RAMAIAH
Institute of Technology

CURRICULUM

Academic year 2022 – 2023

MECHANICAL ENGINEERING

V & VI SEMESTER B.E.

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
Bangalore – 560054.

About the Institute

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 17 UG programs and 15 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **'A^{+}' grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. The institute is also been conferred autonomous status for Ph.D program since 2021. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 65% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility for all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology, Centre for Antennas and Radio Frequency systems (CARFS), Center for Cyber Physical Systems, Schneider Centre of Excellence & Centre for Bio and Energy Materials Innovation. **M S Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 107 & world ranking 600 for the year 2022.**

The Entrepreneurship Development Cell (EDC) and Section 8 company "Ramaiah Evolute" have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology is recognized by Atal Ranking of Institutions on Innovation Achievements (ARIIA), MoE, Govt. of India.** MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. MSRIT is a member of DELNET, CMTI and VTU E-Library Consortium. MSRIT has a modern auditorium and several hi-tech conference halls with video conferencing facilities. The institute has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

As per the National Institutional Ranking Framework (NIRF), MoE, Government of India, M S Ramaiah Institute of Technology has achieved 67th rank among 1249 top Engineering Institutions & 17th Rank for School of Architecture in India for the year 2022 and is 1st amongst the Engineering Colleges affiliated to VTU, Karnataka.

About the Department

The Department of Mechanical Engineering started in the year 1962 with an intake of 40 students. The department has grown strong over the last 60 years and today has an intake of 120 students and 39 teaching staff. All the faculty members are well qualified and possess post graduate degree with 27 doctorates. The department offers four-year degree course and also offers two Master's Degree in Manufacturing Science & Engineering and Computer Integrated Manufacturing, with an intake of 18 each. The Department also offers research program which includes MSc Engineering by research and PhD degree from Visvesvaraya Technological University and at present 15 researchers are pursuing PhD. The department received software grants from Autodesk a leading Computer Aided Design multinational company and has been using them in the curriculum. The faculty members have taken up number of research projects funded by external agencies like DRDO, DST, AICTE and Visvesvaraya Technological University and received funding to the tune of 1 Crore. In view of the golden jubilee celebrations, the department has conducted a national level project exhibition and an International Conference on "Challenges and Opportunities in Mechanical Engineering, Industrial Engineering and Management Studies" – ICCOMIM. Faculty members from the department have published books on different domains of Mechanical Engineering and are recommended by Visvesvaraya Technological University Board of Studies as reference text books.

The students from the department participate both at the national and international competition throughout the year, in the year 2013 – AeRobusta – 4-member student team from the department participated in SAE Aero Design competition and stood 18th position out of 64 teams from all over the world. The team AeRobusta stood FIRST AMONG THE ASIAN COUNTRIES.

Another team from the department also participated in the "Unmanned Air Vehicle System "conducted by U.S. Navy at Maryland, USA. The team secured 5th Place in the technical session out of 36 participating teams from all over the world.

A team of two students also participated in the CAD Design Competition conducted by Autodesk, a CAD multinational company, in association with IIT Madras and secured FIRST PLACE among the teams from all over India with a cash prize of Rs1,20,000 and also received a free Trip to Autodesk University, held at Las Vegas, USA.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

MISSION OF THE INSTITUTE

MSRIT shall meet the global socio-economic needs through

- Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
- Establishing research clusters in emerging areas in collaboration with globally reputed organizations
- Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at M S Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stake holders concerned

VISION OF THE DEPARTMENT

To be a centre of International repute in Mechanical Engineering and to create qualified human resources needed to meet the demanding challenges in different areas and emerging fields of Mechanical Engineering and allied sciences.

MISSION OF THE DEPARTMENT

To impart quality technical education to meet the growing needs of the profession through conducive and creative learning environment, to produce qualified and skilled human resources, create R&D environment, to be a centre of excellence and to offer post graduate programs in the emerging fields of Mechanical Engineering.

Program Educational Objectives (PEOs)

To produce engineers with sound basic theoretical knowledge along with required practical skills in various specialized fields of Mechanical Engineering.

To inculcate team work capabilities and communication skills among students through co-curricular activities.

To motivate students for higher studies in specialized areas of Mechanical Engineering and explore possible profession in R & D, academic and self-employment opportunities.

To bring in awareness on environmental issues and commitments towards Professional ethics, social responsibilities and need for lifelong learning

PROGRAM OUTCOMES (POs):

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSOs of the program offered

Mechanical Engineering Graduates will be able to:

PSO1: Ability to apply their knowledge in engineering mechanics, materials science, design, thermal engineering, production, management, CAD/CAM, robotics - on an applied basis.

PSO2: Ability to apply the learned principles to the analysis, design, development and implementation to advanced mechanical systems and processes, be prepared to work professionally in Mechanical Engineering domain.

Breakup of Credits for BE Degree Curriculum. (I to VIII Semester)

BATCH 2020-2024

Sem	HSS	BS	ES	PCC	Professional Electives PC-E	Open Elective OE	Project / Seminar/ Internship PW/IN	Total Credits
I	04	17	21		-	-	-	**42**
II					-	-	-	
III	-	04	-	21	-	-	-	**25**
IV	-	04	-	21	-	-	-	**25**
V	03	-	-	15	03	03	-	**24**
VI	-	-	-	11	06	03	04	**24**
VII	03	-	-	10	06	-	01	**20**
VIII	-	-	-	-	-	-	15	**15**
Total	**10**	**25**	**21**	**78**	**15**	**06**	**20**	**175**

SCHEME OF TEACHING FOR THE ACADEMIC YEAR 2022-2023

V SEMESTER B.E

MECHANICAL ENGINEERING

Sl.No	Course Code	Course Name	Category	Credits			
				L	T	P	Total
1	ME51	Design of Machine Elements - I	PCC	3	1	0	4
2	ME52	Dynamics of Machinery		4	0	0	4
3	ME53	Turbo Machinery		3	1	0	4
4	ME54	Intellectual Property Rights	HSS	3	0	0	3
5	MEE55X	Professional Elective-1	PC-E	3	0	0	3
6	MEOE0X	Open Elective - 1	OE-1	3	0	0	3
7	MEL56	Turbo machinery Laboratory		0	0	1	1
8	MEL57	Mechanical Measurements & Metrology Laboratory		0	0	1	1
9	MEL58	Manufacturing Process-II Laboratory		0	0	1	1
Total				**19**	**2**	**3**	**24**

L-Lecture T-Tutorial P- Practical's

LIST OF COURSES OFFERED UNDER PROFESSIONAL ELECTIVE-1

CREDITS: 3:0:0

Sl. No.	Subject Code	Subject
1	MEE551	Robotics
2	MEE552	Hydraulics & Pneumatics
3	MEE553	Composite Materials
4	MEE554	Additive Manufacturing
5	MEE555	Electric Vehicle Technology
6	MEE556	Solar Energy
7	MEE557	Industrial Design and Ergonomics
8	MEE558	Theory of Elasticity

DESIGN OF MACHINE ELEMENTS –I

Course Code: ME51 **Course Credits: 3:1:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr. GIRISH V KULKARNI

Course Learning Objectives

1. Application of design consideration, codes, standards and state of stress and strain at a point.
2. To determine the effect of static, impact, fatigue loads and also stress concentration effects.
3. Understanding the procedure of design of machine elements such as shafts, keys, couplings, cotter joints, knuckle joints.
4. Selection and design of riveted and welded joints.
5. Design of threaded fasteners and power screws.

UNIT I

Introduction: Design considerations: codes and standards, Stress analysis, Definitions: Normal, shear, biaxial and tri axial stresses, Stress tensor. Plain stress and Plain strain. Equilibrium equation. Static Strength, Static loads and Factor of safety. Impact loads, Impact stresses due to axial and bending.

Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory Shear strain energy theory, Total strain energy theory.; Failure of brittle materials, Failure of ductile materials.

UNIT II

Stress concentration: Determination of Stress concentration factor for axial, bending, torsion and combined loading.
Design for Fatigue Load: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Endurance limit modifying factors: size effect, surface effect, Stress concentration effects; Fluctuating stresses, Goodman and Soderberg relationship; stresses due to combined loading,

UNIT III

Shafts, Keys and Couplings: ASME & BIS codes for design of transmission shafting, shafts under fluctuating loads and combined loads. Keys: Types of keys, Design of keys and design of splines. Couplings, Rigid and flexible couplings, Flange coupling, Bush and Pin type coupling.
Cotter and Knuckle joints: Design of Cotter and Knuckle joints.

UNIT IV

Riveted Joints – Types, rivet materials, failures of riveted joints, Joint Efficiency, Boiler Joints, Tank and Structural Joints, Riveted Brackets.
Welded Joints: Types, Strength of butt and fillet welds, eccentrically loaded welded joints.

UNIT V

Threaded Fasteners: Stresses in threaded fasteners, Effect of initial tension. Design threaded fasteners under static, dynamic and impact loads, Design of eccentrically loaded bolted joints.
Power Screws: Mechanics of power screw, Stresses in power screws, efficiency and self-locking, Design of Power Screw.

DESIGN DATA HAND BOOKS:

1. Design Data Hand Book – K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
2. Design Data Hand Book by K. Mahadevan and Balaveera Reddy, CBS Publication

TEXT BOOKS:

1. Mechanical Engineering Design: Joseph E Shigley and Charles R. Mischke McGraw Hill International edition, 6th Edition 2003.
2. Design of Machine Elements: V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

REFERENCE BOOKS:

1. Machine Design: Robert L. Norton, Pearson Education Asia, 2001.
2. Design of Machine Elements: M.F.Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram and C.V. Venkatesh, Pearson Education, 2006.
3. Machine Design: Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. Fundamentals of Machine Component Design: Robert C. Juvinall and Kurt M Marshek, Wiley India Pvt. Ltd., New Delhi, 3rd Edition, 2007.

Course Outcomes (COs):

1. Apply concepts of static, impact and fatigue loads in the design of machine components [PO1,PO2,PO3,PO4,PO12,PSO1,PSO2]
2. Relate the fundamentals of theories of failure and stress concentration effect in the design of machine element. [PO1,PO2,PO3,PO4,PO12,PSO1,PSO2]
3. Identify and apply fundamental concepts of machine design. [PO1,PO2,PO3,PO4, PO12,PSO1,PSO2]
4. Demonstrate the ability to analyze the problems of practical interest. [PO1,PO2, PO3,PO4,PO12,PSO1,PSO2]
5. Develop competence to design of machine elements such as shafts, keys and couplings etc. [PO1,PO2,PO3,PO4,PO12,PSO1,PSO2]

DYNAMICS OF MACHINERY

Course Code: ME52 **Course Credits : 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Mr. DEEPAK S

Course Learning Objective

1. To understand and analyze the static forces on mechanisms.
2. To evaluate inertia forces and to analyze Flywheels.
3. To Analyze Belt drives, Concept of friction and Balancing of rotating masses.
4. To apply the knowledge in designing governors and reciprocating masses.
5. To analyze the gyroscope and Design of cams.

UNIT I

Static Force Analysis: Static force analysis: Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism (without friction).

UNIT II

Dynamic Force Analysis: D'Alembert's principle, Inertia force, inertia torque, Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems, Turning moment diagrams Fluctuation of Energy. Determination of size of flywheels.

UNIT III

Friction and Belt Drives: Belt drives: V-belt drives, ratio of belt tensions, centrifugal tension, and power transmitted.

Balancing of Rotating Masses: Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

UNIT IV

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & Secondary forces), V-type engine; Radial engine – Direct and reverse crank method.
Governors: Types of governors; force analysis of Portor and Hartnell governors. Controlling force, stability, sensitiveness, Isochronism, effort and power.

UNIT V

Gyroscope: Vectorial representation of angular motion, basic definitions, Gyroscopic couple. Effect of gyroscopic couple on a plane disc, a boat, an aeroplane, a naval ship, stability of two wheelers and four wheelers.

Analysis of CAMS: Analytical methods for Tangent cam with roller follower and Circular arc cam operating flat faced followers, Undercutting in Cams.

TEXT BOOKS:

1. Theory of Machines: Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2006.
2. Theory of Machines: Sadhu Singh, Pearson Education, 2nd edition, 2007.

REFERENCE BOOKS:

1. Theory of Machines by Thomas Bevan, CBS Publication 1984.
2. Design of Machinery by Robert L. Norton, McGraw Hill, 2001.
3. Mechanisms and Dynamics of Machinery by J. Srinivas, Scitech Publications, Chennai, 2002.

Course Outcomes (COs):

1. Demonstrate the knowledge of static force analysis of mechanisms.
2. Develop ability to evaluate the effect of inertial forces in different mechanisms and analyze flywheels
3. Analyze belt drives, friction and balancing of rotating masses
4. Apply and design governors and reciprocating masses
5. Analyze Gyroscopic effect and design Cams

TURBO MACHINERY

Course Code: ME53 **Course Credits: 3:1:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr. NIRANJAN MURTHY

Course Learning Objectives

1. The purpose of the course is to introduce the means by which the energy transfer is achieved in the main types of turbomachines.
2. To provide knowledge about general analysis of radial flow and axial flow turbomachines.
3. The course aims at introducing preliminary design fundamentals of turbomachines including hydraulic turbines, steam turbines.
4. To provide knowledge of design of centrifugal pumps and stage efficiency, reheat factor and preheat factors in turbines and pumps.
5. To provide knowledge about the working and design of centrifugal and axial compressors.

UNIT I

Introduction: Definition of a Turbomachine; parts of a Turbomachine; Comparison with positive displacement machine; Classification; Dimensionless parameters and their physical significance; Effect of Reynolds number; Specific speed; Illustrative examples on dimensional analysis and model studies.

Energy Transfer in Turbo Machine: Euler Turbine equation; Alternate form of Euler turbine equation – components of energy transfer; Degree of reaction.

UNIT II

General Analysis of Turbines Utilization factor, Vane efficiency, Relation between utilization factor and degree of reaction, condition for maximum utilization factor – optimum blade speed ratio for different types of turbines.

General analysis of centrifugal pumps and compressors – General analysis of axial flow compressors and pumps – general expression for degree of reaction, velocity triangles for different values of degree of reaction. Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance; Theoretical head – capacity relationship.

UNIT III

Hydraulic Turbines: Classification; Pelton Turbine-velocity triangles, Design parameters, turbine efficiency, volumetric efficiency. Francis turbine – velocity triangles, runner shapes for different blade speeds, Design of Francis turbine, Functions of a Draft tube, types of draft tubes, Kaplan and Propeller turbines – Velocity triangles and design parameters. Characteristic curves for hydraulic turbines.

UNIT IV

Steam Turbines: Introduction to steam nozzles and optimum pressure ratio. Impulse Staging and need for compounding, Velocity and pressure compounding, velocity triangle, condition for maximum utilization factor for multistage turbine with equiangular blades, Effects of Blade and Nozzle losses, Reaction staging.

Centrifugal Pumps: Definition of terms used in the design of centrifugal pumps like manometric head, suction head, delivery head, manometric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency, multistage centrifugal pumps design procedure.

UNIT V

Centrifugal Compressors and Axial Flow Compressors: Centrifugal compressors, Main parts and principle of operation, power input factor, pre whirl vanes, surging and choking phenomenon.

Axial Flow Compressors: Construction and working principle, velocity triangle, flow coefficient, pressure coefficient, work done factor, degree of reaction.

Thermodynamics of Fluid Flow and Thermodynamic Analysis of Compression and Expansion Processes: Compression and expansion process – overall isentropic efficiency, Stage efficiency, Comparison and relation between overall efficiency and stage efficiency, Polytrophic efficiency, Preheat factor, Reheat factor

TEXT BOOKS:

1. An Introduction to energy conversion, Volume III – Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers (P) Ltd.
2. A Treatise on Turbo Machines, G. Gopalakrishnan, & D. Prithviraj, Scitech Publications (India) Pvt. Limited 2nd edition 2002.
3. Turbomachines By Dr. Niranjan Murthy and Dr. R.K.Hegde, Sapna Publications Bangalore, 2013

REFERENCE BOOKS:

1. "Principles of Turbo Machinery", D.G.Shepherd, The Macmillan Company (1964)
2. "Gas Turbine Theory", H.Cohen, GFC Rogers, & HIH Saravanamuttoo, Thomson Press (India) Ltd., 4th Edition (1998)
3. Fundamentals of Turbomachinery: William W Perg John Wiley & Sons, Inc. (2008.)
4. "Turbines, Compressors & Fans", S. M. Yahya, Tata-McGraw Hill Co., 2nd Edition (2002).

Course Outcomes (COs):

1. Apply the Concepts of energy transfer processes in Turbo Machines. [PO1,PO2, PO3,PO4, PSO1 & PSO2]
2. Analyze energy transfer through graphical and analytical methods in turbo machines. .[PO1,PO2,PO3,PO4,PSO1 & PSO2]
3. Analyze the performance characteristics in hydraulic turbines. [PO1,PO2,PO3,PO4, PSO1 & PSO2]
4. Evaluate the performance of steam turbines and centrifugal pumps. .[PO1,PO2,PO3,PO4, PSO1 & PSO2]
5. Analyze thermodynamics of compressible flow and working of various compressors. [PO1,PO2,PO3,PO4,PSO1 & PSO2]

INTELLECTUAL PROPERTY RIGHTS

Course Code: ME54 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. K R PHANEESH

Course Learning Objectives:

1. To introduce to the student the fundamentals of intellectual property rights and the various IPR's as accorded in India.
2. To introduce and delve into the details of laws and acts of different IPR's.
3. To understand the different kinds of IPR's and their importance in the practical world.
4. To get a basic idea of what IPR's are and its implementation in day to day life.
5. To learn the fundamentals of Research Methodology helpful in future R & D activities

UNIT I

Introduction to Intellectual property rights: Nature of Intellectual property, Commercial exploitation, Enforcement of rights and remedies against infringement, Intellectual property and economic development, International character of intellectual property rights.
Patents: Introduction to Patents, definition, object and value of patent system, International character of patents, advantages of patents to inventor, validity of patent not guaranteed, patentable invention, Inventions not patentable and patents- a source of technological information.

UNIT II

Procedure to obtain a patent, Term of Patent, Patent of Addition, Specification types – Provisional specification and complete specification, Grounds of Opposition to Patent.
Register of patents and patent office, Powers of the Controller and Central government, Rights and Obligations of a Patentee, Nature of patent rights, Limitations of patentee rights and obligations of patentee, Transfer of patent rights.

