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.

(Revision: A.Y. 2016-17, Effective from: A.Y. 2017-18)

Semester V [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Numerical Methods & Computer Programming	1	1	0	2
2	ILOE in Humanities/HSMC		• English Language Proficiency-I • Finance for Engineers-I • Engineering Economics-I • Industrial Psychology-I • Personnel Psychology-I • Japanese Language-I • German Language-I	2	0	0	2
3	MLC		Environmental Studies	1	0	0	0
4	PCC		Fluid Machinery	2	0	0	2
5	PCC		Heat Transfer	3	0	0	3
6	PCC		Theory of Machines - II	3	0	0	3
7	PCC		Machine Design-I	3	0	0	3
8	PCC		Industrial Fluid Power	3	0	0	3
9	LC		Heat Transfer Lab	0	0	2	1
10	LC		Theory of Machines - II Lab	0	0	2	1
11	SBC		Machine Design-I Lab	0	0	2	1
12	SBC		Fluid Machinery and Fluid Power Lab	0	0	2	1
				18	1	8	22
			Total Academic Engagement and Credits	**Max. 27**			**22**

- **Minor courses:** Elementary Thermal Engineering
- **Honour course Thermal Stream:** Fluid Dynamics
- **Honour course Design Stream:** Advanced Machine Design

Semester VI [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	MLC		Constitution of India	1	0	0	0
2	ILOE in Humanities/HSMC		• English Language Proficiency-II • Finance for Engineers-II • Engineering Economics-II • Industrial Psychology-II • Personnel Psychology-II • Japanese Language-II • German Language-II	2	0	0	2
3	DEC		Department Elective-I	3	0	0	3
4	SLC		MOOC/Flipped Class/Internship/Industry floated Course/Technical SLC	3	0	0	3
5	SBC		Mini Project	1	0	4	3
6	PCC		Machine Design-II	2	1	0	3
7	PCC		Energy Conversion	3	0	0	3
8	PCC		I C Engines	3	0	0	3
9	LC		Machine Design-II Lab	0	0	2	1
10	LC		Engineering Thermodynamics and Energy Conversion Lab	0	0	2	1
11	LC		IC Engines Lab	0	0	2	1
12	HSMC		Entrepreneurship Development	1	0	0	1
				19	1	10	24
			Total Academic Engagement and Credits	**30**			**24**

- **Minor courses:** Elements of Machine Design
- **Honour course Thermal Stream:** Computational Fluid Dynamics
- **Honour course Design Stream:** Finite Element-Boundary Element Methods

Semester- V

(ME) Numerical Methods and Computer Programming

Teaching Scheme:
Theory : 1 Hr/week
Tutorial : 1Hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to:

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

Unit I : Numerical Methods I:
Bracketing and Open Methods. Rate of Convergence. Numerical Solution of Linear and Non-linear Simultaneous Equations: Gauss- Elimination, Gauss- Seidal, Gauss- Jordan, Relaxation Technique, Eigen values, Matrix- Inversion, Tridiagonal systems. Numerical Integration using Newton- Cotes formulae, Gauss-Quadrature, Romberg Integration, Double Integration.
[5hrs]

Unit II : Numerical Methods II:
Approximation by Forward, Backward, Central and Divided Difference Formulae, Richardson Extrapolation Technique, Higher- order derivatives. Least Square Technique, Linear, Exponential and Multiple Regressions. Interpolation by Newton‟s Formulae, Lagrange‟s, Spline Interpolation, Hermite and Stirling Formulae **[5hrs]**

Unit III : Differential Equations:
Ordinary Differential Equations Taylor‟s Series, Picards Method, Euler‟s, Modified Euler‟s, Runge- Kutta (Second and Fourth Order), Predictor- Corrector, Simultaneous and Second Order differential Methods. Introduction to numerical methods for solution of Partial Differential equations **[5hrs]**

Text Books:

- Chapra, Cannale, " Numerical Methods for Engineers", McGraw-Hill Int.
- Shastry, "Introductory Methods of Numerical Analysis", Prentice Hall of India Delhi.

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.

(ILOE) English Proficiency I

Teaching Scheme:
Lectures: 1Hr/week
Practical: 4 Hr/week

Evaluation Scheme:
T1 & T2: 25 Marks each
End-Sem Exam: 50 Marks

Course Objectives:

1. To help students boost their confidence, communicate effectively and to present their ideas in a rational and logical manner
2. To apply effective writing skills widely practised across the globe
3. To enhance their linguistic competence and grasp intricacies involved in the development of their communicative ability to be employable
4. To help students understand the basic concept of employability and its importance in their career path
5. To make them industry ready and enhance employability

Course Outcomes:

Students will be able to:

1. Students will be able to communicate well using meaningful sentences for conversation or speech.
2. They will be able to reproduce their understanding of concepts of communicating using English language
3. Students will be able to read and comprehend communication well and write an effectively and enhance formal communication
4. Students will be able to better Presentation skills and participate in healthy discussions both formal and informal among peers
5. They will be more confident facing interviews, acquiring professional skills and will be industry ready

Unit I: Communication as a skill

Review of the basic understanding of communication as a skill and its need for effective business communication for Engineers **[3 hrs]**

Unit II: Conversational Skill Development

Formal and informal expressions, general discussions, Vocabulary Building. **[4 hrs]**

Unit III: Business Communication

Letter Writing, Note making, Minutes, Summarizing, **[4 hrs]**

Unit IV: Business Etiquette

Basic Mannerisms and Grooming required for professionals **[3 hrs]**

Text books:

- Communication Skills for Technical Students by T.M. Farhathullah (Orient Longman)
- Communication for Business: A Practical Approach by Shirley Tailor (Longman)

Reference Books:

- Communication Skills for Engineers by S. Mishra & C. Muralikrishna (Pearson)
- Written Communication in English by Saran Freeman (Orient Longman)
- Essential English Grammar (Elementary & Intermediate) Raymond Murphy (CUP)
- Enhancing Employability at Soft Skills by Shalini Varma (Pearson)

(ILOE) Engineering Economics-I

Teaching Scheme	**Examination Scheme**
Lectures: 2hrs/week	Field Work/Assignment: 40
	End Semester Exam: 60

Course Education Objectives (CEO)

1. To introduce the essentials of economics
2. To increase economic knowledge and how the markets work
3. To understand competition market and the basis
4. To understand how International Markets work and their principles
5. To understand how start-ups work

Course Outcomes (CO):

Students will be able to:

1. Students would understand the nature of markets and competition
2. Students would learn about Basic Concepts of Economics, Micro and Macro
3. Students would understand the importance of how industries behave
4. Students would understand the basis in our day to day life to gain personal financial control

5. Students would learn about start-up culture and economics
6. Students would get to know finance generation and funding rounds

Unit I: Basic Concepts of Economics
Definitions, Overview of Micro and Macro Economics, Explanation of theories of demand, supply and market equilibrium and Economics Basics – Cost, efficiency and scarcity, Opportunity Cost **[6 hrs]**

Unit II: Micro Economics
Differences and Comparison, Theories of Utility and Consumers Choice, Competition and Market Structures, Markets and Prices, Market Failures, Income Distribution and Role of Government **[8 hrs]**

Unit III: Macro Economics
Aggregate Demand and Supply, Economic Growth and Business Cycles, The role of the Nation in economic activity, New Economic Policy in India, Fiscal Policy, GDP and Inflation, Consumption, savings and investments, Commercial and Central banking **[6 hrs]**

Unit IV: Industrial Economics
Behaviour of firms: Strategies with regard to entry, pricing, advertising, and R & D and innovation. The development of Firms and Market and Industrial Structure: Stochastic models of firm growth, and market structure, inter-industry differences in growth rate variance, economies of scale, technical change, mergers and market concentration. Development of Competitive capabilities: Role of Technology and Skills, FDI and Technology Transfer, Technological Spillovers, Globalization and Technology Intermediation. **[8 hrs]**

Text Books:

- Baumol, William J., Economic Theory and Operations Analysis, [Prentice Hall India Ltd.] Fourth Edition, 1985.
- Sloman, John H., Economics [Prentice Hall India Ltd.] Second Edition, 1994.
- Varian, Hal, ` Intermediate Microeconomics: A Modern Approach, Fifth Edition [Norton, 1999].
- P.A. Samuelson & W.D. Nordhaus, Economics, McGraw Hill, New York, 1995.
- Koutsoyiannis, Modern Microeconomics, Macmillan, 1975.
- R. Pindyck and D.L. Rubinfeld, Microeconomics, Macmillan Publishing Company, New York, 1989.

Reference Books:

- R.J. Gordon, Macroeconomics 4th Edition, Little Brown & Co., Boston, 1987.

- William F. Shughart II, The Organization of Industry, Richard D. Irwin, Illinois, 1990. (Chapter 3).

(ILOE) Industrial Psychology-I

Teaching Scheme
Lectures: 2hrs/week

Examination Scheme
Total Marks: 100
Field Work/Assignment: 40
End Semester Exam: 60

Course Objectives (CO):

1. To introduce the essentials of psychology at workplace
2. To increase insights of work place behavior
3. To understand the psychological functionality of an organization in the 21st century
4. To learn and acknowledge the inter-relationship between Psychology and Engineering

Course Outcomes (CO):

Student will be able to**:**

1. Students would understand the nature, scope, challenges and role of technology in Industrial Psychology
2. Students would learn about major psychological factors that influence individual differences in behavior at work
3. Students would understand the importance of motivation and involvement in determining satisfaction at work
4. Students would understand the elements of psychometric testing and develop skills to face the same in future
5. Students would learn about physical and psychological aspects related to workplace in terms of environmental conditions, safety and health
6. Students would get to know the stressors of work and learn coping strategies to strike work-life balance
7. Students would understand the role of human factors, especially sensory systems and cognitive abilities, in designs that promote man-machine harmony
8. Students would demonstrate the knowledge gained through practical implementation

Unit I: Introduction to Industrial Psychology

Nature and Development of Industrial/Work Psychology

Historical background- Time and Motion Study, Hawthorne Studies, World War I & II

Scope & Challenges: Current status ,Role of Technology **[6 hrs]**

Unit II: People at Work

Individual Differences: Personality, Intelligence, Emotional Intelligence, Creativity & Innovation, Perception & Attitudes

Motivation- N-Ach, Expectancy Theory & Equity Theory, Modern Approach to Motivation; Job Satisfaction- Job Diagnostic Model, Measuring Job Satisfaction

Psychometric Testing at Work- Cognitive Abilities, Personality, Emotional Intelligence **[8 hrs]**

Unit III: Characteristics of Workplace

Working Conditions- Physical (E.g. Work Schedule, etc.) & Psychological (E.g. Fatigue, Boredom, etc.) Safety & Health Practices at Workplace- Accidents, Violence, Harassment, Alcoholism & Drug Stress at Workplace- Individual Responses to Stress; 3 Cs of Stress- Causes, Consequences & Coping with Work Stress **[6 hrs]**

Unit IV: Engineering Psychology-I

Brief History and Scope Person-Machine Systems- Basic Human Factors: Sensory systems- Visual (light, colour, night vision, depth perception), Auditory (sound, alarms, noise), Tactile & Vestibular senses; Cognition & Decision Making

Displays: Visual & Auditory Control **[8 hrs]**

Text Books:

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

Reference Books:

- 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.
- Schultz, D. & Schultz, S. E. (2002). *Psychology and Work Today*. Pearson Education: New Delhi.

