Academic Program: UG

Academic Year 2024-25

Syllabus

VII & VIII Semester B.E.

Mechanical Engineering

SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE OF ENGINEERING & TECHNOLOGY,

DHARWAD – 580 002

(An Autonomous Institution approved by AICTE & Affiliated to VTU, Belagavi)

Ph: **0836-2447465Fax: 0836-2464638 Web:** www.sdmcet.ac.in

SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for VII & VIII semester of UG program in Mechanical Engineering is recommended by the Board of Studies of the Mechanical Engineering Department and approved by the Academic Council, SDM College of Engineering &Technology, Dharwad. This scheme and syllabus will be in force from the academic year 2024-25 till further revision.

Principal Chairman BoS & HoD

SDM College of Engineering & Technology, Dharwad

Department of Mechanical Engineering

College

Vision:
To develop competent professionals with human values.

Mission:
1. To have contextually relevant Curricula.
2. To promote effective Teaching Learning Practices supported by Modern Educational Tools and Techniques.
3. To enhance Research Culture.
4. To involve Industrial Expertise for connecting classroom content to real life situations.
5. To inculcate Ethics and impart soft-skills leading to overall Personality Development.

SDMCET- Quality Policy
- In its quest to be a role model institution, committed to meet or exceed the utmost interest of all the stake holders.

SDMCET- Core Values
- Competency
- Commitment
- Equity
- Team work and
- Trust

Department

Vision:

To establish a synergetic Mechanical Engineering program anchored in fundamentals and relevant state of the art technologies, thereby enabling the students to achieve all round development for careers in industry and for higher learning, being responsible to society and environment.

Mission:

1. To establish a curricula & syllabi consisting of robust core courses with emphasis on imparting fundamental principles of mechanical engineering coupled with adaptive and relevant electives catering to the cutting edge technologies.
2. To promote interactive teaching practices using modern educational tools & techniques to attain synergy in teaching, research and industrial practices.
3. To imbibe industrial expertise for connecting class room learning to real life situation.
4. To impart soft skills and professional ethics enabling students to achieve an all-round personality development, making them responsive to societal needs and environmental concerns.

Programme Educational Objectives (PEOs):

1. Graduates will be successful in industry, research and higher learning.
2. Graduates will formulate, analyze and solve engineering problems.
3. Graduates will work in teams to address industrial and socially relevant problems / projects.
4. Graduates exhibit awareness and commitment to lifelong learning & practice professional ethics.

Program Outcomes (POs)

Engineering Graduates will be able to:

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

2. **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.

3. **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.

4. **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.

5. **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.

6. **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.

7. **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.

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

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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.
12. **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.

Program Specific Outcomes (PSOs)

13. **Industrial interactions:** Enhance knowledge of mechanical engineering with industrial practices and standards by exposure to industries.
14. **Role of economics and costing:** Learn the concepts of economics and costing to provide effective solutions to mechanical engineering problems.

SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD

Department of Mechanical Engineering

VII Semester

Scheme of Teaching and Examinations 2024 – 25

Course Code	Course Category	Course Title	Teaching		Examination				
			L-T-P (Hrs/Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
					Max. Marks	*Max. Marks	Duration in Hrs.	Max. Marks	Duration In Hrs.
21UMEC700	PC	Mechanical Vibrations	2 - 2 - 0	3	50	100	3	-	-
21UMEE72X	PE	Program Elective – 4	3 - 0 - 0	3	50	100	3	-	-
21UMEE73X	PE	Program Elective – 5	3 - 0 - 0	3	50	100	3	-	-
21UMEE74X	PE	Program Elective – 6	3 - 0 - 0	3	50	100	3	-	-
21UMEO75X	OE	Open Elective – 2	3 - 0 - 0	3	50	100	3	--	--
21UHUC700	HU	Research Methodology	2 - 0 - 0	2	50	50	2	--	--
21UMEL701	PC	Dynamics of Machines Laboratory	0 - 0 - 2	1	50	--	--	50	3
21UMEL702	PC	Major Project Phase-1	0- 0 -4	2	50	--	--	50	3
		Total	16 - 2 -6	20	400	550	--	100	

PC- Program Core, PE-Program Elective, OE- Open Elective and HU- Humanities

Electives

Course code	Elective Courses (PE-4)	Course code	Elective Courses (PE– 5)	Course code	Elective Courses (PE– 6)	Course code	Open Elective Courses (OE–2)
21UMEE721	Battery and Fuel Cell Technology	21UMEE731	Organizational Behavior	21UMEE741	Hybrid Vehicle Technology	21UMEO751	Micro Electro Mechanical Systems
21UMEE722	Computational Fluid Dynamics	21UMEE732	Operations Research	21UMEE742	Heating Ventilation and Air Conditioning	21UMEO752	Modeling & Simulation of Dynamic Systems
21UMEE723	Industrial Robotics	21UMEE733	Power Plant Engineering	21UMEE743	Additive manufacturing	21UMEO753	Project Management
21UMEE724	Computer Integrated Manufacturing	21UMEE734	Design of Heat Exchangers	21UMEE744	Estimation and Costing in Mechanical Engineering	21UMEO754	Design of Aircraft structures
21UMEE725	Experimental Stress Analysis	21UMEE735	Design For Manufacturing and Assembly	21UMEE745	Design of IC Engine Components		
21UMEE726	Failure Analysis	21UMEE736	Production Planning & Control	21UMEE746	Design and Drawing of Mechanical Assemblies		
21UMEE727	Control Engineering	21UMEE737	Advanced Metal Joining Technology				

SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD

Department of Mechanical Engineering

VIII Semester

Scheme of Teaching and Examinations 2024 – 25

Course Code	Course Category	Course Title	Teaching		Examination				
			L-T-P (Hrs /Week)	Credits	CIE	Theory (SEE)		Practical (SEE)	
					Max. Marks	*Max. Marks	Duration in Hrs.	Max. Marks	Duration In Hrs.
21UMEL800	PC	Technical Seminar/Independent study	0 - 0 - 2	1	50	--	--	--	--
21UMEL801	PC	Major Project Phase-2 (In Industry/college/ through internship)	0-0 -18	9	50	--	--	50	3
21UMEL802	PC	Internship -2	4 - 6 Week s	3	50	--	--	50	3
Total			0– 0 - 20	13	150	--	--	100	--

PC- Program Core, PE-Program Elective, and OE- Open Elective

VII Semester

21UMEC700	Mechanical Vibrations	(2-2-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Concepts and types of vibrations.
2. Natural frequencies of physical problems.
3. Vibration transmission and methods to reduce vibrations.
4. Numerical methods to solve multi degree systems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain basic concepts and terms in mechanical vibration.	-	-	1
CO-2	Derive mathematical model using Newton's and energy methods for one and two degree of freedom mechanical systems.	1	2	3
CO-3	Evaluate the performance parameters of SDOF systems under forced vibrations and explain working of vibration measuring instruments.	1,2	4	-
CO-4	Formulate mathematical relations for over damped, critical damped and under damped systems.	1,2	3	-
CO-5	Determine natural frequency of multi-degree freedom systems using numerical methods.	-	1, 4, 5	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.4	2.7	1.5	2	2	-	-	-	-	-	-	-	-	-

Prerequisites: Nil.

Course Contents :

Unit - I

Fundamental of Vibrations: Types, Causes, Effects, Terms in Vibration, Simple Harmonic Motion, Representation of SHM, Combination of SHM, Beats, Fourier series.

Single Degree Freedom System: (Undamped) Natural Frequency, Equivalent System, Parallel Springs, Series Springs, Inclined Springs, Geared System. Energy Method-Energy Principle. **Determination of natural frequency of simple pendulum using simulation software.** **8 Hrs**

Unit – II

Single Degree Freedom System: (Damped) Damping Models- Viscous Damping, Structural Damping, Coulomb Damping Single Degree Freedom System with Damping- Over Damped, Under Damped, Critically Damped, Logarithmic Decrement. **7 Hrs**

Unit – III

Single Degree Freedom System – Forced Vibrations: Forced Vibrations with constant Excitation – Steady State Vibrations, Forced Vibrations with Rotating and Reciprocating unbalance, Forced Vibration due to base excitation, Critical Speed of shaft.

Experimental Methods in Mechanical Vibrations: Vibrometers, Accelerometers, Frequency Measuring Instruments, FFT Analyzer. **7 Hrs**

Unit – IV

Two Degree Freedom System: Free Vibration of spring Coupled system, Principle mode of vibrations, combined rectilinear and angular modes, Vibration Absorbers, Forced Damped Vibrations. **Determination of natural frequencies of car suspension system using simulation software.**

Continuous System: Vibration of String, Longitudinal Vibration of Bars Lateral Vibration of beams. **9 Hrs**

Unit – V

Numerical Methods: Holzer Method, matrix method & matrix iteration method. Determination of natural frequencies of arrangement of power plant system using simulation software. **8 Hrs**

Reference Books:

1) S. S. Rao, “Mechanical Vibrations”, 4th Edition, Pearson Publications, 2009.
2) Graham Kelly, “Fundamentals of Mechanical Vibrations”, 2nd Edition, McGraw Hill Publications, 2000.
3) G. K. Grover, “Mechanical Vibrations”, TATA McGraw Hill Publications.
4) Seto, “Mechanical Vibrations”, Schaum series publication TATA McGraw Hill Publications.
5) Kelly S. G, “Mechanical Vibrations”, McGraw Hill, 2014.

21UHUC700	Research Methodology	(2-0-0) 2

Contact Hours: 26

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Types of research,
2. Problem formulation, literature review,
3. Measurement, scaling, data collection,
4. Testing of hypothesis, result interpretation and report writing.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Formulate** the research problem, carryout literature survey and decide the methodology.	-	2	-
CO-2	**Importance** of Literature survey and need to identify gaps	5	2	-
CO-3	**Describe** measurement and scaling and data collection &report writing	-	3	2
CO-4	**Test** the hypothesis, interpret &analyze the results and write the report.	-	4	-
CO-5	**Explain** the need for interpretation and report writing	-	5	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Mapping Level	-	1.66	2	2	2.5	-	-	-	-	-	-	-

Pre-requisites:

Design and Analysis of Engineering subjects related issues

Course Contents :

Unit-I

Research Methodology: Introduction, meaning of research, objectives of research, motivation in research, types of research, research approaches, significance of research, research methods versus methodology.

Defining the Research Problem: Research problem, selecting the problem, necessity of defining the problem, technique involved in defining a problem, an illustration. **06 Hrs.**

Unit-II

Reviewing the literature: Importance of the literature review in research, How to review the literature, searching the existing literature, reviewing the selected literature and writing about the literature reviewed.

Research Design: Meaning of research design, need for research design, features of a good design, important concepts relating to research design. **05 Hrs.**

Unit-III

Measurement and Scaling: Measurement in research, measurement scales, sources of error in measurement, scaling, meaning of scaling and important scaling techniques.

Data Collection: Collection of primary data, observation method, interview method, collection of data through questionnaires. **05 Hrs.**

Unit-IV

Testing of Hypotheses: What is a Hypothesis? Basic concepts concerning testing of hypotheses, procedure for hypothesis testing, flow diagram for hypothesis testing, measuring the power of a hypothesis test, tests of hypotheses. **05 Hrs.**

Unit-V

Interpretation and Report Writing: Meaning of interpretation, technique of interpretation, precaution in interpretation, significance of report writing, different steps in writing report, layout of the research report, types of reports, oral presentation and mechanics of writing a research report, precautions for writing research reports, plagiarism and its significance. **05 Hrs.**

Reference Books:

1) C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, New Age International, 4th Edition, 2018.
2) Ranjit Kumar, Research Methodology a step-by-step guide for beginners, SAGE Publications, 3rd Edition, 2011.
3) Fink A, Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications, 2009.

