B. Tech.

MECHANICAL ENGINEERING

FLEXIBLE CURRICULUM

(For students admitted in 2019-2020 onwards)

DEPARTMENT OF MECHANICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY

TIRUCHIRAPPALLI – 620 015

TAMIL NADU, INDIA

INSTITUTE VISION

To be a university globally trusted for technical excellence where learning and research integrate to sustain society and industry.

INSTITUTE MISSION

1. To offer undergraduate, postgraduate, doctoral and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
2. To create a converging learning environment to serve a dynamically evolving society.
3. To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
4. To be an intellectual ecosystem where human capabilities can develop holistically.

DEPARTMENT VISION

To be a globally renowned Department in Mechanical Engineering where the best of teaching, learning and research synergize to fulfil the requirements of industry and society.

DEPARTMENT MISSION

1. To prepare effective and responsible engineers for global requirements by providing quality education through graduate, post graduate and doctoral research programmes.
2. To constantly strive to improve the teaching and learning processes by adopting innovative pedagogical methods.
3. To respond effectively to the needs of the industry and society by offering sustainable and innovative solutions
4. To conduct basic and interdisciplinary research to publish in reputed international journal and to generate intellectual property.
5. To provide consultancy services and cultivate the spirit of entrepreneurship.

Programme Educational Objectives (PEO's)

1. Graduates will be successful Mechanical Engineers in the industry or in technical or professional career.
2. Graduates will continue to constantly learn the emerging technology and advanced field of study.
3. Graduates will be able to take up leadership positions in interdisciplinary technological activities.

Programme Outcomes (Pos)

1. Apply knowledge of mathematics, science and engineering to arrive solutions for mechanical engineering problems.
2. Identify, formulate and analyze engineering problems through technical literature.
3. Design a component, a process and a system to meet desired needs considering economic, environmental, social, ethical, health and safety, manufacturability and sustainability.
4. Conduct experiment, analyze and interpret data to arrive valid conclusions.
5. Use the techniques, skills, and modern engineering tools for modelling and prediction of problems by understanding the limitations.
6. Recognize the importance of health and safety, societal, cultural responsibility in the design and implementation of engineering projects.
7. Know and apply societal and environmental context to engineering solutions for sustainable development.
8. Apply the standards and professional ethics in engineering practice.
9. Function effectively as a member or leader of a team.
10. Express effectively, comprehend and write reports on the engineering activities.
11. Apply engineering and management principles to manage projects in multidisciplinary environments.
12. Engage themselves in life-long learning by recognizing the need and technological changes.

Programme Specific Outcomes (PSOs)

1. Apply the fundamental knowledge acquired in the area of design, thermal engineering and manufacturing to identify, formulate and solve mechanical engineering problems confronted by the industry and society.
2. Develop products and processes by carrying out research and development considering the economic constraints, sustainability, environment, safety, and cultural perceptions.

CURRICULUM

The total minimum credits for completing B.Tech. Programme in Mechanical Engineering is 158.

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES

The structure of B.Tech. Programme shall have General Institute Requirements (GIR), Programme Core (PC), Elective Courses (PE and OE), Minor (MI) Courses, Honours (HO) Courses and Essential Laboratory Requirement (ELR) Courses are as follows:

Sl. No	Course Category	No. of Courses	No. of Credits
1.	General Institute Requirement (GIR) Courses	22	50
2.	Programme Core (PC) Courses	15	50
3.	Essential Laboratory Requirement (ELR) Courses	8	16
4.	Elective Courses a. Programme Elective (PE) b. Open Elective (OE)	14*	42
Total			**158**
5.	Minor (MI) Course (Optional)	Courses for 15 credits	Additional 15 credits
6.	Honors (HO) Course (Optional)	Courses for 15 credits	Additional 15 credits

*Out of 14 elective courses, eight should be Program Elective (PE) courses. Out of the remaining six electives, a student can opt for Project Work instead of two electives equivalent to 6 credits.

I. GENERAL INSTITUTE REQUIREMENT (GIR) COURSES:

Sl. No	Name of the Course	No. of Courses	Max. Credits
1.	Mathematics	3	10
2.	Physics (Theory and Lab)	2	5
3.	Chemistry (Theory and Lab)	2	5
4.	Industrial Economics and Foreign Trade	1	3
5.	English for Communication (Theory & Lab)	2	4
6.	Energy and Environmental Engineering	1	2
7.	Professional Ethics	1	3
8.	Engineering Graphics	1	3
9.	Engineering Practice	1	2
10.	Basic Engineering	2	4
11.	Introduction to computer Programming	1	3
12.	Branch Specific Course (Introduction to Mechanical Engineering)	1	2
13.	Summer Internship	1	2
14.	Comprehensive viva	1	1
15.	Industrial Lecture	1	1
16.	NSS/NCC/NSO (Compulsory Participation)	1	0
17.	Project Work	1**	6**

**Project work is an optional course. A student can opt for either Project Work or two electives courses equivalent to 6 credits

1. MATHEMATICS

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MAIR11	Matrices and Calculus	-NIL-	3
2.	MAIR21	Complex Analysis and Differential Equations	-NIL-	3
3.	MAIR43	Fourier transforms and Numerical techniques	MAIR11, MAIR21	4
Total				**10**

2. PHYSICS

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	PHIR11	Physics	-NIL-	3
2.	PHIR12	Physics Lab	-NIL-	2
Total				**5**

3. CHEMISTRY

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	CHIR11	Chemistry	-NIL-	3
2.	CHIR12	Chemistry Lab	-NIL-	2
Total				**5**

4. HUMANITIES

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	HSIR11	English for Communication	-NIL-	2
		Language Lab	-NIL-	2
2.	HSIR13	Industrial Economics and Foreign Trade	-NIL-	3
3.	HSIR14	Professional Ethics	-NIL-	3
Total				**10**

5. ENERGY AND ENVIRONMENTAL ENGINEERING

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	ENIR11	Energy and Environmental Engineering	-NIL-	2
Total				**2**

6. ENGINEERING GRAPHICS

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR12	Engineering Graphics	-NIL-	3
Total				**3**

7. ENGINEERING PRACTICE

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	PRIR11	Engineering Practice	-NIL-	2
Total				**2**

8. BASICS OF ENGINEERING

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	EEIR11	Basics of Electrical and Electronics Engineering	-NIL-	2
2.	CEIR11	Basics of Civil Engineering	-NIL-	2
Total				**4**

9. COMPUTER PROGRAMMING

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	CSIR11	Introduction to Computer Programming	-NIL-	3
Total				**3**

10. BRANCH SPECIFIC COURSE

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR15	Introduction to Mechanical Engineering	-NIL-	2
Total				**2**

11. SUMMER INTERNSHIP

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR16	Summer Internship	-NIL	2
Total				**2**

Students should undergo industrial training/internship for a minimum period of six weeks during the summer vacation of III year. Registration for this course shall be along with the courses for VII semester. Attachment with an academic institution within the country (IISc/IITs/NITs/IIITs and CFTIs) or university abroad is also permitted instead of industrial training. A report is to be submitted to the Head of the Department and evaluation (2 credit) will be based on the report and viva-voce examination.

12. PROJECT WORK

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR17	Project Work[#]	-NIL-	6
Total				**6**

13. COMPREHENSIVE VIVA

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR18	Comprehensive Viva	NIL-	1
Total				**1**

The comprehensive examination in the final year of study shall have two objective tests of 25 marks each. The final examination shall have 50 marks. The examination will be of objective type similar to the GATE examination. A department committee comprising the Head of the Department or his/her nominee and two faculty members of the department shall conduct the examinations.

14. INDUSTRIAL LECTURE

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR19	Industrial Lecture	-NIL-	1
Total				**1**

A course based on industrial lectures shall be offered for 1 credit. A minimum of five lectures of two hours' duration by industry experts will be arranged by the Department. The evaluation methodology, will in general, be based on quizzes at the end of each lecture. Due weightage shall be given to attendance also. However, the HoD or her/his nominee may devise a suitable methodology for evaluation and the same should be informed to the students before the commencement of the semester.

15. NSS/NCC/NSO

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	SWIR11	NSS / NCC / NSO	-NIL-	0
Total				**0**

All students admitted to the B.Tech. Program will have to take either NCC or NSO or NSS as a non-credit extra-curricular Program. NCC Program is not available for foreign nationals. The NCC / NSO / NSS requirement should be completed within the first two semesters.

II. PROGRAMME CORE (PC) COURSES

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEPC10	Engineering Mechanics	-NIL-	3
2.	MEPC11	Engineering Thermodynamics	-NIL-	3
3.	MEPC12	Strength of Materials	-NIL-	3
4.	MEPC13	Applied Electrical and Electronics Engineering	EEIR11	4
5.	MEPC14	Fluid Mechanics and Machines	-NIL-	4
6.	MEPC15	Mechanics of Machines – I	MEPC10	3
7.	MEPC16	Manufacturing Technology	-NIL-	3
8.	MEPC17	Thermal Engineering	MEPC11	4
9.	MEPC18	Engineering Materials	-NIL-	4
10.	MEPC19	Heat and Mass Transfer	MEPC11	3
11.	MEPC20	Mechanics of Machines – II	MEPC15	3
12.	MEPC21	Metrology and Measurements	-NIL-	3
13.	MEPC22	Automobile Engineering	-NIL-	3
14.	MEPC23	Energy Conversion systems	MEPC17	3
15.	MEPC24	Design of Machine Elements	MEPC12 MEPC15	4

III. ESSENTIAL LABORATORY REQUIREMENT (ELR) COURSES

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MELR11	Strength of Materials and Fluid Mechanics & Machines Laboratory	-NIL-	2
2.	MELR12	Computer Aided Machine Drawing	-NIL-	2
3.	MELR13	Thermal Engineering Laboratory	-NIL-	2
4.	MELR14	Manufacturing Technology Laboratory	-NIL-	2
5.	MELR15	Heat Transfer and Refrigeration & Air-Conditioning Laboratory	-NIL-	2
6.	MELR16	Metrology and Measurements Laboratory	-NIL-	2
7.	MELR17	Dynamics Laboratory	-NIL-	2
8.	MELR18	Automobile Engineering Laboratory	-NIL-	2

IV. ELECTIVE COURSES

a. *PROGRAMME ELECTIVES (PE)*

Out of the 14 elective courses offered in the curriculum, a Student should opt for a minimum eight Program Elective courses.

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEPE10	Compressible Flow and Jet Propulsion	MEPC14	3
2.	MEPE11	Computational Fluid Dynamics	MEPC14	3
3.	MEPE12	Advanced IC Engines	MEPC17	3
4.	MEPE13	Combustion Engineering	MEPC17	3
5.	MEPE14	Biofuels	-NIL-	3
6.	MEPE15	Refrigeration and Air Conditioning	MEPC17	3
7.	MEPE16	Fundamentals of HVAC Systems	MEPC17	3
8.	MEPE17	Cryogenic Engineering	MEPC17	3
9.	MEPE18	Nano Technology	MEPC18	3
10.	MEPE19	Vehicle Dynamics	MEPC22	3
11.	MEPE21	Dynamics of Machinery	MEPC20	3
12.	MEPE22	MEMS Devices – Design and Fabrication	MEPC13	3
13.	MEPE24	Oil Hydraulics and Pneumatics	MEPC14	3
14.	MEPE25	Industrial Robotics	MEPC13	3

15.	MEPE26	Mechatronics	MEPC13	3
16.	MEPE27	Industrial Tribology	MEPC18	3
17.	MEPE29	Renewable Energy Sources	MEPC17	3
19.	MEPE30	Continuum Mechanics	MEPC12	3
20.	MEPE31	Mathematical Methods for Mechanical Engineers	MAIR43	3
21.	MEPE32	Two phase flow and heat transfer	MEPC19	3
22.	MEPE33	Theory of sprays	MEPC14	3
23.	MEPE34	Additive Manufacturing	MEPC16	3
24.	MEPE35	Computer Aided design and drafting	MEIR12	3
25.	MEPE36	Power Plant Engineering	MEPC17	3
26.	MEPE37	Radiative Heat Transfer	MEPC19	3
27.	MEPE38	Quality Control	-NIL-	3
28.	MEPE39	Industrial Safety engineering	-NIL-	3
29.	MEPE40	Operations Research	-NIL-	3
30.	MEPE41	Mechanical Vibrations	MEPC20	3
31.	MEPE42	Introduction to Fracture Mechanics	MEPC12	3
32.	MEPE43	Theory of Elasticity	MEPC12	3
33.	MEPE44	Industrial Noise and Vibration Control	MEPC14, MEPC17	3

b. OPEN ELECTIVES (OE)

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEOE11	Finite Element Method	-NIL-	3
2.	MEOE12	Composite Materials	-NIL-	3
3.	MEOE15	Optimization in Engineering Design	-NIL-	3
4.	MEOE17	Energy Conservation and Management	-NIL-	3
5.	MEOE18	Energy Storage Technology	-NIL-	3
6.	MEOE20	Low Temperature Technology	-NIL-	3
7.	MEOE21	Waste to Energy Conversion Techniques	-NIL-	3
8.	MEOE22	Non-Destructive Testing	-NIL-	3
9.	MEOE23	Pollution and Control	-NIL-	3
10.	MEOE24	Welding Technology	-NIL-	3

V. MINOR COURSES

MI –Minor Degree: 15 credits over and above the minimum credit as specified by the departments. The details of MINOR will be mentioned only in the transcript not in the Degree certificate

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEMI10	Basic Thermodynamics	-NIL-	3
2.	MEMI11	Fundamentals of Thermal Engineering	-NIL-	3
3.	MEMI12	Fluid Mechanics and Machinery	-NIL-	3
4.	MEMI13	Fundamentals of Heat and Mass Transfer	-NIL-	3
5.	MEMI15	Fundamentals of Automotive Technology	-NIL-	3
6.	MEMI17	Fundamentals of Refrigeration and Air Conditioning	-NIL-	3
7.	MEMI18	Principles of Turbomachinery	-NIL-	3
8.	MEMI19	Fundamentals of Internal Combustion Engines	-NIL-	3
9.	MEMI20	Engine Pollution and Control	-NIL-	3
10.	MEMI22	Dynamics	-NIL-	3
11.	MEMI23	Fundamental of Mechanical design	-NIL-	3

VI. HONORS COURSE

HO –Honours Degree: 15 credits over and above the minimum credit as specified by the departments. The project work is compulsory.

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEHO10	Advanced Heat Transfer	MEPC19	4
2.	MEHO11	Advanced Fluid Mechanics	MEPC14	4
3.	MEHO12	Simulation of IC Engines	MEPC17	3
4.	MEHO13	Design and Analysis of Turbo Machines	MEPC14	3
5.	MEHO14	Advanced Engineering Materials	MEPC18	4
6.	MEHO15	Design of Heat Exchangers	MEPC19	4
7.	MEHO16	Design and Optimization of Thermal Energy Systems	MEPC17	4
8.	MEHO17	Heat Transfer Equipment Design	MEPC19	3
9.	MEHO18	Analysis and Design of Pressure Vessels	MEPC12	3
10.	MEHO19	Analysis of Thermal Power Cycles	MEPC17	3
11.	MEHO20	Fuels Combustion and Emission Control	MEPC17	4
12.	MEHO21	Finite Element Method in Mechanical Engineering	MEPC19	4
13.	MEHO22	Smart Materials and Structures	MEPC13	4
14	MEHO23	Fundamentals of Biomechanics	MEPC10	4
15	MEHO24	Computational Methods in Engineering	-NIL-	4

SEMESTER WISE CURRICULUM

Semester I

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MAIR11	Matrices and Calculus	-NIL-	3
2.	HSIR11	English for Communication (Theory & Lab)	-NIL-	4
3.	CHIR11	Chemistry	-NIL-	3
4.	CHIR12	Chemistry Lab	-NIL-	2
5.	EEIR11	Basics of Electrical and Electronics Engineering	-NIL-	2
6.	MEIR12	Engineering Graphics	-NIL-	3
7.	MEIR15	Introduction to Mechanical Engineering	-NIL-	2
TOTAL CREDITS				**19**

Semester II

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MAIR21	Complex Analysis and Differential Equations	-NIL-	3
2.	PHIR11	Physics	-NIL-	3
3.	PHIR12	Physics Lab	-NIL-	2
4.	CSIR11	Introduction to Computer Programming	-NIL-	3
5.	CEIR11	Basics of Civil Engineering	-NIL-	2
6.	ENIR11	Energy and Environmental Engineering	-NIL-	2
7.	PRIR11	Engineering Practice	-NIL-	2
8.	MEPC10	Engineering Mechanics	-NIL-	3
TOTAL CREDITS				**20**

Semester III

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	HSIR13	Industrial Economics and Foreign Trade	-NIL-	3
2.	MEPC11	Engineering Thermodynamics	-NIL-	3
3.	MEPC12	Strength of Materials	-NIL-	3
4.	MEPC13	Applied Electrical and Electronics Engineering	EEIR11	4
5.	MEPC14	Fluid Mechanics and Machines	-NIL-	4
6.	MELR11	Strength of Materials and Fluid Mechanics & Machines Laboratory	-NIL-	2
7.	MELR12	Computer Aided Machine Drawing	-NIL-	2
8.		Elective I		3
TOTAL CREDITS				**24**

Semester IV

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MAIR43	Fourier transforms and Numerical techniques	MAIR11, MAIR21	4
2.	MEPC15	Mechanics of Machines – I	MEPC10	3
3.	MEPC16	Manufacturing Technology	-NIL-	3
4.	MEPC17	Thermal Engineering	MEPC11	4
5.	MELR13	Thermal Engineering Laboratory	-NIL-	2
6.	MELR14	Manufacturing Technology Laboratory	-NIL-	2
7.		Elective II		3
8.		Elective III		3
TOTAL CREDITS				**24**

Semester V

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	HSIR14	Professional Ethics	-NIL-	3
2.	MEPC18	Engineering Materials	-NIL-	4
3.	MEPC19	Heat and Mass Transfer	MEPC11	3
4.	MEPC20	Mechanics of Machines – II	MEPC15	3
5.	MEPC21	Metrology and Measurements	-NIL-	3
6.	MELR15	Heat transfer and Refrigeration & Air-Conditioning Laboratory	-NIL-	2
7.	MELR16	Metrology and Measurements Laboratory	-NIL-	2
8.		Elective IV		3
TOTAL CREDITS				**23**

Semester VI

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR19	Industrial Lecture	NIL-	1
2.	MEPC22	Automobile Engineering	-NIL-	3
3.	MEPC23	Energy Conversion systems	MEPC17	3
4.	MEPC24	Design of Machine Elements	MEPC12 MEPC15	4
5.	MELR17	Dynamics Laboratory	-NIL-	2
6.	MELR18	Automobile Engineering Laboratory	-NIL-	2
7.		Elective V		3
8.		Elective VI		3
9.		Elective VII		3
TOTAL CREDITS				**24**

Semester VII

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR16	Summer Internship	-NIL-	2
2.		Elective VIII		3
3.		Elective IX		3
4.		Elective X		3
5.		Elective XI		3
TOTAL CREDITS				**14**

Semester VIII

Sl. No	Course Code	Course Title	Pre-requisites	Credits
1.	MEIR18	Comprehensive Viva Voce	-NIL-	1
2.		Elective XII		3
3.		Elective XIII		3
4.		Elective XIV		3
5.		Project Work**		6**
TOTAL CREDITS				**10**

**Project work is an optional course. A student can opt for either Project Work or two electives courses equivalent to 6 credits

I. GENERAL INSTITUTE REQUIREMENT (GIR) COURSES

MAIR11 MATRICES AND CALCULUS

Course Code:	MAIR11	No. of Credits:	03
Course Name:	Matrices and Calculus	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

- Introduce eigen value and eigen vectors and its properties.
- Determine canonical form of given quadratic form.
- Discuss the convergence of infinite series.
- Analyse and discuss the extrema of the functions of several variables.
- Evaluate the multiple integrals and apply in solving problems.
- Introduce vector differential operator for vector function and important theorems on vector functions to solve engineering problems

COURSE CONTENT

Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem. Quadratic form.

