuring machines:
A] Limits, Fits and Tolerances: Meaning of Limit, Fits and Tolerance, Cost – Tolerance relationship, concept of Interchangeability, Indian Standard System.
B] Design of limits gauges: Types, Uses, Taylor's Principle, Design of Limit Gauges, Three surface Generation.
C] Inspection of geometric parameters: Straightness, Flatness, Parallelism, Concentricity, Squareness, and Circularity.
D] Comparators: Uses, Types, Advantages and Disadvantages of various types of Comparators.
E] Measuring machines: Theory of Co-ordinate Metrology, Universal Measuring Machines, Co-ordinate Measuring Machines (CMM), different configurations of CMM, Principle, Error involved, calibration, Probing system, automated inspection system.

Unit 3 **(7 hrs)**

Surface finish measurement, Screw thread metrology, Gear metrology:
A] Surface finish measurement: Surface Texture, Meaning of RMS and CLA values, Roughness Measuring Instruments, Tactile and Non-tactile measuring instruments, difference between waviness and roughness, Grades of Roughness, Specifications, Assessment of surface roughness as per IS, Relationship between surface roughness and Manufacturing Processes.
B] Screw thread metrology: External Screw Thread Terminology, Floating Carriage Instruments, Pitch and flank Measurement of External Screw Thread, Application of Tool Maker's Microscope, Use of Profile Projector.
C] Gear metrology: Spur Gear Parameters, Gear Tooth Thickness Measurement: Gear Tooth Vernier Caliper, Constant Chord Method, Span Micrometer.

Unit 4 **(6 hrs)**

Introduction to mechanical measurements:
Importance of Measurements, Classification of measuring instruments, generalized measurement system, types of inputs for measurements. Concepts such as Linearity, Sensitivity, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc. Errors in Measurements, Classification of errors in measurements, First order instruments and its response to step, ramp, sinusoidal and impulse inputs.

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Unit 5 **(6 hrs)**

Measurement methods and devices:
A] Displacement measurement: Transducers for displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle Flapper Transducer.
B] Velocity measurement: Tachometers, Tacho generators, Digital tachometers and Stroboscopic Methods.
C] Acceleration measurement: theory of accelerometer and vibrometers, practical accelerometers, strain gauge based and piezoelectric accelerometers.
D] Strain measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors.

Unit 6 **(6 hrs)**

Measurement – methods and devices:
A] Pressure measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge.
B] Temperature measurement: Thermocouple, Resistance thermometers, Thermistors, Pyrometers. Liquid in glass Thermometers, Bimetallic strip.
C] Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges.

Text Books

- R. K. Jain, A Text book of Engineering Metrology, Khanna Pblications Pvt. Ltd.18th Edition, 2002
- I.C.Gupta, A Text book of Engineering Metrology, Dhanpat Rai Publications Pvt. Ltd.6th Edition, 2004
- Anand Bewoor, Vinay Kulkarni.Metrology and measurement, Tata McGraw-Hill, first edition 2009.

- N.V. Raghavendra, L. Krishnamurthy, Engineering Metrology And Measurements,Oxford University Press,1st edition 2013
- R.K.Rajput A textbook of measurement and metrology ,S.K. Kataria & Sons,2013.
- R.K.Jain ,Mechanical and Industrial Measurements,Khanna Publishers,1995
- A.K.Sawhney,Mechanical measurement and control,Dhanpat Rai & Co. (P) Limited ,2017

Reference Books

- G.M.S. De Silva, Basic Metrology for ISO 9000 Certification Elsevier Publications, 3rd Edition 2002.
- Ernest Doebelin and Dhanesh Manik, Measurement Systems , McGraw-Hill, 6th Edition, 2017.

ME 21003 Heat Transfer

Teaching Scheme
Lectures: 3hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Anticipate and describe the consequence of heat transfer in thermal analyses of engineering systems.
- Formulate, evaluate and develop solution for one and two dimensional steady state heat conduction and unsteady state heat conduction problem.
- Describe fundamentals related to mass transfer and establish relationship between fluid flow and convection heat transfer.
- Apply empirical correlations for free and forced convection and phase change process to determine values for the convection heat transfer coefficient.
- Formulate and solve the heat exchanger rating and sizing problem.
- Evaluate radiation view factors using tables and obtain numerical solutions for radiation heat transfer problems.

Unit 1 **(6 hrs)**

One dimensional steady state heat conduction:

Introduction, derivation of Generalized heat conduction equation in Cartesian coordinates, Fourier, Laplace and Poission's equation. Generalized heat conduction equation in cylindrical and spherical co-ordinates. (no derivation). Heat conduction through a composite slab, cylinder and sphere, effect of variable thermal conductivity, critical radius of insulation, Economic insulation, and thermal contact resistance. Conduction with heat generation for plane wall, cylinder and sphere.

Unit 2 **(6 hrs)**

Extended surfaces and unsteady state heat conduction:
Types and Applications of Fins, Heat transfer through extended surfaces, derivation of temperature distribution equations and heat transfer through fins of constant cross-sectional area, Effectiveness and efficiency of a fin, Errors in the measurement of temperature in a thermo-well. System with negligible internal resistance, Biot and Fourier numbers. Lumped heat capacity method, use of Heisler charts.

Unit 3 **(5 hrs)**

Two dimensional steady state heat conduction:
Introduction to analytical method – two dimensional steady state heat conduction in rectangular plates, two dimensional steady state heat conduction in semi-infinite plates, graphical method – boundary conditions, conduction shape factors for common geometries.

Unit 4 **(9 hrs)**

Free and Forced convection:
Local and average convective coefficient, Hydrodynamic and thermal boundary layer, Laminar and turbulent flow over a flat plate and through a duct, Friction factor, Drag and drag co-efficient. Dimensional analysis in free and forced convection, physical significance of the dimensionless numbers related to free and forced convection, empirical correlations for free and forced convection for heat transfer in laminar and turbulent flow over a flat plate and through a duct.
Introduction to Condensation and Boiling, pool boiling, critical heat flux, burnout point, forced boiling. Film and drop wise condensation, determination of heat transfer coefficient.
Modes of Mass transfer, Concentrations, velocities and fluxes, Fick's law, general mass diffusion equation in stationery media, steady state diffusion through a plain membrane, steady state diffusion through a cylindrical shell, steady state diffusion through a spherical shell. Convective mass transfer.

Unit 5 **(6 hrs)**

Radiation:
Fundamental concepts, Black body radiation, Planck's distribution law, Wien's displacement law and the Stefan-Boltzmann law. Surface emission, radiative properties of a surface, The grey, black and real surface. Radiation shape factor, use of shape factor charts, Kirchhoff's law, Lambert's cosine law. Heat exchange between non-black bodies, heat exchange between two infinitely parallel planes and cylinders, Radiation shields, heat exchange by radiation, between two finite black/gray surfaces. Gas radiation (elementary treatment only). Solar radiation, irradiation, radiation potential, electrical network method of solving radiation problems.

Unit 6 **(6 hrs)**

Heat exchangers:
Heat exchangers classification, overall heat transfer coefficient, heat exchanger analysis, use of log mean temperature difference (LMTD) for parallel and counter flow heat exchangers, LMTD correction factor, fouling factor, The effectiveness-NTU method for parallel and counter flow heat exchangers. Design considerations of heat exchanger.

Text Books

- S.C.Arora, V. M. Domkundwar, A.V.Domkundwar, A course in Heat and Mass Transfer, Dhanpat Rai and Co. Pvt. Ltd, New Delhi
- S. P Sukhatme, A Text Book of Heat Transfer, University Press, 4th Edition, 2005
- R.K.Rajput, Heat and Mass Transfer, S. Chand and Co. Pvt. Ltd, New Delhi.

Reference Books

- Incropera and Dewitt: Fundamentals of Heat and Mass Transfer, John Wiley and Sons,NY.
- P.K.Nag, Heat and Mass Transfer, Tata McGraw-Hill, 2011
- Yunus A. Cengel, Heat Transfer: A Practical Approach, McGraw-Hill Higher Education, 2002
- J.P. Holman: Heat Transfer; McGraw-Hill, 1996
- C.P. Kothandaraman, S. Subramanyam, Heat and Mass Transfer Data Book, New Age International Publishers, Mumbai.

ME 21004 Design of Machine Components

Teaching Scheme
Lectures: 3 hrs / week
Tutorial: 1 hr/ week

Examination Scheme
100 Marks: Continuous Evaluation
Assignment/Quiz: 40 marks
End– Sem Exam: 60 marks

Course Outcomes (COs):
At the end of the course student will be able to:
- Evaluate the different types of stresses induced in a component due to different types of static loading conditions.
- Apply the principles of static loading to design various joints, keys, couplings, screws, and springs.
- Design shaft as per ASME code.
- Design welded joint for various loading conditions.

Unit 1 **(6 hrs)**

Fundamental aspects of design:

The meaning of design, engineering design, phases of design, design considerations, stress and strain considerations, factor of safety, standardization, preferred series, material selection – weighted point method.

Unit 2 **(6 hrs)**

Design against static load:
Commonly used engineering materials and their important mechanical properties – cast iron, mild steel, non-ferrous materials like Copper and Brass, stress-strain relationship, stresses due to bending and torsional load, design of cotter/knuckle, turn-buckle joints, riveted joints, eccentric loading and theories of failure.

Unit 3 **(6 hrs)**

Design of screws and fasteners:
Design of bolted and threaded joints, design of power screws, introduction to recirculating ball screw.

Unit 4 **(6 hrs)**

Design of shafts, keys and couplings:
Shafts subjected to bending and torsion, types of keys and their design, design of rigid and flexible couplings.

Unit 5 **(6 hrs)**

Design of springs:
Design of mechanical springs, helical torsion spring, design of multi leaf spring, nipping.

Unit 6 **(6 hrs)**

Design of welded joints:
Types of welded joints, eccentrically loaded joints, and welded joints subjected to bending moment.

Text Books
- Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Education (India) Ltd.
- Bhandari V.B. – "Design of Machine Elements" – McGraw Hill Education (India) Ltd.

Reference Books
- Spotts M.F. – "Design of Machine Elements" – Prentice Hall International.

- Black P.H. and O. Eugene Adams – "Machine Design" – McGraw Hill Book Co.Ltd.
- "Design Data" – P.S.G. College of Technology, Coimbatore.
- Hall A.S.; Holowenko A.R. and Laughlin H.G. – "Theory and Problems of Machine Design" – Schaum's outline series.

ME 21005 Fluid Machinery & Fluid Power Laboratory

Teaching Scheme
Practical: 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes (COs):

At the end of the course student will be able to:

- Evaluate performance of hydraulic turbines.
- Evaluate performance of centrifugal pump.
- Describe the construction, working and application of components used in hydraulic and pneumatic circuits.
- Design of various hydraulic and pneumatic circuits.

List of experiments:

The journal consisting of at least seven experiments among the following should be submitted. Two experiments out of first three and the sixth experiment is compulsory.

1. Study and trial on Pelton Turbine for performance testing.
2. Study and trial on Francis Turbine for performance testing.
3. Study and trial on Kaplan Turbine for performance testing.
4. Study & trial on centrifugal pump for performance testing.
5. Study & trial on gear pump for performance testing.
6. Design of Hydraulic Circuits by using Hydraulic Trainer Kit
7. Design of Pneumatic Circuits by using Pneumatic Trainer Kit
8. Demonstration of working of Hydraulic Press
9. Demonstration of cut sections of various Hydraulic Components

ME 21006 Metrology and Mechanical Measurements Laboratory

Teaching Scheme
Practical: 2 hrs / week

Examination Scheme
Term work: 50 marks
Oral: 50 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Understand principle, construction and working of various measuring instruments,
- Select proper instruments for measurement
- Calculate least count of instrument, take reading using the instrument

- Interpret the observations & results.
- Collect and record data and analyse the data

Term Work / Experiments:

The term work shall consist of the conduction of any 12 experiments from the list given below.