21UMEL701	Dynamics of Machines Laboratory	(0-0-2) 1

Contact Hours: 26

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Balancing of rotating masses whirling of shafts, SDOF systems Concept of governors and their characteristics.
2. Principles of strain gauges and photo elasticity.
3. Importance of Pressure distribution around journal bearing.
4. Effect of unbalance in machinery & method of balancing of rotary and reciprocating forces.
5. Concept of gyroscope and gyroscopic effect in automobiles. Aero planes & ships.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Balance rotating masses in single plane and multi planes.	3	4	-
CO-2	Conduct the experiment on gyroscope to verify gyroscope equation.	-	4	-
CO-3	Conduct the experiments using strain gauges and photo elastic bench to compute stresses and strains.	-	4	-
CO-4	Determine theoretical and experimental natural frequencies of various SDOF vibrational systems.	-	3	-
CO-5	Evaluate the performance of different governors.	-	4	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	-	-	2.5	2	-	-	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Part A

1. Experiments on Balancing of Rotating masses in single and multiple planes.
2. Experiments on Porter Governors.
3. Experiments on Whirling of shafts.
4. Experiments on single degree of freedom vibrating systems.
5. Experiments on strain gauges.
6. Experiments on Photo elastic bench.
7. Experiments on Gyroscope.

PART B

(Dynamic simulation lab – Any two of the below) (Demo)

1. Modeling of crank-rocker, double lever and crank-crank mechanisms using Grashoff's law.
2. Kinematic analysis of slider crank mechanism. - 1 exercise
3. Kinematic analysis of four bar mechanism. - 1 exercise.
4. Static force analysis of slider crank mechanism – 2 exercises.
5. Static force analysis of four bar mechanism – 1 exercise.
6. Dynamic force analysis of slider crank mechanism – 1 exercise.
7. Dynamic force analysis of four bar mechanism – 1 exercise.
8. Modeling of single DOF spring mass system.
9. Modeling of multi DOF spring mass system.

Reference Books:

1. Rattan S. S. "Theory of Machines", 2nd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2006.
2. Shigley and Uicker, "Theory of Machines and Mechanisms", International edition, McGraw Hill.1995
3. Multi body dynamics tutorials.
4. Dynamic simulation lab manual.

21UMEL702	Major Project Phase - 1	(0-0-4) 2

Contact Hours: 52

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Practical significance of projects.
2. Engineering concepts and its application to real world problems.
3. Manufacturing problems associated with fabrication.
4. Creativity as an essential component of engineering application.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify, formulate, and solve a problem using basic engineering principles.	1,2	4	1,2
CO-2	Recognize the need and able to design and fabricate the machine parts, components of a system that meets requirement.	3	7	6,12
CO-3	Use the software tools to prepare and analyze models or prototypes and conduct simulation using it.	5, 13	2	-
CO-4	Work in teams and communicate effectively for completion of projects in time.	10	8,11,12	-
CO-5	Prepare a report based on their project and present the concept using ppt.	13, 14	9,10,11	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2	2	3	2	3	1	2	2	2	2.5	2	1.5	3	3

Prerequisites: Nil

Course Contents :

Major project phase-1 in which the students are expected to locate the state of the art technology in his domain of interest by an extensive literature survey and Select a topic from an emerging area relevant to electrical sciences and/or other relevant branches and define the problem for the project work. The material collection, survey, visits, data collection, preliminary design, analysis etc. is to be done in this phase. The project shall consist of a team of students not more than 4. Each batch shall be assigned with a guide. A committee consisting of minimum 3 faculty members of which guide is a member shall evaluate at the end for CIE. There is a viva voce examination which shall be examined by two internal examiners appointed by COE based on the suggestions by the respective HoD.

21UMEE721	Battery and Fuel Cell Technology	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Significance of fuel cells in present energy context of India
2. Working of different batteries
3. Working of different fuel cell and thermodynamics
4. Hydrogen production and storage methods

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain energy scenario and fuel cells as future source of power	-	1	7
CO-2	Describe the working of primary and secondary types of batteries	-	1, 2	6
CO-3	Explain the working principles of fuel cells.	-	1	7
CO-4	Evaluate efficiency and thermodynamic parameters related to fuel cells.	1	2	7
CO-5	Describe different methods of production and storage of hydrogen for fuel cells.	-	1	6, 7

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.2	2	-	-	-	1	1	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Indian energy scenario , sector wise energy patterns, need for alternate sources of energy, fuel cell as an alternate sources of energy pros and cons, brief historical background of fuel cells and batteries , basic working principle and comparison of fuel cell and batteries , international and national status of fuel cell development and application. Fuels for Fuel Cells: Hydrogen, methane, methanol - Sources and preparation, reformation processes for hydrogen. **6 Hrs**

Unit - II

Batteries: Introduction, working of primary and secondary batteries: The chemistry, fabrication, and performance aspects, packing classification and rating of the following batteries: Zinc-carbon, zinc alkaline zinc/air batteries; Lithium primary cells - liquid cathode, solid cathode and lithium-ferrous sulphide cells

Secondary batteries: Lead acid, nickel-cadmium, nickel-zinc, nickel-metal hydride batteries, lithium-ion batteries, ultrathin lithium polymer cells. Advanced Batteries for electric vehicles, requirements of the battery, depth of discharge, sodium-beta and redox batteries. **8 Hrs**

Unit - III

Fuel Cells: Description, working principle, anodic, cathodic and cell reactions, fabrication of electrodes and other components, applications, advantages, disadvantages and environmental aspects of the following types of fuel cells: Proton Exchange Membrane Fuel Cells, alkaline fuel cells, phosphoric acid, solid oxide, molten carbonate, direct methanol fuel cells.

Membranes for fuel cells: Nafion – Polymer blends and composite membranes; assessment of performance – recent developments. **9 Hrs**

Unit - IV

Thermodynamics of fuel cells: First law second law, heat potential reaction enthalpies, Gibbes free energy, reversible voltages, fuel cell efficiency, Nernst equation analysis effect of temperature and pressure and concentration, concept of electrochemical potential calculation of standard electrode potential

9 Hrs

Unit - V

Hydrogen production and storage: Advantages and disadvantages of using hydrogen as fuel, hydrogen production methods, hydrogen storage, recent developments in storage and production of hydrogen.

7 Hrs

Reference Books:

1) M. Aulice Scibioh and B. Viswanathan “Fuel Cells – principles and applications”, University Press, India, 2006.
2) F. Barbir, “PEM fuel cells: theory and practice”, Elsevier, Burlington, MA, 2005.
3) Dell, Ronald M Rand, David A J, “Understanding Batteries”, Royal Society of Chemistry, 2001.
4) G. Hoogers, “Fuel cell handbook”, CRC, Boca Raton, FL, 2003.
5) Ryan P. O'Hayre, Suk-Won Cha, Whitney Colella and Fritz B. Prinz, Fuel cell fundamentals, John Wiley and Sons, 2006

21UMEE722	Computational Fluid Dynamics	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Governing equations of fluid flow
2. Methods of discretizing the governing equations.
3. Methods of solving discretized equations.
4. Fluid flow problems and solutions using software package.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/PSO (13-14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the need, advantages and disadvantages and steps involved in CFD.	-	1	-
CO-2	Derive governing equations of fluid flow and explain the scope and applicability of such equations.	--	1,2	-
CO-3	Discretize governing equations of fluid flow using finite difference/finite volume method.	1,2	-	-
CO-4	Explain Maccormach's and SIMPLE Scheme of solving fluid flow problems.	-	1,2	-
CO-5	Solve set of algebraic equation using numerical methods	-	1,2	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.2	2.2	-	-	-	-	-	-	-	-	-	-	-	-

Pre requisites: Nil

Course Contents :

Unit - I

Introduction to Computational Fluid Dynamics, Advantages, limitations and applications. **CFD solution procedure**: Preprocessing, solving and post processing. **Governing equations** for CFD-Continuity equation.

7 Hrs

Unit - II

Governing equations for CFD momentum equation, Energy equation, Physical boundary conditions, Introduction to Turbulence and k-ε turbulence model.

8 Hrs

Unit - III

Classification of partial differential equations, general behavior of different classes of partial differential equations, well posed problems.

CFD techniques: Discretisation of governing equations by FDM, converting governing equations to algebraic equation system, implicit and explicit approaches.

8 Hrs

Unit - IV

Discretisation of governing equations by FVM, converting governing equations to algebraic equation system, implicit and explicit approaches,

Numerical solution of algebraic equations: direct and iterative methods, Thomas algorithm, Jacobi and Gauss-Siedel methods. **8 Hrs**

Unit - V

Central difference and upwind schemes applied to 1-D situation involving convection and diffusion terms, Maccormack's technique applied to unsteady 2-D inviscid flow, pressure velocity coupling (SIMPLE scheme applied to incompressible viscous flow).

CFD solution analysis: Consistency, stability, convergence, accuracy and efficiency, sources of solution errors, verification and validation.

8 Hrs

Reference Books:

1) Anderson, J. D. Jr., "Computational Fluid Dynamics-The Basics with Applications", McGraw-Hill, New York, 1995.
2) Suhas V. Patankar, "Numerical Heat Transfer and Fluid Flow", Taylor & Francis, 2012.
3) Jiyuan Tu, Guan Heng Yeoh, and Chaoqun Liu, "Computational Fluid Dynamics: A Practical Approach", Butterworth-Heinemann, 2008.
4) J.C. Tannehill, D. A. Anderson and R.H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", 2nd Edition, Taylor & Francis, 1997.

21UMEE723	Industrial Robotics	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Various elements of Robotics.
2. Kinematics of robots.
3. Modeling and analysis concepts of various robotics systems.
4. Trajectory planning and various sensors used in robotics.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain basic structure and performance characteristics of an industrial robot.	-	1	2
CO-2	Describe different types of sensors and vision system in a robot.	-	1	2
CO-3	Derive a mathematical model and equations of motion for a robot.	1	2	3
CO-4	Analyze kinematically serial manipulators.	1	2	3,5
CO-5	Plan the motion of robot using different trajectory planning schemes and explain types of end effectors.	-	1	2,5

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.4	1.4	1	-	1	-	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Introduction: Definition: manipulators, Robotics, Brief history of robotics, Overview of robots, social & economic aspects of robots, Advantages of using robots in industries, Future applications.

Structure of robotic systems: Classification, Geometrical configuration, wrist & its motions, Degrees of freedom, work Envelop, Links and joint, effectors and its type, Robot drive system: Hydraulic, electric selection of drive system, Resolution, accuracy & repeatability, Specifications of robots.

8 Hrs

Unit - II

Sensors: State and Transducers, Classification, Internal & External sensors, Interlocks, Tactile and non- tactile sensors, Proximity and range sensing, force – torque, Static and dynamic characteristics, Selection of sensors, Elements of computer vision, Sensing and digitizing, Lighting techniques, A/D conversion, sampling quantization, Image storage, Image processing and analysis, Feature Extraction &object Recognition.

Robot Programming: Introduction, Types robot programming, Teach pendant, Lead through programming, Programming languages VAL, RAIL, AML, Programming with graphics, storing & operating.

8 Hrs

Unit - III

Robot Motion Analysis: Kinematics, Introduction, Direct & inverse kinematics, Classification, Transformations homogenous transformations, Rotation, matrix, Composite rotation matrix, Rotation matrix about an arbitrary axis, Euler angle representation, Links, joints and their parameters D-H representation.

10 Hrs

Unit - IV

Robot Arm Dynamics: Euler Lagrange formulations, Joint velocities, K.E., P.E, motion equations of a robot manipulator.

