RAMAIAH
Institute of Technology

CURRICULUM

for the Academic year 2020 – 2021

MECHANICAL ENGINEERING

VII & VIII 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.

Curriculum breakdown structure:

Breakup of Credits for BE Degree Curriculum. (I to VIII Semester)
BATCH:2016-2020

Sem	HSS	BS	ES	PCC	Professional Electives PC-E	Other Elective OE	Project / Seminar/ Internship PW/IN	Total Credits
I	06	20	24		-	-	-	**50**
II					-	-	-	
III	-	04	-	18	3	-	-	**25**
IV	-	04	-	18	3	-	-	**25**
V	-	-	-	21	4	-	-	**25**
VI	-	-	-	15	4	-	6	**25**
VII	-	-	-	14	8	4	-	**26**
VIII	-	-	-		4	-	20	**24**
Total	**06**	**28**	**24**	**86**	**26**	**4**	**26**	**200**

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SCHEME OF TEACHING – VII SEM FOR THE ACADEMIC YEAR 2020 – 2021

Sl.No	Subject Code	Subject	Credits				
			L	T	P	S**	Total
1	ME71	CAD/CAM	3	0	0	1	4
2	ME72	Mechanical Vibration	3	1	0	0	4
3	ME73	Control Engineering	3	0	0	1	4
4	OE7X	Open Elective	4	0	0		4
5	ME75	Elective-III	4	0	0		4
6	ME76	Elective-IV	4	0	0		4
7	ME77L	Non-conventional Energy Lab	0	0	1		1
8	ME78L	CAD/CAM lab	0	0	1		1
		Total					**26**

L-Lecture T-Tutorial P- Practicals S** Self Study

LIST OF COURSES OFFERED UNDER ELECTIVE-III

Sl. No.	Subject Code	Subject
1	ME 751	OPERATIONS RESEARCH
2	ME 752	MECHANISM DESIGN
3	ME 753	NANO TECHNOLOGY

LIST OF COURSES OFFERED UNDER ELECTIVE-IV

Sl. No.	Subject Code	Subject
1	ME 761	PRODUCT DESIGN AND MANUFACTURING
2	ME 762	AUTOMOTIVE ENGINEERING
3	ME 763	ARTIFICIAL INTELLIGENCE

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SCHEME OF TEACHING – VIII SEM FOR THE ACADEMIC YEAR 2020 – 2021

Sl.No	Subject Code	Subject	Credits			
			L	T	P	Total
1	ME81	Elective-V	4	0	0	4
2	ME82	Internship,/ Departmental Elective (Industry collaborated course)	0	0	4	4
3	ME83	Project Work	0	0	14	14
4	ME84	EAC and seminar	0	0	2	2
		Total				**24**

L-Lecture T-Tutorial P- Practicals

LIST OF COURSES OFFERED UNDER ELECTIVE-V

Sl. No.	Subject Code	Subject
1	ME 811	WIND ENERGY
2	ME 812	FOUNDRY TECHNOLOGY
3	ME 813	EXPERIMENTAL STRESS ANALYSIS
4	ME 814	OPERATION MANAGEMENT

LIST OF COURSES OFFERED UNDER INTERNSHIP,/ DEPARTMENTAL ELECTIVE (INDUSTRY COLLABORATED COURSE)

Sl. No.	Subject Code	Subject
1	ME 821	CNC MACHINES
2	ME 822	INDUSTRIAL DESIGN AND ERGONOMICS

VII SEMESTER B.E. MECHANICAL ENGINEERING

CAD/CAM

Course Code: ME71 **Course Credits: 3:0:0:1**
Prerequisite: Nil **Contact Hours:** 56
Course Coordinator: Dr SUNITH BABU L

Course Learning Objectives

1) Enable students to learn the concepts of CAD/CAM
2) To create an awareness related to different methods of solving geometric entities
3) Educate students on different technologies related to CAD/CAM
4) To provide guidance on solving different milling and turning programs in CNC Technology
5) To Broaden the student understanding of CAD/CAM technology

UNIT I

Introduction: Definitions, meanings and components of CAD/CAM and other allied computer aided design/manufacturing strategies/techniques.

Hardware for CAD/CAM: Basic configuration of a typical Modern hardware for CAD/CAM – Vector stroke and raster scan ouput devices for CAD. RFID and bar-code readers for CAD/CAM application.

Software for CAD/CAM: A typical CAD/CAM database, use of cloud computing techniques for CAD/CAM, open source softwares for CAD/CAM .

UNIT II

Computer Graphics: Raster Scan Graphics, Coordinate Systems, Database Structure for Graphic Modeling, functions of graphics package, Transformation of geometry, 2D transformations – Simple problems

Geometric Modelling: Requirements for geometric modeling, Geometric Models, Geometric Based Modelling, Constrain Based Modelling, Curve Representation, Surface Representation methods.

UNIT III

Introduction to NC technology: Basic components of NC system. NC Coordinate system, types of NC systems, advantages and applications of NC, influence of computers in manufacturing environment.

DNC, CNC Systems: Types, advantages of adaptive control systems, types of CNC turning centers and machining centers,

UNIT IV

Computer Aided Manufacturing – Programming

Programming of CNC lathe and machining centre for real-time components on 3 axis lathe and machining centers for a typical CNC controller.

UNIT V

Other technologies supporting CAD/CAM

Flexible manufacturing system: FMS Equipment, FMS layouts, Analysis methods of FMS, Benefits of FMS. **Computer aided quality control**: Automated inspection offline online. **Computer aided manufacturing resource planning**: Material resource planning, benefits of MRP, Enterprise resource planning, capacity requirements planning. **Computer integrated manufacturing**: CIM systems, benefits of CIM.

TEXT BOOKS:

1. CAD/CAM principles and applications by P.N. Rao, Tata MC Graw Hill 10th reprint 2008
2. CAD/CAM by Groover, Tata MC Graw Hill 2003, ISBN-8177584162

REFERENCE BOOKS:

1. Mastering CAD/CAM, IbraimZeid, Tata McGraw Hill Publishing Co.
2. Introduction to CAD/CAM Rao P.N, Tata McGraw Hill Publishing Co.
3. Automation, production systems and computer integrated manufacturing, Groover M.P., Prentice Hall of India
4. CAD/CAM/CIM, Radhakrishnan P,
5. James G. Keramas, Robot Technology Fundamentals, Delmar Publishers.