Sequence and series: Convergence of sequence. Infinite Series-Tests for Convergence-Integral test, comparison test, Ratio test, Root test, Raabe's test, Logarithmic test, and Leibnitz's test; Power series.

Functions of two variables: Limit, continuity and partial derivatives; Total derivative, Jacobian, Taylor series, Maxima, minima and saddle points; Method of Lagrange multipliers; Double and triple integrals, change of variables, multiple integral in cylindrical and spherical coordinates.

Gradient, divergence and curl; Line and surface integrals; Green's theorem, Stokes theorem and Gauss divergence theorem (without proofs).

REFERENCE BOOKS

1. Dennis Zill, Warren S. Wright, Michael R. Cullen, *Advanced Engineering Mathematics*, Jones & Bartlett Learning, 2011
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2019.
3. Jerrold E. Marsden, Anthony Tromba, *Vector Calculus*, W. H. Freeman, 2003
4. Strauss M.J, G.L. Bradley and K.J. Smith, *Multivariable calculus*, Prentice Hall, 2002.
5. Ward Cheney, David Kincaid, *Linear Algebra: Theory and Applications*, Jones & Bartlett Publishers, 2012.

COURSE OUTCOME

1. Compute eigenvalues and eigenvectors of the given matrix.
2. Transform given quadratic form into canonical form.
3. Discuss the convergence of infinite series by applying various test.
4. Compute partial derivatives of function of several variables
5. Write taylor's series for functions with two variables.
6. Evaluate multiple integral and its applications in finding area, volume.
7. Compute the dot product of vectors, lengths of vectors, and angles between vectors.
8. Perform gradient, div, curl operator on vector functions and give physical interpretations.
9. Use green's, gauss divergence and stoke's theorems to solve engineering problems.

MAIR21 COMPLEX ANALYSIS AND DIFFERENTIAL EQUATIONS

Course Code:	MAIR21	No. of Credits:	03
Course Name:	Complex Analysis and Differential Equations	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

The course presents

1. an introduction to analytic functions and power series.
2. various Cauchy's theorems and its applications in evaluation of integral.
3. various approach to find general solution of the ordinary differential equations
4. Laplace transform techniques to find solution of differential equations Partial differential equations and methods to find solution.

COURSE CONTENT

Analytic functions; Cauchy-Riemann equations; Line integral, Cauchy's integral theorem and integral formula (without proof); Taylor's series and Laurent series; Residue theorem (without proof) and its applications.

Higher order linear differential equations with constant coefficients; Second order linear differential equations with variable coefficients; Method of variation of parameters; Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

Laplace Transform of Standard functions, derivatives and integrals – Inverse Laplace transform – Convolution theorem – Periodic functions – Application to ordinary differential equation.

Formation of partial differential equations by eliminating arbitrary constants and functions – solution of first order partial differential equations – four standard types – Lagrange's equation. Method of separation of variables.

REFERENCE BOOKS

1. James Ward Brown, Ruel Vance Churchill, *Complex Variables and Applications*, McGraw-Hill Higher Education, 2004
2. Dennis Zill, Warren S. Wright, Michael R. Cullen, *Advanced Engineering Mathematics*, Jones & Bartlett Learning, 2011
3. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley & Sons, 2019.
4. William E. Boyce, Richard C. DiPrima, Douglas B. Meade, *Elementary Differential Equations and Boundary Value Problems*, Wiley, 2017.
5. Ian N. Sneddon, *Elements of Partial Differential Equations*, Courier Corporation, 2013

COURSE OUTCOME

Completion of the course, student will be able to

1. understand analytic functions discuss its properties
2. obtain series representation of analytic functions
3. evaluate various integrals by using Cauchy's residue theorem
4. classify singularities and derive Laurent series expansion
5. find the solutions of first and some higher order ordinary differential equations
6. apply properties of special functions in discussion the solution of ODE.
7. Find Laplace transform of a given function and its inverse Laplace transform.
8. Find solution of first order partial differential equations.

MAIR43 – Fourier transforms and Numerical techniques

Course Code:	MAIR43	No. of Credits:	04
Course Name:	Fourier transforms and Numerical techniques	Prerequisite:	MAIR11, MAIR21

COURSE LEARNING OBJECTIVES

Objective is to introduce

1. Fourier transform and its use to solve the mathematical equations arising in mechanical engineering.
2. Understand Fourier series analysis and its use in solving boundary value problems.
3. Numerical Methods for Solving Linear Systems
4. Numerical Solutions of Ordinary Differential Equations
5. Numerical Methods to solve partial differential equations

COURSE CONTENT

Fourier series - Dirichlet's conditions - Half range Fourier cosine and sine series - Parseval's relation - Fourier series in complex form – Harmonic analysis.

Fourier transforms - Fourier cosine and sine transforms – inverse transforms - convolution theorem and Parseval's identity for Fourier transforms - Finite cosine and sine transforms.

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector.

Numerical Solution of Ordinary Differential Equations- Euler's method - Euler's modified method - Taylor's method and Runge-Kutta method for simultaneous equations and 2nd order equations-Stability analysis of single step methods- Multistep methods - Milne's and Adams' methods.

Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one-dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method - Solution of one-dimensional wave equation.

REFERENCE BOOKS:

1. Debnath L., and Dambaru Bhatta, Integral Transforms and Their Applications, 2nd Ed.(Special Indian Ed).Chapman & Hall/CRC, Indian Edtion, 2010
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2010.
3. David Kincaid and Ward Cheney, Numerical Analysis\, 3rd edition, American Mathematics Society, (Indian edition) – 2010.
4. Gerald C.F., and Wheatley P.O., Applied Numerical Analysis, Addison-Wesley Publishing Company, 1994
5. Jain, M.K., Iyengar, S.R. and Jain, R.K., Numerical Methods for Scientific and Engineering Computation, New Age international,2003

COURSE OUTCOMES:

On completion of the course, students should be able to

1. compute numerical solution of given system AX=B by direct and iterative methods.
2. compute largest eigenvalue and its corresponding eigenvector of matrix A.
3. compute numerical solution of ordinary differential equations by finite difference method.
4. compute numerical solution of partial differential equations by finite difference method.
5. Compute Fourier and inverse Fourier transform of functions.
6. Compute Fourier series of given function and interpret its coefficients.

PHIR11 PHYSICS

Course Code:	PHIR11	No. of Credits:	03
Course Name:	Physics	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

- To introduce the notions of light matter interaction, fabrication of lasers, light propagation in waveguides, applications of lasers and optical fibers to engineering students.
- To comprehend and explain the concepts of matter waves, wave functions and its interpretation to understand the matter at atomic scale.
- To teach the fundamentals of nuclear forces, models and classification of matter.
- To impart knowledge about the basics of conductors, superconductors, nanomaterials and their applications in science, engineering and technology.

COURSE CONTENT

Lasers: Introduction to Laser-characteristics of Lasers-spontaneous and stimulated emissions – Einstein's coefficients – population inversion and lasing action – laser systems: He-Ne Laser, semiconductor laser-applications.

Fiber Optics: Snell's law-optical fiber – principle and construction – acceptance cone - numerical aperture –types of fibers - fiber optic communication principle – fiber optic sensors.

Quantum Mechanics: Inadequacy of classical mechanics-black body radiation, photoelectric effect-wave and particle duality of radiation – de Broglie concept of matter waves – electron diffraction – Heisenberg's uncertainty principle – Schrodinger's wave equation – eigen values and eigen functions – superposition principle – interpretation of wave function – particle confined in one dimensional infinite square well potential.

Nuclear and Particle Physics: Nuclear properties and forces - Nuclear models - Shell model - Nuclear reaction - Radioactivity - types and half-life. Fundamental forces - Particle physics - classification of matter - quark model.

Physics of Advanced Materials: Conductors: classical free electron theory (Lorentz –Drude theory) – electrical conductivity. Superconductors: definition – Meissner effect – type I & II superconductors – BCS theory (qualitative). Nanomaterials: introduction and properties – synthesis – top-down and bottom-up approach – applications.

REFERENCE BOOKS

1. William T. Silfvast, *Laser Fundamentals*, 2nd Edition, Cambridge University press, New York, 2004.
2. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, 6th Edition, John Wiley and Sons, New York, 2001.
3. Arthur Beiser, *Concepts of Modern Physics*, Tata McGraw-Hill, New Delhi, 2010.
4. R. Shankar, *Fundamentals of Physics*, Yale University Press, New Haven and London, 2014.
5. R. Shankar, *Fundamentals of Physics II*, Yale University Press, New Haven and London, 2016.
6. C.P. Poole and F.J. Owens, *Introduction to Nanotechnology*, Wiley, New Delhi, 2007.
7. Charles Kittel, *Introduction to Solid State Physics*, 8th Edition, John Wiley & Sons, NJ, USA, 2005.

COURSE OUTCOME

1. On completion of this course, the students will be able to,
2. know principle, construction and working of lasers and their applications in various science and engineering.
3. explain light propagation in optical fibers, types and their applications.
4. experience and appreciate the behaviour of matter at atomic scale, and to impart knowledge in solving problems in modern science and engineering.
5. understand the role of nuclear and particle physics in applications like radioactivity and nuclear reactions.
6. recognize, choose and apply knowledge to develop materials for specific applications for common needs.

PHIR12 PHYSICS LAB

Course Code:	PHIR12	No. of Credits:	02
Course Name:	Physics Lab	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

- To introduce the spirit of experiments to verify physics concepts such as reflection, refraction, diffraction and interference on light matter interaction.
- To perform experiments to estimate the materials properties and to check their suitability in science and engineering.
- To familiarize physics concepts and to design instruments and experimental set up for better and accurate measurements.
- To teach and apply knowledge to measure and verify the values of certain constants in physics.

LIST OF EXPERIMENTS

1. Determination of rigidity modulus of a metallic wire
2. Conversion of galvanometer into ammeter and voltmeter
3. Wavelength of laser using diffraction grating
4. Dispersive power of a prism – Spectrometer
5. Radius of curvature of Lens-Newton's Rings
6. Numerical aperture of an optical fiber
7. Field along the axis of a Circular coil
8. Wavelength of white light – Spectrometer
9. Calibration of Voltmeter – Potentiometer
10. Thickness of a thin wire – Air Wedge
11. Specific rotation of a liquid – Half Shade Polarimeter
12. Photoelectric effect – Planck's constant

REFERENCE BOOKS

1. *Physics Laboratory Manual*, Department of Physics, National Institute of Technology Tiruchirappalli, 2018.
2. R.K. Shukla, Anchal Srivastava, *Practical Physics*, New age international, 2011.
3. C.L Arora, *B.Sc. Practical Physics*, S. Chand & Co., 2012

COURSE OUTCOME

On completion of this course, the students will be able to

1. Know how to calibrate a galvanometer and convert it into a current and voltmeters.
2. To make experimental setup to verify certain physics concepts of wave and particle nature of light.
3. Understand the light propagation in fibers, light matter interaction and use of lasers in science and engineering.
4. Acquire knowledge, estimate and suggest materials for engineering applications.

CHIR11 CHEMISTRY

Course Code:	CHIR11	No. of Credits:	03
Course Name:	Chemistry	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

To introduce the student's basic principles of Electrochemistry and Corrosion. They will be familiar with phase rule & its applications. Students will know about the essential requirements of water and its importance in day-to-day life. To provide students with a brief outline of the types and applications of polymers. Finally, students will be equipped with the usage of spectroscopy in industrial applications.

COURSE CONTENT

Electrochemistry and Corrosion

Cell EMF- its measurement and applications - concentration cell - electrode electrolyte concentration cell - concentration cell with and without transference - Dry corrosion and wet corrosion, mechanisms, types of corrosion, Differential metal corrosion, differential aeration corrosion, intergranular, Passivity, Pitting, Polarization - Chemical conversion coatings and organic coatings- Paints, enamels.

Phase rule

Definition of terms – phase- components- degree of freedom- derivation of Gibbs phase rule – one component system – H_2O, CO_2, Sulfur – Two-component system – Eutectic systems – reduced phase rule - Pb-Ag system – Compound Formation with congruent melting – Zn- Mg Alloy system- Copper-nickel alloy system - systems with incongruent melting – Na_2SO_4- H_2O system and simple three-component systems.

Water

Sources, Hard & soft water, Estimation of hardness by EDTA method, Scale & Sludge- Caustic embrittlement - softening of water, zeolite process & demineralization by ion exchangers, boiler feed water, internal treatment methods-specifications for drinking water, BIS & WHO standards, treatment of water for domestic use, desalination - Reverse osmosis & Electrodialysis.

Spectroscopy

Interaction of electromagnetic radiation with matter, Electronic spectroscopy - Theory of electronic transitions, instrumentation, Beers Lambert law, Woodward FIESER rule, applications. IR spectroscopy - Fundamentals, Instrumentation, and applications, Raman spectroscopy – Fundamentals and applications.

Polymers and Composites

Concept of macromolecules- Tacticity- Classification of Polymers- Types of Polymerization- Mechanism- - Ziegler Natta Polymerization - Effect of Polymer structure on properties -Important addition and condensation polymers –synthesis and properties – Molecular mass determination of polymers- Static and dynamic methods, Light scattering- Rubbers –Vulcanization – Synthetic rubbers – Conducting polymers- Composite materials

REFERENCE BOOKS

1. P.C. Jain, M. Jain, *Engineering Chemistry*, Dhanpat Rai Publishing Company, New Delhi, 2005.
2. P. Atkins, J.D. Paula, *Physical Chemistry*, Oxford University Press, 2002.
3. B.R. Puri, L.R. Sharma, M.S. Pathania, *Principles of Physical Chemistry*, Vishal Publishing Company, 2008
4. F.W. Billmayer, *Textbook of Polymer Science*, 3rd Edison, Wiley. N.Y. 1991.
5. S.S. Darer, S.S. Umare, *A Text Book of Engineering Chemistry*, S. Chand Publishing, 2011.

COURSE OUTCOME

- Students will learn about the Electrochemistry and phase rule.
- They will be familiarized with the importance of polymer and its application in industries.
- Additionally, a brief introduction in the area of water, spectroscopy will be very useful for the students in future endeavour

CHIR12 CHEMISTRY LAB

Course Code:	CHIR12	No. of Credits:	02
Course Name:	Chemistry Lab	Prerequisite:	Nil

LIST OF EXPERIMENTS

1. Estimation of carbonate, non-carbonate and total hardness in the given water sample.
2. Estimation of dissolved oxygen in the given water sample.
3. Determination of the percentage of Fe in the given steel sample.
4. Estimation of Fe^{3+} by spectrophotometer.
5. Corrosion rate by polarization technique
6. Conductometric titration
7. Potentiometric titration
8. pH-metric titration
9. Percentage purity of bleaching powder
10. Determination of molecular weight of the polymer by Viscometry
11. Study of three component system.
12. Demonstration experiments using Advanced Spectroscopic Techniques, (UV-Vis, FTIR, Raman)

REFERENCE BOOKS

1. *Laboratory Manual*, Department of Chemistry, National Institute of Technology, Tiruchirappalli.
2. S.K. Bhasin, S. Rani, *Laboratory Manual on Engineering Chemistry*, Dhanpat Rai Publishing Company, New Delhi, 2011.

COURSE OUTCOME

- The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.
- The students will learn how to estimate various components from the corresponding bulk mixture.

HSIR11 ENGLISH FOR COMMUNICATION

Course Code:	HSIR11	No. of Credits:	04
Course Name:	English for Communication	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

The primary objective is to develop in the under-graduate students of engineering a level of competence in English required for independent and effective communication for academic and social needs.

COURSE CONTENT

Theory: Language and communication-reading strategies: skimming, scanning, inferring, predicting and responding to content – Guessing from context – Note making – Vocabulary extension - speed reading practice – use of extensive reading texts.

Analytical and critical reading practice- critical, creative and lateral thinking- language and thinking – thinking process and language development.

Effective writing practice – Vocabulary expansion - Effective sentences: role of acceptability, appropriateness, brevity & clarity in writing – Cohesion & coherence in writing –Writing of definitions, descriptions - Paragraph writing.

Reciprocal relationship between reading and writing –thinking and writing - Argument Writing practice – Perspectives in writing –professional writing - Narrative writing.

Lab: Listening process & practice – Exposure to recorded & structured talks, class room lectures – Problems in comprehension & retention – Note-taking practice – Listening tests- Importance of listening in the corporate world.

Barriers to listening: Physical & psychological – Steps to overcome them – Purposive listening practice – Active listening and anticipating the speaker – Use of technology to improve the skill.

Fluency & accuracy in speech –Improving self-expression – Tonal variations – Listener oriented speaking -Group discussion practice – Interpersonal Conversation -Developing persuasive speaking skills.

Barriers to speaking – Building self-confidence & fluency – Conversation practice- Improving responding capacity - Extempore speech practice – Speech assessment.

REFERENCE BOOKS

1. M. Ashraf Rizvi, *Effective Technical Communication*, Tata McGraw-Hill, New Delhi, 2005.
2. Strunk, William, and E B. White, *The Elements of Style*. Boston: Allyn and Bacon, Pearson Edition, 1999.
3. Garner, Bryan A, *HBR Guide to Better Business Writing*, Hardvard Business Review Press, Boston, Massachusetts, 2013.

COURSE OUTCOME

The students will be able to express themselves in a meaningful manner to different levels of people in their academic and social domains.

HSIR13 INDUSTRIAL ECONOMICS AND FOREIGN TRADE

Course Code:	HSIR13	No. of Credits:	03
Course Name:	Industrial Economics and Foreign Trade	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. Give a simple yet thorough introduction into the main methods of economic analysis of industry structure and firm behaviour under various conditions of technology, competition, and organization.
2. Elaborate students' skills and abilities to use modern theoretical and empirical tools to formulate and solve economic problems.
3. Explore in details how economists approach and answer specific empirical questions.

COURSE CONTENT

Demand and Supply – Forecasting techniques – Cost and Revenues.

Competitive nature of the firms – Keynesian economics – National income.

International Trade – Meaning and Benefits – Basis of International Trade – Foreign Trade and Economic Growth – Balance of Trade – Balance of Payment – Current Trends in India – Barriers to International Trade – WTO – Indian EXIM Policy.

Foreign Exchange Markets – Spot Prices and Forward Prices – Factors influencing Exchange rates – The effects of Exchange rates in Foreign Trade – Tools for hedging against Exchange rate variations – Forward, Futures and Currency options – FEMA – Determination of Foreign Exchange rate and Forecasting

Exchange Rate determination – Marketing – Product life cycle – Marketing research – Branding – Personality – Motivation – Leadership – Working in Teams.

REFERENCE BOOKS:

1. Adhikary Manab, Business Economics, Excel Books, 2004.
2. Dwivedi, D.N., Macro Economics Theory & Policy, Tata Mc Graw-Hill, 2005.
3. Aczel D. Amir, Soundarapandian Jayavel, Complete Business Statistics, Tata Mc Graw-Hill, 2005.
4. Robins P. Stephen, Organizational Behaviour, Prentice-Hall, 2002.
5. Apte P.G., International Financial Management, Tata McGraw Hill, 2011.
6. Jeff Madura, International Corporate Finance, Cengage Learning, 9th Edition, 2011.

COURSE OUTCOMES:

At the end of the course student will be able to

1. Analyze the risk of decision making in a firm.
2. Describe and explain the determinants of the size and structure of firms.
3. Give an overview of trade cycle, inflation, cash flow analysis and Balance sheet.
4. Explain the marketing research, product life cycle, motivation and leadership.
5. Describe the competitive nature of the firm and team working.

HSIR14 PROFESSIONAL ETHICS

Course Code:	HSIR14	No. of Credits:	03
Course Name:	Professional Ethics	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. Identify the core values that shape the ethical behavior of an engineer
2. To create an awareness on professional ethics and Human Values
3. To appreciate the rights of others

COURSE CONTENT

Morals, Values and Ethics - Integrity - work Ethic - Service Learning - Civic Virtue - Respect for others - Living peacefully - Caring - Sharing - Honesty - Courage - Valuing time - Co-operation - Commitment - Empathy - Self-Confidence - Character - Spirituality - The role of engineers in modern society - social expectations.