Control Systems and Components: Basic control system concepts and models, Transfer function with block diagram of spring mass system, Transient response to second order systems, controllers on/off, proportional and integral, PID, Digital, Adoptive control, AI.

7 Hrs

Unit - V

Trajectory Planning: Introduction, General considerations on trajectory planning, Joint interpolated trajectories, 4-3-4 trajectory examples, Planning of Cartesian path Trajectories.

Robot End Effectors: types of end effectors, Mechanical Grippers, Other types of Grippers, tools as End effectors, the robot/end effector interface, considerations in gripper selection and design.

6 Hrs

Reference Books:

1) Mohsen Shahinpoor, “A Robot Engineering Textbook”, Harper & Row.
2) Mikell P Grover, Mitchel Weiss, Roger N Nagel, Nicholas G Odrey & Ashish Dutta, “Industrial Robots”, McGraw Hill, 2003.
3) K.S. Fu, R. C. Gonzalez & C.S.G. Lee, “Robotics- control, sensing, vision and intelligence”, McGraw Hill, International, New Delhi 2001.
4) Yoram Koren, “Robotics for Engineers”, McGraw Hill International, New Delhi 2001.
5) Richard Paul, “Robot manipulators-Mathematics, Programming and control”, 2000.
6) Saeed B. Niku, “Introduction to Robotics”, Wiley student edition, second edition, 2011.
7) S. K. Saha, “Introduction to Robotics”, McGraw Hill, second edition, 2015.

21UMEE724 Computer Integrated Manufacturing (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Basics of Computer Integrated Manufacturing.
2. Automated assembly system.
3. Latest computerized manufacturing practices.
4. Shop floor control & quality.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the basic concepts of automation, flow lines, line balancing and high-volume production systems.	-	1, 2	-
CO-2	Analyze different Automated Flow Line, and line balancing.	1	2	-
CO-3	Analyze different Automated Assembly systems. Describe Material handling system, Automated guided vehicle system.	1	2	-
CO-4	Describe Computerized Manufacturing & Planning Systems and basics of Robotics in industry.	-	1, 2	-
CO-5	Describe shop floor control systems and computer aided quality control systems in a factory environment.	-	1, 2	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.4	2	-	-	-	-	-	-	-	-	-	-	-	-

Prerequisites: Nil.

Course Contents :

Unit - I

Computer Integrated Manufacturing System: Introduction, Types of Automation, Production concepts, Mathematical Models, Automation Strategies (Numerical).

High Volume Production System: Automated FLOW lines, Work Part Transport Mechanism, Buffer Storage (Numerical). **8 Hrs**

Unit - II

Analysis of Automated Flow Line and line balancing: Analysis of Transfer Lines without storage and with storage, Partial automation, Manual Assembly Lines, Methods of line balancing, Computerized line balancing (Numerical)

8 Hrs

Unit - III

Automated Assembly System: Types, Parts feeding Devices, Analysis of single station assembly machine, Analysis of multi station assembly machine, automated material handling system, Automated guided vehicle system.

8 Hrs

Unit - IV

Computerized Manufacturing Planning System: Computer Aided Process Planning: Retrieval Type, Generative type. Material Requirement Planning, Fundamental concepts of MRP, Inputs to MRP, Capacitive Planning.

Robotics: Introduction to Robot, Robot anatomy and configuration, work volume, end effectors, Robot sensors and Robot applications.

8 Hrs

Unit - V

Shop Floor Control: Factory Data Collection System, Automatic Identification System.

Computer Aided Quality Control: Contact inspection methods, Non-contact inspection methods, Co-ordinate Measuring Machine.

7 Hrs

Reference Books:

1) Mikell O. Groover, “Automation, Production system and Computer Integrated Manufacturing”, 3rd edition, PHI, New Delhi, 2010.
2) Mikell P. Groover, “CAD/CAM”, 3rd edition PHI, New Delhi, 2003.
3) Ibrahim Zeid, “CAD/CAM”, 2nd edition, Tata McGraw Hill, 2010.

21UMEE725 Experimental Stress Analysis (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Stresses, strains, equilibrium and photo elastic analysis.
2. Stress separation holographic applications.
3. Solution of problems in plane stress, plane strain, torsion and bending using strain gauges.
4. Strain gauges, mounting techniques, coating techniques and recording.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain concepts and methods of experimental stress analysis	1	-	-
CO-2	Explain theory of birefrengent coatings, sensitivity methods of separation of principal stresses, and principles of holography.	1	-	-
CO-3	Explain principle of brittle coating method and derive relation between state of stress in coating & that in the model	1	-	-
CO-4	Explain crack detection techniques & calibration procedure of brittle materials	1	-	-
CO-5	Explain theory & procedure of measuring strain using electrical strain gauges, including mounting technique.	1	-	-
CO-6	Analyze strain gauge data	1	-	4

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 13	PSO 14
Mapping Level	3	-	-	1	-	-	-	-	-	-	-	-	-	-

Pre requisites: Engineering Mathematics, Engineering Physics, Theory of Elasticity.

Course Contents :

1) **Theory of photo elasticity:** Temporary double refraction, stress optic law, effect of Stressed model in a plane polariscope, fringe multiplication. **6 Hrs**

2) **Two dimensional photo-elasticity:** Isochromatic fringe patterns, isoclinic fringe patterns. **5 Hrs**

3) **Compensation techniques,** calibration methods, separation method. **5 Hrs**

4) **Birefrengent coatings:** Coating stresses and strains, sensitivity, application, effect of thickness. **5 Hrs**

5) **Stress separation, holographic applications.** **5 Hrs**

6) **Brittle coatings methods:** Coating stress, brittle coating crack patterns, crack detection, test procedures, calibration procedures and analysis of data. **4 Hrs**

7) **Strain measurements methods:** Electrical resistance strain gauges, semiconductors strain gauges, strain gauge circuits. **4 Hrs**

8) **Recording instruments,** analysis of strain gauge data, mounting techniques. **5 Hrs**

Reference Books:

1) James Dalley and William Ralley, Experimental stress analysis, McGraw Hill Publishers 1978
2) L.S.Srinath and others, Experimental stress analysis, TMH 1980
3) Sadhu Singh, Experimental stress Analysis, 4th edition, Khanna Publishers, 2010

21UMEE726	Failure Analysis	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Role of failure in materials for better sustainability of materials and prevent failure of materials by testing under various loads.
2. The importance failure modes in materials.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Discuss failure criteria and different modes of mechanical failures.	-	1,2	-
CO-2	Apply damage theories to determine failure criteria	1	2	3
CO-3	Use statistics in fatigue analysis	1	2	3
CO-4	Explain concepts of creep, stress rupture and fatigue	-	1,2	-
CO-5	Explain concepts of fretting, wear, and other failure modes	-	1,2	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.4	2	1	-	-	-	-	-	-	-	-	-	-	-

Pre requisites: Nil.

Course Contents :

Unit - I

The role of Failure Prevention Analysis in Mechanical Design: Introduction, Definition of Design, Some Design objectives, Modes of Mechanical failure, definition of failure mode, failure modes observed in practice.

High Cycle fatigue: The nature of fatigue, Fatigue loading, Laboratory fatigue testing, The S-N-P curves-A basic design tool, factors that affect S-N-P curves, The influence of nonzero mean stress, multiaxial fatigue stresses.

8 Hrs

Unit - II

Concepts of cumulative damage, life prediction, and fracture control: The linear damage theory, Cumulative Damage Theories: Henry Cumulative Damage theory, Gatts Cumulative Damage theory, Martin Cumulative Damage theory, Damage tolerance and fracture control

8 Hrs

Unit - III

Use of Statistics in Fatigue analysis: Definitions, Population Distributions, Sampling Distributions, Statistical Hypotheses, confidence limits, Properties of good estimators, sample size for desired confidence, probability paper.

Fatigue testing Procedures and statistical interpretation of data: Standard method, Constant stress level testing, response or survival method, Prot method, extreme value method.

8 Hrs

Unit - IV

Low cycle fatigue: The strain cycling concept, the strain life cycle curve and low cycle fatigue relationships, the influence of nonzero mean strain and nonzero mean stress, cumulative damage in low cycle fatigue, Influence of multiaxial states of stress, Relationship of thermal fatigue to low cycle fatigue.

7 Hrs

Unit - V

Creep, stress rupture and fatigue: Prediction of long term creep behavior, Theories for predicting creep behavior, cumulative creep concepts.

Fretting, Fretting fatigue, and Fretting wear: Variables of importance in the Fretting process, Fretting Fatigue, Fretting wear, Fretting Corrosion, minimizing or preventing Fretting damage. Wear, corrosion and other important failure modes.

8 Hrs

Reference Books:

1) Jack A. Collins, “Failure of Materials in Mechanical Design: Analysis, Prediction”, Prevention, 2nd Edition, John Wiley & Sons, 1983.
2) Richard M Christensen, “Theory of Materials Failure”, Oxford University Press, 2013.
3) Ashok Choudhury, “Failure Analysis of Engineering Materials”, Charles R. Brooks, McGraw Hill Professional, 2002.

21UMEE727 Control Engineering (3-1-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Various mathematical models, methods and limitations of physical models and their mathematical equivalents.
2. Transfer functions of various systems such as thermal, hydraulic, and pneumatic systems.
3. Transient and steady state analysis for step, ramp, impulse, and sinusoidal inputs.
4. Different types of plots used for analysis of stability of control systems.
5. Types of compensators and controllers.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Outline different aspects of control systems and convert different control systems into mathematical model.	1,2	4	-
CO-2	Obtain transfer functions for block diagrams & signal flow graphs and parameters of time responses to various inputs.	1, 2	4	3
CO-3	Determine the stability of control systems by Routh's stability criterion and root locus plots and plot the graphs using MATLAB.	1, 2, 4	3	-
CO-4	Find the stability of control systems by constructing bode plots and plot the graphs using MATLAB.	1, 2, 4	3	-
CO-5	Determine the stability by constructing Polar, Nyquist Diagrams and plot the graphs using MATLAB.	3, 4	2	1
CO-6	Explain various controllers and compensators.	-	-	1

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.3	2.8	2	2.6	-	-	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Introduction: Introduction to control systems, Classification of control systems, open loop & closed loop control systems, elements of Control systems, Characteristics, advantages & disadvantages of control system.

Mathematical modelling: Mechanical systems (translation & rotational), Electrical systems, servos, D.C Motors, A.C Servomotors, Hydraulic (liquid level, Fluid power), Thermal systems, Hydraulic servomotor, Temperature control, Error detectors.

7 Hrs

Unit - II

Representation of control systems: Block diagram representation of system elements**,** reduction of block diagrams; Signal flow graphs, basic properties, transfer function, Masons gain formula.

System response: First and second order response to step, ramp and sinusoidal inputs, concept of time constant, and speed of response.

8 Hrs

Unit - III

System design: Routh's stability criterion, Root locus Method, Definition, construction of root loci and plot the graphs using Matlab, Graphical relationship for setting system gain.

8 Hrs

Unit - IV

Analysis using logarithmic plots: Bode attenuation diagrams, stability using Bode diagrams and plot the graphs using Matlab. **8 Hrs**

Unit - V

Frequency response: Polar and rectangular plots for frequency response, analysis using Nyquist Diagrams, Relative stability, gain and phase margin, M and N circles and plot the graphs using Matlab.