Course Outcomes (COs):

At the end of the course student will:

1. Identify the different CAD Hardware and software modules.[PO1,PO3,PO5,PO12, PSO1,PSO2]
2. Apply the CAD data base and transformation functions for computing different types of geometric entities. [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2]
3. Demonstrate NC technology and adaptive control machining in computer aided manufacturing environment [PO1,PO2,PO3,PO5,PO11,PO12,PSO1,PSO2]
4. Develop NC programs based on sketches using G & M Codes. [PO1,PO2,PO3,PO11,PO12, PSO1,PSO2]
5. Analyze different technologies supporting CAD/CAM [PO1,PO2,PO3,PO5,PO11, PO12, PSO1,PSO2]

MECHANICAL VIBRATIONS

Course Code: ME72 **Course Credits: 3:1:0**
Prerequisite: Nil **Contact Hours: 42 L+14T = 56**
Course Coordinator: Mr D VENKATESH

Course Learning Objectives

1. Impart the knowledge of fundamentals of vibrations for various applications.
2. Understand the concepts of vibrations of damped and un-damped systems under free and forced vibrations.
3. Develop skill to solve simple problems on single degree of freedom and multi degree of freedom systems.
4. Develop competence in applying the numerical methods in solving multi degree of freedom systems.
5. Develop an understanding of working of various automotive components based on vibrations.

UNIT I

Introduction: Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems.

Undamped free vibrations: Single degree of freedom systems. Mass Undamped free vibration-natural frequency of free vibration, stiffness of spring elements, effect of mass of spring, Compound Pendulum.

UNIT II

Damped free vibrations: Single degree freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement. Steady state solution with viscous damping due to harmonic force.

UNIT III

Forced Vibration: Solution by force vector polygon (graphical analysis), Reciprocating and rotating unbalance, vibration isolation-transmissibility ratio, due to harmonic excitation and support motion.

Vibration measuring instruments & Whirling of Shafts: Vibrometer and accelerometer. Whirling of shafts with and without air damping. Discussion of speeds above and below critical speeds.

UNIT IV

Systems with two degrees of freedom: Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, free vibration in terms of initial conditions. Geared systems. Forced Oscillations-Harmonic excitation.

Applications: Vehicle suspension. Dynamic vibration absorber. Dynamics of reciprocating Engines.

UNIT V

Numerical methods for Multi degree Freedom systems: Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation and Raleigh's method. Orthogonality of principal modes, Method of matrix iteration - Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method.

TEXT BOOKS:

1. Theory of Vibration with Applications: W.T. Thomson and Marie Dillon Dahleh, Pearson Education 5th edition, 2007.
2. Mechanical Vibrations: V.P. Singh, Dhanpat Rai & Company Pvt. Ltd., 3rd edition, 2006.

REFERENCE BOOKS:

1. Mechanical Vibrations: S.S. Rao, Pearson Education Inc, 4th Edition, 2003.
2. Mechanical Vibrations: S. Graham Kelly, Schaum's Outline Series, Tata McGraw Hill, Special Indian edition, 2007.
3. Theory & Practice of Mechanical vibrations: J.S. Rao & K. Gupta, New Age International Publications, New Delhi, 2001.
4. Elements of Vibrations Analysis: Leonanrd Meirovitch, Tata McGraw Hill, Special Indian edition, 2007.

Course Outcomes (COs):

The students will be able to

1. Develop an understanding of concept of Vibrations and undamped free vibrations. [PO1,PO2,PO5,PO12,PSO1,PSO2]
2. Develop competence and skills to solve the problems of damped free vibrations. [PO1,PO2,PO12,PSO1,PSO2]
3. Demonstrate the ability and skill to solve forced vibration problems and gain knowledge of vibration measuring instruments. [PO1,PO2,PO5,PO12,PSO1,PSO2]
4. Demonstrate the ability to solve problems of related to two degree freedom system. [PO1,PO2,PO5,PO12,PSO1,PSO2]
5. Develop competence to solve multi degree freedom systems using numerical methods. [PO1,PO2,PO5,PO12,PSO1,PSO2]

CONTROL ENGINEERING

Course Code: ME73 **Course Credits: 3:0:0:1**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr VISHWANATH KOTI

Course Learning Objectives

1. To understand the basic fundamentals related to automatic control system and to obtain mathematical models of the engineering systems using differential equations describing the behavior of engineering systems
2. To use the block diagram reduction techniques and signal flow graphs to derive system transfer functions (input-output relations)
3. To determine the time domain response to a wide range of inputs and to gain the in-depth knowledge of the transient and steady state response analysis of first and second order systems.
4. To analyze the performance of the control systems using polar plots, Nyquist plots, Bode plots.
5. To analyze the performance of the control systems using Root locus and to study different types of controllers in the design and analysis of closed loop control.

UNIT I

Introduction: Concept of automatic controls, open and closed loop systems, concepts of feedback, requirement of an ideal control system..

Mathematical Models: Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems, Pneumatic system, Analogous systems Force voltage, Force current.

UNIT II

Block Diagrams and Signal Flow Graphs: Transfer Functions definition, function, block representation of system elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula.

UNIT III

Transient and Steady State Response Analysis: Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response, System stability: Routh's-Hurwitz Criterion.

UNIT IV

Frequency Response Analysis: Polar plots, Nyquist Stability Criterion, Stability Analysis, Relative stability concepts, phase and gain margin, M & N circles.

Frequency Response Analysis using Bode Plots: Bode attenuation diagrams, Stability Analysis using Bode plots, Simplified Bode Diagrams.

UNIT V

Root locus plots: Definition of root loci, general rules for constructing root loci, Analysis using root locus plots.

Control Action and System Compensation: Types of controllers– Proportional, Integral, Proportional Integral, Proportional Integral Differential controllers**.** Series and feedback compensation, Physical devices for system compensation.

