Academic Program: UG

Academic Year 2025-26

Department of

Mechanical Engineering

VII & VIII 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
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SDM College of Engineering & Technology, Dharwad

It is certified that the scheme and syllabus for VII & VIII 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 2025-26 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 COLLEGEOF ENGINEERING AND TECHNOLOGY, DHARWAD
Department of Mechanical Engineering
VII Semester
Scheme of Teaching and Examinations 2025 – 26

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	22UMEC700	Mechanical Vibrations	ME	3	2	0	03	50	100	100	4
2	PEC	22UMEE7XX	PEC-IV	ME	3	0	0	03	50	100	100	3
3	PEC	22UMEE7XX	PEC-V	ME	3	0	0	03	50	100	100	3
4	OEC	22UMEO7XX	OEC-II	ME	3	0	0	03	50	100	100	3
5	PCCL	22UMEL701	Dynamics of Machines Laboratory	ME	0	0	2	03	50	50	100	1
6	PROJ	22UMEL702	Major Project-I	ME	0	0	12	03	50	50	100	6
								Total			**600**	**20**

Program Elective Course -IV												
1	PEC-IV	22UMEE721	Computational Fluid Dynamics	ME	3	0	0	03	50	100	100	3
2	PEC-IV	22UMEE722	Design of Heat Exchangers	ME	3	0	0	03	50	100	100	3
3	PEC-IV	22UMEE723	Tribology and Bearing Design	ME	3	0	0	03	50	100	100	3
4	PEC-IV	22UMEE724	Additive Manufacturing	ME	3	0	0	03	50	100	100	3
5	PEC-IV	22UMEE725	Industrial Robotics	ME	3	0	0	03	50	100	100	3
Program Elective Course -V												
1	PEC-V	22UMEE731	Control Engineering	ME	3	0	0	03	50	100	100	3
2	PEC-V	22UMEE732	Hybrid Vehicles Technology	ME	3	0	0	03	50	100	100	3
3	PEC-V	22UMEE733	Mechanics of Composite Materials	ME	3	0	0	03	50	100	100	3
4	PEC-V	22UMEE734	Cryogenics	ME	3	0	0	03	50	100	100	3
5	PEC-V	22UMEE735	Internal Combustion Engines	ME	3	0	0	03	50	100	100	3
Open Elective Course-II												
1	OEC-II	22UMEO741	Operations Research	ME	3	0	0	03	50	100	100	3
2	OEC-II	22UMEO742	Electric and Autonomous Vehicle Technology	ME	3	0	0	03	50	100	100	3
3	OEC-II	22UMEO743	Micro Electro-Mechanical Systems	ME	3	0	0	03	50	100	100	3
4	OEC-II	22UMEO744	Design of Aircraft Structures	ME	3	0	0	03	50	100	100	3

PCC: Professional Core Course, PCCL: Professional Core Course laboratory, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation. PEC: Program elective course, OEC: Open 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. 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.
Major Project-I: The objective of the project work is to encourage development of independent learning, innovative attitude, communication skills, organisation, time management, presentation skills, team work, punctuality, setting and meeting deadlines. In Major project the students are expected to identify the state-of-the-art technology in their 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 project shall consist of a team of students not more than 2-4. Each batch shall be assigned with a faculty member. A committee constituted by HOD consisting of minimum 2 faculty members shall evaluate for CIE. There is SEE, a viva voce examination which shall be examined by two examiners constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the project work carried out, report, project presentation,communication skill and question and answer session.
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 COLLEGEOF ENGINEERING AND TECHNOLOGY, DHARWAD

Department of Mechanical Engineering

VIII Semester

Scheme of Teaching andExaminations2025 – 26

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	TS	22UMEL800	Technical Seminar/Independent study	ME	0	0	2	-	50	-	50	1
2	PROJ/INT	22UMEL801	Major Project-II /Internship	ME	12 Weeks			03	50	50	100	10
3	INT	22UMEL802	Summer Internship	ME	4 Weeks			03	50	50	100	03
								Total			**250**	**14**

Technical Seminar/Independent study (TS): Students are expected to learn how to conduct a literature survey to identify the state-of-the-art technology in their chosen engineering domain. They are required to select an emerging topic beyond the syllabus relevant to their branch of study, understand the concept, analyse it, and present it effectively with technical innovations or novel work in a 15–20minute session, followed by a 5-minute question and answers with their classmates and faculty. Additionally, students must develop effective communication skills and understand the modalities of technical interactions. They are required to submit a seminar report following the format provided by the DUGC. The technical seminar is evaluated for CIE based on the rubrics prescribed by the DUGC.