UNIT III

Industrial Designs: Introduction, appeal to the eye, Novelty and originality, publication, Designs prohibited from Registration, registration of design, rights conferred by registration

Trade Marks: Definition, Function of trademark, Evolution, Object of Trademark Law, Attributes of a good trademark, Protection to trademarks, Licensing of trademarks.

UNIT IV

Copyright: Introduction, object of copyrights, copyright and technology, International conventions, copyright and GATT, Nature of copyright, subject matter of copyrights like literary works, dramatic works, musical works, artistic works, cinematography and sound recording.

Geographical Indications: Introduction, need for GI's, Protection of GI's, well known GI's of India, Guidelines for application of GI's, Examples, Advantages and limitations of GI's.

UNIT V

Research Methodology: Introduction, Meaning, Objectives, Motivation, Types, Research Approaches, Significance, Methods vs. Methodology.
Research Process, Criteria of good research, problems encountered by researchers in India. Role of Computers and Internet in Research

TEXT BOOKS:

1. Intellectual Property Law by P Narayan, IIIrd edition, Eastern Law House, New Delhi, 2007 edition.
2. Basic Principles and acquisition of Intellectual Property Rights, Dr. T Ramakrishna, CIPRA, NLSU-2005.
3. Intellectual Property Law by P Narayan, III edition, Eastern Law House, New Delhi, 1st edition. 2007

REFERENCE BOOKS:

1. Intellectual Property Law Handbook. Dr.B.L. Wadehhra, Universal Law Publishing Co. Ltd., 2002.
2. Intellectual Property by W R Cornish, Sweet and Maxwell.
3. Research Methodology – Methods & Techniques, by Kothari C. R, Wishwa Prakashan, A Division of New Age International Pvt. Ltd.

Course Outcomes (COs):

Students will be able to:

1. Describe the Fundamentals of intellectual property Rights as seen legally in India [PO6,PO8 & PO12]
2. Understand the philosophical basis of intellectual property law [PO6,PO8 & PO12]
3. Distinguish between the different kinds of intellectual property rights [PO6,PO8 & PO12]
4. Identify and implementing the different concepts of IPR in day to day life [PO6,PO8,PO11,PO12,PSO1 & PSO2]
5. Summarize the fundamentals of Research Methodology useful in R&D activities [PO6,PO8,PO11,PO12,PSO1 & PSO2]

ROBOTICS

Course Code: MEE551 **Course Credits : 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. SUNITH BABU L

Course Learning Objectives

1. Define Robot, Robotics and Various Components of Robots.
2. Understand the various Drives and Control Systems for developing an Ideal Actuation System.
3. Apply the Robot Programming Methods & Algorithms.
4. Evaluate the concepts of Mobility and Visual Planning.
5. Design and develop robotic system using various configurations for different industrial applications.

This course provides an overview of the various functional components of Robots and the application of Robotics. The topics include anatomy, configurations, sensors, actuators, visual planning and mobile robotics. A wide scope is given to the Applications of Robots where in students understand as to how Robotics can be applied in areas pertaining to industrial and non-industrial applications.

UNIT I

Introduction

Introduction Definition of Robotics, History of Robot, Robot Components, Degree of Freedom, Robot Characteristics, Workspace, Criteria for Defining a Robot; Robot System Integration. Classification of Robots based on Configuration – Construction & Working of Cartesian, Cylindrical, Polar, Jointed-Arm Configuration & SCARA, **Robot Manipulator Configuration**; Types of End-Effectors – Features of Mechanical End-Effectors, Grippers & End-of-Arm Tools

UNIT II

Sensors

Definition of Sensors; Comparison of Human and Robot Sensing; Types of Robot Sensors – Description and Examples of Preprioceptive, Exteroceptive & Environmental Sensors; Classification of Sensors – Attributes & Examples of Analog & Digital Sensors, Active & Passive Sensors;

Robot Sensors – Working & Attributes of Color & Light Sensor, Ultrasonic & Infrared Sensor, Camera & Image Sensor; Compass Sensor; Force & Tactile Sensor

UNIT III

Actuators & Programming

Actuators & Programming Definition of Actuators; General Features of Hydraulic, Pneumatic & Electric Actuators; Criteria for Selection of Actuators for Pick & Place Robots, Welding Robots, Spray Painting Robots Programming of Robots; Types of Programming – Offline Programming, Online programming – Manual and Lead through, **Fanuc Teach Pendant and concepts**; Algorithms & Flow Charts for developing programs for Pick & Place Robots

UNIT IV

Mobility & Visual Planning

Definition of Mobility & Locomotion; Legged Mobile Robot – Leg Configuration & Stability; Wheeled Mobile Robots – Wheel Configuration & Stability; Description of Robot Maneuverability

Definition & Explanation of Robot's Environment; Deterministic & Non-Deterministic Environments; Terrain Challenges; Algorithms & Flow Charts for Obstacle Avoidance; Mapping the Environment; Creating a Floor Plan; Subroutines

UNIT V

Robot Applications

List of Industrial and Non-Industrial Applications of Robots; Various features of Robots used in Space Applications – Russian & American Moon Rovers & Martian Rovers

Limitations of Robots – Difficulties in Implementing Robots for Military Combat Operations; Industrial Tasks beyond the Capability of Robotic Automation & Difficulties in Implementing Robots for Domestic Tasks

TEXT BOOKS:

1. Robotics for Engineers by Yoram Koren, Mc Graw-Hill
2. Industrial Robotics - Mikell P Groover, Mitchell Weiss, Roger N Nagel and Nicholas G Odrey

REFERENCE BOOKS:

1. Robot Technology by Philippe Coffet (Vol. 1 to Vol. 7)
2. Walking Machines, An introduction to legged Robots by D J Todd
3. Fundamentals of Robot Technology by D J Todd
4. Introduction to Autonomous by Roland Siegwart, Illah R Nourbakhsh, MIT Press, 2004
5. Robot Programming by Cameron Hughes, Tracey Hughes – Pearson Publication, 2015
6. Mars Rover Curiosity by Rob Manning, William L Simon

Course Outcomes (COs):

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

1. **Acquaint** with the basic Configurations, Actuators and Sensors used in Robotic systems. [PO1,PO7,PO12,PSO1 & PSO2]
2. **Elucidate** the Different Drives and Control Techniques. [PO1,PO7,PO12,PSO1 & PSO2]
3. **Build** customized Robot Programming Sequence for Industrial Applications. [PO1,PO5,PO7,PO12,PSO1 & PSO2]
4. **Analyze** the Robot Mobility and Visual Planning Scenarios. [PO1,PO2,PO3,PO5, PO7,PO12,PSO1 & PSO2]
5. **Evaluate** & Implement appropriate Robotics Solutions for Industrial and Domestic Applications. [PO1,PO2,PO3,PO7,PO8,PO11,PO12,PSO1 & PSO2]

HYDRAULICS AND PNEUMATICS

Course Code: MEE552 **Course Credits : 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. MOHANDAS K N

Course Learning Objectives:

1. To provide a sound understanding of the working of hydraulic and pneumatic systems.
2. To provide knowledge about controlling components of hydraulic and pneumatic systems.
3. To provide knowledge of design of hydraulic and pneumatic systems for various applications.
4. To provide an understanding of choice, preparation and distribution of compressed air.
5. To introduce the concept of pressure and time dependent controls.

UNIT I

Introduction to Hydraulic Power: Pascal's law and problems on Pascal's Law, continuity Equations, introduction to conversion of units, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps.
Hydraulic Actuators: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder Loading

UNIT II

Hydraulic Motors: Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.
Control Components in Hydraulic Systems: Directional Control Valves – Symbolic Representation, Constructional features, pressure control valves – direct and pilot operated types, Flow control valves.

UNIT III

Hydraulic Circuit Design and Analysis: Control of single and double – acting Hydraulic Cylinder, regenerative circuit, pump unloading circuit, Counter Balance Valve application, Hydraulic cylinder sequencing circuits. Cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, Accumulators.

UNIT IV

Introduction to Pneumatic Control: Choice of working medium, characteristics of compressed air. Structure of Pneumatic control system. Compressed air: Production of compressed air –compressors, preparation of compressed air- Driers, Filters, Regulators, Lubricators, Distribution of compressed air.
Pneumatic Actuators: Linear cylinders – Types, conventional type of cylinder working, end Position cushioning, seals, mounting arrangements applications.

UNIT V

Directional Control Valves: Symbolic representation as per ISO 1219 and ISO 5599. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, Basic pneumatic valves, Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling, use of quick exhaust valve. Pressure dependent controls types. Time dependent controls.

Maintenance of Hydraulic Systems: Hydraulic oils; Desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting.

TEXT BOOKS:

1. **Fluid Power with applications,** Anthony Esposito, Fifth edition Pearson education, Inc. 2017.
2. **Pneumatics and Hydraulics,** Andrew Parr. Jaico Publishing Co. 2017.

REFERENCE BOOKS:

1. **Oil Hydraulic Systems - Principles and Maintenance,** S.R. Majumdar, Tata Mc Graw Hill Publishing company Ltd. 2001.
2. **Pneumatic Systems,** S.R. Majumdar, Tata Mc Graw Hill publishing Co., 1995.
3. **Industrial Hydraulics,** Pippenger, Hicks, McGraw Hill, New York, 2009

Course Outcomes (COs):

Students will be able to:

1. Demonstrate the working of hydraulic and pneumatic systems. [PO1,PO2,PO12,PSO2 &PSO2]
2. Identify the controlling components of hydraulic and pneumatic systems. [PO1,PO2, PO3,PO5,PO12,PSO2 &PSO2]
3. Design the hydraulic and pneumatic systems for various applications. [PO1,PO2,PO3, PO5,PO12,PSO2 &PSO2]
4. Examine the choice, preparation and distribution of compressed air. [PO1,PO2,PO3, PO12,PSO2 &PSO2]
5. Predict the use of pressure and time dependent controls. [PO1,PO2,PO3,PO5,PO12, PSO2 &PSO2]

COMPOSITE MATERIALS

Course Code: MEE553 **Course Credits : 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. K R V SUBRAMANIAN

Course Learning Objectives:

1. To study the basic concept of the composites and classification of composites.
2. To study of the different processing/ fabrication techniques of composite materials.
3. To study of the response of the material on the basis of individual phases present in the system.
4. To study the macro mechanics of the material based on phases present in the system
5. To Study of different types of hybrid composites, the applications of composite materials in various fields of engineering.

UNIT I

Introduction: Introduction to Composite Materials: Fundamentals of composites – need for composites, Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites and particulate composites. Advantages, Disadvantages of Composite materials.

UNIT II

Processing of Composites: Commonly used Matrices, Basic Requirements in Selection of constituents, Spray processes - Osprey Process, Pultrusion, Filament winding, Hand lay-up techniques, vacuum Bag moulding, Pulforming, Thermoforming, Compression Moulding – Injection Moulding – Resin Transfer Moulding.

UNIT III

Micro Mechanical Analysis of a Lamina: Introduction, Volume and Mass Fractions, Density, and Void Content, Numerical problems, Assumption and limitations of micromechanical analysis, Mechanical properties, Transverse stresses, Hygeral and thermal stresses.

UNIT IV

Macro Mechanics of a Lamina: Introduction, Hooke's law for different types of materials, Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Micromechanical Analysis of Laminates- laminate codes, Classical lamination theory, and stress and strain in laminate, hygrothermal stresses and strains

UNIT V

Non-conventional composites: Nano composites, Polymer clay nano composites, self-healing composites, Self-reinforced composites, bio composites, hybrid composites.

Applications: Automobile, Aircrafts. Missiles. Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites.

TEXT BOOKS

1. Autar K Kaw, "Mechanics of composite Materials" Second Edition, Taylor and Francis, ISBN 978-0-8493-1343-1
2. Krishnan K Chawla, "Composite material science and Engineering", Springer, ISBN 978-0-387-74364-6

REFERENCE BOOKS:

1. D Hull and T. W. Clyne, "An introduction to composite materials", Cambridge University Press, ISBN- 9781139170130.
2. Rober M. Jones "Mechanics of composite Materials" Second Edition, CRC Press, ISBN 9781315272986

Course Outcomes (COs):

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

1. Discuss the need for composite materials by comparing the limitations of conventional materials. [PO1, PO2, PO7, PO12, PSO1, PSO2]
2. Summarize the knowledge of different fabrication techniques of composite materials. [PO1, PO2, PO5, PO6, PO12, PSO2]
3. Evaluate the volume and weight fractions, elastic properties of the lamina. [PO1, PO2, PO5, PO11, PO12, PSO2]
4. Predict the responses of the composite on the basis of properties and geometries of the individual phases. [PO1, PO2, PO5, PO6, PO12, PSO1, PSO2]
5. Examine different unconventional composite materials and the applications of composite materials in various Engineering fields. [PO1, PO2, PO7, PO12, PSO1, PSO2].

ADDITIVE MANUFACTURING

Course Code: MEE554 **Course Credits : 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. JAYA CHRISTIYAN K G

Course Learning Objectives:

1. The aim of the course is to provide the students, with an opportunity to conceive, design, and implement products quickly and effectively, using the latest rapid prototyping methods.
2. Technologies associated with material addition process are identified and its advantages are evaluated.
3. Students learn to differentiate various process parameters associated with Rapid Manufacturing Technique & choose tooling techniques for a specific application.
4. Learn how relative improvements can be established by using computers and optimization techniques as compared to initial, manual solutions.
5. Software associated with rapid prototyping techniques are explored.

UNIT I

Introduction: History of RP system, Need for the compression in Product development, Growth of RP industry, classification of RP system.
Stereo lithography systems: Principle, Process parameter, Data preparation, data files and machine details, application.

UNIT II

Fused Deposition Modeling: Principle, process parameter, Application. Laminated Object Manufacturing: principle of operation, LOM materials. Process details, application finishing a LOM part.
Software Issues for Additive Manufacturing: Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist AM.

UNIT III

Laser Engineered Net Shaping: Principle, Build material, Build process, Post processing, application, Solid Ground Curing: Principle of operation, applications. Selective Laser Sintering Principle
Direct Laser Cladding of AM: Fundamentals of Direct Laser Cladding., Fundamentals of the Laser Cladding Process, Material Aspects of Laser Cladding, Future Trends for Laser Cladding., Laser-Based Joining of Metallic and Non-Metallic Materials

UNIT IV

Rapid Tooling: Indirect Rapid tooling. Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Direct Rapid Tooling, Quick cast process, copper polyamide, DMILS, Pro-metal, Sand casting tooling, Soft tooling and hard tooling.

Process Optimisation: Factors influencing Accuracy, Data Preparation, Part building, Part finish, Selection of Part Build orientation.

UNIT V

Reverse Engineering: Introduction to reverse Engineering, Computer aided forward/Reverse Engineering, Structural light range Imaging, Scanner pipe line.

Relation between Reverse Engineering and Additive manufacturing, Modeling cloud data in RE, data processing for Additive manufacturing, Integration of RE and AM for layer based model Generation

TEXT BOOKS:

1. Stereo lithography and other RP & M Technologies, Paul F.Jacobs: "SME, NY 1996.
2. Rapid manufacturing, FIham D.T &Dinjoy S.S verlog London 2001.

REFERENCE BOOKS:

1. Rapid prototyping, Terry Wohler's Report 2000" association 2000.
2. Rapid prototyping materials by Gurumurthi. IISc Bangalore.
3. Rapid automated by lament wood. Indus press New York.

Course Outcomes (COs):

1. Identify the stages of development related to RP system and classification based of material types [PO1,PO2,PO4,PO12,PSO1,PSO2]
2. Compare different RP process based on process parameter [PO1,PO2,PO4,PO12, PSO1,PSO2]
3. Analyze the different Rapid Tooling process for batch production [PO1,PO2,PO3, PO4,PO5,PO12,PSO1,PSO2]
4. Select and use correct data formats in the manufacture of a 3D printed part [PO1,PO2,PO3,PO4,PO5,PO12,PSO1,PSO2]
5. Analyze suitable orientation workflow for better part fabrication process & reduced part build errors [PO1,PO2,PO3,PO4,PO5,PO12,PSO1,PSO2]

ELECTRIC VEHICLE TECHNOLOGY

Course Code: MEE555 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Mr. NISHANTH R ACHARYA

Course Learning Objectives:

1. To help students be thorough with the concepts of hybrid vehicles, EVs and its advantages to traditional ICE vehicles in the longer run.
2. To allow students to learn the basic structure of an EV and also the different power trains and operating modes.
3. To provide insights into the various energy storage systems, battery management systems, electric motors and allied accessories that are essential for proper functioning of an EV system.
4. To enable students to learn to synthesize and characterize high performance nanomaterials for Li battery application. To enable students to design and assemble battery components and test them
5. To help students understand the challenges and opportunities present in methods of EV charging and its infrastructure.

UNIT I

Review of conventional IC engine vehicle –limitations and environmental impact, Introduction to Electric vehicles: brief study of hybrid vehicles, architecture of hybrid electric vehicles, Need for electric vehicles, Introduction to EV design- basic working principle of plug-in EV, Importance /advantages of EV and hybrid vehicles in present context

UNIT II

Electric vehicle power train- Brief outline of electric motor, battery pack, inverter, charger and converter, series hybrid electric drive train, parallel hybrid electric drive train, operation modes-pure electric traction mode, pure engine traction mode, hybrid traction mode, engine traction with battery charging mode, regenerative braking mode, battery charging mode

UNIT III

Batteries- Types of batteries, architecture, battery charging and discharging cycles, use of batteries in powertrain, battery modeling and battery management system (BMS)

UNIT IV

Electric Motors- AC/DC Motors/ Generators, Brushed DC Motor/ Brushless DC Motor - Torque Characteristics, motor layout, switched reluctance motors, induction motors, Actuators & Capacitors., DC-AC & AC-DC Convertors

UNIT V

EV charging –methods of charging: conductive, inductive and battery swapping, AC charging, DC charging, thermal management for motor, technology trends in EV-brief outline

TEXT BOOKS:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, John Wiley & Sons Ltd, 2nd ed., 2012
2. K. T. Chau - Electric Vehicle Machines and Drives Design, Analysis and Application-Wiley-IEEE Press (2015)
3. G A Goodarzi, John G Hayes - Electric powertrain _ energy systems, power electronics & drives for hybrid, electric & fuel cell vehicles (2018, John Wiley & Sons)
4. Christopher D. Rahn, Chao Yang Wang - Battery Systems Engineering,2013 edition, John Wiley and Sons Ltd.

