Academic Program: UG

Academic Year 2026-27

Department of
Mechanical Engineering

V & VI Semester B.E.

Syllabus

SHRI DHARMASTHALA MANJUNATHESHWARA COLLEGE
OF ENGINEERING & TECHNOLOGY,
DHARWAD – 580 002
(An Autonomous Institution Approved by AICTE & Affiliated to VTU, Belagavi
Accredited by NBA under Tier-1
Ph: 0836-2447465 Fax: 0836-2464638 Web: www.sdmcet.ac.in

It is certified that the scheme and syllabus for V & VI semester B.E. in Mechanical Engineering is recommended by the Board of Studies of 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 2026-27 till further revision.

Chairman BoS & HoD **Principal**

Department of Mechanical Engineering

College Vision and Mission

Vision

To develop competent professionals with human values

Mission

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

QUALITY POLICY:

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

CORE VALUES:

Competency

Commitment

Equity

Team work and Trust

DEPARTMENT VISION AND MISSION

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
V Semester
Scheme of Teaching and Examinations 2026-27

Sl. No	Course	Course code	Course Title	TD/PSB	Teaching Hours/Week			Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HSMS	22UMEC500	Management, Economics and Entrepreneurship	ME	3	0	0	03	50	100	100	3
2	PCC	22UMEC501	Theory of Machines	ME	4	0	0	03	50	100	100	4
3	PCC	22UMEC502	Thermo-Fluid Engineering	ME	4	0	0	03	50	100	100	4
4	PEC	22UMEE5XX	Program Elective Course-I	ME	4	0	0	03	50	100	100	4
5	PCCL	22UMEL503	Machine Shop Practice	ME	0	0	2	03	50	50	100	1
6	PCCL	22UMEL504	Thermal Engineering Laboratory - II	ME	0	0	2	03	50	50	100	1
7	PROJ	22UMEL505	Minor Project - I	ME	0	0	4	03	50	50	100	2
8	MC	22URMK506	Research Methodology and IPR	ME	2	0	0	02	50	50	100	2
9	MC	22UESK507	Environmental Studies	ME	1	0	0	01	50	50	100	1
10	HSMS	22USSK508	Soft Skills - I		0	0	2	-	50	-	50	Audit
11	MC	22UNSK509	National Service Scheme	NSS	0	0	2	-	50	-	50	Audit
		22UPYK509	Physical Education and Yoga	PE&Y								
Total											**1000**	**22**
Program Elective Course –I												
11	PEC-I	22UMEE521	Scientific Computing	ME	4	0	0	03	50	100	100	4
12	PEC-I	22UMEE522	CAD/CAM	ME	4	0	0	03	50	100	100	4
13	PEC-I	22UMEE523	Fundamentals of Automobile Design	ME	4	0	0	03	50	100	100	4

14	PEC-I	22UMEE524	Mechatronics	ME	4	0	0	03	50	100	100	4
15	PEC-I	22UMEE525	Robotics And Automation	ME	4	0	0	03	50	100	100	4
16	PEC-I	22UMEE526	Power Plant Engineering	ME	4	0	0	03	50	100	100	4

Fill -- with your branch code CV, ME, EE, EC, CS, IS, CH, AI

HSMS: Humanity and management Science course, PCC: Professional Core Course, PCCL: Professional Core Course laboratory, AEC: Ability Enhancement course, MC: Mandatory Course, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation. K: This letter in the course code indicates common to all the stream of engineering. PEC: Program elective course, PROJ: Project. TD: Teaching department, PSB: Paper setting Board.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course.

Minor-Project-I: The students are expected to identify the state-of-the-art technology in his/her domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define the problem for the project work. The problem could be defined to develop prototypes for industrial needs. A team consisting of not more than 2-4 students shall be guided by a faculty member. This project work is to supplement and prepare the students to take up major project work at higher semesters. A committee constituted by HOD consisting of minimum 2 faculty members shall evaluate for CIE with suitable rubrics. The weightage of marks shall be 50% for the committee and 50% for the guide. There is a SEE (viva voce) examination which shall be examined by two internal examiners recommended by the HoD.

Soft Skills-I: Training on communication skills, proficiency in English language and aptitude ability is arranged involving external resource. The external resource person shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component. There shall be one test conducted at the end for 50 marks. The arrangement for CIE evaluation is to be done by the department and maintain the relevant documents.

AICTE activity point: Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the program. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case student fails to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD
Department of Mechanical Engineering
VI Semester
NEP Scheme of Teaching and Examinations 2026-27

Sl. No	Course	Course code	Course Title	TD/PSB	Teaching Hours/Week			Examination				Credits
					Lecture	Tutorial	Practical Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	22UMEC600	Heat Transfer	ME	4	0	0	03	50	100	100	4
2	PCC	22UMEC601	Finite Element Methods	ME	4	0	0	03	50	100	100	4
3	PCC	22UMEC602	Fluid Power Control	ME	3	0	0	03	50	100	100	3
4	PEC	22UMEE6XX	Program Elective Course -II	ME	3	0	0	03	50	100	100	3
5	PEC	22UMEE6XX	Program Elective Course - III	ME	3	0	0	03	50	100	100	3
6	OEC	22UMEO6XX	Open Elective Course -I	ME	3	0	0	03	50	100	100	3
7	PCCL	22UMEL603	Thermal Engineering Laboratory -III	ME	0	0	2	03	50	50	100	1
8	PCCL	22UMEL604	Computer Aided Engineering Analysis Lab	ME	0	0	2	03	50	50	100	1
9	PROJ	22UMEL605	Minor Project - II	ME	0	0	4	03	50	50	100	2
10	HSMS	22USSK606	Soft Skills - II		0	0	2	-	50	-	50	Audit
11	MC	22UNSK607	National Service Scheme	NSS	0	0	2	-	50	-	50	Audit
		22UPYK607	Physical Education and Yoga	PE&Y								
								Total			**1000**	**24**
			Program Elective Course -II									
11	PEC-II	22UMEE621	Design of Mechanical Elements	ME	2	2	0	03	50	100	100	3
12	PEC-II	22UMEE622	Battery and Fuel Cell Technology	ME	3	0	0	03	50	100	100	3
13	PEC-II	22UMEE623	Introduction to MATLAB	ME	3	0	0	03	50	100	100	3
14	PEC-II	22UMEE624	Heating Ventilation and Air Conditioning	ME	3	0	0	03	50	100	100	3
15	PEC-II	22UMEE625	Estimation and Costing in Mechanical	ME	3	0	0	03	50	100	100	3

			Engineering									
Program Elective Course – III												
16	PEC-III	22UMEE631	Advanced Automobile Design	ME	3	0	0	03	50	100	100	3
17	PEC-III	22UMEE632	Tool Design Engineering	ME	3	0	0	03	50	100	100	3
18	PEC-III	22UMEE633	Design for Manufacturing and Assembly	ME	3	0	0	03	50	100	100	3
19	PEC-III	22UMEE634	Industry 4.0 & Artificial Intelligence	ME	3	0	0	03	50	100	100	3
20	PEC-III	22UMEE635	Refrigeration and Air Conditioning	ME	3	0	0	03	50	100	100	3
Open Elective Course-I												
21	OEC-I	22UMEO641	Introduction to Aircraft Industry and Aircraft Systems	ME	3	0	0	03	50	100	100	3
22	OEC-I	22UMEO642	Project Management	ME	3	0	0	03	50	100	100	3
23	OEC-I	22UMEO643	Design of Renewable Energy Systems	ME	3	0	0	03	50	100	100	3
24	OEC-I	22UMEO644	Total Quality Management	ME	3	0	0	03	50	100	100	3
25	OEC-I	22UMEO645	Applied Scientific Computing	ME	3	0	0	03	50	100	100	3

HSMS: Humanity and management Science course, PCC: Professional Core Course, PCCL: Professional Core Course laboratory, AEC: Ability Enhancement course, MC: Mandatory Course, L: Lecture, T: Tutorial, P: Practical S= SDA: Skill Development Activity, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation. K: This letter in the course code indicates common to all the stream of engineering. PEC: Program elective course, OEC: Open elective course, PROJ: Projects. TD: Teaching department, PSB: Paper setting Board.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum numbers of students' strength for offering Open Elective Course are as prescribed by the DAP.

Open Elective Courses (OEC): Students belonging to a particular stream of Engineering and Technology are entitled to opt for the open electives offered by their parent Department and other departments provided that they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course are as prescribed by the DAP.

Minor-project-II: It is either a continuation of Mini-Project-I or a new project. The students are expected to identify the state-of-the-art technology in his/her domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define

the problem for the project work. The problem could be defined to develop prototypes for industrial needs. A team consisting of not more than 2-4 students shall be guided by a faculty member. This project work is to supplement and prepare the students to take up major project work at higher semesters. A committee constituted by HOD consisting of minimum 2 faculty members shall evaluate for CIE with suitable rubrics. The weightage of marks shall be 50% for the committee and 50% for the guide. There is a SEE (viva voce) examination which shall be examined by two internal examiners recommended by the HoD.
Soft Skills-II: Training on communication skills, proficiency in English language and aptitude ability is arranged involving external resource. The external resource person shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component. There shall be one test conducted at the end for 50 marks. The arrangement for CIE evaluation is to be done by the department and maintain the relevant documents.
AICTE activity point: Every regular student, who is admitted to the 4-year degree program, is required to earn 100 activity points in addition to the total credits earned for the program. The activity points earned by the student shall be reflected on the students VIII semester grade card. The activities to earn the points can be spread over the duration of the program. However, minimum prescribed duration should be fulfilled. Activity points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case student fails to earn the prescribed activity points; VIII semester grade card shall be issued only after earning the required activity Points. Students shall be eligible for the award of degree only after the release of the VIII semester grade card.

V semester

22UMEC500	Management, Economics and Entrepreneurship	(3-0-0) 3

Contact Hours: 39

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

1. Consequences of software piracy on software developers and the role of relevant enforcement organizations.
2. Role of entrepreneurship in the modern economy and entrepreneurial opportunities.
3. Understanding the basic concepts and techniques of Engineering Economics used in Industries.

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	Enumerate developments of management thought and functions of a manager	-	1	-
CO-2	Demonstrate the ability to recognize a business opportunity and launch an entrepreneurial career.	-	2	11
CO-3	Estimate direct, indirect costs and expenses of product and organization.	1	11,14	8
CO-4	Explain the rules and regulations of Government agencies supporting Industries and project management concepts	-	6	-
CO-5	Identify problems of present business environment and carry out feasibility studies.	-	8	10,11,13

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2	2	-	-	-	2	-	2	-	1	1.3	-	1	2

Pre requisites: Nil

Course Contents:

Unit - I

Engineering and Management: Historical Development of Engineering, Management, Engineering, Management and Engineering & Management a synthesis.

Planning; Forecasting and Decision Making: Nature of Planning, the foundation of planning, some planning concepts, forecasting, nature of decision making, management science, tools for decision-making.

Organizing and staffing: nature of organizing, traditional organizational theory, technology and modern organization structures, staffing technical organization, authority and power; delegation, meeting & committees.

7Hrs

Unit - II

Motivation: Motivation, Theories of Motivation leadership, motivating and leading technical professionals. Motivating factors for Engineers. Leadership, Types and styles of leadership,

Controlling: process of control, financial controls, and non-financial controls**.** Process of control and steps involved in controlling**.** Various financial and non-financial ratios.

Foundations of Entrepreneurship: Meaning of entrepreneur, functions of entrepreneur, types of entrepreneurs, concept of entrepreneurship, role of entrepreneurs in economic development, barriers of entrepreneurship.

9Hrs

Unit – III

Small Scale Industry: Definition, characteristics, objects, role of SSI in economic development, advantages of SSI, steps to start a SSI, impact of liberalization, privatization, and globalization on SSI, definition of ancillary and tiny industry.

Government and Institutional Support: Nature of support of government, Central organizations NSTEDB, NPC, NISIET, NIESBUD. objectives and functions of SISI, SIDBI, DIC, single window agency, KIADB, KSSIDC, KSFC.

Preparation of Project: Meaning of project identification, project report, contents and formulation, identification of business opportunities, feasibility studies, types and purpose. **8Hrs**

Unit – IV

Elements of Economics: Economics- Income-Investment-Reserve-Assets and Liabilities-Utility-Market-Money-Trade Cycle Profit-Theories of Profit-Cost Control and Cost Reduction-Price-Price Determination-Value-Wants-Wealth-Goods-

Credit-Stock Exchange-Demand-Supply-Economies of Size-Laws of Return-Capital-Integration-Exchange-Production-Production function.

Economics Applied to Industries: Introduction-Launching a Business Enterprise-Variety Reduction verses Diversification-Price, Demand, and supply-Marginal Price in-Forms of Market-Inflation-Nominal and Effective Rates-Single Payment Factor-Rate of Return.

Engineering Economics: Introduction: Time value of Money-Cash Flows – Taxation Concept-Tools for Engineering Economics –Models-Operations. Research-Value Engineering-Make and Buy Decisions-Economic Lot (Batch)Size-Economic Theory

10Hrs

Unit – V

Elements of Costs: Calculation of Material costs, Calculation of Direct Labour cost, Labour cost, Factory expenses. Administrative Expenses, selling and Distribution expenses. Fixed and Variable overheads, Components of cost; Selling price; Allocation of on-cost-Percentage on Prime cost, Direct Labour cost, Direct material cost, Man hour rate, Machine hour rate, Combination of Man hour and Machine hour rate, Unit rate method; Numerical.

Indirect Expenses: Factory, Administrative, sales and distribution expenses. Calculation of various overheads- Depreciation, Obsolescence: Methods of calculating Depreciation; Interest on Capital; Idleness of machines and workers; Repairs and Maintenance. Estimation of Material cost, Procedure and numerical.