Summer Internship: Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship should be completed over a period of four weeks during the summer vacation after the IV or VI semester and must be completed before the VII semester.Students are required to prepare a report on the work carried out during the internship and submit both the report and the internship certificate during the VIII semester. The internal faculty will monitor student performance and award CIE marks in the VIII semester. Additionally, there will be a SEE, in which students must present their work before a panel of two examiners constituted by the HoD during the SEE of the VIII semester.

Major Project-II: This project work is intended for students who do not undertake an internship. The objective of the project is to foster independent learning, an innovative mindset, communication skills, organization, time management, presentation skills, teamwork, punctuality, and the ability to set and meet deadlines.In this project, students are expected to conduct an extensive literature survey to identify state-of-the-art technology in their domain of interest, select a topic from an emerging area relevant to their branch or an interdisciplinary field, and define the problem for their project work. Each project team shall consist of 2 to 4 students and will be assigned a faculty mentor.The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE, along with marks awarded by the faculty guide. A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE.For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD. The rubrics of evaluation includes objectives defined, literature review, demonstration of the project work carried out, report, project presentation,communication skill and question and answer session.

Internship: The internship is intended for students who do not undertake a project. Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship shall be for a duration of 12 weeks during the VIII semester, either through placement or on an individual basis.Students are required to prepare a report on the work carried out during the internship and submit both the report and the internship certificate during the VIII semester. The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE.A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE. For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD.The rubrics of evaluation includes objectives defined, literature review, demonstration of the work carried out, report, project presentation,communication skill and question and answer session.

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.

VII Semester

22UMEC700	Mechanical Vibrations	(3-2-0) 4

Contact Hours: 52

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

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

Course Outcomes (COs):

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

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

Prerequisites: Nil.

Course Contents :

Unit - I

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

Single Degree Freedom System: (Undamped) Natural Frequency, Equivalent System, Parallel Springs, Series Springs, Inclined Springs, Geared System. Energy Method-Energy Principle.

11Hrs

Unit – II

Single Degree Freedom System: (Damped) Damping Models- Viscous Damping, Structural Damping, Coulomb Damping Single Degree Freedom System with Damping- Over Damped, Under Damped, Critically Damped, Logarithmic Decrement. **10Hrs**

Unit – III

Single Degree Freedom System – Forced Vibrations: Forced Vibrations with constant Excitation – Steady State Vibrations, Forced Vibrations with Rotating and Reciprocating unbalance, Forced Vibration due to base excitation, transmissibility, Critical Speed of shaft (Without damping).

Experimental Methods in Mechanical Vibrations: Vibrometers, Accelerometers, Frequency Measuring Instruments. **10Hrs**

Unit – IV

Two Degree Freedom System: Free Vibration of spring Coupled system, Principle mode of vibrations, combined rectilinear and angular modes, Vibration Absorbers, Forced Damped Vibrations,

Introduction to Noise, Vibration, Harshness (NVH) and control: Subjective response of sound: Frequency and sound dependent human response; the decibel scale; relationship between, sound pressure level (SPL), sound power level and sound intensity scale; auditory effects of noise; hazardous noise. **10 Hrs**

Unit – V

Numerical Methods: Holzer Method, matrix method, matrix iteration method, Dunkerley's method, Stodola method, Rayleigh's method. **11 Hrs**

Reference Books:

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

22UMEE721	Computational Fluid Dynamics	(3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

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

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

Pre requisites: Nil

Course Contents :

