RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2020 – 2021

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 13 UG programs and 15 PG programs. All these programs are approved by AICTE. All the UG programs & 09 PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with 'A' grade by NAAC in 2014. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs till the year 2029. 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 60% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility to 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 & Schneider Centre of Excellence. **M S Ramaiah Institute of Technology has obtained "Scimago Institutions Rankings" All India Rank 65 & world ranking 578 for the year 2020.**

The Centre for Advanced Training and Continuing Education (CATCE), and Entrepreneurship Development Cell (EDC) have been set up on campus to incubate startups. **M S Ramaiah Institute of Technology secured All India Rank 8th for the year 2020 for Atal Ranking of Institutions on Innovation Achievements (ARIIA), an initiative of Ministry of Human Resource Development (MHRD), 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. It 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, MHRD, Government of India, M S Ramaiah Institute of Technology has achieved 59th rank among 1071 top Engineering institutions of India for the year 2020 and 1st rank amongst Engineering colleges (VTU) in 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 52 years and today has an intake of 180 students and 50 teaching staff. All the faculty members are well qualified and possess post graduate degree with 20 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 24 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 specialised 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 2018-2022

Sem	HSS	BS	ES	PCC	Professional Electives PC-E	Open Elective OE	Project / Seminar/ Internship PW/IN	Total Credits
I	02	17	21		-	-	-	**40**
II					-	-	-	
III	-	04	-	21	-	-	-	**25**
IV	-	04	-	21	-	-	-	**25**
V	3	-	-	15	3	3	-	**24**
VI	-	-	-	11	6	3	4	**24**
VII	3	-	-	10	6	-	1	**20**
VIII	-	-	-	-	-	-	17	**17**
Total	**08**	**25**	**21**	**78**	**15**	**6**	**22**	**175**

RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE – 560 054
(Autonomous Institute, Affiliated to VTU)
SCHEME OF TEACHING FOR THE ACADEMIC YEAR 2020-2021
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]	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- Practicals

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

OPEN ELECTIVES I[Offered for Other Departments]

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

DESIGN OF MACHINE ELEMENTS –I

Course Code: ME51 **Course Credits: 3:1:0**
Prerequisite: Nil **Contact Hours: 42L+14T**
Course Coordinator: Dr. GIRISH V KULKARNI

Preamble

For the manufacture of any machine component the first and foremost operation is design. The design concept involves identifying the problem, selection of process material, environmental conditions and proper understanding of various types of loads and its effect for the maximum production of any machine component.

This course machine design deals starting with the concepts of basic design of machine components taking all the factors mentioned above into account.

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; 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

SUB CODE: ME52 **CREDITS: 4:0:0**
Prerequisite: ME 404 **Contact Hours: 56**
Course Coordinator: Dr. RAJEESH S

Preamble

The subject comprises a wider and deeper on the engineering aspects involving forces, inertia, friction and balancing of masses. It covers bigger spectrum for dynamic aspects of machines that is, force analysis related to static equilibrium of two or three force members. It also covers four bar mechanisms and slider crank mechanisms with or without friction. Discussion involves the utilization of mechanical energy from I.C engines by using the flywheel. It is aimed to study the different types of power transmission by using flat belt drives of open and cross belt with problems. The subject involves the study of rotating masses, so as balance the system by using the counter balancing masses in the same or different planes graphically or analytically. Balancing of reciprocating masses is one of the important chapter, contains the effect of inertia of crank and connecting rod, related to single and multi cylinders with examples. Subject also focuses on functions of governors and gyroscope, considering different types and their applications. For example applications of gyroscope to four wheeler, boat, aeroplane, etc. In case of cam analysis, discussion involves analytical methods with roller followers and circular arc cam with flat faced and roller followers etc.

Course Learning Objective

1. To Understand and Analyse the static forces on mechanisms.
2. To evaluate inertia forces and to analyse Flywheels.
3. To Analyse Belt drives, Concept of friction and Balancing of rotating masses.
4. To Apply the knowledge in designing governors and reciprocating masses.
5. To analyse 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: Flat & 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, 4th Edition, 2014.
2. Theory of Machines: Sadhu Singh, Pearson Education, 3rd edition, 2013.
3. Dynamics of Machinery: J B K Das and Dr. P L Srinivas Murthy, Sapna publications, Bangalore 2013.