5Hrs

Reference Books:

1) Daniel L. Babcock, “Managing Engineering and Technology”, 4th edition, PHI.
2) N V R Naidu, “Management and Entrepreneurship”.
3) Thomas W. Zimmers, “Essentials of Entrepreneurship & small business management”, 5th edition, PHI, 2011.
4) Peter Drucker, “The Practice of Management”.
5) Khan & Jain, “Cost Accounting”, TMH, 2013.
6) T. R. Banga and S.C. Sharma, “Mechanical Estimation and Costing”, Khanna Publishers.
7) T.R.Banga, S.C. Sharma, “Industrial Organization and Engineering Economics”

22UMEC501	Theory of Machines	(4-0-0) 4

Contact Hours: 52

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

1. Kinematics, linkages for motion constrained, their applications, and kinematic analysis.
2. Cams/followers/follower motion pattern and cam profile synthesis.
3. Gears/gear trains, their terminology, and application of gears/gear trains
4. Force analysis in gear trains and planar mechanisms.
5. Balancing for rotating and reciprocating machines.
6. Gyroscopic effects in automobiles and aircraft.

Course Outcomes (COs): At the end of the course students will be able to

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 mechanisms, inversions of kinematic chains with or without relevant sketches and derivations	1	-	-
CO-2	Determine the velocity, accelerations, forces of various members of the mechanisms by graphical or analytical method.	1	2	-
CO-3	Draw cam profiles with relevant calculations	1	-	3
CO-4	Evaluate the various gear parameters with or without derivations, speeds/ torques on gears found in gear trains.	1	2	-
CO-5	Calculate the necessary masses for balancing rotary system.	1	-	-
CO-6	Analyze the effects of gyroscopic couples / forces on vehicles/mechanical systems.	1	2	-

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions, QRMs, Intermittent motion mechanisms, straight line motion mechanisms and Steering mechanisms used in automobiles. **9 Hrs**

Unit - II

Velocity and Acceleration analysis of planar mechanisms: Velocity and acceleration analysis of four bar mechanism and slider crank mechanisms by graphical/ analytical methods. Corioli's component of acceleration.

Force analysis of planar mechanisms: Static force analysis of four bar mechanism. **10Hrs**

Unit - III

Gears: Spur Gears – Terminology, Law of gearing, velocity of sliding, contact ratio, path of contact, arc of contact, interference in gears, minimum number of teeth to avoid interference, comparison between involute and cycloidal profile.

Gear trains: Types of gear trains, epicyclic gear trains, speed and torques in epicyclic gear trains. **12Hrs**

Unit - IV

Balancing- Balancing for rotating masses by graphical or analytical method.

Gyroscope: Gyroscopic forces and couples in aero planes, ship and two-wheel vehicles. **12Hrs**

Unit - V

Cams: Types of cams and followers, follower motion analysis, Layout of cam profiles for different follower motions. **9Hrs**

Reference Books:

1) S S Rattan, "Theory of Machines", TATA McGraw Hill publishing company Ltd, New Delhi, 3rd edition,2009.
2) Shigley, J.V and Uicker JJ, "Theory of Machines and Mechanisms", 2nd edition, McGraw Hill, 1995.
3) John J Uicker, Gordon R Pennock, Joseph E Shigley, "Theory of Machines and Mechanisms", 3rd edition, Oxford publisher, 2009.
4) Dr. R K Bansal and Dr. J S Brar, "Theory of Machines", 5th edition, Laxmi publications, 2015.

22UMEC502	Thermo-Fluids Engineering	(4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): The objectives of this course are to make the student to learn, basic laws of thermodynamics related to IC Engines, and turbomachines.

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 testing of IC engines and Determine the nozzle dimensions for pressure ratios,	--	1	2
CO-2	Explain and draw velocity triangles of turbo machines and compare Turbomachines with positive displacement machines	--	1,2	--
CO-3	Evaluate performance parameters of hydraulic turbo machines and centrifugal pumps	--	1.2	--
CO-4	Evaluate performance parameters of steam and gas turbine	1, 2	--	--
CO-5	Evaluate the performance centrifugal blower and compressors	--	1, 2	--

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.2	1.6	-	-	-	-	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents:

Unit - I

Performance Testing of IC Engines: Two-stroke and Four-stroke I.C. engines - Measurement of speed, air flow, fuel consumption, Measurement of Brake Power and Indicated Power, Performance curves, Heat Balance sheet and Multi cylinder Engines testing, Morse test.

Thermodynamics of fluid flow: static and stagnation properties, compression and expansion process and efficiencies, **flow through passages;** Area change effect of friction in nozzles and diffusers, Characteristics of converging and diverging nozzles. **10 Hrs**

Unit - II

Introduction to Turbo machines: Classification, comparison between turbo machines and positive displacement Euler's equation for a Turbo machine Impulse & Reaction machine- Axial flow and radial flow machines utilization factor, degree of reaction & efficiencies of Turbo machines. **10 Hrs**

Unit - III

Hydraulic Turbines: Classification of hydraulic turbines- Pelton wheel - Francis turbine- Kaplan turbine. Draft tubes. Cavitation, characteristic curves

Centrifugal Pumps: Main Parts of centrifugal pump, basic terms and definitions, work done, minimum speed for starting centrifugal pump, Classifications- Performance characteristics of centrifugal pumps. Multistage pumps characteristic curves. **10 Hrs**

Unit - IV

Steam Turbines and Gas turbines: Impulse turbines, Staging - expression for work done in a 2 stage velocity compounded turbine- effect of blade & nozzle losses- Reaction staging- reheat factor- performance characteristics, problems using Mollier's chart & introduction to gas turbines. **11Hrs**

Unit - V

Centrifugal Blowers & Compressors: Centrifugal blower - types- size & speed- vane shape & efficiency- vane shape & stresses- vane shape & characteristics- actual performances characteristics- slip. Introduction to Reciprocating Compressors **11 Hrs**

Reference Books:

1) Energy Conversion Volume-III Turbo-machinery by V Kadambi & Manohar Prasad Tata Mc Graw Hill 4th edition
2) Turbo Machines by M.S. Govindegowda and A.M. Nagaraj
3) Turbo Machines by BU Pai- Wiley Publications.
4) R.K.Bansal “Fluid Mechanics and Hydraulics” Metropolitan Book Co. Pvt. Ltd., New Delhi, 1995.

22UMEL503	Machine Shop Practice	(0-0-2) 1

Contact Hours: 26

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

1. Fundamentals of machining, machine tools & their elements
2. Sequence of operation
3. Metal cutting practice
4. Safety while operating machine.
5. CNC Machining operation, writing NC programming.

Course outcomes (COs): Upon the completion of the course, the student should be able to

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	Measure and mark dimensions using suitable instruments.	1	9	3
CO-2	Perform basic turning operations on Lathe	1	9	-
CO-3	Carry out the basic machining operations on milling and shaping machines.	1	-	4
CO-4	Write NC programs to perform machining operation on CNC milling machine.	1	5	3

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

Prerequisites: Nil

Course Contents:

1. **CNC machine**: Setting the machine and exercises comprising of plain milling, Step milling and drilling.
2. **Lathe:** Plain Turning, Taper Turning. Step Turning, Thread Cutting. Facing, Knurling, Eccentric Turning (Demo).
3. **Milling machine:** square milling and gear teeth cutting using horizontal/ vertical milling machines.
4. **Shaping machine:** Cutting of V-groove /keyway groove.

References:

1. Kundra Rao and Tiwari. Numerical Control and CAM. Tata Mc Grraw Hill Publishing Company Ltd. 2020
2. S. K. Hajra Choudhury, Nirjhar Roy, Workshop Technology, Vol. II-Machine Tools, Media Promoters and Publishers Pvt. Ltd, 2020.
3. Anderson James, Earl E Tatro. Shop Theory, Tata Mc Graw Hill Publishing Company Ltd. 2010

22UMEL504	Thermal Engineering Laboratory-II	(0-0-2) 1

Contact Hours: 26

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

1. Pressure measurement and application to flow measuring devices
2. Impact of jet on vanes and pressure coefficient of flow across cylinder
3. Evaluation of lift and drag coefficient for standard bodies in wind tunnel experiment
4. Turbomachines and their performance

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	Calibrate flow measuring devices	-	4,5	3
CO-2	Determine minor, major losses in pipe flow and study impact of jet on vanes	-	3, 4	9
CO-3	Experiment on Water turbine and draw characteristic curves	1,2	4	9
CO-4	Calculate performance parameters of power absorbing turbo machines and Positive displacement Machines	1,2	4	9
CO-5	Determine coefficient of pressure, lift and drag in a flow across standard bodies in wind tunnel.	-	3, 4, 5	9

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	3	3	1.6	2	2	-	-	-	1	-	-	-	-	-

Pre-requisites: Basic principles of Engineering Thermodynamics and Fluid Mechanics.

1. Measurement of pressure using different Manometers for high- and low-pressure measurements (manometers using different manometric fluids).
2. Determine the coefficient of discharge of Orifice meter and Venturimeter.
3. Determine the coefficient of discharge of Notches.
4. Determine the minor losses & major losses.
5. Study of performance of Impact of Jet on flat and curved surfaces.
6. Estimation of distribution of coefficient of pressure on a cylinder at different Reynolds numbers.
7. Calibration of wind tunnel using Pitot tube.
8. Determination of drag and lift coefficient of standard objects using wind tunnel.
9. Performance test on double acting Reciprocating pump.
10. Performance test on single and multi-stage centrifugal pump.
11. Performance test on Pelton turbine and draw main and operating characteristics.
12. Performance test on Kaplan turbine and draw main and operating characteristics.
13. Performance test on Francis turbine and draw main and operating characteristics.
14. Performance test on centrifugal blower and draw operating characteristics for different vane shapes.

References:

1. Fluid Mechanics by R K Bansal, Lakshmi Publications, 2018
2. Turbo Machines by Kadambi and Prasad, New Academic Science, 2015

22UMEL505	Minor Project - I	(0-0-4) 2

Contact Hours: 54

Course Learning Objectives (CLOs):

The course is included to provide an exposure, focusing more on the domain related problem definitions, building prototypes which can lead to take up the project in the higher semester(s). The work based on using the concepts studied in the core/elective courses studied shall be used to formulate the problem. They are also required to learn to find related material, use appropriate tool to obtain the solution and prepare a report based on the work carried out.

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 the domain related problem and formulate a problem statement	6	-	9
CO-2	Propose the technical approach towards the solution.	11	4	9
CO-3	Develop physical model or software solution.	4	1, 2, 3, 5, 11	9,10, 12,13
CO-4	Prepare the report in a specified format.	8, 10	-	9, 14

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

Prerequisites: Nil

Minor project – 1 The students are expected to identify the state-of-the-art technology in his/her domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define the problem for the project work. The problem could be defined to develop prototypes for industrial needs. A team consisting of not more than 2-4 students shall be guided by a faculty member. This project work is to supplement and prepare the students to take up major project work at higher semesters. A committee constituted by HOD consisting of minimum 2 faculty members shall evaluate for CIE with suitable rubrics. The weightage of marks shall be 50% for the committee and 50% for the guide. There is a SEE (viva voce) examination which shall be examined by two internal examiners recommended by the HoD.

22URMK506 Research Methodology & IPR (2-0-0) 2

Contact Hours: 26

Course Learning Objectives (CLOs):

The students are expected to learn about the need and types of research, problem formulation, literature review, measurement, scaling, data collection, testing of hypothesis, result interpretation and report writing. Also expected to learn about the importance of IPR and trade mark.

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	-	2	5
CO-3	**Describe** measurement and scaling and data collection &report writing	-	-	3
CO-4	**Basic** concepts concerning IPR and copy rights	-	4	-
CO-5	**Explain** the need for Trademark and IT act.	-	5	-

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

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.

5 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.

5 Hrs.

Unit-III

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

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

Interpretation and Report Writing: Meaning of interpretation, technique of interpretation, precaution in interpretation, significance of report writing.

6 Hrs.

Unit-IV

Meaning and conception of IPR, competing, rationale for protection, international conventions, world court.

Copy right: Historical evolution of the law on copy right, meaning, content

Patents: Meaning of Patent, purpose and policy object of patent law, gains to inventor, application of patents, joint application, discovery and invention, patentable and non-patentable inventions.

5 Hrs.

Unit-V

Trademarks: Definitions and conceptions of Trademark, advantages of registration, marks which are not registrable, known and well-known trade marks, application for registration and procedure for registration, procedure and certification of Trademarks.

The Information Technology Act:

Definitions, certifying authority, meaning of compromise of digital signature, offences and penalties, applicability of IPRs, cybercrimes, adjudicating officer, violation, damages and penalties, Cyber regulation appellate tribunal, World Wide Web and domain names and cyber flying, Self study. **5 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.
4) N. K. Acharya, Text book on Intellectual Property Rights, 4th Edition, Asia Law House, Hyderabad.

22UESK507 Environmental Studies (1-0-0) 1

Contact Hours: 13

Course Learning Objective (CLO):

1. The students are to learn in this course about the need of balanced ecosystem, effects of human activities on environment, optimized use of natural resources including energy extraction and current Environmental issues.

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 (13-15)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Discuss the concept of ecosystem and effects of human activities on environment.	-	7	-
CO-2	Describe the adverse effects on health and society due to erratic exploitation of natural resources.	-	-	6
CO-3	Understand various types of energy, sources of energy.	-	6	-
CO-4	Explain different types of Pollution and concept of Global warming, Ozone layer depletion.	-	7	-
CO-5	Discuss the current developments towards NGO to protect environment.	-	6	-

POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Mapping Level	-	-	-	-	-	1.6	2	-	-	-	-	-	-	-	-

Course content:

Unit - I

Environment and Effects of Human activities on Environment: Introduction, Ecosystem – Types & Structure of Ecosystem, Impacts of Agriculture & Housing, Mining & Transportation. Environmental Impact Assessment, Sustainable Development. **3 Hrs**.