Sense of 'Engineering Ethics' - Variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy - Models of Professional Roles & Professionalism - theories about right action - Self-interest - customs and religion - uses of ethical theories.

Engineering as experimentation - engineers as responsible experimenters - Research ethics - Codes of ethics - Industrial Standard - Balanced outlook on law - the challenger case study.

Safety and risk - assessment of safety and risk - Riysis - Risk benefit analysis and reducing risk - Govt. Regulator's approach to risks - the three mile island and Chernobyl case studies & Bhopal - Threat of Nuclear power, depletion of ozone, greenery effects - Collegiality and loyalty - respect for authority - collective bargaining - Confidentiality - conflicts of interest - occupation crime - professional rights - employees' rights - Intellectual Property rights (IPR) - discrimination.

Multinational corporations - Business ethics - Environmental ethics - computer ethics - Role in Technological Development - Weapons development engineers as managers - consulting engineers - engineers as expert witnesses and advisors - Honesty - leadership - sample code of conduct ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management Institution of electronics and telecommunication engineers (IETE), India, etc.,.

REFERENCE BOOKS:

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2005).
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Thompson Learning, (2000).
3. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, (1999).
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, (2003)
5. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, (2001)
6. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective", Biztantra, New Delhi, (2004)

COURSE OUTCOME

At the end of the course student will be able to

1. Understood the core values that shape the ethical behaviour of an engineer
2. Exposed awareness on professional ethics and human values.
3. Known their role in technological development

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ENIR11 ENERGY AND ENVIRONMENTAL ENGINEERING

Course Code:	ENIR11	No. of Credits:	02
Course Name:	Energy and Environmental Engineering	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

- To teach the principal renewable energy systems.
- To explore the environmental impact of various energy sources and also the effects of different types of pollutants.

COURSE CONTENT

Present Energy resources in India and its sustainability - Different type of conventional Power Plant--Energy Demand Scenario in India-Advantage and Disadvantage of conventional Power Plants – Conventional vs Non-conventional power generation.

Basics of Solar Energy- Solar Thermal Energy- Solar Photovoltaic- Advantages and Disadvantages-Environmental impacts and safety.

Power and energy from wind turbines- India's wind energy potential- Types of wind turbines- Offshore Wind energy- Environmental benefits and impacts.

Biomass Resources-Biomass conversion Technologies- Feedstock preprocessing and treatment methods- Bioenergy program in India-Environmental benefits and impacts.

Geothermal Energy resources –Ocean Thermal Energy Conversion – Tidal.

Air pollution- Sources, effects, control, air quality standards, air pollution act, air pollution measurement. Water Pollution-Sources and impacts, Soil Pollution-Sources and impacts, disposal of solid waste.

Greenhouse gases – effect, acid rain. Noise pollution. Pollution aspects of various power plants. Fossil fuels and impacts, Industrial and transport emissions- impacts.

REFERENCE BOOKS

1. Boyle G, *Renewable energy: Power for a sustainable future*. Oxford University press, 2004.
2. B H Khan, *Nonconventional Energy Resources,* The McGraw –Hill Second edition.
3. G. D. Rai, *Nonconventional energy sources*, Khanna Publishers, New Delhi, 2006.
4. Gilbert M. Masters, *Introduction to Environmental Engineering and Science*, 2nd *Edition, Prentice Hall, 2003.*
5. G Sargsyam, M Bhatia, S G Banerjee, K Raghunathan and R Soni, *Unleashing the Potential of Renewable Energy in India,* World bank report, Washington D.C, 2011.
6. Godfrey Boyle, Bob Everett and Janet Ramage, *Energy Systems and Sustainability: Power for a sustainable future.* Oxford University press, 2010.

COURSE OUTCOME

Students will be introduced to the Principal renewable energy systems and explore the environmental impact of various energy sources and also the effects of different types of pollutants.

MEIR12 ENGINEERING GRAPHICS

Course Code:	MEIR12	No. of Credits:	03
Course Name:	Engineering Graphics	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. Irrespective of engineering discipline, it has become mandatory to know the basics of Engineering Graphics. The student is expected to possess the efficient drafting skill depending on the operational function in order to perform day to day activity.
2. Provide neat structure of industrial drawing.
3. Enables the knowledge about position of the component and its forms Interpretation of technical graphics assemblies.
4. Preparation of machine components and related parts.

COURSE CONTENT

Fundamentals Drawing standard - BIS, dimensioning, lettering, type of lines, scaling-conventions.

Orthographic projection Introduction to orthographic projection, drawing orthographic views of objects from their isometric views - Orthographic projections of points lying in four quadrants.

Orthographic projection of lines parallel and inclined to one or both planes Orthographic projection of planes inclined to one or both planes. Projections of simple solids - axis perpendicular to HP, axis perpendicular to VP and axis inclined to one and both planes.

Sectioning of solids Section planes perpendicular to one plane and parallel or inclined to other plane.

Intersection of surfaces Intersection of cylinder & cylinder, intersection of cylinder & cone, and intersection of prisms.

Development of surfaces Development of prisms, pyramids and cylindrical & conical surfaces. Isometric and perspective projection Isometric projection and isometric views of different planes and simple solids, introduction to perspective projection.

REFERENCE BOOKS

1. Bhatt, N. D. and Panchal, V.M, Engineering Drawing, Charotar Publishing House, 2010.
2. Ken Morling, Geometric and Engineering Drawing, 3rd Edition, Elsevier, 2010
3. Jolhe, D. A., Engineering drawing, Tata McGraw Hill, 2008
4. Shah, M. B. and Rana, B. C., Engineering Drawing, Pearson Education, 2009
5. K.V. Natarajan, A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 2006.

COURSE OUTCOME

At the end of the course student will be able to visualize the engineering components. A number of chosen problems will be solved to illustrate the concepts clearly.

PRIR11 ENGINEERING PRACTICE

Course Code:	PRIR11	No. of Credits:	02
Course Name:	Engineering Practice	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

- To use hand tools and machinery in Carpentry, welding shop, Foundry, Fitting shop and Sheet Metal work.
- To manufacture engineering products or prototypes.

COURSE CONTENT

Foundry: Mould preparation for Flange and Hand Wheel, Plastic moulding / Wax moulding.

Welding: Fabrication of Butt Joint and Fabrication of Lap Joint.

Carpentry: Wood sizing exercise in planning, marking, sawing, chiseling and grooving to make; Tee Through Halving Joint and Dovetail Scarf Joint.

Fitting: Preparation of joints, markings, cutting and filling for making; Semi-circle part with the given work piece, Dovetail part with the given work piece.

Sheet metal: Fabrication of Dust Pan and Fabrication of Corner Tray.

REFERENCE BOOKS

1. R.K. Rajput, *Workshop Practice*, Laxmi Publications (P) Limited, 2009.
2. Shashi Kant Yadav, *Workshop Practice*, Discovery Publishing House, New Delhi, 2006.

COURSE OUTCOME

1. Know to utilize hand tools and machineries in Carpentry, Welding shop, Foundry, Fitting shop and Sheet Metal work.
2. Produce simple engineering products or prototypes

CEIR11 BASIC CIVIL ENGINEERING

Course Code:	CEIR11	No. of Credits:	02
Course Name:	Basic Civil Engineering	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

- To give an overview of the fundamentals of the Civil Engineering fields to the students of all branches of Engineering.
- To realize the importance of the Civil Engineering Profession in fulfilling societal needs.

COURSE CONTENT

Properties and uses of construction materials - stones, bricks, cement, concrete and steel.

Site selection for buildings - Component of building - Foundation- Shallow and deep foundations - Brick and stone masonry - Plastering - Lintels, beams and columns - Roofs.

Roads-Classification of Rural and urban Roads- Pavement Materials-Traffic signs and road Marking-Traffic Signals.

Surveying - Classification-Chain Survey-Ranging-Compass Survey-exhibition of different survey equipment.

Sources of Water - Dams- Water Supply-Quality of Water-Wastewater Treatment – Sea Water Intrusion – Recharge of Ground Water.

REFERENCE BOOKS

1. Punmia, B.C, Ashok Kumar Jain, Arun Kumar Jain, *Basic Civil Engineering*, Lakshmi Publishers, 2012.
2. Satheesh Gopi, *Basic Civil Engineering*, Pearson Publishers, 2009.
3. Rangwala, S.C, *Building materials*, Charotar Publishing House, Pvt. Limited, Edition 27, 2009.
4. Palanichamy,M.S, *Basic Civil Engineering*, Tata McGraw Hill, 2000.
5. Lecture notes prepared by Department of Civil Engineering, NITT.

COURSE OUTCOME

1. The students will gain knowledge on site selection, construction materials, components of buildings, roads and water resources
2. A basic appreciation of multidisciplinary approach when involved in Civil Related Projects.

EEIR11 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code:	EEIR11	No. of Credits:	02
Course Name:	Basic Electrical and Electronics Engineering	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

- This course aims to equip the students with a basic understanding of Electrical circuits and machines for specific types of applications.
- The course gives a comprehensive exposure to house wiring.
- This course also equips students with an ability to understand basics of analog and digital electronics.

COURSE CONTENT

DC & AC Circuits: Current, voltage, power, Kirchhoff's Laws - circuit elements R, L and C, phasor diagram, impedance, real and reactive power in single phase circuits.

DC & AC Machines: DC Motor, Induction motor, Synchronous motor, Synchronous generator and Transformers- construction, principle of operation, types and applications.

House wiring & safety: Single phase and three phase system – phase, neutral and earth, basic house wring - tools and components, different types of wiring – staircase, florescent lamp and ceiling fan, basic safety measures at home and industry.

Analog Electronics: semiconductor devices – p-n junction diode, Zener diode, BJT, operational amplifier – principle of operation and applications – Introduction to UPS.

Digital Electronics: Introduction to numbers systems, basic Boolean laws, reduction of Boolean expressions and implementation with logic gates.

REFERENCE BOOKS

1. Hughes revised by Mckenzie Smith with John Hilcy and Keith Brown, *Electrical and Electronics Technology*, 8th Edition, Pearson, 2012.
2. R.J. Smith, R.C. Dorf, *Circuits Devices and Systems*, 5th Edition, John Wiley and sons, 2001.
3. P. S. Dhogal, *Basic Electrical Engineering – Vol. I & II*, 42nd Reprint, McGraw Hill, 2012.
4. Malvino, A. P., Leach D. P. and Gowtham Sha, *Digital Principles and Applications*, 6th Edition, Tata McGraw Hill, 2007.
5. Vincent Del Toro, *Electrical Engineering Fundamental*, Prentice Hall India, 2002.

COURSE OUTCOME

The students shall develop an intuitive understanding of the circuit analysis, basic concepts of electrical machines, house wiring and basics of electronics and be able to apply them in practical situation.

CSIR11 INTRODUCTION TO COMPUTER PROGRAMMING

Course Code:	CSIR11	No. of Credits:	03
Course Name:	Introduction to Computer Programming	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To learn the fundamentals of computers.
2. To learn the problem solving techniques using algorithms and procedures
3. To read, write and execute simple Python Programs
4. To learn and use Python data structures – lists, tuples and dictionaries

COURSE CONTENT

Introduction to computers – Computer Organization – Characteristics – Hardware and Software – Modes of operation – Types of programming languages – Developing a program. Algorithms – Characteristics – Flowcharts.

Data types; variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments; understanding error messages; Conditions, Boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation

Strings and text files; manipulating files and directories, OS and SYS modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated). String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers

Lists, tuples, and dictionaries; basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.

Design with functions: hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments- Program structure and design- Recursive functions – Introduction to classes and OOP.

List of Programs

1. Programs using sequential constructs
2. Programs using selection constructs
3. Programs using Iterative constructs
4. Programs using nested for loops
5. Programs using lists
6. Programs using tuples and dictionaries
7. Simple Python functions
8. File input and output
9. Sorting and searching programs
10. Recursion

REFERENCE BOOKS

1. Kenneth A. Lambert, Fundamentals of Python: First Programs, CENGAGE Learning, 2012.
2. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.
3. Reema Thareja, Python Programming using Problem Solving Approach, Oxford University Press, 2017
4. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016. (http://greenteapress.com/wp/thinkpython/)
5. John V Guttag, Introduction to Computation and Programming Using Python, Revised and expanded Edition, MIT Press, 2013.

COURSE OUTCOME

1. Write algorithms for problems
2. Use syntax and semantics of Python programming language for problem solving
3. Code a given logic in Python language
4. Appreciate and apply appropriate Data structures available in Python language for solving problems

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MEIR15 – INTRODUCTION TO MECHANICAL ENGINEERING

Course Code:	MEIR15	No. of Credits:	02
Course Name:	Introduction to Mechanical Engineering	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To introduce and define the basics concept of mechanical engineering.
2. To familiarize the working principles of IC engines and automobile systems.
3. To enable the students to understand the details about the energy systems and its components.
4. To demonstrate the various machine elements, materials and its function.
5. To help the students acquire knowledge about the various manufacturing process.

COURSE CONTENT

Introduction to Mechanical Engineering, Thermal Engineering, Design, manufacturing Engineering. Role and Responsibilities of a Mechanical Engineers

IC Engines – 2 Stroke and 4 stroke systems in IC Engines. Automobiles - Transmission systems, Suspension system, ABS, Airbag Systems, E-Vehicles.

Energy Systems - Power plants, Types, Gas Turbines, Steam Turbines, Utility boilers, R & A/C system- Green Energy production and Devices – Fluid Movers, Pumps and Compressors

Engineering materials, Machine elements and its functions

Manufacturing, Classification, Metal forming, Casting, Lathe, drilling machines, Milling machines, Metal joining, Additive Manufacturing.

REFERENCE BOOKS:

1. Lecture notes prepared by Department of Mechanical Engineering, NITT.
2. K. Venugopal, ‘Basic mechanical Engineering’ ISBN: 9788187721291, Anuradha Agencies Pub- Chennai, 2014

COURSE OUTCOMES

At the end of the course, students will be able

1. To identify the basic concept and fundamentals of mechanical engineering.
2. To understand the working principle of IC engines and Energy systems.
3. To appreciate the process and materials involved in the manufacture of various machine element components.

MEIR16 – SUMMER INTERNSHIP

Course Code:	MEIR16	No. of Credits:	02
Course Name:	Summer Internship	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To provide undergraduate engineering students with hands-on exposure to industry facilities, thereby furthering their understanding of the basics and operations of sciences and its applications
2. During the assignment period, students apart from technical exposure, will also learn to work in teams that possess diverse knowledge and skills; experience project management; develop time management; and most importantly learn to understand rules and regulations as well as adhere to policies and procedures.
3. Students' communication and presentation skills are expected to improve after the internship period as a result of constant contacts with mentors and administrative personnel.
4. Students must make the best use of this opportunity to apply their theoretical background in engineering learned at the PI to solve design and maintenance problems and demonstrate an awareness of current and future engineering applications in the industry.

COURSE OUTCOME

At the end of the course, students will be

1. An ability to function on multi-disciplinary teams.
2. An ability to identify, formulate and solve engineering problems.
3. An understanding of professional and ethical responsibility.
4. An ability to communicate effectively with written, oral and visual means.
5. The broad education necessary to understand the impact of engineering solution in a global and society context.
6. A recognition of the need for and ability to engage in life-long learning.

MEIR17 – PROJECT WORK

Course Code:	MEIR17	No. of Credits:	06
Course Name:	Project Work	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
2. To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOME

At the end of the course student will

1. Identify real world problems of mechanical engineering and related systems.
2. Interpret the working of mechanical engineering systems.
3. Apply the principles of mechanical engineering in real world systems.
4. Criticize and experiment to arrive at solutions for real world mechanical engineering problems.
5. Analyse and evaluate to obtain solution for problems in mechanical engineering systems.

MEIR18 – COMPREHENSIVE VIVA

Course Code:	MEIR18	No. of Credits:	01
Course Name:	Comprehensive Viva	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. The objective of the comprehension exam is to attain an understanding of the concepts of simultaneous manufacturing systems including materials, fabrication process, product and process control, manufacturing with computer and quality management.
2. The students work in groups and solve different types of problems/ activities given to them.
3. The activities given to the students should be real time like problems in industries chosen by a team of faculty members of the concerned department.
4. A minimum of three small problems have to be solved by each group of students
5. The evaluation is based on continuous assessment by group of faculty members constituted by the professor in-charge of the course.

COURSE OUTCOMES

Recall, recognize, visualize, illustrate, demonstrate, criticize and appraise the aspects of mechanical engineering systems and the interaction among them.

MEIR19 – INDUSTRIAL LECTURE

Course Code:	MEIR19	No. of Credits:	01
Course Name:	Industrial Lecture	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To provide hands-on training to truly appreciate the various fields of mechanical engineering related concepts.
2. Invited talks from industry experts are planned to further enrich the course.

COURSE OUTCOME

At the end of the course, student skills, personal, exposure and knowledge will be developed.

SWIR11 – NSS/ NCC/ NSO

Course Code:	SWIR11	No. of Credits:	00
Course Name:	NSS/ NCC/ NSO	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

To enable the students to gain knowledge about NCC/NSS/NSO/YOGA and put the same into practice

COURSE CONTENT

National Cadet Corps (NCC) – Any student enrolling as a member of National Cadet Core (NCC) will have to attend sixteen parades out of twenty parades each of four periods over a span of academic year. Attending eight parades in first semester will qualify a student to earn the credits specified in the curriculum. Grading shall be done based on punctuality, regularity in attending the parades and the extent of active involvement.

National Service Scheme (NSS) – A student enrolling as member of NSS will have to complete 60 hours of training / social service to be eligible to earn the credits specified in the curriculum. Grading shall be done by the faculty member handling the course based on punctuality, regularity in attending the classes and the extent of active involvement.

National Sports Organization (NSO) – Each student must select one of the following games/sports events and practice for one hour per week. An attendance of 75% is compulsory to earn the credits specified in the curriculum. Grading shall be done by the faculty member handling the course based on punctuality, regularity in attending the classes and the extent of active involvement. List of games/sports: Basket Ball, Football, Volleyball, Ball Badminton, Cricket, Throw-ball, Track events Field events or any other game with the approval of faculty member.

COURSE OUTCOME

To imbibe in the minds of students the concepts and benefits of NCC/NSS/NSO/YOGA and make them practice the same

II. PROGRAMME CORE (PC)

MEPC10 – ENGINEERING MECHANICS

Course Code:	MEPC10	No. of Credits:	03
Course Name:	Engineering Mechanics	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To explain the importance of mechanics in the context of engineering and conservation principles
2. To explain the significance of centroid, center of gravity, and moment of inertia.
3. To introduce the techniques for analyzing the forces in the bodies.
4. To analyze the internal member forces acting on structures.
5. To understand the basic principles involved in the dynamics of particle and rigid body.

COURSE CONTENT

Fundamentals: Mechanics and its relevance, concepts of forces, laws of mechanics – Lami's Theorem, Concept of free-body diagram, centroids, center of gravity, area moment of inertia, mass, moment of inertia.

Statics: Principles of statics, Types of forces, concurrent and non-concurrent forces, composition of forces, forces in a plane and space, simple stresses and strains, elastic constant.

Friction: Laws of friction, application of laws of friction, wedge friction, body on inclined planes.

Dynamics: Principles of dynamics, D'Alembert's principle, conservation of momentum and energy.

REFERENCE BOOKS:

1. Ferdinand P Beer, E Russel Johnston, D F Mazurek, P J Cornwell, B P Self, S Sanghi, Vector Mechanics for Engineers – Statics and Dynamics, McGraw Hill Education(India) Private Limited – 12th Edition, ISBN- 978-9353166625, 2019.
2. Irving H Shames, G. K. Mohana Rao, Engineering Mechanics – Statics and Dynamics, Pearson Education India – 4th Edition, ISBN- 978-8177581232, 2005.
3. Timoshenko S, and Young D.H, J. V. Rao, S. Patil, Engineering Mechanics, McGraw Hill, ISBN-978-1259062667, 2015..