REFERENCE BOOKS:

1. C.C. Chan and K.T. Chau, *Modern Electric Vehicle Technology*, Oxford University Press, 2001.
2. Ali Emadi, Handbook of Automotive Power Electronics and Motor Drives, CRC Press Taylor & Francis Group, 2005
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press Taylor & Francis Group, 2003.

Course Outcomes (COs):

1. Understand the development of EV technology over the years and also its suitability in different areas of transportation. [PO1, PO3, PO6, PO12 & PSO1]
2. Learn the important components in an EV and different power train systems [PO1, PO9& PSO1]
3. Identify and Categorize the different parts and systems necessary for smooth and hassle-free operation of EV [PO1, PO3& PSO1]
4. Reflect upon the need to improve the charging system and infrastructure in terms of faster charging rate and wider coverage [PO1, PO3, PO5, PO6& PSO2]
5. Learn effective battery management systems and compare the EV technology with other prevalent technologies like fuel cells for automotive applications [PO1, PO6, PO7 &PO12]

SOLAR ENERGY

Course Code: MEE556 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Mr. GURURAJ

Course Learning Objectives:

1. To make students understand importance of renewable energy and in particular solar energy.
2. To enable them to understand the measurement of solar radiation using various instruments.
3. To enable them to design liquid flat collectors for liquid heating systems.
4. To enable them to design concentrating collectors and solar air heater.
5. To enable them to know photovoltaic cell operation and economics of solar systems.

UNIT I

Introduction: energy sources, Renewable energy sources, potential, Achievements in India, energy alternatives, Solar energy option, overview, devices for thermal collection and storage, Thermal applications, Water and space heating, Power generation, Space cooling and refrigeration, Distillation, Drying, cooking and Grid connected solar pumping system.

UNIT II

Solar Radiation: Solar radiation outside atmosphere, Solar radiation at earth's surface, Instruments for measuring solar radiation and sunshine recorder, solar radiation data, Solar radiation geometry, Empirical equations, prediction of availability of solar radiation, solar radiation on tilted surfaces, Numerical problems.

UNIT III

Liquid flat plate collectors: Performance analysis, Transmissivity of cover, transmissivity-absorptivity product, Overall loss coefficient, hear transfer correlations, Collector efficiency factor, Collector heat removal factor, Numerical problems, Effect of various parameters on performance, Analysis of collectors, transient analysis, testing procedures, Alternative to conventional collectors, numerical problems.

UNIT IV

Concentrating Collectors: Introduction, Flat plate collectors with plane reflectors, cylindrical parabolic collector, compound parabolic collectors, parabolic dish collctor. Central receiver collector, tracking, numerical problems.
Solar air heaters: performance analysis, types, testing procedures.

UNIT V

Photo-Voltaic Conversion: Solar cell, working principles, conversion efficiency, commercial solar cells, applications.

Economic analysis: initial and annual costs, definitions, present worth calculations, Repayment of loan, annual solar savings, payback period, concluding remarks.

TEXT BOOKS:

1. Solar Energy-Principles of energy conversion and storage, S P Sukhatme, Tata Mcgraw hill co., New Delhi.
2. Solar Energy Utilisation, G. D. Rai, Khanna publishers, New-delhi

REFERENCE BOOKS:

1. Solar engineering of Thermal processes, Duffi J A and Beckman, W. A. John Wiley & Sons, New York.

Course Outcomes (COs):

1. Identify the significance and applications of various solar energy devices and instrument for measuring solar radiation. [PO1,PO2,PO3,PSO1 &PSO2]
2. Understand the concept of solar radiation geometry and empirical equation for solar radiation [PO1,PO2,PO3,PO4,PSO1 &PSO2]
3. Apply the solar radiation concept related to flat plate collector, concentrated collector and solar air heater systems appropriately in various environmental conditions. [PO1,PO2,PO3,PO4,PO6,PO7,PO8,PO12,PSO1 &PSO2]
4. Analyze the overall loss coefficient, heat transfer correlation, collector efficiency factors in collectors and propose necessary solutions. [PO1,PO2,PO3,PO4,PO6,PO7, PO12,PSO1 &PSO2]
5. Evaluate the issue related to photovoltaic conversion efficiency and economical aspects [PO1,PO2,PO3,PO4,PO6,PO8,PO12,PSO1 &PSO2]

INDUSTRIAL DESIGN AND ERGONOMICS

Course Code: MEE557 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. SUNITH BABU L

Course Learning Objectives:

1. Students are initially made to know the concept of the subject Industrial Design and its creating ability.
2. Students will have the knowledge to study various methods of industrial design.
3. To analyze different processes/ terminologies of the various Control and display and its applications.
4. To obtain brief description of visual effects of line and form and **t**he mechanics of seeing.
5. The students will have the knowledge to improve aesthetic concepts of various products**.**

UNIT 1

INTRODUCTION: AN Approach to Industrial Design, elements of design structure for industrial design in engineering application in modern manufacturing systems. Ergonomics and Industrial Design: Introduction, general approach to the man-machine relationship, workstation design-working position. Case Study

UNIT 1I

CONTROL AND DISPLAY: Shapes and sizes of various controls, multiple displays and control situation design of major controls in automobiles, machine tools etc, design of furniture, design of instruments. Ergonomics and production; Ergonomics and product design, ergonomics in automated system expert systems for ergonomics, anthropomorphic data and its applications in ergonomic design, limitation of anthropomorphic data. Case Study

UNIT III

VISUAL EFFECTS OF LINE AND FORM: The mechanics of seeing-psychology of seeing general influences of line and form. **COLOR; COLOR** and light, color and objects-color and the eye-color consistency-color terms reactions to color and color continuation-color on engineering equipments. Case Study

UNIT 1V

AESTHETIC CONCEPTS: Concept of unity-concept of order with variety-concept of purpose style and environment –Aesthetic expressions. Style –components of style house style, observation style in capital goods, case study.

UNIT V

INDUSTRIAL DESIGN IN PRACTICE: General design specifying design equipments, rating the importance of industrial design, industrial design in the design process.
Case Study

REFERENCE BOOKS:

1. **Human Factor Engineering**: Sanders & McCormick McGraw Hill Publications.
2. **Applied Ergonomics Hand Book,** Brain Shakel, Butterworth Scientific, London 1988
3. **Introduction to Ergonomics,** R. C. Bridger, McGraw Hill Publications.
4. **Industrial Design for Engineers,** Mayall W. H. London Hiffee Books Ltd., 1988

Course Outcomes (COs):

Students will be able to

1. Understand the concept of the subject Industrial Design and its creating ability. [PO1,PO2,PO3,PO4 & PO5]
2. Understand the various methods of industrial design. [PO1,PO2,PO3,PO4 & PO5]
3. Analyze the different processes of various Control and applications. [PO1,PO2,PO3,PO4 & PO5]
4. Obtain brief description of visual effects of line and form and the mechanics of seeing. [PO1,PO2,PO3,PO4 & PO5]
5. Understand and improve aesthetic concepts of various products. [PO1,PO2,PO3,PO4 & PO5]

THEORY OF ELASTICITY

Course Code: MEE558 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. RAJI GEORGE

Course Learning Objectives:

1. Introduce the various aspects of Theory of Elasticity as applied to engineering problems in a systematic manner.
2. Impart the knowledge of fundamental concepts of Stress and Strain at a point.
3. Understand the concepts of Stress and Strain at a point by solving problems of practical interest. Develop skill to solve simple problems on concepts of Plane stress and Plane strain.
4. Develop competence in analyzing the 2D problems of elasticity. Develop an understanding of problems on thermal stresses and develop skill to solve them.
5. Develop an understanding of the concepts of torsion of shafts of circular and non circular cross section and applying them for solving problems. Learn the practical implications and applications of torsion of thin walled tubes.

UNIT I

Definition And Notations**,** Stress, Stress at a point, equilibrium equations, equality of cross shear stress, principal stress, octahedral stress, boundary condition equations, stress on an inclined plane.

UNIT II

Strain at A Point, Compatibility equations, principal strains, Mohr's Diagram Generalized Hooke's Law, Plane stress and Plain Strain, Aeris Stress Function, Analysis of beams, cantilever beam.

UNIT III

General Equation in Cylindrical Coordinators, Equilibrium equations, analysis of thick cylinder subjected to internal and external pressure, shrink fits

UNIT IV

Stresses in Rotating Discs and Cylinders, Stress Concentration in an infinite plate. Thermal Stresses, Thermo elastic stress strain relation, thermal stresses in think circular disc and long cylinders.

UNIT V

Principal of superposition theorem, Saint Venant's principle, uniqueness theoretician of circular, elliptical and triangular bar, membrane analogy

TEXT BOOKS:

1. Theory of Elasticity – SP Timoshenko and Goodier, Mc Graw Hill International, 3rd Edition 1972
2. Advanced Mechanics of Solids – LS Srinath – Tata Mc Graw Hill

REFERENE BOOKS:

1. Applied Elasticity – CT Wang, Mc Graw Hill Book 1953
2. Elasticity Theory applications and numericals – Martin H Sadd, Elsiver 2005

Course Outcomes (COs):

1. Evaluate and compare the conventional strength of material approach and that of TOE [PO1,PO2,PO3,PO4,PSO1 & PSO2]
2. Compile fundamentals of TOE for engineering applications. [PO1,PO2,PO3,PO4, PSO1 & PSO2]
3. Develop ability to identify a problem and apply the fundamental concepts of TOE. Demonstrate the ability to solve problems of practical interest. [PO1,PO2,PO3,PO4, PSO1 & PSO2]
4. Develop competence to design and analyze problems of engineering involving design of components [PO1,PO2,PO3,PO4,PO5,PSO1 & PSO2]
5. Demonstrate ability to have the competence for undergoing knowledge up gradation in the field of TOE With particular reference to Theory of Plasticity and Finite Element Method. [PO1,PO2,PO3,PO4,PO5,PSO1 & PSO2]

TURBO MACHINERY LABORATORY

Course Code: MEL56 **Course Credits: 0:0:1**
Prerequisite: Fluid Mechanics
Course Coordinator: Dr. NIRANJAN MURTHY

Course Learning Objectives:

1. Students apply the knowledge and conduct the experiments on Flow measuring devices.
2. Students analyze the characteristics curves and evaluate the performance of various pumps.
3. Students analyze the energy conversion devices such as pumps and turbines.

Experiments

1. Determination of coefficient of friction of flow in a pipe.
2. Determination of minor losses in flow through pipes.
3. Determination of force developed by impact of jets on vanes.
4. Calibration of flow measuring devices
    a. Orifice plate.
    b. Orifice meter.
    c. Venturimeter.
    d. Rota meter.
    e. V notch.
    f. Rectangular notch.
5. Performance testing of Turbines
    a. Pelton wheel.
    b. Francis Turbine.
    c. Kaplan Turbines.
6. Performance testing of Pumps
    a. Single stage and Multi stage centrifugal pumps.
    b. Reciprocating pump.

TEXT BOOKS:

1. An Introduction to energy conversion, Volume III – Turbo machinery, V. Kadambi and Manohar Prasad, New Age International Publishers (P) Ltd.
2. A Treatise on Turbo Machines, G. Gopalakrishnan, & D. Prithviraj, Scitech Publications (India) Pvt. Limited 2nd edition 2002.
3. Turbo Machines laboratory manual, Department of Mechanical Engineering, MSRIT

REFERENCE BOOKS:

1. "Principles of Turbo Machinery", D.G. Shepherd, The Macmillan Company (1964)
2. "Gas Turbine Theory", H. Cohen, GFC Rogers, & HIH Saravanamuttoo, Thomson Press (India) Ltd., 4th Edition (1998)
3. Fundamentals of Turbomachinery: William W Perg John Wiley & Sons, Inc. (2008.)
4. "Turbines, Compressors & Fans", S. M. Yahya, Tata-McGraw Hill Co., 2nd Edition (2002).

Course Outcomes (COs):

1. Students will be able to demonstrate the knowledge of flow measuring devices and calibrate the discharge under various condition. [PO1,PO2,PO4,PO9,PO10,PO12, PSO1 &PSO2]
2. Students will be able to analyze the characteristics curves and evaluate the performance of various pumps. [PO1,PO2,PO3,PO4,PO9,PO10,PO12,PSO1 &PSO2]
3. Students will be able to identify the various turbines and determine the performance parameters. [PO1,PO2,PO3,PO4,PO9,PO10,PO12,PSO1 &PSO2]

Scheme of Examination:

CIE:

Lab Record (Conducting experiment, calculation and writing record with graph) = 30 marks
Lab Test (One test at the end) = 15 marks
Viva Voce = 05 marks

Total CIE = 50 marks

SEE:

1. Student should have obtained not less than 75% attendance and 20 CIE Marks to become eligible for appearing the examination.
2. Student has to conduct two experiments (One group experiment and one individual experiment)

Max Marks:	**50**
Group Experiment:	**25**
Individual Experiment:	**15**
Viva-voce:	**10**
TOTAL:	**50**

MECHANICAL MEASUREMENTS & METROLOGY LABORATORY

Course Code: MEL57 **Course Credits: 0:0:1**
Prerequisite: Nil
Course Coordinator: Dr. NAGESH S N

Course Learning Objectives:

1. Apply calibration technique to various measuring device to standardize the instruments
2. Demonstrate usability of different measuring instruments to measure various parameters applicable in mechanical engineering
3. Investigate the applicability of standard measuring devices.

A. Tests conducted are listed below

Conduct the following Experiments.

1. Calibration of pressure transducer
2. Calibration of thermocouple
3. Calibration of LVDT
4. Determination of material constants, E & G.
5. Calibration of stroboscope
6. Calibration of micrometer using slip gauges
7. Double flank test using gear roll tester
8. Determination of gear tooth profile using gear tooth tester
9. Measurement of tool-tip temperature
10. Digimatic miniprocessor

B. Conduct the following Experiments.

1. Measurements using tool makers microscope
2. Measurements using profile projector
3. Measurement of angles using sine center, sine bar and bevel protractor
4. Determination form tolerance of a ground product using pneumatic comparators
5. Drawing of Merchant's circle diagram
6. Determination of screw thread parameters using floating carriage diameter measuring machine.
7. Measurement of alignment using Autocollimator.

C. Conduct the following Experiments.

1. Monochromatic checklite
2. Surface finish measurement

TEXT BOOKS:

1. Mechanical measurements, by Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. Engineering Metrology, by R.K.Jain, Khanna Publishers, 1st edition 1994.

REFERENCE BOOKS

1. Engineering Metrology, by I.C. Gupta, Dhanpat Rai Publications, Delhi. 2nd edition 2006 edition.
2. Mechanical measurements, by R.K. Jain. 5th edition 2006.
3. Industrial Instrumentation, Alsutko, Jerry.D.Faulk, Thompson Asia Pvt. Ltd.1st edition 2002.
4. Measurements Systems Applications and Design, by Ernest O. Doblin, McGraw Hill Book Co. 2nd edition. 2006

Course Outcomes (COs):

After successful completion of this course, students will be able to

1. Apply calibration technique to various measuring device to standardize the instruments. [PO1,PO2,PO4,PO12,PSO1 & PSO2]
2. Demonstrate usability of different measuring instruments to measure various parameters applicable in mechanical engineering. [PO1,PO2,PO4,PO12,PSO1 & PSO2]
3. Investigate the applicability of standard measuring devices. [PO1,PO2,PO4,PO12, PSO1 & PSO2]

Scheme of Examination: CIE:

Lab Record (Conducting experiment, calculation and writing record with graph) = 30 marks
Lab Test (One test at the end) = 15 marks
Viva Voce = 05 marks

Total CIE = 50 marks

SEE:

Student should have obtained not less than 75% attendance and 20 CIE Marks to become eligible for appearing the examination.
Student has to conduct two experiments (One group experiment and one individual experiment)

Max Marks:	**50**
Group Experiment:	**25**
Individual Experiment:	**15**
Viva-voce:	**10**
TOTAL:	**50**

MANUFACTURING PROCESS – II LABORATORY

Course Code: MEL58 **Course Credits: 0:0:1**
Prerequisite: Nil
Course Coordinator: Dr. MOHANDAS K N

Course Learning Objectives:

1. To make students understand about various machining operations including eccentric turning on Lathe and selection of cutting tools for the same.
2. To give basic practical experience to the students on the use of Milling machine and various operations on the same
3. To give basic practical experience to the students on the use of Shaping machine and various operations on the same.

Lathe: Step turning, thread cutting (V-thread, Square thread, Left hand and Righthand threads) Eccentric turning.
Milling Machine: Indexing, Indexing methods, cutting of gear tooth (Spur gear, Helical gear), face milling and grooving.
Surface Grinding: Demonstration of Surface grinding machine.
Shaping Machine: Cutting of V groove, Dovetail and Rectangular groove.