1. Determination of Linear dimensions of a part using Precision and Non Precision measuring Instruments.
2. Precision angular measurement using a set-up of Sine Bar and Slip Gauges
3. Measurement of straightness, circularity, run out and total run out.
4. Measurement of screw thread parameters using Floating Carriage Micrometre.
5. Surface Finish measurement using suitable instrument.
6. Interferometry: Measurement of surface flatness using optical flat.
7. Study and Measurement of parameters using Profile Projector.
8. Exercise on Design of Limit Gauges using Taylor's Principles.
9. Study and Measurement of parameters using Tool Makers Microscope.
10. Demonstration of Digital Comparator and Pneumatic Comparator
11. Demonstration of CMM and Vision Measurement Machine
12. Measurement of temperature using RTD
13. Measurement of flow using flowmeter
14. Measurement of solar radiation flux density using pyranometer
15. Measurement of pressure using U tube manometer
16. Measurement of wind speed using anemometer

Assignments:

1. Exercise on Design of Limit Gauges using Taylor's Principles.
2. Develop a Matlab-Simulink model for First order instrument for various inputs.

ME 21007 Heat Transfer Laboratory

Teaching Scheme
Practical: 2 hrs / week

Examination Scheme
Term work: 50 marks
Practical/Oral: 50 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Determine heat conduction properties of materials and observe heat transfer phenomenon and practically relate to concepts discussed in the heat & mass transfer course
- Account for the consequence of heat transfer in thermal analyses of engineering systems
- Analyze problems involving steady state heat conduction in simple geometries.
- Evaluate heat transfer coefficients for natural convection, for forced convection inside ducts, for forced convection over exterior surfaces.
- Calculate radiation heat transfer between black body surfaces and heat exchange between graybody surfaces.

Students have to perform **any eight** of the following experiments, make a report and submit as Term work for evaluation

List of Experiments:

1. Determination of thermal conductivity of a metal rod
2. Determination of thermal conductivity of insulating powder.
3. Determination of thermal conductivity of a given liquid.
4. Determination of thermal resistance of composite slab
5. Determination of Time required to Heat/Cool a body (Unsteady State Heat Conduction)
6. Determination of heat transfer coefficient in natural convection
7. Determination of heat transfer coefficient in forced convection for flow through cylinder
8. Determination of critical heat flux
9. Determination of emissivity of given surface
10. Determination of Stefan Boltzmann constant
11. Determination of effectiveness of heat exchanger (shell and tube type, cross flow type and plate type)

Minor in Product Design and Optimization
ME (MI) 21001 Product Design

Teaching scheme
Lectures: 3 hrs/week

Examination Scheme
Internal Test 1: 20 Marks
Internal Test 2: 20 Marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Practice various steps involved in the design of new product.
- Apply strategies involved in industrial design.
- Understand and implement the importance of economic factors in the product design.
- Apply principles of value engineering to new product development.
- Understand and exercise product development cycle, especially Booz Allen & Hamilton new product development cycle & ATAR model in financial analysis.

Unit 1 **(8 hrs)**

Introduction to product design:

Design by innovation, evolution, essential factors of product design, production consumption cycle (pcc), flow and value addition in pcc, morphology of design, primary phases of design, role of allowances, process capability and tolerances in design and assembly

Unit 2 **(6 hrs)**

Application of product design in industry:
Product design strategies in industry, pricing, quality, utility, luxuriousness, product analysis, simplification, designer and his role, Industrial design considerations, procedures, problems, types of models, role of aesthetics, functional design practices

Unit 3 **(6 hrs)**

Economic factors in product design:
Economic factors influencing design, product value, economic analysis, profit, competitiveness, break even analysis

Unit 4 **(6 hrs)**

Value engineering in product design:
Value, value analysis job plan, value analysis tests, cost reduction through value engineering, material and process selection in value engineering.

Unit 5 **(6 hrs)**

Product management:
Defining product by nature and demand, New product strategy, product classification, product development & management, product life cycle, Booz Allen & Hamilton new product development cycle, ATAR model applied to financial analysis in business.

Unit 6 **(6 hrs)**

Modern approaches to product design:
Concurrent engineering, rapid prototyping, reverse engineering, Quality function deployment.

Text Books

- Product Design and Manufacturing , K. Chitale, R. C. Gupta, PHI Publication, 2013
- Product Design, Creativity, Concepts and Usability, Prashant Kumar, , PHI Learning Pvt. Ltd. New Delhi, 2012

Reference Books

- Product Design and development, Karl T. Ulrich, Steven Eppinger, McGraw-Hill Education; 5th edition, 2011.
- New Product Development: Design & Analysis, Roland Engene Y., Inetoviez, John Wiley and Sons Inc., N.Y. 1990.

- Successful Product Design, Bill Hollins, Stuart Pugh, Butterworth, London, 1990.

Honor in Hybrid and Electric Vehicle
ME (HO) 21001 Automotive Engineering Systems

Teaching scheme
Lectures: 3 hrs/week

Examination Scheme
Research Assignment: 20 Marks
Internal Test: 20 Marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students should be able to:

- Identify the need of transmission system, its function, and discuss different types of passenger car transmission systems.
- Calculate vehicle resistance, predict vehicle power requirement curve.
- Calculate transmission gear ratio's & predict vehicle performance.
- Categorize different vehicles bodies & layout's, its nomenclature, structural elements and synthesis it to meet vehicle crashworthiness requirements.
- Describe the different breaking & suspension systems in an automobile & demonstrate the vehicle safety.

Unit 1 **(4 hrs)**

Introduction:

History, Development of Vehicles & Drive Units, Stages in the Development of Automotive Transmissions, Development of Gear-Tooth Systems and other, Transmission Components, Basic Elements of Vehicle and Transmission Engineering, Need of Gearboxes, Functions of Vehicle Transmissions, and Fundamental Performance Features of Vehicle Transmissions, Trends in Transmission Design, Transmission Losses and Efficiency.

Unit 2 **(6 hrs)**

Basic design principles:

Arrangement of the Transmission in Passenger / Commercial / All-Wheel Drive Passenger Cars / Transverse and Longitudinal Dynamics with All-Wheel Drive, Transmission Formats & Designs, Basic Gearbox Concept. Passenger Car Transmissions: Manual Passenger Car Transmissions (MT); Automated Manual Passenger Car Transmissions (AMT); Dual Clutch Passenger Car Transmissions (DCT); Automatic Passenger Car Transmissions (AT); Passenger Car Hybrid Drives; Continuously Variable Passenger Car Transmissions (CVT). Final Drives: Axle Drives for Passenger Cars, Axle Drives for Commercial Vehicles, Differential Gears and Locking Differentials, Hub Drives for Commercial Vehicles; Transfer Gearboxes.

Unit 3 **(8 hrs)**

Passenger vehicle body:
The Automobile Body, Description of the Automobile Body Types (space frame, central frame, Body-on-frame, Monocoque), Body Nomenclature, Body Mass Benchmarking, Steel used in passenger vehicle. Vehicle layout, Different types of Car Body Style, Automotive Body Structural Elements, Overview of Classical Beam Behavior, Design of Automotive Beam Sections, Design for Crashworthiness: Standardized Safety Test Conditions and Requirements, Front Barrier, Side Impact, Note on Rear Impact.

Unit 4 **(12 hrs)**

Brakes, Suspension systems:
Type of brakes, Disc & Drum brake theory, constructional details, advantages, Brake actuating systems, Materials, and braking torque. Factors affecting brake performance, Parking & Exhaust brakes, power assisted brakes, Antilock Breaking System (ABS). Testing of brakes, thermal Considerations, Construction of suspension system, Solid Axles & Independent Suspension system, four-link & multi-link, Trailing Arm, Short Long Arm (SLA), MacPherson Strut suspension system, Anti-Squat, Anti-Pitch, and Anti-Dive suspension system, Roll Centre& stability Analysis

Text Books

- Harald Naunheimer, Bernd Bertsche, Joachim Ryborz, Wolfgang Novak "Automotive Transmission: Fundamentals, Selection, Design & Application" 2ndEdition, Springer-Verlag Berlin Heidelberg 1994, 2011
- Donald E. Malen "Fundamentals of Automobile Body Structure Design" SAE International Publication.
- K. Newton, W.Steeds and T.K.Garret, "The Motor Vehicle", 13thEdition, Butterworth Heinemann, India, 2004.
- P.M.Heldt, "Automotive Chassis", Chilton Co., New York, 1982.5.W.Steed, "Mechanics of Road Vehicles", Illiffe Books Ltd., London. 1992.
- Heinz Heisler, "Advanced Vehicle Technology", second edition, Butterworth –Heinemann, New York, 2002.

Reference Books

- William Crouse, "Automobile Engineering"
- Harban Singh Rayat, "The Automobile", S. Chand & Co. Ltd, New Delhi, 2000
- G.J.Giles, "Steering Suspension and Tyres", Illiffe Books Ltd., London, 1975
- Kirpal Singh, "Automobile Engineering", Standard publishers, Distributors, Delhi, 1999
- G.B.S.Narang, "Automobile Engineering", Khanna Publishers, Twelfth reprint New Delhi, 2005

- R.P.Sharma, "Automobile Engineering", Dhanpat Rai & Sons, New Delhi, 2000.
- Dr. N. K. Giri, "Automobile Mechanics", Seventh reprint, Khanna Publishers, Delhi, 2005
- Automotive Hand book/ Robert Bosch, SAE, 2003.8.2. K.K. Ramalingam, "Automobile Engineering ", Scitech Publications (India) PVT

Honour Course (Thermal Stream)
ME (HO) 21002 Fluid Dynamics

Teaching Scheme
Lectures: 3hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Understand and define the fluid flow problems along with range of governing parameters
- Use the governing equations for different flow conditions for exact and approximate solutions.
- Differentiate the different fluid flow patterns, flow regimes and its effects.
- Devise the fluid flow problems of industrial base.
- Design and develop experimental procedure for internal and external fluid flow conditions.

Unit 1 **(6hrs)**

Governing equations in Fluid Dynamics:

Reynolds Transport Theorem, Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations.

Unit 2 **(6hrs)**

Exact solutions of Navier-Stokes equations

Fully developed flows, parallel flow in straight channel – Couette flow with and without applied pressure gradients, Fully Developed Flow in a Round Pipe— Poiseuille Flow, unconfined Flow over the horizontal and inclined plate, Creeping flow approximation

Unit 3 **(6 hrs)**

Potential flow:

Irrotational flow approximations for continuity and momentum equations, Kelvin's theorem, Bernoulli Equation in Inviscid Regions of Flow, Two-Dimensional Irrotational Regions of Flow, Elementary Planar Irrotational Flows – uniform, source, sink, Irrotational Flows Formed by Superposition – doublet, flow past a half body, a Rankine Oval Body, a circular cylinder, lift and

drag Forces on Submerged Bodies – stationary and rotating cylinder. Drag Force acting on a rotating cylinder

Unit 4 **(7hrs)**

Boundary layer approximation:
Boundary layer equations, Laminar flat plate boundary layer exact solution, Turbulent flat plate boundary layer approximate solution, approximate solution methodology for boundary layer equations, Von-Karman integral Momentum equation for boundary layer, Pressure gradients in boundary layer flow, Separation of Boundary Layer, Control of Boundary Layer Separation

Unit 5 **(6hrs)**
Turbulent flow:
Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, Reynolds stresses, Prandtl's mixing length theory, derivation of governing equations for turbulent flow- Continuity, Reynolds Navier-Stokes equation, shear stress models, universal velocity distribution law and friction factor in duct flows for very large Reynolds number, Fully developed turbulent flow in a pipe for moderate Reynolds number.