Unit - I

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

7 Hrs

Unit - II

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

8 Hrs

Unit - III

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

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

8 Hrs

Unit - IV

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

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

Unit - V

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

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

8 Hrs

Reference Books:

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

22UMEE722	Design of Heat Exchangers	(3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

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

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

Pre requisites: Nil

Course Contents :

Unit - I

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

9 Hrs

Unit - II

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

6 Hrs

Unit - III

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

8 Hrs

Unit - IV

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

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

10Hrs

Unit - V

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

6 Hrs

Reference Books:

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

22UMEE723 Tribology and Bearing Design (3-0-0) 3

Contact Hours: 39

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

1. Laws of friction, and fluid flow, mechanisms of friction and lubrication friction space, stiction, stick slip, and surface temperature.
2. Various modes of wear: adhesive, delamination, fretting, abrasive, erosive, corrosive and the wear-mechanism maps.
3. Design and applications of sliding contact bearings.
4. Applications of rolling contacts, Magnetic bearing and elimination of leakage using seals.

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 laws of fluid flow and different lubrication methods.		1	2
CO-2	Compute power losses and frictional forces in hydrodynamic bearings.	1	2	-
CO-3	Explain different fluid film formation mechanisms in bearings.	-	1	-
CO-4	Analyze pressure distribution around the hydrostatic journal bearing.	1	-	2
CO-5	Discuss different wear mechanisms and advanced bearings and its components.	-	1, 2	-

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

Pre requisites: Nil.

Course Contents:

Unit - I

Introduction: Properties of oil, equation of flow, absolute viscosity, Hagen Poiseullie's law, flow between parallel stationary plates, apparatus for measuring viscosity, factors that affect viscosity. **8 Hrs**

Unit - II

Hydrodynamic Lubrication: Tower's experiments, Petroff's equation, friction forces, power losses in lightly loaded bearings, mechanism of pressure development in an oil film, numericals on Petroff's equation and oil flow through capillary.

8 Hrs

Unit - III

Reynolds equation in two dimensional flow: idealized journal bearing friction forces, power losses, pivoted shoe bearing, friction forces, power losses, collar thrust bearing with end leakage, thermal equilibrium. **8 Hrs**

Unit - IV

Hydrostatic Lubrication: Application of hydrostatic lubrication, hydrostatic thrust bearing, introduction to hydrostatic journal bearing and numerical.

8Hrs

Unit - V

Wear and abrasion: Wear mechanism, Mechanism of wear in elastomers, wear Measurements.

Introduction: Magnetic and foil bearings, seals and types. **7 Hrs**

Reference Books:

1) E.I. Radzimovsky, "Lubrication of Bearings", The Ronold Press Company, 1959.
2) Suhilkumar Srivastava, "Industrial Tribology", S.C. Chand And Company, 2001.
3) B.C Muzumdar, "Lubrication of Bearings", Wheeler Publishers1996.
4) K. Lingaiah, "Design Data Hand book", Vol2, Suma publishers 1984.

22UMEE724	Additive Manufacturing	(3-0-0) 3

Contact Hours:39

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

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

Course Outcomes:

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

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

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

Course Contents :

Unit I

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

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

Unit II

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

Unit III

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

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

4Hrs

Unit IV

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods. Indirect Rapid tooling: Silicon rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling. Direct Rapid Tooling: Direct AIM, Quick cast process, Copper

polyamide, Laminated Object Manufactured (LOM) Tools, Direct Metal Laser Sintering (DMLS) Tools. **8Hrs**

Unit V

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

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

Text Books:

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

Reference Books:

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

22UMEE725	Industrial Robotics	(3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Course Contents :

Unit - I

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

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

8 Hrs

Unit - II

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

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

8 Hrs

Unit - III

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

10 Hrs

Unit - IV

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

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

7 Hrs

Unit - V

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

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

6 Hrs

Reference Books:

1) Mohsen Shahinpoor, “A Robot Engineering Textbook”, Harper & Row.