TEXT BOOKS:

1. Modern Control Engineering: Katsuhiko Ogata, Pearson Education, 2008.
2. Control Systems Principles and Design: M. Gopal, TMH, 2010
3. Control Engineering: U.A.Bakshi & V.U. Bakshi, Technical publications, Pune,2009
4. Control Systems Engineering: Nise, Wiley, Fourth edition

REFERENCE BOOKS:

1. Feedback Control Systems: Schaum's series 2010.
2. Control systems: I.J. Nagarath & M. Gopal, New age International publishers 2012.
3. Automatic Control Systems – B.C. Kuo, F. Golnaraghi, John Wiley & Sons, 2008.
4. Modern control Engineering: Dorf Bishop, Pearson, Eleventh edition

Course Outcomes (COs):

1. Develop skill to identify the basic elements and structures of feedback control systems and develop mathematical models. [PO1,PO2,PO5,PO10,PO11,PO12, PSO1,PSO2]
2. Use efficiently signal flow graphs and block diagrams to study the input-output relations of various control systems. [PO1,PO2,PO5,PO10,PO11,PO12,PSO1,PSO2]
3. Obtain competence in Transient response analysis of control systems subjected to standard test signals and stability analysis [PO1,PO2,PO5,PO10,PO11,PO12, PSO1,PSO2]
4. \ Obtain competence in Frequency analysis of control system using various plots such as Polar, Nyquist and Bode plots. [PO1,PO2,PO5,PO10,PO11,PO12, PSO1,PSO2]
5. Be able to construct design and analyze performance of control systems using Root-locus and understand the various system compensation techniques, compensators and control actions. [PO1,PO2,PO5,PO10,PO11,PO12,PSO1,PSO2]

OPERATIONS RESEARCH

Course Code: ME751 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56.**
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, Models in 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, Finding solution for Primal and Dual problems, 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]

MECHANISM DESIGN

Course Code: ME752 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr MAHANTESH MATUR

Course Learning Objectives

The students shall able to:

1. Understand analysis and synthesis of mechanisms with basic terminologies
2. Develop skills in synthesis of mechanisms and inversions
3. Develop ability in the analytical analysis of mechanisms and generation of coupler curves
4. Develop skills in the dimensional synthesis and basics of spatial mechanisms
5. Understand basics and applications of computing mechanisms.

UNIT I

Introduction to analysis and synthesis of mechanism, Terminologies: planar, spherical and spatial, mobility, Grashof's Law, Mechanical advantage, simple numericals. Type, number and dimensional synthesis, Function generation path generation and body guidance, Precision positions, structural error, Chebychev spacing and numericals.

UNIT II

Kinematic inversions, poles and relative poles four bar mechanisms; Kinematic inversions, poles and relative poles slider crank mechanisms, Two position and three position synthesis of four bar mechanisms by Kinematic inversion and relative pole methods. Two position and three position synthesis of slider crank by Kinematic inversion and relative pole methods, numericals.

UNIT III

Analytical analysis of displacement, velocity and acceleration in four bar and slider crank mechanisms, coupler curve and generation of coupler curves for simple mechanisms, simple cases of path generation, function generation and rigid body guidance, cognate linkages, numericals.

UNIT IV

Freudenstein's equations for four bar mechanism mechanisms and examples, Freudenstein's equations slider crank mechanisms and examples, Bloch's method of synthesis, Mobility of spatial mechanisms, The Eulerian angles, The Denavit-Hartenberg parameters, Transformation Matrix position, velocity and acceleration analyses, Forward and inverse kinematics.

UNIT V

Computing mechanisms: Analog computers, mechanisms for addition and subtraction, multiplication and division, Mechanisms for integration, trigonometric functions, inversion, squares, square roots and square roots of products, computing gears and cams.

TEXT BOOKS :

1. **Theory of Machines and Mechanisms**, Joseph Edwrd Shigley and John Joseph Uicker Jr, McGrawHill International Book Company.
2. **Theory of Machines and Mechanisms,** John J Uicker Jr, Gordon R Pennock, Joseph E Shigley, Indian Edition, Third Ed, Oxford University Press, 2007**.**
3. **Robotics for Engineers**, Yaren Koren, McGraw Hill book Co, ISBN 0070353417.
4. **Theory of Machines**, S. S. Rattan, 3rd Edition , Tata McGraw Hill Education Pvt. Ltd

REFERENCE BOOKS :

1. **Kinematics, Dynamics and Design of Machinery**, Kenneth J Waldron, Gary L Kinzel. 2007, Wiley India.
2. **Mechanism and Machine Theory** , A G Ambekar, Prentice Hall, India.
3. **Design of Machinery**, R.C. Norton, Tata McGraw Hill Publication.
4. **Mechanisms and Dynamics of Machinery** Hamilton H. Mabie and Fred W. Ocvirk, Third edition, SI version, John Wiley and Sons, 1978.

Course Outcomes (COs):

At the end of the course students are able to comprehend and grasp

1. Student will be able to analyse and synthesize a mechanism using graphical and analytical methods[PO1,PO2,PO3,PO5,PO10,PO12,PSO1,PSO2]
2. Will demonstrate ability to apply different methods of synthesis such as , two and three position synthesis and relative pole method. [PO1,PO2,PO3,PO5,PO10, PO12,PSO1,PSO2]
3. Will be able to use analytical methods of analyses of four bar and slider crank mechanism along with generation of curves. [PO1,PO2,PO3,PO5,PO10,PO12, PSO1,PSO2]
4. Will be able to demonstrate the synthesis of spatial mechanisms. [PO1,PO2,PO3,PO5,PO10,PO12, PSO1,PSO2]
5. Will demonstrate ability to use computing mechanisms and design them [PO1,PO2,PO3,PO5,PO10,PO12,PSO1,PSO2]

NANOTECHNOLOGY

Course Code: ME753 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
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.

UNIT II

Synthesis of nanomaterials - Chemical Vapor Deposition (CVD) – Physical Vapor Deposition (PVD). Sol-Gel Technique, Mechanical Methods: -Ball Milling.