REFERENCE BOOKS:

1. Theory of Machines by Thomas Bevan, CBS Publication, 3rd edition, 2005.
2. Design of Machinery by Robert L. Norton, McGraw Hill, 3rd edition, 2003.
3. Mechanisms and Dynamics of Machinery by J. Srinivas, Scitech Publications, Chennai, 2002.

Course Outcomes (COs):

1. Demonstrate the ability to analyze four bar, slider crank mechanisms subject to static forces and under static equilibrium. (PO1, PO2, PO8, PO11, PO12, PSO1 & PSO2)
2. Ability to carry out dynamic analysis of four bar, slider crank mechanisms and designing a flywheel based on energy consideration. (PO1, PO2, PO3, PO8, PO11, PO12, PSO1 & PSO2)
3. Develop skills in design of flat and V belt drives for different transmission of power. (PO1, PO2, PO3, PO8, PO11, PO12, PSO1 & PSO2)
4. Demonstrate the ability in balancing of rotating & reciprocating masses using graphical & analytical methods and analyzing the porter & hartnell governors. (PO1, PO2, PO3, PO8, PO11,PO12, PSO1 & PSO2)
5. Develop the skill in applying concepts of gyroscopic couples in stability of disc, automobiles, ships & aero plane and analysis of cams by analytical method. (PO1, PO2, PO3, PO8, PO11,PO12, PSO1 & PSO2)

TURBO MACHINERY

SUB CODE: ME 53 **Credits:3:1:0**
Prerequisite: Basic Thermodynamics and Fluid Mechanics **Contact Hours: 42L+14T**
Course Coordinator: Dr. NIRANJAN MURTHY

Preamble

Turbomachines are most commonly used devices in day today life. These are the machines used to produce head or pressure or to generate power. Turbo Machines are different from reciprocating and rotary machines (i.e. Reciprocating air compressor and Gear pump) in the energy transfer aspect. In turbomachines, fluid is not positively contained but flows steadily undergoing pressure change due to dynamic effects. This course deals with the fundamental aspects related to the design of turbo machines.

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 checking 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

SUB CODE: ME54 **CREDITS 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. K R PHANEESH

Preamble

As the world moves towards organized living with the outlook of a global village, it becomes imperative for every nation to ensure that the rights of people who innovate, invent, discover, research, etc are safeguarded. Without risks and rewards that goes with new inventions and innovative products, the world would not have never come this far. IPR therefore is a must-study for all students especially those from professional courses since there are at the forefront of technology which is the main source of all innovations.

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, WishwaPrakashan, 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

Sub. Code: MEE551 **CREDITS: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. SUNITH BABU L

Preamble:

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.

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.

UNIT I

Introduction

Definition of Robotics, History of Robot, Robot Components, Degree of Freedom, Robot Characteristics, Workspace, Criteria for Defining a Robot; Robot Categories – Description of Aerospace, Underwater & Ground Based Robots, Robot System Integration.

Classification of Robots based on Configuration – Construction & Working of Cartesian, Cylindrical, Polar, Jointed-Arm Configuration & SCARA; 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

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 Teaching; Algorithms & Flow Charts for developing programs for Pick & Place Robots, Welding Robots, Spray Painting 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

Subject Code: MEE552 **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Dr MOHANDAS K N

Preamble

History of fluid power goes back to our ancient civilization wherein man used water to generate power using water wheels, and air to run windmills and propel ships. These fluids were used in large quantities at relatively low pressure (corresponding to atmospheric pressure). Until industrial revolution in 1850 in England fluid power concept was not introduced in industries. But by 1870 fluid power was used in hydraulic cranes, jacks, shearing and riveting machines, water pumps etc. During and after World War II, fluid power technology gained momentum. And today there is an after list of fluid power application in almost every industry. Automobiles, missiles, machine tools, aero planes etc. extensively use fluid power technology. This course deals with the fundamental aspects of hydraulics and pneumatics, the two fields of relevance to fluid power engineering.