TEXT BOOK:

1. Manufacturing Process – II laboratory manual, Department of Mechanical Engineering, MSRIT.

Course Outcomes (COs):

The Student will;

1. Be able to demonstrate the skill developed in preparing models using different operations on a lathe [PO1,PO2,PO4,PO8,PO9,PO12,PSO1 & PSO2]
2. The Student will be able to demonstrate the skill developed in preparing models using different operations on a milling machine [PO1,PO2,PO4,PO8,PO9,PO12,PSO1 & PSO2]
3. The student will be able to understand the operations carried using the Shaping machine. And will demonstrate the skill of surface grinding and Wood turning. [PO1,PO2,PO4,PO8,PO9,PO12,PSO1 & PSO2]

Scheme of Examination
CIE:

Lab Record (Conducting experiment, calculation and writing record with graph) = 30 marks
Lab Test (One test at the end) = 15 marks
Viva Voce = 05 marks

Total CIE = 50 marks

SEE:

1. Student should have obtained not less than 75% attendance and 20 CIE Marks to become eligible for appearing the examination.
2. Student has to conduct two experiments (One group experiment and one individual experiment)

Max Marks:	**50**
Group Experiment:	**25**
Individual Experiment:	**15**
Viva-voce:	**10**
TOTAL:	**50**

SCHEME OF TEACHING FOR THE ACADEMIC YEAR 2022-2023

VI SEMESTER B.E MECHANICAL ENGINEERING

Sl.No	Course Code	Course Name	Category	Credits			
				L	T	P	Total
1	ME61	Design of Machine Elements-II	PCC	3	1	0	4
2	ME62	Heat and Mass Transfer		3	1	0	4
3	MEE63X	Professional Elective-2		3	0	0	3
4	MEE64X	Professional Elective-3	PC-E	3	0	0	3
5	MEOE0X	Open Elective - 2	OE-2	3	0	0	3
6	ME65	Mini-Project/ Professional Elective/NPTEL Course	PW/IN	0	0	4	4
7	MEL66	Finite Element Analysis Laboratory	PCC	0	0	1	1
8	MEL67	Heat and Mass Transfer Laboratory		0	0	1	1
9	MEL68	Design and Dynamics Laboratory		0	0	1	1
Total				**15**	**2**	**7**	**24**

L: Lecture **T**: Tutorial **P**: Practical's

LIST OF COURSES OFFERED UNDER PROFESSIONAL ELECTIVE –2
CREDITS: 3:0:0

Sl. No.	Subject Code	Subject
1.	MEE631	Finite Element Analysis
2.	MEE632	Smart Manufacturing
3.	MEE633	Total Quality Management

LIST OF COURSES OFFERED UNDER PROFESSIONAL ELECTIVE –3
CREDITS: 3:0:0

Sl. No.	Subject Code	Subject
4.	MEE641	Operations Research
5.	MEE642	Computational Fluid Dynamics
6.	MEE643	Nano Technology
7.	MEE644	Non Traditional Machining
8.	MEE645	Basic To Machine Learning And Phython
9.	MEE646	Mechatronics & MEMS
10.	MEE647	CNC Machines

OPEN ELECTIVE 2[Offered for Other Departments]

Subject Code	Subject	Credits
MEOE05	Automotive Engineering	3:0:0
MEOE06	Non-Conventional Energy Sources	3:0:0
MEOE07	Product Design & Manufacturing	3:0:0
MEOE08	Non-Destructive Testing	3:0:0
MEOE09	Fundamentals of Electric Vehicle Technology	3:0:0
MEOE10	CNC Machines	3:0:0
MEOE11	Science, Education And Technology for Rural India	3:0:0

DESIGN OF MACHINE ELEMENTS-II

Course Code: ME61 **Course Credits: 3:1:0**
Prerequisite: Nil
Course Coordinator: Dr. GIRISH V KULKARNI

Course learning objectives:

1. Concept in selection of material.
2. Deciding the proper steps to be followed in manufacturing of the components involved in the product.
3. Knowledge of the components to be designed.
4. Factors to be considered while designing the components which involve human life such as brakes, clutches, springs, bearings etc.
5. Alternate design procedure.
6. Selection of some of the components from charts, catalogues and by other means that are in practice.

UNIT I

Curved Beams: Stresses in Curved Beams of Standard Cross Sections used in Crane Hook, Punching Presses & Clamps, Closed Rings and Links.

Clutches & Brakes: Design of Clutches: Single Plate, Multi Plate and Cone Clutches. Design of Brakes: Block and Band Brakes: Self Locking of Brakes: Heat Generation in Brakes.

UNIT II

Springs: Types of Springs - Stresses in Helical Coil Springs of Circular and Non-Circular Cross Sections. Tension and Compression Springs, Leaf Springs: Stresses in Leaf Springs & Equalized Stresses.

UNIT III

Spur & Helical Gears: Spur Gears: Definitions, Stresses in Gear Tooth: Lewis Equation and Form Factor, Design for Strength, Dynamic Load and Wear Load. **Helical Gears**: Definitions, Formative Number of Teeth, Design Based on Strength, Dynamic and Wear Loads.

UNIT IV

Bevel Gear: Definitions, Formative Number of Teeth, Design Based on Strength, Dynamic and Wear Loads.

Worm Gears: Definitions, Design Based on Strength, Dynamic, Wear Load and Efficiency of Worm Gear Drives.

Design of IC Engine parts: Selection of Types, Principle of similitude, General Design Consideration. Design of principal parts: Cylinder, Cylinder head, Piston.

UNIT V

Lubrication and Bearings: Lubricants and their properties, Mechanisms of Lubrication, Bearing Modulus, Coefficient of Friction, Minimum Oil Film Thickness, Heat Generated, Heat Dissipated, Bearing Materials, Examples of Journal Bearing, Thrust Bearing Design, Design of Antifriction Bearings.

DESIGN DATA HAND BOOKS:

1. **Design Data Hand Book** – K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
2. **Design Data Hand Book** by K. Mahadevan and K. Balaveera Reddy, CBS Publication

TEXT BOOKS:

1. Mechanical Engineering Design: Joseph E Shigley and Charles R. Mischke. McGraw Hill International edition, 6th Edition 2003.
2. Design of Machine Elements: V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

REFERENCE BOOKS:

1. Machine Design: Robert L. Norton, Pearson Education Asia, 2001.
2. Design of Machine Elements: M.F. Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram and C.V. Venkatesh, Pearson Education, 2006.
3. Machine Design: Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
4. Machine Design: A CAD Approach: Andrew D DIMAROGONAS, John Wiley Sons, Inc, 2001.

Course Outcomes (COs):

1. Evaluate and analyse stresses in curved beams and power transmission elements invarious applications. [PO1,PO2,PO3,PO4,PO12,PSO1 & PSO2]
2. Design and develop various types of springs for various applications. [PO1,PO2,PO3,PO4,PO12,PSO1 & PSO2]
3. Decide and design gears for engineering applications. [PO1,PO2,PO3,PO4, PO12,PSO1& PSO2]
4. Understand and choose the design concepts of appropriate brakes and clutches used inpractice. [PO1,PO2,PO3,PO4,PO12,PSO1 & PSO2]
5. Identify & choose lubricants, bearings for various applications. [PO1,PO2,PO3, PO4,PO12, PSO1 & PSO2]

HEAT AND MASS TRANSFER

Course Code: ME62 **Course Credits: 3:1:0**
Prerequisite: Nil
Course Coordinator: Mr. NAVEEN KUMAR B K

Course Learning Objectives

The course should enable the students to understand:

1. Modes and basic laws of heat transfer, one dimensional steady state conduction through plane wall, cylinder, sphere of uniform and non-uniform thermal conductivity with and without heat generation.
2. The steady state heat transfer from straight fins subjected to different boundary conditions and unsteady state conduction with lumped analysis and use of Heisler charts.
3. The evaluation of convective heat transfer in free and forced convection from walls, cylinder etc under different conditions with the use dimensional analysis.
4. The analysis of heat exchangers by LMTD and NTU methods and the heat transfer with change of phase i.e. boiling and condensation.
5. The radiation heat transfer for different cases including radiation shield and the basics of diffusion and convective mass transfer.

UNIT I

Introductory concepts: Modes of Heat Transfer, Basic Laws of Heat Transfer, Overall Heat Transfer Coefficient, Boundary Conditions, 3-D Conduction equation In Cartesian coordinates, Discussion On 3-D Conduction equation in Cylindrical and Spherical coordinate systems (No Derivation). 1-DConduction equations in Cartesian, Cylindrical and Spherical Coordinate Systems. Composite Walls, Cylinders and Spherical Systems with Constant Thermal Conductivity, Numerical Problems.

Derivation for 1-D heat flow and temperature distribution in plane wall, cylinder, sphere with variable thermal conductivity. Insulating materials and their selection, critical thickness of insulation. Steady state 1-D conduction in slab, cylinder and spheres with heat generation.

UNIT II

Heat transfer in extended surfaces: Derivation for 1-D heat flow and temperature distribution in straight fin with end conditions such as, infinitely long fin, fin with insulated tip, fin with convection at the tip and fin connected between two heat sources. Fin efficiency and effectiveness, 1-D numerical method for fin. Numerical problems.

1-D transient conduction: conduction in solids with negligible internal temperature gradient (lumped system analysis), Use of Heislers charts for transient conduction in slab, long cylinder and sphere, Use of transient charts for transient conduction in semi-infinite solids, Numerical problems.

UNIT III

Concepts and basic relations in boundary layers: Hydrodynamic and thermal boundary layers, critical Reynolds number, local heat transfer coefficient, average heat transfer coefficient, Flow inside a duct, hydrodynamic and thermal entrance lengths.

Natural or Free convection: Application of dimensional analysis for free convection. Physical significance of Grasshoff number, Rayleigh number. Use of correlations in free convection for horizontal, vertical plates and cylinders. Numerical problems

Forced convection heat transfer: Application of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of correlations for hydro-dynamically and thermally developed flows in case of a flow through tubes, flow over a flat plate, cylinder and across a tube bundle. Numerical problems.

UNIT IV

Heat exchangers: Classification of heat exchangers, Tubular and compact heat exchangers, overall heat transfer coefficient, fouling factor, L.M.T.D method, effectiveness, NTU method of analysis of heat exchangers, Numerical problems.

Condensation and Boiling heat transfer: Types of condensation, Nusselt's theory for laminar condensation on a vertical flat surface, expression for film thickness and heat transfer coefficient, use of correlations for condensation on inclined flat surfaces, horizontal tube and horizontal tube banks, Regimes of pool Boiling, Numerical problems.

UNIT V

Mass Transfer: Fick`s law of diffusion mass transfer, Isothermal evaporation of water, convective mass transfer, Numerical problems.

Radiation heat transfer: Thermal radiation, definitions of various terms used in radiation heat transfer, Stefan-Boltzman law, Kirchoff`s law, Planck`s law and Wein`s displacement law, Radiation heat exchange between two parallel infinite black surfaces and gray surfaces, effect of radiation, shield, Intensity of radiation and solid angle, Lambert`s law, radiation heat exchange between two infinite surfaces, Radiation shape factor, properties of shape factors, shape factor algebra, Hottel`s cross string formula, network method for radiation heat exchange in an enclosure, Numerical problems**.**

TEXT BOOKS:

1. Heat and Mass Transfer, S.C. SACHDEV, New Age International Edition. ,2006.,
2. Basic Heat Transfer, OZISIK, McGraw-Hill publications, NY. 2005.,
3. Heat and Mass Transfer, M. THIRUMALESHWAR, Pearson Edition. 2006.,
4. Heat and Mass transfer Data book, C. P KOTHANDARAMAN & S. SUBRAMANYAN, New age international(p) limited publishers, 2007

REFERENCE BOOKS:

1. Heat Transfer, a practical approach. YUNUS A CENEGAL, Tata McGraw-Hill publishers, NY. 2001.,
2. Heat Transfer, J.P HOLMON, McGraw-Hill Publishers special Indian edition 2011.
3. Principles of engineering heat transfer, KRIETH F, Thomas learning. 2001.

Course Outcomes (COs):

1. Understand the basic laws of heat transfer and able to solve conduction, convection and radiation problems. [PO1, PO2, PO3, PO4, PO5, PO12, PSO1 &PSO2].
2. Apply the basic mechanism of heat transfer from fins and lumped analysis [PO1, PO2, PO3,PO4,PO5,PO12]
3. Evaluate heat transfer coefficients in natural and forced convection Heat transfer. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1 &PSO2]
4. Ability to design and analyze the performance of heat exchangers. Understand the basic concepts of boiling and condensation. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1 &PSO2]
5. Understand the principles of radiation heat transfer and basics of mass transfer. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1 &PSO2].

FINITE ELEMENT ANALYSIS

Course Code: MEE631 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. LOKESHA

Course Learning Objectives

1. To understand and apply concepts of theory of elasticity, principle of minimum potential energy variational and weighted residual methods and steps of finite element method
2. To understand concepts of shape functions and stiffness matrix, methods of solving equilibrium equations and be able to solve one dimensional and truss problems including temperature effects.
3. To understand fundamentals of two dimensional CST and Quadrilateral elements, higher order elements and Gaussian quadrature and be able to solve related problems.
4. To understand the fundamentals of Beam elements and be able to solve beam problems.
5. To apply FEA insolving dynamic problems such as finding eigen values and eigen vectors of vibrating members.

UNIT I

Introduction: Equilibrium equations in elasticity subjected to body force, Traction force, Stress - strain relations for plane stress and plane strain, Principle of minimum potential energy, introduction to Rayleigh-Ritz method (without numerical). Galerkins method (without numerical) Geometric Isotropy, Pascal's triangle, Convergence criteria, General Description of Finite Element Method, Advantages, Basic steps in the formulation of Finite Element Analysis.

UNIT II

Shape functions of Linear simplex element, co- ordinate systems, Stiffness matrix by potential energy approach, Load vector, Elimination approach and Penalty approach of handling boundary conditions, Temperature effect Quadratic Shape Functions of 1D Elements, Problems on stepped bar subjected to axial and thermal loads.
Truss Element: Truss element, Local and Global coordinate systems, Elemental stiffness matrix, Element stress, Temperature effects, Problems on trusses.

UNIT III

Shape functions of CST element, isoparametric representation of CST element, Four node quadrilateral element, Stiffness matrix, Element stress, Lagrangian interpolation functions, Higher order elements, six nodes triangular element, eight nodes quadrilateral element. Numerical Integration using one, two and three point's Gaussian quadrature formula.

UNIT IV

Beam element: Beam element, Hermit shape function, Stiffness matrix, Load vector, Shear force and Bending moment, Problems on beams.

UNIT V

Equation of motion for 1D element, derivation of element mass and stiffness matrices, Eigen value and Eigen vector problems for bar subjected to axial vibrations.

TEXT BOOKS

1. Finite Element in Engineering, Chandrupatla T.R., 2nd Edition, PHI,2000
2. The Finite Element Method in Engineering, S.S. Rao, 4th Edition, Elsevier, 2006

REFERENCE BOOKS

1. Text book of Finite Element Analysis, P.Seshu, PHI India, 2004
2. Finite Element Method, J.N. Reddy, McGraw- Hill International Edition.
3. Finite Element Analysis, C.S. Krishnamurthy, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 1995

Course Outcomes (COs):

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

1. Apply concepts of theory of elasticity, principle of minimum potential energy variational and weighted residual methods and describe finite element method. [PO1,PO2,PO3,PO4,PO5, PO7, PSO1 & PSO2]
2. Explain and evaluate one dimensional bar and truss problems. [PO1,PO2,PO3,PO4,PO5, PO7,PSO1 & PSO2]
3. Apply fundamentals of two dimensional elements and higher order elements and develop skill to solve related problems. [PO1,PO2,PO3,PO4,PO5,PO7,PSO1 & PSO2]
4. Apply the fundamentals of Beam elements and have skill to solve beam related problems. [PO1,PO2,PO3,PO4,PO5,PO7,PSO1 & PSO2]
5. Describe and evaluate dynamic problems of vibrating one dimensional members. [PO1,PO2,PO3,PO4,PO5,PO7,PSO1 & PSO2]

SMART MANUFACTURING

Course Code: MEE632 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. JYOTHI LAKSHMI R

Course Learning Objectives:

1. Educate the importance of Smart Manufacturing
2. Implement the use of appropriate Technologies from Industry
3. Prepare for the ever changing Manufacturing Techniques
4. Use of modern tools to solve complex industry manufacturing methods
5. To enable the process automation between humans and digital workflow

UNIT I

Introduction: History of Smart Manufacturing, Definition, SMLC concept, big data processing, Industrial connectivity devices and services, Benefits, Emerging business practices, Eliminating workplace inefficiencies and hazards

Transparent Factory: Shop Floor Visualization and Alerting, Web based visualization, ANDON displays, Role bases shop floor reporting, Right Info to the Right role at the right time (RI-RR-RT) concept: Operator, Product Manager, Maintenance, Industrial Engineer, Plant Manager

UNIT II

Smart Factory: Information and Communication Technology, Industrial Internet and Cyber Physical Systems, Disruptive BIG Data Technology: Any Browser, Any Geography, Any Language, Any Machine, Any Device, Customer case study

Industrial Internet: Introduction, Power of 1%, Key IIoT Technologies, Do's and Don't of Industrial Internet, Catalysts and Precursors of the IIoT,

UNIT III

Industrial Internet: Definition, Use cases – Healthcare, Oil and Gas Industry, Smart Office, Logistics and Industrial Internet, Retail, Wireless Technology, IP Mobility, Cloud and Fog, M2M learning, Augment Reality and 3D Printing.

Designing II system: Concept of IIoT, Proximity Network, Modern Communication Protocol,Examining access network technology and protocol, middleware transport protocol, middleware software patterns.

UNIT IV

Middleware IIoT: Definition, Architecture, IIoT WAN, Securing Industrial Internet, Industry4.0

Smart Factories: Definition, Real World Smart Factories, Case Studies – GE, Airbus, Siemens.

UNIT V

Economics: Economics Aspects of Smart Manufacturing, ecosystem, skill set requirements, Effects of 4M – Man Machine Material and Methods in Smart Manufacturing

Business Process: Nine Pillars of SM, Business Propositions delivered with Smart Manufacturing, Adding Smartness to Manufacturing – Adoption & Scaling

TEXT BOOKS:

1. Industry 4.0 The Industrial Internet of Things, Alasdair Gilchirst, Apress ISBN – 978-1-4842-2046-7
2. Smart Manufacturing, Shoukat Ali, LAP LAMBERT Academic Publishing ISBN – 978-3659933554

REFERENCE BOOKS:

1. OEE Guide to Smart Manufacturing, Dr. Jill A O'Sullivan, ISBN – 97809912142-4-2, Library of Congress, IMAE Business & Academic ERP Implementation Series

Course Outcomes (COs):

1. Identify the stages of Smart Manufacturing scenario in modern engineering [PO1,2,12, PSO1 &PSO2]
2. Choose technologies and practices that can aid the Industry 4.0 workflow [PO1,2,12,PSO1 & PSO2]
3. Assess Manufacturing Techniques to implement in a real world complex engineering cases. [PO1,2,12,PSO1 &PSO2]
4. Formulate workflow to solve day to day problems and provide proven solutions[PO1,2,12,PSO1 &PSO2]
5. Organize levels of work exchange to implement better communication with Man – Machine [PO1,2,12,PSO1 &PSO2]

TOTAL QUALITY MANAGEMENT

Course Code: MEE633 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. C M RAMESHA

Course Learning Objectives:

1. The aim of course provides the knowledge of TQM, Benefits of TQM, and Contribution of Gurus.
2. Students learn characteristics of leaders and role of TQM leaderships. Continuous process improvement.
3. Selectively choose Tools & Techniques of TQM.
4. Learn how to select product acceptance control plan and characteristics of OC curves.
5. Learn how to check reliability and life of process.

UNIT I

Over view of Total Quality Management: Introduction, Definition, Basic Approach, Contribution Of quality Gurus. Quality circle TQM frame work, Historical review, benefits of TQM, TQM organisation.
Leadership: characteristics of quality leaders, Demings Philisopy, role of TQM Leaders, continuous processes improvement, Juranos Triology. quality costs, 6 sigma, Reengineering.