(ILOE) Personnel Psychology (I)

Teaching Scheme-
2 Lectures per week

Examination Scheme-
Assignments for 60 marks
End semester of 40 marks

Course Objectives:

1. To enable to understand basic concepts in organizational set up.
2. To create awareness about corporate world and efficacy of employee.
3. To understand importance of groups and its dynamics
4. To understand the importance of self management

Course Outcomes:

Student will be able to:

1. Students will have understanding of organizational concepts and behavior.
2. Students will have understanding about their own personality for corporate world.
3. Students will understand importance of groups and its dynamics.
4. Students will understand the importance of self management and development.

Unit I- Introduction-
Basic concepts in Organizational set up and its importance **[2 Hrs]**

Unit II- Personality and corporate world-
Know and accept you. Preparing for corporate world, approaches towards work **[8 Hrs]**

Unit III- Group behavior and leadership.-
Group behavior and effectiveness, Effective Leadership and management principles **[8 Hrs]**

Unit IV- Self management & development-
Efficient working habit self training and self development **[4 Hrs]**

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 Hand Masters L.- (2008) Personality development..Cengage Learning India Pvt. Ltd.

Reference books:

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

(ILOE) Japanese Language -I

Teaching Scheme:
2 Hours/ week

Evaluation Scheme:
Oral Exam: 20 Marks
Written Exam: 80 Marks

Course Education Objectives (CEO):

1. Introduction to Japan & Japanese language.
2. Greetings, Set phrases, Vocabulary
3. Understanding of numerals, counting
4. Introduction to Japanese Grammar - Sentence Formation, Particles, Pronouns, Tense, Adjectives, Basic verbs
5. Question Formation

Course Outcomes (CO):

Students will able to**:**

1. Students would know the basic information of Japan
2. Students would be familiar with the pronunciation, Accent, Intonation and Japanese writing System Hiragana, Katakana and Kanji
3. Students would be able to speak daily greetings
4. Students would be able to count the numerals
5. Students would be able to introduce themselves, Family members
6. Students would be able to form basic questions
7. Students would be able to understand Colors, Years ,Months and Days, Time expressions, Directions to read the city map

Unit I

Introduction to Japanese Syllables (phonetic alphabet), greetings & Self introduction, Identifying things, point objects and listen to their names, Listen to things and places etc. Creating shopping lists. **[6 Hrs]**

Unit II

Introduction to Time, day of the week, simple inquiries on telephone, Means of transport, Basic conversations of everyday life. **[6 Hrs]**

Unit III

Frame questions in Japanese. Vocabulary of giving and receiving objects, Stating impressions/things surrounding us, Expressing likes and dislikes, good/bad, possessions, Talking about the country, town and the environment**.** **[6 Hrs]**

Unit IV

Quantity, number of people, time, period etc., Stating thoughts and impressions, Conveying movement (e.g. go / come). **[6 Hrs]**

Text book:

- Minnano no Nihongo 1-1.Goyal Publishers& Distributors Pvt. Ltd. Delhi, India

(ILOE) German Language -I

Teaching Scheme:
2 Hours/ week

Evaluation Scheme:
Oral Exam: 20 Marks
Written Exam: 80 Marks

Course Education Objectives (CEO):

1. Introduction of Germany
2. Greetings, phrases, vocabulary
3. Understanding of numbers till 100
4. Grammar- Introductory Sentence Formation, Articles, Pronouns, Tense, Prepositions
5. Question Formation

Course Outcomes (CO):

Students will able to:

1. Students would know the basic information of Germany
2. Students would be familiar with the pronunciation of German letters and greetings
3. Students would be able to count till 100
4. Students would be able to introduce themselves
5. Students would be able to form basic questions
6. Students would be able to read the city map

Unit I Start auf Deutsch: (Begin in German)

Deutschland, Deutsch sehen und hören, erste Kontakte, Texte: Lied, Postkarte, Wortfelder: internationale Wörter, deutsche Namen **[8 hrs]**

Unit II Café: (Café)
Gespräche im Café, Texte: Getränkekarte, Telefonbuch, Rechnungen, Wortfelder: Gespräche im Café, Zahlen bis 100, Strukturwörter **[6 hrs]**

Unit III Städte, Länder, Sprachen: (Cities, Countries, Languages)
Sehenswürdigkeiten in Europa, Sprachen in Europa, Nachbarsprachen, Texte: Landkarten, ein Statistik, Wortfelder: Himmelsrichtungen, Sprachen **[5 hrs]**

Unit IV Menschen und Haüser: (People and Houses)
Wohnwelten, Texte: Möbelkatalog, E-Mail, Wohnungsgrundriss, Wortfelder: Räume und Möbel, Wohnformen **[5 hrs]**

Text Book:

- Funk, Kuhn, & Demme. Studio d A1. Deutsch als Fremdsprache. 2011. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India

Environmental Studies

Teaching scheme:
ONE interactive session per week (TOTAL – 12 lectures including field work like exposure visit/ interaction/ actual contribution/ small project etc.)

Scheme for evaluation:
T1: Noting the classroom discussions & presentations on selected topics (50 marks)
T2: Report on field work &group activity/ies (50 marks)

Course objectives:

1. To make students aware about environmental assets
2. To make students understand the sources, types of environmental challenges
3. To understand the concept and approaches of sustainable development
4. To realize our role in the protection and conservation of environment

Course Outcomes:

1. Students will understand the concept of environment and its importance for the mankind.
2. Students will also become aware of the current issues and environmental problems at local, national and global level
3. Students will be sensitized towards the protection, conservation and sustainable development
4. Students will think seriously about the impact human actions on environment and measures to minimize and mitigate them as an engineer

5. Students will learn about their role as professionals in protecting the environment from degradation

Course content:

Unit	Topics	Lectures
1.	**The Global environmental issues** Human population and environment : Population growth, Environment and human health, Women and child welfare Social issues and environment : People and environment, Social consequences of development and Environmental changes	**02**
2.	**Natural resources** Concept, spheres, Direct & Indirect utilization of natural resources, Types - Renewable and non-renewable, Overexploitation & pollution, Conservation - 3R principle	**02**
3.	**Ecosystem** Concept, Types – Terrestrial & aquatic with subtypes, Function, Food chain & web, Energy pyramid, Niche, Ecotone	**04**
4.	**Biodiversity** Introduction, levels, Types, Distribution & Magnitude, Threats, Conservation	**04**
5.	**Pollution** Concept, Types & Sources, Direct & indirect Impacts, Prevention, control and mitigation measures, Disaster management	**04**
6.	**Environmental rules and regulations** Concepts, Local, national and Global level framework, tools like Environmental Impact Assessment, Environmental Management System, Certifications, Role of an engineer in environmental management	**04**

Text books:

- Bharucha, E. (2013) Textbook of Environmental Studies for Undergraduate Courses.
- Rajgopalan, R (2011) Environmental Studies: From Crisis to Cure. Oxford University Press
- Wright, RT (2007) Environmental Science. Pearson Education (Low Prise 9th Edition) 712 p.

Reference books:

- Carson, Rachel (1962) The Silent Spring
- Leelakrishnan, P. (2006) Environmental Law Case Book (IInd Edition) LexisNexis Butterworths (Student Serise) 466 p.
- McKibben, Bill (1989) The end of Nature
- Meadows, Donella, Meadows Dennis & Randers Jorgen (1996) Beyond the limits
- Odum, EP (1971) Fundamentals of Ecology, W.B. Saunders (Publi.). 574 p.
- United Nations Environment Program (2005) Atlas of Our Changing Environment
- Weisman, Alan (2007) The World without us

Important web resources:

Official websites of UNEP, UNESCO, MoEFCC, various NGO's

(ME) Fluid Machinery

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Students will be able to

1. Acquire and implement the knowledge of basic principles, working and applications of various hydraulic machines, components and devices.
2. Critically analyse the performance of pumps and turbines.

Unit I: Momentum Principle and its Application
Impulse-momentum principle, calculation of force exerted on fixed plate, moving flat plates & curved vanes, Calculation of force exerted on series of moving vanes, velocity diagrams & its analysis. [**4 hrs]**

Unit II: Impulse Water Turbines
Classification of water turbines, Pelton wheel, its construction and working, velocity triangles, efficiency, power, work done, Pelton wheel design, Governing of Pelton wheel [**4 hrs]**

Unit III: Reaction Water Turbines
Principle of operation, Construction and working of Francis and Kaplan Turbine, Effect of modification of velocity triangles on runner shape, Draft tube, Cavitations calculation of various efficiencies, Power, Discharge, Blade angles, Runner dimensions etc. governing of Francis and Kaplan turbine, Draft tube-types and analysis **[6 hrs]**

Unit IV: Performance of Turbines
Factors influencing the performance of turbines, unit head, unit speed, unit quantity, unit power, Specific speed of turbine, performance characteristics curves of turbine. **[4 hrs]**

Unit V: 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 **[4 hrs]**

Unit VI: Miscellaneous Hydraulic Systems

Introductions, submersible pump, Air lift pump, hydraulic ram, hydraulic coupling, and hydraulic torque converter. **[4 hrs]**

Text Books:

- C.S.P. Ojha, P.N. Chandramouli, and R. Berndtsson "Fluid Mechanics and Machinery" Oxford university press , 2010
- Modi & Seth, Fluid Mechanics & Fluid Machinery, Standard Book House 2002.
- S. Ramamurtham, Hydraulic Fluid Mechanics and Fluid Machines, Dhanpat Rai Publishing,2002

Reference Books:

- Terry Wright, Philip Gerhart "Fluid Machinery: Application, Selection, and Design", Second Edition Publisher: CRC Press, 2009.
- S Larry Dixon B.Eng ,Cesare Hall "Fluid Mechanics and Thermodynamics of Turbomachinery", Seventh Edition Publisher: Butterworth-Heinemann 2013
- R. K. Rajput, A Text book of Fluid Mechanics and Hydraulic Machines, S. Chand Co.Ltd.,2002

(ME) Heat Transfer

Teaching Scheme
Lectures: 3 hr/Week

Examination Scheme
Test (I & II)-40 marks
End Sem. Exam- 60 marks

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Explain the basic laws of heat transfer, various modes of heat transfer and fundamentals of heat exchangers
2. Anticipate and describe the consequence of heat transfer in thermal analyses of engineering systems
3. Formulate, evaluate and develop solution for one and two dimensional steady state heat conduction and unsteady state heat conduction problem.
4. Establish and describe fundamental relationship between fluid flow and convection heat transfer
5. Apply empirical correlations for forced, free convection and phase change process to determine values for the convection heat transfer coefficient.
6. Formulate and solve the Heat Exchanger Rating and Sizing problem

7. Evaluate radiation view factors using tables and obtain numerical solutions for radiation heat transfer problems

Unit I: Introduction

Modes/laws of heat transfer, thermo-physical properties, Electrical Analogy in conduction, 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). **[6hrs]**

Unit II: One dimensional steady state heat conduction

Heat conduction through a plane wall, cylindrical wall and sphere. Heat conduction through a composite slab, cylinder and sphere, effect of variable thermal conductivity, critical radius of insulation, Economic insulation, and thermal contact resistance. One dimensional steady state heat conduction with heat generation for plane wall, cylinder and sphere. **[6hrs]**

Unit III: Extended Surfaces

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.

Unsteady state heat conduction

System with negligible internal resistance, Biot and Fourier numbers. Lumped heat capacity method, use of Heisler charts. **[6hrs]**

Unit IV: 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.