Unit 6 **(8hrs)**

Experimental techniques:
Introduction to measurements related to fluid flow, Analysis of experimental data- types of errors, sources of error, uncertainty analysis, Measurement of temperature- thermoelectric thermometry, resistance thermometry, pyrometry, bimetallic and liquid crystal thermometer, Measurement of pressure-U-tube manometer, pressure transducers, Measurement of volume flow rate- orifice plate meter, flow nozzle, venturi meter, rotameter, velocity measurement based on thermal effect - Hot wire Anemometry, Laser Doppler Velocimetry, Particle Image Velocimetry

Text Books

- Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha Science International, 2005
- Hydraulics and Fluid Mechanics including Hydraulic Machines, Dr. P. N. Modi and Dr. S. M. Seth, Standard Book House, New Delhi

Reference Books

- Y.A.Cengel, J.M.Cimbala, Fluid Mechanics – Fundamentals and Applications,McGraw Hill, 2004
- Irwin Shames, Mechanics of Fluids, McGraw Hill, 2003

- Fox R.W., McDonald A.T, Introduction to Fluid Mechanics, John Wiley and Sons Inc,1985
- Pijush K. Kundu, Ira M Kohen and David R. Dawaling, Fluid Mechanics, Fifth Edition,2005

Honour Course (Design Stream)
ME (HO) 21003 Comprehensive Design

Teaching Scheme
Lectures: 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course student will be able to:

- Demonstrate applicability of creativity, manufacturability, assembly, maintainability, emotions, reliability in the design of new products.
- Demonstrate the ability to identify needs of the customer and convert them in to technical specifications of a product.
- Generate different ideas after identifying the need and determining the specifications and constraints of a product for a particular purpose.
- Select appropriate material, manufacturing process, and shape by applying the principles of design for manufacturing.
- Apply various methods of rapid prototyping and reverse engineering to test and modify the designs.
- Design the components considering strength based reliability.

Unit 1 **(3 hrs)**

Product life cycle:

Development processes and organizations, product planning

Unit 2 **(10 hrs)**

Product design:

Need identification and problem definition, product specification, concept generation and selection, evaluation, creativity methods, concept testing

Unit 3 **(10 hrs)**

Design for manufacturing & assembly:

Selection of materials, Manufacturing processes & shapes for optimum design. Design for assembly,

Unit 4 **(6 hrs)**

Quality and robust design:
Design for reliability, strength based reliability, parallel and series systems, robust design, design for maintenance

Unit 5 **(3 hrs)**

Industrial design:
Design for emotion and experience, Introduction to retrofit design, Human behavior in design.

Unit 6 **(6 hrs)**

Modern methods of Design:
Various methods of rapid prototypingand reverse engineering, their applications, advantages and disadvantages.

Text Books

- Engineering Design, George E Dieter, McGraw Hill Company, 2000.
- Product Design, Creativity, Concepts and Usability, Prashant Kumar, Eastern economy edition, PHI New Delhi. 2012.

References

- Introduction to Engineering Design, Woodson T.T., McGraw Hill Book Company, 1966.
- Design Methods, John J.C., Wiley Inter Science, 1970.
- Simulation, modeling and analysis, Averil M. Law and W. David Kelton, McGraw Hill Book Company, 1991.
- Engineering Design – A Systematic Approach,Pahl, G. and W. Beitz, Springer. 2nd edition, 1996.
- Product Design and development, Karl T. Ulrich, Steven Eppinger,McGraw-Hill Education; 5th edition, 2011.

ML 21001 Constitution of India

Teaching scheme
Lectures: 1 hr/week

Examination Scheme
T1 and T2: 40 Marks
End-Sem. Exam: 60 marks

Course Outcomes (COs):
At the end of the course, student will be able to:

- Interpret the Preamble and know the basics of governance of our nation.

- Identify the different aspects covered under the different important Articles.
- Apprehend the basic law, its interpretation and the important amendments.
- Understand our Union and State Executive better.
- Recognize the basic that along with enjoying the rights one needs to fulfill one's duties.
- Summarize and Gain confidence on our Constitution by knowing it better.

Unit 1 **(5 hrs)**

Understanding the concept 'Rule of Law ', Meaning and history of Constitution, Introduction to The Constitution of India, understanding its objects, Preamble to the constitution of India.

Unit 2 **(4 hrs)**

Understanding the concept of Human Rights and Fundamental Rights, Fundamental rights under Part – III, exercise of the Rights, limitations and important cases, Prerogative Writs, Fundamental duties & their significance.

Unit 3 **(4 hrs)**

Relevance of Directive principles of State Policy, Legislative, Executive & Judiciary (Union and State), Constitutional Provisions for Scheduled Castes, Scheduled Tribes, & Backward classes, Constitutional Provisions for Women & Children.

Unit 4 **(2 hrs)**

Emergency Provisions, Electoral procedure in India, Amendment procedure and few important Constitutional Amendments.

Text Books:

- Introduction to the Constitution of India by Durga Das Basu (Students Edn.), Prentice – Hall EEE, 19th/20th Edn..
- Engineering Ethics by C. E. Haries, M. S. Pritchard and Michael J. Robins Thompson Asia,.

Reference Books:

- An Introduction to Constitution of India by M.V. Pylee, Vikas Publishing

Humanities and Social Sciences Open Courses-I
AS (HS) 21001 English Proficiency Language

Teaching scheme **Examination Scheme**

Lectures: 2 hrs/ week

T1 & T2: 60 Marks
End Semester: 40 Marks

Course Outcomes (COs):

At the end of the course, student will be able to:

- Understand concepts of English language and apply them practically.
- Reproduce meaningful and well-structured sentences for conversation or speech in English.
- Analyze, comprehend and write well and effectively produce enhanced formal communication in English.
- Display their Presentation skills and participate and produce healthy discussions both formally and informally among peers using English.
- Create impact by acquiring professional skills, confidently face interviews and be better employable and industry ready.

Unit 1 **(8 hrs)**

English for communication:

Basic understanding of language and its need for effective business communication for Engineers, formal and informal expressions, vocabulary building, business idioms.

Unit 2 **(6 hrs)**

Presentation skill development:

Oral presentations, basic mannerisms and grooming required for professionals, cross cultural communication, business etiquette.

Unit 3 **(8 hrs)**

Business writing:

Writing mechanics, note making, summarizing, letter &email writing, business reports, statement of purpose.

Unit 4 **(6 hrs)**

Employability enhancement:

Job readiness, interview skills and mock interviews.

Reference Books

- Business Communication by Shalini Verma (2nd Edition) (Vikas Publishing House)
- Communication for Business: A Practical Approach by Shirley Tailor (Longman)
- Communication Skills for Engineers by S. Mishra & C. Muralikrishna (Pearson)
- Communication Skills for Technical Students by T.M. Farhathullah (Orient Longman)
- Enhancing Employability at Soft Skills by Shalini Varma (Pearson)
- Written Communication in English by Saran Freeman (Orient Longman)

- Corporate Communication by Jaishri Jethwaney (Oxford University Press)
- Business Correspondence and Report Writing, R. C. Sharma & Krishna Mohan (McGraw Hill)
- Essential English Grammar (Intermediate & Advanced) Raymond Murphy (CUP)

AS (HS) 21002 German Language

Teaching scheme
Lectures: 2 hrs /week

Examination Scheme
Assignment: 40 Marks
End Semester: 60 Marks

Course Outcomes (COs):
At the end of the course, student will be able to:

- Acquire knowledge of facts about Germany and German culture (cultural sensitization).
- Adapt pronunciation of German letters and greetings.
- Identify and calculate numerical till 1000.
- Describe themselves and third person.
- Construct simple questions or sentences and interact with the teacher and classmates.
- Comprehend time and time related phrases, illustration of the same in conversations.
- Handle day to day situations like placing an order in the restaurant or interact with shopkeeper in the supermarket.

Unit 1 **(6 hrs)**

Guten Tag! (Good day):
Greetings, self introduction and partner introduction, numbers till 100, how to mention telephone number and email address, about countries, nationalities and languages.

Unit 2 **(6 hrs)**

Freunde, Kollegen und ich (Friends, colleagues and myself):
Hobbys, days of the week, months, seasons and professions, classroom objects and classroom communication.

Unit 3 **(6 hrs)**

Dining out:
Understanding German cusine, meal courses, names of the ingredients, conversation with the waiter and in the supermarket.

Unit 4 **(6 hrs)**

Uhrzeit (Timing):
Mention time, daily routine, making appointments

Unit 5 **(6 hrs)**

Grammatik (grammar):
Vocab, Verb conjugations, WH-question, verbs, pronounciation, personal pronouns, articles, Singular and Plural, negation.

Reference Books

- Dengler.S., Rusch. P., Schmitz.S., & Sieber.T. Netzwerk, Deutsch als Fremdsprache. 2015. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India
- You tube video series "learn German", "easy German" etc.
- Funk.H., Kuhn.C., & Demme.S. Studio d A1. Deutsch als Fremdsprache. 2011. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India.

AS (HS) 21003 Japanese Language

Teaching scheme
Lectures: 2 hrs/week

Examination Scheme
Assignment: 40 Marks
End Semester: 60 Marks

Course Outcomes (COs):
At the end of the course, student will be able to:

- Acquire knowledge of facts about Japan and Japanese culture,
- Familiarize with pronunciation of Japanese letters and daily greetings, accent, intonation and Japanese writing system Hiragana, Katakana and Kanji
- Identify numbers, colors, years, months and days, time expressions, directions to read the city map.
- Describe themselves and third person and family members
- Construct simple questions or sentences and interact with the teacher and classmates.
- Apply engineering terminology and Japanese work culture such as Monozukuri, 5S, Kaizen, 3M, 5W1H etc.

Unit 1 **(6 hrs)**

Introduction to Japanese language (Nihongo):
Recognize Japanese Characters Hiragana. Can read /write Hiragana script, Use basic classroom expressions, Exchange greetings Can thank someone or apologize someone, Recognize Japanese Characters Katakana Can read /write Katakana script, Can ask someone to say something again if you don't really understand.

About Me & food:
Give simple self introduction Can ask and answer where you live and your age, Can write your name, nationality, date of birth and occupation in Japanese, Recognize the parts of a business card, Talk someone briefly about your family using a family photo and answer simple questions such as who is that? Number of family members.

Talk about your favorite foods you like and dislike. Talk about your breakfast, Can respond when offered a drink. For example saying what you want to drink, Can look at menu in a fast

food restaurant and understand what is available, Can look at different restaurants' signboards and understand what each place is.

Unit 2 **(6 hrs)**

Home and Daily life:
Say what kind of house you live in. Say what you have in your home, Write an e mail inviting someone to your home. Visit/ Welcome a friend, Ask /say where to put things in the room. Can read the buttons on an electric appliance, Can listen to a simple explanation when being shown around a room and understand the layout, Recognize the name and address on signs.
Talk about your daily routine. Say the time you do something, Talk about your schedule at work for the week, Can listen to short and simple instructions at work and understand what to do, Can read a simple, handwritten note at work and understand the instructions, Can ask someone to lend you something at work, Can look at a list of equipment and confirm if you have all the items.

Unit 3 **(7 hrs)**

Holidays and days off 1 and Towns:
Can give a simple answer when asked about your hobbies and favorite things to do, Talk about what you do on your days off, Can read an event poster and find the important information such as the date, time and place, Can ask and answer questions about whether you are going to an event etc., Can say when you are available, when you are inviting someone to something or being invited.
Recognize station and Taxi signs, How to get to particular destination using a map, Can say how you go to work and how long it takes, Describe places in town and location, Can look at common signs in a station and understand what they mean.

Unit 4 **(6 hrs)**

Shopping and Holidays and days off 2:
Talk about what you want to buy, Can ask staff in a shopping center etc. Where to go for a certain item and understand the answer, Can look at discount signs and read the prices. Make a brief comment on things in a shop.
Can read a short blog / simple e mail, Can talk in simple terms about impressions of the holiday/trip, Can write a simple post for social media etc. About what you did in holiday.

References:

- Marugoto A1 Katsudo Starter Coursebook for Communicative Language Activities.
- Marugoto A1 Rikai Starter Coursebook for Communicative Language Competences
- The Japan Foundation
- Minna no Nihongo Main Textbook Elementary Lesson 1-12
- Minna no Nihongo Translation & grammatical Notes in English Elementary Lesson 1-12,3A Corporation Goyal Publishers

AS (HS) 21004 Spanish Language

Teaching scheme
Lectures: 2 hrs/week

Examination Scheme
Assignment: 40 Marks
End Semester: 60 Marks

Course Outcomes (COs):
At the end of the course, student will be able to:

- Acquire knowledge of facts about Spain and Latin Americaand Spanish culture, pronunciation of Spanish letters and greetings.
- Identify and calculate numerical till 1000.
- Describe themselves and third person.
- Construct simple questions or sentences and interact with the teacher and classmates.
- Comprehend time and time related phrases, illustration of the same in conversations, handle day to day situations like placing an order in the restaurant or interact with shopkeeper in the supermarket.