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

22UMEE731 Control 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. Various mathematical models, methods and limitations of physical models and their mathematical equivalents.
2. Transfer functions of various systems such as thermal, hydraulic, and pneumatic systems.
3. Transient and steady state analysis for step, ramp, impulse, and sinusoidal inputs.
4. Different types of plots used for analysis of stability of control systems.
5. Types of compensators and controllers.

Course outcomes (COs):

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

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

Mapping Level	2.3	2.8	2	2.6	-	-	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents :

Unit - I

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

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

7Hrs

Unit - II

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

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

8Hrs

Unit - III

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

8 Hrs

Unit - IV

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

Unit - V

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

Design in Frequency Domain: Control action & system compensation: Types of controllers, proportional, integral, and differential, PID Controllers (basic concepts),

series and feedback compensation design of control parameters, Physical devices for system compensation. **8 Hrs**

Reference Books:

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

22UMEE732 Hybrid Vehicle Technology (3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

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

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

Prerequisites: Basic Science, Applied mechanics

Course Contents:

Unit - I

Introduction to electric vehicles: History and present scenario of electric vehicles, Challenges faced by electric vehicles to replace ICE. Major requirements of electric vehicles Basic concept of electric traction and drive-train topologies, Power flow control in electric drive-train topologies. Need of Electric Vehicles, Economic, social and environmental importance of electric vehicles, impact of modern drivetrains on energy supplies.

Hybrid Vehicles: Basics of vehicle performance, vehicle power source, Power transmission, Fuel economy characteristics. Introduction to Hybrid Electric Vehicles: Merits and demerits of electric and hybrid vehicles.

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

8 Hrs

Unit - II

Hybrid vehicles: Hybrid traction, introduction to various hybrid drive-train topologies, Vehicle power plant and transmission characteristics and vehicle performance including braking performance. Basic architecture of hybrid drive train and analysis series drive train. Analysis of parallel, series parallel and complex drive trains and power flow in each case. Basic concept of electric traction and architecture. Topologies for electric drive-train and their analysis, power flow control in electric drive-train topologies. **8 Hrs**

Unit - III

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

8 Hrs

Unit - IV

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis and simplified models of battery. Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. **7 Hrs**

Unit - V

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

Air pollution and global warming: Impact of different transportation technologies on environment and energy supply. **8 Hrs**

Reference Books:

1) James Larminie, John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003.
2) Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.
3) Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.
4) R1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010.
5) Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes, 2000.
6) John B Heywood, “IC Engine Fundamentals”, International Editions, Automobile Technology Series, McGraw hill, 2010.
7) M. L. Mathur and R. P. Sharma, “I.C. Engines”, Dhanpat Rai & Sons, New Delhi, 2011.
8) A.K. Babu, “Electric & Hybrid Vehicles” Khanna Publishing House, New Delhi, 2018.

22UMEE733	Mechanics of Composite Materials	(3-0-0) 3

Contact Hours: 39

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

1. composite properties including longitudinal and lateral moduli, Poisson's ratio, and shear modulus
2. To determine the generalized stiffness and compliance matrix relating in plane stresses to strains for a composite layer assuming plane stiffness
3. Powder metallurgy applications & know what are surface treatments for materials

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the basic terms and concepts of composite materials.	-	1, 4	3
CO-2	Use generalized Hooks law for evaluating stiffness and compliance matrix for different conditions	3	4	1
CO-3	Evaluate mechanical properties of composite materials.	3	4	1
CO-4	Explain fabrication and machining methods of composite laminates.	-	4	2, 3
CO-5	Discuss the defects in composite laminates, and applications of composites in various fields.	-	4	2

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

Prerequisites: Nil

Course Content:

Unit - I

Introduction to Composite Materials: Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction. Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Applications. **8 Hrs**

Unit - II

Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems. **9Hrs**

Unit - III

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths. *Failure Criteria:* Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsai-Hill theory, Tsai, Wu tensor theory, Numerical problem, practical recommendations. **8 Hrs**

Unit - IV

Manufacturing and Testing: Layup and curing - open and closed mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair.