Instruments and Methods – Electron microscopes – scanning probe microscope —Atomic force microscope – x-ray diffraction - Surface enhanced Raman spectroscopy (SERS) - Scanning Electron microscopy (SEM) - Scanning Tunneling Microscope (STM)- Transmission Electron microscopy (TEM).

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

UNIT V

Nano Composites- Introduction to nanocomposites – classification- - properties of nanocomposite materials - synthesis of nanocomposite materials -Applications.

Nanotribology –Introduction- Nanotribometer-Surface force apparatus-quartz crystal microbalance – nano-lubrication- applications.

TEXT BOOKS

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

REFERENCE BOOKS

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

Course Outcomes (COs):

Students will be able to

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

PRODUCT DESIGN AND MANUFACTURING

Course Code: ME761 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr SRIDHAR B S

Course Learning Objectives

1. To understand and simulate the different phases of product design with relevant flow charting and industrial practices in the area of product design concern to design considerations, problems faced and functional design practices
2. To understand, analyze the various material properties and loading conditions for the product design based on the manufacturing possibilities.
3. To understand the product design optimization by using different approaches such as differential Calculus, Lagrange Multipliers, safety, reliability, manufacturing and environmental aspects related to the economics of the product design
4. To understand the ergonomics of working environment and the role of computers in the area of product design.
5. To understand the value engineering by adopting the various steps in problem solving leading to the effective solution for the challenge and to understand the modern approaches like quality functional deployment (QFD) in product design

UNIT I

INTRODUCTION TO PRODUCT DESIGN:

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

PRODUCT DESIGN PRACTICE AND INDUSTRY:

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

UNIT II

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

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

DESIGN FOR PRODUCTION – METAL PARTS:

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

UNIT III

OPTIMIZATION IN DESIGN:

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

ECONOMIC FACTOR INFLUENCING DESIGN:

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

UNIT IV

HUMAN ENGINEERING CONSIDERATIONS IN PRODUCT DESIGN:

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

UNIT V

VALUE ENGINEERING AND PRODUCT DESIGN:

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

MODERN APPROACHES TO PRODUCT DESIGN:

Concurrent Design and Quality Function Deployment (QFD).

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Course Outcomes (COs):

1. The student will analyze the basic approaches in product design by following the standard design phases practiced in an industry. [PO1,PO2,PO3,PO4,PO5,PO12, PSO1,PSO2]
2. The student will understand the importance of consideration of various material properties and abilities of manufacturing aspects in product design. [PO1,PO2,PO4,PO5,PO12, PSO1,PSO2]
3. The students will be able to evaluate the economics and optimizations of the design for the best profit level by not compromising its utility. [PO1,PO2,PO4,PO5,PO12, PSO1,PSO2]
4. The students will apply the use of computers in design and other related areas of a manufacturing industry in consideration with safety, reliability and environmental aspects. [PO1,PO2,PO3,PO4,PO12,PSO1,PSO2]
5. The students will demonstrate the effective problem solving techniques and modern design approaches. [PO1,PO2,PO3,PO4,PO5,PO6,PSO1,PSO2]

AUTOMOTIVE ENGINEERING

Course Code: ME762 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Mr NAVEEN KUMAR B K

Preamble

The rise in civilization is closely related to improvements in transportation. In the development of transport the internal combustion engines and automotive engineering occupies very important position. The internal combustion engines have provided reliable small power unit for the personalized transport of the layman and in this way revolutionized the living habits of people to a great extent. Indeed internal combustion engine may be considered as an important landmark of the machine age. The teaching of automotive engineering is a very important part of mechanical engineer's education.

Course Learning Objectives

The students shall be able to:

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

UNIT I

I C Engine Components, Cooling & Lubrication systems: SI & CI engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Compression ratio, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, different lubrication arrangements.

Fuels: Conventional fuels, LPG and Natural gas operation of SI engines; Operation of SI engines with alternate fuels like ethanol and ethanol blends, introduction to new fuels for Automotive Engines like hydrogen, hybrid fuels and fuel cells.

UNIT II

Fuel supply systems for SI and CI engines: Properties of air-fuel mixtures - Mixture requirements for steady state and transient operation, Mixture formation studies of volatile fuels, design of elementary carburetor , simple carburetor systems, mono point, multi point and direct injection systems - Principles and Features, Bosch injection systems. Fuel feed systems, Mechanical and electrical pumps. Normal and abnormal combustion.

Electric Propulsion system: Automotive vehicle application batteries and motors(Basic)

Ignition systems: Battery Ignition systems, magneto Ignition system, Electronic Ignition, Automatic Ignition advance systems.

UNIT III

Power Trains: Principle of friction clutches and constructional details, Fluid flywheel, Single plate, multi-plate and centrifugal clutches.

Gear box: Necessity for gear ratios in transmission, synchromesh gear box. Freewheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epi-cyclic gear box, principles of automatic transmission, calculation of gear ratio.

Drive to wheels. Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, condition for exact steering, steering gears, power steering- hydraulic and electric power assisted, over steer, under steer and neutral steer (No numerical).

UNIT IV

Automotive Chassis: Types of chassis layout with reference to power plant locations and drive, Vehicle frames. Various types of frames. Constructional details, Materials. Testing of vehicle frames. Unitized frame body construction: Loads acting on vehicle frame.

Suspension and springs: Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system.

Brakes: Types of brakes, mechanical, air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system. (No numerical)

UNIT V

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

Performance parameters and Engine Test Technology: Various performance parameters used for testing, Engine diagnosis, Electronic system testing and ECU diagnostics.

Superchargers and Turbochargers: Introduction. Turbocharger construction and operation, Intercooler, Turbocharger lag.

TEXT BOOKS:

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

REFERENCE BOOKS:

1. **Automotive mechanics: Principles and Practices**, Joseph Heitner, D Van Nostrand Company, Inc
2. **Fundamentals of Automobile Engineering,** K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd.
3. **Automobile Engineering**, R.B.Gupta, Satya prakashan, 4th edn. 1984.
4. **Automobile engineering**, Kirpal Singh. Vol I and II 2002.
5. **E.Hughes-** Eletrical and Electronics Technology, Pearson - 2010

Scheme of Examination:

Two questions to be set from each unit. Students have to answer any FIVE full questions choosing at least ONE question from each unit.