Design in Frequency Domain: Control action & system compensation: Types of controllers, proportional, integral, and differential, PID Controllers (basic concepts), series and feedback compensation design of control parameters, Physical devices for system compensation. **8 Hrs**

Reference Books:

1) U. A. Bakshi & V. A. Bakshi “Control systems”, 1st Edition, Technical publication Pune, 2010.
2) A. Anandkumar “Control systems”, 2nd Edition, PHI, 2014.
3) K. Ogatta, “Modern Control Engineering”, 5th edition, Prentice Hall (India), Pearson Education, 2010.
4) I. J. Nagarath and M. Gopal, “Control systems Engineering”, 5th edition, New Age International Publishers, 2010.
5) B. C. Kuo, “Automatic Control Systems”, 8th edition, Prentice Hall (India), 2010.
6) Schaum’s series, “Feedback Control Systems”, McGraw Hill, 2001.

21UMEE731	Organizational Behavior	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Human behavior when working in groups.
2. Scientific methods of motivation.
3. Theories of leadership.
4. Managing self and managing teams.
5. Developing the Proficiency in managing different activities in any organization.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Define various basic and related terminology of organizational behavior.	-	1, 2	8
CO-2	Explain various concepts and techniques of organizational behavior.	-	-	1, 2
CO-3	Describe various theories pertaining to individual and group behaviors.	-	1, 2	-
CO-4	Discus organizational change, stress management, and quality of working life (QWL)	-	1, 2	-
CO-5	Explain conflict process, different bargaining strategies, and organizational structures.	-	1, 2	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	1.8	1.8	-	-	-	-	-	1	-	-	-	-	-	-

Prerequisites: Nil.

Course Contents :

Unit - I

Introduction: Definition of O.B., functions of a manager, Fields contributing to the development of O.B, Challenges and opportunities to O.B. ethics. The Individual:

Foundations of individual behavior, Ability. Learning – theories of learning, Reinforcement types, aptitude and interests of the individual.

8 Hrs

Unit - II

Values, Attitudes, Job Satisfaction & Perception: Definitions, Types of values and their importance Types of attitudes – Job satisfaction Job involvement and organizational commitment. Perception: Definition, Factors affecting perception, making judgments about others, selective perception, projection and stereotyping.

8 Hrs

Unit - III

Motivation: Definition, Early theories of motivation – Maslow's hierarchy of needs theory, McGregor's Theory X and Theory Y, Herzberg's two factor theory, Contemporary theories – David McClelande's three needs theory, Equity theory, Goal setting theory

8 Hrs

Unit - IV

The Group: Definition and classification of groups, Factors affecting group formation, Stages in group development, Group norms Hawthorne studies, Group decision making and its techniques. Leadership: Definition, Theories of leadership – Blake and Mouton managerial grid, Heresy – Blanchard's situational theory, Fiedler's model. Leadership style.

8 Hrs

Unit - V

The organisation: Definition of conflict, conflict process. Functional and Dysfunctional conflict, Negotiation – Bargaining strategies. Mechanistic and Organic structures. Mintzberg's basic elements of organization, Organizational change and stress management, QWL (Quality of Work Life).

7 Hrs

Reference Books:

1) Stephen Robbins and Seema Sanghi, "Organizational Behavior", 13th edition Pearson educational publications New Delhi ISBN 0131914359, 2009.
2) Fred Luthens, "Organizational Behavior", 11th International Edition, McGraw Hill publications New York 2011 ISBN 0-07-124762-9 2008.

21UMEE732	Operations Research	(2-2-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Modeling, solving and analyzing the problems using linear programming with emphasis on theory and applications.
2. Mathematical tools that are needed to solve optimization problems.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Formulate the industrial and real-world problems as linear programming problem and solve LPP by using Simplex algorithm.	1, 2	3	6
CO-2	Formulate transportation, assignment models and derive solutions through various approaches.	1, 2	3	6
CO-3	Solve various Sequencing and queuing problems.	1, 2	3	6
CO-4	Estimate various parameters of projects using PERT and CPM approaches.	11	1,2	6
CO-5	Solve Games for value, suitable strategies and integer programming problems.	1, 2	-	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.8	2.8	2	-	-	1	-	-	-	-	3	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Introduction: Linear programming, Definition, scope of Operations Research (O.R) approach and limitations of OR Models, Characteristics and phases of OR Mathematical formulation of L.P. Problems. Graphical solution methods.

Linear Programming Problems: The simplex method - slack, surplus and artificial variables, degeneracy and procedure for resolving degenerate cases,artificial variables techniques, special cases, concept of duality, dual simplex method.

9 Hrs

Unit - II

Transportation Problem: Formulation of transportation model, Basic feasible solution using different methods, Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Applications of Transportation problems.

Assignment Problem: Formulation, unbalanced assignment problem, Traveling salesman problem. **8Hrs**

Unit - III

Sequencing: Johnson's algorithm, n - jobs to 2 machines, n jobs 3 machines, n jobs m machines without passing sequence. 2 jobs n machines with passing. Graphical solution.

Queuing Theory: Queuing system and their characteristics. The M/M/1 Queuing system, Steady state performance analysing of M/M/ 1 and M/M/C queuing model.

9 Hrs

Unit - IV

PERT-CPM Techniques: Network construction, determining critical path, floats, scheduling by network, project duration, variance under probabilistic models, prediction of date of completion, crashing of simple networks.

7 Hrs

Unit - V

Game Theory: Formulation of games, two person - Zero sum game, games with and without saddle point, Graphical solution (2x n, m x 2 game), dominance property, method of sub-groups.

Integer programming: Gommory's technique, branch and bound logarithm for integer programming problems, zero one algorithm.

6 Hrs

Reference Books:

1) S. D. Sharma, “Operations Research”, Kedarnath Ramnath & Co, 2002.
2) Prem Kumar Gupta and D S Hira, “Operations Research”, 7th edition, S Chand Pub. New Delhi, 2007.
3) Taha H. A, “Operation Operations Research and Introduction”, 9th edition, Pearson Education, 2014.
4) Hiller and Lieberman, “Introduction to operation research”, 5th edition, McGraw Hill, 2001.

21UMEE733	Power Plant Engineering	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Working of steam power plants used for power generation and their auxiliaries.
2. Thermal power generation through coal and gas turbines.
3. Accessories used in a boiler to enhance efficiency of power generation.
4. Disposal of flue gas effluents and Waste disposal in Nuclear power plants into the environment.
5. Hydroelectric plants, Nuclear power plants in comparison with thermal power plants.
6. Selection of site and economics of power plant.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Apply the basic thermodynamic cycle on conventional power plant to improve the power plant efficiency	1, 2	3	-
CO-2	Explain the working of different sections of a thermal power plant	-	1	-
CO-3	Determine preliminary sizing of heat exchanging devices of thermal power plant	-	1,3	-
CO-4	Explain the pollution control strategies in power plant and determine efficiency of hydroelectric power plant	-	2	1
CO-5	Evaluate the cost of power generation and economic viability of power stations	-	2	1,14

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	1.8	2.3	2.5	-	-	-	-	-	-	-	-	-	-	1

Pre requisites: Nil.

Course Contents :

Unit - I

Introduction to power generation: Indian energy Scenario, energy resources used for power generation Conventional sources.

Applied thermodynamics of power generation: Rankine & Brayton cycle/ Regeneration & Reheat power cycle. **9 Hrs**

Unit - II

Conventional power plants: Thermal power plants-Introduction, Layout of Modern steam power plant, Fuel handling, Combustion equipment's, Ash handling, Steam generators. **Gas turbine power plant-** Closed cycle and open cycle plants. **Nuclear Power Plant-** Nuclear fission and chain reaction, types of reactors, PWR, BWR, gas cooled reactor (GCR), Breeder reactor. **Combined Cycles-** steam and gas combined cycle power plant, a combined cycle for Nuclear power plants. Only qualitative discussion. **9 Hrs**

Unit - III

Thermal analysis of heat exchanger equipment in power plant: Boiler condenser, super-heater, economizer, cooling tower calculations. Numerical problems. **6 Hrs**

Unit - IV

Hydroelectric Power plant Merits and demerits of waterpower, Essential elements of a hydroelectric power plant, classification of Hydro-electric power plants. Numerical.

Pollution and its control: Various Pollution from thermal, nuclear power plants and their control strategies. **6 Hrs**

Unit - V

Economics of Power Generations: Conventional power plant economics- Load duration curves, Location of Power plants, Power Plant Economics, Coal-Fueled Electricity Generating Unit. Numerical problems Power plant economics. Numerical problem. **9Hrs**

Reference Books:

1) P. K. Nag, "Power Plant Engineering", 3rd edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2011.
2) S. C. Arora and S. Dumkunadwar, "A course in Power plant Engineering", Dhanpat Rai & Co., (P) Ld., NaiSarak, Delhi. 2011.
3) M MEL. Wakil, "Power Plant Technology", McGraw Hill Book-Coy. New York, 2010.
4) R. K. Rajput, "A textbook of Power Plant Engineering", 4th Laxmi publications (p) Ltd., New Delhi, 2010.

21UMEE734	Design of Heat Exchangers	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Significance of heat transfer and applications of heat exchangers.
2. Theory of heat exchangers and their performance analysis based on LMTD and NTU methods.
3. Process of boiling and condensation and the correlation used for the governing process.
4. Design and development of heat exchangers and utilization of heat transfer data available for solving the problems
5. Use of Heat transfer Data Handbook to solve the problems.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Classify heat exchangers based on different criteria	-	1,2	-
CO-2	Explain different methods of analysis for heat exchangers.	-	1,2	-
CO-3	Design double pipe, shell & tube type heat exchangers for size and rating.	-	1,2,3	-
CO-4	Evaluate the rate of heat transfer and area for different heat exchangers	-	1,2,3	-
CO-5	Determine size and rate of heat transfer in air heat exchanger and combustion chambers.	-	2,3	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2	2	2	-	-	-	-	-	-	-	-	-	-	-

Pre requisites: Nil

Course Contents :

Unit - I

Introduction to Heat Exchanger Design: Types of heat exchangers and their applications: Flow arrangements and temperature distributions in transfer type of heat exchangers. Overall heat transfer coefficient: - Clean overall heat transfer coefficient, dirt factor, Dirt overall heat transfer coefficient, dirt factors for various process services. Basic design equation. Mean temperature difference Concept: LMTD for parallel flow and counter flow arrangement, correction factor for LMTD for cross flow and multi-pass heat exchangers. Effectiveness-NTU method for heat exchanger design /analysis. Rating and sizing problems**.**

9 Hrs

Unit - II

Double Pipe Heat Exchangers: Constructional features. Applications, Design Parameters Tube side and shell side film coefficients, cut and twist factor, fin efficiency, overall heat transfer coefficient, mean temperature difference, available surface area, fin geometry, fin height , number of fins, tube side and shell side pressure drop, calculation procedure for the design/analysis of double pipe heat exchanger.

6 Hrs

Unit - III

Shell and Tube Heat Exchangers: Constructional features. Applications, Correlations for tube side pressure drop and heat transfer coefficients. Pressure drop and heat transfer Coefficient correlations for shell side flow:-Effect of By - pass and leakage. Calculation procedure for Shell and Tube Heat Exchanger:- Heat balance equations; LMTD; Reference temperature calculation; Evaluation of overall heat transfer coefficient, calculation of surface area, calculation of tube side and shell side pressure drops, specifications of other details as per TEMA standards; calculation procedure for 1-2 and 2-4 heat exchanger.

8 Hrs

Unit - IV

Compact Heat Exchangers: Introduction; Definition of Geometric Terms: Plate fin surface geometries and surface performance data; correlation of heat transfer and friction data; Goodness factor comparisons; specification and Calculation procedure of rating and sizing problems.

Air-Cooled Heat Exchangers: Air as coolant for industrial processes; Custom- built units; Fin-tube systems for air coolers; Fin-tube bundles; Thermal rating; tube side flow arrangement; cooling air supply by fans; cooling air supply in natural draft towers.