Free and Forced Convection

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. **[6hrs]**

Unit V: 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, Kirchoff'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. **[6hrs]**

Unit VI: 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, compact heat exchangers. **[6hrs]**

Text Books:

- R.C. Sachdeva: Fundamentals of Engineering Heat and Mass Transfer, Wiley Eastern Ltd. (I), 2010
- S. P Sukhatme, A Text Book of Heat Transfer, University Press, 4th Edition, 2005

Reference Books:

- Incropera and Dewitt: Fundamentals of Heat and Mass Transfer, John Wiley and Sons, NY, 7th Edition, 2011..
- Frank Kreith: Principles of Heat Transfer, Cengage Learning, 7th Edition 2011.
- Yunus A. Cengel, Heat Transfer: A Practical Approach, McGraw-Hill Higher Education, 2002
- J.P. Holman: Heat Transfer; McGraw-Hill, 1996

(ME) Theory of Machines-II

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Student will be able to

1. Explain and classify different types of transmission and machine elements.
2. Discuss and describe various principles involved in the working of machine elements.
3. Apply balancing concept to various types of rotating and reciprocating machine elements.
4. Calculate various output parameters and performance of machine elements.

Unit I: Belt & Chain Drives:

Introduction, Type of belts, Tension ratio in belts, Initial tension, Open & cross belt drive, Length of belt, Power transmitted by belt, chain drives. Advantages & Disadvantages of chain drive. **[6 hrs]**

Unit II: Theory of Gears II:

Spiral Gears, Worm and worm Gears, Bevel Gears; their terminologies, center distance, force analysis and efficiency, Gear Trains. **[6 hrs]**

Unit III: Clutches, Brakes and Dynamometer:

Introduction, Types of clutch, uniform wear and Uniform pressure for the clutch, Types of brakes, the braking of a vehicle, Dynamometer and its type**.** **[6 hrs]**

Unit IV: Gyroscope:

Introduction, Angular acceleration, gyroscopic couple, Effect of gyroscopic couple on aeroplane, naval ship, Stability of vehicles. **[6 hrs]**

Unit V: 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. **[6 hrs]**

Unit VI: 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. **[8 hrs]**

Text Books:

- 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
- Ratan S. S. "Theory of Machines", Tata McGraw Hills

Reference Books:

- 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
- Ramamurthy, "Mechanics of Machines" , Narosa Publishing House
- Kimbrell J.T., "Kinematics Analysis and Synthesis" McGraw – Hill International Editons.
- Rao J.S. & Dukkipati R.V. , "Mechanisms and Machine Theory" New Age International Pvt. Ltd.

(ME) Machine Design I

Teaching Scheme:
Lectures : 3 Hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

Student will be able to

1. Evaluate the different types of stresses induced in a component due to different types of static loading conditions.
2. Apply the principles of static loading to design couplings, screws, springs and welded joints.
3. Apply balancing concept to various types of rotating and reciprocating machine elements.

Unit I: Fundamental aspect of design

The meaning of design, Engineering design, Phases of design, design consideration, stress and strain consideration, factor of safety, standardization , preferred series, material selection – weighted point method **[6 hrs]**

Unit II: 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, eccentric loading and theories of failure **[6 hrs]**

Unit III: Design of screw and fasteners

Design of bolted and threaded joints, design of power screws, introduction to re-circulating ball screw **[6 hrs]**

Unit IV: Design of shafts, keys and coupling

Shafts subjected to bending and torsion, types of keys and their design, design of rigid and flexible couplings**.** **[6 hrs]**

Unit V: Design of mechanical springs, helical torsion spring, design of multi leaf spring, Nipping. [6 hrs]

Unit VI: Design of welded joints:

Types of welded joints, eccentrically loaded joints, welded joints subjected to bending moment. **[6 hrs]**

Text Books:

- Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ. Co. Ltd.
- Bhandari V.B. – "Design of Machine Elements" – Tata McGraw Hill Publ. Co. 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) Industrial fluid Power

Teaching Scheme:
Lectures: 3hrs/week

Examination Scheme :
T1 and T2 – 40 marks
Theory- 60 marks

Course Outcomes:

Student will be able to

1. Ability to understand, identify and select components of hydraulic system
2. Analyze the performance of act actuators and motors
3. Ability to model and decide design components for intelligent hydraulic system

Unit I: Introduction to fluid power

Evolution of fluid power systems, introduction to work and power, Principles of pressure and flow. Analogies with electrical components, Merits and Demerits of fluid power systems, Hydraulic leverage and comparison with mechanical leverage, components of fluid power, Numerical examples on leverage and power. Hydraulic fluids: Fluid properties, SAE grades and ISO viscosity numbers, selection of fluid, sources of fluids and additives. **[6 hrs]**

Unit II: Reservoirs and Filters

Reservoir function and its components, standard reservoir designs, reservoir sizing and heat exchanger. Sources and effect of contamination, relative size and measurement of contamination, method of taking fluid samples, ISO contaminant code, establishing and achieving a target cleanliness level, Filters, types, rating and filter construction. **[6 hrs]**

Unit III: Hydraulics pump

Types of pumps, volumetric fixed and variable displacement pumps, aeration, cavitation, fixed displacement pumps: gear pumps, vane pumps, piston pumps. Variable displacement pumps: vane, radial piston, bent axis, in-line piston pumps, Pump controls, modeling leakages path to derive the volumetric losses, model the friction losses to derive the mechanical losses, characteristics and efficiencies. Power, Pump selection and Symbols. Numerical examples for power, efficiencies. **[6 hrs]**

Unit IV: Actuators

Hydraulic Cylinders, classification based on function and mounts, construction and operation, cushioning, Pressure intensification (booster), actuator speed, Selection of mounts with FBD, buckling, and bearing calculations. ASME/DNV standards for cylinder body, Numerical examples for cushion, stop tube, sizing, speed and buckling.

Hydraulic motors, motor ratings, classification, Geroter motor, Axial Piston motor, basic knowledge of flow path in typical motors, modeling leakages path to derive the volumetric losses, model the friction losses to derive the mechanical losses. Symbols for motor and actuators, modeling of Flow and torque ripple characteristic of different motors. Numerical examples for torque, speed, power and efficiencies. **[6 hrs]**

Unit V: Hydraulics valves

Classification of valves based on pressure, flow and direction control.

Direction control: Check valves, mounting, spool positions, direct acting valves, two stage valves and deceleration valves.

Pressure control: relief, unloading relief, pressure reducing, direct acting, spool type and pressure control valves.

Flow controls: flow control methods, temperature compensation, proportional control Cartridge and Stack valves: Cartridge valve concept, screw-in cartridge valves, functional characteristics, direction control, Valvistor screw-in cartridge valves, slip-in cartridge valves, valvistor slip-in cartridge valves, stack valves, symbols and circuits.

Proportional valves: proportional solenoid valves, basic hydraulic principles of proportional valves, proportional pressure, direction and flow control valves, application guidelines, load compensation.

Servo valves: Mechanical servo valves, electrohydraulic servo valves, flapper nozzle, jet pipe servo valves, high performance valve capacities, servo valve performance, **[6hrs]**

Unit VI: System accessories and Fluid power circuits

Fluid conductors, material considerations, installation recommendation, compatibility of hydraulic fluids with hose material, design parameters (cover, tube & reinforcement), governing standards (performance & reliability test for hoses). Determining pipe size requirements, velocity in pipes.

Seals: Sealing, static and dynamic seals, backup rings, different types of static and dynamic seals, seal materials

Accumulator, smoothing pressure pulsations by accumulators, absorption of hydraulic shocks by accumulators, pressure switch, Build a simple hydraulic system to protect and control the system.

Principle of Pneumatics**:** comparison of Pneumatics with Hydraulic power transmissions, FRL unit, Pneumatic system control elements, quick exhaust valve, time delay valve and shuttle valve, basic pneumatic circuits. **[6hrs]**

Text Books:

- H. L. Stewart, "Hydraulic and Pneumatic Power for Production", Industrial Publishing Corporation, 1963.
- S. R.Majumdar, "Pneumatic Systems-Principles and Maintenance", Tata McGraw-Hill Education, 1996.
- John Watton "Fundamentals of fluid power control"
- Anthony Esposito "Fluid Power with Applications", Pearson Education
- A.B. Goodwin: Power Hydraulics.

References:

- Hydraulic symbols http://www.hydraulicsupermarket.com/upload/db_documents_doc_19.pdf
- William Durfee, Zongxuan Sun and James Van de Ven "Fluid Power System Dynamics" Department of Mechanical Engineering, University of Minnesota.
- Jaroslav Ivantysyn and Monika Ivantysynova "Hydrostatic pumps and motors" Academia books international.
- S R Majumdar "Oil hydraulic systems, principles and maintenance" Mc Graw Hill publication
- Colin Ewans "Hose Technology"
- C M Blow "Rubber Technology & Manufacture"
- Eaton-Vickers, Industrial Hydraulics Manual. Eaton Corporation

(ME) Heat transfer Laboratory

Teaching Scheme:
Practical: 2 hr/week

Examination Scheme :
Term work – 50 marks
Oral- 50 marks

Students have to perform Any Eight of following experiments, make a report and submit as Term work for evaluation

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 heat transfer coefficient in natural convection
6. Determination of heat transfer coefficient in forced convection for flow through cylinder
7. Determination of critical heat flux

8. Determination of emissivity of given surface
9. Determination of Stefan Boltzmann constant
10. Determination of effectiveness of heat exchanger (shell and tube type, cross flow type and plate type)

(ME) Theory of Machines II Laboratory

Teaching Scheme:
Practical : 2hrs / week

Examination Scheme:
Continuous evaluation= 50 marks
End Sem. Oral Exam: 60 marks

Course Outcomes:

Students will be able to

1. Classify various transmission devices with their application, limitations and advantages.
2. Draw various performance curves for the machine elements.
3. Verify various principles of machine elements.
4. Determine various parameters involved in working of the machine elements

List of Experiments/Assignments:

1. To determine the belt slip.
2. To study frictional properties of clutch/brake lining and to determine experimentally torque carrying capacity and slip of the clutch or brake.
3. Study of mechanical/transmission type dynamometer.
4. Verification of gyroscopic principle and determination of gyroscopic couple
5. Study of principle of static and dynamic balance machines.
6. Determination of natural frequency of transverse vibrations of a bar.
7. Determination of damping coefficient of torsional vibrations.
8. Determination of node point of two rotor system.
9. Determination of critical speed of shaft of single rotor.

(ME) Machine Design- I Laboratory

Teaching Scheme:
Practical : 2 Hrs/week

Examination Scheme:
Term Work : 50 Marks
Term work: 50 Marks

Course Outcomes:

Students will be able to:

1. Approach a design problem involving several mechanical components, successfully, taking decisions when there is not a unique answer.
2. Design and draw mechanical components.
3. Use software for analysis and design proficiently.

Unit I: Design 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.