Course Outcomes (COs):

1. Student will be able to understand IC engine, its components and selection of fuels[PO1,PO2,PO3,PO6,PO7,PO12,PSO1,PSO2]
2. Will be able to analyze carburetor & ignition system to be suitable for CI and SI engines. . [PO1,PO2,PO3,PO6,PO7,PO12,PSO1,PSO2]
3. Will be able to demonstrate power trains and its structure. [PO1,PO2,PO3,PO4, PO6,PO12,PSO1,PSO2]
4. Will be able to familiarize with automotive chassis, suspension system and brakes. [PO1,PO2,PO3,PO4, PO6,PO7,PO12,PSO1,PSO2]
5. Will be able to expose knowledge of automotive emission control system. [PO1,PO2,PO3,PO4, PO6,PO7, PO12,PSO1,PSO2]

ARTIFICIAL INTELLIGENCE

Course Code: ME763 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr R KUMAR

Preamble

AI is a branch of computing science that deals with the specification, design and implementation of information systems that have some knowledge related to the enterprise in which the information systems are situated. Furthermore, such systems are designed per se to be responsive to the needs of their end-users. Intelligent machines have replaced human capabilities in many areas. Artificial intelligence is the intelligence exhibited by machines or software. It is the branch of computer science that emphasizes on creating intelligent machines that work and react like humans.

Course Learning Objectives

1. Examine the different ways of approaching AI & example systems that use AI.
2. Students should be able to understand and implement the forward & backward chaining reasoning algorithm.
3. Students should understand the representing predicate logic and syntax and semantics for prepositional logic.
4. Students should learn about different aspects of a statistics and probabilistic reasoning and expert system.
5. Students will understand the examples of expert system and machine learning system.

UNIT I

Introduction to AI and production systems: Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Heuristic Search Techniques.

UNIT II

Knowledge Representation Issues: Representations and Mappings, Approaches to knowledge representation. Issues in knowledge representation. **Use of Predicate Logic**: Representing simple facts, Instance and ISA relationships, Computable Functions and Predicates, Resolution, Natural deduction.

UNIT-III

Knowledge Representation Using Rules: Procedural Vs Declarative knowledge, Logic programming. Forward Vs Backward reasoning, matching. **Symbolic reasoning under uncertainty**: No monotonic reasoning. Implementation Depth First Search and Breadth First Search.

UNIT-IV

Statistical And Probabilistic Reasoning: Probability and Bayes' theorem, Certainity factors and Rule based systems, Bayesian Networks, Shafer Theory, Fuzzy Logic and simple exercises.

UNIT V

Expert systems: Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.

TEXT BOOKS:

1. Artificial Intelligence, Elaine Rich & Kevin Knight, 3rd Ed., M/H 2009.
2. Introduction to AI & ES, Dan W. Patterson, Prentice Hall of India, 1999.

REFERENCE BOOKS:

1. Principles of Artificial Intelligence, Springer Verlag, Berlin, 1981.
2. Artificial Intelligence in business, Science & Industry, Wendy B. Ranch 179
3. A guide to expert systems, Waterman, D.A., Addison – Wesley inc. 1986
4. Building expert systems, Hayes, Roth, Waterman, D.A. Addison – Wesley, 1983

Course Outcomes (COs):

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

1. Understand a AI-Problem formulation and production system concepts. [PO1,PO2,PO3,PO5, PSO1,PSO2]
2. Solve the concept of knowledge representation issues and the forward, backward reasoning. [PO1,PO2,PO3,PO5,PSO1,PSO2]
3. Ability to use of predicate logic to represent simple facts and Instances. [PO1,PO2,PO3,PO5,PSO2]
4. Identify a problem in statistical and probabilistic reasoning. [PO1,PO2,PO3,PSO2]
5. Demonstrate the various learning typical expert system. [PO1,PO2,PO3,PSO2]

NON-CONVENTIONAL ENERGY LAB

Course Code: ME 77L **Course Credits: 0:0:1**
Prerequisite: Nil **Contact Hours: 14**
Course Coordinator: Dr VEERANA B NASI

Preamble:

Non-conventional energy lab involves all the forms of renewable energies like solar, Wind and photovoltaic power. Production of electrical power using these is prime concern due to the non-availability of fossil fuels in future. And also thermal heating of water for domestic and industrial requirements has become more important using solar energy. Hence, various experiments on these sources of energies to learn the basics of performance studies is of great value in the development of renewable energies for the production of electrical power.

Course learning objectives:

During the course students will be learning the following.

1. Fundamentals of renewable energy.
2. Various types of renewable energy and their applications.
3. Experiments on solar energy.
4. Experiments on wind energy.
5. Experiments on Photovoltaic cells.

Part-A

1. Evaluation of different parameters (Ul.Fr. and Efficiency) in thermosyphon mode of flow for a flat plate collector with fixed input parameters.
2. Evaluation of different parameters (Ul.Fr. and Efficiency) in thermosyphon mode of flow for a flat plate collector at different radiation level.
3. Evaluation of different parameters (Ul.Fr. and Efficiency) in thermosyphon mode of flow for a flat plate collector at different inlet water temperatures.
4. Determination of the performance parameters (Ul.Fr. and Efficiency) of the parabolic trough collector with varying solar radiation and water as the working medium.
5. Determination of the performance parameters (Ul.Fr. and Efficiency) of the parabolic trough collector with water as the working medium at different flow rates.
6. Determination of the performance parameters (Ul.Fr. and Efficiency) of the parabolic trough collector with varying solar radiation and water as the working medium at different flow rates.

Part-B

7. Evaluation of cut-off and cut-in speed of a wind turbine.
8. I-V characteristics of wind turbine at different wind speeds.
9. Study of impact of load and wind speed on power output and its quality.
10. Study of I-V characteristics of a solar cell.
11. Study of P-V characteristics of a solar cell.
12. Study of shading and altitude angle on the operation of a cell.