COURSE OUTCOMES

At the end of the course student will

1. To be able to draw free body diagram and identify unknown reactions at supports

2. To be able to locate the center of gravity and mass center of an object and compute the mass and area moment of inertia.
3. Effective utilization of the gravitational and frictional forces in mechanical systems
4. To be able to compute the linear and angular acceleration of translating and rotating bodies
5. Ability to compute the energy required to establish prescribed motion of rigid body

MEPC11 – ENGINEERING THERMODYNAMICS

Course Code:	MEPC11	No. of Credits:	03
Course Name:	Engineering Thermodynamics	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To learn the principles of work and energy.
2. To acquire knowledge about the fundamentals of thermodynamic laws, concepts and principles.
3. To understand the principles of various cycles and to apply the thermodynamic concepts in various applications like IC engines and Air conditioning systems

COURSE CONTENT

Basic definitions - microscopic and macroscopic approaches, engineering thermodynamic systems. Thermodynamic properties - definition and units, intensive, extensive properties, specific properties. Thermodynamic state - state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes. Thermodynamic equilibrium; definition, mechanical equilibrium, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics and the concept of temperature. Measurement of temperature. Thermodynamic definition of work and heat, sign convention. Displacement work - expressions through p-v diagrams. Shaft work; Electrical work. Other types of work.

Joule's experiment and the first law of thermodynamics for cyclic and non-cyclic processes. Energy - modes. First law of thermodynamics for control volumes - steady flow energy equation (SFEE) and applications. Limitations of first law of thermodynamics and introduction to the second law of thermodynamics. Heat engine – concept of efficiency. Concept of refrigerator and heat pump – coefficient of performance. Statements of second law and their equivalence - PMM I and PMM II. Carnot cycle.

Definitions of a reversible process and irreversible process - reversible heat engine. Causes of irreversibility. Unchecked expansion of Carnot's engine. Internal and external reversibility. Definition of the thermodynamic temperature scale. Entropy - Clasius inequality, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate. Available (Exergy) and Unavailable energy. Exergy analysis. Irreversibility and second law efficiency.

Pure Substances - P-T and P-V diagrams. Vapor states of pure substance using water as example. Latent heat. Dryness fraction (quality). T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables. Ideal gas mixtures - Dalton's and Amalgam's model. Real gases – Van-der Waal's equation of state. Difference between ideal and real gases. Thermodynamic relations - Partial derivatives - Maxwell relations - Clapeyron equation.

Vapour power cycles - Rankine cycle - Effect of pressure and temperature on Rankine cycle - Reheat cycle - Regenerative cycle. Air standard power cycles - Otto, Diesel, Dual, Stirling and Brayton cycles. Vapour compression refrigeration cycle - Psychometric properties of air - Psychometric chart.

REFERENCE BOOKS:

1. Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J., Fundamentals of Thermodynamics, 6th ed., John Wiley, 2003.
2. Cengal, Y.A and Boles, M.A, Thermodynamics: An Engineering Approach, 5th ed., McGraw Hill, 2006.
3. Nag, P.K., Engineering Thermodynamics, 3rd ed., Tata McGraw-Hill, 2005.
4. Arora.C.P., "Refrigeration and Air Conditioning", Tata McGraw Hill, 1994.

COURSE OUTCOMES

At the end of the course student will

1. Define the fundamentals of the first and second laws of thermodynamics and explain their application to a wide range of systems.
2. Analyze the work and heat interactions associated with a prescribed process path and to perform analysis of a flow system.
3. Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
4. Analyze various thermodynamic cycles

MEPC12 – STRENGTH OF MATERIALS

Course Code:	MEPC12	No. of Credits:	03
Course Name:	Strength of Materials	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To develop the theoretical basis about the stress, strain and elastic modulus concepts in various components.
2. To understand the mechanical behavior of materials.
3. To familiarize the student in calculating shear force, bending moment, deflection and slopes in various types of beams for different loading conditions
4. To solve practical problems related to springs and shafts.

COURSE CONTENT

Axial and shear stresses and strains – Elasticity, Hook's law – Lateral strain – Poisson's ratio – Volumetric strain – Elastic constants – Stress in composite bars. Strain energy impact and suddenly applied loads.

Thin cylindrical and spherical shells subjected to internal pressure. Principal stresses and their planes. Plane of maximum shear – Mohr's circle of stresses. Thick cylinders – Lame's equation, shrink fit. Compound cylinders.

Shear force and bending moment diagrams for beams subjected to different types of loads – Theory of simple bending and assumptions.

Leaf spring, shear stress. Deflection – The moment area method, Macaulay's method – superposition (statically determinate beams only).

Torsion of solid and hollow circular shafts – Power transmission, strength and stiffness of shafts. Stress and defection in open helical spring.

REFERENCE BOOKS:

1. Beer, F.P, Johnston, E.R., Mechanics of Materials, McGraw-Hill Education -7th edition, ISBN: 9780073398235, 2015.
2. Hibbeler, R.C., Mechanics of Materials, Pearson Prentice Hall, ISBN- 978-0136022305, 2010.
3. Gere, M.J., Timoshenko, S.P., Mechanics of Materials, C.B.S., Publishers, 2004. ISBN: 9788123908946
4. Popov, E.P., Engineering Mechanics of Solids, Pearson,2006. ISBN: 8177585789.
5. Ramamurtham, S., Strength of Materials, Dhanpat Rai Publications, ISBN: 978-9384378267, 2014.
6. Albrecht Bertram, Rainer Gluege, Solid Mechanics: Theory, Modeling, and Problems, Springer-Verlag Berlin Heidelbergr, ISBN - 978-3319195650, 2015.
7. D Gross, W.Hauger, J. Schroeder, W.A. Wall, J. Bonet, Engineering Mechanics 2 – Mechanics of Materials, Springer-Verlag Berlin Heidelbergr, ISBN 978-3-642-12885-1, 2011.

COURSE OUTCOMES

At the end of the course student will

1. Analyze and design structural member subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behavior of materials.
2. Ability to draw the mohr's circle and to determine the principle stresses and its directions.
3. Calculate the stresses and strain associated with thin wall spherical & cylindrical pressure vessels

4. Present the concept of shear force, bending moment, slope and deflection and their use in machine design.
5. Understand the structural stability long columns under different supporting conditions.

MEPC13 – APPLIED ELECTRICAL AND ELECTRONICS ENGINEERING

Course Code:	MEPC13	No. of Credits:	04
Course Name:	Applied Electrical and Electronics Engineering	Prerequisite:	EEIR11

COURSE LEARNING OBJECTIVES

1. To provide the key concepts about AC motors and thereby able to choose the appropriate drives for various applications.
2. To equip students to understand and apply the basic concepts of control techniques used for drives in industries and to appraise the implementation of various control circuits

COURSE CONTENT

Three-phase induction motor - Cage and slip ring motors -torque slip characteristics –equivalent circuit - starting and speed control of induction motors – applications.

Single phase induction motors and universal motors- applications. Synchronous motors – principle of operation, starting and applications.

Electric drive for general factory, textile mill , cement mill - pump, blowers, hoists, traction etc. - group and individual drives. Choice of motors for various applications – drive characteristics and control of drives.

Introduction to operational amplifiers – applications in control circuits. Combinational logic - representation of logic functions – SOP and POS forms K-map representations – minimization using K maps - simplification and implementation of combinational logic – multiplexers and demultiplexers – Introduction to micro-processors and micro-controllers

Control systems – introduction – block diagram reduction – Routh Herwitz criterion based stability analysis – implementation of control logics to drives.

List of experiments

1. Speed control of three phase induction motor
2. Load test on three phase induction motor
3. Load test on single phase induction motor
4. Realization of integrator and differentiator using operational amplifiers
5. Simulation of performance of three phase induction motor using control blocks

REFERENCE BOOKS:

1. Mehta V K and Rohit Mehta, 'Principles of Electrical Machines', S Chand and company Ltd., 2006.
2. Dubey G K , 'Fundamentals of Electric drives', Narosa book distributors pvt. ltd , 2nd edition, 2012
3. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Applications with 8085', Penram Intl. Publishing, 6th edition, 2013.
4. Morris Mano, Michael D Ciletti, 'Digital Design', Pearson Education, 4th edition, 2008.
5. Theraja B L,'A TextBook of Electrical Technology', vol 2,S Chand,23rd edition,2007.
6. Vincent Del Toro, 'Electrical Engineering Fundamentals', PHI, 2nd edition, 2009.
7. Subrahmanyan V, 'Thyristor control of Electric Drives', Tata McGraw Hill, 1st edition.

COURSE OUTCOMES

At the end of the course student will be able to

1. Analyze the performance of AC motors under various operating conditions using their various characteristics.
2. Choose appropriate motor for various applications in industries
3. Design and analyze combinational logic circuits.
4. Understand the architecture and instruction set of 8085.
5. Analyse the various control logics for industrial drive applications

MEPC14 – FLUID MECHANICS AND MACHINES

Course Code:	MEPC14	No. of Credits:	04
Course Name:	Fluid Mechanics and Machines	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To familiarize with the properties of fluids and the applications of fluid mechanic and fluid machines.
2. To formulate and analyze problems related to calculation of forces in fluid structure interaction.
3. To classify flows and to understand and apply the conservation principles for fluid flows.
4. To understand the principles of dimensional analysis.
5. To analyze design aspects of the fluid machinery and introduce the methods to study their flow behavior.

COURSE CONTENT

Introduction: Fluids and continuum, Physical properties of fluids, Newton's law of viscosity. Ideal and real fluids, Newtonian and non - Newtonian fluids. Fluid Statics-Pressure -density-height relationship,

manometers, pressure on plane and curved surfaces, center of pressure buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.

Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function.

Inviscid flow: Euler equation, Bernoullis equation and its applications, Reynolds transport theorem: conservation of mass, linear and angular momentum, Navier-Stokes equations (without proof): some exact solutions Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen-Poiseuille Equation. Turbulent flow: Darcy-Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses.

Concept of Boundary Layer: Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, calculation of drag, boundary layer separation. Dimensional analysis and similarity: Buckingham Pi theorem, Model Testing and Dimensionless numbers.

Fluid Machinery: similarity, Euler equation for turbomachines, velocity triangles, centrifugal and axial flow pumps, hydraulic turbines – impulse and reaction, cavitation, water hammer, introduction to air compressors, fans and blowers.

REFERENCE BOOKS:

1. Fox, R.W. and Mc Donald, A.T., Introduction to Fluid Mechanics, 10th ed., John Wiley, 2019.
2. White, F.M., Fluid Mechanics, 5th ed., McGraw-Hill, 2003.
3. Yungus A. Cengel, John Cimbala, Fluid Mechanics Fundamental and applications, 3rd ed. Tata McGraw-Hill Education.
4. S. K. Som, Gautam Biswas, Suman Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, 3rd ed. Tata McGraw-Hill Education.
5. Sayers, A.T., Hydraulic and Compressible Flow Turbomachines, CBLS, 2003.

COURSE OUTCOMES

At the end of the course student will be able to

1. Calculate pressure variations in accelerating fluids using Euler's and Bernoulli's equations
2. Become conversant with the concepts of flow measurements and flow through pipes 3. Apply the momentum and energy equations to fluid flow problems.
3. Evaluate head loss in pipes and conduits.

4. Use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity
5. Analyze flow and performance of fluid machines.

MEPC15 – MECHANICS OF MACHINES – I

Course Code:	MEPC15	No. of Credits:	03
Course Name:	Mechanics of Machines – I	Prerequisite:	MEPC10

COURSE LEARNING OBJECTIVES

1. To impart knowledge on various types of Mechanisms and its generalization
2. To understand kinematic diagram of mechanism and perform synthesis
3. To impart skills to do position analysis
4. To impart skills to analyze velocity and acceleration of linkages in mechanisms
5. To familiarize higher pairs like cams and gears

COURSE CONTENT

Kinematics Fundamentals: Types of links, Degrees of freedom - Kinematic chains, mechanisms, Machines - lower pairs and higher pairs - Mobility-Number Synthesis – isomers -Linkage Transformation – inversions - Grashof conditions - Barker's classification - Rotatability and revolvability of N bar Linkages - Compliant Mechanism-MEMS

Graphical Linkage Synthesis: Two position synthesis, rocker output coupler output - three position synthesis - quick return mechanism - coupler curves-symmetrical 4-bar linkage –cognates - introduction to synthesis using coupler curve atlas-limiting conditions, toggle position and transmission angle. Introduction to animation software: Working model

Position analysis: translation rotation and complex motion - Euler's theorem and Chasles' theorem - graphical position analysis - algebraic position analysis - vector loop equation for four bar linkages - circuits and branches in linkages

Velocity analysis: definition of velocity - graphical velocity analysis - instant centers of velocity - Kennedy's rule - velocity analysis using instant centers - mechanical advantage-centrodes - analytical velocity analysis of a 4 bar linkage

Acceleration analysis: definition of acceleration-graphical acceleration analysis - analytical acceleration Analysis - Coriolis acceleration-human tolerance to acceleration

Cams: types of cams and followers-types of motion program-pressure angle and radius of curvature

Gears: fundamental law of gearing - involute tooth form-pressure angle – changing center distance-interference and under cutting- contact ratio - types of gears-simple gear trains - compound gear trains - epicyclic gear Trains - Ferguson's paradox

REFERENCE BOOKS:

1. Robert L. Norton.,"Design of Machinery: an introduction to synthesis and analysis of mechanisms and machines", McGraw-Hill Education, ISBN - 978-9351340201, 2017.
2. Uicker,J.J., Jr., Pennock,G.R., and Shigley, J.E., Theory of Machines and Mechanisms ,3rd ed., Oxford University Press – 4th Edition, ISBN-978-0199454167, 2014.
3. Kenneth J Waldron, Gary L Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley India Pvt Ltd – 2nd Edition, ISBN – 978 – 8126512553, 2007.
4. David H Myszka, Machines & Mechanisms: Applied Kinematic Analysis, Pearson – 4th Edition, ISBN-13: 978-0132157803, 2010.
5. Amitabha Ghosh, Asok Kumar Mallik, Theory of Mechanisms and Machines, East-West Press – 3rd Edition, ISBN – 978-8185938936, 1988.
6. S.S. Rattan, Theory of Machines, McGraw Hill -5th Edition, ISBN – 978-9353166281, 2019.

COURSE OUTCOMES

At the end of the course student will be able

1. To perceive the importance of motion transformation involved in various mechanisms and able to make classifications
2. Gain the knowledge of synthesis methods and use software for mechanism animation
3. To precisely perform position analysis of linkages in mechanisms
4. To quantify the velocity and acceleration at required regions in a mechanism
5. Able to analyze the cams and gears and initiate design steps

MEPC16 – MANUFACTURING TECHNOLOGY

Course Code:	MEPC16	No. of Credits:	03
Course Name:	Manufacturing Technology	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To learn the various methods and types of castings, welding processes, sheet metal forming, plastics.
2. To impart knowledge on selection of suitable manufacturing process for the typical component.
3. To understand the working of machine tools such as lathe, shaper, planner, slotter, milling, hobbing, and grinding.

4. To know the basic concepts of NC and CNC machine tool programming and additive manufacturing processes

COURSE CONTENT

Introduction to manufacturing process - Selecting manufacturing process – global competitiveness of manufacturing costs – Fundamentals of materials – their behaviour and manufacturing properties – Ferrous metals and alloys – Non Ferrous metals and alloys.

Casting: Solidification of Alloys and its mechanism – Gating system design and estimation of solidification time – Riser Design and Riser placement – Defects and Product Design. Welding: Physics of Arc sources – Welding equipments - Types of welding processes – Electrode designation and fluxes – Principle and application of Special welding processes. Brazing and Soldering

Forming process: Forging, Rolling, Drawing, Extrusion – Classification, Defects and Inspection. Sheet metal forming process – Shaping process for plastics – Extrusion, Injection and Compression Molding.

Machining process: Various machining process and its working principles – Metal Cutting: Tool geometry – single edge tools – reference plane – Tool specifications –ASA, NRS – Mechanics of Orthogonal cutting and Oblique cutting – Tool wear and Tool life – Economics of Machining

NC & CNC machine tools and manual part programming Machining centre. NC part programming – Computer aided part programming - Rapid Prototyping processes: Stereolithography, Fused Deposition modelling, 3D Printing, Selective laser sintering – Rapid Tooling techniques

REFERENCE BOOKS:

1. Jain R.K., Production Technology, Khanna Publishers, 2001.
2. Hajra Choudhry, Elements of Workshop Technology, Vol – II Media Promoters & Publishers, 1994.
3. Production Technology by HMT, Tata McGraw-Hill, 2002.
4. Chapman, W.A.J., Workshop Technology, Vol - II, Oxford & IBH Publishing Co. Ltd., 1986. Course
5. Khanna, O.P., and Lal, M., A Text Book of Production Technology, Vol II, Dhanpat Rai & Sons, 1992.
6. Yoram Koren, Computer Control of Manufacturing Systems, McGraw-Hill, 1986.
7. Choudhry, S.K.H., Elements of Work Shop Technology, Vol II, Media Promoters & Publishers, 1994.
8. Kundra, T.K., Rao. P.N., and Tiwari, N.L.K., Numerical Control and Computer Aided Manufacturing, Tata McGraw-Hill, 2006.
9. Serope Kalpakjian; Steven R.Schmid (2010), Manufacturing Engineering and Technology, 6th Edition, Publisher: Prentice Hall, ISBN-10 0 13 – 608168-1.
10. Ian Gibson, David W.Rosen, Brent Stucker, Additive manufacturing technologies; rapid prototyping to direct digital manufacturing, Springer,2010

COURSE OUTCOMES

At the end of the course student will be able to

1. Recognize the different types of casting and welding process.
2. Explain the concept of forging, rolling process and drawing.
3. Explain the features and applications of various machining processes.
4. Recognize the knowledge of NC & CNC Part programming and Additive Manufacturing process

MEPC17 – THERMAL ENGINEERING

Course Code:	MEPC17	No. of Credits:	04
Course Name:	Thermal Engineering	Prerequisite:	MEPC11

COURSE LEARNING OBJECTIVES:

1. To enable the students, understand the principles, working and performance of IC engines
2. To introduce students to the working of compressors, steam nozzles and various refrigeration and air-conditioning systems.
3. To teach students the principles of waste heat recovery and thermal storage systems.

COURSE CONTENT

Classification of IC engines – Working of SI & CI, two and four stroke engines – Ideal and actual valve and port timing diagrams – Comparison of ideal and actual air standard cycles (p-v diagram) – Engine operating characteristics: mean effective pressure, torque and power, specific fuel consumption, efficiencies, pressure-crank angle diagram – Determination of fuel properties – Thermochemistry of fuels – Calculation of air fuel ratio – stochiometric, lean and rich mixtures – Exhaust gas analysis

Subcritical and supercritical boilers, fluidized bed boilers, fire-tube and water-tube boilers, mountings and accessories - Steam turbine basic cycles – velocity diagrams, Work done and efficiency – Multistage turbines, governing systems, Effects of reheating and regeneration, Application of Mollier diagram, Gas turbine basic cycle (open and closed), Application of intercooling, reheating and regeneration – cogeneration and combined system

Steam Nozzles: Types and Shapes of nozzles – Flow through nozzles – Stagnation, sonic properties and isentropic expansion in nozzle – Critical pressure ratio – Effect of friction. Metastable flow.

Compressors: Classification of compressors – Radial and axial compressors – Performance characteristics: Volumetric efficiency, Isothermal efficiency and Isentropic efficiency – Effect of clearance volume – Multi stage air compressor with intercooling – Surging and stalling, Slip

Refrigeration & air conditioning system: Vapour compression system – Effect of Super heat and Sub cooling – Performance calculations - Vapour absorption system - Ammonia water, Lithium bromide water – Psychrometric processes – Air conditioning system – Working principles and concept of RSHF, GSHF, ESHF- Cooling load calculations.