7 Hrs

Unit - V

NDT tests: Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites. **7Hrs**

Reference Books:

1) Autar K. Kaw, “Mechanics of composite materials” CRC press, 2nd Edition, 2006.
2) Robert M. Jones, “Mechanics of Composite Materials” Taylor & Francis, 1998.
3) Krishan K Chawla, “composite materials” Springer, 2nd edition, 1998.

22UMEE734	Cryogenics	(3-0-0) 3

Contact Hours: 39

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

1. Principles of cryogenics and applications.
2. Low temperature properties of engineering materials.
3. Gas separation and gas purification and production of ultralow temperature.
4. Vacuum technology cryogenics insulation fluid storage and 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	Discuss various cryogenic fluid properties and cryogenic systems.	1	-	2
CO-2	Describe the importance of effectiveness of heat exchanger used in Gas liquefaction Systems.	1,2	-	-
CO-3	Explain Gas purification and Cryogenic refrigeration systems.	1,2	-	-
CO-4	Illustrate various methods of measurements in cryogenic systems and cryogenic insulation.	-	1,2,3	-
CO-5	Explain Cryogenic fluid storage and suspension systems and Discuss cryogenics applications.	1,2	-	-

POs/PSOs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Mapping Level	2.8	2.5	2	-	-	-	-	-	-	-	-	-	-	-

Prerequisites: Nil

Course Contents:

Unit – I

Introduction and Low temperature properties of engineering materials: Cryogenic Systems. Applications and Areas of Cryogenic Engineering. Mechanical properties, Thermal properties, Electrical properties.

Gas liquefaction Systems: Introduction The thermodynamically Ideal system Production of low temperatures- joule Thomson Effect Adiabatic expansion Liquefaction systems for Air/Nitrogen/Oxygen- Simple Linde -Hampson System, Pre cooled LH System, Claude System, Kapitza System. Comparison of Liquefaction Systems. **8 Hrs**

Unit – II

Gas liquefaction Systems and heat exchanger: Liquefaction Systems for hydrogen, (pre cooled linde-hampson and pre cooled Claude systems),helium liquefaction systems (collin's system and Simon's system) Heat exchanger effectiveness.

Gas separation: Thermodynamics ideal separation system, Principles of gas separation. Linde single column air separation. Linde double column air separation. **8 Hrs**

Unit – III

Gas purification systems: Absorption**,** Adsorption Process and Combined purification method.

Cryogenic refrigeration systems: Ideal Refrigeration system (Isothermal source), Joule Thomson Refrigeration systems, Solvay Refrigerator. Magnetic Refrigeration systems, He3_He4 Dilution refrigerator. **7 Hrs**

UNIT – IV

Measurement systems: Resistance thermometers Thermocouples Thermistors Gas Thermometry. Liquid level sensors, vacuum pumps, Ion Pumps, Diffusion pumps,

Cryogenic Insulation: Heat transfer due to conduction, Evacuated porous insulation powder& Fibers, Opacified powder insulation, Gas filled powders &Fibrous materials, Multilayer super-insulation, Composite insulation. **8 Hrs**

Unit – V

Cryogenic fluid storage and suspension systems: Design of cryogenic fluid storage vessels Inner vessel Outer vessel Insulation Suspension system.

Application of cryogenic systems: Cryogenic applications for food preservation, Biology and Medicines, Super conductive devices, space technology.

8 Hrs

Reference Books:

1) Mamata Mukhopadhyay, “Fundamentals of Cryogenic Engineering”, PHI publications, 2010.
2) Randal Barron, “Cryogenics Systems”, oxford Press, 1985.
3) Marshall Sitting D.Van Nostrand, “Cryogenics, Research and application co.inc Princeton New Jersy, 1989.
4) Klaus D. Timmerhaus& Thomas M. Flynn, Cryogenic process Engineering, Plenum Press, New York & London, 1989.
5) Thomas M Flynn, Marcel Dekker, Cryogenic Engineering Inc. N.Y.Basal, 1997.