TEXT BOOKS:

1. Non-conventional energy sources by B.H.Khan Tata McGraw hill, 2002
2. Solar energy by S.P. Sukhatme, Tata McGraw hill, 2002

Course Outcomes (COs):

After the completion of course, students can do the following.

1. Students can install and conduct performance study of domestic water heating system and conduct performance study of domestic water heating system. [PO1,PO2,PO3,PO4,PO5,PO12, PSO1,PSO2]
2. Students can install and conduct performance study of wind energy system. [PO1,PO2,PO3,PO4,PO5,PO12, PSO1,PSO2]
3. Students can install and conduct performance study of Photovoltaic system also design and fabricate any required power capacity solar, wind and photovoltaic system.. [PO1,PO2,PO3,PO4,PO5,PO12, PSO1,PSO2]

Scheme of Examination:

Students should do 2 experiments with one experiment each from pat-A and Part-B.

Each experiment carries 20 marks for both Part A and Part B

Max. Marks: 50

PART-A: 20

PART-B: 20

Viva-Voce: 10

Total: 50

CAD/ CAM LAB

Course Code: ME 78L **Course Credits: 0:0:1**

Prerequisite: Nil **Contact Hours: 14**

Course Coordinator: Dr R. KUMAR

Preamble

Computer Aided Design and Manufacturing (CAD/CAM) involves all the processes of conceptualizing, designing, analyzing, prototyping and actual manufacturing with Computer's assistance. A versatile Geometric Model can characterize all physical properties of real component and can incorporate all types of simulations and can quickly generate the modified outcomes (eg. Production drawings) for a predefined set of design rules. Use of CAD/CAM technologies enables the user to make accurate and precise changes in the geometric models, production drawings and simulation at any stage of the Product Design and Development Cycle.

Course Learning Objectives

During the course the students will be learning

1. The fundamentals of CAD/CAM process, use of data base, applications of CAD/CAM.
2. Various types of turning and machining centers.
3. The manual part programming and computer aided part programming.
4. Programming for milling and turning operations using CAM PACKAGES.
5. Programming the Industrial Robots etc.

PART A

CAM: Simulation of machining process (Turning and Milling) using CAM PACKAGES (MASTER CAM or ESPRIT etc.)

CNC Machining: Demonstration of part programming. Manual Part programming for CNC Machines to perform Turning and Milling operations.

PART B

Pneumatics, Hydraulics, Electro-Pneumatics: Four typical experiments on the basis of these topics to be conducted.

Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects.

Development of Ladder Logic Diagram/ Programming PLC for level control, Position control, Robot pick and place or any two simulations to be carried out.

TEXT BOOKS:

1. CAD/CAM principles and applications by P.N. Rao, Tata MC Graw Hill 2002
2. CAD/CAM by Groover, Tata MC Graw Hill 2003

REFERENCE BOOKS:

1. CAD/CAM – Ibrahim Zeid- Tata MC Graw Hill 2nd edition
2. Computer aided manufacturing- P.N. Rao, Tiwar, Tata MC Graw Hill 3rd eidtion

Course Outcomes (COs):

At the end of the course the students are accustomed with:

1. Analyze the fundamentals of CAD/CAM process [PO1,PO2,PO3,PO4, PO5,PO12, PSO1,PSO2]
2. Demonstrate the Practical knowledge about turning and milling centers using CAM tool [PO1,PO2,PO3,PO4, PO5,PO12,PSO1,PSO2]
3. Formulate Manual part program for the machining process and Create CNC part program using commercial CAM package [PO1,PO2,PO3,PO4,PO5,PO12, PSO1,PSO2]

Scheme of Examination:

The student should solve 2 exercises. 1 should be from PART A and the other from PART B

Each exercise carries 20 marks.

Viva – Voce carries 10 Marks

Total Maximum Marks = 50

Max Marks:	**50**
PART A:	**20**
PART B:	**20**
Viva-voce:	**10**
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TOTAL:	**50**

VIII SEMESTER B.E. MECHANICAL ENGINEERING

WIND ENERGY

Course Code: ME 811 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Mr VINAYAK TALUGERI

Preamble

Wind energy is an important non-conventional and renewable energy source which contributes for a significant portion of total energy consumption in India and the world. It is one of the thrust areas in the energy sector and the demand for wind energy is expected to grow at faster rate in the coming years. Considerable progress has been made in the recent years in wind energy technologies because of the need for very large machines and complex working conditions. This course has been tailored to expose students to the recent advances in wind energy technologies and to prepare them to the challenges in the coming years.

Course Learning Objectives

1. Study of modern wind turbines, components and various types of wind turbines.
2. Study of the methods and importance of wind resource assessment.
3. Study of aerodynamics and performance parameters of wind turbines.
4. Study of the wind turbine design and various aspects of siting and wind farm design.
5. Study of the economics and environmental impacts of wind energy generation.

UNIT I

Introduction: Modern wind turbines; Wind resource; Technology achievements; Wind energy penetration levels.

Wind resource assessment: Characteristics of steady wind; Weibull wind speed distribution function; Vertical profiles of steady wind; Wind rose; Energy pattern factor; Energy content of the wind; Resource assessment; Numerical problems

UNIT II

Aerodynamics: Introduction; Aerofoil; Actuator disc; Axial momentum theory; Momentum theory for a rotating wake; Blade element theory; Strip theory; Tip losses; Tip loss correction; Wind machine parameters; C_p-λ characteristics, SERI Blade sections; Wind machine mechanics; Numerical problems.

Wind turbine: Classification of wind turbines; turbine components.

UNIT III

Wind turbine design: Rotor blade theory; Blade geometry; Variation of aerofoil characteristics with Reynolds number; cambered aerofoil's; Simplified methods for loss calculation; basis for design loads; Functions of control and safety systems; Turbulence and

wakes; Non-operational load cases; Cost modeling; Relationship between rotational speed and solidity; Teetering; Power control; Braking systems; Blades.

UNIT IV

Siting and Wind farm design: Wind flow modeling, Power curve for wind turbine generator; Capacity factor; Planning of wind farms, Siting, wake models.