10 Hrs

Unit - V

Furnaces and Combustion Chambers: Introduction; Process heaters and boilers; Heat transfer in furnaces: - Heat source; Heat sink; Refractory surfaces; Heat transfer to the sink; Design methods: - Method of Lobo and Evans; Method of Wilson, Lobo and Hottel; the Orrok-Hudson equation; Wohlenberg simplified method.

6 Hrs

Reference Books:

1) Donald Q. Kern, "Process Heat Transfer" Tata McGraw-Hill, 1997.
2) Necati Ozisik, "Heat Transfer-A Basic Approach" McGraw-Hill International edition, 1985.
3) Sadik kakac, “Heat exchangers selection, rating and thermal design”, 2nd edition, CRC press 2002.
4) W. M. Kays & A. L. London, "Compact Heat Exchangers", McGraw-Hill co. 1997.
5) Ernst U Schlunder et.al, "Heat Exchanger Design Hand Book", Volumes 2 and 3, Hemisphere Publishing Co. 1983.

21UMEE735	Design For Manufacturing and Assembly	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. To identify major phases of design, effect of material properties on design, material selection process, tolerance analysis, review of tolerance grades through different manufacturing processes.
2. Identifying and analyzing various interchangeable part assembly, group tolerance, and functional datum.
3. Reviewing design considerations in casting, special sand cores, component design, component milling, drilling and finished machining.
4. Identifying and discriminating conventional feature location, tolerance, virtual size concept, position tolerance, functional gauge.
5. Identifying the importance of design of gauges for components checking in assembly.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify effect of material properties on design, and explain tolerance analysis	1,2	-	3
CO-2	Discuss various interchangeable part assemblies, group tolerance, and functional datum.	1	-	3
CO-3	Review design considerations in various manufacturing processes.	-	1,2	-
CO-4	Explain component design for various machining processes.	-	1, 2	-
CO-5	Explain various tolerancing methods and gauge design.	-	1, 2	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.4	2.7	1	-	-	-	-	-	-	-	-	-	-	-

Course Content:

Unit - I

Effect of Materials And Manufacturing Process On Design: Major phases of design. Effect of material properties on design Effect of manufacturing processes on design. Material selection process- cost per unit property, Weighted properties and limits on properties methods.

Tolerance Analysis: Process capability, mean, varience, skewness, kurtosis, Process capability metrics, Cp, Cpk, Cost aspects, Feature tolerances, Geometries tolerances, Geometric tolerances, Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerance – Sure fit law and truncated normal law.

8 Hrs

Unit - II

Selective Assembly: Interchangeable part manufacture and selective assembly, Deciding the number of groups -Model-1: Group tolerance of mating parts equal, Model total and group tolerances of shaft equal. Control of axial play-Introducing secondary machining operations, laminated shims, examples.

Datum Features: Functional datum, Datum for manufacturing, changing the datum. Examples. **7 Hrs**

Unit - III

Design Considerations: Design of components with casting consideration. Pattern, Mould, and Parting line. Cored holes and machined holes. Identifying the possible and probable parting line. Casting requiring special sand cores. Designing to obviates and cores.

10 Hrs

Unit - IV

Component Design: Component design with machining considerations link design for turning components-milling, Drilling and other related processes including finish-machining operations.

6 Hrs

Unit - V

True positional theory: Comparison between coordinate and convention method of feature location. Tolerance and true position tolerancing virtual size concept, Floating and fixed fasteners. Projected tolerance zone. Assembly with gasket, zero position tolerance. Functional gauges, Paper layout gauging.

Design of Gauges: Design of gauges for checking components in assemble with emphasis on various types of limit gauges for both hole and shaft.

8 Hrs

Reference Books:

1) Harry Peck, “Designing for Manufacturing”, Pitman Publications, 1983.
2) Dieter, “Machine Design”, McGraw-Hill Higher Education, -2008
3) R. K. Jain, "Engineering Metrology", Khanna Publishers, 1986
4) Geoffrey Boothroyd “Product design for manufacture and assembly”, 3rd Edition, Peterdewhurst, Winston Knight, Merceldekker. Inc. CRC Press,
5) “Material selection and Design” Vol. 20 - ASM Hand book.

21UMEE736	Production Planning & Control	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. The problems and opportunities faced by the operations manager in manufacturing and service organizations.
2. Apply PPC concepts in a various areas like marketing, accounting, finance, engineering, personnel management, logistics, etc.
3. To integrate operations concepts with other functional areas of business
4. To understand the PPC function in both manufacturing and service organizations.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Recognize the objectives, functions, applications of PPC and forecasting techniques.	1	-	-
CO-2	Apply different Inventory control techniques for manufacturing sectors.	1	2	3, 5
CO-3	Solve routing and scheduling problems	3	-	1
CO-4	Solve problems of aggregate production planning techniques.	-	4	1
CO-5	Describe way of integrating different departments to execute PPC functions	-	-	5

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2	2	2	2	1	-	-	-	-	-	-	-	-	-

Pre requisites: Nil

Course Contents :

Unit - I

Introduction: Definition – Objectives of production Planning and Control – Functions of production planning and control – Elements of production control – Types of production – Organization of production planning and control department – Internal organization of department.

Forecasting: Importance of forecasting –Types of forecasting, their uses – General principles of Forecasting –Forecasting techniques– qualitative methods- Jury/Expert Method, Survey of Expert opinion method , Sales force composite method, Survey of buyers intention method and quantitative methods- Simple average, moving average, smoothing coefficient, Least Square method.

8 Hrs

Unit - II

Inventory Management: Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P– Systems and Q-Systems Introduction to MRP-I, MRP-II & ERP, JIT inventory, Kanban systems.

8 Hrs

Unit - III

Routing: Definition – Routing procedure –Route sheets – Bill of material – Factors affecting routing procedure.

Scheduling: Definition – Activities-Difference with loading, Scheduling types: Forward, Backward scheduling, Job shop scheduling methods – Arrival pattern, processing pattern, number of workers available, machine varieties available, Priority rules for job sequencing FIFO, SPT, SOT, EDD, STR, CR, LISO, Random Orders. Scheduling Techniques Gantt Charts, LOB, Johnson's job sequencing rules- n jobs on 2machines, jobs on 3 machines, n jobs on m machines.

8 Hrs

Unit - IV

Line Balancing: Introduction, objectives, terms related to line balancing, procedures, simple problems

Aggregate Planning: Introduction, Inputs to aggregate planning, strategies- Line strategy, chase strategy, capacity options, demand options.

8 Hrs

Unit - V

Dispatching: Centralized and Decentralized Dispatching- Activities of dispatcher – Dispatching procedure –follow-up – definition – Reason for existence of functions – types of follow up, applications of computer in production planning and control.

7 Hrs

Text Book:

1) Stephen N Chapman "The Fundamentals of Production Planning and Control", Pearson education, 2009.

Reference Books:

1) Elwood S Buffa & Rakesh K Sarin, “Modern Production & Operations management”, 8th edition, John Wiley, 2016.
2) Samuel Eilon, “Elements of Production Planning and Control”, Universal Publishing Corporation.1999.
3) Jain K C & L. N. Agarwal, “Production, Planning and Control & Industrial Management”, 8th edition, Khanna Publishers, 1999.

21UMEE737	Advanced Metal Joining Technology	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Overview of welding process and it advances including types and their applications.
2. Modeling and simulation of operas.
3. Mechanical aspects of processes.
4. Welding defects causes, remedies and methods to detect.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the working principles of various advanced welding processes.	-	1	2
CO-2	Select appropriate welding procedure, consumables and welding parameters for various engineering applications.	-	1	2
CO-3	Identify various defects in weld using different testing methods and remedial measures.	-	1	2
CO-4	Apply the principles of welding metallurgy, thermal molding and simulation to produce defect free welding for different materials.	-	5	3

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2	1	1	-	2	-	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Overview of welding processes and their classification, types of joints, edge preparation, weld symbols, weld nomenclature, bead geometry, power density, heat sources, welding techniques – linear and orbital. Arc characteristics. Voltage – current characteristics. Types of welding manipulators and their applications. **8 Hrs**

Unit - II

Advances welding processes: submerged arc, TIG, MIG, electro-slag, ultrasonic, electron beam and laser beam welding thermite welding, underwater welding. Case studies and applications – industrial automotive and aerospace.

Thermal modeling and simulation of welding processes – governing heat transfer equations and boundary conditions for various types of welding processes. Estimation of cooling rates.

8 Hrs

Unit - III

Prediction of mechanical properties. Micro/macro-structures of weldments and heat-affected zone. Prediction of weld defects such a crack, segregation, lack of fusion. Modeling and simulation of pulsed arc processes.

7 Hrs

Unit - IV

Solidification behavior of fusion weld: structural zones, epitaxial growth, weld pool shape and columnar grain structures. Welding of metals – steels, stainless steels, aluminium, copper, nickel and titanium alloys.

7 Hrs

Unit - V

Microstructures of weldments: Segregation of alloying elements. Impact of micro/macro-structures and segregation on mechanical properties. Pre-and post-treatment. Effects of heat flow on residual stresses and distortion. Welding tests.

Welding defects: causes and remedies. Methods of testing welding – mechanical, Pressure and leak testing. Inspection methods – visual, magnetic, ultrasonic, x-ray and radiography. **9 Hrs**

Text Books:

1) Khanna O. P. “A text book on welding Technology”, Dhanpat Rai and Sons, New Delhi, 2013.
2) Parmar R. S. “Welding process and Technology”, Khanna publishers, Delhi,1992.

Reference Books:

1) Little R. L. “Welding and Welding Technology”, Tata McGraw Hill Publishing company Limited New Delhi, 1989.
2) Grong O. “Metallurgical Modeling of Welding”, The institute of Materials, 2nd edition, 1997.
3) Kou S. “Welding Metallurgy”, John wiley publications, New York, 2nd Edition. 2003.

21UMEE741 Hybrid Vehicle Technology (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Explain the basics of electric and hybrid electric vehicles, their architecture, technologies and fundamentals.
2. Explain plug – in hybrid electric vehicle architecture, design and component sizing and the power electronics devices used in hybrid electric vehicles.
3. Analyze various electric drives suitable for hybrid electric vehicles.
4. Discuss different energy storage technologies used for hybrid electric vehicles and their control.
5. Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design optimization and energy management

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain working of IC engines and factors affecting the combustion	-	1	-
CO-2	Discuss different configurations of electric and hybrid vehicles and their parts.	-	1,2	-
CO-3	Describe various aspects of hybrid and electric vehicle drive trains	-	1,2	3
CO-4	Discuss different energy storage technologies and control	-	1,2	-
CO-5	Explain sizing of drive system, components, and pollution aspects	-	2,6, 7	3

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	3	2	1	-	-	2	1	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Conventional Vehicles: Introduction to conventional internal combustion engines, Basics of vehicle performance, vehicle power source, Power transmission, Fuel economy characteristics of internal combustion engine.

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, Merits and demerits of electric and hybrid vehicles.

8 Hrs

Unit - II

Basic concept of Electrical and Hybrid vehicles: Hybrid traction, introduction to various hybrid drive-train topologies, Vehicle power plant and transmission characteristics and vehicle performance including braking performance. Basic architecture of hybrid drive train and analysis series drive train. Analysis of parallel, series parallel and complex drive trains and power flow in each case. Basic concept of electric traction and architecture. Topologies for electric drive-train and their analysis, power flow control in electric drive-train topologies.