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 signal processing elements and control.

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. 2017.
2. **Pneumatic Systems,** S.R. Majumdar, Tata Mc Graw Hill publishing Co., 2018.
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,PSO1 &PSO2]
2. Identify the controlling components of hydraulic and pneumatic systems. [PO1,PO2,PO3,PO5,PO12,PSO1 &PSO2]
3. Design the hydraulic and pneumatic systems for various applications. [PO1,PO2,PO3,PO5,PO12, PSO1 &PSO2]
4. Examine the choice, preparation and distribution of compressed air. [PO1,PO2,PO3,PO12, PSO1 &PSO2]
5. Predict the use of pressure and time dependent controls. [PO1,PO2,PO3,PO5,PO12, PSO1 &PSO2]

COMPOSITE MATERIALS

SUB CODE: MEE553 **CREDITS 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr. K R V SUBRAMANIAN

Preamble

In present days different types of materials pertaining to engineering field. The conventional materials whose properties are already there in the hand books. As the new inventions are taking place, the conventional materials are not fit at that place. So, there is a need for newer materials which suits to the need, with improved properties and structures. And also, there is a need for the newer materials with improved mechanical, chemical, electrical and other properties. This course deals with the study of such advanced materials to serve the required purpose in the field of aerospace and specialty areas, where light weight and high strength are of interest.

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, 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, vacuumBag 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, 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

SUB CODE: MEE554 **CREDITS: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr JAYA CHRISTIYAN K G

Preamble

The current marketplace is undergoing an accelerated pace of change that challenges companies to innovate new techniques to rapidly respond to the ever changing global environment. A country's economy is highly dependent on the development of new products that are innovative with shorter development time. Organizations now fail or succeed based upon their ability to respond quickly to changing customer demands and to utilize new innovative technologies. In this environment, the advantage goes to the firm that can offer greater varieties of new products with higher performance and greater overall appeal.

At the center of this environment is a new generation of customers. These customers have forced organizations to look for new methods and techniques to improve their business processes and speed up the product development cycle. As the direct result of this, the industry is required to apply new engineering philosophy such as Rapid Response to Manufacturing (RRM). RRM concept uses the knowledge of previously designed products in support of developing new products.

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

Fusion 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

SUB CODE: MEE555 **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

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 &PO 12]

SOLAR ENERGY

SUB CODE: MEE556 **CREDITS 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr VEERANA B NASI

Preamble

The demand for clean energy sources is increasing at a fast rate because of the depletion of fossil fuels and the damage caused by emissions to the environment. Solar energy is an important renewable and clean energy source being explored in a large scale for heating and power generation all over the world. Proper assessment of the availability of solar energy and understanding of the various solar energy conversion systems is essential for the optimum application and use of solar energy.

The course on Solar Energy has been tailored to provide the understanding of thermal and photo-voltaic methods of solar energy conversion. Methods to predict the availability of solar energy and principles of working and performance evaluation of various solar thermal devices such as liquid flat plate collectors, concentrating collectors and air heaters will be introduced. The course also includes the study of photo-voltaic conversion and the economic analysis of investments in solar energy conversion power plants.

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 propos 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 SRIDHAR B S

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 the 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

Sub Code: MEE558 **Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr RAJI GEORGE

Preamble

Preamble: In the present context of mechanical engineering curriculum the course on Theory of Elasticity provides a machine designer with an advanced approach for design of components. With the advances being made in the areas of manufacturing, design and automotive engineering newer and efficient design of machinery and equipments require an in depth knowledge of behavior of components under stressed condition within elastic limit. The course being a first course at UG level,
the topics cover the fundamentals of TOE and application of the concepts to solve problems encountered in designing of machine components. The various topics of practical interest give the students a deeper insight into the field of machine design.