22UMEE735	Internal Combustion Engines	(3-0-0) 3

Contact Hours: 39

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

1. Different types of internal combustion engines, principles of operations, parameters that define engine performance and efficiency aspects.
2. Thermodynamics of theoretical cycles.
3. Importance of fuel-air mixture preparation processes and fuel supply system in gasoline and diesel engines.
4. Spark-ignition (SI) and compression ignition (CI) engine combustion, SI and CI engine knock, and combustion chambers.
5. Diesel combustion and diesel engine emissions formation and control.

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 fuel-air cycles and combustion phenomena in SI engines.	1	2	-
CO-2	Explain air-fuel ratios and combustion phenomena in CI engines.	1	2	-
CO-3	Describe the need for spray pattern in CI engines and working of Electric, Hybrid and Autonomous vehicles	1, 3	2	-
CO-4	Compare effect of alternative fuel properties on the performance of IC engine and fossil fuels.	-	1	-
CO-5	Evaluate emission characteristics and methods used to reduce emission.	1	2, 6	-

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction: Fuel Air Cycles, Variations in specific heat, Dissociation, Simple problems.

Combustion in S. I. Engines: Ignition limits- Stages of combustion in S. I. Engine, Effect of engine variables on ignition lag and flame propagation, Detonation – theory of detonation, Effect of engine variables on detonation, Octane number, Control of detonation, S.I. engine combustion chambers. **7 Hrs**

Unit - II

Combustion in C.I Engine: Stages of combustion in C. I. engine, Variables affecting delay period, Diesel knock, Effect of engine variables on knocking, methods of controlling knocking, cetane number, Diesel engine combustion chambers, Difference between SI and CI Engine.

Fuel supply system in SI engines: mixture requirements for steady and transient operations, Fuel consumption loop, carburetor, Petrol injection – MPFI, numerical problems, **8 Hrs**

Unit - III

Fuel supply system in CI engines: Requirements of a diesel injection system, Types of injection system, Fuel pump, Fuel injectors, fuel nozzles, quantity of fuel per cycle, Size of orifice, Effect of orifice diameter, Fuel spray behavior, Overall spray structure, Spray penetration, Droplet size distribution, spray formation, Injection pressure, and spray direction, CRDI system.

Testing of an I.C Engines: Performance parameters, Measurement of air and fuel consumption, Heat balance sheet, and Numerical problems. **8 Hrs**

Unit - IV

Electric, Hybrid and Autonomous vehicles: Meaning of Electric, Hybrid and Autonomous vehicle, Architecture of series, parallel and combined series-parallel hybrid electric merits and demerits, Components of Electric and hybrid vehicles, Regenerative braking, Drive systems, AC and DC motors, Motor Controllers and Control System, Automotive Battery Requirements, Classification of Batteries, type of Batteries (Li-Ion, Metal-hydride, Ni-Cd etc), Battery materials.

Alternative Fuels for an I. C. engine: SI and CI Engine fuels properties. Alternative fuels for SI and CI engine. Performance of SI and CI engine when operated on alternative fuels. Dual fuel engine, factors affecting combustion of dual fuel engine, Advantages of Dual fuel engine. Homogeneous charged compression ignition engines. **8 Hrs**

Unit - V

Pollution from I. C. Engines: Pollutants from I.C engines, Emission standards, Effect of mode of operation, Diesel emissions – Diesel smoke and control, diesel odor and control, Comparison of diesel and gasoline emissions.

Emission control devices: Exhaust gas recirculation, Water injection, Thermal reactor, Catalytic converter, Control of engine and operating parameters to control emissions. **8 Hrs**

Text Book:

1) John B Heywood, “IC Engine Fundamentals, International Editions”, Automobile Technology Series, McGraw hill, 2010.

Reference Books:

1) M. L. Mathur & R. P. Sharma, “I.C. Engines”, Dhanpat Rai & Sons, New Delhi, 2011.
2) Edward F.Obert, “", Harper & Row Publishers”, New york, 1973.
3) Willard W. Pulkrabek, “Engineering fundamentals of the I. C. Engines”, PHI Pvt. Ltd., New Delhi, 2002.
4) M. Ehsani, Y. Gao, S. Gay and Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2005.
5) Iqbal Husain, “Electric and Hybrid Vehicles” Design Fundamentals, Second Edition, 2nd Edition, CRC Press, 2010.
6) Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes, 2000.