8 Hrs

Unit - III

Electric Propulsion Systems: Components used in hybrid and electric vehicles, Electric drives used in HEV/EVs, their classifications and general characteristics. Induction motors, their configurations and optimization for HEV/EVs. Induction motor drives, their control and applications in EV/HEVs. DC Motor drives and their principle of operation and performance including multi-quadrant control. Permanent magnet motors, their configurations and optimization. Permanent magnet motor drives, their control and applications in EV/HEVs. Configuration and control of DC and Induction Motor drives.

8 Hrs

Unit - IV

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis and simplified models of battery. Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

7 Hrs

Unit - V

Sizing the drive system: Matching the electric drive and ICE, Transmission selection and gear step selection. Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

Air pollution and global warming: Impact of different transportation technologies on environment and energy supply.

8 Hrs

Reference Books:

1) James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003.
2) Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.
3) Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.
4) R1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010.
5) Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes, 2000.
6) John B Heywood, “IC Engine Fundamentals”, International Editions, Automobile Technology Series, McGraw hill, 2010.
7) M. L. Mathur and R. P. Sharma, “I.C. Engines”, Dhanpat Rai & Sons, New Delhi, 2011.

21UMEE742 Heating ventilation and air conditioning (HVAC) (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. The thermodynamic cycle employed in of air-conditioning
2. Properties of air and ventilation in building and its significance
3. The types and working of air-conditioning systems
4. Heating and cooling load calculation for thermal comfort in building
5. Fluid flow and duct design for air conditioning system

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Review the thermodynamics of vapor compression cycle	-	1,2	-
CO-2	Calculate properties of air through equations and psychrometric chart	1,2	-	-
CO-3	Explain heating, and ventilation of different air conditioning systems	1,2	-	-
CO-4	Determine cooling load on the air conditioning system	-	1,3	-
CO-5	Calculate insulation thickness, duct size and list the noise control strategies for A/C systems	-	1,2	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.4	2.4	2	-	-	-	-	-	-	-	-	-	-	-

Pre-requisites: Nil

Course Contents :

Unit - I

Introduction: Review of vapor compression refrigeration cycles, T-S and PH charts, refrigerants, and components

Psychrometry: Properties and relations Psychrometric processes Winter air conditioning system and summer air conditioning system and year around air condition system psychrometric chart.

8Hrs

Unit - II

Ventilation and infiltration factors affecting thermal comfort, comfort charts, indoor air quality, outdoor design conditions, natural and mechanical ventilation, air distribution devices.

Heating systems: Warm air, hot water and steam heating systems, panel and infrared heating system. **8 Hrs**

Unit - III

Cooling load calculation for design of air conditioning systems heat sources, heat loads in building, design of air conditioning systems, bypass factor effective sensible heat factor cooling coils and dehumidifying air washers and numericals. **8Hrs**

Unit - IV

Air conditioning systems: Central, Unitary and district air conditioning systems, all water, all air, air-water systems factory air conditioning

Insulation for air conditioning systems: desired properties, factors and types of insulating materials. Heat transfer through insulation, economical thickness, selection of insulating material.

8 Hrs

Unit - V

Fluid flow and duct design for air conditioning systems: Pressure loss duct sections, distribution and design, air distribution and ventilation systems, temperature gradients Noise control in air conditioning systems.

7 Hrs

Reference Books:

1) Arora and domkundwar, dhanpat rai and sons, “A course on Refrigeration and air conditioning”, 2018.
2) Manohar Prasad, “Refrigeration and air conditioning”, Newage international (P) Limited, publishers 2006.
3) Kreider, Peter S Curtiss, “Heating and cooling of building”, principals and practice of energy efficient design, Jan F CRC Press 2018.
4) ASHRAE hand book (HVAC systems)
5) Stocker W.F and Jones J W. “Refrigeration and air conditioning”, Mc Graw hill 1982.
6) ASHRAE, “Air conditioning System Design manual”, 2nd Edition.

21UMEE743 Additive Manufacturing (3-0-0) 3

Contact Hours:39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. The need and importance of Rapid Prototyping methods in design process and in other applications.
2. Realize the basic working principle of various Rapid Prototyping techniques.
3. An insight of Rapid Prototypes those are used as Concept modelers.
4. The importance and working of Rapid Tooling methods and the various software's in RP.
5. Recognize the Rapid Prototyping process optimization parameters in building the physical models.

Course Outcomes:

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1,4)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Discuss various Rapid Prototyping Methods and applications.	-	1	3
CO-2	Apply CAD modeling and data processing methods for various Rapid Prototyping techniques.	1,3	-	4
CO-3	Describe Photo polymerization, Powder Bed Fusion and Extrusion in Rapid prototyping.	-	1,3	-
CO-4	Discuss 3D printing, Sheet Lamination and Beam Deposition techniques.	-	1,3	4
CO-5	Compare various Rapid Tooling methods.	-	1,3	4
CO-6	Identify the various Rapid Prototyping process parameters and optimize these parameters.	-	1,3	-

POs	PO1	PO2	PO3	PO4
Mapping Level	2.2	-	2	1

Pre requisites: CAD/CAM, Manufacturing engineering, Tool Design.

Course Contents :

Unit I

Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP. **4 Hrs**

CAD Modeling and Data Processing for RP: CAD model preparation, Data Requirements, Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation. **4 Hrs**

Unit II

Solid and Liquid Based RP Systems: Stereo lithography (SLA): Principle, Process, Materials, Advantages, Limitations and Applications. Solid Ground Curing (SGC): Principle, Process, Materials, Advantages, Limitations and Applications. Fused Deposition Modeling (FDM): Principle, Process, Materials, Advantages, Limitations and Applications. Laminated Object Manufacturing (LOM): Principle, Process, Materials, Advantages, Limitations and Applications. **8 Hrs**

Unit III

Powder Based RP Systems: Selective Laser Sintering (SLS): Principle, Process, Materials, Advantages, Limitations and Applications. Laser Engineered Net Shaping (LENS): Principle, Process, Materials, Advantages, Limitations and Applications. Electron Beam Melting (EBM): Principle, Process, Materials, Advantages, Limitations and Applications. **4 Hrs**

Other RP Systems: Three-Dimensional Printing (3DP): Principle, Process, Materials, Advantages, Limitations and Applications. Ballistic Particle Manufacturing (BPM): Principle, Process, Materials, Advantages, Limitations and Applications. Shape Deposition Manufacturing (SDM): Principle, Process, Materials, Advantages, Limitations and Applications. **4 Hrs**

Unit IV

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods. Indirect Rapid tooling: Silicon rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling. Direct Rapid Tooling: Direct AIM, Quick cast process, Copper polyamide, Laminated Object Manufactured (LOM) Tools, Direct Metal Laser Sintering (DMLS) Tools. **8 Hrs**

Unit V

Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS. **4 Hrs**

RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP. **3 Hrs**

Text Books:

1. Pham D.T. and Dimov S.S., “Rapid Manufacturing; the technologies and application of RPT and Rapid tooling”, Springer, London 2001.
2. Chua Chee Kai, Leong Kah Fai, Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.

Reference Books:

1. Ian Gibson, David W Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.Burns. M, “Automated Fabrication”, PHI, 1993.
3. Chua. C.K, “Rapid Prototyping”, Wiley, 1997.
4. Jacohs P.F., “Stereo lithography and other Rapid Prototyping and Manufacturing Technologies”, ASME, 1996.

21UMEE744 Estimation and Costing in Mechanical Engineering (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. The estimation and costing procedure in industries.
2. The actual costing process and calculation of selling prices.
3. The depreciation of equipment, plants and to know the different methods of calculating depreciation.
4. The procedure for calculating material cost of various components.
5. The procedure for estimation of various shop, labour wages and incentives.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain the estimation and costing procedure in industries.	-	1,2,11, 14	9,12
CO-2	Calculate the actual cost and selling prices.	14	1,2,6,11	9,12
CO-3	Estimate the depreciation of equipment, plants and machineries.	14	1,2,6,11	9,12
CO-4	Estimate material cost of various components	14	1,2,6,11	9,12
CO-5	Calculate various costs of various shops, labour wages and incentives	14	1,2,6,11	9,12

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2	2	-	-	-	2	-	-	1	-	2	1	-	2.8

Pre requisites: Nil.

Course Contents :

Unit - I

Introduction to Estimation and costing: Estimation - Definition, Importance and Aims, Qualities and functions of an Estimator, Source of errors in estimation, Constituents of Estimation, Costing - Definition and Aims, Standard cost and its

Advantages, Difference between estimation and costing, Advantages of efficient costing

Elements of costs: Elements of cost- material, labour, expenses, Material - Direct material, indirect material and examples, Calculation of Material cost, Labour - direct, indirect labour and examples. Calculation of labour cost, Expenses - direct, indirect expenses and examples, Classification of expenses - factory, administrative, selling and distribution expenses and examples, Fixed and variable expenses and examples, Components of cost - prime cost, factory cost, office cost, total cost, Selling price, Block diagram to show the relationship between elements and components of cost, problems on above, Allocation of on-cost - methods and simple problems

8 Hrs

Unit – II

Indirect expenses and depreciation: Indirect expenses - depreciation, obsolescence, inadequacy, idleness, repair and maintenance, Depreciation - causes, methods of calculating depreciation, Simple problems on each method

Mensuration and Estimation of material cost: Area of regular plane figures, Volume and surface area of solids (formulae only), Estimation of material costs of step pulley, spindle lathe centre, Rivets, Fly wheel, Crankshaft, Chain link, Wedge and Gib-headed key.

8 Hrs

Unit - III

Mechanical Estimation: Estimation in machine shop - Definition of cutting speed, feed, depth of cut, Estimation of time for various operations like Turning, Knurling, Facing, Drilling, Boring, Reaming, Threading, Tapping, Milling, Grinding, Shaping and Planning, Estimation in sheet metal shop - Sheet material and gauge number, Sheet metal joints, Select suitable formula for estimation, Estimate the material required for preparation of container open on one side Cylindrical drum, funnel and tray, Estimation in foundry shop-pattern allowances, estimation of pattern cost, simple problems on C.I pulley and C.I. Wheel, Estimation in welding shop - estimation of gas welding cost, estimation of arc welding cost -Simple problems

10 Hrs

Unit - IV

Wages and incentives: Definition of wages, normal wages, real wages, living wages, fair wages minimum wages, methods of wage payment, Incentives - definition of incentive, types of incentives, examples, Characteristics of a good wage and incentive systems, Standard time - work measurement, Bonus system - collective bonus system, group bonus system.

6 Hrs

Unit - V

Project planning and Break even analysis: Concept of project work, Project planning like market survey, project capacity, selection of site, plant layout, product design, drawing, specification, material requirement operation planning, Break even

analysis - break event chart, diagram to illustrate break event point, Simple problems on break even analysis. **7 Hrs**

Reference Books:

1) T. R. Banga and S. C. Sharma “Mechanical estimation and costing”, Khanna Publishers,
2) Acharya and Narang “Estimation and costing”,
3) Banga and Sharma, “Industrial Organisation and Engineering Economics”,
4) Malhotra, “Mechanical Estimation”,

21UMEE745	Design of IC Engine Components	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Different types of internal combustion engines and different parts of SI and CI engine.
2. Design of crack shaft, piston, connecting rod, camshaft, piston rings, fly wheel, combustion chambers and clutches.
3. Different conventional and modern type of fuel injection systems used in SI & CI Engines.
4. Design of effective cooling systems used in IC engines and heat exchanges.
5. Designing suitable emission control systems to meet stringent emission norms.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Design combustion chamber and cylinder head for both SI & CI Engines.	3	1,2	-
CO-2	Design crank shaft, cam, connecting rod, piston for different types of automobiles.	3	1,2	-
CO-3	Design clutch, flywheel and cooling systems.	3	1,2	-
CO-4	Explain the use of fuel injector & cooling system.	-	1	-
CO-5	Discuss hazards and emission control of IC engines.	-	1	7

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2	2	3	-	-	-	1	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Classification of I C Engines, SI & CI Engines. Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines.