Unit II : Design Report

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) Fluid Machinery and Fluid Power Laboratory

Teaching Scheme:
Practical : 2hr / week

Examination Scheme:
Term Work: 50 Marks each
End Sem. Oral Exam: 50 marks

Course outcomes:

Students will able to

1. Ability to analyze the performance of various hydraulic devices under different working conditions
2. Ability to determine the efficiency of different hydraulic devices
3. Ability to determine pressure drop across the hydraulic components in the system

List of Experiments

Perform eight experiments with first four experiments mandatory

1. Trial on Pelton turbine for obtaining its main characteristic

2. Trial on Francis turbine for obtaining its main characteristic
3. Trial on Kaplan turbine for obtaining its operating characteristic
4. Trail on centrifugal pump for obtaining its H-Q characteristic
5. Resistance in series and parallel flow path
6. Fluid types and contamination testing
7. Cylinder-seal breakaway, seal leakage test (rod and piston), Cushion function test,
8. Valves-understanding functions of pressure, flow and direction control; flow vs pressure drop, velocity fuse.
9. Pump and motor-flow vs pressure, flow vs torque, volumetric efficiency, mechanical efficiency, starting torque efficiency, flow vs speed.
10. Piping and fittings-pressure loss in rigid and hose pipes, Shock load behaviour at pump outlet (Pressure pulse test), Pipe and hose sizing based on flow and velocity.

Minor course

Elementary Thermal Engineering

Teaching Scheme:	**Examination Scheme :**
Lectures: 3hrs/week	T1 and T2 – 40 marks Theory- 60 marks

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Define the basic concepts of units and dimensions, systems (open and closed systems and control volumes) and its boundaries, properties, state, process, cycle, quasi-static process etc. required as foundation for development of principles and laws of thermodynamics
2. Develop Intuitive problem solving technique
3. Use & Practice two property rule and hence thermodynamic tables, thermodynamic diagrams and concept of equation of state, also their simple application
4. Explain heat, work and first law of thermodynamics. Application of energy balance
5. Discuss Second law of thermodynamics and its corollaries viz. absolute (thermodynamic) temperature scale, reversibility, entropy, feasibility of a process based on first law and second law, isentropic efficiency of adiabatic machines.
6. Review introductory concept of power and refrigeration cycles. Their efficiencies and coefficients of performance
7. Illustrate ideas of heat transfer in conduction, convection and radiation modes and Application of these concepts to heat transfer in single and combined modes

8. Illustrate ideas of Spark Ignition and Compression Ignition Engine and Application of these concepts to Two stroke and Four stroke engines

Unit I: Fundamentals of Thermodynamics

Basic Concepts, properties, equilibrium; Measurement of Temperature and pressure, Ideal gas relations, Properties of pure substance, Thermodynamic processes; Thermodynamic work and Heat , Laws of thermodynamics and their applications in Engineering, Concept of Heat Engine, Refrigerator and Heat pump, Carnot cycle.(Elementary treatment, Elementary Numerical).

[6hrs]

Unit II: Introduction to Air Standard and Vapour Cycles

Carnot Cycle and concept of thermal efficiency, Otto cycle, Diesel Cycle, Duel Cycle, Brayton Cycle, Vapor Compression Cycle, Rankine Cycle

Energy Conversion Devices (Elementary treatment only):

Steam generation, steam table and dryness fraction; Introduction to Boiler, Steam Turbines, Gas turbines, and Hydraulic turbines, Reciprocating Compressor, Rotary Compressors, Fans, Blowers, Air motors, Reciprocating Pumps (single acting & double acting), SI and CI Engines.

[6hrs]

Unit III: Introduction to Fluid Mechanics:

Fluids: Fluid properties, pressure, density and viscosity. Pressure variation with depth, static and kinetic energy, Bernoulli's equation for incompressible fluids, Viscous and turbulent flow

[6hrs]

Unit IV: Introduction to Heat Transfer:

Introduction to modes of heat transfer, Statement and explanation of Fourier's law of heat conduction and thermal conductivity, Conducting and insulating materials and their properties, Concept of critical thickness of insulation, Newton's law of cooling and concept of heat transfer coefficient and overall heat transfer coefficient, Stefan-Boltzmann's law Concept of heat exchanger, types and concept of effectiveness. Concept of thermal radiation, properties and processes **[6hrs]**

Unit V: Introduction to Refrigeration and Air Conditioning

Air refrigeration cycle, vapour compression cycle, vapour absorption cycles, other refrigeration methods.

Human comfort and air conditioning, psychrometric processes, Introduction to air conditioning system, introduction to heating/cooling load **[6hrs]**

Unit VI

Measurement of physical quantities viz.: mass, temperature, pressure, velocity, discharge, force, torque, rpm, viscosity, calorific value, radiation flux measurement **[6 hrs**]

Text Book:

- S. C. Gupta, Thermal Engineering, Pearson Education
- D. S. Kumar, Thermal Science and Engineering, S. K Kataria & Sons

Reference Books:

- T. D. Eastop and A. McConkey, “Applied Thermodynamics”, Addison Wesley Longman
- Michel J Moran, Introduction to thermal systems engineering: thermodynamics, fluid mechanics, and heat transfer, John Wiley & Sons, Inc
- Cengel and Boles, Thermodynamics: An Engineering Approach (Mechanical Engineering), McGraw Hills

Honour Course (Thermal Stream)

Fluid Dynamics

Teaching Scheme:
Lectures: 3hrs/week

Examination Scheme :
T1 and T2 – 40 marks
Theory- 60 marks

Course Outcomes:

At the end of the course:

1. The Students shall be able to understand and define the fluid flow problems along with range of governing parameters
2. The student shall be eligible to take up the fluid flow problems of industrial base.
3. The students shall be able to devise the experiments in the field of fluid mechanics.
4. The Students shall be able understand the flow patterns and differentiate between the flow regimes and its effects.

Syllabus Contents:

- Governing equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and deferential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities
- Exact Solutions of Navier-Stokes Equations: Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows
- Potential Flow: Kelvin's theorem, Irrotational flow, Stream function-vorticity approach,
- Laminar Boundary layers: Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations
- Turbulent Flow: Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution

- Experimental Techniques: Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry

References:

- Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha Science International, 2005
- 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)

Advance Machine Design

Teaching Scheme:
Lectures: 3hrs/week

Examination Scheme :
T1 and T2 – 40 marks
Theory- 60 marks

Course Outcomes:

At the end of the course:

1. Students will realize that creativity, manufacturability, assembly, maintainability, emotions, reliability are also important aspects of design other than finding dimensions and stresses in the highly competitive, dynamic and customer centered market.
2. Students will demonstrate the ability to identify needs of the customer and convert them in to technical specifications of a product.
3. Students will be able to generate different ideas after identifying the need and determining the specifications and constraints of a product for a particular purpose.
4. Students will understand the principals used while designing for manufacture, assembly, emotions and maintenance.
5. Students will know various methods of rapid prototyping the products to test and modify the designs.
6. Students will be able to design the components considering strength based reliability.

Syllabus Contents:

Unit 1 :

Development processes and organizations, Product Planning

Unit 2 :

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

Unit 3 :

Design for manufacture, assembly, maintenance, casting, forging,

Unit4 :

Design for Reliability, strength based reliability, parallel and series systems, robust design,.

Unit 5 :

Industrial design: Design for Emotion and experience, Introduction to retrofit and Eco design, Human behavior in design

Unit 6 : Rapid Prototyping

References:

- George E Dieter, "Engineering Design", McGraw Hill Company, 2000.
- Prashant Kumar, "Product Design, Creativity, Concepts and Usability", Eastern Economy Edition, PHI New Delhi. 2012
- Woodson T.T., "Introduction to Engineering Design", McGraw Hill Book Company, 1966.
- John J.C. "Design Methods", Wiley Inter science, 1970.
- Averill M. Law and W. David Kelton "Simulation, modelling and analysis", McGraw Hill Book Company, 1991.
- Pahl, G.and W.Beitz, *Engineering Design–A Systematic Approach* – Springer, 2nd Ed., 1996.
- Product Design and development Karl T. Ulrich, Steven Eppinger

SEMESTER VI

Constitution Of India

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Continuous evaluation Assignments /Quiz : 40 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

1. Student will be able to understand how India has come up with a Constitution which is the combination of the positive aspects of other Constitutions.
2. Student will be able to understand the interpretation of the Preamble.
3. Student will be able to understand the basics of governance of our nation.
4. It helps in understanding the different aspects covered under the different important Articles.
5. Student will be able to understand the basic law and its interpretation. Understand the important amendments which took place and their effects.
6. Student will be able to understand our Union and State Executive better.
7. Student will be able to understand the basic that along with enjoying the rights one needs to fulfill one's duties.
8. Student will be able to understand and Gain confidence on our Constitution by knowing it better.

Unit 1
Meaning and history of Constitution. Understanding the concept of Human Rights and Fundamental Rights. **(03 hrs)**

Unit 2
Introduction to The Constitution of India, understanding its objects. Preamble to the constitution of India. Fundamental rights under Part – III, exercise of rights, limitations and important cases. Prerogative Writs. **(06 hrs)**

Unit 3
Relevance of Directive principles of State Policy under Part – IV, Fundamental duties & their significance. **(04 hrs)**

Unit 4
Union Executive – President, Prime Minister, Parliament & the Supreme Court of India. **(03 hrs)**

Unit 5
State executive – Governors, Chief Minister, State Legislature and High Courts **(03 hrs)**

Unit 6
Constitutional Provisions for Scheduled Castes & Tribes, Women & Children & Backward classes. Emergency Provisions. **(04 hrs)**

Unit 7

Electoral process. Amendment procedure, 42nd , 44th , 73rd,74th , 76th , 86th , 91st , 98th and latest amendment. Constitutional amendments. **(03 hrs)**

Text Books:

- Introduction to the Constitution of India by Durga Das Basu (Students Edn.) Prentice – Hall EEE, 19th/20th Edn., 2001.
- Engineering Ethics by Charles E.Haries, Michael. S.Pritchard and Michael J.Robins Thompson Asia, 2003-08-05. 6

Reference Book:

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

(ILOE) English Proficiency II

Teaching Scheme:
Lectures: 1Hr/week
Practical: 4 Hr/week

Evaluation Scheme:
T1 & T2: 25 Marks each
End-Sem Exam: 50 Marks

Course Objectives:

1. To help students boost their confidence, communicate effectively and to present their ideas in a rational and logical manner
2. To apply effective writing skills widely practised across the globe
3. To enhance their linguistic competence and grasp intricacies involved in the development of their communicative ability to be employable
4. To help students understand the basic concept of employability and its importance in their career path
5. To make them industry ready and enhance employability

Course Outcomes:

Students will able to

1. Students will be able to communicate well using meaningful sentences for conversation or speech.
2. They will be able to reproduce their understanding of concepts of communicating using English language
3. Students will be able to read and comprehend communication well and write an effectively and enhance formal communication
4. Students will be able to better Presentation skills and participate in healthy discussions both formal and informal among peers

5. They will be more confident facing interviews, acquiring professional skills and will be industry ready

Unit I: **Linguistic Competence Building**
Enhancement of Word Power, Formal and Group Discussions **[3 hrs]**

Unit II: Presentation Skill Development
Oral and Written Presentations **[3 hrs]**

Unit III: Business Writing
Business Reports, CV, Resume, Statement of Purpose **[4 hrs]**

Unit IV: Job Readiness
Interview Skills and Mock Interviews **[4 hrs]**

Text books:

- Communication Skills for Technical Students by T.M. Farhathullah (Orient Longman)
- Communication for Business: A Practical Approach by Shirley Tailor (Longman)

Reference Books:

- Corporate Communication by Jaishri Jethwaney (Oxford University Press)
- Written Communication in English by Saran Freeman (Orient Longman)
- Business Correspondence and Report Writing, R. C. Sharma & Krishna Mohan (Tata McGraw Hill)

(ILOE) Engineering Economics-II

Teaching Scheme
Lectures: 2hrs/week

Examination Scheme
Field Work/Assignment: 40
End Semester Exam: 60

Course Education Objectives (CEO):