Wind energy economics: Annual energy output; Simple payback period; Capital recovery factor, Depreciation; Life cycle costing; Project appraisal.

UNIT V

Electrical and control systems: Classification of electrical machines; synchronous and induction generators; Variable speed generators; Control systems; Power collection systems; earthing of wind farms; Embedded (Dispersed) Wind generation.

Environmental impact: Biological impact; Surface water and wet lands; Visual impact; Sound impact; Communication impact.

TEXT BOOK:

1. Wind Energy – Theory and Practice by Siraj Ahmed, PHI Learning Private Limited, Eastern Economy Edition, New Delhi, 2010.

REFERENCE BOOKS:

1. Freris, L.L., Wind Energy Conversion Systems, Prentice Hall.
2. Spera, D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press.

Course Outcomes (COs):

At the end of course student have

1. Acquaint the modern wind turbines, components and various type of wind turbines. [PO1,PO2,PO10,PO11,PO12,PSO1]
2. Understand the methods and importance of wind resource assessment. [PO1,PO2,PO12,PSO1]
3. Apply the aerodynamic and performance parameters in wind turbines. [PO1,PO2,PO11,PO12,PSO1,PSO2]
4. Analyze the wind turbine design and various aspects of sitting and wind farm design. [PO1,PO2,PO10,PO11,PO12,PSO1,PSO2]
5. Evaluate the issues related to economics and environmental impacts of wind energy generation. [PO1,PO2,PO6,PO12,PSO1,PSO2]

FOUNDRY TECHNOLOGY

Course Code: ME 812 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr SIDDARAJU C

Course Learning Objectives

1. To study foundry metallurgy and concept of solidification of metals.
2. To study design aspects of casting, riser.
3. To study gating and melting techniques.
4. To study ferrous castings composition, properties & applications.
5. To study modernization and mechanization of foundry.

UNIT I

Foundry Metallurgy – Oxidation of Metals ,Gas dissolution in liquid Metals, Methods of degassing, Fluidity ,factors affecting Fluidity, hot tearing, Shrinkage of liquid metals.

Casting design – Introduction, Functional design Simplification of foundry practice, Metallurgical design, Economical design.

UNIT II

Solidification of Castings – Crystallization and development of cast structure, Nucleation and growth , Dendrite growth, Structure of castings, Significance and practical control of cast structure, Concept of progressive and directional solidification, Refinement and modification of cast structure, Solidification time and Chworinov rule

Risering - Needing for risering **,** Riser shape , size, Types of risers, Design and location of feeder heads, Design modifications, padding, chills and insulation.

UNIT III

Gating of Castings – Essential features of gaiting system, Design of gating system, General aspects of gating practice, Forces acting on the mould.

Special Casting Techniques :- Principle, material used , process details and application of Vaccum Process or V-Process Dissamatic moulding or Flaskless moulding

Cupola Melting:- Construction, Preparation and Operation of the cupola, Zones of Cupola Development of Cupola, Charge calculations.

UNIT IV

Ferrous foundry - Composition, Properties, applications of Gray Iron, Malleable Iron, SG Iron - Production, Magnesium recovery, Heat treatment and properties , application of SG Iron, ADI Production, Properties, , application.

Compostion ,properties , application of Low , Medium , High Carbon Steel, Alloy steels

UNIT V

Nonferrous foundry - Introduction, Melting procedure, Casting characteristics of Aluminum based alloys, Copper based alloys, Magnesium based alloys.

Modernization and Mechanization - Introduction, Need for modernization, mechanization, Elements of Mechanization, Moulding line mechanization, Mechanization of Melting , Pouring and shakeout units. Material Handling equipments.

TEXT BOOKS:

1. Principles of metal casting by Heine, Loper & Rosenthal, Tata McGraw Hill 2001
2. Foundry technology by Beeley.P.R.(Buttersworth) 2000
3. Principles of Foundry Technology P L Jain TMH 2006

REFERENCE BOOKS:

1. Metal casting – ASME handbook 2002
2. Metal casting technology by P.C. Mukerji 2002
3. Principles of solidification by B. Chalmers, Tata McGraw Hill 2001

Course Outcomes (COs):

Students will be able to

1. Understand the concepts of foundry metallurgy, casting characteristics, the gating system and the concepts in casting design [PO1,PO2,PO8,PO12,PSO2]
2. Interpret the solidification of pure metal and alloys, special casting techniques, production of ferrous and nonferrous metals [PO1,PO2,PO8,PO12,PSO2]
3. Recognize the composition, properties and application of ferrous and nonferrous materials [PO1,PO2,PO8,PO12,PSO2]
4. Exercise the charge calculations for melting process and the designing the gating system [PO1,PO2,PO8,PO12,PSO2]
5. Organize the need for modernization and mechanization of foundries [PO1,PO2,PO5,PO8, PO12,PSO2]

EXPERIMENTAL STRESS ANALYSIS

Course Code: ME 813 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr GIRISH V KULKARNI

Course Learning Objectives

1. To understand and study the various types of strain gauges and their working principles.
2. Able to analyse and calibrate the strain gauge rosettes and strain measuring systems
3. Understanding the nature of light and two dimensional photoelasticity
4. Aplly the two dimensional photoelastic analysis and its applictions.
5. Study on the birefringent and brittle coatings techniques.

UNIT-I

Strain Measurement: Introduction, Types of strain gauges: Mechanical, Optical, Pneumatic, Acoustic strain gauges, Electrical resistance strain gauges ,Gauge factor for electrical resistance strain gauge, Properties of an ideal gauge material, Backing material, adhesive material, protective coating, Methods of bonding strain gauges, strain gauge load wire and connections, semiconductor ,Strain gauge problems.

UNIT-II

Stain gauge circuits: Whetstone's bridge, Error due to input impedance of measuring instrument, Temperature compensation and multiple gauge circuits, Calibration of strain measuring system, Load cells, problems, Strain gauge rosettes, Necessity, analysis, problems.