8 Hrs

Unit - II

Design of piston, piston pin & piston rings for small cars **7 Hrs**

Unit - III

Classification & design of connecting rod, Classification & Design of crankshafts.

8 Hrs

Unit - IV

Design of inlet and exhaust cam profile, Design of Clutch: Single & multi-plate Clutches, Dry and wet clutches. Design of Flywheel – Single and multi-cylinder engines.

8 Hrs

Unit - V

Cooling System, Spray formation, Fuel injection system,

Emission Control: Common emission control systems, measurement of emissions, exhaust gas emission testing.

8 Hrs

Text Book:

1) V. B. Bhandari “Design of Machine Elements”, Tata McGraw-Hill, 2008.

Reference Books:

1) Newton Steeds & Garratte, The Motor Vehicle Lliffee & Sons Ltd., London
2) Kolchin, “I. C. Engines”, MIR Publications, Moscow
3) N. K. Giri, Automobile Mechanics, Khanna Publications, 1994

21UMEE746 Design of and Drawing of Mechanical Assemblies (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Types of engineering materials used in power transmission elements.
2. Concepts of designing various machine elements and assemblies.
3. Usage of design data handbook, BIS standards and draw manually the production drawing.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Interpret the Geometrical dimensioning and tolerance symbols in technical drawings.	10	-	3
CO-2	Design components of IC Engine, Power transmission & Material handling equipment.	1,3	2	6
CO-3	Use standards & codes for designing, selecting and drawing parts and their assemblies	3	10	1,8
CO-4	Select materials and configurations based on manufacturing, cost and assembly criteria	1	11	3,9

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.3	2	2.3	-	-	1	-	1	1	2.5	2	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Drawing & sketching conventions & standards – BIS

Direct Tolerancing Methods, Tolerance Expression, Interpretation of Limits, Single Limits, Tolerance Accumulation, Limits of Size, Applicability of Modifiers on Geometric Tolerance Values and Datum Feature References, Screw Threads, Gears and Splines,

Boundary Conditions, Angular Surfaces, Conical Tapers, Flat Tapers, Radius, Tangent Plane, Statistical Tolerancing

9 Hrs

Unit - II

Design & drawing of engine components: Piston, Connecting rod, Valve gear mechanism

9 Hrs

Unit - III

Design and drawing of load handling equipment: Screw jack, Crane hook, Overhead crane hoist

9 Hrs

Unit - IV

Assembly drawings –Couplings – (any one) **6 Hrs**

Unit – V

Assembly drawings –Clutches & brakes (any one) **6 Hrs**

Examination pattern (3 Hrs – 100 marks)

Any two question to be answered out of four questions each question carries 50 marks and should include complete design and drawing to dimension on the drawing sheet.

Text Books:

1) Prof. K.R. Gopalakrishna, “Machine Drawing”, Subash Publishers, Bangalore, 2005.
2) Robert L. Norton, “Machine Design an integrated approach”. 2nd edition, Pearson Education, Asia University Press, 2013.

Reference Books:

1) N.D. Bhatt & V.M. Panchal, “Engineering Drawing”. 50th edition, Charotar Publishing House, Gujarat, 2010.
2) Harry Peck, “Designing for Manufacture”, Pitman Publishing, 1973.

21UMEO751	Micro Electro Mechanical Systems	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Various Micro Electronic Mechanical systems which find extensive usage in Industrial applications

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Understand the working of MEMS technology & Miniaturization	-	1,2	-
CO-2	Explain the Process of Micro Fabrication Techniques	-	1,2	-
CO-3	Explain the principles of system modelling	-	1,2	3
CO-4	Understand the working principles of Mechanical sensors and actuators	-	1,2	-
CO-5	Describe the working principles of Micro-Opto-Electro Mechanical Systems	-	1,2	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2	2	1											

Prerequisites: Nil

Course Content:

Unit - I

Introduction: Micro Electro-Mechanical Systems, Ultra Precision Engineering, Micro-sensors; Micro-actuators; Microelectronics Fabrication; Micromachining; Mechanical MEMS; Thermal MEMS: MOEMS; Magnetic MEMS; RF MEMS; Micro-fluidic Systems; Bio and Chemo – Devices; MEMS Packages and Design Considerations; Micro-Instrumentation.

Microfabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining: Isotropic Etching and Anisotropic Etching, Wafer Bonding, High Aspect-Ratio Processes (LIGA)

08Hrs

Unit - II

Mechanical Sensors and Actuators: Principles of Sensing and Actuation; Beam and Cantilever; Microplates; Capacitive Effects; Piezoelectric material as Sensing and Actuating Elements; Strain Measurement; Pressure measurement; Flow Measurement using Integrated Paddle – Cantilever Structure; Pressure Measurement by Microphone; Shear mode Piezo actuator; Gripping Piezo actuator; Inchworm Technology.

08 Hrs

Unit - III

Thermal and Fluidic Micro Sensors and Actuators: Thermal sensors, Electrical Sensors, Chemical and Biosensors Electromagnetic and Thermal microactuation, Mechanical design of microactuators, Microactuator examples, Micro Fluidic systems, Fluid actuation methods, microvalves, micropumps, micromotors-Microactuator systems : Ink-Jet printer heads, Micro-mirror TV Projector.

08 Hrs

Unit - IV

Surface Micromachining: One or two sacrificial layer processes, Surface micromachining requirements, Polysilicon surface micromachining, Other compatible materials, Silicon Dioxide, Silicon Nitride, Piezoelectric materials, Surface Micromachined Systems: Success Stories, Micromotors, Gear trains, Mechanisms.

MEMS: Design and Analysis: Basic concepts of design of MEMS devices and processes, Design for fabrication, Other design considerations, Analysis of MEMS devices, FEM and Multiphysics analysis, Modelling and simulation.

08hrs

Unit - V

MEMS: Characterization: Technologies for MEMS characterization, Scanning Probe Microscopy (SPM): Atomic Force Microscopy (AFM), Scanning tunneling microscopy (STM), Magnetic Force Microscopy, Scanning Electron Microscope, Laser Doppler vibrometer, Electronic Speckle Interference Pattern technology (ESPI).

07Hrs

Text Books:

1.Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning Private Limited, 2009.

2.Stephen D. Senturia, "Microsystem Design" Springer, 2001.

3.MarcMadou, “Fundamentals of Microfabrication” Taylor & Francis Group, 2002.

4.Gregory Kovacs, “Micromachined Transducers Sourcebook” McGraw Hill 1998

Reference Books:

1.Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning Private Limited, 2009.

2.Stephen D. Senturia, "Microsystem Design" Springer, 2001.

3.MarcMadou, “Fundamentals of Microfabrication” Taylor & Francis Group, 2002.

4.Gregory Kovacs, “Micromachined Transducers Sourcebook” McGraw Hill 1998

21UMEO752 Modeling and Simulation of Dynamic Systems (3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Basic concepts relat ed to modeling and simulation
2. Bond graph according to causality conflicts, and from a given bond graph
3. Find dynamic response and transfer function using various tools for system modeling.
4. Modeling and simulation of mechanical and electrical systems using computer tools

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain basic concepts related to modeling and simulation	-	1,2	-
CO-2	Analyze the bond graph according to causality conflicts, and from a given bond graph	1,2	-	-
CO-3	Use conservation laws and constitutive relationships to model mechanical, electrical and flow systems, and combinations of these.	-	1,2	-
CO-4	Find dynamic response and transfer function using various tools for system modeling.	-	1,2	-
CO-5	Model and simulate mechanical and electrical systems using softwares	1,2	-	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.4	2.4	-	-	-	-	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

Introduction to modeling and simulation: Introduction to modeling, Examples of models, modeling of dynamic system, Introduction to simulation, MATLAB as a simulation tool, Bond graph modeling, causality, generation of system equations. **8 Hrs**

Unit - II

Random-Number Generation, Random-Variate Generation: Properties of random numbers; Generation of pseudo-random numbers; Techniques for generating random numbers; Tests for Random Numbers Random-Variate Generation: Inverse transform technique; Acceptance Rejection technique; Special properties. **7 Hrs**

Unit - III

Input Modeling: Data Collection; Identifying the distribution with data; Parameter estimation; Goodness of Fit Tests; Fitting a non-stationary Poisson process; Selecting input models without data; Multivariate and Time-Series input models.
System models of combined systems: Linearity and non linearity in systems combined rotary and translatory system, electro mechanical system, hydromechanical system. **8 Hrs**

Unit - IV

Dynamic Response and System Transfer Function: Dynamic response of 1st order system and 2nd order system, performance measures for 2nd order system, system transfer function, transfer function of 1st and 2nd order system Block diagram algebra, signal flow diagram, state variable formulation, frequency response and bode plots. **8 Hrs**

Unit - V

Types of simulations with respect to output analysis: Stochastic nature of output data; Absolute measures of performance and their estimation; Output analysis for terminating simulations; Output analysis for steady-state simulations.
Verification, Calibration, and Validation; Optimization: Model building, verification and validation; Verification of simulation models; Calibration and validation of models, optimization via Simulation **8 Hrs**

Reference Books:

1) Gordon, G., “System Simulation”, 2nd edition, Prentice-Hall 1978.
2) Close, C.M., and Frederick, D.K., “Modeling and Analysis of Dynamic Systems”, 2nd edition, John Wiley & Sons 1995.
3) Bhonsle, S. R., and Weinmann, K. J., “Mathematical Modeling for Design of Machine Components”, Prentice-Hall 1998.
4) D’Souza, A. F., and Garg, V. K., “Advanced Dynamics: Modeling and Analysis”, 2nd edition, Prentice-Hall 1984.

21UMEO753	Project Management	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Concepts and different aspects related to projects.
2. Applications of different aspects of management of projects.
3. Analytical skills associated with techniques of managing projects.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain various aspects of project management, project stakeholders, project life cycle phases, tools & techniques.	1	11	-
CO-2	Analyze the influence of project organizational structures on project management.	11	-	-
CO-3	Explain the importance of contracting and tendering in project management.	-	11	-
CO-4	Apply PERT & CPM to evaluate project time and cost trade- off.	11	5,14	1, 2
CO-5	Apply the concepts of economics and project finance to estimate project feasibility.	11	14	1

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	1.2	1	-	-	2	-	-	-	-	-	2.6	-	-	2

Prerequisites: Nil

Course Contents :

Unit - I

Concepts of Projects /Project Management: Definition of Projects, Categories, Comparison of Project management with routine management. Overview of project management. Objectives and goals of project. Project stake holders, some tools and techniques used in project management.

Project management Knowledge areas and Processes. Project phases, Project life cycle, Software development life cycle, Project management processes, Process interactions. **8 Hrs**

Unit - II

Organizing and Staffing: Roles and responsibilities of project leader, Skills and abilities required. Organizational systems, Line and staff functions, project manager as a staff assistant, as a consultant, as a specialized function in an organization, Matrix organization, Task force organization. Influence of Organizational structures on projects. **7 Hrs**

Unit - III

Contracts: Need, 3R's of Contracts, Factors affecting number of contracts, Types of re-imbursements. Risk: To the owner and to the contractor. Tendering and selection of contractor sequential steps.