UNIT II

Tools and techniques of TQM: Basic tools of TQM, Bench marking, processes of bench marking, quality management systems .ISO-9000 series of standards, implementation and documentation of ISO_9000.
Introduction of QFD and QFD process, TQM exemplatory organisation. Design of Failure Mode and Effect analysis [FMEA], process of FMEA.

UNIT III

Statistical Process control (SPC): Seven basic tools of quality control, control charts for variables**.** construction and interpretation and analysis of control charts process capability indices, process improvement through problem analysis. (Intensive coverage with numerical problems)
Control charts for attributes: construction, interpretation and analysis of P-chart np-chart, C-chart and U-chart, improvement through problem analysis. (Intensive coverage with numerical problems)

UNIT IV

Product acceptance control: Design of single sampling, double sampling and multiple samp [ling plan analysis of the characteristics of the SSP, DSP and MSP. (Intensive coverage with numerical problems)

Operating characerstics curves (OC-Curves): construction, characteristics of OC curves, Terms used in OC curves, LTPD, Outgoing quality Level, {OQL]), LTPD.AOQ, AOQL etc., (Intensive coverage with numerical problems)

UNIT V

Reliability and Life Testing: Reliability and analysis of components, standard configurations systems like series, parallel redundancy and principles of design for reliability. reliability testing (Intensive coverage with numerical problems)

Experimental design: one factor design, two factor design, orthogonal design, full factorial and fractional design .Taguchi philosophy of quality engineering, loss function, orthogonal array ,sign to noise function, parameter design, tolerance design (Basic concepts and treatment only).

TEXT BOOKS:

1. Total quality Management Dale H Berster field(etal) Pears education, Third edition Indian Reprint -2004
2. Statistical quality Control by Grant Levenworth (2000)

REFERENCE BOOKS:

1. Stastical quality control by Douglos C Mantego third editon Pearson Education -2006
2. A new American TQM for revolution in management:Sho- shiba, Alan Graham and, David walder Productivity press Oregon-1990
3. Organizational excellence through TQM H Lal, New Age Publishers
4. Quality control and Total quality management-PL Jain TMH Publications company Ltd - 2001 New Delhi
5. Total quality management and Text cases by Sreedhar Bhat. K Himalaya publishing House edition-1, 2002

Course Outcomes (COs):

1. Students can express basic approaches in TQM, will know the contribution of Quality gurus and able to explain the aspects of leadership qualities. [PO6,PO7,PO8,PO9,PO10, PO11 & PO12]
2. Students would have understood the details of various tools in TQM and concepts of QFD and FMEA [PO1,PO2,PO3,PO4,PO5,PO6,PO7,PO8,PO9,PO10,PO11,PO12, PSO1 & PSO2]
3. Students will be able to demonstrate their knowledge on Statistical process control tools, apply and interpret the same. [PO1,PO2,PO3,PO4,PO5,PO6,PO7,PO8,PO9,PO10, PO11, PO12,PSO1 & PSO2]
4. Students will be able to explain the concepts of sampling plan and quantify their characteristics. [PO1,PO2,PO5,PO10,PO11, PSO1 & PSO2]
5. Students will be able to explain the concepts of reliability and life test, and will be able to solve simple numericals. The students will also be able to explain the basic concepts of design of experiments with special reference to Taguchi method. [PO1,PO2,PO3, PO4,PO5,PO6,PO7,PO8,PO10,PO11,PO12,PSO1 & PSO2]

OPERATIONS RESEARCH

Course Code: MEE641 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. T ANIL KUMAR

Course Learning Objectives

1. Fundamentals of OR, formulation of linear programming problems.
2. Graphical solution, Simplex method, Big M method, duality principals
3. Various types of transportation and assignment problems
4. Replacement of machines at suitable time, queing model & Network analysis (PERT/CPM)
5. Games theory, solution by graphical method and dominance rule.

UNIT I

Introduction, Definition, History of OR, Scope of OR, Phases of OR, Characteristics of OR, Limitations of OR, Formulation of LPP, Graphical solutions. Linear Programming Problems-Simplex Method, Big M method.

UNIT II

Concept of Duality, Primal and Dual properties, Dual Simplex method.
Assignment problems Hungarian method, Maximization problem, unbalanced problems. Travelling Salesmen problems.

UNIT III

Transportation problems, basic feasible solution, optimality methods, unbalanced problems, maximization problems, degenerate problems.
Replacement problems: Replacement of machines with and without considering the value of money, Group replacement problems.

UNIT IV

Game theory: 2 person zero sum game, Games with and without saddle point, Graphical solutions for 2Xn, mX2 games, Dominance property.
Queing theory: Queing systems and their characteristics, M/M/1 Queing systems, problems.

UNIT V

PERT-CPM Techniques: Network construction, determining critical path, Floats, Project duration, PERT problems, Crashing of simple networks.

TEXT BOOKS:

1. Operations Research: An Introduction by Taha.H.A.-Pearson Education Edition.
2. Operations Research-S.D. Sharma, Kedarnath Ramnath and Co. 2002.

REFERENCE BOOKS:

1. Introduction to Operations Research- Hiller and Liberman, Mcgrawhill 5th Edition, 2001.
2. Operations Research-Principles and Practice, Ravindran, Philips, Wiley India Ltd, 2nd Edition 2007.

Course Outcomes (COs):

1. To formulate a given problem, then to solve either by Graphical/Simplex/Big M method. [PO1,PO2,PO3,PO7,PO9,PO12,PSO1,PSO2]
2. To create the duality property and solve and assignment problem [PO1,PO2,PO7,PO9, PO11,PO12,PSO1,PSO2]
3. To understand the transportation problems and find the best time to replace the old machine [PO1,PO2,PO3,PO9,PO11, PO12,PSO1,PSO2]
4. To evaluate the problems on games theory using graphical and dominance rule, Queuing theory application [PO1,PO2,PO7,PO9,PO11, PO12,PSO1,PSO2]
5. To Analyze the problems on PERT, CPM and crashing [PO1,PO2,PO3,PO7,PO12, PSO1,PSO2]

COMPUTATIONAL FLUID DYNAMICS

Course Code: MEE642 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. NAGESH S N

Course Learning Objectives:

1. Ability to apply knowledge of Mathematics, science and Engineering in static and dynamic flow analysis of fluids
2. Ability to design and understand how exactly CFD problems are categorized and differentiated before solving for solution
3. Ability to apply the exact mathematical, physical, thermal conditions to solve the given problem
4. Ability to identify, formulate and solve engineering problems either by using Finite element method or Finite volume method.
5. Ability to apply numerical methods like implicit or explicit methods.
6. Finally to apply and use the techniques, skills and modern engineering tools, necessary for engineering practice such as application of Engineering Maths, Engineering techniques and develop codes for solving flow related, chemical reactions or combustion problems.

UNIT I

Introduction to CFD: Comparison of Experimental, Theoretical & computational approach, 3-D general mass conversation, Momentum & Energy equation in differential form, Integral form.
Partial differential equations: Classification physical and mathematical, Equilibrium problems, Marching problems, Hyperbolic, parabolic problems, Elliptic and system of equations.

UNIT II

Basics of numerical methods: Solution of algebraic equations –Gauss elimination, Crouts method, Solution of ODE, Euler's, Rungekutta Method Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

UNIT III

Basics of Discretization methods: Finite difference equations, Finite difference rep.n of PDE, Truncation Error, Round off and Discretization error, Consistency, Stability, Convergence criteria.

UNIT IV

Application of numerical methods: Heat equation Simple explicit method, Richardson's method simple implicit method, Laplace equation FD rep.n, Simple example for Laplace equations

UNIT V

Finite volume Method: Finite volume method for diffusion equation-simple problems, Finite volume method for convection, diffusion equation, steady 1-dimensional convection diffusion, Conservativeness, boundedness, transportiveness, Central differencing schemes, upwind differencing schemes.

TEXT BOOKS:

1. Computational Fluid Mechanics and Heat transfer- 2nd Edition 1998, John C Tannehill, Dule A Anderson, Richard H, Taylor and Francis, UK 2001
2. Numerical Fluid and Heat Transfer, Patankar, 2000

REFERENCE BOOKS:

1. Numerical Methods for Engineers – Iyer and Iyer 2001
2. An Introduction to Computational Fluid dynamics H K V and W Malalasekera

Course Outcomes (COs):

1. Able to categorize the given problem and develop mass, momentum and energy equations [PO1,PO2,PO3,PO12,PSO1 &PSO2]
2. Able to understand and solve Basic Numerical methods [PO1,PO2,PO3,PO4,PO5, PO12, PSO1 &PSO2]
3. Able to discretize the given problem and develop FINITE DIFFERENCE EQUATIONS [PO1,PO2,PO3,PO4,PO12,PSO1 &PSO2]
4. Able to apply the numerical methods for heat and wave equations using implicit and explicit methods. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1 &PSO2]
5. Able to solve Finite Volume Method and related basic problems [PO1,PO2,PO3,PO4, PO5,PO12, PSO1 &PSO2]

NANOTECHNOLOGY

Course Code: MEE643 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. K.R.V. SUBRAMANIAN

Course Learning Objectives

1. To make students understand importance of nanotechnology and its application.
2. To enable them to understand the different synthesis and characterization methods for nanomaterials.
3. To encompass knowledge about fullerenes and carbon nano tubes
4. To enable them to understand the importance of graphene and metal nanoparticles.
5. To enable them to know about nanocomposites and nanotribology concepts.

UNIT I

An overview of Nanoscience & Nanotechnology – historical background – nature, scope and content of the subject – multidisciplinary aspects – industrial, economic and societal implications-Applications. Nanomaterials-Nano materials size effects - Classifications of nanomaterials - Zero dimensional, one-dimensional and two dimensional nanostructures - Methodology of synthesis- Top down and bottom up approaches.
Nanomaterials for electronics, health, solar, energy storage – Nano oxides in devices like FET, JFET, MOSFET, nano-oxides and nano-polymers in drug delivery and design, cancer therapy, oxides and nitride nanostructures in solar technology, graphene, carbon nanotubes, oxides for energy storage

UNIT II

Synthesis of nanomaterials – Overview of top-down and bottom-up techniques. Top down: Ball milling and arc discharge technique. Bottom up: CVD, PVD and sol gel technique.
Instruments and Methods – Electron microscopes: SEM and TEM. Scanning probe microscope: atomic force microscopy: x-ray diffraction

UNIT III

Fullerenes – discovery, synthesis and purification – chemistry of fullerenes in the condensed phase – orientational ordering – pressure effects – conductivity and superconductivity – ferromagnetism – optical properties-Applications.
Carbon Nanotubes – synthesis and purification – filling of nanotubes – mechanism of growth – electronic structure – transport properties – mechanical and physical properties – applications.

UNIT IV

Graphene – Discovery-electronic structure-synthesis – mechanical, optical and electrical properties – applications.

Monolayer-Protected Metal Nanoparticles – method of preparation– characterization – functionalized metal nanoparticles – applications
Nanofluids – types, synthesis methods, characterization, application in areas of solar, machining, petroleum, oil recovery

UNIT V

Nano Composites- Introduction to nanocomposites – classification- - properties of nanocomposite materials - synthesis of nanocomposite materials -Applications.
Nanotribology –Introduction- Nanotribometer-Surface force apparatus-quartz crystal microbalance – nano-lubrication- applications.

TEXT BOOKS

1. NANO: The Essentials – Understanding Nanoscience and Nanotechnology; T Pradeep (Professor, IIT Madras); Tata McGraw-Hill India (2007).
2. Nanocomposites Science and Technology - P. M. Ajayan, L.S. Schadler, P. V. Braun 2006.

REFERENCE BOOKS

1. Introduction to Nanoscale Science and Technology [Series: Nanostructure Science and Technology], Di Ventra, et al (Ed); Springer (2004)
2. Nanotechnology Demystified, Linda Williams & Wade Adams; McGraw-Hill (2007)
3. Introduction to Nanotechnology, Charles P Poole Jr, Frank J Owens, Wiley India Pvt. Ltd., New Delhi, 2007.
4. Nanostructures & Nanomaterials: Synthesis, Properties & Applications, G. Cao, Imperial College Press, 2004.

Course Outcomes (COs):

Students will be able to

1. To understand the nature, scope of the nanotechnology and its interdisciplinary application. [PO1,PO7,PO8,PO12,PSO1,PSO2]
2. Have a thorough knowledge of different synthesis techniques of nano materials and their characterization [PO1,PO2,PO3,PO4,PO12,PSO2] techniques
3. Describe the synthesis and properties of Fullerenes, CNT's and their applications [PO1,PO2,PO4,PO12,PSO2]
4. To explain the Graphene, Monolayered protected nano particles, their synthesis, properties and applications [PO1,PO2,PO4,PO12,PSO2]
5. Familiarize the approaches about the nano composite materials, their properties and applications also understand the concept of nanotribology and their applications [PO1,PO2,PO4,PO12,PSO2]

NON TRADITIONAL MACHINING

Course Code: MEE644 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. MOHANDAS K N

Course Learning Objectives:

1. Introduction of non-traditional machining methods and their difference with conventional machining methods
2. Different classification criteria of non-traditional machining methods and their classifications
3. Working principle of various non-traditional machining methods
4. Process details of various non-traditional machining methods
5. Applications, advantages and limitations of non-traditional machining

UNIT I

Introduction to NTM, Classification of NTM, Comparison between conventional and Non conventional process.

Ultrasonic Machining: Introduction, Equipment, Tool material and tool size, Abrasive slurry, cutting tool system design, Effect of parameter: effect of amplitude, frequency, Effect of vibration, abrasive diameter, Effect of applied static load, slurry, tool and work material, USM process characteristics: MRR, tool wear, accuracy, surface finish, Application, advantages and disadvantages of USM.

Abrasive Jet Machining: Introduction, Equipment, Variables in AJM, Carrier gas, types of abrasive, size of abrasive grain, Velocity of the abrasive jet, mean number, abrasive particles/unit volume of carrier gas, Work material, stand-off distance, nozzle design, shape of cut, Process characteristics: MRR, nozzle wear, accuracy, surface finish, Applications, advantages and disadvantages of AJM.

UNIT II

Electro Chemical Machining: Introduction, study of ECM machine, elements of ECM, Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of process, ECM process characteristics,-MRR, accuracy, surface finish, ECM tooling: ECM tooling technique and Example, Tool and insulation materials, tool size, electrolyte flow arrangement, Handling of slug, Economics of ECM, applications such as electrochemical turning, Electrochemical grinding, Electrochemical honing, deburring, advantages, limitations.

Chemical Machining: Introduction, elements of process, Chemical blanking process: preparation of work piece, Preparation of masters, masking with photo resists, etching for blanking, Accuracy, applications of chemical blanking, chemical milling, Process steps-masking, etching, process characteristics of CHM, MRR, accuracy, surface finish, hydrogen embrittlement, Advantages and application of CHM.

UNIT III

Electro Discharge Machining: Introduction, Mechanism of material removal, Dielectric fluid, Spark generator, EDM tools, electrode feed control, electrode manufacture, Electrode wear, EDM tool design, choice of machining operation, Electrode material selection, under sizing, length of electrode, machining time, Flushing, pressure flushing, suction flushing, Side flushing, pulsed flushing, EDM process characteristics: MRR, accuracy, surface finish, HAZ, machine tool selection, Application, EDM accessories/ applications, Electric discharge grinding, traveling wire EDM.

UNIT IV

Plasma Arc Machining: Introduction, equipment, nonthermal generation of plasma, Selection of gas, Mechanism of metal removal, PAM parameter, Process characteristics, safety precautions, applications, advantages and limitations.

Laser Beam Machining: Introduction, equipment of LBM, Mechanism of metal removal LBM parameters, process characteristics, Advantages, limitations.

UNIT V

Electron Beam Machining: principles, Equipment, operations, Applications, advantages, limitations of EBM.

Water Jet Machining: principle, equipment, operation, Applications, advantages and limitations of WJM.

TEXT BOOKS

1. Modern Machining Processes, Pandey, P.C. and Shan, H. S., Tata McGraw Hill Publications (2018).
2. Production Technology, HMT, Tata McGraw Hill, 2010

REFERENCE BOOKS

1. Advanced Machining Processes, Vijay K Jain, Allied Publishers Mumbai, 2002.
2. Unconventional Manufacturing Process, M K Singh, New Age International, 2010.

Course Outcomes (COs):

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

1. Recognize the importance of NTM methods and describe Ultrasonic and abrasive jet machining processes. [PO1,PO5,PO7,PO12,PSO1 &PSO2]
2. Illustrate the working principle and applicability of the electro-chemical and chemical machining processes. [PO1,PO2,PO5,PSO1 &PSO2]
3. Describe the importance of Electro Discharge machining process, aspects related to MRR, surface finish. [PO1,PO2,PO4,PO7,PSO1 &PSO2]
4. Illustrate the working principle, advantages, process limitations of PAM, LBM processes. [PO1,PO4,PSO1 &PSO2]
5. Choose a process for machining, material for different applications to satisfy the requirement of the modern day developments. [PO1,PO2,PO5,PO12,PSO1 &PSO2]

BASIC TO MACHINE LEARNING & PYTHON

Course Code: MEE645 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. JAYA CHRISTIYAN K G

Course Learning Objectives

1. To introduce students to the Read and write simple Python programs.
2. To make students learn the basics of machine learning and apply concept learning to real time scenarios.
3. To give an introduction to working of Decision trees.
4. To understand the importance Bayesian learning algorithm and its variants, Instance based learning.
5. To learn the role of concept learning, Bayes classifier, k nearest neighbour, Regression.

UNIT I

Introduction, Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments. Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: while, for.

UNIT II

Strings: string slices, immutability, string functions and methods, string module. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters. Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods.

UNIT III

What is Machine Learning, Benefits, opportunities and risk for the mechanical engineering, Well-posed learning problems, Designing a learning system, Perspectives and Issues, a concept learning task, Concept learning as search, Find-S: Finding a maximally specific hypothesis, Version spaces and candidate elimination algorithm.

UNIT IV

Decision tree learning: Representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, Introduction to Linear and Non-Linear regression

UNIT V

Bayes Theorem and Concept learning, Maximum Likelihood and Least Squared Error, Maximum Likelihood hypotheses for predicting probabilities Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, Instance based learning: k-nearest neighbor learning, Locally weighted regression

TEXT BOOKS:

1. Think Python: How to Think Like a Computer Scientist Allen B. Downey Shroff O'Reilly Publishers 2nd edition 2016
2. An Introduction to Python – Revised and updated for Python 3.2 Guido van Rossum and Fred L. Drake Jr Network Theory Ltd., 2011
3. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (INDIAN EDITION), 2013

REFERENCE BOOKS:

1. Introduction to Programming in Python: An Inter-disciplinary Approach Robert Sedgewick, Kevin Wayne, Robert Dondero Pearson India Education Services Pvt. Ltd 2016
2. Fundamentals of Python: First Programs Kenneth A. Lambert CENGAGE Learning 2012
3. Ethem Alpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.