Unit 1 **(6 hrs)**

¡Hola! (Hello)
Greetings, self introduction and partner introduction, numbers till 100, how to mention telephone number and email address, about countries, nationalities and languages. Hobbys, days of the week, months, seasons and professions, classroom objects and classroom communication.

Unit 2 **(6 hrs)**

La comida (Food):
Understanding Spanish cusine, meal courses, names of the ingredients, converstaion with the waiter and in the supermarket.

Unit 3 **(6 hrs)**

La ropa (clothing):
Clothing, accessory (as per weather), season+ weather, vocabulary, Demonstrative pronouns, how to ask about price, numbers till 1000.

Unit 4 **(6 hrs)**

La hora (Timing):
Mention time, daily routine, making appointments

Unit 5 **(6 hrs)**

La gramática (grammar)
Vocab, Verb conjugations, WH-question, verbs, pronounciation, personal pronouns, articles, Singular und Plural, negation.

Reference Books

- Aula internacional 1Jaime Corpas, Eva García, Agustín Garmendia, Neus Sans Baulenas (contributor), published by Goyal Publisher's and Distributors Pvt. Ltd.

HS 21001 Entrepreneurship Principles and Process

Teaching scheme
Lectures: 1 hr/week

Examination Scheme
Field Work /Assignment: 40 Marks
End Sem. Exam: 60 marks

Course Outcomes (COs):
At the end of the course, student will be able to

- Discover, develop, and assess different types of Entrepreneurial ventures and opportunities.
- Learn about opportunity and risk analysis
- Use the strategies for valuing your own company, and how venture capitalist and angel investors use valuations in negotiating milestones, influence and control
- Pick correct marketing mix and how to position the company in the market by using analytical tools
- Learn how to sale themselves and the product/service and to handle objections
- Know how organizations operates, their process matrices, start new ventures, write winning business plans

Unit 1 **[3 Hrs]**

Market research, types of companies and organizations
Introduction to Entrepreneurship, Profile of the Entrepreneur, Market Gap /Opportunity Analysis, Market Research Methods, Defining the Focal Market: Market Segmentation, Industry analyzing– Research /Competitive Analysis. Company/ Organization Types, Legal Aspects, Taxation, Government Liaison, Building the Team, Mergers and Acquisitions

Unit 2 **[4 Hrs]**

Business finance, marketing & digital marketing
Shares and Stakes, Valuation, Finance Creation (Investors/Financers), Revenue Plans and Projections, Financial Ratios, Business Lifecycle, Break Even. Marketing Basics, Marketing Strategy and Brand Positioning, Plans and Execution Techniques, Marketing Analytics, Online Marketing

Unit 3 **[3 Hrs]**

Sales & Operations management
Understanding Sales, Pitching Techniques, Sales strategies, Inside Sales v/s Outside Sales, RFP Operational Basics, Process Analysis, Productivity, Quality

Unit 4 **[2 Hrs]**

Start-ups
Start-up Basics, Terms, Start-up Financing, Start-up Incubation, Start-up Incubation, Getting Listed

Text Books

- The Startup Playbook:Secrets of the Fastest-Growing Start ups From Their Founding Entrepreneurs by David Kidder
- True North by Bill George and Peter Sims
- Cardullo,M.W.P.E.(1999).Technological entrepreneurism: Enterprise formation, financing, and growyh. England:Research Studies Press Ltd.

References

- Kanungo,R.N.(1998).Entrepreneurship and innovation: Models for development (Ed.,Vol.2). New Delhi: Sage.
- Van Nostrand.Verma, J.C.,& Singh,G.(2002).Small business and industry: A hand book for entrepreneurs. New Delhi: Response-Sage.
- Richard A Brealy & Steward C Myres. Principles of Corporate Finance, McGraw Hills, 7th Edn, 2004
- Prasanna Chandra, Financial Management:Theory and Practice,Tata McGraw Hills, 6th Edn, 2004 IM Pandey,Financial Management,Vikas Publishing

ME 21016 Mini Project

Teaching Scheme
Practical: 4 hrs / week

Examination Scheme
Term work: 50 marks
Oral: 50 marks

Course Outcomes (COs):
At the end of the course, students will demonstrate the ability to:

- Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
- Design, implement and test the prototype/algorithm in order to solve the conceived problem.
- Write comprehensive report on mini project work.

Guidelines:

1. The mini-project is a team activity having 3-4 students in a team. Mini project should include mainly Mechanical Engineering contains but can be multi-disciplinary too.
2. The mini project may be a complete hardware or a combination of hardware and software. The software part in mini project should be less than 50% of the total work.
3. Mini Project should cater to a small system required in laboratory or real life.
4. It should encompass components, devices etc. with which functional familiarity is introduced.
5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.
6. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
7. The student is expected to exert on design, development and testing of the proposed work as per the schedule.
8. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

ME 21009 Computational Methods and Programming

Teaching Scheme
Lectures: 2 hrs / week

Examination Scheme
Research assignment: 20 marks
Practical exam: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):
At the end of the course students should be able to:

- Use numerical methods in modern scientific computing.
- Determine numerical solutions of nonlinear equations in a single variable.
- Use numerical interpolation.
- Estimate solution to problems using numerical integration and differentiation.
- Obtain numerical solution to engineering problems using programming.

Unit 1 **(6 hrs)**

Numerical methods I:
Introduction to numerical methods: Difference between analytical & numerical approach
Error Approximations: Types of Errors: Absolute, Relative, Algorithmic, Truncation, Round off Error, Error Propagation, Concept of convergence-relevance to numerical methods
Roots of equations: Bracketing and Open Methods
Simultaneous Equations: Gauss-Elimination, with partial pivoting, Gauss-Seidal, Gauss- Jordan, Gauss-Jacobi, Thomas algorithm for Tri-diagonal Matrix

Unit 2 **(6 hrs)**

Numerical methods II:

Numerical Integration: Trapezoidal rule, Simpson's 1/3rd Rule, Simpson's 3/8th Rule, Gauss Quadrature 2 point and 3 point method. Double Integration using Trapezoidal rule, Simpson's 1/3rd Rule

Ordinary Differential Equations [ODE]: Taylor series method, Euler Method, Runge-Kutta fourth order, Simultaneous equations using RungeKutta2nd order method

Partial Differential Equations [PDE]: Finite Difference methods Introduction to finite difference method, Simple Laplace method, PDEs- Parabolic explicit solution, Elliptic-explicit solution

Unit 3 **(6 hrs)**

Curve fitting and Regression analysis :

Interpolation: Approximation by Forward, Backward, Central and Divided Difference Formulae, Interpolation by Newton's Formulae, Lagrange's, Spline Interpolation, Hermite and Stirling Formulae

Curve fitting: Least square technique- Straight line, Power equation, Exponential equation and Quadratic equation

Regression using Machine Learning algorithms: Linear Regression, Logistic Regression, Polynomial Regression, Support Vector Regression, Regression trees: Decision tree, random forest, Ridge Regression, Lasso Regression, Clustering/ K-Means, K-Nearest Neighbor (KNN), Neural Networks

Text Books

- Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, 4th edition, Tata McGraw Hill Co-Ltd
- Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientist, 2nd edition, Tata McGraw Hill Co-Ltd
- S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India Delhi
- Rajaraman, "Computer Oriented Numerical Methods", Prentice Hall of India Delhi
- T Veerarajan, T Rama Chandran, "Theory and Problems in Numerical Method" Tata McGraw Hill Co-Ltd

Reference Books

- William H. Press, Saul A. Tenkolsky, William T, Vellering, Brain P. Flannery "Numerical Recipes in C", Cambridge University Press
- Alex Smola and S.V.N. Vishwanathan, Introduction to Machine Learning, Cambridge University Press
- Rudolph Russell, Machine Learning: Step-by-Step Guide to Implement Machine Learning Algorithms with Python, an open source book.

- Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems, O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

ME 21010 Theory and Design of Mechanical Systems

Teaching Scheme
Lectures: 3 hrs / week
Tutorial: 1 hr/week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Apply fundamental principles of fatigue and stress concentration while designing various components.
- Design spur, helical, bevel and worm gears.
- Select of sliding and rolling contact bearings.
- Explain and select different types of transmission drives.
- Identify different type of vibrations and calculate natural frequency of various systems.
- Apply balancing concept to various types of rotating and reciprocating machine elements.

Unit 1 **(6 hrs)**

Design against fluctuating load:

Stress concentration, fatigue failure, endurance limit, notch sensitivity, Goodman and Soderberg diagrams, and modified Goodman diagram.

Unit 2 **(4 hrs)**

Bearings:

Working principle of hydrodynamic, hydrostatic bearing and rolling contact bearing. Classification of bearings. Selection of bearings from manufacturer's catalogue. Comparison of sliding contact and rolling contact bearings.

Unit 3 **(10 hrs)**

Design of gears:

Terminology, force analysis, gear tooth failures of spur gear, helical gear, bevel gear and worm gear. Design of all above mentioned types of gears. Methods of lubrication.

Unit 4 **(6 hrs)**

Friction drives:

Belts, Clutches and Brakes: types, power and torque transmission, and absorption derivations.

Unit 5 **(6 hrs)**

Balancing:
Static and dynamic balance, balancing of revolving several masses on several planes, balancing of reciprocating masses in single and multi cylinder engines, balancing machines.

Unit 6 **(8 hrs)**

Mechanical vibrations:
Fundamentals, undamped and damped free vibrations of single degree freedom system, forced vibration of single degree of freedom system, critical speed of shafts.

Text Books

- Bhandari V.B. – "Design of Machine Elements" – McGraw Hill Education (India) Ltd.
- Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ. Co.Ltd.
- Ballaney, P.L., "Theory if Machines and Mechanisms", 2005, ISBN 9788174091222
- Hannah and Stephens, "Mechanics of Machines: Advanced Theory and Examples", 1970, ISBN 0713132329 Edward Arnold London

Reference Books

- Spotts M.F. – "Design of Machine Elements" – Prentice HallInternational.
- Black P.H. and O. Eugene Adams – "Machine Design" – McGraw Hill BookCo.Ltd.
- "Design Data" – P.S.G. College of Technology,Coimbatore.
- Hall A.S.; Holowenko A.R. and Laughlin H.G. – "Theory and Problems of Machine Design" – Schaum"s outlineseries.
- Ulicker Jr. J.J., Penock G.R. & Shigley J.E. "Theory of Machines and Mechanisms" Tata McGraw Hills
- Ghosh Amitabha & Mallik Asok Kumar, "Theory of Mechanisms and Machines" east-West Press Pvt. Ltd. New Delhi

ME 21011 Steam and Gas Turbine

Teaching Scheme
Lectures: 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):
This course is designed to expose the students to the practical applications of thermodynamics at the end of this course students will be able to:

- Acquire specific knowledge of components of the thermal power plant such as boiler, nozzles, turbines, condensers, gas turbine, and jet engine.
- Evaluate the thermal performance of steam nozzles, steam turbine, steam condensers, cooling tower, gas turbine, and suggest methods for improvement of performance.
- Apply turbo machinery design principles to the gas turbine engine.
- Analyze thermodynamic cycles of gas turbine power plant and jet propulsion systems

Unit 1 **(6 hrs)**

Steam generator:
Introduction to layout of thermal power plant, principle of steam generation, fuel for steam generators, necessity of water treatment, classification of steam generators, fire tube and water tube boilers, high pressure and supercritical boilers, boiler mountings and accessories. Performance of steam generators: Evaporation capacity, equivalent evaporation, boiler efficiency.

Unit 2 **(6 hrs)**

Steam nozzles:
Adiabatic expansion in nozzles, maximum discharge, critical pressure ratio, choking, effects of friction, nozzle efficiency, calculation of throat and exit areas, supersaturated flow, Wilson Line.

Unit 3 **(8 hrs)**

Steam turbines:
Working principle of steam turbines, classification of steam turbines, comparison of impulse and reaction turbines, compounding of steam turbines, flow of steam through turbine blades, Reheat factor, Velocity diagrams, Performance analysis graphical and analytical methods, steam turbine efficiencies, governing of turbines and Losses in turbines.