REFERENCE BOOKS:

1. Rajput R.K., (2013), Thermal Engineering, 10th Edition, Laxmi Publications (P) Ltd.
2. Kothandaraman.C.P., Domkundwar. Domkundwar. A.V., “A course in thermal Engineering", Fifth Edition, ”Dhanpat Rai & sons , 2002
3. Sarkar, B.K,”Thermal Engineering” Tata McGraw-Hill Publishers.
4. Arora.C.P, ”Refrigeration and Air Conditioning ,” 3rd Edition, Tata McGraw-Hill Publishers.
5. Ganesan V..” Internal Combustion Engines” , 4th Edition, Tata McGraw-Hill.
6. Rudramoorthy, R, “Thermal Engineering “,Tata McGraw-Hill, New Delhi.
7. Ramalingam. K.K., "Thermal Engineering", 2nd Edition, SCITECH Publications (India) Pvt. Ltd., 2009

COURSE OUTCOME:

Student will be able to

1. Solve problems on internal combustion engines and prepare heat balance sheet.
2. Get an insight of various components and principles of engines, boilers, compressors, Steam Nozzles, etc.
3. Design refrigeration and air-conditioning system for a particular application.
4. Demonstrate the knowledge of waste heat recovery and thermal storage.

MEPC18 – ENGINEERING MATERIALS

Course Code:	MEPC18	No. of Credits:	04
Course Name:	Engineering Materials	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To impart knowledge on the atomic arrangement and structure of metals and alloys.
2. To acquire sound knowledge on phase diagram and heat treatment of materials.
3. To understand the influence of material processing on the material properties
4. To deepen the knowledge about stress-strain curves and metal plasticity
5. To understand the various material testing methods.

COURSE CONTENT

Materials Fundamentals: material classification, atomic structure, atomic bonding in solids, crystal structure, crystal systems, crystallographic directions, Miller-Bravais scheme, crystallographic planes, Polycrystalline Materials. Imperfections: point defects, dislocations, Burger vector, grain size, microscopic techniques.

Phase Diagrams: Solubility Limit, phases, microstructures, Gibbs phase rule, Equilibria, binary phase diagram, eutectic, eutectoid, peritectic reactions, Iron-Carbon phase diagram. Phase transformations in metals, kinetics of phase transformations, metastable, equilibrium states, Isothermal transformation (TTT) diagrams, CCT diagram, mechanical behavior of Iron-Carbon alloys.

Material Processing: Ferrous Alloys - classifications, Nonferrous Alloys - copper and aluminum alloys, forming, casting, Heat treatments: Annealing, Precipitation hardening, austempering, martempering, ausforming, surface hardening, hardenability.

Testing: Concepts of stress-strain, elastic properties, tensile properties, true stress-strain, elastic recovery and plastic deformation, hardness. Dislocations and Strengthening Mechanisms: Characteristics of dislocation, slip systems and slip in single crystal. plastic deformation in polycrystalline materials, twinning, strengthening by grain size reduction, strain hardening, recovery, recrystallization, grain growth.

Failure: Fracture - Fundamentals of Fracture, Ductile and brittle fracture, Impact Fracture Testing. Fatigue – Cyclic stress, S-N curve, crack initiation and propagation, fatigue life and improvement methods, Creep behavior, stress and temperature effects, alloys for high temperature.

Laboratory Experiments:

Metallography specimen preparation, Optical microscopy (micro structure evaluation of cast iron, carbon steel. stainless steel and alloy steels), Mechanical Characterization of materials- Tensile testing, Impact testing and Hardness testing, heat treatment of steels – annealing, normalizing, and quenching microstructure comparison.

REFERENCE BOOKS:

1. Sidney H Avner, Introduction to Physical Metallurgy, McGraw Hill Education – 2nd edition, ISBN-978-0074630068, 2017.
2. George E Dieter, Mechanical Metallurgy, McGraw Hill Education – 3rd edition, ISBN- 978-1259064791, 2017.
3. R. Balasubramaniam, Callister's Materials Science and Engineering, Wiley – 2nd edition, ISBN - 978-8126541607, 2014.

4. William F Smith, Javad Hashemi, Ravi Prakash, Material Science and Engineering, McGraw Hill Education- 5th edition, ISBN-978-1259062759, 2017.
5. A.V.K. Suriyanarayana, Testing of metallic materials, BS Publications, ISBN- 978-8178001340, 2007.

COURSE OUTCOMES

At the end of the course student will

1. Interpret the atomic arrangement and structure of metals and alloys.
2. Describe the iron-carbon equilibrium diagram and phase diagrams.
3. Explain the behavior of material upon heat treatment from iron-carbon equilibrium diagram
4. Interpret the uniaxial tension test and ductility of various materials
5. Predict the behavior of materials upon impact, fracture and creep testing

MEPC19 – HEAT AND MASS TRANSFER

Course Code:	MEPC19	No. of Credits:	03
Course Name:	Heat and Mass Transfer	Prerequisite:	MEPC11

COURSE LEARNING OBJECTIVES

1. To learn the various modes of heat transfer and understand the basic concepts of mass transfer.
2. To understand the applications of various experimental heat transfer correlations in engineering applications.
3. To discuss the thermal analysis and sizing of heat exchangers.

COURSE CONTENT

Conduction - general 3-D equation – one dimensional steady state heat conduction in simple geometries – plane wall – cylinder and sphere – composite walls – critical thickness of insulation – thermal contact resistance - heat generation in plane wall, cylinder and sphere – extended surfaces - unsteady state heat conduction.

Convection - boundary layer theory – conservation equations of mass, momentum and energy for laminar flow over a flat plate – turbulent flow over a flat plate – flow over cylinders – spheres – bank of tubes - internal flows – natural convection – vertical, inclined and horizontal surfaces.

Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect.

Boiling and condensation – pool boiling regimes and correlations – crictical heat flux - flow boiling correlations - Nusselt's theory – filmwise and dropwise condensation - Condensation over surfaces.

Heat exchangers - types - fouling factor - LMTD and NTU methods - Mass transfer - Fick's law - analogy between heat and mass transfer

REFERENCE BOOKS:

1. Bergman T.L., Lavine A.S., Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 7th ed., John Wiley, 2011.
2. Holman, J.P., Heat Transfer, 10th ed., Tata McGraw-Hill, 2010.
3. Ozisik, M.N., Heat Transfer - A Basic Approach, McGraw-Hill, 1985.
4. Cengel, Y.A., Heat Transfer - A Practical Approach, 2nd ed., McGraw-Hill, 2002.
5. Sachedva, R.C., Fundamentals of Heat and Mass Transfer, 4th ed., New Age International, 2012.

COURSE OUTCOMES

At the end of the course, students will be able to

1. Analyze the real time applications of conduction heat transfer in solids.
2. Describe the fundamentals of natural and forced convective heat transfer processes.
3. Design the heat exchange equipment.
4. Explore the real time applications of radiation mode of heat transfer.
5. Relate the mass transfer concepts for various industrial applications.

MEPC20 – MECHANICS OF MACHINES – II

Course Code:	MEPC20	No. of Credits:	03
Course Name:	Mechanics of Machines – II	Prerequisite:	MEPC15

COURSE LEARNING OBJECTIVES

1. To establish strong foundation in kinetics of mechanisms
2. To familiarize balancing methods for rotating and reciprocating masses
3. To introduce gyroscope and flywheels
4. To familiarize fundamentals of vibrations in machineries
5. To understand vibration control

COURSE CONTENT

Fundamentals of dynamics: center of mass, mass moment of inertia, principle of virtual work. Static and inertial force analysis of mechanisms: Newtonian method, four-bar linkage, slider crank, shaking force and moment.

Balancing: rotating masses in single and several planes- reciprocating masses- single and multi-cylinder engines-Lanchester balancer

Flywheel: industrial uses of flywheels- design of a flywheel of IC engines and punch press. Gyroscopes: rigid body motion in 3D, Euler's equation, symmetrical rotor, Gyrodynamics, Effect of Gyroscope in ship and flights.

Mechanical vibrations: Introduction to vibration, Types of vibration, single DoF system, Free vibration of rigid bodies, linear and torsional vibrations- two rotor, three rotors and multi rotor systems- damped vibrations, types of damping - coupled vibrations - forced vibrations - vibration sensors

Vibration control: philosophy of vibration control-vibration isolations- suspension systems-tuned vibration absorbers- uses of vibration in condition monitoring

REFERENCE BOOKS:

1. Robert L. Norton., "Design of Machinery: an introduction to synthesis and analysis of mechanisms and machines", McGraw-Hill Education, ISBN - 978-9351340201, 2017.
2. George H. Martin., "Kinematics and Dynamics of Machines" 2nd ed., Waveland PrInc., 2002.
3. Morrison. J.L.M., Crossland.B., "An Introduction to the Mechanics of Machines" 1st ed., Longman Higher Education Division (a Pearson Education company), ISBN – 978-0582447295, 1971.
4. Daniel J. Inman, Engineering Vibrations, Pearson Education – 4th Edition, ISBN - 978-0132871693 , 2013.
5. Uicker,J.J., Jr., Pennock,G.R., and Shigley, J.E., Theory of Machines and Mechanisms ,3rd ed., Oxford University Press – 4th Edition, ISBN-978-0199454167, 2014.
6. Kenneth J Waldron, Gary L Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley India Pvt Ltd – 2nd Edition, ISBN – 978 – 8126512553, 2007.
7. David H Myszka, Machines & Mechanisms: Applied Kinematic Analysis, Pearson – 4th Edition, ISBN-978-0132157803, 2010.
8. Amitabha Ghosh, Asok Kumar Mallik, Theory of Mechanisms and Machines, East-West Press – 3rd Edition, ISBN – 978-8185938936, 1988.
9. S.S. Rattan, Theory of Machines, McGraw Hill -5th Edition, ISBN – 978-9353166281, 2019.

COURSE OUTCOMES

At the end of the course student will

1. Perform static and dynamic analysis of mechanisms
2. Understand the issues related to balancing of reciprocating and rotating machinery
3. Know the working of gyroscopes and flywheels
4. Have understanding about the types and effects of vibration

MEPC21 – METROLOGY AND MEASUREMENTS

Course Code:	MEPC21	No. of Credits:	03
Course Name:	Metrology and Measurements	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. Describe the evolution of quality standards and metrology.
2. Provide knowledge of limits, fits, tolerances and gauging.
3. Introduce measurement systems and methods with emphasis on different transducers, intermediate modifying and terminating devices.

COURSE CONTENT

Introduction to Metrology- Introduction to Metrology, Fundamental principles and definitions, measurement standards / primary and tertiary standards, distinction between precision and accuracy. Limits, fits and tolerances, Tolerance grades, Types of fits, IS919, GO and NO GO gauges- Taylor's principle, design of GO and NO GO gauges, filler gauges, plug gauges and snap gauges.

Comparators - Constructional features and operation of mechanical, optical, electrical/electronic and pneumatic comparators, advantages, limitations and field of applications. Principles of interference, concept of flatness, flatness testing, optical flats, optical interferometer and laser interferometer. Surface Texture Measurement - importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters- Ra, Ry, Rz, RMS value etc., surface roughness measuring instruments – Tomlinson and Taylor Hobson versions, surface roughness symbols.

Screw Thread Measurement - Two wire and three wire methods, floating carriage micrometer. Gear Measurement - Gear tooth comparator, Master gears, measurement using rollers and Parkinson's Tester. Special Measuring Equipment - Principles of measurement using Tool Maker's microscope profile projector & 3D coordinate measuring machine

Generalized instrumentation system – Error theory – Calibration of instruments – Range – resolution – Span – Linearity, Sensitivity – Signal conditioning systems. Error analysis – Uncertainty propagation – Oscilloscope for analysis of dynamic and transient events.

Principles and analysis of measurement systems used for measurement of flow, power, pressure and temperature.

REFERENCE BOOKS:

1. Mechanical Measurements, Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. Measurement Systems, Ernest O Doeblin, Mc Graw-Hill, 2004.

3. Theory and Design for Mechanical Measurements, 3rd edition, Richard S Figliola, Donald E Beasley, WILEY India Publishers

COURSE OUTCOMES

At the end of the course student will

1. Demonstrate different measurement techniques.
2. Reproduce the fundamental knowledge on metrology techniques.
3. Identify suitable metrological methods for measuring the components.
4. Explain the acceptance test for machines.
5. Outline the working of various optical measuring instruments.

MEPC22 – AUTOMOBILE ENGINEERING

Course Code:	MEPC22	No. of Credits:	03
Course Name:	Automobile Engineering	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To study the automobile structure, comfort and safety systems.
2. To impart knowledge on IC engine, electric and hybrid vehicles.
3. To understand the manual and automatic transmission systems.
4. To understand vehicle running and control systems.
5. To analyze various electrical and electronics system for vehicle management.

COURSE CONTENT

Vehicle Structure, Comfort and Safety

Automobiles - layouts, chassis, frame, body – material and construction. Aerodynamics - Flow phenomenon - drag, side and lift force, rolling resistance. Ergonomics and anthropometry - comfort systems - air conditioning - Noise, Vibrations and Harshness. Vehicle safety systems - Regulations and test standards. Vehicle maintenance.

Engine and Auxiliary Systems

IC Engine and auxiliary systems - SI and CI Engines – Principle of operation, components and materials. Air and fuel systems - MPFI, GDI & CRDI, Turbochargers. Cooling and lubri-cation systems. Typical performance, combustion and emission characteristics of automobile engines. Emission standards and control strategies - recent developments.

Transmission Systems

Manual and automatic transmission system – clutch, gear box, over drives, transfer box, fluid flywheel, torque convertors, Continuously Variable Transmission (CVT). Propeller shaft - hotchkiss drives, torque tube drive, universal joints. Final drive - differential - rear axle.

Steering, Brakes and Suspension Systems

Front axle - Wheel geometry - Wheel alignment and balancing - Steering geometry - Steering linkages & gear box - Power steering. Hydraulic and pneumatic braking systems - power and power assisted brakes - disc & drum brakes - braking torque - factors affecting braking - Antilock Braking System (ABS). Suspension - types, factors influencing ride comfort, shock absorbers. Tyres - types, construction and materials - static and rolling properties tyre wear and maintenance.

Automotive Electrical and Electronics

Electricity generation, storage and distribution - wiring harness. Starting & Ignition system. Automotive lighting. Automotive sensors & actuators, Engine Management Control System (EMS). Vehicle Management System- vehicle tracking system, Collision avoidance, Radar warning system, Global Positioning Systems (GPS).

Fundamentals of electric and hybrid vehicles - Layout and operation - Power electronics - Electric machines and drives - Power train - Regenerative braking - Electric charging and bat-teries - Performance of electric and hybrid vehicles - Thermal management - NVH - Artificial Noise Generator - recent developments.

REFERENCE BOOKS:

1. Newton, K., Steeds, W., and Garrett, T.K., The Motor Vehicle, Butterworth, 1989.
2. Joseph Heitner, “Automotive Mechanics”, 2nd edition, East-West Press, 1999.
3. Heinz Heisler,”advanced Engine technology “SAE international publications USA, 1998.
4. Kirpal Singh, Automotive Engineering, Vol. I & II, Standard Publishers, New Delhi, 1997
5. Ganesan .V”Internal Combustion Egines” Third edition, Tata McGraw –hill, 2007.
6. J.B.Heywood, ‘Fundamentals of Internal Combustion Engine’, McGraw Hill Book Co, 1989.
7. James D. Halderman, Automotive Heating and Air Conditioning (8th Edition), Pearson Education Inc., 2018.
8. George A. Peters and Barbara J. Peters, Automotive Vehicle Safety, Tailor and Francis, CRC Press, 2002.
9. Mark Gonter, Ulrich W. Seiffert, Integrated Automotive Safety Handbook, SAE International, 2013.
10. Tom Denton, Automobile Electrical & Electronic Systems (5th Edition), Taylor and Francis, 2018.
11. Chris Mi, M. Abul Masrur, Electric Vehicles, 2nd Edition, Wiley, 2017.
12. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design, CRC Press, 2004.

COURSE OUTCOMES

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

1. Understand the automobile structure, comfort and safety systems.
2. Understand the principles of IC engine, electric and hybrid vehicles.
3. Understand the manual and automatic transmission systems.
4. Understand vehicle running and control systems.
5. Analyse various electrical and electronics system for vehicle management.

MEPC23 – ENERGY CONVERSION SYSTEMS

Course Code:	MEPC23	No. of Credits:	03
Course Name:	Energy Conversion Systems	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES:

1. Analyze the thermodynamic cycles used in power generation
2. Evaluate the merits of direct thermal energy conversion systems compared to conventional techniques
3. Analyze the performance of fuel cells
4. Select the best energy storage mechanism for any given application
5. Developing a mechanism for total energy recovery from a system adopting CHCP concept

COURSE CONTENT

Energy Conversion Cycles: Bell Coleman, Scuderi, Stirling, Ericsson, Lenoir, Atkinson, Stoddard and Kalina cycle – Comparison with Rankine and Brayton cycles

Direct Conversion of Thermal to Electrical Energy: MHD - Thermoelectric Converters – Thermoelectric refrigerator – Thermoelectric Generator – Thermionic converters – Ferro electric converter – Nernst Effect Generator – Thermo Magnetic Converter.

Direct Conversion of Chemical to Electrical Energy: Fuel Cell : Basics – working advantages and drawbacks – types – comparative analysis – thermodynamics and kinetics of fuel cell process – performance of fuel cell – applications

Energy Storage Systems: Batteries – types – working – performance governing parameters – hydrogen energy – solar cells. Energy storage devices for Mechanical Energy, Electrical Energy, Chemical Energy, Thermal Energy.

Combined Heat and Power Production: Cogeneration - types - Configuration and thermodynamic performance of steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – concept of Polygeneration

REFERENCE BOOKS:

1. Archie.W.Culp, Principles of Energy Conversion, 2ndEdition, McGraw-Hill Inc., 1991, New York.
2. Kordesch Karl, and Günter R. Simader, Fuel Cell and Their Applications, Wiley 2006
3. Bent Sorensen, Renewable Energy Conversion, Transmission, and Storage Technology & Engineering, Academic Press, 2007.
4. Charles R. Russell, Elements of Energy Conversion, Permagon Press, 1967.
5. Hart A.B. and Womack, G.J., Fuel Cells: Theory and Application, Prentice Hall, 1989.
6. Kettari, M.A., Direct Energy Conversion, Addison-Wesley, 1997.
7. Yogi Goswami, D. and Frank Kreith, Energy Conversion, Second Edition, Science, 2017.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Analyze the thermodynamic cycles used in power generation
2. Evaluate the merits of direct thermal energy conversion systems compared to conventional techniques
3. Analyze the performance of fuel cells
4. Select the best energy storage mechanism for any given application
5. Develop a mechanism for total energy recovery from a system adopting CHCP concept

MEPC24 – DESIGN OF MACHINE ELEMENTS

Course Code:	MEPC24	No. of Credits:	04
Course Name:	Design of Machine Elements	Prerequisite:	MEPC12, MEPC15

COURSE LEARNING OBJECTIVES

1. To familiarize machine components failure under various loadings
2. To develop the basic steps involved in the design of shaft and couplings.
3. To analyze the functional and strength requirements of various mechanical joints and bearings.
4. To understand the factors involved in the design of springs, flexible elements and gears.

COURSE CONTENT

Introduction to Design: Design process - Problem formulation and calculation – Factor of safety – Design codes. Materials and process, Loading determination – Static loading, Dynamic loading, Impact loading. Displacement, Stress, Strain, Principal stresses, Types of stresses. Design of simple machine parts.

Failure Theories – failure theories of ductile and brittle materials under static loading, Fatigue failure theories: Mechanism, Models, Notches and stress concentration.

Design of Shafts, Keys and Couplings – Static loads, combined torsion-Bending and axial loads, Critical speed of the shaft. Design of keys and Keyways, Failure of keys. Couplings – Rigid and Flexible types.