1. To introduce the essentials of managerial economics
2. To increase international economic knowledge and how international markets work
3. To understand personal finance and investments
4. To understand how exchange rates and currency markets work
5. To understand how start-ups finances are generated

Course Outcomes (CO):

Students will able to

1. Students would understand how managerial decisions are based on economics
2. Students would learn about capital budgeting and planning
3. Students would understand the importance balance trade, monetary policies and exchange rates
4. Students would understand the importance of day to day budgeting and personal finances at early stage
5. Students would learn about start-up culture and economics
6. Students would get to know funding rounds which would help them to run their own start-ups

Unit I: **Managerial Economics**

Nature and scope of Managerial Decisions, Objectives of firms, Techniques of analyses with special reference to econometric method, Analysis of demand pattern, demand forecasting, Production function and production planning, cost and product relationships, cost function, Break-even-point analysis, Pricing and price related policies, Labour productivities and wages, Optimization problems, Introductory aspects of capital budgeting, Selected case studies under Indian conditions. **[10 Hrs]**

Unit II: 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. **[7 Hrs]**

Unit III: Personal Economics

Compound Interest and Credit, Financial Markets, Human Capital and Insurance, Money Management/Budgeting, Risk and Return, Saving and Investing **[5 Hrs]**

Unit IV: **Start – up Economics**

Introduction to Start-up Finance, Introduction to Financial Terms, Financial Ratios, Capital Funding, VC's , Funding Rounds, Series A, B.. **[6 Hrs]**

Text Books:

- Carton, D. and J.Perloff. Modern Industrial Organization (Reading, Massachusetts: Addison-Wesley), 1999.
- Hay, Donald A. and Derek J. Morris. Industrial Economics and Organization: Theory and Evidence, 2nd Edition (Oxford: Oxford University Press), 1991.
- Lall, Sanjaya. Competitiveness, Technology and Skills (Cheltenham: Edward Elgar), 2001.
- Scherer, F. M. and D. Ross. Industrial Market Structure and Economic Performance, 3rd Edition (Houghton: Mifflin), 1990.

Reference:

- Schmalensee, R., Inter-industry studies of Structure and Performance, in Schmalensee, R. and R. D. Willig (eds.): Handbook of Industrial Organization [Amsterdam: North-Holland] Vols. 2 Chapter 16, pp. 951-1009, 1989.
- Siddharthan, N. S. and Y.S. Rajan. Global Business, Technology and Knowledge Sharing: Lessons for Developing Country Enterprises (New Delhi: Macmillan), 2002.

(ILOE) Industrial Psychology-II

Teaching Scheme
Lectures: 2hrs/week

Examination Scheme
Field Work/Assignment: 40
End Semester Exam: 60

Course Education Objectives (CEO):

1. To gain insights about the role of psychology in employability in the 21st century
2. To understand the elements of interpersonal relationships at work place
3. To connect basic principles of Industrial Psychology with Engineering with respect to engineering disciplines through practical application
4. To learn the importance of Psychology in designing consumer based products

Course Outcomes (CO)

Student will able to

1. Students would learn about major psychological factors involved in the process of employment
2. Students would acquire psychological skills required to sustain employability
3. Students would understand the elements of organizational culture for enhancing group/team behaviour
4. Students would understand the role of diversity in workforce and acknowledge the multicultural factors influencing workplace behaviour
5. Students would learn to apply the concepts of Engineering Psychology with respect to their disciplines
6. Students would learn about the impact of Psychological factors in consumer behaviour and role of conscious efforts needed in designing products
7. Students would demonstrate the knowledge gained through practical implementation

Unit I: Managing People at Work

Employee Selection- Techniques, Fair Employment Practices, Biographical Information, Interviews, References & Letters of Recommendation
Job Analysis- Types; Newer Developments
Performance Assessment: Evaluation & Appraisal- Objective & Subjective Techniques, Bias, Post Appraisal Interviews
Organizational Training- Types of Training, Psychological Issues; Career Development & Planning **[8 hrs]**

Unit II: Groups at Work
Relationships- At workplace, Issues, Developing Effective Relationships
Groups & Teams- Stages of Group Development, Group Behaviour, Social Identity Theory
Leadership- New Approaches- Leader-Member Exchange, Transactional, Transformational & Charismatic Leaderships
Diversity at Workplace- Cultural Differences (Multiculturalism, Psychometric Testing, Motivation, Work-related Attitude, Leadership, Team work, etc.) **[6 hrs]**

Unit III: Engineering Psychology-II
Workspace Designs- General Principles, Design of Standing & Seating Work Areas; Human Anthropometry- Structural & Functional Data, Use of Anthropometric Data in Design
Human Computer Interaction- Software Design Cycle, System & User Characteristics, Principles & Guidelines for Design
Automation- Problems, Function Allocation; Transportation- Visibility, Hazards & Collisions, Characteristics of Impaired Driver, Safety Improvements
Industrial Robots **[8 hrs]**

Unit IV: Consumer Psychology
Scope & Research Methods- Surveys, Public Opinion Polls, Focus Groups, Observations of Shopping Behaviour, Neuromarketing
Advertising- Nature, Scope & Types
Consumer Behaviour & Motivation- Buying Habits, Product Pricing, Targeted Advertising
Visual Merchandising- Psychological Perspective- Techniques, Impulse Buying, Online Visual Merchandising **[6 hrs]**

Text Books:

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

- 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.

References:

- 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.
- Schultz, D. & Schultz, S. E. (2002). *Psychology and Work Today*. Pearson Education: New Delhi.

(ILOE) Personnel Psychology (II)

Teaching Scheme-	**Examination Scheme-**
2 Lectures per week	3 Assignments for 60 marks End semester of 40 marks

Course Objectives:

9. To understand importance of motivation
10. To understand importance of standards of conduct.
11. To understand ways of successful career
12. To make students aware about stressors and conflicts at workplace and their management.

Course outcomes-

Students will able to

1. Students will understand importance of motivation.
2. Students will be able to realize importance of standards of behavior at work place.
3. Students will get guide lines to achieve workplace success.
4. Students will enable to manage stress and conflict in their personal life and at workplace.

Unit I- Motivation-
Self motivation and motivating others in their job **[4 Hrs]**

Unit II - Emotional Intelligence & values-
Emotional intelligence and Standards of conducts **[4 Hrs]**

Unit III - Work place success –
Setting goals, performance appraisal and moving ahead **[8 Hrs]**

Unit IV- Stress & conflict management at work place-

Occupational stress and conflict, strategies for stress and conflict management **[6 Hrs]**

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.

Referece books:

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

(ILOE) Japanese Language -II

Teaching Scheme:
2 Hours/ week

Evaluation Scheme:
Oral Exam: 20 Marks
Written Exam: 80 Marks

Course Education Objectives (CEO)

1. Introduction to Situational Conversations
2. Telephone etiquettes and conversation
3. Writing and reading basic texts
4. Grammar- Two types of adjectives, conjugation of verbs, transitive, intransitive verbs,
5. Comparative Degree, Causative & Imperative forms

Course Outcomes (CO)

Students will be able to

1. Students would be able to acquire target phrases and expressions
2. Students would master elementary Japanese grammar
3. Students would be able to converse about professions at work
4. Students would be familiar with the customs, work culture & society of Japan

Unit I

Formation of requests, asking for permission/prohibition, speaking conversations of everyday life. **[6 hrs]**

Unit II
Rules and prohibitions, expressing potential and hobbies, sharing experiences. **[6 hrs]**

Unit III
Informal Conversations with friends, Expression of opinions, expectations, Utilization of modifying forms **[6 hrs]**

Unit IV
Vocabulary of Machines, Directions, Forms of verbs (give/take/receive), Description of condition and coming to decision **[6 hrs]**

Text books:

- Minnano no Nihongo 1-2.Goyal Publishers& Distributors Pvt. Ltd. Delhi, India.

(ILOE) German Language -II

Teaching Scheme:
2 Hours/ week

Evaluation Scheme: Total Marks
Oral Exam: 20 Marks
Written Exam: 80 Marks

Course Education Objectives (CEO)

1. Situational Conversations
2. Telephonic Conversation
3. Writing and reading basic texts or emails
4. Grammar- Accusative, Dative, Prepositions, Comparative Degree, Adjective Endings, Imperative
5. Introduction to tourism and culture of Germany

Course Outcomes (CO)

1. Students would understand conversations of time and appointments
2. Students would be familiar with the place orientation and directions
3. Students would be able to converse about professions and schedules at work
4. Students would be familiar with the tourism and culture of German

Unit I Termine: (Appointments)
Termine und Verabredungen, Pünktlichkeit interkulturell, Texte: Meldebestätigung, Veranstaltungsangebote, Arztchild, Gedicht, Wortfelder: Uhrzeiten, Wochentage, Tageszeiten

[7 hrs]

Unit II Orientierung: (Orientation)
Orientierung am Arbeitsplatz, Der Weg zur Arbeit, Die Stadt Leipzig/ Quiz online, Texte: Stadtplan, Etagenplan, Terminkalender, Prospekt, Wortfelder: Stadt, Verkehrsmittel, Büro und Computer **[7 hrs]**

Unit III Berufe: (Professions)
Beruf und Alltag, Texte: Visitenkarten, Wörterbuchauszüge, Wortfelder: Berufe und Tätigkeiten **[6 Hrs]**

Unit IV Berlin sehen: (To see Berlin)
Eine Exkursion durch Berlin, Orientierung in der Stadt, Projekt ,,Internetrally'' Texte: Busplan, Stadtplan, Postkarte, Exkursionsprogramm, Wortfelder: Tourismus, Kultur **[6 Hrs]**

Text Book:

- Funk, Kuhn, & Demme. Studio d A1. Deutsch als Fremdsprache. 2011. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India

DEPARTMENTAL ELECTIVE -I

(ME) Non Conventional Energy Sources

Teaching Scheme:	**Examination Scheme:**
Lectures : 3hrs / week	T1 and T2: 20 Marks each End Sem. Exam: 60 marks

Course Outcomes:

Student will be able to

1. Understand effect of fossil fuels on global warming and their relative impact on the environment. Differentiate between conventional and non-conventional energy source.
2. Comprehend the energy scenario of India and scope of non-conventional energy sources
3. Describe the difference between the non-conventional energy and the renewable
4. Evaluate the performance of the various non-conventional and renewable energy sources.
5. Recent advancements in energy generations like magneto hydro dynamic power generation, fuel cell technology, hydrogen energy and management of energy in the industries
6. Gain design skills in non-conventional energy systems and enhance written communication.

Unit I : Introduction to Solar Energy

Solar Energy: Present status of energy scenario. Renewable and non-renewable energy sources. Availability, limitations, application of solar energy.

Solar Radiation: Structure of the sun, energy radiated by the sun, angular relationship of earth, and sun position, measurement of solar radiation. Derivations and Numerical Problems.

[6hrs]

Unit II : Solar Collectors

Flat Plate Collectors: Types and constructional details of flat plate collector, energy-balance for a flat plate collector, simple equation and performance curves, selection of flat plate collector.

Solar Concentrator: Limitations of flat plate collectors, various types of concentrators, their advantage, simple, thermal energy-balance equations, heliostats, selection of various materials for concentrators and reflecting surfaces. **[6hrs]**

Unit III : Solar Energy Systems

Solar Heating Systems: Solar water and space heating systems, passive solar heating systems, solar heating economics, solar air-heating systems, typical solar ponds.