22UMEO741	Operations Research	(3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Course Contents :

Unit - I

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

Linear Programming Problems: The simplex method - slack, surplus and artificial variables, degeneracy and procedure for resolving degenerate cases,artificial variables techniques, special cases, concept of duality, dual simplex method. **9Hrs**

Unit - II

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

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

Unit - III

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

Queuing Theory: Queuing system and their characteristics. The M/M/1 Queuing system, Steady state performance analysing of M/M/ 1 and M/M/C queuing model. **9Hrs**

Unit - IV

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

7Hrs

Unit - V

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

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

6 Hrs

Reference Books:

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

22UMEO742 Electric and Autonomous Vehicle Technology (3-0-0) 3

Contact Hours: 39

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

1. Concepts of electric vehicles.
2. Technology of electric vehicles.
3. Concepts of autonomous vehicles.
4. Technology of autonomous vehicles.

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	Illustrate the basics of electric vehicles	-	1	-
CO-2	Explain drive-train topologies	-	2	-
CO-3	Classify various electric drives	-	1	-
CO-4	Discuss concepts of autonomous vehicles	-	2	-
CO-5	Apply knowledge of sensors	1	-	-

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

Prerequisites: Nil.

Contents:

Unit – I

INTRODUCTION TO ELECTRIC VEHICLES: History of electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies. Comparison by efficiency of Conventional, Hybrid, Electric and Fuel cell Vehicles. **08Hrs**

Unit – II

ELECTRIC DRIVE-TRAINS: Basic concept of electric traction, Introduction to various electric drive-train topologies, Power flow control in electric drive-train topologies. **08Hrs**

Unit – III

ELECTRIC DRIVES & CONTROL: Introduction to electric components used in electric vehicles, Control of Induction Motor Drive, Permanent Magnet (PM) motor Drive & Switched Reluctance Motor (SRM) Drive. **09 Hrs**

Unit – IV

INTRODUCTION TO CONNECTED, AUTOMATED AND INTELLIGENT CARS: Introduction to Connected, automated and Intelligent cars-Automotive Electronics Overview, Advanced Driver Assistance Electronic Systems, Connected Car Technology- Connectivity Fundamentals, Navigation and Other Applications, Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory. **07Hrs**

Unit – V

SENSOR TECHNOLOGY:
Sensor Technology for Advanced Driver Assistance Systems- Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology **07Hrs**

Reference Books:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2nd Edition, 2017.
2. Ali Emadi, “Advanced Electric Drive Vehicles (Energy, Power Electronics, and Machines)”, CRC Press, 2015.
3.HankySjafrie,“IntroductiontoSelf-Driving VehicleTechnology”,1st Edition, Published December 11, 2019 by Chapman and Hall/CRC

22UMEO743 Micro Electro-Mechanical Systems (3-0-0) 3

Contact Hours: 39

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

1. Students are exposed to the MEMS technology & Miniaturization.
2. Students will understand the Process of Micro fabrication Techniques.
3. Students are made to understand the principles of system modelling.
4. Students are made to understand the working principles of Mechanical sensors and actuators.
5. Students are made to understand the working principles of Micro-Opto-Electro Mechanical 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)/PSO (13-14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Understand the working of MEMS technology & Miniaturization	1	-	-
CO-2	Explain the Process of Micro fabrication Techniques	1	-	-
CO-3	Explain the principles of system modelling.	1	-	-
CO-4	Understand the working principles of Mechanical sensors and actuators	1	-	-
CO-5	Describe the working principles of Micro-Opto-Electro Mechanical systems	1	-	-

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

Pre-requisites: Introduction to Electro Mechanical Systems

Course Contents :

Unit – I

MEMS: Introduction, Production Engineering, Precision Engineering and UltraPrecision Engineering, Integrated circuits, Micro Electro Mechanical Systems.