Unit 4 **(6 hrs)**

Steam condensers and cooling towers:
Types of condensers, classification of condensers, quality and quantity of cooling water required, calculations for surface condenser, Dalton's law of partial pressure, sources of air leakages and air removal, air ejectors. Cooling towers: wet cooling towers, dry cooling towers, cooling ponds.

Unit 5 **(8 hrs)**

Gas turbines:

Classification, open and closed cycle, gas turbine fuels, actual Brayton cycle, optimum pressure ratio for maximum thermal efficiency, work ratio, air rate, effect of operating variables on the thermal efficiency and work ratio, and air rate, simple open cycle turbine with regeneration, reheating and Intercooling, Combined steam and gas turbine plant, requirements of combustion chamber, types of combustion chambers.

Unit 6 **(6 hrs)**

Jet Propulsion:
Fundamental of propulsion technology, Turbojet Engine, thrust, thrust power, propulsive efficiency, thermal efficiency, Turboprop, Ramjet, scramjet and Pulsejet engines.

Text Books

- Yunus Çengel and Michael, Boles "Thermodynamics: An Engineering Approach", 3rd Edition, Tata McGraw Hill.
- T. D. Eastop and A. Mc Conkey, "Applied Thermodynamics", Addison Wesley Longman
- R. Yadav, "Steam & Gas Turbines & Power Plant Engineering", Central Publishing House, Allahabad, 2004
- R. C. Patel and C. J. Karamchandani, Elements of Heat Engines vol. I, II, and III, 18th Edition 1997, Acarya Publications Vadodara

Reference Books

- Thermodynamics, 4th Edition, J.P. Holman, McGraw-Hill.Engineering Thermodynamics, 2nd Edition, Jones J.B. and Hawkins G.A., John Wyley and Sons.
- Fundamentals of Engineering Thermodynamics, Moran M.S. and Shapiro H.N., John Wyley and Sons, 1988. Thermodynamics, 5th Edition, K. Wark, McGraw-Hill
- A Course in Power Plant Engineering, Arora & V.M. Domkundwar, Dhanpat Rai & Sons
- P.K. Nag, "Power Plant Engineering", 2nd edition Tata McGraw Hill,
- Power Plant Engineering, M. M. EI- Wakil, McGraw Hill International

List of Open Source Software/learning website:
- http://nptel.ac.in/courses/112104117/18
- http://nptel.ac.in/courses/112104117/4
- http://nptel.ac.in/courses/112104117/17

ME 21012 Fuels and Combustion

Teaching Scheme
Lectures: 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks

End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course student will be able to:

- Analyze the properties of fuels
- Compare the suitability of fuels utilization poit of view.
- Evaluate the performance of an engine.
- Demonstrate stages of combustion in SI and CI engine
- Analyze the emission and performance of an engine.

Unit 1 **(4 hrs)**

Characterization:

Fuels - Types and Characteristics of Fuels, Fuels Analysis, Proximate and Ultimate Analysis, Moisture Determination, Calorific Value, Gross & Net Calorific Values, Calorimetry, DuLong's Formula for CV Estimation, Flue gas Analysis.

Unit 2 **(6 hrs)**

Solid fuels:

Coal Family, Properties, Calorific Value, DMMF, DAF and Bone Dry Basis, Ranking, Storage, Washability, Coking & Caking Coals, Renewable Solid Fuels, Biomass, Wood Waste, Agro Fuels, Manufactured Solid Fuels.

Liquid fuels:

Sources, Petroleum Fractions, Classification, Refining, Properties of Liquid Fuels, Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number etc, Alcohols, Liquefaction of Solid Fuels

Unit 3 **(4 hrs)**

Gaseous fuels:

Classification, Composition & Properties, Estimation of Calorific Value, Gas Calorimeter, Rich & Lean Gas, Wobbe Index, Natural Gas, LPG, LNG, CNG, Methane, Producer Gas, Water Gas, Town Gas, Coal Gasification, Gasification Efficiency, Biogas.

Unit 4 **(2 hrs)**

Combustion:

Combustion equations, stoichiometric air fuel ratio, enthalpy of formation, adiabatic flame temperature.

Unit 5 **(10 hrs)**

SI and CI Engine:
Otto cycle, fuel supply system, stages of combustion in SI engines, abnormal combustion and knocking in SI engines, factors affecting knocking, effects of knocking, control of knocking, combustion chambers for SI engines
Diesel cycle, fuel supply system, stages of combustion in C.I. Engines, delay period, factors influencing delay period, diesel knock, control of diesel knock, types of combustion chamber.

Unit 6 **(10 hrs)**

Performance and Emission:
Engine Performance and parameters, determination of IP, BP, FP, IMEP, BMEP, various efficiencies, energy balance, performance of CI and SI engine. Exhaust after treatment, catalytic converters, exhaust gas recirculation, emission control in engines, sources of SI and CI engine emission, Euro and Bharat stage norms, Emission control methods in SI and CI engine

Text Books

- Ganesan. V, "Internal Combustion Engines", Tata McGraw Hill
- Mathur & Sharma, "A Course in Internal Combustion Engines", R. P. Dhanapat Rai Publications.
- Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990

Reference Books

- Edward E. Obert, "Internal Combustion Engines and Air Pollution", Internal Educational Pub, 1973
- Crouse W.H., "Automotive Mechanics", McGraw Hill
- Heywood J., "I.C. Engines Fundamentals", McGraw Hill publications
- Sharma SP, Mohan Chander, Fuels & Combustion, Tata McGraw Hill, 1984

ME 21013 Computational Methods and Programming Laboratory

Teaching scheme
Practicals: 2 hrs/week

Examination Scheme
Term work: 50 Marks
Practical Exam: 50 Marks

Course Outcomes (COs):
At the end of the course students should be able to:
- Use numerical methods in modern scientific computing.
- Determine numerical solutions of nonlinear equations in a single variable.
- Use numerical interpolation.
- Estimate solution to problems using numerical integration and differentiation.

- Obtain numerical solution to engineering problems using programming.

Experiments:

1. Design of an algorithmfor findingroots of equation (Iteration & accuracy criteria based)
    a. Bisection Method
    b. Regula Falsi Method
    c. Newton Raphson Method
    d. Successive approximation Method
2. Design of an algorithm for finding solution of simultaneous equations
    a. Gauss-Elimination, with partial pivoting,
    b. Gauss-Seidal,
    c. Gauss- Jordan,
    d. Gauss-Jacobi,
    e. Thomas algorithm for Tri-diagonal Matrix
3. Design of an algorithm for finding numerical integration
    a. Trapezoidal rule
    b. Simpson's $1/3^{rd}$ Rule
    c. Simpson's $3/8^{th}$ Rule
    d. Gauss Quadrature 2 point and 3 point method
    e. Double Integration using Trapezoidal rule, Simpson's $1/3^{rd}$ Rule
4. Design of an algorithm for solving ODE
    a. Euler Method
    b. Runge-Kutta Methods-fourth order
    c. Simultaneous equations using Runge-Kutta 2nd order
    d. Simple pendulum equation or Spring mass damper equation
5. Design of an algorithm for solving PDE
    a. Finite Difference methods
    b. Simple Laplace method
    c. Parabolic explicit solution
    d. Elliptic-explicit solution
6. Design of an algorithm for fitting a curve using Least square technique
    a. Straight line
    b. Power equation
    c. Exponential equation
    d. Quadratic equation
7. Design of an algorithm for interpolation
    a. Lagrange's Interpolation
    b. Newton's Forward interpolation
8. Design of an algorithm for predictive modelling using Machine Learning algorithms:
    a. Logistic Regression
    b. Support Vector Regression

c. Regression trees: Decision tree, random forest
d. Ridge Regression
e. Lasso Regression
f. Clustering/ K-Means
g. K-Nearest Neighbor (KNN)
h. Neural Networks

ME 21014 Theory and Design of Mechanical Systems Laboratory

Teaching Scheme:
Practical: 2hrs/week

Examination Scheme:
Term Work: 50 marks
Practical Exam with oral: 50 marks

Course Outcomes (COs):
At the end of the course students will be able to:

- Approach a design problem involving a complete mechanical system, successfully, taking decisions when there is not a unique answer.
- Use software for analysis and design proficiently.
- Develop industrial drawing with conventions.
- Calculate torque and power for various transmission devices and understand their applications
- Draw various performance curves for the vibration of machine elements

1. Term work shall consist of **"ONE"** design projects. Each project shall consist of two imperial size sheets – one involving assembly drawing with a parts list and overall dimensions and the other sheet involving detailed drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified so as to make it a working drawing.
2. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. **Design project** should be in the form of "Design of a complete Mechanical system" comprising of machine elements including gears and bearings. Design data book shall be used, wherever necessary, to select materials and standard components.

Experiments to perform in Laboratory

3. Determinations of torque and power transmitted by various friction drives
4. Determination of unbalanced forces in reciprocation engines
5. Determination of natural frequency of transverse vibrations of a bar.
6. Determination of damping coefficient of torsional vibrations.
7. Determination of node point of two rotor system.
8. Determination of critical speed of shaft of single rotor.

The ORAL shall be based on Term Work.

ME 21015 Steam & Gas Turbine and Combustion Laboratory

Teaching Scheme
Practical: 2 hrs / week

Examination Scheme
Term work: 50 marks
Oral: 50 marks

Course Outcomes (COs):

This course is designed to expose the students to the practical applications of thermodynamics at the end of this course students will be able to:

- Elucidate construction and operational principles of ideal gas and steam nozzle, steam turbine, steam condenser, cooling tower, gas turbine and jet engine
- Apply basic laws of thermodynamics in analysis of thermal systems
- Evaluate performance of boiler.
- Evaluate the thermal performance of steam nozzles, steam turbine, steam condensers, and solar panels.
- Acquire specific knowledge to design solar powered thermal systems
- Compare the application of solid, liquid and gaseous fuels.

Conduct any 8 experiments (any 2 trials on IC engines are mandatory)

1. Study of boilers and boiler mountings and accessories.
2. To determine dryness fraction of steam
3. Trial on boiler to determine boiler efficiency
4. To measure the pressure/Velocity variation of gas or steam in a convergent-divergent nozzle
5. Trial on a condenser to determine the condenser efficiency
6. To determine the conversion efficiency of solar cell/panel
7. Visit to a thermal/solar power plant and submit the visit report.
8. Combustion, performance and emission analysis of diesel engine
9. Combustion, performance and emission analysis of petrol engine
10. Comparative study of CNG and petrol fuelled SI engine
11. Comparative study of biodiesel and diesel fuelled CI engine

Departmental Elective
ME (DE) 21001 Computational Fluid Dynamics and Heat Transfer

Teaching Scheme
Lectures: 3hrs/week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Describe physical interpretation of governing equations.
- Apply the appropriate boundary conditions
- Formulate the discretization of governing equations using fdm and fvm
- Solve the linear algebraic equations for different advection, diffusion schemes.
- Develop simple, simpler algorithm for determination of field variable values.

Unit 1 **(6 hrs)**

Introduction to CFD and principles of conservation:

Computational Fluid Dynamics: History, Necessity, Future Scope, Applications, Various Approaches - Numerical vs Analytical vs Experimental, Modeling vs Experimentation, Reynolds Transport Theorem, Fundamental principles of conservation of mass, linear momentum, energy, General scalar transport equation.

Mathematical classification of Partial Differential Equation, Physical examples of elliptic, parabolic and hyperbolic PDEs.

Unit 2 **(6 hrs)**

Discretization of PDEs – FDM, FVM:

Discretization of Governing Equations, Discretization Approaches - Finite Difference, Finite Volume, System of Algebraic Equations, Numerical Methods, Approximate Solutions for flow field variables, Types of Boundary Conditions, FVM for Diffusion problems - One and Two Dimensional Steady and Unsteady State Diffusion, Unsteady State Diffusion Problems: Implicit, Fully Explicit and Crank-Nicholson scheme.

Unit 3 **(6 hrs)**

Geometry modeling and Grid generation:

Practical aspects of computational modeling of flow domain, grid generation, Types of mesh and selection criteria, Mesh Quality, Key Parameters and their importance.

Unit 4 **(6 hrs)**

FVM for advection diffusion problems:

Discretization of Steady One and Two Dimensional convection diffusion equation, Advection schemes –Extrapolation, interpolation, properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Accuracy, Central differencing scheme, First Order Upwind scheme, Second Order Upwind scheme, QUICK Scheme, Assessment of Different Schemes.