Solar Distillation Systems: Various solar stills and selection, constructional details, Solar Energy Storage Systems.

Solar Electric Power: Solar photovoltaic system, materials used and their performance, types of solar thermal power plant, working substance used, and temperature required various systems used.

Solar Dryer: Types, selection, constructional details, materials used and their performance **[8hrs]**

Unit IV: Wind Energy:

Availability of wind, various types of windmills and their constructional details and performance study, Power generated by windmills. Offshore Windmills. Derivations and Numerical Problems.

[6hrs]

Unit V: Geothermal and Tidal Energy:

Geothermal Energy Sources: Geothermal Energy Sources and application of geothermal energy, various types of geothermal power plants.

Tidal Energy: Tidal energy available in India, suitable locations, study of various tidal energy power plants, and characteristics of turbines required. Introduction to Wave Energy, Phenomenon of wave generation. **[4hrs]**

Unit VI: Bio gas and Recent advancements in energy generations:

Chemistry of biogas generation variables affecting simple gas plants, types of digestoers their working and construction, application of biogas, use of bio-gas, case study of “pura” village bio gas electricity generation”.

Recent advancements in energy generations like magneto hydro dynamic power generation, fuel cell technology, hydrogen energy and management of energy in the industries. **[6hrs]**

Text Books:

- Sukhatme S.P., " Solar Energy", Tata McGraw Hill Publishing Company Limited, New Delhi, 1994
- Rai G.D., " An Introduction to Power Plant Technology", Khanna Publishers, Third Edition, Delhi, 1996
- Bansal N K and others " Non-Conventional Energy Sources".
- S. Rao and Dr. B. B. Parulekar, Energy Technology, Khanna Publishers, New Delhi.

Reference Books:

- Krieth and Krieder, "principles of solar engineering", Tata McGraw Hill Publishing Company Limited, New Delhi, 1994
- Wakil M.M., " Power Plant Technology", McGraw Hill International Book Company, 1984.
- Pai B.K., and Ramprasad M.S., " Power generation through renewable sources of energy".
- Garg H.P. and Prakash J., " Solar Fundamental and Application" Tata McGraw Hill Publishing Company Limited, New Delhi, 1997

(ME) Steam Technology

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/Week	Test I & 2: 40 marks
	End Sem. Exam: 60 marks

Course Outcomes:

1. Students will be able to explain working of different boilers and significance of mountings and accessories. Students will know and appreciate the provisions in Indian Boiler Regulation Act(IBR)
2. Students will be able to use techniques, skills, and modern engineering tools necessary for boiler performance assessment.
3. Students will have a theoretical and practical orientation in thermal systems, and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation.
4. Students will be able draw a steam piping system for a process with various components and also design economical and effective insulation.
5. Students will be able to analyze a thermal system to determine sources of waste heat and design waste heat recovery systems.
6. Students will understand importance of controls and instrumentation for effective monitoring of the process.

Pre requisites for the course:

The student should have fundamental knowledge of Thermodynamics, Heat Transfer, Fluid Dynamics, Metallurgy and Fuels and Combustion

Unit I: Boilers
Types, Mountings and Accessories, Combustion in boilers, Feed Water and its quality, Blow down; IBR, Boiler standards **[6hrs]**

Unit II: Piping & Insulation
Water Line, Steam line design, IS Pipe colour codes; insulation, Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss. **[6hrs]**

Unit III: 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. **[6hrs]**

Unit IV: Boiler Performance Assessment
Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance. **[6hrs]**

Unit V: Energy Conservation and Waste Minimization
Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization **[6hrs]**

Unit VI: Instrumentation & Control
Process instrumentation; control and monitoring **[6hrs]**

Text Book:

- T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication, 5th Edition, 2009
- Domkundwar; A Course in Thermal Engineering; Dhanapat Rai and Sons, 6th Edition, 2010
- R.K. Rajput, Applied Thermodynamics, S. Chand & Company Limited, 8th Edition, 2011.

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, 42nd Edition, 2015
- P. Chatopadhyay; Boiler Operation Engineering: Questions and Answers; Tata McGrawHill Education Pvt Ltd, N Delhi, 3rd Edition 2013.

(ME) Hydraulic Embedded Systems

Teaching scheme:
Lectures: 3 Hrs/week

Examination scheme:
T1and T2: 20 Marks each
End-sem. Exam: 60 marks

Course Outcomes:

1. Ability to understand, identify components of a typical embedded system
2. Ability to select sensors, actuators and controllers for a typical electro-hydraulic application
3. Introduction to industry trends in IoT, Industrie 4.0 and cyber-security
4. Ability to identify and demonstrate how intelligence can be used to control hydraulic system through programming

Unit I: Basic electronics components

Basic circuit theory and electrical component, analogue electronic components and devices, power supplies and voltage regulators, power electronics-devices, controller and processor, A/D & D/A convertor, signal conditioning circuits using operational amplifiers, noise problems, grounding and shielding. **[6 hrs]**

Unit II: Local intelligence

Sensors - Measurement principles, sensor and actuator techniques, technical properties of sensors and actuators, methods of sensor and actuator classification, types of sensors (sensors of linear and angular displacement, speed sensors, accelerometers, force and torque; pressure sensors, level and flow; sensors for measuring temperature and humidity, proximity sensors, tactile sensors) **[6 hrs]**

Unit III: Actuators and controllers

Actuators: modern integrated micro-actuators (positioners, optical elements), electromechanical actuator - permanent magnet devices classification, magnetic linear actuators, voice-coil motors, piezo-electric actuator

Controllers - embedded development board, Interfacing peripherals, Embedded Operating System Overview. **[6 hrs]**

Unit IV: Device Connectivity

Basics of computer networking, network topologies ,OSI Reference Model, RS232, RS485,USB, CANopen, J1939, MODBUS, Ethernet/IP, EtherCAT, wireless communication – Bluetooth , Wi-Fi, HART **[6 hrs]**

Unit V: Connected Intelligence

Overview of IoT, Industrie 4.0, machine to machine (M2M) communication, IoT network and application architecture, Client Server Architecture, Publish Subscribe Architecture, Cyber-Security Overview (threat and prevention), **[6 hrs]**

Unit VI: Embedded Software Development

Introduction to assemblers, linkers and loaders; binary file formats for processor executable files; typical timer-interrupt driven programs. GNU-GCC compiler introduction, programming with LINUX environment and gnu debugging, gnu insight with step level trace debugging, make file interaction, building and execution; embedded C-programming concepts: macros, functions, modifiers, data types, device drivers, interrupt service routines, cross-compiler optimization for speed/memory needs. **[6 hrs]**

Text Books:

- Allen Mottershed, "Electronic Devices and Circuits", Prentice Hall International, Third Edition
- Robert H. Bishop , Mechatronic Systems, Sensors, and Actuators: Fundamentals and Modeling
- M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "The 8051 Microcontroller & Embedded systems", Pearson Publications, Second Edition 2006.
- Embedded/Real-Time Systems: Concepts, Design & Programming – Dr. K. V. K. K. Prasad, Dreamtech Press, India.
- Rajkamal, Embedded Systems - Architecture, Programming and Design, Tata McGraw Hill, Second edition, 2009
- Brian Evans, "Beginning Arduino Programming", Springer, 2011
- Michael J. Pont , "Embedded C", Pearson Education, 2nd Edition, 2008

References:

- Microprocessor architecture and applications with 8085: By Ramesh Gaonkar (Penram International Publication)
- M. D. Singh and J. G. Joshi, "Mechatronics – Principles and Applications", Prentice Hall India publication-EEE.
- D. Shetty, R. A. Kolk, Mechatronics System Design
- Brauer, J. R., Magnetic actuators and sensors
- L. D. Goettsche, "Maintenance of Instruments and Systems – Practical guides for measurements and control", ISA, 1995.
- CANopen and CAN - http://www.can-cia.org/can-knowledge/canopen/canopen/
- Modbus http://www.modbus.org/
- An Embedded Software Primer, David Simon

(ME) Analysis and Synthesis of Mechanisms

Teaching Scheme:
Lectures : 3hrs / week

Examination Scheme:
T1 and T2: 20 Marks each
End Sem. Exam: 60 marks

Course Outcomes:

Student will be able to

1. Analyse various existing mechanisms.
2. Design and analyse extensive range of mechanisms.
3. Simulate and verify performance of designed mechanisms.

Unit I: Basic Concepts

Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms, review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration. **[4 hrs]**

Unit II: Graphical Synthesis

Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method. **[8 hrs]**

Unit III: Analytical Synthesis

Synthesis of four-bar mechanisms. Freudenstein's equation, synthesis for three, four and five accuracy points **[8 hrs]**

Unit IV: Coupler Curves

Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry.
[6 hrs]

Unit V: Spatial Mechanisms and Robotics

Introduction, mobility, describing spatial motions, Kinematic analysis and synthesis of spatial mechanisms, Kinematics of robotic anipulators **[6 hrs]**

Unit VI: Computer Programming with applications

Introduction to programming, preparing program for angular velocity of various links of four bar mechanisms, velocity and acceleration of coupler points; complete analysis of mechanisms
[6 hrs]

Text Books:

- R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, New York, 1980.
- A.S. Hall, "Kinematics and Linkage Design", Prentice Hall of India.

Reference Books:

- Robert L.Nortan ,"Design of Machinery',Tata McGraw Hill Edition

- Hamilton H.Mabie,"Mechanisms and Dynamics of Machinery",John Wiley and sons New York
- A. Ghosh and A.K. Mallik, “Theory of Machines and Mechanisms”, Affiliated East-West Press, New Delhi, 1988.
- A.G. Erdman and G.N. Sandor, “Mechanism Design – Analysis and Synthesis”, (Vol. 1 and 2), Prentice Hall India, 1988.
- J.T. Kimbrell, “Kinematic Analysis and Synthesis”, McGraw Hill, Inc.
- R. F. Ghans, “ Analytical Kinematics” Buttorworth Heinemann Boston.

(ME) Mechatronics

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End Sem. Exam: 60 marks

Course Outcomes:

Students will be able to

1. Understand basic terminologies and concepts associated with Mechatronics
2. Study various Mechatronic sub-systems
3. Understand interfacing concepts, Electro Mechanical Systems and the related terms.

Unit I

Introduction: Computer Integration of Electro-Mechanical System, Virtual Instrumentation and Computer Monitoring and control Basics solid state components and devices, elements of electromechanical energy conversion, starting, inversion and control of electrical drives, coupling of mechanical loads to DC and AC electrical drives and speed control. **[6 hrs]**

Unit II

Study of various devices such as Accelerometers, Tachometers for velocity measurement, Potentiometers, strain , stress and force measurement using strain gauges. **[6 hrs]**

Unit III

Optoelectronic encoding, sensing, signal shaping and processing devices and techniques. Basics of digital signal processing data acquisition. Special simulation techniques for mechatronic systems, special techniques for solving of shift system model with switching and delay components. **[6 hrs]**

Unit IV

Elements of Telemetry and remote control of Mechatronics systems, theory of linear observers, optimal filters and their digital implementations, design and implementation of digital control strategies for mechanical system. **[6 hrs]**

Unit V

System modeling: Mixed Dynamic Systems modeling and simulations, Object oriented modeling, Virtual prototyping. Modeling of the sensors, modeling of the Actuators **[8 hrs]**

Unit VI

Data acquisition and Virtual Instrumentation: Data Acquisition and analysis Tools, Programming for virtual Instrumentation, signal generation and its processing for the Fourier transform. Real time monitoring and Control, Solutions for real time applications, Various tools for real time data acquisition and control. Real time data acquisition and control.