Unit - II

Natural Resources : Introduction Water resources – Availability & Quality aspects, Water borne diseases, Fluoride problem in drinking water. Material Cycles - Carbon cycle and Nitrogen cycle. **3 Hrs**.

Unit - III

Energy in Ecological System: Different types of energy, Conventional sources & Non Conventional sources of energy. Solar energy, Hydro electric energy, Wind energy, Nuclear energy, Biomass & Biogas, Fossil Fuels, Hydrogen as an alternative energy. **3Hrs.**

Unit - IV

Environmental Pollution: Water Pollution, Land Pollution, Air Pollution, Global Warming, Ozone layer depletion. **2 Hrs.**

Unit - V

Current Environmental Issues & Environmental Protection: Environmental Acts & Regulations, Role of Nongovernmental Organizations (NGOs). Introduction to GIS & Remote Sensing, Applications of GIS & Remote Sensing. **2 Hrs.**

Reference Books:

1. P. Meenakshi, " Elements of Environmental Science and Engineering", Prentice Hall of India Private Limited, New Delhi, 2006.
2. Benny Joseph " Environmental Studies", Tata McGraw – Hill Publishing Company Limited, 2010.
3. Raj Gopalan " Environmental Studies" Oxford University press, New Delhi, 3rd Edition, 2016.
4. Kaushik and Kaushik " Perspectives in Environmental Studies ", New Age International Private Limited, 2005.
5. D. L. Manjunath " Environmental Studies ", Pearson, Noida, 2016.

22USSK508	Soft Skills - I	(0-0-2) 1

Contact Hours: 26

Course Learning Objectives (CLOs):

This is included with the objectives of improving the communication skills, proficiency in English language and aptitude ability of the student to enhance the employability.

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 significance of communication in the profession.	-	10	-
CO-2	Use the English language with proficiency	-	10	12
CO-3	Solve Aptitude related problems	-	9	12
CO-4	Demonstrate the competency in the placement activities.	-	9	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	-	-	-	-	-	-	-	-	2.0	2.0	-	1.0	-	-

Prerequisites: Nil

Course Contents:

Number System, Linear Equations + Assessment Test ▪ HCF and LCM, Ratios & Proportions + Assessment Test ▪ Percentage, Profit & Loss + Assessment Test ▪ Time, Work & Distance + Assessment Test ▪ Simple and compound Interest, Averages and Mixtures + Assessment Test ▪ Permutations, Probability + Assessment Test ▪ Data analysis **14Hrs**

Cyptarithmetic ▪ Analytical Puzzles ▪ Classification Puzzles ▪ Mathematical Puzzles ▪ Human Relations ▪ Directional tests ▪ Coding and decoding ▪ Series completion – Verbal and Non-verbal ▪ Questions from recent recruitment tests

10 Hrs

Evaluation:

Both the internal and external resource persons shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component. There shall be one test conducted at the end for 25 marks in Aptitude testing and there shall be one presentation by the student for 25 marks or any other suitable testing components. The arrangement for CIE evaluation is to be done by the department and maintain the relevant documents.

22UPYK509	Physical Education and Yoga	(0-0-2) Audit

Contact Hours: 24

Course Learning Objectives:

1. The course focuses on overall development and importance of Physical Education & Yoga in day to day life.

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)**
CO1	Gaining the importance of Physical Education & yoga	12	--	8, 9
CO2	Understanding the benefits & preventive measures of health	12	6	8, 9
CO3	Gaining the knowledge of yoga	12	--	8, 9
CO4	Understanding the importance of Human Body conditioning & Sports training	12	--	8, 9
CO5	Get awareness of Modern technology in sports	12	--	5, 8, 9

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

Contents

Unit-I

Introduction to Physical Education: Meaning and importance, definition, components, benefits of physical education. **4Hrs**

Unit-II

Health and Wellness, Anatomy and Physiology: Meaning and importance, definition, components, benefits, health habits, basics of diseases and preventive measures, mental health, physical health, social health, spiritual health. Meaning and definition, first aid, injuries and preventions. **5Hrs**

Unit-III

Introduction of Yoga: Origin and history of Yoga, meaning and definition, benefits, Importance prayer Suryanamaskara,

Asana:- Trikonasana, Ardha Chakrasana, Baddha konasana, Utkatasana.

Pranayama:- Bhramari Pranayamai, Kapalbhati Pranayama.

Mudras:- Chinmaya mudra & Nasika mudra. **5Hrs**

Unit-IV

Sports Training: Meaning and definitions, warming up, cooldown, methods of exercises, stretching, speed, endurance, flexibility, agility, Athletics, Netball, Kabaddi, Football Tug ofwar, Throwball Rules and regulation of all games. **5Hrs**

Unit-V

Modern Technology in Sports and Games: Meaning and definitions, objectives, assisting umpires/ referees, hawk-eye technology, sports specific, computer software, technology in playfields, athletes clothing and equipment, graphics of sports and games, artificial intelligence. **5Hrs**

Reference Books:

1) Petipus, et al., Athlete's Guide to Career Planning, Human Kinetics, 1997
2) The Human Body in Health and Disease with Access 8th Edition 2023.
3) Anatomy and Physiology, Shri K.G. Nadgir College of Physical Education. Dharwad.
4) Health & Wellness Shri K.G. Nadgir College of Physical Education. Dharwad.
5) Nagendra HR., The art and science of Pranayama, 2009
6) Iyengar BKS., The illustrated Light on Yoga(English), 2005

22UMEE521	Scientific Computing	(4-0-0) 4

Contact Hours: 52

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

1. To improve their ability in solving mathematical problems using Python software
2. To develop skills in handling errors, functions, and loops in program, enhance problems solving capability.
3. To emphasize signification of plotting graphs and interpreting the data's in Python software.
4. To gain knowledge in scientific methods and familiarize with application of differential equation and integration to solve engineering 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) / PSO (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Develop program by analyzing problem and handling errors in Python software.	5	1,2	3
CO-2	Use data structures in programming approach.	5	1,2	3
CO-3	Apply function features to develop realistic programs.	5	1,2	3
CO-4	Develop Python Programs using NumPy array and matplotlib for solving problems	5	1,2	3
CO-5	Use various package's and libraries SciPy, ODEINT to solve a mathematical problem.	5	1,2	3

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction: Introduction to Scientific Computing and Python ,Features and Applications of Python, Installing Python and Development Environment (IDLE, VS Code, Jupyter Notebook), Writing and Executing Python Programs, Python Syntax and Program Structure , Variables, Data Types and Type Conversion , Input and Output Functions, Operators (Arithmetic, Relational, Logical, Assignment, Membership and Identity), Expressions and Statements, Reserved Words and Keywords, Standard Mathematical Functions (math module) , Comments and Documentation and Simple Programming Exercises, **10Hrs**

Unit - II

Decision Making, Loops and Data Structures: Decision Making using if, if-else, if-elif-else and Nested if, Looping Statements (while and for), break, continue and pass Statements, Nested Loops, Strings and String Operations, Lists: Creation, Indexing, Slicing, Updating and Deleting Elements, List Methods and List Operations, Tuples and Tuple Operations, Dictionaries and Dictionary Methods, Programming Exercises on Loops and Data Structures **10Hrs**

Unit - III

Functions: Introduction to Functions, Built-in Functions, User-defined Function Arguments (Positional, Keyword, Default and Variable-Length Arguments), Scope of Variables (Local and Global Variables), Return Values, Recursive Functions, Lambda Functions, Modules and Packages, Exception Handling (try, except, finally), Programming Exercises using Functions.**10Hrs**

Unit - IV

Array Computing and Curve Plotting: Introduction to NumPy, NumPy Arrays and Array Operations, Reading and Writing Array Data, Matrix Creation and Manipulation, Linear Algebra using NumPy, Matrix Addition, Multiplication and Transpose, Dot Product, Cross Product and Matrix Inverse, Polynomial Operations, Introduction to Matplotlib, Line, Scatter, Bar and Pie Charts, Contour Plots and 3D Surface Plots, Visualization of Engineering and Scientific Data. **10 Hrs**

Unit - V

Numerical Methods and Scientific Applications: Introduction to Numerical Computing, Ordinary Differential Equations (ODE), Partial Differential Equations (PDE) – Basic Concepts, Numerical Integration, Double Integration, Initial Value Problems, Optimization Techniques, Linear Programming Problems (LPP) **12 Hrs**

Activity Beyond Syllabus

Students shall develop a mini project using Python to solve a real-world engineering or scientific problem involving numerical computation, data analysis, simulation, optimization or visualization. Students are encouraged to use Python libraries such as NumPy, Matplotlib, and SciPy, and present the results through graphical visualization and technical reports

Reference Books:

1) Allen B. Downey, “Think Python”, 2nd Edition, O’Reilly Publication, 2015.
2) Christian Hill, “Learning Scientific Programming with Python”, Cambridge University Press, 2015.
3) Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd, 2015.
4) T.R. Padmanabhan, “Programming with Python”, Springer, 2016.
5) Hans Petter Langtangen, “A Primer on Scientific Programming with Python”, Springer; 3rd Edition, 2012.

22UMEE522	CAD/CAM	(4-0-0) 4

Contact Hours: 52

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

1. Basics of CAD/CAM
2. Automation concepts, graphics & modeling
3. Latest CAD/CAM technologies and FEA

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 role of CAD/CAM, hardware and computer graphics in today's manufacturing automation.	1,2	-	-
CO-2	Develop geometric model of engineering problem by various modelling schemes using geometric transformations.	1	-	4
CO-3	Discuss stages in FEA and concepts of CNC machine tools and tooling.	1,2	-	4
CO-4	Write manual and advanced part programs for a given geometry during milling and turning operations.	2,3	-	1
CO-5	Use of manufacturing simulation packages to solve turning and milling problems.	1,2	-	4
CO-6	Explain the material handling systems like robots and AGVs, along with concepts of FMS, CIM and CAPP.	3	-	1,2

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

Prerequisites: Nil

Course Contents:

Unit - I

Fundamentals of CAD: Definition of CAD /- Product cycle in conventional and CAD/CAM environment- Automation & CAD / CAM- Design Process (Application of computers for design) - Advantages & Disadvantages of CAD.
CAD Networking and Computer Graphics: Design Workstation- Architecture of typical graphics workstation, Network and its topologies. Software configuration of a Graphic system- Graphical Kernel System- Graphic standards- Functions of Graphics package. **10 Hrs**

Unit - II

Geometric Modeling: Construction of Geometry- Data structures- Data base for Graphic modeling- CSG- Boundary representation- parametric modeling variant approach- Wire frame- surface & solid modeling advantages and disadvantages.
Transformations: 2-D Transformation- 3-D Transformation- Concatenation- Homogeneous Transformation- Clipping & Windowing- Viewing Transformations- Windowing Transformation. 3 - D modeling Concepts.
10 Hrs

Unit - III

Introduction to FEA: Preprocessing- Analysis- Post processing- Discretization- Element types- Nodes- Degrees of freedom- constraints- Loads.
Introduction NC-CNC-DNC: NC, CNC & DNC- Elements- CNC machining centers- CNC Turning Centers- High speed machine tools- MCU & Supporting Systems.
CNC Tooling - Turning Tool geometry- Milling tooling- systems- Tool presetting - ATC Work-holding devices. **10Hrs**

Unit - IV

CNC Part Programming: Part program fundamentals- Manual part programming a) milling b) Turning
Advanced part programming Methods: Parameters- Looping & Jumping- Subroutines and Macros. **10Hrs**

Unit - V

Computer Aided part programming - Introduction to CAM simulation packages.
Material handling systems – Introduction to Robots-Anotomy, Configurations, Work volume, Robot end effectors, Robotic Sensors, applications. AGVs - Introduction to FMS & CIM- Group Technology & CAPP.
12 Hrs

Reference Books:

1) Grover, “CAD/CAM”, Tata Mc Greaw hill, 2003.
2) P.N. Rao, “CAD/CAM”, Principles and Application, Tata Mc Grew Hill 2010.
3) Ibrahim Zeid, “CAM/CAM”, 2nd edition, Tata Mc Grew hill, 2010.
4) Newman and Sproull, “Principles and Interactive Computer Graphics”, TATA McGrew Hill, 1995.

22UMEE523 Fundamentals of Automobile Design (4-0-0) 4

Contact Hours: 52

Course Learning Objectives (CLOs): The objective of this course is to make the student aware of:

1. Theoretical concepts of automotive industry.
2. Design and development automotive systems.
3. Die and Fixtures Design.
4. Explain Industrial Design and its importance

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 the importance of design and styling for Automotive Product Development	1	-	-
CO-2	Apply fundamental concepts on the bonnet design	-	2	-
CO-3	Investigate the concept of FEA and NVH in the process of model creation and analysis.	3	-	-
CO-4	Investigate the Die and fixture design process	3	-	-
CO-5	Discuss on different methods of sheet metals process and its use in automobile.	-	2	-
CO-6	Describe various methods of operations performed on sheet metals fixtures	-	2	-

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

Prerequisites: Nil

Course Contents:

Unit - I

Automotive design and development cycle: Introduction to styling, Design, Design Examples, Industrial Design, applications. Typical Product Life Cycle, Automotive Design Process (Design Process for production release), Design Studio Process or Product Conceptualization process, case study, Computer Aided Styling (CAS) Surfaces or Digital Clay Models, Class A Surfaces, Role of Class A Surface Engineer, Requirements for Class A Surface, Case Studies for Class A Surfaces, Step by Step Process for Bonnet Class A Surface Creation. Good Design & its examples.