Unit 5 **(7 hrs)**

Discretization of Navier Stokes equations for incompressible flow (Part 1):
Discretization of the Momentum Equation: Pressure velocity coupling, Checkerboard Pressure field, Concept of Staggered grid, Semi-Explicit Method, Semi-Implicit method for Pressure linked equation (SIMPLE), Relaxation Parameters, SIMPLE Algorithm.

Unit 6 **(7 hrs)**

Discretization of Navier Stokes equations for incompressible flow (Part 2):
Concept of collocated grid system, Semi-Explicit Method, Pressure Correction equation, Semi-Implicit method for Pressure linked equation revised (SIMPLER), SIMPLER Algorithm.

Text Books

- Atul Sharma, introduction to Computational Fluid Dynamics: development, Application and Analysis, John Wiley & Sons Ltd, 2016
- Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics – A Practical Approach, Reed Elsevier India Pvt. Ltd, India.
- H.K.Versteeg, W.Malalasekera, An Introduction to computational Fluid Flow (Finite Volume Method), Printice Hall, New Delhi

Reference Books

- J.A. Anderson Jr., Computational Fluid Dynamics-The Basics with Applications,McGraw Hill International Editions, Mechanical Engineering Series, 2004
- Suhas Patankar, Numerical Methods in Fluid Flow and Heat Transfer, Hemisphere Publishing Corporation,1980
- Murlidhar, Sundarrajan, Computational Fluid Flow and Heat Transfer, Narosa Publications
- Chun Yen Chow, An Introduction to Computational Fluid Dynamics, Wiley Publications

Departmental Elective
ME (DE) 21002 Steam Technology

Teaching Scheme
Lectures: 3hrs/week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):
At the end of the course students will be able to:
- Understand and explain working of different boilers and significance of mountings and accessories.
- Use conventional, and modern engineering tools for boiler performance assessment.

- Understand working of simple thermal systems along with energy conservation fundamentals and opportunities.
- Design a steam piping system, its components for a process and also design economical and effective insulation.
- Understand process instrumentation, design and develop controls and instrumentation for effective monitoring of the process.

Pre requisites for the course:
Fundamentals of Thermodynamics, Heat Transfer, Fluid Dynamics, Metallurgy and Fuels and Combustion

Unit 1 **(6 hrs)**

Boilers:
Types, Mountings and Accessories, Combustion in boilers, Feed Water and its quality, Blow down; IBR, Boiler standards

Unit 2 **(7 hrs)**

Piping & Insulation:
Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.

Unit 3 **(9 hrs)**

Steam systems:
Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems; Identifying opportunities for energy savings.

Unit 4 **(6 hrs)**

Boiler performance assessment:
Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

Unit 5 **(6 hrs)**

Energy conservation and Waste minimization:
Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization

Unit 6 **(5 hrs)**

Instrumentation & Control:
Process instrumentation; control and monitoring

Text Book

- T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication
- Domkundwar; A Course in Thermal Engineering; Dhanapat Rai and sons
- R.K. Rajput, Applied Thermodynamics, S. Chand & Company Limited
- Yunus A. Cengel and Boles, "Engineering Thermodynamics ",Tata McGraw-Hill Publishing Co. Ltd

Reference Books

- Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency
- Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency
- Edited by J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company
- P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; Tata McGrawHill Education Pvt Ltd, N Delhi

Departmental Elective
ME (DE) 21003 Advanced Manufacturing Technology

Teaching Scheme
Lectures: 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):
At the end of the course student will be able to:

- Learn non-conventional processes and their applications
- Learn surface coating processes
- Use rapid prototyping process for product development
- Select appropriate type of plastics and plastics processing method
- Design and fabricate understanding mems systems

Unit 1 **(8 hrs)**

Plastic material and processes:

Different thermosetting and thermoplastic compounds, compression moulding, transfer moulding, injection moulding, film and sheet forming, thermoforming and their applications.

Unit 2 **(6 hrs)**

Rapid prototyping:
Product development cycle and importance of prototyping, types of prototypes-principles and advantages, different types of generative manufacturing process viz. streolithography, FDM and SLS.

Unit 3 **(6 hrs)**

Non-conventional machining processes:
Principles, process parameters and applications of Laser material processing, EDM, WEDM and ECG.

Unit 4 **(6 hrs)**

Special processes:
Principles, silent features, advantages and applications of abrasive floor machining, magnetic abrasive machining, honing, lapping and other super-finishing processes.

Unit 5 **(6 hrs)**

Micro electromechanical Systems (MEMS):
Introduction, micro fabrication for MEMS- bulk micromachining of silicon, surface micromachining of MEMS, wafer bonding for MEMS, LIGA process, micromachining of polymeric MEMS devices, 3D micro- fabrication, materials for MEMS.

Unit 6 **(6 hrs)**

Surface coating:
Principles, elements, process, advantages and surface preparation, physical vapour deposition, chemical vapour deposition, Electroless coating.

Text Books

- B.H. Amsteal, Philip F. Ostwald & Myron L. Begeman, "Manufacturing Processes", John Wiley & Sons, eighth edition.
- P. K. Mishra, Non-Conventional Machining Processes", Narosa Publication
- Amitabha Ghosh, "Rapid Prototyping: Prinicples and Applications in Manufacturing", John Wiley & Sons, Inc.

Reference Books

- Rajaraman, "Computer Oriented Numerical Methods", Prentice Hall of India Delhi.
- T Veerarajan, T Rama Chandran, "Theory and Problems in Numerical Method" Tata McGraw-Hill
- William H. Press, Saul A. Tenkolsky, William T, Vellering, Brain P. Flannery "Numerical Recipes in C", Cambridge University Press.
- G.F. Benidict, "Advanced Manufacturing Processes", Marcel Deker Publisher.
- Willer, "Manufacturing Analysis", "Non-Traditional Machining Processes", SME Publications
- John C. Ion, "Laser processing of engineering materials: principles, procedure and Industrial application", Elsevier
- Chua Chee kai & Leong kah Fai, " Rapid Prototyping : Principles and applications in Manufacturing", Jonn Weiley & Sons, Inc

Departmental Elective
ME (DE) 21004 Operations Research

Teaching Scheme:
Lectures: 3hrs/ week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course student will able to:

- Illustrate the need to optimally utilize the resources in various types of industries.
- Apply and analyze mathematical optimization techniques to various applications.
- Demonstrate cost effective strategies in various applications in industry.
- Demonstrate in use of quantitative techniques in project management.

Unit 1 **(8 hrs)**

Introduction to Operations research and Linear programming problem:

Scope, applications of operations research, phases and models of operations research, advantages and limitations of operations research.

Linear programming problem (LPP)- formulation of linear programming problem (LPP), graphical method of solution, simplex method, artificial variable technique- Big M method and two phase method, duality in LPP, sensitivity analysis.

Unit 2 **(6 hrs)**

Transportation, Assignment and Sequencing problem:

Mathematical formulation of TP, methods to obtain initial basic feasible solution, TP without degeneracy and TP with degeneracy.

Assignment Problem (AP) - Mathematical formulation of AP, comparison with TP, variations of AP, Travelling salesman problem.
Sequencing Problem- Assumptions in sequencing problem, processing of n jobs through two machines, processing of n jobs through three machines, and processing of n jobs through m machines.

Unit 3 **(6 hrs)**

Replacement models:
Introduction, replacement of items that deteriorates- replacement of items whose maintenance and repair cost increases with time, ignoring money value and - replacement of items whose maintenance and repair cost increases with time, considering money value, replacement of items that fail suddenly- group replacement.
Queuing theory- Kendall's notation for representing queuing models, single channel Poisson arrivals with exponential service times, infinite population.

Unit 4 **(6 hrs)**

Games theory:
Minimax (Maximin) criterion for optimality, characteristics of games, dominance principles, 2X2 game- arithmetic and algebraic method, 2Xn and mX2 game-graphical method and method of sub games, 3X3 game- method of matrices, iteration method and applications of games theory

Unit 5 **(6 hrs)**

Inventory models and Simulation:
Need and types of inventory, inventory associated costs, Economic order quantity, Classical EOQ inventory model with uniform demand rate and infinite replenishment. EOQ model with multiple price breaks.
Simulation- Monte Carlo simulation, advantages and limitations of simulation, applications of simulations.

Unit 6 **(6 hrs)**

Network analysis:
Network construction, identification of critical path, various types of floats and their computations, Programme Evaluation and Review Technique (PERT) time calculations, crashing of network, resource scheduling, network updating.

Text Books

- Operations Research- theory, methods & applications, Eighteenth revised edition 2017, S. D. Sharma, Kedar Nath Ram Nath
- Operations Research, Revised and enlarged edition 2012 Prem Kumar Gupta and D S Hira, S Chand & Company Ltd.

Reference Books

- Operations Research-An Introduction, Ninth edition 2014, Hamdy A Taha, Pearson Education India
- Operations Research: Methods and Problems, Maurice Saseini, Arhur Yaspan and Lawrence Friedman, John Wiley and Sons., New York

Departmental Elective (Industry Floated)
ME (DE) 21005 Mathematical Modeling and Analysis of Thermal System

Teaching Scheme:
Lectures: 3hrs/ week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Understand the basic concepts of thermal system.
- Identify various components of thermal system.
- Use various mathematical and numerical relations for modeling, simulation and analysis of the system.
- Optimize the results obtained from the analysis

Unit 1 **(4 hrs)**

Introduction:

Introduction of thermal system, Thermal system design and challenge, Conventional method of thermal design and their limitation, Use of numerical technique in thermal system design.

Unit 2 **(8 hrs)**

Mathematical modeling and Simulation:

Introduction to Mathematical model, System of nonlinear equations, Successive substitution technique and its application in simple thermal simulation problem, Newton Rapson technique for simultaneous nonlinear equations, System of linear equations, Case study

Unit 3 **(10 hrs)**

Simulation and analysis of a heat exchanger and heat exchanger network:

Heat exchanger design, Conventional method and challenges, Concept of overall heat transfer coefficient and LMTD, Type of heat exchangers, Simulation of a single heat exchanger, Thermal simulation using successive substitution and Newton Raphson technique and their application in heat exchanger simulation, Simulation of a multi pass heat exchanger, Simulation of boiler and condenser, Use of discretization in boiler simulation, Discretization in heat exchanger simulation problem, Heat exchanger network and simulation.

Unit 4 **(8 hrs)**

Flow network model:
Flow network model and it's application, Pump characteristics and system characteristics, Concept of resistance, parallel and series combination of resistances, Kirchhoff analogy to solve flow distribution problem, Generalized approach to solve flow problem, Newton Raphson technique to solve flow distribution problem, Two phase flow and Thermosyphon loop, Thermosyphon loop analysis.

Unit 5 **(6 hrs)**

Simulation of thermal power cycle:
Thermal power and refrigeration cycle, Rankine cycle, design and simulation, Gas turbine cycle, Combined cycle, Concept of exergy and exergy analysis, First law and second law efficiency, Refrigeration and heat pump, Simulation of vapor compression cycle

Unit 6 **(4 hrs)**

Optimisation:
Optimisation technique, it’s application in thermal system design.

Text Books

- Design of Thermal System, W F Stoecker, Mc Graw Hill International Edition, Engineering series.

Reference Books

- Basic and Applied Thermodynamics, 2nd Edition, Nag P. K., Tata McGraw-Hill.
- Heat Exchangers: Selection, Rating, and Thermal Design. Sadik Kakaç, Hongtan Liu, Anchasa Pramuanjaroenkij. CRC Press.
- Heat Transfer-A practical approach, Yunus Cengel, McGraw Hill.

Departmental Elective
ME (DE) 21006 Micro Electro Mechanical Systems

Teaching Scheme:
Lectures: 3hrs/ week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Distinguish several classes of MEMS devices from one another and prepare lumped parameter models using tools like MATLAB Simulink.
- Demonstrate the ability to design a simple MEMS device such as cantilevers, fixed-fixed beams, resonator, and comb-drive actuator.
- Design a fabrication process for a given device involving surface micromachining
- Perform basic thermal, structural and electrical simulations using software like ANSYS, COMSOL, etc.
- Propose the use of MEMS devices for a new (out-of-the-box) application.