[6 Hrs]

Text Books:

- Dan Necsulescu, Mechatronics , Pearson Education Asia, India, 2002.
- Mark W. Spong, Seth Hutchinson, M. Vidyasagar Robot Modeling and Control, Wiley India Pvt. Ltd., 2006
- Mahalik, N, Mechatronics : Principles, Concepts And Applications, Tata McGraw-Hill, 2007

Reference Books:

- Introduction to Mechatronics and Measurement Systems , David Alciators & Michael B. Histand, Tata McGraw Hills, India

(ME) Advanced Manufacturing Technology

Teaching Scheme:
Lectures : 3 hrs/week

Examination Scheme:
T1 and T2: 20 Marks each
End Sem. Exam: 60 marks

Course Outcomes:

Student will be able to

1. Learn non-conventional processes and their applications
2. Learn surface coating processes
3. Use rapid prototyping process for product development
4. Select appropriate type of plastics and plastics processing method
5. Design and fabricate understanding MEMS systems

Unit I: Plastic Material and Processes

Different thermosetting and thermoplastic compounds, compression moulding, transfer moulding, injection moulding, film and sheet forming, thermoforming and their applications. **[8hrs]**

Unit II: 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. **[6hrs]**

Unit III: Non-conventional machining processes

Principles, process parameters and applications of Laser material processing, EDM, WEDM and ECG. **[6hrs]**

Unit IV: Special processes

Principles, silent features, advantages and applications of abrasive floor machining, magnetic abrasive machining, honing, lapping and other super-finishing processes. **[6hrs]**

Unit V: 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. **[6hrs]**

Unit VI Surface Coating

Principles, elements, process, advantages and surface preparation, physical vapour deposition, chemical vapour deposition, Electro less coating. **[6hrs]**

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

(ME) Operational Research

Teaching Scheme:
Lectures :3hrs/ week

Examination Scheme:
T1 and T2: 20 Marks each
End Sem. Exam: 60 marks

Course Outcomes:

Student will able to

1. Illustrate the need to optimally utilize the resources in various types of industries.
2. Apply and analyze mathematical optimization techniques to various applications.
3. Demonstrate cost effective strategies in various applications in industry.

Unit I: Introduction to Operations research-

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. **[8 Hrs]**

Unit II: Transportation Problem (TP)-

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, Traveling 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. **[6 Hrs]**

Unit III: Replacement models-

Introduction, replacement of items that detoriates- 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 model- Kendall's notation for representing queuing models, single channel Poisson arrivals with exponential service times, infinite population. **[6 Hrs]**

Unit IV: Games theory-

Minimax (Maximin) criterion for optimality, characteristics of games, dominance principles, 2X2 game-arithmatic and algebraic method, 2Xn and mX2 game-graphical method and method of subgames, 3X3 game- method of matrices, iteration method and applications of games theory.
[6 Hrs]

Unit V: Inventory models-
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. **[6 Hrs]**

Unit VI: 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. **[6 Hrs]**

Text Books:

- Operations Research: S. D. Sharma, Kedar Nath Ram Nath, Meerut
- Operations Research: P. K. Gupta, Sultan, Chand & Sons

Reference Books:

- Operations Research-An Introduction: Hamdy A Taha, Pearson Eduction
- Operations Research: Methods and Problems, Maurice Saseini, ArhurYaspan and Lawrence Friedman

Mini-Project

Teaching Scheme:	**Examination Scheme:**
Lectures : 1hr / week	Term work: 50 Marks
Practical : 4 hrs/week	Oral: 50 marks

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

1. Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis.
2. Design, implement and test the prototype/algorithm in order to solve the conceived problem.
3. 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) Machine Design-II

Teaching Scheme:
Lectures : 3hrs / week

Examination Scheme:
T1 and T2: 20 Marks each
End Sem. Exam: 60 marks

Course outcomes:

Students will be able to

1. Apply fundamental principles of fatigue and stress concentration while designing various components.
2. Design spur, helical, bevel and worm gears.
3. Design sliding and rolling contact bearings.

Unit I : Design against fluctuating load
Stress concentration, fatigue failure, endurance limit, notch sensitivity, Goodman and Soderberg diagrams, and modified Goodman diagram, fatigue design under combined stresses. **[6 hrs]**

Unit II : Sliding contact bearings
Working principle of hydrodynamic and hydrostatic bearing, Design of hydrodynamic and hydrostatic bearings **[6 hrs]**

Unit III : Rolling contact bearings

Classification, static and dynamic load carrying capacity, load-life relationship, selection from manufacture's catalogue, comparison of sliding contact and rolling contact bearings. **[6 hrs]**

Unit IV : Design of spur and helical gears
Design of spur gear: Terminology, Force analysis, Gear tooth failures.
Design of helical gear: Terminology, Virtual number of teeth, force analysis **[6hrs]**

Unit V : Design of Bevel gears:
Terminology, Force analysis, beam strength of bevel gears, Wear strength of bevel gears, and effective load on gear tooth. **[6hrs]**

Unit VI : Design of worm gears:
Terminology, Force and efficiency analysis, Bending and surface fatigue strength, Worm gear thermal considerations, Methods of lubrications. **[6hrs]**

Text Books:

- Bhandari V.B. – "Design of Machine Elements" – Tata McGraw Hill Publ. Co. Ltd.
- Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ. Co. 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) Energy Conversion

Teaching Scheme:
Lectures : 3hrs / week

Examination Scheme:
T1 and T2: 40 marks
End sem: 60 marks

Course Outcomes:

Students will be able to

1. Elucidate construction and working of steam nozzle, steam turbine, steam condenser, cooling tower, gas turbine, jet engine
2. Evaluate thermal performance of steam nozzles, steam turbine, steam condenser, cooling tower, gas turbine, jet engine and suggest methods for improvement of thermal performance and compare the performance

3. Acquire specific knowledge about energy economics of fossil, fissile and renewable energy, determine the energy cost and understand how they complement and/or compete with each other
4. Draw load duration curves for different customers.
5. Explain the direct and indirect solar energy conversion, collectors and storage systems
6. Determine the Ultimate solar conversion efficiency

Unit I: Steam nozzles
Compressible fluid flow, Static and Stagnation properties, Isentropic flow, Flow of fluid through nozzles, Continuity equation, Variation of velocity, area and specific volume, Mass of discharge, Maximum discharge, Critical pressure ratio, Choking, Effect of friction, Nozzle efficiency, Back pressure effect, Super saturated flow. **[7 hrs]**

Unit II: Steam turbines
Types of turbines, Compounding, Velocity diagrams, Performance analysis, Reheat factor, Stage efficiency, Governing, and Losses in turbines. **[8 hrs]**

Unit III: Condensers and Cooling Towers
Necessity of condenser, Types, Performance, Cooling towers, Types; Performance **[5 hrs]**

Unit IV: Gas turbines
Classification of gas turbines, Analysis, Regeneration, Inter-cooling, Reheating, Applications, Types of jet engines, Construction and working; propulsive efficiency **[6 hrs]**

Unit V: Economics of Power Generation
Loads- terms and definitions, Load duration curves, Factors, Performance of power plants at variable load, Energy rate, Cost analysis. **[6 hrs]**

Unit VI: Solar Energy Conversion
Solar Thermal and Thermo-Photovoltaics, Photovoltaic Conversion; Flat Plate and Concentrating Collectors, Ultimate solar conversion efficiency, Thermal Energy Storage, Solar Ponds **[6 hrs]**

Text Books:

- T. D. Eastop and A. McConkey, “Applied Thermodynamics”, Addison Wesley Longman
- R. Yadav, “Steam & Gas Turbines & Power Plant Engineering”, Central Publishing House, Allahabad, 2004
- S. P. Sukhatme; Solar Energy: Principles of Thermal Collection and Storage; Tata McGraw-Hill Publishing Company Ltd

Reference Books:

- M. M. ElWakil, “Power Plant Technology”, McGraw Hill
- H. A. Sorensen, “Energy Conversion”

- A.W. Culp, “Energy Conversion”, McGraw hill
- P.K. Nag, “Power Plant Engineering”, Tata McGraw Hill, 2nd edition

(ME-) I C Engines

Teaching Scheme:
Lectures : 3hrs / week

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

Course Outcomes:

Student will be able to

1. Evaluate performance of an engine.
2. Demonstrate stages of combustion in SI and CI engine
3. Implement effectively the various methods studied towards control of vehicle pollution.
4. Analyze the emission performance of an engine.
5. Interpret various subsystems of an engine

Unit I: Basics of I C Engine
Introduction of I. C. Engines, Types of engine, working of engine, Nomenclature of engine, Otto cycle, Diesel cycle Fuel air cycles Characteristics of fuel - air mixtures Actual cycles, Properties of fuels and its importance, rating of fuels, alternate liquid and gaseous fuels **[6 Hrs]**

Unit II: Combustion in IC Engine
Combustion in S.I. Engine and C.I. Engines: Stages of combustion in S.I. Engine, Detonation and its Control. Stages of combustion in C.I. Engines, Delay period, Factors influencing delay period, Diesel knock, Control of diesel knock, types of combustion chamber. **[8 Hrs]**

Unit III: Elements of Fuel supply system and Ignition system in IC engine
Requirements of fuel supply system, components of modern carburettor, components and working of electronic fuel Injection system, types of diesel injection system, requirements of ignition system, battery ignition system, spark plugs, electronic ignition system **[5 Hrs]**

Unit IV: Sub Systems of IC engines
Supercharger, methods of supercharging, supercharging limits, Turbochargers, methods of turbocharging, effect of engine variables on engine friction, Lubrication principle, Introduction to engine cooling, types of cooling system, governing of IC engine, **[5 Hrs]**

Unit V: Testing and Performance
Engine Performance and parameters, basic measurements, determination of IP,BP, FP, IMEP, BMEP, various efficiencies, engine performance characteristics and variables affecting to it, energy balance, performance of CI and SI engine. **[8 Hrs]**

Unit VI: Emission and controls

Exhaust after treatment, catalytic converters, exhaust gas recirculation, emission control in engines, Sources of SI and CI engine emission and factors affecting to it, Euro and Bharat stage norms, Emission control methods in SI and CI engine, methods to control emission.

[6 Hrs]

Text Books:

- Ganesan. V, "Internal Combustion Engines", Tata McGraw Hill
- Mathur & Sharma, "A Course in Internal Combustion Engines", R. P. Dhanapat Rai Publications.

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

(ME) Machine Design- II Laboratory

Teaching Scheme:
Practical : 2hrs / week

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

Course Outcomes:

Students will be able to

1. Approach a design problem involving a complete mechanical system, successfully, taking decisions when there is not a unique answer.
2. Use software for analysis and design proficiently.
3. Develop industrial drawing with conventions.

Unit I: Design 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 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.

Unit II : Design Report

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.

The drawings of one project shall be completed using design and drafting software.

The ORAL shall be based on Term Work.