Practical sessions:

Session1: Exercise to obtain the outer surface (CAS) of a bonnet based on car style

Session2: Writing the Requirement Specification of car bonnet (idea is to provide this as input to source a supplier)

Session3: Basic introduction to CAD & suitable software (Siemens NX, Catia) **10 Hrs**

Unit - II

Introduction to styling: Function of a bonnet, Inputs for the bonnet, Design procedure- Develop Hood Package Layout, Develop Typical Sections, Define Block Surfaces in 3D, Define Dynamic Clearance Surfaces in 3D, Define Hood Structural Members, Computer Aided Engineering (CAE) 1(Durability, crash), Panel Detail Design, Define Body Assembly Process, CAE 2(Durability, crash, Individual pane l level). Design Updating and Detailing Prototypes, Design Updating and Production Release.

Practical sessions:

Session 1: CAD design of a bonnet - 1

Session 2: CAD design of a bonnet – 2

Session 3: Application of CAE simulation on bonnet CAD (air flow, water flow, etc) **10 Hrs**

Unit - III

Introduction to CAD, CAM & CAE: Finite Element Analysis(FEA),Noise Vibration and Harshness(NVH), Dura, Crash, Occupant Safety, CFD Implicit vs. Explicit Solvers, Degrees of Freedom, Stiffness matrix, Pre -Post and Solver; Types of Solvers, Animations, Durability: Oil Canning on Hood, Scope of Work, NVH: Constrained Modal Analysis on Hood, Scope of Work, Loading, Boundary Conditions, Results & Conclusion, Crash: Vehicle Crashworthiness, Energy Management Biomechanics, Head Impact Analysis on Hood, Importance of Failure Criteria, Von Mises Stress.

Practical sessions

Session 1: Application of CAE simulation on bonnet CAD (strength & stiffness, debt resistance)

Session 2: Fixture design

Session 3: Assembly& disassembly considerations for components (after sales, service) **10Hrs**

Unit - IV

Sheet metal design and manufacturing: Introduction to Sheet metal design and manufacturing cycle, Simultaneous Engineering (SE) feasibility study, Auto body and its parts Important constituents of an automobile, different types of Sheet metal processes, Types of draw dies, Draw Model development, Considerations while developing draw model, Forming simulations, Material properties Forming Limit Curve (FLD), Pre- processing, Post Processing, Sheet Metal Formability – Simulation.

Practical sessions:

Session 1: Design for manufacture of plastic parts (mould flow, draft angle etc)

Session2: Bench marking a bonnet by studying competitor data (2 or 3 examples) **10Hrs**

Unit - V

Die design: Requirements, Sheet metal parts and their operation like Cutting, Non-cutting etc., Presses, and Various elements used in die design. Function of each element, Different types of dies, working of dies.Real life 3D experience of Die design.

Fixture design: Requirements, definition, operation and elements of fixture design, Different types of welding processes used for fixture, Body Coordinates 3- 2-1 principle, need for Fixture, Design Considerations. Specification of product using GD&T in the Fixture design. Fixture Elements. typical operations in Sheet metal Fixture using Manual/Pneumatic/Hydraulic fixture, typical Unit Design for Sheet metal parts (Rest/Clamp/location/Slide/Dump units/base), types of Fixture (Spot welding/Arc welding/Inspection Fixture/Gauges)

Practical sessions:

Session 1: Example Design Failure mode and Effect Analysis (DFMEA) practical 1 - how to analyze risk & define counter measures.

Session 2: Example DFMEA practical 2 - how to analyse risk & define counter measures. **12 Hrs**

Reference Books:

1) Banabic, D. (n.d.). “Sheet Metal Forming Processes”, Constitutive Modelling and Numerical Simulation.
2) Klocke, F. (n.d.). “Manufacturing Processes 4 Forming”, Retrieved from http://www.springer.com/series/7858.
3) Mikell P. Groover “Fundamentals Of Modern Manufacturing”, Materials, Processes, and Systems Fourth Edition,
4) H-Point The Fundamentals of Car Design & Packaging, copy write 2008 by Design Studio press.
5) Delmar, Cengage Learning, “Jig and Fixture Design”, Fifth Edition Edward G. Hoff man, 2004.
6) Mohammed A. Omar, “The Automotive Body Manufacturing Systems And Processes”, John Wiley & Sons Ltd, Edition first published 2011,

22UMEE524	Mechatronics	(4-0-0) 4

Contact Hours: 52

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

1. Recognize various elements of mechatronics system.
2. Synergic integration of mechanical, electrical, electronic systems.
3. Illustrate various components of Mechatronics systems.
4. Assess various control systems used in automation.
5. Develop mechanical, hydraulic, pneumatic, and electrical control 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 elements of mechatronic systems and sensors.	1	-	-
CO-2	Explain microcontrollers and microprocessors used in automation systems.	-	1	-
CO-3	Construct the ladder diagrams for PLC applications.	-	3	-
CO-4	Describe various mechanical and electrical actuation systems.	2	-	-
CO-5	Develop solutions for automation applications using fluid power systems.	2	-	3,13

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction: Definition, Multidisciplinary Scenario, Evolution of Mechatronics, Mechatronics systems - Measurement systems, examples of microprocessor-based controllers- Principle of working of automatic washing machine, autofocus camera, engine management system. Definition and classification of sensors and transducers, principle of working and applications of capacitive sensors, inductive sensors, light sensors, ultrasonic sensors, proximity switches and Hall Effect sensors. **10 Hrs**

Unit – II

Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers.

Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data, Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.

10 Hrs

Unit – III

Programmable logic controller: Introduction to PLC's, basic structure, Principle of operation, Programming and concept of ladder diagram, concept of latching & selection of a PLC.

Integration: Introduction & background, Advanced actuators, Pneumatic actuators, Industrial Robot, different parts of a Robot-Controller, Drive, Arm, End Effectors, Sensor & Functional requirements of robot. **10Hrs**

Unit - IV

Mechanical actuation systems: Mechanical systems, types of motion, Cams, Gear trains, Ratchet & Pawl, belt and chain drives, mechanical aspects of motor selection.

Electrical actuation systems: Electrical systems, Mechanical switches, Solenoids, Relays, DC/AC Motors, Principle of Stepper Motors &servomotors.

10 Hrs

Unit - V

Pneumatic and hydraulic actuation systems: Actuating systems, Pneumatic and hydraulic systems, Classifications of Valves, Pressure relief valves,

Pressure regulating/reducing valves, Cylinders and rotary actuators **DCV & FCV:** Principle & construction details, types of sliding spool valve, solenoid operated, Symbols of hydraulic elements, components of hydraulic system, functions of various units of hydraulic system. Design of simple hydraulic circuits for various applications. **12Hrs**

Reference Books:

1) W.Bolton, Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education 1st Edition, 2005.
2) Nitaigour Premchand Mahalik, Mechatronics-Principles, Concepts and Applications, Tata McGraw Hill, 1st Edition, 2003.
3) Mechatronics by HMT Ltd. – Tata McGraw Hill, 1st Edition, 2000.
4) Anthony Esposito, “Fluid Power”, Pearson Education, 6th Edition, 2011.

22UMEE525	Robotics and Automation	(4-0-0) 4

Contact Hours: 52

Course Objectives (CLO's): The objectives of this course are to make the student to learn:

1. Gain knowledge of Robotics and automation.
2. Understand the working methodology of robotics and automation.

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 different types and components of automation system and Robot.	-	1,2	-
CO-2	Explain different fundamental concepts of Robot and controllers used.	-	1,2	-
CO-3	Discuss various end effectors and working principles of sensors used in Robots.	-	1,2	-
CO-4	Explain different programming principles and methods used in Robots.	-	1,2	-
CO-5	Explain different material handling and identification technologies	-	1,2	-

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

Prerequisites: Nil

Course Contents:

Unit – I

Industrial Automation: Definition, Types of automation, List basic Devices in Automated Systems, Distinguish Different Controllers Employed In Automated Systems. Identify Safety in Industrial Automation Basic Concepts: Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov's laws of robotics

10 Hrs

Unit – II

Fundamentals of Robotics: robot anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, Introduction to Manipulator kinematics, Robot Dynamics. Basic control systems and components: Basic control systems concepts and models, Controllers, control system analysis, **10 Hrs**

Unit – III

Robot End Effector: Types of End effectors, Mechanical Grippers, Other types of Grippers, Tools and End effector, The Robot/End effector interface Consideration in Gripper selecting and Design. Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics. **10 Hrs**

Unit – IV

Robot Programming: Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods. **10 Hrs**

Unit – V

Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification **12 Hrs**

Reference Books :

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, “Industrial Robotics: Technology, Programming and Applications”, 2 nd Edition, Tata McGraw Hill, 2012.

2. Roland Siegwart, Illah R. Nourbakhsh, an d Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, 2 nd Edition, PHI, 2011 Web links and Video Lectures (e-Resources): • NPTEL course on Industrial Robotics • Videos on Industrial Automation Annexure-II 3

22UMEE526	Power Plant Engineering	(4-0-0) 4

Contact Hours: 52

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. **10 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.

10 Hrs

Unit - III

Thermal analysis of heat exchanger equipment in power plant: Boiler condenser, super-heater, economizer, cooling tower calculations. Numerical problems. **10 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. **10 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. **12Hrs**

Text Book:

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.

Reference Books:

1) M MEL. Wakil, “Power Plant Technology”, McGraw Hill Book-Coy. New York, 2010.
2) R. K. Rajput, “A textbook of Power Plant Engineering”, 4th Laxmi publications (p) Ltd., New Delhi, 2010.

VI Semester

22UMEC600	Heat Transfer	(4-0-0) 4

Contact Hours: 52

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

1. Principles of heat transfer.
2. Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate system.
3. Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface.
4. Radiation heat transfer mechanism .

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	Solve steady state heat transfer problems in conduction.	-	1,2	-
CO-2	Determine heat transfer and temperature profiles in transient system	-	1,2	-
CO-3	solve convection heat transfer problems using correlations	-	1,2	-
CO-4	Explain the mechanisms of boiling and condensation. And determine performance of extended surfaces	-	1,2	-
CO-5	Evaluate radiation and Heat exchanger related problems	-	1,2	-

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

Prerequisites: Nil

Course Contents:

Unit - I

Introductory Concepts :Modes of heat transfer, basic laws governing conduction, convection and radiation heat transfer, Thermal conductivity, convective heat transfer coefficient, Stefan-Boltzmann constant, Combined heat transfer mechanism.

General one-dimensional heat conduction equation: Derivation of general one-dimensional heat conduction equation in Cartesian, Cylindrical and Spherical coordinate systems.

One dimensional Steady state heat conduction without internal heat generation: Derivation of temperature distribution and heat transfer in slab, cylinder and sphere. Solution of problems.

One dimensional Steady state heat conduction with internal heat generation: no derivation, discussion on one-dimensional equations for temperature distribution and heat transfer with internal heat generation and solution of problems.

10Hrs

Unit - II

Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation.

One dimensional Transient conduction: Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; concept of semi-infinite solids.

10Hrs

Unit - III

Concepts and Basic Relations in Boundary layers: Flow over a flat plate -Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient.

Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere.

Free or Natural Convection: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal cylinder/plate. **11Hrs**

Unit - IV

Boiling and Condensation; Film, dropwise condensation theory, Pool boiling regimes

Extended surfaces: Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness. **10Hrs**

Unit - V

Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers.

Radiation Heat transfer: Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; **11Hrs**

Reference Books:

1) MN. Ozisik, “Heat Transfer A basic approach”, McGraw Hill International, 1988.
2) R. C. Sachdeva, “Fundamentals of Engineering Heat and Mass transfer”, Wieley Eastern Ltd., 1995.
3) Incropera, DeWitt,Bergmann, Lavine “Fundamentals of Heat and Mass Transfer” Sixthe edition, 2011 (reprint), Wiley India Pvt. Ltd.,
4) Yunus A Cengel, “Heat Transfer A Practical approach”, TATA McGraw Hill 2002
5) Mahesh M. Rathore, “Engineering Heat and Mass transfer”, Laxmi Publications, 2nd edition, 2006.
6) Heat Transfer data handbook by C P Kothandaraman, S Subramanyan,8th edition, New Age International Publisher Delhi.

22UMEC601	Finite Element Methods	(4-0-0) 4

Contact Hours: 52

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

1. Numerical methods used to solve engineering problems.
2. Skills associated with the principles of FEM.
3. Skills in applying the basic matrix operation to form a global matrix equation and enforce the concept of steps in obtaining solutions for a truss Structures.
4. Interpolation functions to solve beam problems.
5. Skills in applying FEM solution to structural and thermal 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	Solve problems on matrix algebra and numerical integration.	-	1,2	-
CO-2	Explain basic concepts of theory of elasticity and FEM.	1,2	-	-
CO-3	Solve basic problems in solid mechanics using variational and other principles	1,2	-	-
CO-4	Develop finite element formulation for 1D bars and trusses.	1,2	-	3
CO-5	Develop finite element formulation for higher order elements and 1D heat transfer problems.	-	1,2	3

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction: Need for use of FEM, Advantages, disadvantages and applications of FEM; Matrix Algebra - (Terminology and operations), Gaussian elimination method. **9 Hrs**

Unit – II

Numerical Integration- Gauss quadrature, one point and two point formula, 1D and 2D integrals.