Unit 1 **(6 hrs)**

Introduction to microsystems:

Overview and motivation of microelectronics manufacture and microsystems technology: Definition, MEMS materials, laws of scaling, the multi-disciplinary nature of MEMS, survey of materials central to micro engineering, applications of MEMS in various industries and commercial examples, Eg., Biomems.

Unit 2 **(6 hrs)**

Micro sensors and Actuators:

Working principle of Microsystems, structural mechanics and lumped modelling, micro actuation techniques, Microsensors and its types pressure transducer, accelerometer, gyroscope, chemical sensors, etc. Microactuators and its types micropump, micromotors, microvalves, microgrippers, and their applications in real systems.

Unit 3 **(6 hrs)**

Fabrication process:

Substrates, single crystal silicon wafer formation, photolithography, ion implantation, diffusion, oxidation, chemical vapour deposition (CVD), physical vapor deposition (PVD), deposition epitaxy, etching process, etc.

Unit 4 **(6 hrs)**

Micro system manufacturing:
Bulk micro manufacturing, surface micro machining, LIGA, SLIGA, Micro system– die preparation, surface bonding, wire bonding, sealing.

Unit 5 **(6 hrs)**

Microsystems design and Simulations:
Design considerations, mechanical design, process design, realization of MEMS components using MEMS specific tools like Coventor Ware/ Intellisuite, etc. and multiphysics simulation tools like ANSYS, COMSOL, etc.

Unit 6 **(6 hrs)**

Microsystems packaging:
Micro system integration and packaging, packaging technologies, assembly of microsystems, reliability in MEMS, packaging materials, die level, device level, system level, packaging techniques, Lab-on-a-chip.

Text Books

- Mohamed Gad – el – Hak, "MEMS Handbook", CRC Press, 2002.
- Rai - Choudhury P. "MEMS and MOEMS Technology and Applications", PHI Learning Private Limited, 2009.
- Sabrie Solomon, "Sensors Handbook," Mc Graw Hill, 1998.
- Marc F Madou, "Fundamentals of Micro Fabrication", CRC Press, 2nd Edition, 2002.

Reference

- Francis E.H. Tay and Choong .W.O, "Micro fluidics and Bio mems application", IEEE Press New York, 1997.
- Trimmer William S., Ed., "Micromechanics and MEMS", IEEE Press New York, 1997.
- Maluf, Nadim, "An introduction to Micro electro mechanical Systems Engineering", AR Tech house, Boston 2000.
- Julian W.Gardner, Vijay K.Varadan, Osama O. Awadel Karim, "Micro sensors MEMS and Smart Devices", John Wiby & sons Ltd., 2001.

Departmental Elective
ME (DE) 21007 Finite Element Analysis

Teaching Scheme
Lectures: 3 hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Develop system level matrix equations from a given mathematical model of a problem following the galerkin weighted residual method or principle of stationary total potential.
- Implement fem, for problems of bars and beams, to obtain the values of the field variable at the global nodes,
- Implement fem, for a 2-dimensional and axi-symmetric problems from structural mechanics to find displacements, stresses and strains, using triangular and quadrilateral element.
- Summarize the sources of errors in implementing fem and suggest remedies to minimize them.
- Determine using fem, parameters of interest for a potential field problem, using triangular and quadrilateral elements.
- Apply fem to estimate the fundamental frequency of natural vibration of bars and beams using the methods mentioned in the curriculum.

Unit 1 **(5 hrs)**

Introduction:

Introduction, An overview of engineering problems and methods for solving them, demonstration by an example – Physical system – Physical model – Mathematical model – Methods for solution – Solution. Need for using numerical method to solve engineering problems-Types of Engineering Analysis.

Unit 2 **(6 hrs)**

Introduction to FEM and 'BAR' problems:

Governing differential equation,787415Introduction to steps of FEM for the problem of finding elongation of an axially loaded bar as an example of a 1-D problem. Step- by-step development of the procedure of Galerkin weighted residual FEM for the bar problem - residual error, weighting function, discretization, elements and nodes, local variables, approximation functions (or shape functions), need for numerical integration and co-ordinate transformation, Gauss-Legendre integration scheme. Process of assembly of local matrix equations into global, solution to the equations, equation solvers.

Unit 3 **(6 hrs)**

FEM for beams:

FE formulation for beams, Governing differential equation, Characteristics of formulation for problems demanding C1 continuity, Hermitian polynomials and shape functions based on them, BEAM element, FEM procedure followed for the beam problems. Computation of derived quantities like strains and stresses from the nodal values of the field variables, Result post-

processing. Finite element formulation using variational and virtual work methods, demonstration for bar and beam problems.

Unit 4 **(7 hrs)**

2-D Problem from structural mechanics:
Introduction to 2-dimensional problem from structural mechanics static analysis, Triangular and quadrilateral elements, Basic concepts of Plain stress and Plain strain. Constant strain triangular element Stiffness Matrix and Equation. Finite element Solution of a plane stress Problem. Higher order elements, iso-parametric elements.

Unit 5 **(6 hrs)**

Potential field problems:
Introduction to potential field problems, examples from structural mechanics - of torsion of non-circular prismatic bars, 2-D steady state heat transfer with convection from surface. Sources of errors, error analysis, remedies to minimize the errors. Application of FEM to Axisymmetric problems, Axisymmetric solids under rotation.

Unit 6 **(8 hrs)**

Eigen-value problems:
Eigen value problems, Mass and stiffness matrices, 2 Dof and 3 Dof spring mass problems. Tranverse vibration of beams .Methods to find Eigen values and Eigen vectors.

Text Books

- Introduction to Finite Element Method By J.N .Reddy.
- Daryl L Logan "Finite Element Method" Thomsom Canada Limited.
- Cook R.D. "Concepts and applications of finite element analysis" Wiley, New York, 1981.

Reference Books

- Bathe K.J., Cliffs, N.J. "Finite element procedures in Engineering Analysis", Englewood. Prentice Hall, 1981.
- Desai C.S. and J.F. Abel "Introduction to the finite element method." New York, Van Nostrand Reinhold, 1972.
- O. P. Gupta, "Finite and boundary element methods in Engineering", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2000.
- Chandrupatla and Belegundu "Introduction to finite elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, 2001.

Minor in Product Design and Optimization
ME (MI) 21002 Engineering Design

Teaching Scheme
Lectures: 3hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Apply design criteria while designing products
- Select appropriate manufacturing process-material combination while designing products.
- Apply design for manufacture & assembly principles for part consolidation & minimizing the cost.
- Design environment friendly products.
- Use quality assurance principles and control charts for mass manufacturing processes.

Unit 1 **(10 hrs)**

Design criteria:

Introduction to strength, rigidity & fracture considerations in design.

Unit 2 **(6 hrs)**

Engineering materials and their selection:

Engineering materials including metals, non metals, composites & smart materials, properties, nomenclature, selection & application.

Unit 3 **(4 hrs)**

Manufacturing processes and compatibility to materials:

Various manufacturing processes with their capabilities, limitations & compatibility with materials.

Unit 4 **(8 hrs)**

Design for manufacture and assembly:

Introduction, Principles and application to product design

Unit 5 **(6 hrs)**

Design for environment:

Techniques to reduce Environmental impact, life cycle assessment, Eco indicator.

Unit 6 **(8 hrs)**

Quality assurance & control charts:
Sampling plans, control charts, six sigma quality concepts, Robust design

Text Books

- A. K. Chitale, R. C. Gupta Product Design and Manufacturing ,PHI Publication, 2013

Reference Books

- Fiksel J., (Ed) Design for Environment, McGraw-Hill, New York, 1996.
- David G. Ullman , the mechanical Design Process, McGraw-Hill, New York, 1992
- Roland Engene Y., Inetoviez, New Product Development: Design & Analysis, John Wiley and Sons Inc., N.Y. 1990.
- Bill Hollins, Stwout Pugh, Butterworth, Successful Product Design by London 1990.

Honor in Hybrid and Electrical Vehicles
ME (HO) 21004 Automotive Mechatronics

Teaching Scheme
Lectures: 3 hrs / week

Examination Scheme
Mini project: 40 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):
At the end of the course students should be able to:

- Understand the basic components of mechatronics used in automobiles and its control system.
- Learn the working principle of sensors, actuators used in automobiles.
- Identify locations of various sensors and actuators in automobiles and its necessity.
- Learn the layout, components and working of electronic engine control system.
- Analyze smart vehicle motion controls, suspensions, telematics smart mechatronic systems for occupant protection and diagnostics in automobiles.
- Apply machine learning (ml), reinforcement learning (rl), and deep learning (dl), soft computing, open source software and hardware, machine vision for automobiles

Unit 1 **(8 hrs)**

Introduction of automotive mechatronics, sensors and actuators:
Introduction to mechatronics: Motivation, Structures, Characteristics, and Functions of Mechatronics Systems, Components of Mechatronics Systems (Motors, Actors, Valves, Pumps, Sensing Technologies, Signal- & Data Processing, Control Systems)
Sensors: Acceleration, Angular rate, Air flow, Air pressure, Ambient light, Antennas, Crankshaft/Camshaft position, Distance – Acoustic, Distance – Optical, Distance – RADAR, Fluid

level, Fluid pressure, Force and Load, Fuel Type, Infrared imaging, Knock sensor, Microphone, Optical imaging, Oxygen sensor, Position, Rain sensor, Temperature, Torque, Vehicle speed, Wheel speed

Actuators: Airbag inflators, Motors - DC Brushed, DC Brushless, AC, Stepper, Servo, Spark plugs, Speakers, Solenoids, Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, VVP Mechanism Model, Ignition System, Ignition Coil Operations

Unit 2 **(6 hrs)**

Signal communication & Data acquisition:

Introduction to Signal Communication & Types-Synchronous, Asynchronous, Serial, Parallel; Dedicated Short Range Communications, Automotive Data Communication Buses, CAN (Controller Area Network), LIN (Local Interconnect Network), FlexRay, MOST (Media Oriented Systems Transport), Ethernet, Signal collection, conditioning, ADC and DAC, processing, sampling, aliasing, sample and hold circuit, Interfacing of Sensors / Actuators to Data Acquisition system

Unit 3 **(6 hrs)**

Electronic engine control:

Motivation for Electronic Engine Control, Exhaust Emissions, Fuel Economy, Electronic Engine Control system, Inputs to Controller, Output from Controller, Exhaust Catalytic Converters, Oxidizing Catalytic Converter, The Three-Way Catalyst, Electronic Fuel-Control System, Engine Control Sequence, Open-Loop Control, Closed-Loop Control, Analysis of Intake Manifold Pressure, Measuring Air Mass, Influence of Valve System on Volumetric Efficiency, Idle Speed Control, Electronic Ignition

Unit 4 **(6 hrs)**

Vehicle motion controls, suspensions and telematics:

Adaptive Cruise Control Systems, Stepper Motor-based Actuator Electronics, ABS system with layout and working, Autonomous Emergency Braking Systems, Active Yaw Control, Electronic control of suspension –Damping control (Active Suspension Systems), Driver state monitoring (DSM), Supplementary Restraint, System of air bag, seat belts, Vehicle security systems alarms, vehicle tracking system, Collision avoidance, Radar warning system, Introduction to Global Positioning Systems, Lane Departure Warning System, Tire Pressure Monitoring System, Tyre-Slip Controller, Electronic Suspension System, Electronic Steering Control, Telematics, GPS Navigation, The GPS System Structure

Unit 5 **(8 hrs)**

Smart mechatronic systems for occupant protection and diagnostics:
Accident Recorders, Active Vibration Control, Adaptive Front Lighting, Airbag Deployment Systems, Battery Management System, Blind Spot Detection, Cabin Environment Controls, Driver Alertness Monitoring, Auto-Dimming Mirrors, Convertible Top Control, Cylinder Deactivation Systems, Seat Position Controls, Electronic Stability Control, Electronic Toll Collection, Entertainment Systems, Event Data Recorders, Head-Up Displays, Hill Hold Control, Idle Stop-Start Systems, Instrument Clusters, Intelligent Turn Signals, Interior Lighting Control, Lane Departure Warning Systems, Lane Keeping Assist, Night Vision Systems, Parental Controls, Parking Systems, Rear-View Camera Systems, Precrash Safety, Remote Keyless Entry Systems, Security Systems, Tire Pressure Monitoring Systems, Traction Control, Traffic Sign Recognition Systems, Transmission Control, Windshield Wiper Controls, Active Exhaust Noise Cancellation, Active Cabin Noise Suppression, Service Bay Diagnostic Tool, On-board Diagnostics, Model-Based Sensor Failure Detection, Diagnostic Fault Codes, Model-Based Misfire Detection System