(ME) Energy Conversion Laboratory

Teaching Scheme:
Practical: 2hrs / week

Examination Scheme:
Term Work: 50 Marks
Oral: 50 marks

Course Outcomes:

Students will be able to:

1. Elucidate construction and operational principles of ideal gas and steam nozzle, steam turbine, steam condenser, cooling tower, gas turbine and jet engine
2. Apply basic laws of thermodynamics in analysis of thermal systems
3. Evaluate thermal performance of steam nozzles, steam turbine and steam condenser
4. Evaluate performance of boiler
5. Draw load duration curves for different customers
6. Determine the solar conversion efficiency

List of experiments
Set A
Any three experiments from the list
1. To prove that heat transfer is a path function
2. To determine dryness fraction of steam
3. To determine thermal efficiency of Otto cycle/Diesel cycle
4. To determine COP of vapour compression cycle

Set B
Any five experiments from the list
1. To measure the pressure/Velocity variation of an ideal gas in a convergent-divergent nozzle
2. To determine the mass flow rate, critical pressure and velocity of steam at the exit of nozzle
3. Trial on steam turbine to determine the efficiencies of turbine
4. Trial on a condenser to determine the condenser efficiency
5. To draw the load distribution curves for various consumers
6. To determine the conversion efficiency of solar cell/panel
7. Visit to a thermal/solar power plant

(ME) IC. Engines Laboratory

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term work: 50 marks
Oral: 50 Marks

Course Outcomes:

Student will able to

1. Exhibit his competency towards preventive maintenance of IC engines.
2. Evaluate basic performance parameters of I.C. Engine and implement the knowledge in industry.
3. Analyze exhaust emission on the basis of factors affecting them and report the remedies.
4. Contribute towards reduction in vehicle pollution.

List of experiments (Any Eight):

1. Determine calorific value of solid and liquid fuel using bomb Calorimeter
2. Perform a trial on single cylinder Diesel engine for variable load test and energy balance.
3. Perform a trial on single cylinder Petrol engine for variable speed test and energy balance.
4. Development of cylinder pressure and crank angle (p-theta) diagram and p-v diagram
5. Measurements of Exhaust Emissions of Petrol engine.
6. Measurements of Exhaust Emissions of Diesel engine.
7. Perform a trial on multi-cylinder SI engine for variable speed test and energy balance
8. Perform a trial on Multi-cylinder CI engine for variable load test
9. Visit to Automobile Industry (Compulsory).

Entrepreneurship Development

Teaching Scheme:
Lectures: 2hr/week

Examination Scheme :
T1 and T2 – 40 marks
Theory- 60 marks

Course Education Objectives (CEO)

1. To introduce and understand Entrepreneurship and its types
2. To understand how to evaluate risk in entrepreneurial ventures
3. To understand different type of finances available and financing methods
4. To understand marketing, digital marketing and their analytics
5. To understand detailed information about the principles, practices and tools involved in all aspects of the sales processes
6. To understand basics of operations management

7. To understand the nuances of Start-up
8. To understand how to use proven tools for transforming an idea into a product / service that creates value for others

Course Outcomes (CO)

1. Students would understand different types of Entrepreneurial ventures and would be able to discover, develop, and assess opportunities
2. Students would learn about opportunity and risk analysis
3. Students would understand the strategies for valuing your own company, and how venture capitalist and angel investors use valuations in negotiating milestones, influence and control
4. Students would understand to pick correct marketing mix and how to position the company in the market by using analytical tools
5. Students would learn how to sale themselves and the product/service and to handle objections
6. Students would get to know how organizations operates and their process matrices
7. Students will learn how start new ventures
8. Students will learn how to write winning business plans

Unit I: Market Research

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 **(2 hrs)**

Unit II: Types of Companies and Organizations

Company/ Organization Types, Legal Aspects, Taxation, Government Liaison, Building the Team, Mergers and Acquisitions **(1 hr)**

Unit III: Business Finance

Shares and Stakes, Valuation, Finance Creation (Investors / Financers), Revenue Plans and Projections, Financial Ratios, Business Lifecycle, Break Even **(2 hrs)**

Unit IV: Marketing

Marketing Basics, Marketing Strategy and Brand Positioning, Plans and Execution Techniques, Marketing Analytics, Online Marketing **(2 hrs)**

Unit V: Sales

Understanding Sales, Pitching Techniques, Sales strategies, Inside Sales v/s Outside Sales, RFP **(2 hrs)**

Unit VI: Operations Management

Operational Basics, Process Analysis, Productivity, Quality **(1 hr)**

Unit VII: Start-ups

Start-up Basics, Terms, Start-up Financing, Start-up Incubation, Start-up Incubation, Getting Listed **(2 hrs)**

Text Books:

- The Startup Playbook: Secrets of the Fastest-Growing Startups From Their Founding Entrepreneurs by David Kidder
- Creativity, Inc.: Overcoming the Unseen Forces That Stand in the Way of True Inspiration by Ed Catmull
- True North by Bill George and Peter Sims
- Bhargava, S. (2003). Transformational leadership: Value based management for Indian Organizations (Ed.). New Delhi: Response-Sage.
- Cardullo, M. W. P. E. (1999). Technological entrepreneurism: Enterprise formation, financing, and growyh. England: Research Studies press Ltd.
- Hisrich, R. D. & Peters, M. P. (2001). Entrepreneurship: Starting, developing, and managing a new enterprise (5th Ed.). New York: McGraw-Hill.

References:

- Kanungo, R. N. (1998). Entrepreneurship and innovation: Models for development (Ed., Vol.2). New Delhi: Sage.
- McClelland, D. C. (1961). Achieving society. Princeton
- Van Nostrand. Verma, J. C., & Singh, G. (2002). Small business and industry: A handbook 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
- I M Pandey, Financial Management, Vikas Publishing, 9th Edn, 2004

- Aswath Damodaran, Corporate Finance-Theory and Practice , John Wiley & Sons, 1997
- I.M. Pandey & Ramesh Bhat, "Cases in Financial Management", Tata McGraw-Hill, New Delhi.
- Horowitch (ED), Technology in the modern Corporation: A Strategic perspective, Pergamon Press, 1986.
- M. Dodgson (ED), Technology and the firm: Strategies, management 7 Public Policy, Longman, Harlow, 1989.

Minor course

Elements of Machine Design

Teaching Scheme:	**Examination Scheme :**
Lectures: 3hrs/week	T1 and T2 – 40 marks Theory- 60 marks

Course Outcomes:

Student will be able to

1. Students will be able to evaluate the different types of stresses induced in a component due to different types of static loading conditions.
2. Students will be able to analyze the stress and strain on mechanical components;
3. Demonstrate knowledge on basic machine elements used in machine design

Unit I : Fundamental aspect of design:

The meaning of design, Engineering design, Phases of design, design considerations, stress and strain consideration, factor of safety, standardization , preferred series, material selection – weighted point method. **[6 hrs]**

Unit II : Design against static load:

Commonly used engineering materials and their important mechanical properties – Cast Iron, Mild Steel, Stress-strain relationship, stresses due to bending and torsional load, design of cotter/knuckle, eccentric loading and theories of failure**.** **[7 hrs]**

Unit III: Introduction to Design of mechanical components:

Design of bolted and threaded joints, welded joints **[7 hrs]**

Unit IV: Introduction to Design of mechanical components

Design of shafts, keys and coupling and springs **[7 hrs]**

Unit V: Introduction to Fluctuating loads

Stress concentration, fatigue failure, endurance limit, notch sensitivity, Goodman & Soderberg diagram **[4 hrs]**

Unit VI: Design of gears: Terminology, Types, Force analysis, Gear tooth failures **[4 hrs]**

Text Books:

- Shigley J.E. and Mischke C.R. – "Mechanical Engineering Design" McGraw Hill Publ. Co. Ltd.
- Bhandari V.B. – "Design of Machine Elements" – Tata McGraw Hill Publ. Co. 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.

Honour Course (Thermal Stream)

Computational Fluid Dynamics

Teaching Scheme:
Practical:3hrs/week

Examination Scheme :
T1 and T2 – 40 marks
Theory- 60 marks

Course Outcomes:

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

1. Understand the governing equations
2. Create a grid for simple problems
3. Apply the boundary conditions
4. Write simple algorithms

Syllabus Contents:

Introduction to CFD: Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.

Governing Equations: Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy.

Finite Volume Method: Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach

Geometry Modeling and Grid Generation: Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance

Methodology of CFDHT: Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation

Solution of N-S Equations for Incompressible Flows: Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid System and Non-Staggered Grid System of N-S Equations for Incompressible Flows

References:

- Computational Fluid Dynamics, The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series.
- Numerical Methods in Fluid Flow & Heat Transfer by Dr. Suhas Patankar.
- An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W.Malalasekera, Printice Hall
- Computational Methods for Fluid Dynamics by Ferziger and Peric, Springer Publication.
- An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow, Wiley Publication.
- Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, Narosa Publication.

Honour Course (Design Stream)

Finite Element-Boundary Element Methods

Teaching Scheme:
Practical:3hrs/week

Examination Scheme :
T1 and T2 – 40 marks
Theory- 60 marks

Course Outcomes:

At the end of the course:

For one and two dimensional, linear, static and dynamic problems in Structural Mechanics and Heat Transfer, the student will be able to demonstrate the learning outcomes as mentioned below:

1. The student will be able to classify a given problem on the basis of its dimensionality as 1-D, 2-D, or 3-D, time-dependence as Static or Dynamic, Linear or Non-linear.
2. The 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 potential.
3. While demonstrating the process mentioned in 2 above, he will be able to identify the primary and secondary variables of the problem and choose correct nodal degrees of freedom and develop suitable shape functions for an element, implement Gauss-Legendre scheme of numerical integration to evaluate integrals at element level, and assemble the element level equations to get the system level matrix equations. He will also be able to substitute the essential boundary conditions correctly and obtain the solution to system level matrix equations to get the values of the field variable at the global nodes.
4. The student will be able to state three sources of errors in implementing FEM and suggest remedies to minimize the same for a given problem, viz. Modeling errors, Approximation errors, and numerical errors.
5. The student will be able to obtain consistent and lumped mass matrices for axial vibration of bars and transverse vibration of beams and obtain fundamental frequency of natural vibration using the methods mentioned in the curricula.
6. The students will be able use MATLAB for implementation of FEM to obtain elongations at nodes of a bar subjected to traction and concentrated loads and prescribed boundary conditions
7. The students will be able to use commercial software like ANSYS or ABAQUS for implementation of FEM to obtain stress concentration due to a small hole in a rectangular plate subjected to traction on edges and concentrated loads at points on the edges and prescribed boundary conditions

The student will be able to apply principles of boundary element method to solve field problems

Syllabus Contents:

Unit 1

Introduction, steps in finite element method, discretisation, types of elements used, Shape functions

Unit 2

Linear Elements, Local and Global coordinates, Nodal degrees of freedom, Finite element formulation - variational, weighted residual and virtual work methods

Unit 3

Field problems, conduction heat transfer, electromagnetic and electrostatic fields, Quasi harmonic equation, Axisymmetric field problems, computer implementation,

Unit 4

Higher order elements, isoparametric version, Serendipity elements – Derivation of shape functions, h and p methods of improvements of accuracy, Criteria of making a choice between them , error analysis

Unit 5

Application to non-linear problems, solution to Nervier Strokes equations, phase change, radiation, temperature dependant materials, stress analysis in simple cases, axisymmetric solids, stress concentration factors,

Unit 6

Boundary element approach, numerical implementation, analyzing time domain, boundary element formulation, discretisation and matrix formulation, adaptive mesh refinement.

References:

- Cook R.D. “Concepts and applications of finite element analysis” Wiley, New York, 1981.
- 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.
- Chandrupatla and Belegundu “Introduction to finite elements in Engineering”, Prentice Hall of India Pvt. Ltd. New Delhi, 2001.
- O. P. Gupta, “Finite and boundary element methods in Engineering”, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2000.