Course Outcomes (COs):

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

1. Read and write by hand simple Python programs. [PO1,PO2,PO3,PO4 & PO5]
2. Outline the preliminaries of machine learning and apply concept learning to real time scenarios. [PO1,PO2,PO3,PO4 & PO5]
3. Illustrate the working of Decision trees. [PO1,PO2,PO3,PO4 & PO5]
4. Describe Bayesian learning algorithm and its variants, Instance based learning. [PO1,PO2,PO3,PO4 & PO5]
5. Investigate concept learning, Bayes classifier, k nearest neighbor, Regression. [PO1,PO2,PO3,PO4 & PO5]

MECHATRONICS AND MEMS

Course Code: MEE646 **Course Credits: 3:0:0**
Prerequisite: Nil
Course Coordinator: Dr. R KUMAR

Course Learning Objectives:-

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

1. Define Mechatronics systems and recognize its various elements.
2. Compile the key elements of signal conditioning circuits.
3. Express the concepts of actuation systems.
4. Express the concepts of programming logic controllers.
5. Understand the concept of MEMS

UNIT I

Mechatronics, Sensors and Transducers: Introduction to Mechatronics Systems, Measurement Systems Control Systems Microprocessor based Controllers. Sensors and Transducers Performance, Terminology Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light sensors selection of sensors.

UNIT II

Signal Conditioning: Introduction to signal conditioning. The operational amplifier, Protection, Filtering, wheat stone bridge, digital signals Multiplexers, data acquisition, Introduction to Digital system processing pulse modulation, Numerical problems

UNIT III

Actuation System: Electrical Actuation Systems - Mechanical Switches – Solid State Switches, Solenoid Construction and working principle of DC and AC Motors speed control of AC and DC drives, Stepper Motors-switching circuitries for stepper motor – AC & DC Servo motors. Introduction to Hydraulic and Pneumatic actuation systems and their application

UNIT IV

Micro Electro Mechanical Systems (MEMS): Introduction –MEMS, MEMS micro sensor, Mems micro actuator, manufacturing processes of MEMS, commonly used MEMS micro sensors, Advantages and applications of MEMS.

UNIT V

Programmable Logic Controllers:
Programmable Logic Controllers– Basic Structure – Input / Output Processing – Programming –Mnemonics – Timers, Internal relays and counters – Shift Registers-Master and Jump Controls – DataHandling – Analogs Input / Output – Selection of a PLC. Experiments on Home automation with the application of PLC.

TEXT BOOKS:

1. Mechatronics- W. Bolton, Longman, 2nd Pearson Publications, 2007
2. Microprocessor Architecture, programming and applications with 8085.8085A- R.S. Ganokar, Wiley Eastern.

REFERENCE BOOKS:

1. Mechatronics Principles & applications by Godfrey C. Canwerbolu, Butterworth-Heinemann 2006.
2. Mechatronics- danNecsulescu, Pearson Publication, 2007
3. Introduction Mechatronics & Measurement systems, David. G. Aliciatore & Michael.B. Bihistand, tata McGraw Hill, 2000. Mechatronics: Sabricentinkunt, John wiley& sons Inc. 2007

Course Outcomes (COs):

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

1. Define Mechatronics systems and recognize its various elements. [PO1,PO2,PO3,PO4 & PO5]
2. Compile the key signal conditioning circuits. [PO5]
3. Demonstrate the concepts of system models and controllers. [PO1,PO2,PO3,PO4 & PO5]
4. Understand the concepts of programming logic controllers. [PO1,PO2,PO3,PO4 & PO5]
5. Understand the concepts of MEMS. [PO1,PO2,PO3,PO4 & PO5]

CNC MACHINES

Course Code: MEE647 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. JAYA CHRISTIYAN K G

Course Learning Objectives

1. Recognize the need for numerically controlled machine tools
2. Use the knowledge of AC and DC motors for selecting drives for CNC machines
3. Apply the fundamental concepts of numerical control for designing CNC machines
4. Formulate the part programs for operating CNC machines.
5. Verify the CNC machines for various parameters like accuracy and safety.

UNIT I

Numerical Control of Machine Tools: Fundamental concepts, Classification and structure of numerical control systems, open and close loop systems, Point systems, positioning cum straight cut systems, continuous path systems, coding Systems, program mediums –tape format and codes, interpolators – linear interpolation, Circular interpolation and parabolic interpolation, feedback devices – encoders, linear Scales inductosyn, resolvers.

Drives for CNC Machine Tools: Introduction to drives, spindle drives, Requirements, types of spindle drives – AC drives and DC drives; feed drives – Requirement, servo mechanisms, types of feed drives – stepper motors, DC servo drives, AC servo drives, selection criterion for drive system.

UNIT II

Design of Modern CNC Machines and Manufacturing Elements (Excluding Numerical Problems): Introduction, machine Structures, guide ways – linear motion guides, feed drives, servo motors, mechanical Transmission systems including ball screws. Timer belts, flexible belts, flexible Connections for connection encoders, spindle / spindle bearings, measuring systems. Controls, software and user interface, gauging, tool monitoring systems.

UNIT III

Assembly Techniques: Guide ways, ball screws and nut, feedback elements, spindle bearings.

Introduction to Modern CNC Machines and Manufacturing Systems: Introduction, advantages of CNC Machines, CNC machining center developments, turning center developments, automatic tool changing, tool monitoring on CNC machine, other CNC machine development like adaptive control, advanced manufacturing systems, benefits of FMS, trends in adaptation of FMS systems.

UNIT IV

Programming and operation of CNC Machine: Introduction to part programming, co-ordinate systems, dimensioning, axes and motion nomenclature, structure of a part program, word address format, circular interpolation, tool compensation, sub-routines, canned cycles, programming examples for machining centers, programming for turning center, computer assisted part programming,

UNIT V

Testing of CNC Machine Tools: Introduction, Verification of technical specification, verification of functional aspect, verification during idle running, verification of machine tool accuracy & work piece accuracy, metal removal capability test, safety aspects.

TEXT BOOKS:

1. Computer control of Manufacturing Systems - Yoram Koren, McGraw Hill Intl. Pub.
2. Mechatronics - HMT Ltd., Tata MaGraw Hill Pub.

REFERENCE BOOKS:

1. Numerical control of machine tools - S.J. Martin
2. Computer Numerical Control - Joseph Pusztai and Michael Sava
3. Programming for Numerical Control - Roberts Prentice.
4. Numerical control and Computer Aided Manufacture - Pressman and Williams.
5. CAD/CAM - Mikell P. Groover and Emory W. Zimmers Jr.
6. Introduction to Automated Process Planning System - Tiess Chieu Chang & Richard A. Wysk

Course Outcomes (COs):

1. The student will be able to identify the importance of CNC machines in the modern world [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2]
2. The student will be able to select drives for CNC machines [PO1,PO2,PO3,PO5,PO11, PO12,PSO1,PSO2]
3. The student will be able to construct the different components of CNC machines [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2]The student will be able to write NC part programs for milling and turning [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2]
4. The student will be able to assess the CNC machines for various functional parameters [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2]

MINI PROJECT

Course Code: ME65 **Course Credits: 0:0:4**
Prerequisite: Nil
Course Coordinator: Dr. RAJEESH S

Course learning objectives

1. Demonstrate a systematic understanding of project contents;
2. Understand methodologies and professional way of documentation;
3. Know the meaning of different project contents;
4. Demonstrate a wide range of skills and knowledge learned,
5. Understand established techniques of project report development.

Course Outcomes (COs):

After successful completion of this course, students will be able to

1. Identify problem specification and develop conceptual design and methodology of solution for the problem with mathematical and scientific approach. [PO1-P012 and PSO1 & PSO2]
2. Learn team work and share responsibility. [PO1-P012 and PSO1 & PSO2]
3. Develop and implement ideas to build physical model in order to meet the society, curriculum requirements and needs. [PO1-P012 and PSO1 & PSO2]
4. Demonstrate to respect the professional and ethical values of engineering problems. [PO1-P012 and PSO1 & PSO2]
5. Develop effective communication skills for presentation of project related activities & engage themselves for lifelong learning to meet the technological challenges. [PO1-P012 and PSO1 & PSO2]

FINITE ELEMENT ANALYSIS -LAB

Course Code: MEL66 **Course Credits: 0:0:1**
Prerequisite: Nil
Course Coordinator: Dr. LOKESHA

Course Learning Objectives:

1. Apply the knowledge of FEM to construct finite element models using the library of finite elements available in the software
2. Choose suitable number of finite elements for the given domain to carry out analysis
3. Use the appropriate type of boundary conditions for the given problem
4. Solve the problem using a commercially available software (Solver)
5. Compare the results obtained using FEA with analytical or experimental techniques.

List of Exercises:

2. Bars of constant cross section area, tapered cross section area and stepped bar, Multipoint Constraints, Temperature Stresses in 1D Bars
3. Trusses
4. Beams – Simply supported, cantilever beams with UDL, beams with varying load etc
5. Stress analysis of a rectangular plate with a circular hole subjected to both axial and bending
6. Thermal Analysis – 2D problem with conduction and convection Boundary conditions.
    a. Natural Frequencies of Spring mass and dampers systems of Single and two degrees Systems.
    b. Natural Frequencies of fixed – fixed beam.
    c. Bars subjected to forcing function
    d. Fixed- Fixed beam subjected to forcing function.

TEXT BOOK:

1. FEA Laboratory Manual ------By the Department of Mechanical Engineering, MSRIT

REFERENCE BOOK:

1. Practical Finite Element Analysis ---- Published By Finite to Infinite, Pune, India. ---- ISBN 978-81-906195-0-9

Course Outcomes (COs):

1. Demonstrate the use of FEA tools for different Engineering Problems [PO1,PO2,PO12,PSO1 &PSO2]
2. Predict the performance of Structural member [PO1,PO2,PO3,PO4,PO12,PSO1 & PSO2]
3. Analyze the results obtained from is FEA tool [PO1,PO2, PO5,PO12,PSO1 &PSO2]

Scheme of Examination:

The student should solve 2 exercises. 1 of them should be a heat transfer / vibration problem.
Each exercise carries 20 marks.
Viva – Voce carries 10 Marks
Total Maximum Marks = 50

HEAT AND MASS TRANSFER-LAB

Course Code: MEL67 **Course Credits: 0:0:1**
Prerequisite: Nil
Course Coordinator: Dr. PUTTABORE GOWDA

Course Learning Objectives:

Student is expected to

1. To understand the concept and theoretical aspects of experiments conducted in the laboratory.
2. To analysis and solve practical problems from various modes of heat transfer by using basic principles.
3. To investigate complex heat transfer problems and provide solutions using heat transfer data hand book.

LIST OF EXPERIMENTS:

1. Determination of Thermal Conductivity of a Metal Rod.
2. Determination of Overall Heat Transfer Coefficient of a Composite wall.
3. Determination of Effectiveness of a Metallic fin.
4. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
5. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
6. Performance evaluation of vapour compression refrigeration system.
7. Determination of Emissivity of a Surface.
8. Determination of Stefan Boltzman Constant.
9. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
10. Performance test on air conditioning system to understand different psychrometric process
11. Determination of overall heat transfer co-efficient in drop and film wise condensation.
12. Study of two phase but transfer phenomena for pool boiling.

REFERENCE BOOKS:

1. Heat transfer Manual prepared by Department of Mechanical Engineering.
2. Heat and Mass Transfer, 2006., M.Thirumaleshwar, Pearson Edition.
3. Heat and Mass Transfer data book (seventh Edition) C P Kothandaraman and S Subramanyam

Course Outcomes (COs):

1. To determine the thermal conductivity, heat transfer coefficient and stefen Boltzman constant. [PO1,PO2,PO4,PO5,PO9,PO12,PSO1,PSO2]
2. To analyze and solve practical problems in various modes of heat transfer. [PO1,PO2,PO4,PO5,PO9,PO12,PSO1,PSO2]
3. To investigate complex heat transfer problems and provide solutions. [PO1,PO2,PO4,PO9,PO10,PO12,PSO1,PSO2]

Scheme of Examination

1. Students should have obtained not less than 75% attendance and 20 CIE Marks to become eligible for appearing the examination.
2. Students have to conduct two experiments (One group experiment and one individual experiment).

Group Experiment	25
Individual Experiment	15
Viva-voce	10
Max Marks	50

DESIGN AND DYNAMICS LABORATORY

Course Code: MEL68 **Course Credits: 0:0:1**
Prerequisite: Nil
Course Coordinator: Dr. BALASUBRAMANYA H S

Course Learning Objectives:

1. To develop skill in conducting experiments related to vibrations and their measurements
2. To develop skills in carrying experiments related to photo elasticity
3. To develop skills in conducting experiments related to dynamics of machines such as governors and determination of stresses & strains using strain gauges.

List of Experiments

1. Longitudinal vibration of spring mass system
2. Transverse vibration of a beam
3. Longitudinal vibration of spring mass system loaded through beam
4. Single rotor system subjected to torsional vibration
5. Two rotor system subjected to torsional vibration
6. Porter governor
7. Hartnell governor
8. Whirling of shafts with pulley and without pulley
9. Determination of principal stresses and strains in a member subjected to combined loading strain rossets
10. Determination of fringe constant of photoelastic material using circular disc
11. Determination of fringe constant of photoelastic material using pure bending specimen
12. Determination of stress concentration using photoelasticity.
13. Determination of fringe constant of photoelastic material using circular disc & Pure bending specimen using polychromatic light.
14. Static & Dynamic Balancing of masses in single plane and several planes - Demo
15. Pressure distribution in journal bearing
16. Gyroscope – Demo
17. FFT analyzer – Demo

TEXT BOOK:

1. Design laboratory manual, Department of Mechanical Engineering, MSRIT.

Course Outcomes (COs):

1. Apply the principles of dynamics & Mechanical vibrations, design & conduct experiments related to Longitudinal, transverse, torsional vibrations, Governors, bearings and lubrication. [PO1,PO2,PO3,PO4,PO9,PO12,PSO1 & PSO2]
2. Demonstrate the use of experimental techniques and design the machine elements using Polarioscope and strain gauges. .[PO1,PO2,PO3,PO4,PO9,PO12,PSO1 & PSO2]
3. The above skills with practical experiments will equip students to realize efficient & better design of machine elements in practice. .[PO1,PO2,PO3,PO4,PO9,PO12,PSO1 & PSO2]

Scheme of Examination

1. Students should have obtained not less than 75% attendance and 20 CIE Marks to become eligible for appearing the examination.
2. Students have to conduct two experiments (One group experiment and one individual experiment).

Group Experiment	25
Individual Experiment	15
Viva-voce	10
Max Marks	50

OPEN ELECTIVES

Subject Code	Subject	Credits
MEOE01	3D Printing	3:0:0
MEOE02	Finite Elements Method	3:0:0
MEOE03	Sustainable Waste Management Techniques	3:0:0
MEOE04	Traditional Indian Science and Technology	3:0:0
MEOE05	Automotive Engineering	3:0:0
MEOE06	Non-Conventional Energy Sources	3:0:0
MEOE07	Product Design & Manufacturing	3:0:0
MEOE08	Non-Destructive Testing	3:0:0
MEOE09	Fundamentals of Electric Vehicle Technology	3:0:0
MEOE10	CNC Machines	3:0:0
MEOE11	Science, Education and Technology for Rural India	3:0:0

3D PRINTING

Course Code: MEOE01 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. JAYA CHRISTIYAN K G

Course Learning Objectives

1. The aim of the course is to provide the students, with an opportunity to conceive, design, and implement products quickly and effectively, using the latest Additive Manufacturing Techniques.
2. Technologies associated with material addition process are identified and its advantages are evaluated.
3. Students learn to differentiate various process parameters associated with Additive Manufacturing Technique & choose tooling techniques for a specific application.
4. Learn how relative improvements can be established by using computers and optimization techniques as compared to initial, manual solutions.
5. Students learn the Software associated with rapid prototyping techniques is explored.

UNIT I

Additive Manufacturing, The Generic AM Process, AM Information work flow, AM – An Integral part of Time compression Engineering, The Benefits of AM, Distinction Between AM and CNC Machining.

Reverse Engineering Technology: Introduction to reverse Engineering, Computer aided forward/Reverse Engineering, Reverse Engineering Hardware, Contact methods, Non contact Methods, Reverse Engineering Software.

UNIT II

Classification of AM Processes: Liquid Polymer Systems, Discrete Particle Systems, Molten Material Systems, Solid Sheet Systems, New AM Classification Schemes, Metal Systems, Hybrid Systems,

Design for AM: Part Orientation, Removal of Supports, Hollowing Out Parts, Reduction of Part Count in an Assembly.

UNIT III

Vat Photo polymerization Processes: Introduction, Vat Photo polymerization Materials, Photo polymerization Process,

Powder Bed Fusion Processes: Introduction, Materials, Powder Fusion Mechanisms, Process Parameters and Modeling, Polymer Laser Sintering

UNIT IV

Extrusion-Based Systems: Introduction, Basic Principles, Fused Deposition Modeling from Stratasys, Materials, Limitations of FDM, Bio extrusion,

Directed Energy Deposition Processes: Introduction, Material Delivery, Powder Feeding, Wire Feeding, Laser Based Metal Deposition Processes; Electron Beam Based Metal Deposition Processes

UNIT V

Direct Methods for Rapid Tool: RTV Tools, Paper Pulp Molding Tools
Indirect Methods for Rapid Tool Rapid Tooling: Silicone rubber tooling, Aluminum filled epoxy tooling, and Spray metal tooling.
Applications for Additive Manufacture: Medical, art models, Engineering analysis models, Functional models.

TEXT BOOKS:

1. Additive Manufacturing Technologies, I. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht London, 2010.
2. Stereo lithography and other RP & M Technologies, Paul F.Jacobs: "SME, NY 1996.
3. Rapid manufacturing, FIham D.T & Dinjoy S.S verlog London 2001.

REFERENCE BOOKS:

1. Rapid prototyping, Terry Wohler's Report 2000" association 2000.
2. Rapid prototyping materials by Gurumurthi. IISc Bangalore.
3. Rapid automated by lament wood. Indus press New York.