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. 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

Subject Code: MEL 56 **Credits: 0:0:1**
Prerequisites: Fluid Mechanics **Contact Hours: 14**
Course Coordinator: Dr VEERANA B NASI

Preamble

Turbo Machines is relevant to study the performance of machines which involves energy conversion processes and the study also involves measurement of flow & to determine the head loss in flow through pipes.

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

Subject Code: MEL57 **Credits: 0:0:1**
Prerequisites: Nil **Contact Hours: 14**
Course Coordinator: Dr NAGESH S N

Preamble

This course aims at introducing a student to know the concepts of measurement and metrology. The course includes measurement of length, diameter, taper, flatness, squareness, pressure, temperature, force, strain.etc.

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.

Syllabus

A.Tests conducted are listed below

1. 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.

C. Conduct the following Experiments.

2. Monochromatic checklite
3. 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: <u>CIE:</u>

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

<u>SEE</u>:

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**
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TOTAL:	**50**

MANUFACTURING PROCESS – II LABORATORY

Subject Code: MEL58 **Credits: 0:0:1**
Prerequisites: Nil **Contact Hours: 14**
Course Coordinator: Dr MOHANDAS K N

Preamble

Machine shop is a place where components are produced on a large scale. The students will be conducting experiments in the laboratory pertaining to lathe work, shaping machine, milling and grinding.

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.

Syllabus

Lathe: Step turning, thread cutting (V-thread, Square thread, Left hand and Right hand 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**
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TOTAL:	**50**

RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE – 560 054
(Autonomous Institute, Affiliated to VTU)
SCHEME OF TEACHING FOR THE ACADEMIC YEAR 2020-2021
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

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	Machine Learning and Phythan
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

DESIGN OF MACHINE ELEMENTS-II

Sub Code: ME61 **Credits: 3:1:0**
Prerequisite: Design of Machine Elements-1 **Contact Hours: 42L+14T**
Course Coordinator: Dr GIRISH V KULKARNI

Preamble

In machine design certain topics were discussed in detail. In the course Machine Design -2 some more components for complete design are considered. This enables the person who undergoes the course understanding the subject as below.

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 and Thrust Bearing Design.

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 in various 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 in practice. [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

Sub Code: ME62 **Credits: 3:1:0**
Prerequisite: Nil **Contact Hours: 42L+14T**
Course Coordinator: Dr VEERANA B NASI

Preamble:

Heat transfer is the science that seeks to predict the energy transfer that may takes place between material bodies as a result of a temperature difference. The course is normally required in mechanical and chemical engineering curricula but it has applications in cooling problems in the field of electrical and electronics engineering, space applications etc. the three modes of heat transfer that is conduction, convection and radiation are clearly described in this course and students will learn how to formulate, analyze, design and solve the problems related to heat transfer. In addition a small portion of mass transfer is also presented in the course for the students to understand the problems related to simultaneous heat and mass transfer.

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

REFERENC 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. Evaluate heat transfer coefficients in natural and forced convection Heat transfer. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1 &PSO2]
3. Ability to design and analyze the performance of heat exchangers. [PO1,PO2,PO3,PO4,PO5,PO12,PSO1 &PSO2]
4. 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

Sub Code: MEE631 **Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr LOKESHA

Preamble

Finite Element Method is proving to be a very powerful technique of solving and analyzing complex engineering problems. It is a numerical method which yields fairly accurate results for complex engineering problems and of late has emerged as a very rapidly growing area of research for applied mathematics. Its usefulness in various branches of engineering is due to the ease with which the method is made amenable to computer programming, leading to a process of iterative design. Its uniqueness lies in the fact that complex engineering problems having no analytical solutions can be solved with ease and iterative designs can be worked out. Of late, this technique has found a lot of applications in the area of design, manufacturing and thermal engineering applications as newer and specialized techniques and materials are being used with changing technology. The method can also be used in the development of machine tools, newer materials and in failure analysis of processes and structures.

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 menbers.