UNIT-III

Nature of light: Harmonic wave, phase, amplitude, polarization, crystal optics, passage of light through crystalline media, Absolute and relative phase difference, Quarter wave plate, Half wave plate, Production of plane & circularly polarized light

Two dimensional photo elasticity: stress optic law, Plane polariscope, Circular polariscope, Isochromatic and Isoclinics, Dark & bright field arrangements, Methods of compensation, separation technique.

UNIT-IV

Photoelastic Analysis: Calibration, properties, Casting, machining, Stress reliving and application, Two dimensional application, Problems

UNIT-V

Birefringent coating: Theory, Reflection polariscope, Moire techniques, Moire fringe analysis, Introduction to holography, Brittle coating techniques, Computer techniques, Fringe analysis

TEXT BOOKS:

1. Experimental Stress Analysis, L S Srinath & others, Tata Mc Graw Hill Publication,1984
2. Experimental Stress Analysis, Dally & Riley, Tata Mc Graw Hill Publication,2001.
3. Experimental Stress Analysis,Dr.Sadhu Singh,Khanna Publishers,2010

REFERENCE BOOKS:

1. Analysis of stress and strain,A J Duraelli,T, Tata Mc Graw Hill Publication,1958
2. Moire Analysis of Strain, Durelli & Parks,1996

Course Outcomes (COs):

1. Apply concepts of strain measurements using the various types of strain gauges [PO1,PO2,PO3,PO4,PO12,PSO1,PSO2]
2. Understand the concept of strain gauge circuits, calibration and analysis of strain gauge rosettes . [PO1,PO2,PO3,PO4,PO12,PSO1,PSO2]
3. Apply fundamental concepts of nature of light and two dimesional photoelasticity. [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 understand the different coating techniques such as birefringent ,brittle and fringe analysis etc. [PO1,PO2,PO3,PO4,PO12,PSO1,PSO2]

OPERATIONS MANAGEMENT

Course Code: ME 814 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
Course Coordinator: Dr D K VISHWAS

Preamble

The success of any industry or service sector depends on two factors. Technical aspect is one thing and equally important is management of resources. It is important to learn the basics of production planning and controlling the operations so that resources are optimally used and finally productivity increases.

Course Learning Objectives:

1. Know the basics of operations management and productivity concepts.
2. Study the various aspects of decision making situation, probability rules, and breakeven analysis by solving problems.
3. Learn forecasting methods and errors in them and problems on the above topic, fundamentals of supply chain management.
4. Understand aggregate planning and production schedules and related problems.
5. Know the MRP & CRP basics, to solve problems on that. Understand scheduling methods using single/ multiple machines, Gantt charts.

UNIT I

Operations Management Concepts: Introduction, Historical Development, Operations Management Definition, Production and Manufacturing Systems, Products v/s Services, Productivity, Factors affecting Productivity, International Dimensions of Productivity.
Operations Decision Making: Introduction, Characteristics of decisions; framework for Decision Making, Decision methodology, Decision support systems; Economic models; Statistical models.

UNIT II

Forecasting: Forecasting Objectives and Uses, Forecasting Variables, Opinion and Judgmental methods, Time Series methods, Simple Exponential smoothing, Regression and Correlation methods, Application and Control of Forecasts.
Supply Chain Management: Introduction, components of supply chain, Process orientation, supply chain structure, Bullwhip effect in supply chains, Contracts and supply chain performance, Measures of supply chain performance.

UNIT III

Aggregate Planning and Master Scheduling: Introduction, Planning and Scheduling, Objectives of Aggregate Planning, Pure Strategies of Aggregate Planning. Master Scheduling - Objectives, Master Scheduling Methods.

UNIT IV

Material and Capacity Requirements Planning: Overview: MRP and CRP; MRP: Time phasing concepts, MRP inputs and outputs; Bill of Materials; MRP Logic ; System refinements CRP inputs and outputs; CRP activities; Infinite and finite loading.

UNIT V

Scheduling and controlling production activities: Introduction, PAC objectives and data requirements; forward and backward scheduling; Gantt charts.

Single Machine Scheduling: concepts, measures of performance SPT Rule, Weighted SPT Rule; EDD Rule; minimizing number of tardy jobs.

Multi-Machine Scheduling: Johnson's algorithm, n-jobs to 2-machines, n-jobs to 3-machines, 2 jobs to n machines, Graphical solutions.

TEXT BOOKS:

1. Operations Management, B. Mahadevan. Theory and practice, Pearson, 2007
2. Operations Management, Monks, J.G., McGraw-Hill International Editions, 1987.
3. Operations Management, Monks, J.G., Schaum's Outline Series, Tata McGraw Hill Ed. (2004).

REFERENCE BOOKS:

1. Modern Production/Operations Management, Buffa and Sarin, Wiley Eastern Ltd.2001
2. Production and Operations Management, Pannerselvam. R., PHI. 2002
3. Productions & Operations Management, Adam & Ebert. 2002
4. Production and Operations Management, Chary, S. N., Tata-McGraw Hill. 2002

Course Outcomes (COs):

Students will be able to

1. Take a better decision for a given situation**.** [PO1,PO2,PO5,PO11,PO12,PSO1,PSO2]
2. Forecast the future demand from the history**.** [PO1,PO2,PO3,PO5,PO12,PSO1,PSO2]
3. Plan the production satisfying the demand, scheduling accordingly**.** [PO1,PO2,PO11, PO12, PSO1,PSO2]
4. Calculate material required ,men and machines required**.** [PO1,PO2,PO3,PO11, PO12, PSO1,PSO2]
5. Schedule properly so that there will be full utilization of men and machines and time taken will be minimum [PO1,PO2,PO5,PO11,PO12,PSO1,PSO2]

CNC MACHINES

Course Code: ME 821 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
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]

INDUSTRIAL DESIGN AND ERGONOMICS

Course Code: ME 822 **Course Credits: 4:0:0**
Prerequisite: Nil **Contact Hours: 56**
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 **t**he mechanics of seeing.
5. The students will have the knowledge to improve aesthetic concepts of various products**.**

UNIT 1

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

UNIT 1I

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

UNIT III

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

UNIT 1V

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

UNIT V

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

REFERENCE BOOKS:

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

Course Outcomes (COs):

Students will be able to

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