Lubrications and Bearings: Lubricants – Properties – Types. Bearings – Sliding contact, rolling contact bearings – Hydrodynamic Bearing.

Design of springs: Helical compression springs – Terminologies, Static and Fatigue loading. Leaf Springs.

Design of Welding and Fastening: Joints subjected to axial and eccentric loads.

Design of Flexible mechanical elements – Belt, Chain and Rope.

Design of Gears – Gear Terminologies, Types of gears, Materials for gears, Design of Spur Gear, Helical Gear, Bevel gears, Worm and Worm Gear

Design of single stage and multistage Gear boxes.

REFERENCE BOOKS:

1. Joseph Edward Shigley, Mechanical Engineering Design, McGraw-Hill, Tenth Edition in SI units, 2017.
2. Robert L. Norton, Machine Design, Pearson Paperback, 2018.
3. Robert C. Juvinall and Kurt M. Marshek, Machine Component Design, Wiley Publishers, 2016.
4. V.B. Bhandari, Design of Machine Elements Paperback, McGraw Hill, 2017
5. Linda C. Schmidt, George Dieter, Engineering Design, McGraw Hill, 2017
6. Design Data: Data Book Of Engineers By PSG College-Kalaikathir Achchaga, Coimbatore, 2012.

COURSE OUTCOMES

At the end of the course student will

1. Describe the design process, material selection, stress concentrations under various loading.
2. Ability to design the machine elements like shaft, couplings, bearings and springs.
3. Recognize the need and procedure to design flexible and positive drives.
4. Apply catalogues and standards in machine component design.

III. ESSENTIAL LABORATORY REQUIREMENT COURSES

MELR11 – STRENGTH OF MATERIALS AND FLUID MECHANICS & MACHINES LABORATORY

Course Code:	MELR11	No. of Credits:	02
Course Name:	Strength of Materials and Fluid Mechanics & Machines Laboratory	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To study the mechanical properties of materials when subjected to different types of loading.
2. To verify the principles studied in Fluid Mechanics theory by performing experiments in lab.

COURSE CONTENT

Strength of Materials - List of Experiments

1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Hardness test on metal beam (Rockwell and Brinell Hardness Tests)
4. Compression test on helical spring
5. Deflection test on carriage spring

Fluid Mechanics - List of Experiments

1. Flow through Venturi meter
2. Characteristics of Centrifugal pumps
3. Characteristics of Gear pump
4. Characteristics of Submersible pump
5. Characteristics of Reciprocating pump
6. Characteristics of Francis turbine
7. Determination of Metacentric height

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Perform Tension, Torsion, Hardness, Compression, and Deformation test on Solid materials.
2. Use the measurement equipment’s for flow measurement.
3. Perform test on different fluid machinery.

MELR12 – COMPUTER AIDED MACHINE DRAWING

Course Code:	MELR12	No. of Credits:	02
Course Name:	Computer Aided Machine Drawing	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. Applying standard drawing practices using fits and tolerances.
2. Modeling orthogonal views of machine components and assembly.
3. Preparing standard drawing layout for modeled parts or assemblies with BoM.
4. Exposing the student to contemporary computer design tools for aerospace and mechanical engineers.

COURSE CONTENT:

Standardization - Interchangeability - Selective Assembly - Tolerance. Tolerance of form and position - grades of tolerance - fits -Standard tolerances - Machining symbols - surface finish indication - Functional and manufacturing datum.

Drawing, Dimensioning, Detailing of various components -

Shaft Couplings: rigid, flexible: cotter joints, knuckle joints, Hook's joints. Bearings - Journal - Footstep, thrust or Collar bearing; Plummer block; Pulleys for flat belts, V-belt and rope.

Engine parts - Stuffing box, Connecting rod, Atomizer, spark plug, fuel injection pump. Valves - stop valve- safety valve, relief valve and non-return valve. Machine tool components - Drill jig, Tail stock,

Tool post, Tool head for shaping machine, machine vice, screw jack.

Reference Books:

1. Dhawan, R.K., A Text Book of Machine Drawing, S. Chand & Company, 1996.
2. Ostrowsky, O., Engineering Drawing with CAD Applications, ELBS, 1995.
3. Engineering Drawing Practice for Schools and Colleges SP: 46- 1988.

COURSE OUTCOMES

At the end of the course student will

1. Identify the national and international standards pertaining to machine drawing.
2. Apply limits and tolerances to assemblies and choose appropriate fits.
3. Recognize machining and surface finish symbols.
4. Explain the functional and manufacturing datum.
5. Illustrate various machine components through drawings

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MELR13 – THERMAL ENGINEERING LABORATORY

Course Code:	MELR13	No. of Credits:	02
Course Name:	Thermal Engineering Laboratory	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To provide knowledge on testing of properties of fuels and lubricating oils
2. To demonstrate and conduct experiments, interpret and analyze data and report the results of IC Engine testing.

COURSE CONTENT

1. Valve timing and port timing diagrams.
2. Heat balance test on 4-stroke water cooled and Air cooled Engine.
3. Morse test on Multi-cylinder four stroke SI Engine.
4. Performance test on Multi-cylinder four stroke Engine.
5. Performance test on single cylinder two stroke Engine
6. Performance and combustion studies on computerized IC engine test rig.
7. Study and performance test on a reciprocating Air Compressor
8. Determination of viscosity using Redwood viscometer.
9. Flash point and Fire point test using Cleveland apparatus.
10. Flash point and Fire point test using Pensky Martens apparatus.
11. Determination of calorific value for liquid and gaseous fuels.
12. Measurement of exhaust gas emissions.
13. Determination of derived cetane number of fuel using cetane analyzer
14. Determination of moisture content in fuel using Karl Fischer Coulometry
15. Study the elemental composition of fuel using ultimate analyzer
16. Categorize the organic compounds of fuel using proximate analysis.

COURSE OUTCOMES

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

1. Determine the property of fuels and lubricating oils.
2. Evaluate the performance of internal combustion engines and air compressors.
3. Interpret the emission characteristics of internal combustion engines.

MELR14 – MANUFACTURING TECHNOLOGY LABORATORY

Course Code:	MELR14	No. of Credits:	02
Course Name:	Manufacturing Technology Laboratory	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required in the core industries.
2. To Study and acquire knowledge on various basic machining operations in special purpose machines and its applications in real life manufacture of components in the industry

COURSE CONTENT

1. Lathe – Simple / Step / Taper Turning, Thread Cutting, Drilling and Boring.
2. Shaping – V – Cutting
3. Milling – Job requiring Indexing.
4. Hobbing – Spur Gear Cutting
5. Grinding – Surface / Cylindrical grinding
6. CNC Lathe – Simple Turing, Step Turning, Thread Turing
7. Machining Center – A typical job production.
8. Selective laser sintering and Fused Deposition Modelling – Modelling of a 3D part using Solidworks/CATIA and tessellation of surfaces using MAGICS/MIMICS software for processing in RP machine.
9. Additive manufacturing/3D printing

COURSE OUTCOMES

Upon completion of this course, the students can able

1. To demonstrate and fabricate different types of components using the machine tools
2. To use different machine tools to manufacturing gears.
3. To use different machine tools for finishing operations
4. To manufacture tools using cutter grinder
5. To develop CNC part programming

MELR15 – HEAT TRANSFER AND REFRIGERATION & AIR-CONDITIONING LABORATORY

Course Code:	MELR15	No. of Credits:	02
Course Name:	Heat Transfer and Refrigeration & Air-Conditioning Laboratory	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To expose the students to the basic knowledge of thermal equipment's and help them to develop experimental skills.
2. To study the concepts, applications of the thermal engineering laboratory.

COURSE CONTENT

1. Study and performance tests on vapour compression refrigeration.
2. Study and performance tests on vapour absorption refrigeration.
3. Study and performance tests on air conditioning test rig.
4. Heat transfer experiments based on conduction and convection.
5. Heat transfer experiments based on radiation.
6. Experiments on heat exchangers.

COURSE OUTCOMES

At the end of the course student will

1. Demonstrate conduction, convection and radiation heat transfer through experiments.
2. Interpret heat transfer enhancement mechanisms.
3. Estimate the size and type of heat exchangers.
4. Calculate the cooling load of air conditioning systems and cooling towers.

MELR16 – METROLOGY AND MEASUREMENTS LABORATORY

Course Code:	MELR16	No. of Credits:	02
Course Name:	Metrology and Measurements Laboratory	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. Identify the uncertainties in dimensional metrology and the define the measurement standards; describe the fundamentals of dimensional and geometrical tolerances;
2. Measure length and angles using line-graduated instruments, i. e. vernier callipers, micrometers, bevel protractor, sine bar and surface plates;
3. Use comparative length-measuring instruments, i.e. dial indicator, to measure variations in the distance between two or more surfaces

COURSE CONTENT

Measurements on precision instruments; sine bar, CMM - Universal measuring microscope,

Profile projector - Electronic comparator, optical flat, surface roughness - Gear tooth thickness - MAAG gear tester - Calibration of LVDT - Statistical Quality Control charts.

COURSE OUTCOMES

At the end of the course student will

1. Illustrate on different metrological tools and perform measurements in quality impulsion.
2. Describe and explain the working of precision instruments.
3. Outline of electronic comparator, optical flat, surface roughness, gear thickness measuring instruments.
4. Demonstrate the statistical quality control chart.
5. Distinguish with the different instruments that are available for linear, angular, roundness and roughness measurements.
6. Locate appropriate measuring instrument according to a specific requirement.

MELR17 – DYNAMICS LABORATORY

Course Code:	MELR17	No. of Credits:	02
Course Name:	Dynamics Laboratory	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To equip students with understanding of the fundamental principles of dynamics.
2. To develop a model of a mechanical system using a free body diagram.
3. To develop equations of motion for translational and rotational mechanical systems.

COURSE CONTENT

1. Measurement of moment of inertia of rigid bodies.
2. Gyroscope.
3. Linear vibration.
4. Torsional vibration.
5. Balancing.
6. Geared system

COURSE OUTCOMES

At the end of the course student will

1. Compute the moment of inertia of rigid bodies
2. Demonstrate the working principles of gyroscope.
3. Experiment with vibrations and balancing.

MELR18 – AUTOMOBILE ENGINEERING LABORATORY

Course Code:	MELR18	No. of Credits:	02
Course Name:	Automobile Engineering Laboratory	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To understand various components of automobile engines.
2. To impart knowledge in the assembling and dismantling of any vehicles and its sub-systems.
3. To Develop students with skills needed for troubleshooting the practical automobile problems

COURSE CONTENT

1. Study on garage tools and equipments.
2. Experiments on the cleaning & greasing of automobiles.
3. Experiments on the quality of lubrication oil and maintenance.
4. Experiments on the condition of battery quality and maintenance.
5. Experiments on the diagnostic of an Electronic Control Unit (ECU) of an automobile.
6. Dismantling of two / four stroke engine and bring back to the working condition.
7. Dismantling & assembly of Clutch (light / heavy duty vehicle).
8. Dismantling & assembly of Constant mesh gearbox and synchromesh gearbox.
9. Dismantling & assembly of Drive line (universal joint, propeller shaft, slip joint).
10. Dismantling & assembly Final drive & differential.
11. Dismantling & assembly of automatic transmission.
12. Experiments on Wheel balancing and Wheel Rotation.
13. Inspection of Tyre wear pattern and verification of Wheel alignment.
14. Measurement of Exhaust Gas emission and Combustion Analysis.
15. Driving Cycle Analysis using Chassis Dynamometer

COURSE OUTCOMES

At the end of the course student will be able to

1. Identify different automotive systems and subsystems
2. Ability to dismantle and assemble engine, transmission, steering, suspension, braking, electrical and electronics systems.
3. Illustrate working and functions of various automotive components

IV. ELECTIVE COURSES

a. PROGRAMME ELECTIVE (PE)

MEPE10 – COMPRESSIBLE FLOW AND JET PROPULSION

Course Code:	MEPE10	No. of Credits:	03
Course Name:	Compressible Flow and Jet Propulsion	Prerequisite:	MEPC14

COURSE LEARNING OBJECTIVES

1. To familiarize with the differences between incompressible and compressible flows.
2. To draw the connection between compressible flow and thermodynamics.
3. To provide knowledge on various types of shocks.
4. To impart knowledge on the effect of friction and heat transfer on compressible flows.
5. To impart skills to analyze engines used for jet propulsion

COURSE CONTENT

Fundamentals: Governing equations for inviscid-compressible flows - static and stagnation properties - speed of sound and Mach number, continuity, momentum and energy equations, mathematical derivations of Bernoulli's equation for incompressible and compressible fluid flows, effects of compressibility on the fluid flow measurements, application incompressible fluid flow standard tables.

Isentropic flows: through variable area passage ducts - Flow through nozzles and diffusers, chocked flow, critical pressure ratio, application of equation of critical pressure ratio, variable cross-sectional area flow.

Flow with shocks: Normal and oblique shocks, causes and effects of shocks, Prandtl-Meyer and Rankin-Hugoniot equation equations.

Flow with effects of friction and heat transfer: Fanno flow, isothermal fluid flow, Rayleigh flow, concepts of maximum length and its variation on subsonic and supersonic fluid entry.

Jet Propulsion: Fundamentals of jet propulsion - Thermodynamic cycle analysis and efficiencies of propulsive devices. Thrust equation, classification and comparison of ram jets, turbojets, pulse jets and rockets. Performance of turbo-prop, turbo-jet and turbo-fan engines. Augmentation of thrust.

REFERENCE BOOKS:

1. Yahya, S. M., Fundamentals of Compressible Flow, Pub.: New Age International Publishers
2. Balachandran, P., Fundamentals of Compressible Fluid Dynamics, Pub. PHI Learning
3. Radhakrishnan, E., Gas Dynamics, Pub. PHI Learning

4. Radhakrishnan, E., Applied Gas Dynamics, Pub.: Wiley India
5. Oosthuizen, P.H. and Carscallen, W.E., Compressible Fluid Flow, Pub.: Mc Graw-Hill Education
6. Anderson, J. D., Modern Compressible Flow with Historical Perspective, Pub.: Mc Graw-Hill Education
7. Cumpsty, N. A., Jet Propulsion: A Simple Guide to the Aerodynamic and Thermodynamic Design and Performance of Jet Engines, Cambridge University Press, 2003

COURSE OUTCOMES:

At the end of the course student will

1. Be able to identify, appreciate and analyze the compressible fluid flow problems by applying the fundamental technologies of fluid mechanics.
2. Analyze compressible flow problems with constant area & converging / diverging ducts, fluid flow with shocks, heat transfer and frictional effects.
3. Interpret and analyze the performance characteristics of jet propulsion engines.

MEPE11 – COMPUTATIONAL FLUID DYNAMICS

Course Code:	MEPE11	No. of Credits:	03
Course Name:	Computational Fluid Dynamics	Prerequisite:	MEPC14

COURSE LEARNING OBJECTIVES

1. To introduce numerical modeling and its role in the field of heat transfer and fluid flow.
2. To enable the students to understand the various discretization methods and solving methodologies.
3. To create confidence to solve complex problems in the field of heat transfer and fluid dynamics by using high speed computers

COURSE CONTENT

Computational Fluid Dynamics: What, When, and Why?, CFD Advantages and Applications, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy, General scalar transport equation. Approximate Solutions of Differential Equations: Error Minimization Principles, Functional involving higher order derivatives, Essential and natural boundary conditions.

Discretization methods - Finite Element Method and Finite difference methods: Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples and Some Conceptual Basics and Implementation of boundary conditions. Discretization of 1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme.

Important Consequences of Discretization of Time Dependent Diffusion Type Problems: Consistency, Stability, Convergence, Grid independent and time independent study, Stability analysis of parabolic and hyperbolic equations. Finite Volume Discretization of 2-D unsteady State Diffusion type problems.

Solution of Systems of Linear Algebraic Equations: Criteria for unique solution, infinite number of solutions and no solution, Solution techniques for systems of linear algebraic equations: Elimination, Iteration and Gradient Search methods with examples. Norm of a vector, Norm of a matrix, some important properties of matrix norm, Error analysis of elimination methods.

Finite volume discretization of Convection-Diffusion Equations: Schemes. The concept of false diffusion, QUICK scheme. Discretization of Navier Stokes Equations: Discretization of the Momentum Equation, Staggered grid and Collocated grid, pressure-velocity coupling, Chorin's projection method, SIMPLE Algorithm, SIMPLER Algorithm. What is there in implementing a CFD code: The basic structure of a CFD code: Pre-processor, Solver and Postprocessor, User-defined subroutines.

REFERENCE BOOKS:

1. Tannehill, J.E., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, 2nd ed., Taylor & Francis, 1997.
2. Hoffmann, K.A. and Chiang, S.T., Computational Fluid Dynamics for Engineers, Engineering Education Systems, 2000.
3. Anderson J.D., Computational Fluid Dynamics – The basics with Applications, Mc Graw-Hill, 1995.
4. Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics – The finite volume method, Longman Scientific & Technical, 1995.
5. Patankar, S.V., Numerical Heat Transfer & Fluid Flow, Hemisphere, 1980.
6. Date A.W., Introduction to Computational Fluid Dynamics, Cambridge University Press, 2005.
7. Ferziger, J. H., Perić, M., & Street, R. L., Computational methods for fluid dynamics, Vol. 3, Berlin: springer, 2002.

COURSE OUTCOMES

At the end of the course student will

1. Express numerical modeling and its role in the field of fluid flow and heat transfer.
2. Estimate the various errors and approximations associated with numerical techniques.
3. Apply the various discretization methods and solution procedures to solve flow and heat transfer problems.
4. Be able to evaluate the best method for a given thermo-fluids problem.

MEPE12 – ADVANCED IC ENGINES

Course Code:	MEPE12	No. of Credits:	03
Course Name:	Advanced IC Engines	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. Apply principles of thermodynamics, fluid mechanics, and heat transfer to the design and analysis of engines and engine components.
2. Become aware of the relevance of environmental and social issues on the design process of internal combustion engines.
3. Develop mathematical methods for designing components and systems
4. Apply numerical methods to perform design calculations.
5. Advance proficiency in professional communications and interactions.

COURSE CONTENT

SI and CI engines: Mixture requirements – Stages of combustion – Normal and Abnormal combustion, Knock and Pre-ignition – Factors influencing knock – SI Fuel injection systems: Multi Point Fuel Injection (MPFI) & Gasoline Direct Injection (GDI) Systems – Diesel Fuel Injection system: Common Rail Direct Injection (CRDI) & Unit Pump Systems – Fuel Spray behavior – Spray structure and spray penetration – Air motion: Tumble, Swirl & Squish – Different Combustion chamber geometries – Turbo charging – Waste Gate, Variable Geometry turbochargers

Emission Formation and Control: Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Exhaust Gas Analysis – Methods of controlling emissions – In-cylinder treatments: Injection strategies, Exhaust gas recirculation, Spark Advancement – After treatment systems: Three Way Catalytic converter, SCR, LNT, DOC, DPF and Particulate Traps.