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, 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 bars 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

Sub Code: MEE632 **Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
Course Coordinator: Dr JYOTHI LAKSHMI R

Preamble

Smart Manufacturing is an amalgamation of Information Technology, Cloud Computing & traditional Mechanical, Production Engineering towards achieving excellence in manufacturing. Maximum results with minimum resources being used. The course will introduce the concepts of Smart Manufacturing, how various technologies can be leveraged to achieve minimum breakdowns, First Time Right Production, 100% Delivery on Time with minimum turnaround time. Nine Pillars of Smart Manufacturing will be explained to the Students. The course will make the students aware of developments in Technology those are going to alter the Traditional Manufacturing scenario. The following topics may be broadly covered in the classroom. The practical will be in the form of Group Discussion based on Case Study.

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, Industry 4.0

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

Sub Code: MEE633 **Credits: 3:0:0**
Prerequisite: Nil **Contact Hours: 42**
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

Overview 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 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 SRIDHAR B S

Preamble

Technology as it advances, offers many advantages, should be backed by management techniques to improve efficiency. Operations research is one of optimization tool to find the best solution in the given situation of the problem with many constraints. It can be a maximization or minimization problem.

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, Scope of OR, Characteristics of OR, Phases of OR, Advantages and limitations of OR, Formulation of LPP, Graphical solutions.
Linear Programming Problems-The Simplex Method, Big M method.

UNIT II

Concept of Duality, Primal and Dual properties, Dual Simplex method.
Assignment problems Hungarian method, Maximisation 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

Subject Code: MEE642 **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Dr NAGESH S N

Preamble

In recent years, industrial revolution and modernization, lot of competition is there among the various industries. To fulfill need of customers and give the components at lower cost, it is important to produce the components with minimum time using various available techniques. Computational Fluid Dynamics, cost effective tool, is more often used to change the design of various components. It provides numerical approximation to the equations that govern fluid motion. Application of the CFD is to analyze a fluid problem requires the following steps. First, the mathematical equations describing the fluid flow and are usually a set of partial differential equations. These equations are then discretized to produce a numerical analogue of the equations. The domain is then divided into small grids or elements. Finally, the initial conditions and the boundary conditions of the specific problem are used to solve these equations. The solution method can be direct or iterative. In addition, certain control parameters are used to control the convergence, stability, and accuracy of the method.

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

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

Preamble

As the size of objects is scaled down to the nanometer regime, the material properties undergo a transformation, presenting a great potential for promising applications. Nanotechnology is considered more powerful than even the industrial revolution, with applications ranging from automobiles to medicine.

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, nanofluids 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

Subject Code: MEE644 **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Dr MOHANDAS K N

Preamble

The main objective of all machining operations is to remove excess material to obtain the desired shape and size. Unlike in the conventional machining operation as cited above, unconventional machining uses special technique for the removal of material which leads to a greater accuracy, surface finish. The source of energy could be electrical, mechanical motion, chemical reaction, power radiation or fluid motion, etc. Normally the magnitude of energy involved will be highly concentrated at any given point/location. A very rapid development of newer materials having higher hardness and other mechanical properties which demand higher dimensional accuracy and high production rate, a need for developing newer manufacturing process arose. The present subject deals with various nontraditional machining processes and its advantages and limitations over the conventional processes.

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, non thermal 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 (2017).
2. Production Technology, HMT, Tata McGraw Hill, 2017.

REFERENCE BOOKS

1. Advanced Machining Processes, Vijay K Jain, Allied Publishers Mumbai, 2018.
2. Unconventional Manufacturing Process, M K Singh, New Age International, 2017.

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

Subject Code: MEE645 **Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Dr JAYA CHRISTIYAN K G

Preamble

Machine learning is about designing programs that can learn without being explicitly programmed. It is a branch of Artificial Intelligence in which we learn concepts/patterns/hypotheses from Data by using heuristic based algorithms. Accordingly, this field is about study and implementation of two main category of algorithms: Supervised and Unsupervised. Supervised learning algorithms make use of data with known classification, aka labeled examples whereas Unsupervised learning algorithms use data with unknown classification, aka unlabeled examples. This field has become so popular that one can find machine leaning applications in virtually all domains ranging from identifying emails as spam or legitimate to automated vehicle guided system to game playing to credit card fraud detection. As this form is unlikely to become exact science, a learning method/algorithm needs to be evaluated and estimated for its performance on unseen data or the population.