Project Design: Project work system, Work packaging, Work break down structures-examples, advantages. Project execution plan, Systems and procedure plan. **8 Hrs**

Unit - IV

Project Time management: Bar (Gantt)chart, Networks, Types, Critical Path method (CPM), Program Evaluation Review Technique (PERT), construction of network, Estimation of completion time, Computation of slack, Crashing of network. Numerical examples. **8 Hrs**

Unit - V

Estimation of Project Viability: Project cost elements, Means of Finance, Project cost management, Financial Ratio, Evaluation of profitability: Breakeven Analysis, Pay- back period, Return on Investment, Net Present Value, Benefit cost ratio. Numerical examples. Feasibility report need and Contents. **8 Hrs**

References Books:

1) Patel B, "Project Management", 2nd Edition, 2010.
2) S. Choudhary, "Project Management", TMH publication, 2010.
3) A Guide to project Management Project Management Body of Knowledge", Project Management Institute. Published 2012.
4) L. S. Srinath, "PERT & CPM" principles & applications", 3rd Ed., EWP Pvt. Ltd., 2000.

21UMEO754	Design of Aircraft structures	(3-0-0) 3

Contact Hours: 39

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Aerodynamics, aerospace materials, aircraft and spacecraft structures, aircraft and space propulsion, flight mechanics, stability and control systems, orbital mechanics, space environment
2. Determination and control, telecommunications and design competence of aircraft and spacecraft using systems engineering principles;
3. Independent research opportunities, involving teamwork and exposure to modern engineering analytical and computational tools;
4. Application based analysis and innovation.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/PSO (13-14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Discuss the requirements, functions & design process of aircraft structural components.	-	1,2	-
CO-2	Analyze aircraft loads & their effect on aircraft structure.	1	3, 9	8
CO-3	Discuss aircraft materials, manufacturing methods, aircraft structural damage & repair.	-	1	10
CO-4	Analyze aircraft cell for torsion loads.	1,2	3	-
CO-5	Perform structural analysis of aircraft structures using thin plates & shell theory.	1	3, 2	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.6	2.3	2	-	-	-	-	1	2	1	-	-	-	-

Pre-requisites: Introduction to Aircraft Industry & Aircraft Systems

Course Contents :

Unit - I

Overview of the Aircraft Design Process: Introduction, Phases of Aircraft Design, Aircraft Conceptual Design Process, Conceptual Stage, Preliminary Design, Detailed Design, Design Methodologies.

Fundamentals of Structural Analysis: Review of Hooke's Law, Principal stresses, Equilibrium and Compatibility, Determinate Structures, St. Venant's Principle, Conservation of Energy, Stress Transformation, Stress Strain Relations, Numerical problems on principle stresses, critical stresses in structural members of the aircraft etc. **10 Hrs**

Unit - II

Introduction to Aircraft Structures: Sectional Properties of structural members and their loads, Types of structural joints, Type of Loads on structural joints.

Aircraft Loads: Aerodynamic Loads, Inertial Loads, Loads due to engine, Actuator Loads, Maneuver Loads, VN diagrams, Gust Loads, Ground Loads, Ground conditions, Miscellaneous Loads. **7 Hrs**

Unit - III

Aircraft Materials and Manufacturing processes: Material selection criteria, Aluminum Alloys, Titanium Alloys, Steel Alloys, Magnesium Alloys, copper Alloys, Nimonic Alloys, Non-Metallic Materials, Composite Materials, Use of Advanced materials Smart materials, Manufacturing of A/C structural members, Overview of Types of manufacturing processes for Composites, Sheet metal Fabrication, Machining, Welding, Superplastic Forming and Diffusion Bonding.

Airworthiness and Aircraft Certification: Definition, Airworthiness Regulations, FAR-25, Regulatory Bodies, Type certification, General Requirements, Requirements Related to Aircraft Design Covers, Performance and Flight Requirements, Airframe Requirements, Landing Requirements, Fatigue and Failsafe requirements, Emergency Provisions, Emergency Landing requirements. **10 Hrs**

Unit - IV

Torsion Theory, Aircraft Structural Repair: Theory of Torsion- Shafts of Non-Circular Sections, Torsion in Closed Section Beams, Torsion in Open Section Beams, Multi Cell Sections, Sample Exercises. Types of Structural damage, Nonconformance, Rework, Repair, Allowable damage Limit, Repairable Damage

Limit, Overview of ADL Analysis, Types of Repairs, Repair Considerations, best practices. **5 Hrs**

Unit - V

Structural Analysis of Aircraft Structures: Theory of Plates- Analysis of plates for bending, stresses due to bending (No derivation), Plate deflection under different end conditions, Strain energy due to bending of circular, rectangular plates, Plate buckling, Compression buckling, shear buckling, Buckling due to in plane bending moments. Theory of Shells-Analysis of Shell Panels for Buckling, Compression loading, Shear Loading / Shell Shear Factor, (No derivations) Circumferential Buckling Stress, sample exercises Theory of Beams-Symmetric Beams in Pure Bending, Deflection of beams. Sample Exercises.

7 Hrs

Tutorials / Assignments

The assignments for Electives could include the following,

- Hands-on calculation on Exercises related to Fundamentals of Structural Analysis
- Hands-on Calculation on Exercises involving, plate theory, beam theory and shell theory, Panel buckling, Shear-flow
- Exercises in Aircraft Structures.

Reference Books:

1) T. H. G. Megson, “Aircraft Structures”, Elsevier Aerospace Engineering Series, Fourth Edition, Elsevier publications.
2) Ian Moir, Allan Seabridge, “Aircraft Systems”, Mechanical, Electrical and Avionics Subsystems Integration
3) Daniel P. Raymer, “Aircraft Design-A Conceptual Approach”, 6th edition AIAA education series,
4) Michael Niu, “Airframe Structural”, 2nd edition, Design Conmilit Press, 1988.
5) Michael Niu, “Airframe Stress Analysis and Sizing”, 3rd edition, Conmilit Press, 1999.

VIII Semester

21UMEL800	Technical Seminar	(0-0-2) 1

Contact Hours: 26

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Selection of current topics relevant to mechanical engineering
2. How to prepare PPT using power point
3. Report writing

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Refer to the learning resources, recognize and collect the required information.	2	4	12
CO-2	Describe the usefulness of information and make effective oral presentation using ppt.	10	2	4
CO-3	Compile the information published and prepare a technically sound report.	10	5	-
CO-4	Justify the technical solutions presented and draw the concluding remarks.	4	10	6

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	-	2.5	-	2	2	1	-	-	-	2.7	-	1	-	-

Prerequisites: Nil

Course Contents :

Technical Seminar: The students are expected to learn how to carry out literature survey to locate the state of the art technology in engineering domain of their interest. They are required to carry out selection of an emerging topic beyond the syllabus relevant to the branch of study, understand the concept, analyze and present effectively for 15-20 minutes followed by 5 minutes of questions and answers before their classmates and faculty. They can also present the technical innovative/novel work carried out in the laboratory. They are also required to learn the effective communication and modalities of technical

interactions. Further, they have to submit the seminar material in the form of a paper in IEEE format. All the students are required to attend all the session throughout the semester.

Procedure to conduct technical Seminar:

- All the students are informed to select a topic from the field of their interest from their branch or relevant to their branch and register the topic with the faculty (ies) In charge of Seminar.
- Two faculty members assigned to carry out this activity. The faculty members prepare the schedule of the seminar spread over the entire semester and display the same in the notice board.
- Change of seminar topic is not allowed once registered, however in the case of genuine reasons only once change of topic may be permitted.
- Based on the number of hours mentioned in the scheme, 4-6 students shall present the seminar in one slot of 2/3 hours.
- The faculty members shall conduct the seminar session every week as per the schedule in the slot mentioned on the time table and carry out the evaluation.
- Attendance is compulsory for all the students for all the seminars.
- The students are required to submit two hard copies of report not exceeding 6 pages and one soft copy of seminar report one week prior to their date of presentation.
- Report shall be in IEEE format viz A4 size paper, Title**:** Bold, Times new Roman Font 14, Sub heading & Body of the text**:** Times new Roman font 12. Margin for left should be 1 ½.
- Student name, USN, seminar date should be mentioned on the report.
- Presentation is for about 15-20 minutes, followed by 5 minutes for questions and answers.
- Typical evaluation methodology: The seminar shall be evaluated for maximum 50 marks. The breakup of marks shall be:
  Presentation: a) 40 marks b) Report: 10 marks.
  For presentation, the following points not limited to may be considered.
  Concept, understanding, depth of the knowledge, originality of the topic, Quality of PPT, communication skills etc.
  For report evaluation, the following points not limited to may be considered
  Adherence to IEEE format, relevance of topic, subject depth and originality in writing etc.

The seminar is aimed at as an educative program for the students. This is because, the students shall listen to 60- 70 seminars on different topics from emerging areas is as good as undergoing a course on latest happenings in the related branch of Engineering.

21UMEL801	Major Project Phase - 2	(0-0-18) 9

Contact Hours: 234

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Practical significance of projects.
2. Engineering concepts and its application to real world problems.
3. Manufacturing problems associated with fabrication, design related analysis and numerical concepts.
4. Creativity as an essential component of engineering application.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify, formulate and solve a problem using basic engineering principles.	1,2	4	1,2
CO-2	Recognize the need and able to design and fabricate the machine parts, components of a system that meets particular requirement.	3	7	6,12
CO-3	Use the software tools to prepare and analyze models or prototypes and conduct simulation using it.	5, 13	2	-
CO-4	Use the machine tools to prepare models or prototypes.	5, 13	2	-
CO-5	Work in teams and communicate effectively for completion of projects in time.	10	8,11,12	-
CO-6	Prepare a report based on their project and present the concept using ppt.	13, 14	9,10,11	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	3	2.4	3	2	3	1	2	2	2	2.5	2	1.4	3	3

Prerequisites: Nil

Course Contents :

Major project phase-2 is the continuation from phase –I in which the students are expected to go for material collection, survey, visits, data collection, preliminary design, analysis, model development, code writing, field work etc. The same project team formed for phase –I will continue the work under the guidance of the same faculty member. For all the projects, problems may be domain specific or interdisciplinary also in nature. A committee consisting of minimum 3 faculty members of which guide is a member shall evaluate at the end for CIE. There is a viva voce examination which shall be examined by two examiners one internal and one external to the college appointed by COE based on the suggestions by the respective HoD.

The reference materials for the project work are as listed below but not limited to:

Reference materials / Books:

1. Engineering books.
2. Journals.
3. Manuals and data sheets.
4. Software packages.
5. Previous project reports.
6. Product information brochures.
7. Interaction with academia and industrial experts.
8. Internet etc.

21UMEL703	Internship-2	(4 Weeks) 3

Contact Hours: 4 Weeks

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn:

1. Industry/R&D activities.
2. Engineering concepts and its application to real world problems.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Study of existing procedures in the organization.	1	13	9
CO-2	Analyze and evaluate the problem in hand.	-	2,13	-
CO-3	Suggest alternative solutions to the problem.	-	6, 12, 13	5, 3, 4
CO-4	Prepare report based on work carried out and present the concept using ppt.	10	-	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	3	2	1	1	1	2	-	-	1	3	-	2	2	-

Prerequisites: Nil

Course Contents :

Internship: The students are to undergo internship in Private industries / R&D organizations / Centres of Excellence / Laboratories of Reputed Institutions / Govt. & Semi Govt. organizations, PSUs, construction companies, entrepreneurial organizations, inter departments within the college etc. to get an exposure to the external world for a period of 4 weeks in the summer vacation after VI sem and before the start of VII semester. The students are to prepare a report on the internship work carried out. The internal faculty shall monitor the student and award CIE marks. The student shall present his work before a panel of examiners consisting of HoD, Guide and one faculty member during VIII semester as final exam. The performance shall be communicated to the CoE office and the same shall reflect in the VIII semester grade card.