Basics of Theory of Elasticity: Definitions of stress and strain, strain-displacement relations, stress-strain relations in 2D Cartesian and polar co-ordinates. **9 Hrs**

Unit - III

Continuum methods: Principal of minimum potential energy; Rayleigh – Ritz method applied to simple problems on axially loaded members, cantilever and simply supported beam; Galerkin method and its application to simple axially loaded problems. **10 Hrs**

Unit - IV

Finite Element Method: Direct approach to discrete systems (Derivation of stiffness matrix by direct method for 2 node bar& 2D truss), transformation law, Displacement method; Different co-ordinate systems, Shape functions, Formulation of 2 node bar element, stress recovery, Boundary conditions (Single point Constraints only), Elimination of handling boundary conditions. **11 Hrs**

Unit – V

Finite Element Method (Continued): Direct approach to discrete systems Derivation of stiffness matrix by direct method for beam element, shape functions and determining [B] for CST element.

One-dimension steady state heat conduction: formulation of 2 node, 1-D element, using Galerkin method. **12 Hrs**

Reference Books:

1) Rao S.S., “The finite Element Method in Engineering”, 5th edition, Butterworth-Heinemann, 2013.
2) T. R. Chandrupatla and A. D. Belegundu, “Introduction to finite Elements in Engineering”, 2nd edition, Prentice Hall of India, New Delhi, 2001.
3) R. D. Cook et al, “Concepts and Applications of Finite Element Analysis” 4th edition, Joln Wiley & Sons, inc, 2005.

22UMEC602 Fluid Power 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. Types of Hydraulic power actuators, motors and concepts of circuit design.
2. Maintenance of fluid power systems.
3. Various actuators, valves, control signal processing elements and multi cylinder 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	Explain the construction and working of various positive displacement pumps and hydraulic principles.	-	1, 2	-
CO-2	Discuss different types of actuators and their performance parameters.	-	1, 2	-
CO-3	Explain various control components used in fluid power systems.	-	1,2	-
CO-4	Design hydraulic circuitsfor mechanical applications and explain basic elements of Pneumatics	1	2,3	-
CO-5	Discuss working principles of pneumatic & electro pneumatic components and design application circuits.	1	2,3	-

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction to Fluid Power: Hydraulic system Components, Pneumatics system components, advantages, applications in the field of M/c tools, material handling, hydraulic presses, mobile & stationary machines, Pascal's Law and its application, Problems on Pascal's Law, Types of Hydraulic fluid petroleum based, synthetic & water based. Properties of fluids. Selection of fluids.

The Source of Hydraulic power: Pumping theory, Classification, Principle of working and constructional details of Gear Pump, Vane Pump, Axial and Radial Piston Pumps, Variable displacement Pumps, Power and Efficiency calculations, Pump Selection for hydraulic power transmission.

8Hrs

Unit – II

Hydraulic Actuators and Motors: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors)

7Hrs

Unit - III

Control Components in fluid power:

Pressure Control Valves: Necessity of pressure control directional control, flow control valves, Principle of pressure control valves, direct operated, pilot operated, relief valves pressure reducing valve, sequence valve & methods of actuation of valves.

Flow Control Valves: Principle of operation, pressure compensated, temp. Compensated flow control valves,

Direction Control Valves: Check valves, types of D.C. Valves :Two way two position, four way three position, four way two position valves, open center, close center tandem center valves, method of actuation of valves, manually operated solenoid operated, pilot operated etc.

7Hrs

Unit - IV

Hydraulic Circuit Design and Analysis:

ISO Symbols used for elements FPC system,Control of Single and Double - Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Hydraulic circuit for force multiplication, Speed Control of Hydraulic Cylinder, Speed

Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction, and applications with circuits.

Basic Pneumatics: Physical properties in pneumatics, advantages and disadvantages of pneumatics, DC valves, linear and rotary actuators, flow control valves, pneumatic symbols, time delay valve, pressure sequence valve, quick exhaust valve, AND Valves, OR valves, NOT Valves.

9Hrs

Unit – V

Basic Pneumatic control : Control element description, Symbols, Impulse operation, Speed control, sequencing of motion, vacuum handling, basic pneumatic application examples.

Electro pneumatics: Introduction to electro pneumatics, actuating magnets, construction of electromagnet, contactors and switches, relays, limit switch, electro pneumatic circuits, single acting and double acting cylinder control examples, Electro Pneumatics application examples.

8Hrs

Reference Books:

1) Anthony Esposito, “Fluid Power with applications”, 7th edition, PHI, 2009.
2) S. R. Majumdar, “Pneumatic systems”, Tata McGraw Hill New Delhi, 2010.
3) F. Don Norvelle “Fluid Power Technology”, West Publishing Company, Minneapolis, 1995.
4) S. R. Majumdar, “Oil hydraulic systems”, PHI, 2010.

22UMEL603 Thermal Engineering Lab - III (0-0-2) 1

Contact Hours: 26

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

1. Basic principles of heat transfer.
2. Theoretical aspects of heat transfer and physical approaches and measuring parameters significance.
3. Importance of effectiveness of heat exchangers.
4. Validation of natural convection and forced convection with theoretical values of heat transfer coefficients.
5. Working and performance of vapor compression refrigeration and air-conditioning.

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	Determine performance parameters for different modes of heat transfer.	-	1, 2	4, 9
CO-2	Calculate the efficiency of different types of fins.	-	1, 2	4, 9
CO-3	Evaluate heat transfer coefficient related to film & drop wise condensation.	-	1, 2	3, 9
CO-4	Evaluate time and temperature relation for lumped system.	-	1	3, 9
CO-5	Conduct performance test on, VCR, heat exchangers and Air conditioning.	-	1, 2	3

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

Prerequisites: Nil

Course Contents :

1. Determine the thermal conductivity of composite wall.
2. Determine the thermal conductivity of lagged pipe.
3. Determine the thermal conductivity of insulating powder in sphere.
4. Determination of (natural) convection heat transfer coefficient for air.
5. Determination of (forced) convection heat transfer coefficient for air.
6. Pin-fin (Natural convection).
7. Pin-fin (Forced convection).
8. Determine the critical Heat flux of a wire.
9. Heat exchanger Parallel flow and counter flow.
10. Determination of the Stefan Boltzmann's constant.
11. Boiling and condensation.
12. Transient heat transfer.
13. VCR (Vapor compression refrigeration) & AC-test rig.

References:

1) M N. Ozisik. Heat Transfer A basic approach. McGraw Hill International, 1988.
2) Incropera, DeWitt, Bergmann, Lavine. Fundamentals of Heat and Mass Transfer. 6th edition, 2011 (reprint), Wiley India Pvt. Ltd.,
3) Yunus A Cengel. Heat Transfer - A Practical approach. TATA McGraw Hill 2002
4) Heat Transfer data hand book by C P Kothandaraman, S Subramanyan, 8th edition, New Age International Publisher Delhi.

22UMEL604 Computer Aided Engineering Analysis 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. Simulation tools.
2. Computer Aided Engineering (CAE)
3. CAM simulation

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	Use FEA tool to solve loaded bars and trusses.	-	-	3, 4
CO-2	Analyze the behavior of beams under different loading patterns.	5	-	4
CO-3	Validate stresses in 2D structural and thermal problems.	5	-	3,4
CO-4	Determine the natural frequency of bars and beams.	-	5	3, 4
CO-5	Use CAM simulation packages for tool path generation.	-	-	5

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

Prerequisites: Nil

Course Contents:

PART - A

Study of a FEA package and modeling stress analysis of

1. Bars of constant cross section area, tapered cross section area and stepped bar
2. Trusses – (Minimum 2 exercises)

3. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 4 exercises)

PART - B

1. Stress analysis of a rectangular plate with a circular hole
2. Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 2 exercises)
3. Dynamic Analysis
    1) Fixed – fixed beam for natural frequency determination
    2) Bar subjected to forcing function
    3) Fixed – fixed beam subjected to forcing function
4. Tool path generation for milling operation using CAM software package. (2-Exercises)

Reference Books:

1) Anand V Kulkarni & Venkatesh K. Havanur, “A Primer on Finite Element Analysis”, Laxmi Publications (University Science Press) New Delhi, 2011.
2) Dr. S.M.Musa, A.V.Kulkarni and V.K.Havanur, “Finite Element Analysis”, A Primer by Mercury Learning Information, U.S.A., 2013.

22UMEL605	Minor Project - II	(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 & solve a problem using basic engineering principles.	1,2	4	12
CO-2	Design the machine parts, components of a system that meets particular requirement.	3	7	6,12
CO-3	Use the software tools to prepare & 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 in time completion of projects.	10	8,11,12	-
CO-6	Prepare a report and PPT based on the project work.	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

Minor Project II : It is either a continuation of Mini-Project-I or a new project. The students are expected to identify the state-of-the-art technology in his/her domain of interest by an extensive literature survey and select a topic from an emerging area relevant to their branch/interdisciplinary and define the problem for the project work. The problem could be defined to develop prototypes for industrial needs. A team consisting of not more than 2-4 students shall be guided by a faculty member. This project work is to supplement and prepare the students to take up major project work at higher semesters. A committee constituted by HOD consisting of minimum 2 faculty members shall evaluate for CIE with suitable rubrics. The weightage of marks shall be 50% for the committee and 50% for the guide. There is a SEE (viva voce) examination which shall be examined by two internal examiners recommended by the HoD.

22USSK606	Soft Skills - II	(0-0-2) 1

Contact Hours: 26

Course Learning Objectives (CLOs):

This is included with the objectives of improving the communication skills, proficiency in English language and aptitude ability of the student to enhance the employability.

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 significance of communication in the profession.	-	10	-
CO-2	Use the English language with proficiency	-	10	12
CO-3	Solve Aptitude related problems	-	9	12
CO-4	Demonstrate the competency in the placement activities.	-	9	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	-	-	-	-	-	-	-	-	2.0	2.0	-	1.0	-	-

Prerequisites: Nil

Vocabulary ▪ Formatting and feeding correct structures ▪ Synonyms and Antonyms ▪ Analogies ▪ Sentence Completion ▪ Error Detection and Correction ▪ Faster reading of Passages ▪ Essays ▪ Carryover plan - Dictionary Usage

10Hrs

Understanding Discussions ▪ Parameters measured in GDs ▪ Video Analysis of GDs ▪ Knowledge base and Ideas ▪ Taking the initiative ▪ Introduction and Conclusion **4Hrs**

Most common personal interview questions ▪ What companies expect ▪ Showing Commitment and Learning Ability ▪ Handling difficult questions ▪ Understanding interviewer psychology ▪ Situation Reaction and Presence of Mind ▪ Dressing right ▪ Interview etiquette. **10 Hrs**

Evaluation:

Both the internal and external resource persons shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component. There shall be one test conducted at the end for 25 marks in Aptitude testing and there shall be one presentation by the student for 25 marks or any other suitable testing components. The arrangement for CIE evaluation is to be done by the department and maintain the relevant documents.

22UPYK607 Physical Education and Yoga (0-0-2) Audit

Contact Hours: 26

Course Learning Objectives:

1. The course focuses on overall development and importance of Physical Education & Yoga in day to day life.

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)**
CO1	Gaining the importance of Physical Education & yoga	12	--	8, 9
CO2	Understanding the benefits & preventive measures of health	12	6	8, 9
CO3	Gaining the knowledge of yoga	12	--	8, 9
CO4	Understanding the importance of Human Body conditioning & Sports training	12	--	8, 9
CO5	Get awareness of Modern technology in sports	12	--	5, 8, 9

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

Contents

Unit-I

Introduction to Physical Education: Meaning and importance, definition, components, benefits of physical education. **4Hrs**

Unit-II

Health and wellness, Anatomy and Physiology: Meaning and importance, definition, components, benefits, health habits, basics of diseases and preventive measures, mental health, physical health, social health, spiritual health, Meaning and definition, first aid, injuries and preventions. **5Hrs**

Unit-III

Introduction of Yoga: Origin and history of Yoga, meaning and definition, benefits, importance prayer Suryanamaskara,

Asana:- Padahastasana, Ardha matsyendrasana, Halasana, Navasana.

Pranayama:- Sitali Pranayama & Nadishodhana Pranayama

Mudras:- Prana mudra & Adhi mudra. **6Hrs**

Unit-IV

Sports Training: Meaning and definitions, warming up, cooldown, methods of exercises, stretching, speed, endurance, flexibility, agility, Athletics, Football, Badmintion, Chess, Teakwondo, Rules and regulation of all games. **6 Hrs**

Unit-V

Modern technology in sports and games: Meaning and definitions, objectives, assisting umpires/ referees, hawk-eye technology, sports specific, computer software, technology in playfields, athletes clothing and equipment, graphics of sports and games, artificial intelligence. **5Hrs**

Reference Books:

1) Petipus, et al., Athlete's Guide to Career Planning, Human Kinetics, 1997
2) The Human Body in Health and Disease with Access 8th Edition 2023.
3) Anatomy and Physiology, Shri K.G. Nadgir College of Physical Education. Dharwad.
4) Health & Wellness Shri K.G. Nadgir College of Physical Education. Dharwad.
5) Nagendra HR., The art and science of Pranayama, 2009
6) Iyengar BKS., The illustrated Light on Yoga(English), 2005

22UMEE621	Design of Mechanical Elements	(2-2-0) 3

Contact Hours: 39

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

1. Different types of engineering materials used in power transmission elements.
2. Concepts of designing various machine elements and also power transmission elements
3. Use of design data handbook and BIS standards.
4. Design commonly used power transmission elements such as gears, belts, chains and bearings.

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 helical coil and leaf springs subjected to various conditions of static and fatigue loading.	1,3,	-	10
CO-2	Solve problems on design of curved beams of different cross sections.	1,3	-	10
CO-3	Design spur, helical, bevel and worm gears used for power transmission.	2,3	12	-
CO-4	Design and select various power transmitting machine elements.	2,3	12	-
CO-5	Design and choose suitable bearing based on various loading conditions.	1,3	9,12	10

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

Prerequisites: Strength of materials.