Course Outcomes (COs):

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

1. Describe the differences and of the application of a range of additive manufacturing processes [PO1,PO2,PO4,PO12,PSO1,PSO2]
2. Select and use correct CAD formats in the manufacture of a 3D printed part. [PO1,PO2,PO4,PO12,PSO1,PSO2]
3. Understand the operating principles, capabilities, and limitations of liquid and solid based additive manufacturing system, including fused deposition modeling and stereolithography. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1,PSO2]
4. Appreciate the operating principles, capabilities and limitations of powder based additive manufacturing system, including 3D printing and laser sintering [PO1,PO2,PO3,PO4,PO5, PO12,PSO1,PSO2]
5. Describe the important process parameters of AM techniques [PO1,PO2,PO3,PO4, PO5,PO12, PSO1,PSO2]

FINITE ELEMENT METHOD

Course Code: MEOE02 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. LOKESHA

Course Learning Objectives

1. To understand basics of engineering mechanics and finite element methods.
2. To understand finite element formulation for 1D and 2D problems.
3. To be able to solve bar, truss and beam problems using finite element method.
4. To understand linear and non linear principles in engineering mechanics.
5. To be able to understand the working principle of finite element analysis commercial package.

UNIT I

Introduction: Stress, strain, equilibrium equations and compatibility conditions, stress-strain relations, kinetic and potential energy associated with deforming bodies, Principle of minimum potential energy. Mathematical models and solutions of physical problems - Analytical and Numerical solutions, the overview of finite element method (FEM) - Basic steps of finite element methods.

UNIT II

Bar Element: Need and applications of bar element, coordinate system, Local coordinate system, natural coordinate system, Shape functions of linear simplex element, stiffness matrix by potential energy approach, Load vector, Problems on bar subjected to simple loading.

UNIT III

Truss Element: Need and applications of truss element, truss element, Elemental stiffness matrix, Element stress, Problems on trusses.

UNIT III

Beam element: Need and applications of beam element, Hermite shape function, Stiffness matrix, Load vector, Problems on beams.

UNIT IV

CST and Quad elements: Introduction, shape functions and strain - displacement matrix of CST and four node quadrilateral element, simple numerical

UNIT V

Introduction to higher order elements: three and four node 1D elements, six node triangular element, eight and nine node quadrilateral element.

FEA packages: Preprocessor, solver, post processor, latest FEA package available and their capabilities.

TEXT BOOKS

1. Finite Element IN Engineering, Chandrupatla T.R., 2nd Edition, PHI,2000
2. The Finite Element Method in Engineering, S.S.Rao, 4th Edition, Elsevier, 2006

REFERENCE BOOKS

1. Text book of Finite Element Analysis, P. Seshu, 2004
2. Finite Element Method, J.N. Reddy, McGraw- Hill International Edition.
3. Finite Element Analysis, C.S. Krishnamurthy,- Tata McGraw Hill Publishing co. Ltd, New Delhi, 1995

Course Outcomes (COs):

1. By the end of this course, the student will be able to recite and interpret the importance of FEM in engineering mechanics. (PO1,2,3,4,5,7, PSO1 &PSO2)
2. By the end of this course, the student will be able to derive shape functions, stiffness matrix, load vectors and mass matrix for a given 1D and 2D element. (PO1,2,3,4,5,7, PSO1 &PSO2)
3. By the end of this course, the student will be able to demonstrate the principle of FEM in solving bar, truss and beam problems. (PO1,2,3,4,5,7, PSO1 &PSO2)
4. By the end of this course, the student will be able to identify the application of higher order elements. (PO1,2,3,4,5,7, PSO1 &PSO2)
5. By the end of this course, the student will be able to understand the application of FEM software packages in solving the engineering mechanics problems. ((PO1,2,3,4,5,7, PSO1 &PSO2)

SUSTAINABLE WASTE MANAGEMENT TECHNIQUES

Course Code: MEOE03 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. JYOTHILAKSHMI R

Course Learning Objectives:

1. Being a member of a planet, we have to understand how the ecosystem of the planet is deteriorated in the last two centuries. Sources of deterioration, types of waste generated, and the manners, in which wastes are managed, are to be studied.
2. Grasping the humongous problem and thinking about the methods to tackle it.
3. Minimizing waste generation will only postpone the debacle.
4. Designing new methods of not generating waste.
5. Understanding practical aspects of waste management and develop sustainable methods to manage the waste management systems.

UNIT I

Municipal solid waste management—Introduction, types of wastes, and sources, composition, generation rate, collection of waste, separation, transfer and transport, treatment and disposal options. Special emphasis on a) single-use plastics 2) e-waste 3) urban mining.

UNIT II

Sustainability-Introduction, 10 reasons for business to become sustainable. Waste defined, typical forms of waste. Biases towards waste.4-steps to achieve sustainability as an objective. Stahel's ratio of manpower to energy use in production and closed-loop material recovery. Life extension -beginning with waste elimination. Managing the change. Saving waste. Micro- power generation.10 ways to minimize product waste. Minimizing packages. Reuse, Repair, Remanufacture and Recycle.

UNIT III

Cradle to Cradle (C2C). Brief history of industrial revolutions. Cradle to Grave design. Strategy of tragedy or strategy of change. "Less bad "is no good. The four Rs. Eco effectiveness. Waste equals food to metabolism. Diversity. Natural energy flows. Diversity of "Isms". An Industrial Revolution.5 steps to eco effectiveness. 5 guiding principles. Cradle to Cradle design, guidelines.

UNIT IV

C2C certification process. New products developed in this field. Problems of incineration, land filling and composting. Ways to follow C2C. Water saving. Related concepts—Biomimicry, Blue economy, Industrial ecology, Resource recovery, System thinking and Biosphere Rules.

UNIT V

Field Trips and Case Studies on Solid waste management sites, case studies, summary and report preparation. Preparation of detailed steps for implementation of waste management methods learnt.

REFERENCE BOOKS:

1. Waste to wealth: The circular economy advantages by Peter Lacy and Jacob Rutqvist
2. The circular economy: A wealth flows-Ken Webster, Ellen MacArthur
3. Integrated Solid Waste Management George Tachobanoglous et al
4. Manual on Municipal Solid Waste Management Govt of India, CPHEEo, Ministry of Urban Development, New Delhi,2000
5. Upcycle ---William McDonough and Michael Brangart
6. The Sustainable Business---Jonathan T. Scott
7. Cradle to Cradle --William McDonough and Michael Brangart

Course Outcomes (COs):

After going through this course the student will be able to:

1. Understand the concept of waste generation, types of wastes and characterization of waste [PO1-PO5]
2. Demonstrate ways of eliminating waste generation and methods of energy generation using waste along with the concepts of repair, Remanufacture and recycle [PO1-PO5]
3. Understand the concept of cradle to cradle design systems [PO1-PO5]
4. Understand C2C certification process and new product development [PO1-PO5]
5. Analyse practical aspects of Waste management and come out with sustainable solutions [PO1-PO5]

TRADITIONAL INDIAN SCIENCE AND TECHNOLOGY

Course Code: MEOE04 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. B P HARICHANDRA

Course Learning Objectives: To teach the students to:

1. To have knowledge of areas where Indians had excelled in Traditional Indian Sciences and Technologies (TISTs)
2. To understand some of the traditional technologies, which could have some modern applications
3. To understand some of the traditional technologies, which are/were far more superior and challenging than the modern ones
4. To understand the pioneering science and technologies of India
5. To be able identify research potentials in TISTs

UNIT I

Introduction: Scope, authors of ancient Indian books/theories/formulae, introduction to vedic literature. Introduction to Indian medical sciences and yoga. Ashtanga yoga, Introduction to state of Indian agriculture and agri-business. Research potentials.

UNIT II

Materials & metallurgy: Typical marvels of Indian iron and steel, Processing of zinc and its alloys, brozes of south India, introduction to Rasaratnasamucchaya, typical method of preparation of bhasma (nano-herbo-metallic compounds). Research potentials.

UNIT III

Aeronautics: Rockets and Rocketry, Bharadwaja Vimana Shastra-typical vimanas, unique concepts, technologies, fuels and materials in BVS. Research potentials.

UNIT IV

Astronomy: Time scale, measurement of time, historic astronomical instruments and observatories. Description of planets, grahas, earth, sun and moon in traditional literature.

UNIT V

Vedic mathematics: Introduction to vedic mathematic sutras, Simple numerical Multiplication, division, squares, square roots, cubes, simultaneous equations, Taylor series, Leibnitz power series, modified Leibnitz series, infinite GP. Geometrical studies, magic squares. Value of pi in Indian mathematics.

TEXT BOOKS:

1. Indian Scientific Heritage – Dr. N Gopalakrishnan, Indian Institute of Scientific Heritage, Thiruvananthapuram, kerala
2. Yoga: Its basis and applications – Dr. H R Nagendra, Swami Vivekananda Yoga Prakashana, Bangalore, India
3. Vymaanikashaastra – Aeronautics by Maharshi Bharadwaaja, translated by G R Josyer, International academy of Sanskrit research.
4. Rasaratna Samuchaya – A D Satpute, Chowkamba Sanskrit Prathistan
5. Encyclopedia of Classical Indian Sciences – Dr. Roddam Narasimhan and Helaine Selin, Vijaykumar Govindram Hasanand Publications, University Press (India) Pvt. Ltd., Hyderabad
6. Faculty Notes

REFERENCE BOOKS:

1. Founders of sciences in Ancient India – Swamy Sathyaprakash Saraswathi
2. Indian Technological Heritage – Dr. N Gopalakrishnan, Indian Institute of Scientific Heritage, Thiruvananthapuram.
3. Science & Technology in 18th Century, Prof. Dharampal, Other India Press, Mapusa, Goa.
4. Vedic Mathematics – Bharathi Krishna Theertha Swamiji, MBLD Publications, New Delhi.

Course outcomes (COs):

At the end of the course, the students:

1. Will be able to identify areas where Indians had excelled in Traditional Indian
2. Sciences and Technologies (TISTs)
3. Would have understood some of the traditional technologies, which could have some modern applications
4. Would have understood some of the traditional technologies, which are/were far more superior and challenging than the modern ones
5. Would have understood typical pioneering science and technologies of India
6. To be able identify research potentials in TISTs

AUTOMOTIVE ENGINEERING

Course Code: MEOE05 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. LOKESHA / Mr. GURURAJ

Course Learning Objectives:

The students shall be able to:

1. Understand IC engine, its components and different types of fuels.
2. Develop skills in fuel supply & ignition systems for SI and CI engines.
3. Develop skills in power trains.
4. Understand basic types of automotive chassis, springs and brakes.
5. Develop skills in automotive emission control and boosting system.

UNIT I

Introduction: IC Engine, SI & CI engine, Components of an engine, valve timing diagram of 4 stroke engine, cooling and lubrication requirements, methods of cooling and lubrication.
Fuels: Conventional fuels, LPG and Natural gas, alternate fuels like ethanol and ethanol blends, introduction to new fuels for Automotive Engines like hydrogen, hybrid fuels and fuel cells. Normal and abnormal combustion.

UNIT II

Fuel supply systems for SI and CI engines: Properties of air-fuel mixtures - Mixture requirements for steady state and transient operation, Fuel Supply system for gasoline and diesel engine. Basic principle of fuel pump, carburetor and fuel injector.
Ignition systems: Battery Ignition systems, magneto Ignition system, Electronic Ignition, Automatic Ignition advance systems.

UNIT III

Power Trains: Principle of friction clutches and constructional details, Single plate, multi-plate and centrifugal clutches.
Gear box: Necessity for gear ratios in transmission, synchromesh gear box. Freewheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epi-cyclic gear box, principles of automatic transmission.
Drive to wheels. Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, hydraulic and electric power assisted power steering.

UNIT IV

Automotive Chassis & Suspension system: Types of chassis layout with reference to power plant locations and drive, Vehicle frames. Various types of frames. Constructional details,

Materials, Loads acting on vehicle frame. Requirements suspension system, Torsion bar suspension systems, leaf spring, coil spring, dependent and independent suspension system, Air suspension system.

Brakes: Types of brakes, mechanical, air, hydraulic braking systems, Disk brakes, drum brakes, Antilock –Braking systems.

UNIT V

Automotive emission control systems: Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas, Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Catalytic converter, Emission standards- Euro I, II, III and IV norms, Bharat Stage II, III norms.

Boosting system for IC engine: Superchargers, Turbochargers, Turbocharger lag.

TEXT BOOKS:

1. Automotive mechanics, William H Crouse & Donald L Anglin, 10th Edition Tata McGraw Hill Publishing Company Ltd., 2007
2. Automotive Mechanics by S. Srinivasan, Tata McGraw Hill 2003.

REFERENCE BOOKS:

1. Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
2. Fundamentals of Automobile Engineering, K.K. Ramalingam, Scitech Publications (India) Pvt. Ltd.
3. Automobile Engineering, R.B. Gupta, Satya prakashan, 4th edn. 1984.
4. Automobile engineering, Kirpal Singh. Vol I and II 2002.

Course Outcomes (COs):

1. Identify different components of an IC engine and operating principle of SI & CI engines. (PO1, PO3).
2. Demonstrate the basic knowledge in IC engine power train. (PO1, PO2, PO3).
3. Interpret the need of chassis, suspension, brake and steering system in an automotive vehicle. (PO1, PO6
4. Exhibit the skills on emission standards (PO6, PO7, PO8).
5. Defend the application of boosting elements for an IC engine (PO1, PO3).

NON CONVENTIONAL ENERGY SOURCES

Course Code: MEOE06 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Mr. ASHOK KUMAR

Course Learning Objectives:

1. Create awareness of the need for various non-conventional energy sources, energy conservation and energy storage.
2. Study of the fundamentals of solar energy, and energy systems based on solar thermal and photo-voltaic principles of working.
3. Study of the principles of working and construction of various energy supply systems based on wind energy and bio-mass energy.
4. Study of the principles of working and construction of various energy supply systems based on geothermal energy and ocean energy.
5. Study of various emerging technologies such as fuel cells, hydrogen energy, small hydro resources, and different direct energy conversion technologies.

UNIT I

Fundamentals of energy and energy conservation: Classification of energy resources, importance and features of non-conventional energy sources, environmental aspects of energy, world energy status, energy scenario in India, various aspects of energy conservation, cogeneration, necessity of energy storage, energy storage methods.

Solar energy: Basics, extraterrestrial and terrestrial radiation, basic sun-earth angles. (Simple numerical problems)

UNIT II

Solar energy: Estimation of intensity of terrestrial radiation, solar radiation on horizontal and inclined plane surface, Measurement of solar radiation (No numerical problems).

Solar thermal systems: Solar collectors, water heaters, passive space heating and cooling, industrial heating systems, refrigeration and air conditioning systems, cookers, furnaces, green house, solar desalination, thermo-mechanical systems

UNIT III

Solar photovoltaic systems: Solar cells fundamentals, characteristics, classification, solar cell, module, panel and array construction, solar PV systems, applications.

Wind energy: Nature of winds, applications of wind power, wind turbine working, types, classification, wind energy conversion systems, wind-diesel hybrid systems, and environmental aspects (No numerical problems)

UNIT IV

Biomass energy: Introduction, photosynthesis, bio-fuels, bio-mass resources, bio-mass conversion technologies, urban waste energy conversion, gasification, ethanol production, bio-mass production from waste biomass.

Geothermal energy: Introduction, applications, origin and distribution, types of geothermal resources, exploration and development, environmental consideration

UNIT V

Ocean energy: Introduction, tidal energy, wave energy, ocean thermal energy.

Emerging and Miscellaneous non-conventional technologies: Introduction, fuel cell, hydrogen energy, small hydro resources, magneto-hydrodynamic power generation, thermoelectric power generation, thermionic power conversion.

TEXT BOOKS:

1. Non-conventional energy sources by B.H. Khan, Tata Mc-graw Hill Co. Ltd., 2006.

REFERENCE BOOKS:

1. Non-conventional sources of energy by G.D. Rai, Khanna Publishers.
2. Renewable energy Technologies by Chetan Singh Solonki, PHI Learning Pvt. Ltd., 2009.

Course Outcomes (COs):

1. Understand the importance of non-conventional energy sources for the present energy scenario and apply the principles of energy conservation to meet the present and future energy demand (PO:2,4,7,10,12)
2. Analyze and evaluate the implication of renewable energy concepts in solving numerical problems pertaining to solar radiation geometry (PO:1,2,4,10,12)
3. Possess the knowledge about the fundamental concepts of solar photovoltaic systems and its applications. (PO:1,2,3,4,7,10,12)
4. Possess the knowledge of origin, distribution, utilization and environmental impact resulting from the use of different non conventional energy sources. (PO:1,2,3,4,7,10,12)
5. Demonstrate the knowledge of various emerging technologies available for the usage of Non conventional energy sources. (PO:1,2,3,5,7,10,12)

PRODUCT DESIGN AND MANUFACTURING

Course Code: MEOE07 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. D.K. VISHWAS

Course Learning Objectives:

1. To learn the fundamentals of product design, various definitions and the design principles
2. To understand the concept of design practices.
3. To Understanding the concepts of strength, stiffness and rigidity considerations in product.
4. To study value engineering and product design, optimization in design, economic factor influencing design, human engineering considerations in product design
5. To study value engineering and product design in detail and learn more practical applications.

UNIT I

INTRODUCTION TO PRODUCT DESIGN:

Asimow's model: Definition of product design, Design by Evolution, Design by Innovation, Essential Factors of Product design, Production-Consumption Cycle, Flow and Value Addition in the Production-Consumption Cycle, The Morphology of Design (The seven phases), Primary Design Phases and Flowcharting, Role of Allowance, Process Capability and Tolerance in Detailed Design & Assembly.

PRODUCT DESIGN PRACTICE AND INDUSTRY:

Introduction, Product Strategies, Time to Market, Analysis of the Product, The S's Standardization, Renard Series, Simplification, Role of Aesthetics in Product Design, Functional Design Practice.

UNIT II

REVIEW OF STRENGTH, STIFFNESS AND RIGIDITY CONSIDERATIONS IN PRODUCT DESIGN:

Principal Stress Trajectories (Force-Flow Lines), Balanced Design, Criteria and Objectives of Design, Material Toughness: Resilience Designing for Uniform Strength, Tension vis-a-vis Compression. Review of Production Process: Introduction, Primary Processes, Machining Process, Non-traditional Machining Processes.