Engine Testing and Measurement Systems: Transient dynamometer, Test cells, chassis dynamometer, Fuel and air flow measurement and conditioning system, in-cylinder pressure transducers and crank angle encoders. Driving cycles for emission measurement, National and International emission Norms, Methods and principles of emission measurement – Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer and flame ionization detector, smoke meters and soot analyzer

Advanced Combustion concepts: Low Temperature Combustion - Homogeneous charge compression ignition (HCCI) – Reactivity Controlled Compression Ignition (RCCI) – Gasoline Compression Ignition – Spark Assisted HCCI – Six stroke and Eight stroke engines – Pre-chamber SI engine – Dynamic skip firing – Engine Downsizing and Downspeeding

Combustion Visualization: Optical Engine, Endoscopic access & optical chambers – In-cylinder flow measurements: Particle image velocimetry, Laser Doppler Anemometry – In-cylinder fuel and species measurement:, Planar Laser induced Fluorescence, Raman and Rayleigh Scattering Techniques – Fuel injection and Spray characteristics - Phase Doppler particle analyzer, Mie scattering, Laser sheet droplet sizing – Schlieren and shadowgraphy techniques & Chemi-luminescence Imaging

REFERENCE BOOKS:

1. Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988.
2. Fundamentals of internal combustion engines: Gill, Smith and Ziurys, Oxford and IBH.
3. The Internal combustion Engine in theory and practice: C F Taylor, MIT Press, Cambridge.
4. Internal Combustion Engines and Air Pollution: E F Obert, Intext Educational Publishers, NY.
5. Alternative Fuels Guidebook, Properties, Storage, Dispensing, and Vehicle Facility Modifications, Richard L. Bechtold, SAE Publications 1997.
6. Emission from Combustion engines and their control, Patterson D J and Henein N A: Ann Arbor science publishers.
7. Advanced Engine Technology: Heinz Heisler ISBN 0340568224, SAE Publications.
8. Engines: An Introduction, John L Lumley.
9. Hua Zhao, Laser Diagnostics and Optical Measurement Techniques in Internal Combustion Engine, SAE Publications

COURSE OUTCOMES

At the end of the course student will be able to

1. Understand the combustion phenomena in SI and CI engines.
2. Explain the advanced combustion concepts used to increase engine efficiency and reduce emission levels
3. Understand the different mechanism of different subsystem used in an engine test bed facility
4. Explain the advanced imaging techniques used to study the combustion and spray characteristics of the fuel.
5. Identify the exhaust pollutants formation and measurement techniques.

MEPE13 – COMBUSTION ENGINEERING

Course Code:	MEPE13	No. of Credits:	03
Course Name:	Combustion Engineering	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. This course starts with a review of chemical thermodynamics, statistical mechanics, equilibrium chemistry, chemical kinetics, and conservation equations.

2. Then the following subjects are covered: chemical and dynamic structure of laminar premixed, diffusion, and partially premixed flames; turbulent premixed combustion; turbulent diffusive combustion in one and two-phase flows;
3. Aerodynamics and stabilization of flames; ignition, extinction and combustion instabilities; non-intrusive combustion diagnostics and flame spectroscopy.

COURSE CONTENT

Introduction – Combustion and Thermochemistry – Property Relations – Reactant and Product mixtures – Adiabatic Flame Temperature – Equilibrium Products of Combustion.

Chemical kinetics- Reaction rates- Chemical Mechanisms- Coupling chemical & Thermal analyses of reacting systems.

Simplified Conservation equations for reacting flows- continuity - Momentum Conservation - Energy Conversation - Diffusion equations. General characteristics of combustion, explosion and detonation

Laminar Premixed Flames - Laminar diffusion flames - Flame Propagation – deflagration – Flammability limits – quenching – Ignition – Flame stabilization.

Turbulent Premixed & Non premixed flames - Droplet evaporation and burning – Combustion of carbon particle

REFERENCE BOOKS:

1. An Introduction to Combustion Concepts and Applications by S.R. Turns, McGraw Hill
2. Principles of Combustion by Kenneth Kuo, John Wiley
3. Combustion by Irvin Glassman, Academic Press
4. Combustion Theory by F. A. Williams, ABP
5. Understanding Combustion by H.S. Mukunda, Macmillan India

COURSE OUTCOMES

At the end of the course student will be able to

1. Formulate combustion equations to determine A/F, adiabatic flame temperature and pollutant concentration.
2. Understand the difference between premixed and diffusion combustion.
3. Learn the thermo-chemistry and kinetics of combustion for different fuels
4. Identify factors responsible for laminar and turbulent flame propagation.
5. Apply the different principles of flame stabilization and ignition to design combustor.

MEPE14 – BIOFUELS

Course Code:	MEPE14	No. of Credits:	03
Course Name:	Biofuels	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. To characterize different biomass feedstock's based on its constituents and properties & understand the analytical techniques to characterize biomass.
2. To Understand and evaluate various biomass pre-treatment and processing techniques in terms of their applicability for different biomass types.
3. To provide students with the basic principles of biofuels and bioenergy systems design.
4. To identify biofuels and bioenergy sources; describe biofuels and bioenergy technologies,
5. To distinguish applications and efficiency; analyze biofuels and bioenergy manufacturing, distribution and integration issues.

COURSE CONTENT

Importance of bioenergy and biofuels in solving energy crisis and global warming. Introduction to various biomass types – constituents, characterization. Biogas & bio-electricity, Bio-heat; Clean sustainable bioenergy, bio-electricity and biogas production from Dairy manure and Food Waste streams.

Biomass pre-treatment: Acid/alkali treatment, steam explosion, ammonia fibre expansion, enzymatic, ball milling, other non-conventional techniques, choice of pre-treatment based on biomass types. Pellets made from wood or grass biomass are commercially available at stores for heating homes, schools, businesses.

Seed-based biodiesel, bioethanol, conversion of waste oil to biodiesel, advanced biofuels including algae-biofuel, microbial biofuel, Conversion of waste vegetable oil into biodiesel, and advanced innovations in enzymatic conversion of non-food feed-stocks. Fuel properties, engine applications.

Biomass conversion technologies for biofuel. Thermochemical processes: Combustion, gasification, pyrolysis, hydrothermal liquefaction, hydropyrolysis, torrefaction, choice of thermal process based on biomass type and product requirement.

Biofuels/energy related environmental, economics, & social issues. The source, processing, and social impacts of biofuel utilization

REFERENCE BOOKS:

1. Filemon A. Uriarte Jr., Biofuels from plant oils, National Academy of Science and Technology, 2010.
2. Anju Dahiya, Bioenergy: Biomass to Biofuels, Eslevier, 2015

3. Sunggyu Lee and Y.T. Shah, Biofuels and Bio-energy Processes and Technology, CRC Press, Taylor and Francis Group, 2013.
4. Pandey, A., Larroche, C., Ricke, S.C., Dussap, C.-G., Gnansounou, E., Biofuels: Alternative feedstocks and conversion processes, Academic Press, U.S.A., 2011.
5. Brown, R.C. (Ed.) Thermochemical processing of biomass into fuels, chemicals and power, Wiley, 2011.
6. Clark, J., Deswarte, F. (Ed.) Introduction to chemicals from biomass, John Wiley and Sons, U.K., 2008.
7. Understanding clean energy and fuels from biomass, H. S. Mukunda, 2011

COURSE OUTCOMES

At the end of the course student will be able to

1. Describe the nature and principle of different biomass energy extraction systems and know how to choose the suitable biomass fuels for different bio-energy applications;
2. Address the desirable features of these biomass energy sources and their advantages over traditional fuels such as coal and oil
3. Identify their limited scope in terms of suitable sites, dependence on the elements, capital costs, and cost effectiveness compared with traditional sources

MEPE15 – REFRIGERATION AND AIR CONDITIONING

Course Code:	MEPE15	No. of Credits:	03
Course Name:	Refrigeration and Air Conditioning	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. To understand the principles of refrigeration and air conditioning.
2. To calculate the cooling load for different applications.
3. To select the right equipment for a particular cooling application.
4. To design and implement refrigeration and air conditioning systems using existing standards.
5. Energy Conservation and Management.

COURSE CONTENT

Introduction about Refrigeration – Definitions of various terms. Methods of refrigeration. Air refrigeration system. Bell – Coleman cycle. Introduction about Air craft Air-Conditioning.

Analysis of Vapour compression cycle, Modifications to basic cycle. Multi pressure systems. Multi-evaporator system and Cascade systems.

Discussion of components of V.C system, Servicing. Vacuumizing and charging of refrigerant. Properties of refrigerants. Selection of refrigerants. Sustainable refrigerants.

Psychrometry – Definitions for properties. Introduction to cooling load calculations. Comfort conditions. Effective temperature concept.

Air-conditioning systems – discussion about the central plant with direct evaporator and chiller applications, Ice plant, refrigerators. Food preservation, IQF technique and freeze drying etc. Cold storage and thermal insulation.

REFERENCE BOOKS:

1. Arora, R.C., Refrigeration and Air Conditioning, PHI Pvt Ltd, 2010
2. Arora, C.P., Refrigeration and Air Conditioning, 2nd ed., Tata McGraw-Hill, 2000
3. Dossat R.D., Principle of Refrigeration, 4th ed., Prentice-Hall, 1997.
4. Manohar Prasad, Refrigeration and Air Conditioning, New Age International, 2004.

COURSE OUTCOMES

At the end of the course student will
1. Illustrate the basic concepts of refrigeration system.
2. Analyze the vapour compression cycle and interpret the usage of refrigerants.
3. Explain the components of vapour compression system.
4. Demonstrate the use of psychrometry in analyzing refrigeration systems.

MEPE16 – FUNDAMENTALS OF HVAC SYSTEMS

Course Code:	MEPE16	No. of Credits:	03
Course Name:	Fundamentals of HVAC Systems	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. To learn climate variation and its effects on the building heat load.
2. To learn building material characteristics and their influence on building heating /cooling load for all weather conditions.
3. To study various conversation techniques related to build environment and codes for the same.

COURSE CONTENT

Introduction to Air Conditioning and Refrigeration – Basic Thermodynamics of HVAC, Types of Refrigeration Systems, the Refrigeration Cycle, Refrigerants and their Properties, Plotting the Refrigeration Cycle, Piping and Tubing, Soldering and Brazing, Refrigerant Leak Testing, Refrigerant System Evacuation, Refrigerant System Charging, Control Systems.

Heating systems - Gas Furnaces, Gas Furnace Controls, Gas Furnace Installation, Troubleshooting Gas Furnaces, Oil Fired Heating Systems, Oil Furnace and Boiler Service, Residential Oil Heating Installation, troubleshooting of oil heating systems, Electric Heat, Electric Heat Installation, troubleshooting of electric heat, Heat Pump System Fundamentals, Heat Pumps Applications, Geothermal Heat Pumps, Heat Pump Installation, Troubleshooting of Heat Pump Systems.

Comfort and Psychometrics - Fundamentals: Psychometrics & Airflow, Air Filters, Ventilation and Dehumidification, Heat transmission in building structures -Solar radiation -Infiltration and Ventilation-Cooling/heating load calculations, Residential Load Calculations, Green Buildings and Systems, Indoor Air Quality (IAQ), Building energy calculations

Duct Installation, Duct Design, Zone Control Systems, Testing and Balancing Air Systems.

Chilled Water Systems, Cooling Towers, Commercial Refrigeration Systems, Supermarket Equipment, Ice Machines.

REFERENCE BOOKS:

1. Hand book of heating, ventilation and Air-conditioning, Jan. F. Kreider, CRC press.
2. Automotive heating and Air-conditioning, Mike Stubblefield and John H Haynes
3. Heating ventilation and air conditioning – Jan F. Kreider
4. Control systems for Heating, ventilating and air conditioning, Roger W. Haines, Springer
5. HVAC Equations, Data, and Rules of Thumb - Arthur A. Bell Jr., PE, McGraw-Hill

COURSE OUTCOMES

At the end of the course student will

1. Estimate heating loads, space heat gains and space cooling loads using accepted engineering methods.
2. Determine the coil loads for cooling and heating systems.
3. Select equipment and design systems to provide comfort conditions within the building.

MEPE17 – CRYOGENIC ENGINEERING

Course Code:	MEPE17	No. of Credits:	03
Course Name:	Cryogenic Engineering	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. To builds a solid foundation in the fundamentals of cryogenics
2. To encourage a “hand’s – on” approach to solving cryogenic problems
3. To provide update cryogenic information

COURSE CONTENT

Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics - Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve-Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claude Cycle Dual Pressure Cycle, Ortho-Para hydrogen conversion, Critical Components in Liquefaction Systems.

J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M. Cryocoolers, Pulse Tube Refrigerators Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators

Cryogenic Dewar Design, Cryogenic Transfer Lines. Insulations in Cryogenic Systems, Different Types of Vacuum Pumps, Instruments to measure Flow, Level and Temperature.

REFERENCE BOOKS:

1. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
2. Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1988.
3. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press New York, 1989.
4. Herald Weinstock, Cryogenic Technology, 1969.
5. Robert W. Vance, Cryogenic Technology, John Wiley & Sons, Inc., New York, London, 1969.

COURSE OUTCOMES

At the end of the course student will

1. Introduce the working principles of basic methods to achieve low temperature by using adiabatic expansion, provide a thorough understanding of applications.
2. Able to apply classical thermodynamics to different cryogenic technologies, gas separation and purification system, and low power cryocoolers.
3. Understand the functions and working principles of insulations and various low temperature measuring and storage devices.
4. Understand the application of Cryogenic technology in engineering research and Industry.

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MEPE18 – NANOTECHNOLOGY

Course Code:	MEPE18	No. of Credits:	03
Course Name:	Nanotechnology	Prerequisite:	MEPC18

COURSE LEARNING OBJECTIVES

1. Understand how basic nano systems work
2. Use physical reasoning to develop simple nanoscale models to interpret the behaviour of such physical system
3. Understand the major issues in producing a sustainable nanotech industry

COURSE CONTENT

Introduction to the course, Historical perspective of micro and nano manufacturing technology, Advantages and applications of nanotechnology

Materials overview, atomic structure, bonding, polymers, electrical characteristics, periodic table, crystal structures and defects, physical chemistry of solid surfaces, Introduction to Si-based materials, Ge-based materials, nanomaterials preparation.

Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, CVD - Basics related to nucleation and crystal growth mechanism, PVD, ALD, etching, and material modification methods, processes and equipment, Characterization Tools, Optical microscopy, Profilometry, Ellipsometry, Spectrophotometer, Scanning Electron Microscope, AFM, FFM.

Zero dimensional Nano structures (Nano Particles) - Fabrication procedures, sol-gel processing, applications, properties and applications of Nano Particles, One dimensional Nano structures - Nano wires and nano rods, fabrication methods, Properties and applications of Nano Wires, nano fluids, Two dimensional nano structures.

Top down fabrication procedures, Lithography, Pattern transfer methods, Wet Etching and Dry etching, Nano material characterization methods, Application of nano materials, Carbon Nano Tubes, Quantum dots, thermal insulation, Organic compounds and bio-applications of nano materials.

REFERENCE BOOKS:

1. Jeremy J. Ramsden, Nanotechnology An Introduction, Elsevier, 2011.
2. Amretashis Sengupta, Chandan Kumar Sarkar, Introduction to Nano: Basics to Nanoscience and Nanotechnology (Engineering Materials), Springer, 2015.
3. William Illsey Atkinson, Nanotechnology, Amacom, 2010.

COURSE OUTCOMES

At the end of the course student will

1. Demonstrate a working knowledge of nanotechnology principles and industry applications.
2. Explain the nanoscale paradigm in terms of properties at the nanoscale dimension.

MEPE19 – VEHICLE DYNAMICS

Course Code:	MEPE19	No. of Credits:	03
Course Name:	Vehicle Dynamics	Prerequisite:	MEPC22

COURSE LEARNING OBJECTIVES

1. In-depth understanding of specialist bodies of knowledge within the engineering discipline
2. Application of established engineering methods to complex engineering problem solving
3. Fluent application of engineering techniques, tools and resources

COURSE CONTENT

Multi Degree of Freedom Systems: Closed coupled system, Eigen valve problems, Far coupled systems - Orthogonality of mode shapes-Modal analysis, Forced vibration by matrix inversion. Suspension and Tyres: Requirements. Spring mass frequency.

Wheel hop, wheel wobble, wheel shimmy. Choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and apt directions. Ride characteristics of tyres, behaviour while cornering, power consumed by tyre, effect of driving and braking torque-Gough'styre characteristics.

Vehicle Handling: Oversteer, under steer, steady state concerning. Effect of braking, driving torques on steering. Effect of camber, transient effects in concerning. Directional Stability of vehicles. Stability of Vehicles: Load distribution.

Calculation of tractive effort and reactions for different drives-Stability of a vehicle on a slope, on a curve and a banked road.

Numerical Methods: Approximate methods for fundamental frequency, Dunker-Ley's lower bound, Rayleigh's upper bound-Holzer method for close-coupled systems and branched systems.

REFERENCE BOOKS:

1. Gillespie. T.D., Fundamentals of vehicle dynamics society of Automotive Engineers, Ic USA 1992.
2. Heldt. P.M. Automotive Chassis, Chilton co., New York, 1992
3. Ellis.J.R., Vehicle Dynamics, Business Books Ltd., London, 1991.

4. Giles. J.G. Steering, Suspension and Tyres, IIIife Books Ltd, London, 1988.
5. Giri. N.K. Automobile Mechanics, Khanna Publishers. New Delhi, 1986.
6. Rao. J.S. & Gupta. K., Theory and Practice of Mechanical Vibrations, Wiley Eastern Ltd., New Delhi, 1999.

COURSE OUTCOMES

At the end of the course student will

1. Develop physical and mathematical models to predict the dynamic response of vehicles;
2. Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response;
3. Modify a model of a vehicle to enable it to meet design performance criteria;

MEPE21 – DYNAMICS OF MACHINERY

Course Code:	MEPE21	No. of Credits:	03
Course Name:	Dynamics of Machinery	Prerequisite:	MEPC20

COURSE LEARNING OBJECTIVES

1. To understand the force-motion relationship of components subjected to external forces
2. To analyze the force-motion characteristics of standard machine elements
3. To study the undesirable effects of unbalances resulting from prescribed motions in mechanism.
4. To understand the importance of damping
5. To reduce the physical vibratory system into spring and damping elements

COURSE CONTENT

Fundamentals: Types of vibrations, spring and damping elements, Single degree of freedom systems – free undammed: translations, torsional vibrations, Rayleigh's Energy method.
Free damped vibrations: viscous damping-coulomb damping.

Forced vibration: harmonic force, rotating unbalance / base excitation, concept of frequency response function (FRF), damping-coulomb and hysteresis, transfer functions. General periodic force, Laplace transform.

Two degree of freedom systems – free-undamped, forced, coupling, introduction to multi-DOF systems.

Vibration of continuous systems: transverse vibration, longitudinal vibration. Vibration control: critical speed of shaft, vibration isolation.

Vibration of plates and membranes, modal analysis, Wave and Euler equations, numerical methods.

REFERENCE BOOKS:

1. William T Thomson., Theory of Vibration with Applications, CBS Publishers, New Delhi, 1990.
2. Rao, J.S. and Gupta, K., Introductory Course on Theory and Practice of Mechanical Vibration, New Age International Pvt. Ltd., 2004.
3. Leonard Meirovitch, Fundamentals of Vibrations, McGraw Hill, ISBN 0-07-118174-1, 2001.
4. J.P. Den Hartog, Mechanical Vibrations, Dover Publications, New York, 1934.
5. V. Ramamurti, Mechanical Vibration Practice and Noise Control, Narosa Book Distributors Pvt. Ltd, New Delhi, ISBN: 978-8184871999, 2012.
6. S. Graham Kelly, Mechanical Vibrations, Schaum's outline Series, ISBN 978-0078442667, 1996.

COURSE OUTCOMES

At the end of the course student will

1. State the single degree of freedom systems.
2. Sketch the impulse response for a periodic excitation.
3. Examine the concept of forced vibration.
4. Extend the concept to two degree of freedom systems.
5. Manipulate the vibration of continuous systems.

MEPE22 – MEMS DEVICES – DESIGN AND FABRICATION

Course Code:	MEPE22	No. of Credits:	03
Course Name:	MEMS Devices – Design and Fabrication	Prerequisite:	MEPC13

COURSE LEARNING OBJECTIVES

1. To think in a unified way about interdisciplinary Microsystems
2. Understand the material properties, fabrication technologies, basic structural mechanics, sensing and actuation principles, circuit and system issues, packaging, calibration, and testing.
3. Understand the operation of a wide range of sensors and actuators appropriate for microscale systems.
4. To design, analysis and master simulation techniques for combining a structured top-down system design approach with bottom-up constraints propagation design and simulate microsystems using behavioral modeling languages and finite element analysis.

COURSE CONTENT

An overview of microelectromechanical system (MEMS) and devices; typical product – Micro Gear, Micro Motors, Micro turbines and other related products. Working Principles of Microsystems – Micro sensors, Micro Actuators: Various micro Actuation systems; MEMS integrated with mechanical actuation and Inertial actuation: Micro fluidics.