Course Contents:

Unit - I

Design of springs: Types, classification, terminology, expression for load and deflection for helical springs of round wire section (with derivations). Design of helical springs for static load & for variable loads, leaf springs (no derivation) – expression for stress & deflection concept of uniform stressed beams leaf springs pre stressed springs – problems.

Curved beams: Comparison between straight and curved beams, problems in crane hook and C-clamp (No derivations) – expression for stress.

7 Hrs

Unit - II

Gears: Classification, Force analysis for spur gears basic Lewis equation, (Derivation) concept of weaker gear. Dynamic load, Wear load & Endurance load concepts – problems.

Helical gears: Terminology formative number of teeth, Design of Helical gears Problems. **8Hrs**

Unit - III

Bevel gears: Terminology – Final design equations (No derivation) problems.

Worm gears: Terminology Strength equations, Heat dissipation considerations Efficiency, design problems **8 Hrs**

Unit - IV

Belt & Chain drives: Flat belt: problems – (no derivations) calculations of width & thickness with centrifugal tension. V-Belt: Selection of V – belt. Chain drives: Selection of chains – Power transmitting chains**.**

Clutch drives: Concept of uniform pressure & wear – determination of Torque & Power for single & multi-plate clutches – Cone clutches (no derivation) – problems. **8 Hrs**

Unit - V

Brakes: Band brake for different configurations –Shoe brake- problems.

Bearings: Journal bearings - Mechanism of Hydrodynamic Lubrication – Heat generated & Heat dissipated, Sommerfeld number, bearing modulus – problems.

Ball bearings: Classification – concept of equivalent load, life determination, problems.

Power Screw: Screw jack design & drawing with GD&T.

Design optimization: Concept and methods of optimization of machine elements, case studies.

8 Hrs

Text Book:

1) Robert L. Norton, “Machine Design an integrated approach”, 2nd edition, Pearson Education Asia University Press, 2013.

Reference Books:

1) V. B. Bhandari. “Machine design”, 2nd Edition, TATA McGraw Hill Education, 2007.
2) Joseph Edward Shigley, “Machine Design”, 6th Edition, TMH, 2006.
3) Black and Adams, “Machine Design”, McGraw Hill, 1968.
4) Malleev and Hartman, “Machine Design”, CBS Publishers, 1983.

Design Data Hand Book:

1) K. Mahadevan & Balaveera Reddy, “Design Data Hand Book”, CBS Publication, 2014.

22UMEE622	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

22UMEE623	Introduction to MATLAB	(3-0-0) 3

Contact Hours: 39

Course Learning objectives:

1. To know about fundamentals of MATLAB tool.
2. To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.
3. To understand the concept and importance of Fourier transforms.
4. To gain knowledge about MATLAB Simulink & solve Electrical engineering 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	Implement loops, branching, control instruction and functions in MATLAB programming environment	-	1,2	3
CO-2	Program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems	-	1,2	3,5
CO-3	Explain implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB	-	1,2	-
CO-4	Simulate MATLAB Simulink examples	-	1,2	3

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

Pre-requisites: Nil

Course Contents:

Unit - I

Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control.

Working with files: Scripts and functions, plotting and programming output, examples. **8Hrs**

Unit - II

Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.

Numerical Integration and Differentiation: Trapezoidal method, Simpson method. **8Hrs**

Unit - III

Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss Siedal and Newton-Raphson method. **8Hrs**

Unit - IV

6 Ordinary Differential Equations: Introduction to ODE's, Euler's method, second order Runga Kutta method, MATLAB ode45 algorithm in single variable and multivariable.

Transforms: Discrete Fourier Transforms, **7Hrs**

Unit - V

Demonstration Experiments

7 Application of MATLAB to analyze problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits.

8 MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems **8Hrs**

Reference Books:

1. Agam Kumar Tyagi, "MATLAB and Simulink for Engineers", OXFORD Higher Education.
2. Dr. Shailendra Jain, "Modeling& Simulation using MATLAB – Simulink", Wiley – India.

22UMEE624 Heating Ventilation and Air Conditioning (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. **8 Hrs**

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 **8 Hrs**

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. New Age 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.

22UMEE625 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, 2010
2) Acharya and Narang. Estimation and costing. 2010
3) Banga and Sharma. Industrial Organization and Engineering Economics. 2011
4) Malhotra. Mechanical Estimation. 2010

22UMEE631	Advanced Automobile Design	(3-0-0) 3

Contact Hours: 39

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

1. Concepts of Computer Aided Engineering (CAE) in automotive industry overview.
2. Various stages in CAE.
3. Modal analysis.
4. Safety considerations in automobiles.

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 requirements, PLM and importance of BIW parts	1	-	-
CO-2	Investigate Design process of BIW and TRIMS parts and the study of different materials and grades	-	2	-
CO-3	Identify Trim materials and its applications Understand various methods involved in Manufacturing of plastic trims	1	-	-
CO-4	Analyze the Design Failure Mode and Effect Analysis (DFMEA) methodology and verification of process	3	4,5,6	2
CO-5	Analyze Noise Vibration and Harshness (NVH) using CAE tool and its importance	3	4,5,6	-
CO-6	Identify different methods of test validation and Assessment of Vehicles	-	-	2

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	3	1.7	3	2	2	2	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents:

Unit – I

Requirement Specification in the Pre-Program Stage: Introduction to pre-program stages like voice of customer, competitor insight, innovation, Project and quality planning, legislation, system strategy.

Product life cycle and important gateways for Body in White (BIW): Definition of PLM. Product life cycle: Design milestones, Types of builds, Launch of Vehicle. Flow chart of

Product life cycle Management (PLM), Design gateways: Design phases like virtual build, Prototype build, Mass
Production. Launch of Vehicle

Introduction to BIW. Identification of commodities for BIW: Closures, Body Shell. BIW terminology. BIW Assembly, future trends in BIW, Case studies. Definition of PLM.

Practical sessions:
Session 1: Exercise to obtain the outer surface Computer Aided Styling (CAS) of a bonnet based on car style.
Session 2: Writing the Requirement Specification of car bonnet (idea is to provide this as input to source a supplier)
Session 3: Basic introduction to CAD & suitable software (Siemens NX, Catia) **7 Hrs**

Unit - II

Design concepts and considerations in BIW: BIW parts: Sheet metal, Extrusion, Cast, Moulding. Factors driving BIW Design like Package Space, Master Sections, Cost, Weight, Assembly Process, Manufacturing Methods, Vehicle regulations. Design considerations for Sheet Metal Parts for Manufacture, Assembly and Part location on a vehicle.

BIW Materials and Grades: (Steel, Aluminium, composites): Evolution of automobile to modern Design. Basic material selection criteria for automotive: Emissions, Safety and weight, Material Choice, which is driven by Cost, Safety, Risk, Weight, Market Image, Emission. Classification of steel grade and their properties.Use of aluminium in automotive domain and its properties.Use of Composites in automotive domain and its properties. Light

weight material for future automotive industry. Applications of Composite used in automotive domain.

Practical sessions:
Session 1: CAD design of a bonnet – 1
Session 2: CAD design of a bonnet - 2
Session 3: Application of CAE simulation on bonnet CAD (air flow, water flow, etc.) **7 Hrs**

Unit – III

Geometric Dimensioning & Tolerancing (GD & T) for BIW: Concept of GD & T, Importance of GD&T. International standards for GD&T like BS, ASME, ISO. Role of GD & T on drawing, BIW Dimensional Requirement. BIW Dimensional applications. GD&T Symbols. 3-2-1 Principle. Types of locators. Principles of location. Illustration of Feature Control Frame.
GD & T - Simulation of Datums for inspections BIW Examples and case studies.

Identification of commodities: Introduction to trim, Necessity of trim in automobile, Identification of various trim parts and their positions in vehicle. Various commodities of interior trim like Instrument panel, Centre console, Door trims, Pillar Trims, Seating Trims, Overhead Trims, Floor Carpets & Trunk trims.

Sheet Metal Joining Process: Importance. Welding, Resistant Spot welding (RSW), Advantages and Disadvantages. Concept of Tailor Welded Blanks (TWB), Types of TWB. Laser Beam Welding (LBW), Types, Advantages and Disadvantages. Self Piercing Rivets (SPR) and its advantages. Adhesive Bonding: Types, Types of joints used in it. Conventional Bonding Techniques like bolting and riveting. Classification of Metal joining process.

Practical sessions:
Session 1: Application of CAE simulation on bonnet CAD (strength & stiffness, debt resistance)
Session 2: Fixture design.
Session 3: Assembly & disassembly considerations for components (after sales, service) **7 Hrs**

Unit - IV

Trim Materials in Automotive: Material Classification and Properties, Plastic Material and their applications: Polypropylene, Acrylonitrile Butadiene Styrene (ABS), Polycarbonate, Poly-oxy-methylene, Polyethylene, Polyamides, Usage and Selection Criteria, Plastic Additives: Types of additives, Impact of additives, Application in instrument Panel Assembly.

Design of Plastic part: Overview, Wall thickness, Radii, Draft angle, Ribs, Bosses, Snaps.

Design verification: CAE methods and Gateway supports: Automotive interior trim, Automotive exterior trim, CAE Load cases for Interior Trims: Interior Head impact analysis, Airbag deployment, Side occupant protection, Interior trims durability, Mould flow analysis. Gateway support.

Practical sessions:

Session 1: Design for manufacture of plastic parts (mould flow, draft angle etc.)

Session 2: Bench marking a bonnet by studying competitor data (2 or 3 examples) **10 Hrs**

Unit - V

DFMEA (Design Failure Mode and Effect Analysis): Concept, Objectives of

DFMEA. Overview of DFMEA process, Benefits of DFMEA, Prerequisites of DFMEA, DFMEA Flow, DFMEA team, DFMEA inputs & Outputs, DFMEA Methodology, Logical relationship between DFMEA. DFMEA S/O/D/ rating**.**

Introduction to Design Verification. Concept of Design Verification. Process of verifying Design. Commonly used verification methods like Demonstration, Inspection, analysis, Similarity, Testing. Preparation of verification activities. Conducting verification activities. Gateway support for Design verification.

CAE methods for Design verification of BIW viz. Structural Analysis, Fatigue life Prediction, Noise and vibration, Crash Impact analysis, Multibody Dynamics, Thermal analysis, CFD. Verification and Validation with respect to FEA.

CAE Analysis: NVH, Crash & Durability: Concept of CAE & FEA. NVH Analysis, Load cases for NVH analysis: Static Bending stiffness, Static torsion stiffness, Natural frequency and normal modes, Crashworthiness, Crash Analysis: Full vehicle level: Frontal, Side and rear Impact, Component Level: Seating and roof crush., Durability analysis: Various load cases like Front and Rear Recovery analysis, Trailed towing analysis, Luggage

retention hook analysis, Floor pan fatigue, Roof and Body side oil canning, Vehicle jacking analysis, Vehicle hoisting analysis, Fatigue analysis of BIW.

Design of Plastic part: Overview, Wall thickness, Radii, Draft angle, Ribs, Bosses, Snaps,

Design verification: CAE methods and Gateway supports: Automotive interior trim, Automotive exterior trim, CAE Load cases for Interior Trims: Interior Head impact analysis, Airbag deployment, Side occupant protection, Interior trims durability, Mould flow analysis. Gateway support.

Manufacturing Processes: Vacuum Forming, Injection Moulding, Heat Staking, Extrusion Blow moulding along with their applications characteristics and limitations.

Test Validation & Assessment: Vehicle physical testing, Crash test requirements, Frontal Crash test, Rear and side impact testing, Pedestrian head impact test and roll over. Four post durability tests. Wind tunnel testing

Manufacturing - Sequence (after validation): Welding, Assembly sequence Body shop, Paint Shop, Trim- chassis, Final assembly.

Future Trends in BIW: Energy Storing Body Panels, light Weight Vehicle Technology, Latest Joining Technologies Used in BIW

Practical sessions:
Session 1: Example DFMEA practical 1 - how to analyze risk & define counter measures.
Session 2: Example DFMEA practical's 2 - how to analyze risk & define counter measures. **8 Hrs**

Reference Books:

1) Morello, L., Rosti Rossini, L., Pia, G., & Tonoli, A. (2010). The Automotive Body: Volume I: Components Design (Mechanical Engineering Series). Retrieved from http://www.springer.com/1161---A2
2) Huang, M. (2002). Vehicle crash mechanics. CRC Press.-A2
3) Boljanovic, V. (2004). SHEET METAL FORMING PROCESSES AND DIE DESIGN. A1 and A2
4) Morello, L., Rosti Rossini, L., Pia, G., & Tonoli, A. (2010). The Automotive Body: Volume II: System Design (Mechanical Engineering Series). Retrieved from http://www.springer.com/1161-A2

5) Weber, J. (2009). Automotive development processes: Processes for successful customer oriented vehicle development. Automotive Development Processes: Processes for Successful Customer Oriented Vehicle Development. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-01253-2--A2
6) An Introduction to Modern Vehicle Design. Edited by Julian Happian-Smith,© Reed Educational and Professional Publishing Ltd 2002—A2
7) Automotive Product Development. A Systems Engineering Implementation, by Vivek D. Bhise,© 2017 by Taylor & Francis Group, LLC CRC Press is an imprint of Taylor & Francis Group, an Informa business.—A2
8) Design and Manufacture of Plastic Components for Multifunctionality. (2016). In Design and Manufacture of Plastic Components for Multifunctionality. https://doi.org/10.1016/c2014-0-00223-7-A2
9) Effective FMEAs: Achieving Safe, Reliable, and Economical Products and Processes using Failure Mode and Effects Analysis, Carlson, June 2012.