10 Hrs

Unit – II

Micromachining: Introduction, Photo Lithography, Structural and Sacrificial Materials, Etching, Surface Micromachining, Bulk versus Surface Micromachining, Wafer Bonding, LIGA.

7 Hrs

Unit - III

System Modelling: Introduction, Need for Modelling, System types, Basic Modelling Elements In Mechanical System, Basic Modelling Elements In Electrical Systems, Basic Modelling Elements In Fluid Systems and Thermal Systems.

10 Hrs

Unit - IV

Mechanical sensors and actuators: Introduction, Principles of Sensing and Actuation, Beam and Cantilever, Micro Plates, Capacitive Effects, Piezo Electric Material as Sensing and Actuating Elements.

5 Hrs

Unit – V

Micro-Opto-Electro Mechanical Systems: Introduction, Fundamental Principles of MOEMS Technology, Review on Properties of Light, Light Modulators, Micro mirrors, Digital Micro mirror

7 Hrs

Reference Books:

1. MEMS- Nitaigour Premchand Mahalik, TMH 2007.

2. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat,V.K.Aatre,Wiley India 2010.

3. Design and Development Methodogies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.

4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

22UMEO744	Design of Aircraft structures	(3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

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

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

Pre-requisites: Introduction to Aircraft Industry & Aircraft Systems

Course Contents :

Unit - I

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

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

Unit - II

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

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

Unit - III

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

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

Unit - IV

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

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

Unit - V

Structural Analysis of Aircraft Structures: Theory of Plates- Analysis of plates for bending, stresses due to bending (No derivation), Plate deflection under different end conditions, Strain energy due to bending of circular, rectangular plates, Plate buckling, Compression buckling, shear buckling, Buckling due to in plane bending moments. Theory of Shells-Analysis of Shell Panels for Buckling, Compression loading, Shear Loading / Shell Shear Factor, (No derivations) Circumferential Buckling Stress, sample exercises Theory of Beams-Symmetric Beams in Pure Bending, Deflection of beams. Sample Exercises. **7 Hrs**

Tutorials / Assignments

The assignments for Electives could include the following,

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

Reference Books:

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

22UMEL701	Dynamics of Machines Laboratory	(0-0-2) 1

Contact Hours: 26

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Course Contents :

Part A

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

PART B

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

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

Reference Books:

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

22UMEL702	Major Project-I	(0-0-12) 6

Contact Hours: 156

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Course Contents :

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

VIII Semester

22UMEL800	Technical Seminar/ Independent Study	(0-0-2) 1

Contact Hours: 26

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Course Contents :

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

the seminar material in the form of a paper in IEEE format. All the students are required to attend all the session throughout the semester.

Procedure to conduct technical Seminar:

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

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

22UMEL801	Major Project-II /Internship	(12 weeks)10

Contact Hours: 12 weeks

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Course Contents :

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

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

Reference materials / Books:

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

Internship: The internship is intended for students who do not undertake a project. Students must undergo an internship in private industries, R&D organizations, Center of Excellence, laboratories of reputed institutions, government and semi-government organizations, PSUs, construction companies, or entrepreneurial organizations to gain exposure to the external professional environment. The internship shall be for a duration of 12 weeks during the VIII semester, either through placement or on an individual basis.Students are required to prepare a report on the work carried out during the internship and submit both the report and the internship certificate during the VIII semester. The department shall conduct three project reviews as per the schedule provided by DAP, which must be recorded as part of the project evaluation for CIE.A committee constituted by the HoD, consisting of a minimum of two faculty members, shall conduct the reviews and evaluate the CIE. For SEE, students must appear for a viva-voce examination, which will be assessed by a panel of two examiners—one internal and one external—constituted by the HoD.The rubrics of evaluation includes objectives defined, literature review, demonstration of the work carried out, report, project presentation,communication skill and question and answer session.

22UMEL802 Summer Internship (4 Weeks) 3

Contact Hours:4 Weeks

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Course Contents :

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