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

Subject Code: MEE646 **Course Credits: 3:0:0**
Prerequisites: Nil **Contact Hours: 42**
Course Coordinator: Dr. R KUMAR

Preamble:

Mechatronics, which is also called mechatronic engineering, is a multidisciplinary branch of engineering that focuses on the engineering of both electrical and mechanical systems, and also includes a combination of robotics, electronics, computer, telecommunications, systems, control, and product engineering. As technology advances over time, various subfields of engineering have succeeded in both adapting and multiplying. The intention of mechatronics is to produce a design solution that unifies each of these various subfields. Originally, the field of mechatronics was intended to be nothing more than a combination of mechanics and electronics, hence the name being a portmanteau of mechanics and electronics; however, as the complexity of technical systems continued to evolve, the definition had been broadened to include more technical areas.

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 Data Handling – Analogs Input / Output Selection of a PLC. Experiments on Home automation with the application of PLC.

Lab Component

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

Preamble:

Machine tools can be operated manually, or under automatic control. Early machines used flywheels to stabilize their motion and had complex systems of gears and levers to control the machine and the piece being worked on. Soon after World War II, the numerical control (NC) machine was developed. NC machines used a series of numbers punched on paper tape or punched cards to control their motion. In the 1960s, computers were added to give even more flexibility to the process. Such machines became known as computerized numerical control (CNC) machines. NC and CNC machines could precisely repeat sequences over and over, and could produce much more complex pieces than even the most skilled tool operators.

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

Sub Code: ME 65 **Credits: 0:0:6**
Prerequisite: Nil

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. [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 **Credits:0:0:1**
Prerequisite: Nil **Contact Hours: 14**
Course Coordinator: Dr LOKESHA

Preamble:

FEA is gaining popularity day by day and is a sought after dream career for mechanical engineers. Enthusiastic engineers and managers who want to refresh or update the knowledge on FEA are encountered with volumes of published books. FEA is now a commonly used synonym for a wide range of computational techniques in engineering practice. All the engineering structures today; should be simulated for their performance on a computer compulsorily. Modeling becomes increasingly important to provide quick solutions for a defined problem, which involves equations. As the complexity of the equation increases, computing tools are necessary to solve them. MATLAB is one such tool that gives solutions in real time for a dynamic problem.

Course Learning Objectives:

1. Apply the knowledge of FEM to construct finite element models using available library from the tool.
2. Choose appropriate boundary conditions to carryout analysis and compare the results obtained from commercially available software (Solver)
3. Apply the knowledge of MATLAB to solve numerical & engineering equations

List of Exercises:

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

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, PO5,PO12, PSO1,PSO2]
2. Predict the performance of Structural member [PO1,PO2,PO3,PO4,PO12,PSO1,PSO2]
3. Analyze analytical problems using MATLAB for engineering applications. [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 **Credits:0:0:1**
Prerequisite: ME63 **Contact Hours: 14**
Course Coordinator: Dr VEERANA B NASI

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. Experiment on Transient Conduction Heat Transfer
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. Experiments on Boiling of Liquid and Condensation of Vapour.
11. Evaluation of performace parameter (U_L, F_R, η) in thermosyphonic mode of flow with fixed input parameters of a solar water heating system.
12. Evaluation of performance parameters (U_L, F_R, η) in thermosyphonic mode of flow at different radiation level of a solar water heating system.

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 **Credits :0 :0 :1**
Prerequisite : Nil **Contact Hours: 14**
Course Coordinator: Mr D VENKATESH

Preamble:

Machine design subject deals with the design of machine elements such as beams, ropes, belts, chains, springs, gears concepts of lubrication of bearings and bearing design. All these machine elements are subjected to vibrations, stresses and strains while in operation, machine design lab provides students to gain insight into these practical aspects and develop skill in measuring various parameters influencing the design of machine elements, eventually to obtain better designs.

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 Tension specimen, Circular disc & Pure bending specimen using polychromatic light.
14. Static & Dynamic Balancing of masses in single plane and several planes.
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