Unit 6 **(6 hrs)**

Contemporary topics:
Soft computing methods in automotive technology, applications of open source software and hardware, machine vision for automotive, Autonomous vehicles, key concepts of the perception-planning-control pipeline for autonomous driving (AD); key concepts of machine learning (ML), especially reinforcement learning (RL), and deep reinforcement learning (DRL)

Text Books

- Automotive Mechatronics: Automotive Networking, Driving Stability Systems, Electronics (Bosch Professional Automotive Information), by KonradReif, Springer Fachmedien Wiesbaden, 2014.
- Automobile Electrical & Electronic Equipments -Young, Griffitns -Butterworths, London.
- Understanding Automotive Electronics, Wiliam B. Ribbens, 5th Edition, Newnes, Butterworth–Heinemann.
- Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
- Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004
- Understanding Automotive Electronics –Bechfold SAE 1998
- Automobile Electronics by Eric Chowanietz SAE.
- Fundamentals of Automotive Electronics -V.A.W.Hilliers -Hatchin, London

Reference Books

- Automotive Computer & Control System –Tomwather J. R., Cland Hunter, Prentice Inc. NJ
- Automotive Computers & Digital Instrumentation –Robert N. Brandy, Prentice Hall Eaglewood, Cliffs, NJ
- The Fundamentals of Electrical Systems -John Hartly -Longman Scientific & Technical

- Automobile Electrical & Electronic Systems –TomDenton, Allied Publishers Pvt. Ltd.
- Anderson, J. M., Nidhi, K., Stanley, K. D., Sorensen, P., Samaras, C., &Oluwatola, O. A. (2014). Autonomous vehicle technology: A guide for policymakers. Rand Corporation.
- James D. Halderman, Advanced Automotive Electricity and Electronics, Pearson, 2013.
- Tom Denton, Advanced Automotive Fault Diagnosis, Routledge, 2006.
- Nicolas Navet, Francoise Simonot-Lion, Automotive Embedded Systems Handbook, CRC Press, 2008

Honor in Thermal Stream
ME (HO) 21005 Micro Fludics

Teaching Scheme
Lectures: 3hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Summarize the fundamentals of the physics of flows at micro-scale level.
- Apply mathematical model for micro scale flow.
- Understand the fundamentals of capillary flow.
- Explain and apply fundamentals of electrokinetics to the flow problems
- Design components for applications of microfluidics systems

Unit 1 **(6 hrs)**

Introduction:

Origin, Definition, Benefits, Challenges, Commercial activities,Physics of miniaturization, Scaling laws.

Unit 2 **(8 hrs)**

Microscale fluid mechanics:

Intermolecular forces, States of matter, Continuum assumption, Governing equations, Constitutive relations. Gas and liquid flows, Boundary conditions, Slip theory, Transition toturbulence, Low Re flows, Entrance effects. Exact solutions, Couette flow, Poiseuille flow, Stokes drag on a sphere, Time-dependent flows, Two-phase flows, Thermal transfer in microchannels.

Unit 3 **(6 hrs)**

Capillary flows:

Surface tension and interfacial energy, Young-Laplace equation, Contact angle, Capillary length and capillary rise, Lucas- Washburn equation, Interfacial boundary conditions, Marangoni effect.

Unit 4 **(8 hrs)**

Electrokinetics:
Electro hydrodynamics fundamentals, Electro-osmosis, Debye layer, Thin EDL limit, Boltzman ionic distribution, Stokes Einstein equation, Ideal electroosmoticflow, Ideal EOF with back pressure, Osmotic pressure, velocity scale in electroosmosis, Helmholtz-Smoluchowski velocity, Streaming potential, Lenz's Law, Ionic advection, and conduction current, Electroosmotic velocity profile, Electrophoresis of particles, Electrophoretic mobility, Electrophoretic velocity dependence on particle size, Huckel equation

Unit 5 **(6 hrs)**

Microfabrication techniques:
Materials, Clean room, Silicon crystallography, Miller indices, Oxidation, photolithography- mask, spin coating, exposure and development, Etching, Bulk and Surface micromachining, Wafer bonding, Polymer micro fabrication, PMMA/COC/PDMS substrates, micromolding, hot embossing, fluidic interconnections.

Unit 6 **(6 hrs)**

Microfluidics components:
Micropumps, Check-valve pumps, Valve-less pumps, Peristaltic pumps, Rotary pumps, Centrifugal pumps, Ultrasonic pump, EHD pump, MHD pumps, Microvalves, Pneumatic valves, Thermopneumatic valves, Thermomechanical valves, Piezoelectric valves, Microflow sensors, Differential pressure flow sensors, Drag force flow sensors, Lift force flow sensors, Thermal flow sensors, Droplet generators, Kinetics of a droplet, Dynamics of a droplet, In-channel dispensers, T-junction and Cross-junction, Droplet formation, breakup and transport.

Text Books

- Nguyen, N. T., Werely, S. T., Fundamentals and applications of Microfluidics, Artechhouse Inc., 2002.
- Madou, M. J., Fundamentals of Micro fabrication, CRC press, 2002.

Reference Books

- Bruus, H., Theoretical Microfluidics, Oxford University Press Inc., 2008.
- Tabeling, P., Introduction to microfluidics, Oxford University Press Inc., 2005.
- Kirby, B.J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices,Cambridge University Press, 2010.
- Colin, S., Microfluidics, John Wiley & Sons, 2009.

Honor in Design Stream
ME (HO) 21006 Fracture Mechanics

Teaching Scheme
Lectures: 3hrs / week

Examination Scheme
Internal Test 1: 20 marks
Internal Test 2: 20 marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):
At the end of the course students will be able to:

- Predict different modes of failure and differentiate between brittle fracture and ductile fracture.
- Interpret the damage tolerance of a component with a crack by analyzing the problem by methods of energy release rate and stress intensity factor.
- Explore the test methods for determining critical energy release rate, critical stress intensity factor.
- Analyze stress and displacement fields at the tip of edge crack and embedded crack.
- Analyze variable amplitude fatigue in a component when a crack is present in it.
- Estimate crack propagation, and environment assisted cracking along with various crack detection techniques.

Unit 1 **(6 hrs)**

Energy release rate:
Kinds of failure, Brittle and ductile fracture, Modes of fracture failure, Damage tolerance, Grifth's Dilemma, Surface energy, Grifth's realization, Grifth's Analysis, Energy release rate, crack resistance, stable and unstable crack growth, R-curve for Brittle Cracks, Critical Energy Release Rate.

Unit 2 **(6 hrs)**

Stress intensity factor:
Introduction, Stress and Displacement Fields in Isotropic Elastic Materials ,Stress intensity factor, Background for Mathematical Analysis, Westergaard's Approach, Application of the Principle of Superposition, Crack in a Plate of Finite Dimensions, edge cracks, embedded cracks, The Relation between G_I and K_I, critical stress intensity factor, Bending and Twisting of Cracked Plates.

Unit 3 **(6 hrs)**

Crack tip plasticity:
Shape and size of plastic zone, effective crack length, effect of plate thickness, Crack tip opening displacement, Definition of the J-Integral, Path Independence, Stress-Strain Relation,

Relationship between CTOD, K_I and G_I for Small Scale Yielding, Equivalence between CTOD and J.

Unit 4 **(6 hrs)**

Test methods:
Introduction, Test methods for determining critical energy release rate, Test Methods to Determine J_{Ic}, Test Methods to Determine G_{Ic} and G_{IIc}, Determination of Critical CTOD.

Unit 5 **(6 hrs)**

Fatigue failure and environment-assisted fracture:
Introduction, Terminology, S-N Curve, Crack Initiation, Fatigue failure: Crack propagation, effect of an overload, crack closure, variable amplitude fatigue load, Micro mechanisms, Environment-assisted fracture, Environment assisted Fatigue Failure, Major Factors Influencing Environment-assisted Fracture, Test Methods.

Unit 6 **(6 hrs)**

Crack detection techniques:
Introduction, various crack detection techniques, Examination through Human Senses, Liquid Penetration Inspection, Ultrasonic Testing, Radiographic Imaging, and Magnetic Particle Inspection.

Text Books

- Kumar Prashant, "Elements of Fracture Mechanics", Tata McGraw-Hill, 2009.
- Maiti S K, "Fracture Mechanics: Fundamentals and Applications", Cambridge University Press, 2015.

Reference Books

- Brook D, "Elementary engineering fracture mechanics', Springer, 2012.
- Liebowitz H.," Fracture" Volume I to VII, Academic Press Inc., Nov. 1972.
- Nadai A and Hemp W. S., "Theory of fow and fracture of solids", McGraw Hill Book Company, 1950.

Interdisciplinary Open Course-I (IOC)
IOC 21005 Renewable Energy

Teaching scheme
Lectures: 2 hrs/week

Examination Scheme
Internal Test 1: 20 Marks each
Internal Test 2: 20 Marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Understand effect of fossil fuels on global warming and their relative impact on the environment.
- Comprehend the energy scenario of india and the scope of non-conventional energy sources.
- Describe the difference between the non-conventional energy and the renewable.
- Evaluate the performance of the various non-conventional and renewable energy sources.
- Comprehend the recent advancements in energy generations.
- Design skills in non-conventional energy systems and enhance written communication.

Unit 1 **(5 hrs)**

Introduction to energy:

Energy demand growth and supply, Historical perspectives, Fossil fuels: Consumption and Reserves, Environmental impacts of burning fossil fuels, Sustainable development and the role of renewable energy.

Unit 2 **(6 hrs)**

Wind and Hydro power systems :

Atmospheric circulations, factors influencing the winds, wind turbines and types, coefficient of power, torque, Betz limit, Aerodynamic design principle for blades, Introduction to hydro power plant and types, overview of micro, mini and small hydropower plant, types and operational characteristics of hydro turbine

Unit 3 **(6 hrs)**

Bio energy and bio-fuels:

Biomass source and characterization, direct combustion, pyrolysis, mechanism of bio-renewable energy, Gasifiers, updraft gasifier, downdraft gasifier, gasifier-basedelectricity-generating systems, application of biogas slurry in agriculture, bio ethanol for energy generation

Unit 4 **(8 hrs)**

Fuel cells:

Working principle of fuel cells, fuel cell electrochemistry, types of fuel cells: Alkaline fuel, Fuel Cells, Phosphoric acid fuel cell, Solid oxide fuel cell, Molten carbonate fuel cell, Direct methanol Fuel Cell, their applications, relative merits and demerits. Introduction to thermal heat storage.

Unit 5 **(6 hrs)**

Tidal energy:
Tidal power plants: single basin & two basin plants, variation in generation level, Ocean thermal electricity conversion, electricity generation from waves, shortline and floating wave systems.

Unit 6 **(6 hrs)**

Geothermal energy :
Introduction, Geothermal sites in India, high temperature and low temperature sites in India, Conversion technologies, Steam and binary systems, geothermal power plant, open loop and closed loop system

Text Books

- Godfrey Boyle, Renewable energy, Oxford press, 2012
- Twidell J and Weir T., Renewable energy resources, Taylor and Francis, 2006
- Rai G.D., Non-conventional energy sources, Khanna Publication, 2009
- B.H. Khan, Non-conventional energy sources, Mcgrawhill education, 2006.

Reference Books

- Wind Energy Systems by Johnson G. L., Prentice Hall,1985
- Introduction to Hydro Energy Systems: Basics, Technology and Operation by Wagner H. and Mathur J, Springer, 2009.
- Bio-fuels: biotechnology, chemistry, and sustainable development by DM Mousdale, CRC Press, 2008.
- Fuel Cells: From Fundamentals to Applications by S Srinivasan, Springer, 2006.