22UMEE632 Tool Design Engineering (3-0-0) 3

Contact Hours: 39

Course Objectives: The objectives of this course are to make the student to learn:

1. Tools for sheet metal component manufacturing and plastic components manufacturing
2. Methods of locating and clamping work pieces while machining
3. Design of Jigs & Fixtures
4. Design of press tools for sheet metal parts manufacturing
5. Design of moulds for plastic parts manufacturing

Course outcomes (Cos): At the end of the course Students will be able to

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 principle of various press tools / related terms with relevant sketches.	1	-	-
CO-2	Illustrate the method of locating and clamping of work pieces.	-	1	-
CO-3	Draw the strip lay out as related to press tools.	-	1	-
CO-4	Design press tools, jigs, fixtures, and moulds with sketches and drawings.	1	3	2
CO-5	Calculate the design parameters for press tools.	1	-	-

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction to tool design: Tooling, requirements of a tool designer, General tool design procedure, Drafting and Design techniques, Tool Making practice,

Locating and clamping methods: Introduction, Basic principles of location, Locating methods and Locator pins/plugs, Basic principles of clamping,

Types of clamps. **7Hrs**

Unit - II

Design of drill Jigs: Introduction, Need and advantages of jig, Types of drill jigs- Latch/leaf jig, Plate jig, Channel jig, Box jig, Tumble jig, Post jig, Indexing jig, Drill bush &types, Design of drill jig for the given component.

7 Hrs

Unit - III

Design of Fixtures: Introduction, Need and advantages of fixtures, Types of fixtures- Vise fixture, Milling fixture, Lathe fixture, Boring fixture, Broaching fixture, Grinding fixture. **7 Hrs**

Unit - IV

Design of sheet metal Blanking and Piercing Dies: Introduction, Die cutting operations, Power presses, press terminology, Cutting action in punch and die operation, Die clearance, Cutting force and Press force calculation, Types of Press tools- Progressive, Compound, Combination, Inverted dies, Die design fundamentals, Blanking and Piercing die design construction, Strip layout, Economy factor, Design exercises on blanking and piercing dies for simple components. **9Hrs**

Unit – V

Design of Bending and Drawing Dies: Introduction, Bend allowance-formula, Spring back, Methods to overcome spring back, Blank length calculation, Bend force calculation, Principle of V bending- Air bending and bottoming out, Edge bending, U- bending, Drawing Dies, Drawing operations, Metal flow, Variables affecting metal flow, Determination of blank size and drawing force, Single action and double action draw dies.

Introduction to Design of Moulds: Moulding process, Types of Plastics-Thermoplast and Thermoset resins, Classification of moulding- Injection moulding, Compression moulding, Details of Injection Moulding Tool (single cavity, two cavity mould). **9Hrs**

Assignments: To prepare designs on the following as Term Work sheets:

1) Jig Design **2)** Fixture Design **3)**Press Tool Design

Reference Books:

1) C. Donaldson, G.H.LeCain, V.C. Goold, “Tool design”, 3rd Edition, Tata McGraw Hill Pubication.1976.
2) M H A Kempster, “Introduction to Jig and Tool Design”, ELBS, 1974.
3) J.R. Paquin & R.E. Crowley, “Die Design Fundamentals”, Industrial Inc Press
4) R.G.W. Pye; “Injection Mould Design”, 3rd Edition, Godwin Books, 1983.

22UMEE633 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.

22UMEE634 Industry 4.0 & Artificial Intelligence (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 present a problem oriented in depth knowledge of Industry 4.0 & Artificial Intelligence
2. To address the underlying concepts, methods and application of Industry 4.0 & Artificial Intelligence

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	Develop real life IIoT applications using hardware and software.	1	2	-
CO-2	Explain various IIoT Layers and their relative importance.	-	1,2	-
CO-3	Realize the importance of Data Analytics in IIoT	-	1,2	-
CO-4	Identify appropriate representation & algorithm for an AI problem domain.	-	1,2	-
CO-5	Explain various learning techniques to solve AI problems.	-	1,2	-

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

Industry 4.0: Globalization, the Fourth Revolution, LEAN Production Systems Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis **8 Hrs**

Unit - II

IIoT-Introduction, Industrial IoT: Business Model and Referece Architerture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT NetworkingBig Data Analytics and Software Defined Networks, Machine Learning and Data Science.

8 Hrs

Unit - III

Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT.

Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries.

7Hrs

Unit - IV

Introduction to Artificial Intelligence: Applications- Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems. AI techniques- search knowledge, abstraction.

State space search; Production systems, search space control: depth-first, breadth-first search. Heuristic search - Hill climbing, best-first search, branch and bound. Problem Reduction, Constraint Satisfaction End, Means-End Analysis. **8Hrs**

Unit - V

Predicate Logic: unification, modus pones, resolution, dependency directed backtracking. Rule based Systems: forward reasoning, conflict resolution, backward reasoning, use of no backtracks. Structured Knowledge Representation: semantic net slots, exceptions and default frames, conceptual dependency, scripts.

Introduction to NLP: Basics of Syntactic Processing, Basics of Semantic Analysis, Basics of Parsing techniques, context free and transformational grammars, transition nets, augmented transition nets, Shanks Conceptual Dependency, Scripts ,Basics of grammar free analyzers, Basics of sentence generation, and Basics of translation. **8Hrs**

Reference Books:

1) Adastair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, 2017.
2) D. W. Patterson, “Introduction to AI and Expert Systems”, PHI, 1992.
3) Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat, “Industrial Internet of Things: Cyber manufacturing systems”, Springer, 2017.
4) E. Rich and K. Knight, “Artificial intelligence”, 2nd edition, McGraw Hill, 1992.
5) N.J. Nilsson, “Principles of AI”, Narosa Publ. House, 2000.
6) Robin R Murphy, “Introduction to AI Robotics”, PHI Publication, 2000
7) R. J. Schalkoff, “Artificial Intelligence - an Engineering Approach”, McGraw Hill Int. Ed., Singapore, 1992.
8) George Lugar, “AI-Structures and Strategies for and Strategies for Complex Problem solving”, 4th edition, Pearson Education, 2002.

22UMEE635	Refrigeration and Air-Conditioning	(3-0-0) 3

Contact Hours: 39

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

1. Vapour compression systems of single stage and multi stage and carnot Vapour compression cycle and effect of volumetric efficiency and pressure change and optimum inter mediate pressure, sub-cooling and super heating on COP.
2. Principles of Vapour absorption and water, air refrigeration.
3. Uses and properties of refrigerants also application of secondary refrigerants.
4. Principles of psychrometry and basic processes of air conditioning.
5. Cooling and heating load calculation for air-conditioning and refrigeration.
6. Applications of refrigeration.

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 basic concepts & various methods in refrigeration and air-conditioning.	1,2	-	-
CO-2	Compute performance parameters for single & multi stage VCR.	1,2	-	-
CO-3	Explain VAR system and air conditioning processes.	-	1,2	-
CO-4	Estimate heating and cooling loads for refrigeration and air conditioning systems.	1,2	-	3
CO-5	Discuss non-conventional refrigeration systems, refrigerants and its applications.	-	-	1,2

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction: Basic Definition of Refrigeration and Air-Conditioning, History of Refrigeration and Air-Conditioning, Necessity of Refrigeration and Air-Conditioning, Different methods of Refrigeration.

Air Refrigeration: Carnot refrigeration cycle, Brayton refrigeration cycle- Aircraft refrigeration system – necessity Classification- Basic aircraft refrigeration cycle- Boot strap air refrigeration system Regenerative air refrigeration system- reduced ambient air refrigeration system. **9 Hrs**

Unit - II

Single and Multi stage VCR: Vapour Compression Refrigeration Cycle Single stage systems - Effect of pressure changes on COP- Effect of sub-cooling and super heating- actual vapour compression cycle. Use of p-h chart, Refrigeration property tables. Two stage with given intermediate pressure- Effect of volumetric efficiency on multi staging- optimum inter stage pressure- Cascade refrigeration system- multi evaporator system- Booster system.

Water Refrigeration: Introduction- principle of operation - Centrifugal refrigeration- Steam jet refrigeration. **8 Hrs**

Unit - III

Vapour Absorption system: Simple and Improved Ammonia absorption systems- Maximum COP- Lithium Bromide absorption system- Electrolux system.

Psychrometry of Air Conditioning Processes: Mixing process- Basic processes in conditioning of air- Psychrometric process in Air conditioning equipment- Simple air conditioning system- State and mass rate of supply air- summer air conditioning – Apparatus dew point- winter air conditioning.

8 Hrs

Unit - IV

Cooling and Heat load Calculations: Selection of design temperatures- Sources of heat load- Capacity of Refrigeration system- Cooling load calculations- Heat transfer through structure- Solar radiation- Electrical appliances- Infiltration and Ventilation- Heat generation inside the conditioned space- Air conditioning and cooling loads and apparatus selection- Heating load calculations. **7 Hrs**

Unit - V

Nonconventional Refrigeration Systems, Refrigerants and Applications: Basic principle of operation, Thermodynamic analysis, advantages and disadvantages of Vortex tube, Pulse tube and Thermoelectric refrigeration system;

Refrigerants: Introduction, Classification- Nomenclature- Desirable properties- Common refrigerants and Secondary refrigerants. **Applications:**

All the year–round air conditioner, Air conditioning in Transport: Air conditioning systems for automobiles, Air conditioning systems for trains, Comfort Air Conditioning: Residential air conditioning, Commercial air conditioning; Industrial air conditioning and Refrigeration: Chemical and process industries, Dairy plants and Petroleum refineries, Food processing plants.

7 Hrs

Reference Books:

1) Manohar Prasad, ‘‘Refrigeration and Air-conditioning’’, 2nd edition, Wiley Eastern Publication, 2010
2) C. P. Arora, ‘‘Refrigeration and Air-conditioning’’, 2nd Edition, Tata McGraw Hill Publication, 2000.
3) L. N. Mishra - Vani, ‘’Refrigeration and Air-conditioning’’, Educational Books, New Delhi- 1985.
4) Jordon and Priester, ‘’Refrigeration and Air conditioning’’, PHI Publication, 1995.

22UMEO641 Introduction to Aircraft Industry & Aircraft 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. Theoretical concepts of aircraft industry overview and aircraft systems.
2. Importance of basics of flight and components of an aircraft and different types.
3. Analytical skills associated with the understanding of basics of flight mechanics.
4. Principles of flights to build aircraft models and to understand the mechanics of flight.

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 the manufacturing requirements of aircraft industry & global scenario of airline industry.	-	1, 2	-
CO-2	Explain basic components of aircraft and design configurations	-	1	3, 9
CO-3	Discuss different aircraft systems.	1	-	-
CO-4	Analyze principles of flight & its parameters	1,2	3	-
CO-5	Explain basics of flight mechanics.	-	1,2	-

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping level	2.4	2.3	1.5	-	-	-	-	-	1	-	-	-	-	-

Pre requisites: Nil

Course Contents:

Unit - I

Aircraft industry overview: Evolution and History of Flight, Types Of Aerospace Industry, Key Players in Aerospace industry, Aerospace Manufacturing, Industry Supply Chain, Prime contractors, Tier 1 Suppliers, Key challenges in Industry Supply Chain, OEM Supply Chain Strategies, Mergers and Acquisitions, Aerospace Industry Trends, Advances in Engineering/CAD/CAM/CAE Tools and Materials technology, Global and Indian Aircraft Scenario. **8 Hrs**

Unit - II

Introduction to Aircrafts: Basic components of an Aircraft, Structural members, Aircraft Axis System, Aircraft Motions, Control surfaces and High lift Devices, Types of Aircrafts - Lighter than Air/Heavier than Air Aircrafts Conventional Design Configurations based on Power Plant Location, Wing vertical location, intake location, Tail Unit Arrangements, Land ing Gear Arrangements. Unconventional Configurations-Biplane, Variable Sweep, Canard Layout, Twin Boom Layouts, Span loaders, Blended Body Wing Layout, STOL and STOVL Aircraft, Stealth Aircraft. Advantages and disadvantages of these Configurations. **8Hrs**

Unit - III

Introduction to Aircraft Systems: Types of Aircraft Systems. Mechanical Systems. Electrical and Electronic Systems. Auxiliary systems. Mechanical Systems: Environmental control systems (ECS), Pneumatic systems, Hydraulic systems, Fuel systems, Landing gear systems, Engine Control Systems, Ice and rain protection systems, Cabin Pressurization and Air Conditioning Systems, Steering and Brakes Systems Auxiliary Power Unit, Electrical systems: Avionics, Flight controls, Autopilot and Flight Management Systems, Navigation Systems, Communication, Information systems, Radar System. **8 Hrs**

Unit - IV

Basic Principles of Flight: Significance of speed of Sound, Air speed and Ground Speed, Properties of Atmosphere, Bernoulli's Equation, Forces on the airplane, Airflow over wing section, Pressure Distribution over a wing section, Generation of Lift, Drag, Pitching moments, Types of Drag, Lift curve, Drag Curve, Lift/Drag Ratio Curve, Factors affecting Lift and Drag, Center of Pressure and its effects. Aerofoil Nomenclature, Types of Aerofoil, Wing Section- Aerodynamic Center, Aspect Ratio, Effects of lift, Drag, speed, Air density on drag. **8Hrs**

Unit - V

Basics of Flight Mechanics: Types of Structural members of Fuselage and wing section Ribs, Spars, Frames, Stringers, Longer on, Splices, Stability and Control Degree of Stability- Lateral, Longitudinal and Directional Stability and controls of Aircraft. Effects of Flaps and Slats on Lift Coefficients, Control Tabs, Stalling, Landing, Gliding Turning. **7 Hrs**

Reference Books:

1) A.C Kermode, “Flight without Formulae”, 10th edition, Pearson Education. 2004.
2) A.C Kermode, “Mechanics of Flight”, 11th edition, Pearson Education, 2009.
3) Dave Anderson, “Introduction to Flight”, McGraw Hill Education, 6th edition, 2017.
4) Richard S. Shevell, “Fundamentals of Flight”, Pearson, 2nd edition, 1988.