DESIGN FOR PRODUCTION – METAL PARTS:

Producibility requirements in the Design of machine Components, Forging Design, Pressed components Design, Casting Design, and Design for Machining Ease, The Role of Process Engineer, Ease of Location Casting and Special Casting, Designing with Plastic, rubber, ceramics and wood: Approach to design with plastics, plastic bush bearings, gears in plastics, rubber parts, design recommendations for rubber parts, ceramic and glass parts.

UNIT III

OPTIMIZATION IN DESIGN:

Introduction, Siddal's Classification of Design Approaches, Optimization by Differential Calculus, Lagrange Multipliers, Linear Programming (Simplex Method), Geometric Programming, Johnson's Method of Optimum Design.

ECONOMIC FACTOR INFLUENCING DESIGN:

Product Value, Design for Safety, Reliability and Environmental Considerations, Manufacturing Operations in relation to Design, Economic Analysis, Profit and Competitiveness, Break – even Analysis, Economic of a New Product Design.

UNIT IV

HUMAN ENGINEERING CONSIDERATIONS IN PRODUCT DESIGN:

Introduction, Human being as Applicator of Forces, Anthropometry; Man as occupant of Space, the Design of Controls, the Design of Displays, Man/Machine Information Exchange.

UNIT V

VALUE ENGINEERING AND PRODUCT DESIGN:

Introduction, Historical Perspective, What is Value? Nature and Measurement of Value, Normal Degree of Value, Importance of Value, The Value Analysis Job Plan, Creativity, Steps to Problems-solving and Value Analysis, Value Analysis Test, Value Engineering Idea Generation Check-list, Reduction through value engineering case study on Tap Switch Control Assembly, Material and Process Selection in Value Engineering

MODERN APPROACHES TO PRODUCT DESIGN:

Concurrent Design and Quality Function Deployment (QFD).

TEXT BOOKS:

1. **Product Design and Manufacturing** – A.K Chitale and R.C. Gupta, PHI 4th Edition, 2007
2. **Product Design & Development** - Karl T. Ulrich & Steven D, Epinger, Tata Mc. Graw Hill, 3rd Edition, 2003

REFERENCE BOOKS:

1. **New Product Development**- Tim Jones, Butterworth Heinmann, Oxford, mc1997
2. **New Product Development**- Design & Analysis by Roland Engene Kinetovicz, John Wiley and Sons Inc., N.Y.1990

Course Outcomes (COs):

The student will be able to

1. Analyze the basic approaches in product design by following the standard design phases practiced in an industry. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1 & PSO2]
2. Understand the importance of consideration of various material properties and abilities of manufacturing aspects in product design. [PO1,PO2,PO4,PO5,PO12,PSO1 &PSO2]
3. Evaluate the economics and optimizations of the design for the best profit level by not compromising its utility. [PO1,PO2,PO3,PO5,PO12,PSO1 & PSO2].
4. Utilize computers in design and other related areas of a manufacturing industry in consideration with safety, reliability and environmental aspects. [PO1,PO2,PO3,PO4, PO12,PSO1 & PSO2]
5. Demonstrate the effective problem solving techniques and modern design approaches. [PO1,PO2,PO3,PO4,PO5,PO6,PSO1 & PSO2]

NON-DESTRUCTIVE TESTING

Course Code: MEOE08 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. MOHANDAS K N

Course Learning Objectives:

1. To understand the Nondestructive Testing and Evaluation
2. To study various defect formation in material and processing
3. To acquire the necessary theoretical knowledge on the various Nondestructive testing methods and evaluations
4. To understand the practical aspects of different Nondestructive testing techniques
5. To correlate different methods of Nondestructive testing in real time applications which cover manufacturing, environmental issues and medical sciences

UNIT I

OVERVIEW OF NDT: NDT versus Mechanical Testing, Overview of the Non Destructive Testing Methods for the Detection of Manufacturing Defects. Merits and Limitations, Various Physical Characteristics of Materials and Their Applications in NDT.
VISUAL INSPECTION: Principles, Types, Advantages, Limitations.

UNIT II

SURFACE NDE METHODS: **LIQUID PENETRANT TESTING:** Principles, Types and Properties of Liquid Penetrants, Developers, Advantages and Limitations of Various Methods, Testing Procedure, Interpretation of Results.
MAGNETIC PARTICLE TESTING: Introduction, Inspection Materials Magnetisation Methods, Interpretation and Evaluation of Test Indications, Principles and Methods of Demagnetization, Residual Magnetism.

UNIT III

ULTRASONIC TESTING: Principle, Transducers, Transmission and Pulse-Echo Method, Straight Beam and Angle Beam, Instrumentation, Data Representation, A-Scan, B-Scan, C-Scan. Phased Array Ultrasound, Time of Flight Diffraction.
THERMOGRAPHY: Principles, Contact and Non-Contact Inspection Methods, Techniques For Applying Liquid Crystals, Advantages And Limitation – Infrared Radiation And Infrared Detectors, Instrumentations And Methods, Applications.

UNIT IV

EDDY CURRENT TESTING: Generation of Eddy Currents, Properties of Eddy Currents, Eddy Current Sensing Elements, Probes, Instrumentation, Types of Arrangement, Applications, Advantages, Limitations, Interpretation/Evaluation.
ACOUSTIC EMISSION TECHNIQUE: Principle, AE Parameters, Applications.

UNIT V

RADIOGRAPHIC TESTING: X-ray and Gamma-Ray radiography, Their Principles, Methods of Generation, Industrial Radiography Techniques, Inspection Techniques, Applications, Limitations, Types of Films, screens and Penetrameters. Interpretation of Radiographs, Safety in Industrial Radiography.

COMPUTED TOMOGRAPHY (CT): Principle, Industrial Computed tomography, Capabilities, Industrial CT applications.

TEXT BOOK:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu, Practical Non destructive Testing Edition 3, Illustrated Publisher -Alpha Science International, 2007

REFERENCE BOOKS:

1. R. Halmshaw, Non-destructive Testing, Metallurgy and materials science, Publisher-Edward Arnold, 1987.
2. NDT Handbook Volume 17, ASNT Press, OH, USA

Course Outcomes (COs):

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

1. **Distinguish** between different the Nondestructive Testing and Evaluation methods [PO1,PO2,PO5,PO6,PO7,PSO1 & PSO2]
2. **Characterize** various defect formations in material and processing [PO1,PO5,PO6, PSO1 & PSO2]
3. **Appraise** the necessary theoretical knowledge on the various Nondestructive testing methods and evaluations [PO1,PO2,PO3,PSO1 & PSO2]
4. **Appreciate** the practical aspects of different Nondestructive testing techniques [PO1,PO2,PO3, PO4,P12,PSO1 & PSO2]
5. **Correlate** different methods of Nondestructive testing in real time applications which cover manufacturing, environmental issues and medical sciences [PO1,PO2,PO3,PO5, P12,PSO1 & PSO2]

FUNDAMENTALS OF ELECTRIC VEHICLE TECHNOLOGY

Course Code: MEOE09 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Mr. GURURAJ

Course Learning Objectives

1. To help students be thorough with the concepts of hybrid vehicles, EVs and its advantages to traditional ICE vehicles in the longer run.
2. To allow students to learn the basic structure of an EV and also the different power trains and operating modes.
3. To provide insights into the various energy storage systems, battery management systems, electric motors and allied accessories that are essential for proper functioning of an EV system.
4. To enable students to learn to synthesize and characterize high performance nanomaterials for Li battery application. To enable students to design and assemble battery components and test them
5. To help students understand the challenges and opportunities present in methods of EV charging and its infrastructure.

UNIT I

Review of conventional IC engine vehicle –limitations and environmental impact, Introduction to Electric vehicles, Need for electric vehicles, Introduction to EV design- basic working principle of plug-in EV

UNIT II

Hybrid Electric vehicles – Classification: Full, Plug-in, Vehicle systems-types. EV Layout and Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction.

UNIT III

Electric vehicle power train- brief outline of electric motor, battery pack, inverter, charger and converter, Electric Motors- AC/DC Motors/ Generators, Brushed DC Motor/ Brushless DC Motor - Torque Characteristics, motor layout, torque vectoring, switched reluctance motors, induction motors, Actuators & Capacitors., DC-AC & AC-DC Convertors. Basics of EV suspension. Numericals on electric motor performance

UNIT IV

Batteries-Types, Lithium ion battery-materials, current trend, battery architecture-centralized and scalable, battery charging and discharging cycles, use of batteries in powertrain, Battery management system (BMS): Introduction, Illustration of BMS, battery pack capacity and range, Battery state evaluation: State of charge (SOC), State of health (SOH), State of Life (SOL), Battery Modelling, Challenges encountered in BMS and the possible solutions

UNIT V

EV charging –methods of charging: conductive, inductive and battery swapping, AC charging, DC charging. Fuel cell – Introduction, Types, Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Drawbacks of fuel cells.

TEXT BOOKS:

1. James Larminie, John Lowry, **Electric Vehicle Technology Explained**, John Wiley & Sons Ltd, 2nd ed., 2012
2. K. T. Chau - **Electric Vehicle Machines and Drives Design, Analysis and Application**-Wiley-IEEE Press (2015)
3. G A Goodarzi, John G Hayes - **Electric powertrain _ energy systems, power electronics & drives for hybrid, electric & fuel cell vehicles** (2018, John Wiley & Sons)
4. Christopher D. Rahn, Chao Yang Wang - **Battery Systems Engineering,** 2013 edition, John Wiley and Sons Ltd.

REFERENCE BOOKS:

1. C.C. Chan and K.T. Chau, ***Modern Electric Vehicle Technology***, Oxford University Press, 2001.
2. Ali Emadi, Handbook of Automotive Power Electronics and Motor Drives, CRC Press Taylor & Francis Group, 2005
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press Taylor & Francis Group, 2003.

Course Outcomes (COs):

1. Understand the development of EV technology over the years and also its suitability in different areas of transportation. [PO1, PO3, PO6, PO12 & PSO1]
2. Learn the important components in an EV and different power train systems [PO1, PO9& PSO1]
3. Identify and Categorize the different parts and systems necessary for smooth and hassle free operation of EV [PO1, PO3& PSO1]
4. Reflect upon the need to improve the charging system and infrastructure in terms of faster charging rate and wider coverage [PO1, PO3, PO5, PO6& PSO2]
5. Learn effective battery management systems and compare the EV technology with other prevalent technologies like fuel cells for automotive applications [PO1, PO6,PO7 &PO 12]

CNC MACHINES

Course Code: MEOE10 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. JAYA CHRISTIYAN K G

Course Learning Objectives

1. Recognize the need for numerically controlled machine tools.
2. Use the knowledge of AC and DC motors for selecting drives for CNC machines.
3. Apply the fundamental concepts of numerical control for designing CNC machines.
4. Formulate the part programs for operating CNC machines.
5. Verify the CNC machines for various parameters like accuracy and safety.

UNIT I

Numerical Control of Machine Tools: Fundamental concepts, Classification and structure of numerical control systems, open and close loop systems, Point systems, positioning cum straight cut systems, continuous path systems, coding Systems, program mediums –tape format and codes, interpolators – linear interpolation, Circular interpolation and parabolic interpolation, feedback devices – encoders, linear Scales inductosyn, resolvers.

Drives for CNC Machine Tools: Introduction to drives, spindle drives, Requirements, types of spindle drives – AC drives and DC drives; feed drives – Requirement, servo mechanisms, types of feed drives – stepper motors, DC servo drives, AC servo drives, selection criterion for drive system.

UNIT II

Design of Modern CNC Machines and Manufacturing Elements (Excluding Numerical Problems): Introduction, machine Structures, guide ways – linear motion guides, feed drives, servo motors, mechanical Transmission systems including ball screws. Timer belts, flexible belts, flexible Connections for connection encoders, spindle / spindle bearings, measuring systems. Controls, software and user interface, gauging, tool monitoring systems.

UNIT III

Assembly Techniques: Guide ways, ball screws and nut, feedback elements, spindle bearings. Introduction to Modern CNC Machines and Manufacturing Systems: Introduction, advantages of CNC Machines, CNC machining center developments, turning center developments, automatic tool changing, tool monitoring on CNC machine, other CNC machine development like adaptive control, advanced manufacturing systems, benefits of FMS, trends in adaptation of FMS systems.

UNIT IV

Programming and operation of CNC Machine: Introduction to part programming, co-ordinate systems, dimensioning, axes and motion nomenclature, structure of a part program,

word address format, circular interpolation, tool compensation, sub-routines, canned cycles, programming examples for machining centers, programming for turning center, computer assisted part programming.

UNIT V

Testing of CNC Machine Tools: Introduction, Verification of technical specification, verification of functional aspect, verification during idle running, verification of machine tool accuracy & work piece accuracy, metal removal capability test, safety aspects.

TEXT BOOKS:

1. Computer control of Manufacturing Systems - Yoram Koren, McGraw Hill Intl. Pub.
2. Mechatronics - HMT Ltd., Tata McGraw Hill Pub

REFERENCE BOOKS

1. Numerical control of machine tools - S.J. Martin
2. Computer Numerical Control - Joseph Pusztai and Michael Sava
3. Programming for Numerical Control - Roberts Prentice.
4. Numerical control and Computer Aided Manufacture - Pressman and Williams.
5. CAD/CAM - Mikell P. Groover and Emory W. Zimmers Jr.
6. Introduction to Automated Process Planning System - Tiess Chieu Chang & Richard A. Wysk

Course Outcomes (COs):

1. The student will be able to identify the importance of CNC machines in the modern world [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2]
2. The student will be able to select drives for CNC machines [PO1,PO2,PO3,PO5,PO11, PO12,PSO1,PSO2]
3. The student will be able to construct the different components of CNC machines [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2]
4. The student will be able to write NC part programs for milling and turning [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2
5. The student will be able to assess the CNC machines for various functional parameters [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2].

SCIENCE, EDUCATION AND TECHNOLOGY FOR RURAL INDIA

Course Code: MEOE11 **Course Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. B.P.Harichandra

Preamble

Thousands of youths who are studying in engineering colleges are from rural background. After engineering they are desperate to find jobs in cities, since the aspects they would study during any engineering course hardly directly fit in anywhere, even in case they want to go back to their villages. Further, there is a mindset among the larger student community that if they have to have a bright career, it can happen only in cities. However there are uncountable number of cases to prove that the other way round is also possible. Hence there is a need to show the options on the other side. This elective course is designed to address the issue.

This course educates the engineering students as to how and what sciences, education and technologies could be adopted in villages and make the students confident enough to think about going back to their villages, have a career in their villages; perhaps a more healthier and challenging career than the ones in cities. Thus, the students not only start a career on their own, but also to give employment opportunities to a couple of village youths. This would go a long way in rural development; and urban development too by avoiding overcrowding and mass migration into cities.

Course Learning Objectives

1. Understanding the overall status, typical problems and needs of, and availabilities forrural areas
2. Having overview of sciences and financially viable technologies applicable to rural areas and applications of the same.
3. Developing abilities to suggest suitable strategies for solving problems in rural areas through an engineer's approach
4. Give knowledge of the varieties of economically viable options available for a career in rural areas.
5. Providing and understanding of the success of model villages and attempt to create conceptual models for more villages

UNIT I

Introduction: Current status of villages in India, village swaraj, basic principles of self-sustainable villages, role and potentials of rural economy in the new economic era.

Education: The concept of sustainable education, scope and options for vocational training, Role of computers in rural development.

Rural entrepreneurship: Scope for rural entrepreneurship, development of rural entrepreneurship and career options for engineers.

Overview of Government schemes for rural areas.

UNIT II

Water: Water management and water harvesting techniques for villages. Successful case studies of water management.

Sustainable agriculture: Sustainable agriculture: principles and strategies, successful case studies. Career through growing medicinal plants.

UNIT III

Power projects: Scope of micro power projects through rural wastes. Modules for harnessing wind, solar, biogas, mini and micro hydropower and solar powers technologies. Commercial models of mini power generation units, implementation. Biofuels production.

UNIT IV

Agricultural machinery and processing: The labour problem, need for tiny agricultural machinery, commonly used simple agricultural machinery and implements, micro dairy, processes of value addition for agricultural produce. Typical Tiny technologies for the rural masses.

Khadi & Village Industries: Motivation from history. Varieties and produces of KVI in India. Khadi: Scope and importance of khadi and khadi products. Scope for application of current technologies for KVI. Tiny looms.

Unit V

Role model villages: Study of selected role models of villages; viz., solar village, clean village etc.

Conceptual mini project: Need for application of modern technologies in rural areas - brainstorming. Conceptual mini project on sustainable village model, power, machinery, processing for value addition of agricultural produce. (A student or a group of 2-3 shall come out with any one of these concepts). The same shall be presented as seminar to the peers.

Text books:

Sl.	Title	Author	Publisher	Year
1	Village swaraj	M K Gandhi	Navjivan Trust	2015
2	Principles of Farm machinery	Bainer	Read books design	2010
3	Integrated renewable energy for rural communities	Nasin E I Bassam	Elsevier	2012
4	Rural development in India: Retrospects and prospects	Kowal Singh	Concept publishing company	2010
5	Bhageeratha, War on water crisis: Converting dry land into wet land	AyyappaMasagi	Water Literacy Foundation	2016
6	The Philosophy of Spiritual Farming (Part 1)	SubhashPalekar	SubhashPalekar Publications, Amaravati, Maharashtra	2016
7	The Principles of Spiritual Farming (Part 2)	SubhashPalekar	SubhashPalekar Publications, Amaravati,	2016

Sl.	Title	Author	Publisher	Year
			Maharashtra	
8	**FDP course material "SEAT for Rural India"**	**B. P. Harichandra**	**Ramaiah Institute of Technology, Bengaluru**	**To be released in July 2020**

Reference books:

Sl	Title	Author	Publisher	Year
1	India: health care patterns and planning,	Rais Akhtar	APH Publishing	2004
2	Distributed renewable energies for off-grid communities	Nasir EI Bassam	Elsevier	2013
3	Agricultural process engineering	R Reddy	Gene Tech books	2014
4	Solutions to problems in principles of farm machinery	Beiner	Read books design	2010

Course outcomes (COs):

At the end of the course students will:

- Be able to identify the overall status, typical problems, needs, potentials of rural areas and rural economy. [PO6,PO7]
- Have overview of sciences and technologies applicable to rural areas and applications of the same. [PO6,PO7]
- have abilities to suggest suitable strategies for solving problems in rural areas largely through an engineer's approach. [PO6,PO7]
- Have knowledge of a variety of economically viable options available for a career in rural areas. [PO6,PO7]
- Be able to explain the success of model villages and create conceptual models for typical villages. [PO6,PO7]