Note: The assignments for Electives could include the following,

- Seminars from the topics related to Aerospace Industry.
- Report preparation on Aerospace industries which could involve. History and Evolution of major players, the OEM's and in Aerospace and related businesses.

22UMEO642	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-imbursement. 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**

Text Book:

1) Patel B, “Project Management”, 2nd Edition, 2010.

References Books:

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

22UMEO643 Design of Renewable Energy Systems (3-0-0) 3

Contact Hours: 39

Course Objectives (CLO's): The objectives of this course are to make the student to learn:

1. Energy sources and need of alternative resources.
2. Principles for design and analysis of Renewable Energy Systems
3. Economics & Environmental of energy conversion in renewable energy systems
4. Renewable energy systems for sustainability

Course Outcomes (CO's):

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 need of renewable energy sources for energy requirement	-	1	2
CO-2	Analyze the renewable energy source conversion to different forms of energy	-	2,3	-
CO-3	Design different renewable source for small to large scale applications	-	2,3	7
CO-4	Illustrate the economic viability and sustainability of renewable energy systems	-	-	1,14
CO-5	Compare different renewable energy systems based on techno-economic feasibility	-	2	7,14

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	1.5	1.7	2	-	-	-	1	-	-	-	-	-	-	1

Pre requisites: Nil

Course Contents:

Unit - I

Renewable Energy sources: Introduction, Factors affecting the use of renewable energy sources, Global warming and sustainable development. Renewable energy resources, type's brief energy conversion methods and use pattern of Renewable energy sources in present context in India.

Solar thermal energy systems: Introduction to solar energy, solar radiation data, methods of conversion, different conversion devices Flat plate collectors, concentrating collectors. Principle of design for thermal and other forms of conversion. Principal of solar thermal devices. **8Hrs**

Unit - II

Solar Direct and Indirect conversion: Direct conversion of solar energy to electrical energy, Performance evaluation of PV cell, modules, Panels and arrays and optimization. Principal of conversion solar energy to electrical by using heat engines.

Wind energy systems (WES): Characteristics of wind, wind power profile, aerodynamics of wind turbines. Basic elements of WES, Siting and sizing of WES, Wind turbine site matching, Applications. **9 Hrs**

Unit - III

Biomass energy systems: Densification, Biomass combustion technology, Thermo-chemical and biochemical conversion to useful energy conversion such as thermal, electrical and mechanical energy. Material, size and types of biogas plants. Bio-fuels importance & production. Principal components of Engine Biomass systems.

Other renewable energy systems & hybridization: Wave, Tidal, OTEC, Geothermal, And Hydrogen: Principal of conversion and its utilization individually and in hybrid form. **9 Hrs**

Unit - IV

Economic and environmental aspects of renewable systems: Economic analysis of renewable sources. Based on the life cycle pollution aspect of renewable systems. **7 Hrs**

Unit - V

Solar thermal energy systems: Wind energy systems (WES): Biomass energy systems design analysis including economic aspects of the renewable systems. Energy, exergy analysis of above systems.

6 Hrs

Reference Books:

1) G. D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, Dec 2004.
2) S. Rao, Dr. B. B. Parulekar, “Energy Technology”, 3rd edition, Khanna Publishers, Delhi, 2007.
3) Ziyad Salameh, **“**Renewable Energy System Design”, Academic Press, ELISIEVIR.2014.
4) S. P. Sukatme, “Solar Energy”, TATA McGraw Hill, 1996.
5) Kreith & Goswami, “Solar Energy”, Taylor & Francis 1999.

22UMEO644	Total Quality 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. Theoretical concepts of Total Quality Management.
2. Importance of application of Total Quality management philosophy and concepts.
3. Analytical skills associated with the usage of tools and techniques of Total Quality Management.
4. Principles of experimental design.

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	List the basic tools of quality control and experimental design	-	1,2	-
CO-2	Describe scientific techniques and tools of total quality management	1,2	-	-
CO-3	Demonstrate practical knowledge through case studies.	-	2	-
CO-4	Solve engineering problems using experimental design and modern engineering tools	4, 5	1,2	-
CO-5	Interpret control charts to facilitate quality control	1,2	4	-
CO-6	Differentiate between Taguchi and Deming's philosophy of quality engineering	-	1	2

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.4	2.6	-	2.5	3	-	-	-	-	-	-	-	-	-

Prerequisites: Nil.

Course Contents:

Unit - I

Overview of Total Quality Management: Introduction – Definition, Basic Approach, Contribution of Gurus – Total Quality Management, TQM frame work, Historical Review, Benefits of TQM.

Deming's Philosophy: Customers' satisfaction, Customers' perception, using Customers complaints, Feedback, Employee involvement, Suggestion system, Continuous Process Improvement- Juran's Trilogy PDSA Cycle, Imai's Kaizen. **8 Hrs**

Unit - II

Tool & Techniques of TQM: Bench marking, Definition, Process of bench marking, Quality Management Systems, Reengineering, six sigma, ISO–9000 series of standards, **8 Hrs**

Unit - III

Introduction to QFD & QFD process, FMEA (Failure Mode and effect Analysis), Design FMEA and Process FMEA studies, Cases. **7 Hrs**

Unit - IV

Basic tools of quality control, Control charts for variables, Construction, interpretation, Analysis using x–R control charts, Process capability estimation, Process capability indices, process improvement through problem analysis (Intensive coverage with numerical problems), Control charts for attributes, cases. **8 Hrs**

Unit - V

Experimental Design: One factor designs, two factor designs, Orthogonal design, Full factorial and factional factorial design, Taguchi's Philsophy of quality engineering, Loss function, Orthogonal array, Signal to noise ratio, Parameter design, Tolerance design (Basic Conceptual Treatment only), Cases. **8 Hrs**

Reference Books:

1) Dale H Besterfield, Carol Besterfield, Glen H Besterfield, Mary Besterfield, "Total Quality Management", 3rd Edition, Pearson Education, 2008.
2) Douglas C. Montgomery, "Statistical Quality Control", John Wiley & Sons; 7th Edition edition, 2012.
3) K. Shridhara Bhat, "Total Quality Management Texts cases", Himalaya Publishing House, 2010.
4) P. L. Jain, "Quality Control and Total Quality Management", Tata McGraw hill Publishing Co. Ltd., New Delhi, 2001.
5) Shoji Shiba, Alan Graham & David Walden, "A New Amercian TQM – Four Practical Revolutions in Management", Productivity Press, Portland (USA) 2000.

22UMEO645 Applied Scientific Computing (3-0-0) 3

Contact Hours: 39

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

1. Solve mathematical problems using Python software
2. Develop skills in handling errors, functions, and loops in program, enhance problems solving capability.
3. Plot graphs and interpreting the data's in Python software.
4. Application of differential equations and integration to solve engineering problems using Python codes.

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	Develop program by analyzing problem and handling errors in Python software.	-	1,2	4,5
CO-2	Use data structures in programming approach.	-	1,2	-
CO-3	Apply function features to develop realistic programs.	-	1,2	4,5
CO-4	Develop Python Programs using NumPy array and matplotlib for solving problems	-	1,2	-
CO-5	Use various package's and libraries SciPy, ODEINT to solve a mathematical problem.	-	1,2	4,5

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

Prerequisites: Scientific Computing -1

Course Contents:

Unit - 1

Overview of Scientific Computing

Introduction to Python, Installing Python, Tools for Writing Programs, Using Idle to Write the Program, variables, input and output, Flow control,

Conditional statements, transfer statement and iterative statement, if, else, and elif, foe loop, while loop, break, continue, pass, String, List, tuples, indexing, functions and arguments of function, **8Hrs**

Unit – 2

Engineering Mathematics

Matplotlib: Introduction, Matplotlib basics, Contour plots, 3D plots,

NumPy Library, basic array methods, matrix, computation of matrix, linear algebra, Reading data from file and plotting , ordinary differential equation and partial differential equation, Integration and double integration, initial value problems, Array Computing and Curve Plotting: Basic array methods, Reading and writing an array to a file, Polynomials, Linear algebra, Matrices, computation with matrix, dot product, cross product, inverse matrix.

8Hrs

Unit - 3

Mechanics and Machine Design

SciPy Library, Sympy Library, Newton Raphson method, Finding minima of function, Fast Fourier Transformation, Differential equation using SciPy ODEINT, Projectile motion, Von misses failure theory, Analysis of beam – SFD and BMD and plotting SFD and BMD, fatigue criteria, Kinematic Analysis of mechanism, Animating Kinematic Mechanism, **8Hrs**

Unit - 4

Introduction to Mechanical Vibration

Frequency of spring mass system, Single degree of freedom and plotting using matplotlib, Calculate natural frequency, Eigen value problems , solving a second-order differential equation representing a spring-damper system, Numerical, Linear Programming problems (LPP Problems). **7Hrs**

Unit - 5

Introduction to Engineering Thermal Systems

Analysis of fluid flow and visualization of streamlines using matplotlib, Analysis of Diesel cycle, Otto cycle, Dual cycle, Introduction to one dimensional heat equation, Temperature heat distributed 2D heat transfer problems. Flow over a cylinder and streamline plot and pressure distributed.

8Hrs

Reference Books:

1) Christian Hill, “Learning Scientific Programming with Python”, Cambridge University Press, 2015.
2) Charles Dierbach, "Introduction to Computer Science Using Python", 1st Edition, Wiley India Pvt Ltd, 2015.
3) T.R. Padmanabhan, “Programming with Python”, Springer, 2016.
4) Hans Petter Langtangen, “A Primer on Scientific Programming with Python”, Springer; 3rd Edition, 2012.

CIE and SEE Evaluation (from 2026-27batch)

Courses with LTP 3-0-0 and 4-0-0 or 2-2-0/3-2-0

Continuous Internal Evaluation (CIE):

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: 3 questions of 10 marks each with maximum of two sub divisions. Q.3 is compulsory and one question to be answered from Q.1 and Q.2.
- Course Teacher Assessment (CTA): Minimum two components such as quiz, seminar, written assignment, any technical activity related to course each of 5marks. Total CTA marks-10
- CIE=40 (from tests) +10(from CTA) =50 marks

Semester End Examination (SEE):

- SEE is conducted for100 marks with 3 hours duration. It is reduced to 50 marks.
- Question Paper pattern for SEE: Five units with built in choice. Each question with maximum of three sub divisions.
- Two questions are to be set from each unit with built in choice, for example Q1 or Q2 in unit –I, Q 3 or Q 4 in unit-II and so on.
- A total of 5 full questions to be answered choosing one full question from each unit. All five units are to be answered compulsorily.
- Each question is of 20 marks.
- The Question paper is to be set for duration of 3 hours both for 3 and 4 credits courses.
- The Question paper is to be set for 100 marks for 3 and 4 credits courses.

ASC(IC)/PCC with LTP 2-0-2, 3-0-2 and 2-2-2

Continuous Internal Evaluation (CIE);

Theory CIE component:

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: 3 questions of 10 marks each with maximum of two sub divisions. Q.3 is compulsory and one question to be answered from Q.1 and Q.2.

Course Teacher Assessment (CTA): Totally based on conduction of experiments as set by the course teacher.

Laboratory component assessment:

- 5 marks: for conduction, regularity, involvement, journal writing, etc. Minimum 75% of attendance is compulsory. If the performance is not

satisfactory in laboratory the student shall be detained and required to reregister for the course as a whole whenever offered next.

- 5 marks: Lab Test. A Lab test as per the class time table has to be conducted at the end for50 marks and scale down to 5 marks.
- CIE for integrated course =40 (from IA tests)+10 (from CTA i.e. lab component) =50 marks.
- There will not be any remuneration for Final Lab Test since it is CTA of integrated course.
- Copy of the Marks list to be sent to the concerned course instructor immediately after the completion of test for that batch. Original Marks list to be maintained in the department.
- CIE=40(from tests)+10(from CTA i.e. lab component) =50 marks

Semester End Examination (SEE):

- SEE is conducted for100 marks with 3 hours duration. It is reduced to 50 marks.
- Question Paper pattern for SEE: Five units with built in choice. Each question with maximum of three sub divisions.
- Two questions are to be set from each unit with built in choice, for example Q1 or Q2 in unit –I, Q 3 or Q 4 in unit-II and so on.
- A total of 5 full questions to be answered choosing one full question from each unit. All five units are to be answered compulsorily.
- Each question is of 20 marks.
- The Question paper is to be set for duration of 3 hours both for 3 and 4 credits courses.
- The Question paper is to be set for 100 marks for 3 and 4 credits courses.

AEC/HSMS/Courses with LTP 1-0-0:
Continuous Internal Evaluation (CIE)

- Two Internal Assessment and one Improvement test each of 20 marks and one hour duration.
- Two higher scores from three tests are taken representing 40 marks.
- Question Paper pattern for Internal Assessment: MCQ 20 questions
- Course Teacher Assessment (CTA): Minimum two components such as quiz, seminar, written assignment, any technical activity related to course etc. each of 5marks. Total CTA marks-10
- CIE=40(from tests)+10(from CTA) =50 marks

Semester End Examination (SEE):

- SEE is conducted for 50 marks of 1 hour duration. There will be 50 MCQs.
- Question Paper pattern for SEE: The question paper will contain 12 MCQ questions drawn from each Unit.
- Students have to answer maximum of 10 questions from each unit.
- All five units are to be answered compulsorily.