Review of Mechanical concepts: Stress, Strain, Modulus of 15% Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, diaphragms – Typical applications

Materials for MEMS and Microsystems – Silicon and silicon compounds, Gallium, Piezoelectric and piezoresistive materials, Polymers and metals

Introduction to design and modeling; Scaling laws in miniaturization; Standard microelectronic fabrication technologies - bulk micromachining - surface micromachining - bonding technologies; Related fabrication methods and creating process flows. Role of Finite Element Analysis software in MEMS.

REFERENCE BOOKS:

1. Tai – Ran Hsu, MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering, John Wiley & Sons, 2008.
2. Tai – Ran Hsu, MEMS & Microsystems Design and Manufacturing, Tata McGraw-hill Edition, 2006
3. Stephen D. Senturia, Microsystems Design, Springer Science & Business Media, 2007.
4. Nadim Maluf, Kirt Williams, Introduction to Microelectromechanical Systems Engineering, Artech House, 2004.
5. Mohamed Gad-el-Hak, MEMS: Design and Fabrication, Taylor & Francis Limited, 2019.
6. Marc J. Madou, Fundamentals of Microfabrication, the science of Miniaturization, CRC Press, 2018.

COURSE OUTCOMES

At the end of the course student will

1. Understand the working principles of micro sensors and actuators
2. Understand the typical materials used for fabrication of micro systems
3. Understand the principles of standard micro fabrication techniques
4. Appreciate the challenges in the design and fabrication of Micro systems

MEPE24 – OIL HYDRAULICS AND PNEUMATICS

Course Code:	MEPE24	No. of Credits:	03
Course Name:	Oil Hydraulics and Pneumatics	Prerequisite:	MEPC14

COURSE LEARNING OBJECTIVES

1. The cognitive objective of this course is for each student to comprehend foundational knowledge needed to perform stated entry-level industry competencies.

2. The performance objective of this course is for each student to apply foundational knowledge to hydraulic and pneumatic problems and exercises encountered in class.

COURSE CONTENT

Basic concepts of fluid power system design - Hydraulic oils and fluid properties – Seals and Seal materials - Filters and Filtration.

Hydraulic pumps, cylinders, and motors - Construction, sizing, and selection.

Control valves; pressure, flow, and direction - Servo-valves.

Basic hydraulic circuits, hydrostatic transmission - Cartridge valve circuits.

Control of hydraulic circuits - Electrical, electronics, and PLC - Pneumatic components and basic circuits.

REFERENCE BOOKS:

1. Esposito. A., Fluid Power with Applications, 5th ed., Pearson Education, 2003.
2. Industrial Hydraulics, Vickers - Sperry Manual, 2002.

COURSE OUTCOMES

1. Recall various fluid properties and identify the appropriate fluid power system for particular application.
2. Recognize the suitable pump and actuators for particular application.
3. Select various control valves such as pressure control, flow control, direction control valves and use them in hydraulic and pneumatic circuit development.
4. Analyze the hydraulic and pneumatic circuit for energy efficiency.
5. Select the appropriate control system like electrical, electronics, and PLC to control the fluid power system.
6. Trouble-shoot and identify maintenance problems associated with fluid power system.

MEPE25 – INDUSTRIAL ROBOTICS

Course Code:	MEPE25	No. of Credits:	03
Course Name:	Industrial Robotics	Prerequisite:	MEPC13

COURSE LEARNING OBJECTIVES

1. To introduce the basic concepts, parts of robots and types of robots

2. To make the students familiar with the various drive systems for robot, sensors and their applications in robots, programming of robots
3. To discuss about the various applications of robots, justification, implementation and safety of robot.

COURSE CONTENT

Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Functions – Need for Robots – Different Applications, Principles and problems in robot design and control

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of Drives End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations

Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors. Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Image Processing and Analysis – Data Reduction: Edge detection, Segmentation Feature Extraction and Object Recognition - Algorithms. Applications – Inspection, Identification, Visual Serving and Navigation.

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems. Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs

RGV, AGV; Implementation of Robots in Industries – Various Steps; Safety Considerations for Robot Operations; Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method.

REFERENCE BOOKS:

1. Mair, G.M., Industrial Robotics, Prentice-Hall, 1988.
2. Considine, D.M. and Considine, G.D., Standard Hand Book of industrial Automation, Chapman and Hall, 1986.
3. Groover, M.P., Weiss, M., Nagel, R.N., and Odrey, N.G., Industrial Robotics, Technology, Programming, and Applications, McGraw-Hill, 1995.

COURSE OUTCOMES

At the end of the course student will

1. Classify and characterize the robots based on the configuration and work volume.
2. Explain and solve the problems related to robot design and control.
3. Illustrate the working of the transmission system in a robot.
4. Discuss the concept of vision system and image processing.
5. Write programs for automatic functioning of a robot.
6. Design a working model of a robot using the concepts and principles learnt.

MEPE26 – MECHATRONICS

Course Code:	MEPE26	No. of Credits:	03
Course Name:	Mechatronics	Prerequisite:	MEPC13

COURSE LEARNING OBJECTIVES

1. Apply mechanical engineering and electrical engineering knowledge and skills to problems and challenges in the areas of mechatronic engineering.
2. Integrate and use systems or devices incorporating modern microelectronics, information technologies and modern engineering tools for product design, development and manufacturing.
3. Engage in lifelong learning in their profession and practice professional and ethical responsibility.

COURSE CONTENT

Introduction to mechatronics- Historical perspective- Key elements of a mechatronic system- Examples of mechatronic systems.

Sensors and Transducers – Signal conditioning and Data acquisition systems.

Actuation systems– Pneumatic and Hydraulic system, mechanical and electrical actuation systems.

Smart materials and Systems – Piezoelectric actuators– Shape memory alloy (SMA) actuators, Magneto rheological and Electro rheological Fluids and its applications; Dampers, Clutch, Valves etc.. System models – Engineering systems- Rotational translational systems – Electromechanical systems – Hydraulic mechanical systems – Dynamic responses of systems – Frequency response- Closed loop controllers.

Introduction to microcontrollers and microprocessors– Interfacing microcontrollers with sensors and actuators – Introduction to Programmable logic controllers (PLC) – Case Studies of mechatronic systems.

REFERENCE BOOKS:

1. Godfrey Onwubolu, Mechatronics – Principles and Applications, Butterworth – Heinemann, 2005
2. David G. Alciatore, Michael B. Histand, David Alciatore, Introduction to Mechatronics and Measurement Sytems, McGraw Hill; second edition, 2002
3. W. Bolton, Mechatronics- Electronic control systems in Mechanical and Electrical Engineering, second edition, Pearson Education, 2001.
4. Robert H Bishop, The Mechatronics Handbook CRC Press, 2002

COURSE OUTCOMES

At the end of the course student will

1. To employ the basic mathematical skills needed to solve routine engineering problems.
2. To demonstrate knowledge of electrical circuits and logic design.
3. To implement engineering solutions and techniques to solve design problems.
4. To design mechatronic components and systems.
5. To apply spreadsheets, computer-based modeling and other computer-based methods to solve mechatronic problems.
6. To communicate through writing with others in the field of mechatronics.

MEPE27 – INDUSTRIAL TRIBOLOGY

Course Code:	MEPE27	No. of Credits:	03
Course Name:	Industrial Tribology	Prerequisite:	MEPC18

COURSE LEARNING OBJECTIVES

1. To impart knowledge on friction, wear and lubrication
2. To acquire knowledge on surface coatings and measurements.

COURSE CONTENT

Tribology -- definition, Industrial significance, economic aspects, trends. Factors influencing Tribological phenomena. Engineering surfaces - Surface characterization, Computation of surface parameters.

Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, various laws and theory of friction. Stick-slip friction behavior, frictional heating and temperature rise. Friction measurement techniques.

Wear and wear types. Mechanisms of wear - Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., Wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear controlling techniques.

Introduction to lubrication. Lubrication regimes. Introduction to micro and nano tribology. Coating characteristics, Coating performance evaluation, Powder coatings and types, application methods.

Surface topography measurements - Electron microscope and friction and wear measurements - Laser method. Sliding friction and wear abrasion test, rolling contact and fatigue test, solid particle and erosion test, Use of transducers and instruments in Tribology

REFERENCE BOOKS:

1. Hulling , J. (Editor) --"Principles of Tribology", MacMillan, 1984.
2. Williams J.A . "Engineering Tribology" ,Oxford Univ. Press,1994.
3. Neale M.J , "Tribology Hand Book ", Butterworth Heinemann, 1995.
4. I.M. Hutchings, “Tribology: Friction and Wear of Engineering Materials”, Elsevier Limited, 1992.
5. G. W. Stachowiak, A. W. Batchelor, “Engineering Tribology”, Elsevier Limited, 2005.
6. K.C. Ludema, “Friction, wear, lubrication: A text book in tribology”, CRC Press, 1996.
7. Bharat Bhushan, “Nanotribology and Nanomechanics: An Introduction”, Springer, 2008.

COURSE OUTCOME

At the end of the course student will

1. Apply the knowledge of tribology in industries
2. Identify the types of wear
3. Know the working of surface measuring instruments

MEPE29 – RENEWABLE ENERGY SOURCES

Course Code:	MEPE29	No. of Credits:	03
Course Name:	Renewable Energy Sources	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. To enable the students to understand the principle of working and the components of different non-conventional sources of energy and their utilization.
2. To get an exposure to the wind energy, Biomass, geothermal energy, tidal energy, fuel cells and energy conversion technologies.

COURSE CONTENT

Solar Energy: Present renewable energy status in India - Solar radiation – Measurements of solar radiation and sunshine – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

Wind Energy: Wind data and energy estimation – Betz limit - Site selection for wind farms – Horizontal axis wind turbine – Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

Bio – Energy: Bio resources – Biomass direct combustion – Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

Ocean and Geothermal Energy: Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

New Energy Sources: Fuel cell – Principle - Types of fuel cells – Hydrogen energy – Properties – Hydrogen production – Storage – Transport and utilisation - Safety issues. Energy Storage methods and devices.

REFERENCE BOOKS

1. G.D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi, 2014.
2. Twidell, J.W. & Weir, A., “Renewable Energy Resources”, EFN Spon Ltd., UK, 2005.
3. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K., 2012.
4. S.P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
5. G.N. Tiwari, “Solar Energy – Fundamentals Design, Modelling and applications”, Alpha Science Intl Ltd, 2015.
6. B.H. Khan, “Non-Conventional Energy Resources”, The McGraw Hill companies, 2009

COURSE OUTCOMES

At the end of the course student will

1. To estimate solar radiation and formulate heat transfer equations and analyze of modern energy conversion technologies
2. To describe various renewable energy resources and techniques to utilize them effectively.
3. Compute wind energy potential and predict the performance of wind turbines.
4. Describe and analyze photovoltaic systems.
5. Explain the energy harvesting methods from various energy sources.
6. Distinguish the various form of energies such as magneto hydrodynamic, thermionic and fuel cell.

MEPE30 – CONTINUUM MECHANICS

Course Code:	MEPE30	No. of Credits:	03
Course Name:	Continuum Mechanics	Prerequisite:	MEPC12

COURSE LEARNING OBJECTIVES

1. To introduce basic tensorial calculus for understanding continuum behavior of matters.
2. To familiarize the configuration dependent stress and strain measures.
3. To strengthen the knowledge about the fundamental balance principles of continuum objects.
4. To establish a good foundation in constitutive modeling

COURSE CONTENT

Tensor algebra: Scalar, Vector, second and higher order Tensors, Eigen values & vectors, Transformation of Tensors, Tensor valued functions, gradient operators and Integral theorems.

Kinematics: References and deformations configurations, Mapping and deformation gradients, material and spatial representations, Nanson's formula, Strain measures, Rotation & stretch tensors, rate of deformation.

Kinetics: Concept of stress, Cauchy's stress theorem, first and second Piola- Kirchoff's & Cauchy's stress tensors, Normal and shear stress, Extremal stress values, stress states.

Balance Principles: Mass conservation, Reynold's transport theorem, Momentum and energy balances in references and current configuration, Weak and strong forms of balance equation, Continuum thermodynamics, Clausius-Duhem inequality, Frame dependent and independent quantities, Objective rates.

Constitutive Modeling: Fluid and solid constitutive equations, generalized Hooke's law, material symmetry, visco elasticity, metal plasticity: Yield criteria, Flow rule, Hardening rule, loading & unloading conditions, multiplicative strain decomposition, rheological models.

REFERENCE BOOKS:

1. Holzapfel, G. A. "Nonlinear solid mechanics, vol. 24." Chichester, New York (2000).
2. Shabana, Ahmed A. Computational continuum mechanics. John Wiley & Sons, 2018.
3. Bertram, Albrecht. Elasticity and plasticity of large deformations. Springer-Verlag Berlin Heidelberg, 2005.
4. Simo, Juan C., and Thomas JR Hughes. Computational inelasticity. Vol. 7. Springer Science & Business Media, 2006.

COURSE OUTCOMES

Upon completion of this course, the student will be able to:

1. Understand the unified theory of continuum body such as fluids and solids.
2. Knowledge of stress and strain at a particular configuration on a material and spatial point.
3. Ability to perceive the constitutive modeling of materials.

MEPE31 – MATHEMATICAL METHODS FOR MECHANICAL ENGINEERS

Course Code:	MEPE31	No. of Credits:	03
Course Name:	Mathematical Methods for Mechanical Engineers	Prerequisite:	MAIR43

COURSE LEARNING OBJECTIVES

1. To understand ordinary and partial differential equations from engineering point of view
2. To solve differential equations encountered in mechanical engineering using different analytic, semi-analytic and numerical methods
3. To apply the principles of variational calculus to solve problems encountered in mechanical engineering
4. To introduce applications of different mathematical functions in mechanical engineering problems.

COURSE CONTENT

Ordinary differential equations – variation of parameters, Frobenius method, Sturm-Liouville problems, Bessel and Legendre functions, Green's function, Perturbation methods

Partial differential equations – well-posed problem, separation of variables – series solution, use of transforms and complex numbers, Green's identity and method

Variational calculus – Euler-Lagrange equation – applications, Lagrange multipliers, method of weighted residues

Special functions – understanding beta, gamma and error functions with examples from mechanical engineering

Numerical methods for differential equations – Conversion of differential equation into system of algebraic equations – finite difference method, methods of solution – matrix inversion, Gauss elimination, TDMA, Iterative methods and gradient search methods

REFERENCE BOOKS:

1. Howe, M., Mathematical Methods for Mechanical Sciences, Imperial college press, London, 2016
2. Andrews, L. C. and Phillips, R. L., Mathematical Techniques for Engineering and Scientists, Prentice Hall, 2005.
3. Kreyszig, E., Advanced Engineering Mathematics, 10th ed., John Wiley & Sons, 2015.
4. MacCluer, C. R., Calculus of Variations: Mechanics, Control and Other Applications, Dover, New York, 2005.

COURSE OUTCOMES

1. To analyze and solve differential equations encountered by mechanical engineers using analytic, semi-analytic and numerical methods.
2. To understand the important of special functions in mechanical engineering problems.
3. To use variational calculus principles to analyze and extremize problems.

MEPE32 – TWO PHASE FLOW AND HEAT TRANSFER

Course Code:	MEPE32	No. of Credits:	03
Course Name:	Two Phase Flow and Heat Transfer	Prerequisite:	MEPC19

COURSE LEARNING OBJECTIVES

1. To understand two phase flow in a variety of engineering processes.
2. To understand the applications of various experimental heat transfer correlations in engineering applications.

COURSE CONTENT

Introduction to two phase heat transfer, Continuity, momentum and energy equations, substantial acceleration, temperature distribution in internal flows, relations between thermal boundary layer and hydrodynamic boundary thickness using magnitude analysis, two phase heat transfer in variety of engineering processes.

Droplet condensation, falling film condensation, Nusselt theory. Nucleate boiling, convective boiling with pure fluids, critical heat flux boiling.

Two phase heat transfer in mixtures, temperature Glide, heat transfer coefficient estimation, presence of low vapor-pressure liquid, non-condensing gas, Melting and solidification;

Flow regimes, flow separated model, Lockhart-martinelli model, homogeneous flow model pressure drop-in two-phase flow.

REFERENCE BOOKS:

1. Ghiaasiaan, S. M., Two-Phase flow, Boiling, and Condensation, Cambridge University Press, 2010.
2. Collier, J. G. and Thome, J. R., Convective Boiling and Condensation, 3rd ed., Oxford University Press, 1996.
3. L.S. Tong and Y.S. Tang, Boiling Heat Transfer and Two-Phase Flow (2nd edition), CRC Press, 1997.
4. A. Bejan, Convective Heat Transfer, Wiley ,1984.

COURSE OUTCOMES

- Explain and apply the concepts of two-phase heat transfer
- Estimate the two-phase heat transfer coefficients
- Determine and compute two phase pressure drops and heat losses.

MEPE33 – THEORY OF SPRAYS

Course Code:	MEPE33	No. of Credits:	03
Course Name:	Theory of Sprays	Prerequisite:	MEPC14

COURSE LEARNING OBJECTIVES

1. To understand the spray and atomization characteristics of different atomizers
2. To analyze the different approaches adopted for atomization mechanism
3. To familiarize the methods adopted for understand spray pattern and drop sizing

COURSE CONTENT

Introduction - Basic spray processes, drop size and velocity distribution functions: Number distributions, Mass/volume distributions, Empirical distributions, Theoretical distributions.

Atomization mechanisms – deterministic theories – linear stability theories. Effervescent atomizers. Kelvin-Helmholtz instabilities of aerodynamic origin – turbulent atomization. Cavitation as atomization mechanism. Ligaments and drop formation

Approaches to analyze atomization – Eulerian. Statistical approach - Break-up cascades by normal distribution, Weibull–Rosin/Rammler distributions, fractal method. Maximum Entropy formalism. Population balance equations (PBE).

Spray characteristics – Spray properties, Penetration, cone angle, radial and circumferential liquid distribution and drop drag coefficient. Droplet Evaporation – Steady state and unsteady state analysis

droplet lifetime and burning. Drop sizing – Factors – Methods: Mechanical, Electrical and optical Methods

Atomizers – requirements – Pressure, Rotary, Air-assist, Air blast, Effervescent, Electrostatic and Ultrasonic Atomizers – flow and performance relationships

REFERENCE BOOKS

1. Lefebvre, Arthur H., and Vincent G. McDonell. Atomization and sprays. CRC press, 2017.
2. Bayvel, L. P. Liquid atomization. Vol. 1040, no. 2756. CRC Press, 1993.

MEPE34 – ADDITIVE MANUFACTURING

Course Code:	MEPE34	No. of Credits:	03
Course Name:	Additive Manufacturing	Prerequisite:	MEPC16

COURSE LEARNING OBJECTIVES

To imbibe knowledge on

1. Development of Additive Manufacturing (AM) and opportunities for product development.
2. Acquaint with software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
3. Familiarize with VAT polymerization and material extrusion processes, powder bed fusion and direct energy deposition.
4. Applications of binder jetting, material jetting and laminated object manufacturing processes

COURSE CONTENT

INTRODUCTION: Overview – Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping, Rapid Tooling – Rapid Manufacturing – Additive Manufacturing. AM Process Chain-Classification – Benefits. Applications: Building Printing-Bio Printing- Food Printing-Printing Electronics. Business Opportunities and Future Directions - Intellectual Property.

DESIGN FOR ADDITIVE MANUFACTURING (DFAM): Concepts and Objectives- AM Unique Capabilities: Part Consolidation -Topology Optimization - Lightweight Structure - DFAM for Part Quality Improvement. Data Processing - CAD Model Preparation - Part Orientation and Support Structure Generation -Model Slicing - Tool Path Generation, Customized Design and Fabrication for Medical Applications- Case Studies.

VAT POLYMERIZATION AND MATERIAL EXTRUSION: Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process –Advantages and Limitations- Applications. Digital Light

Processing (DLP) - Materials – Process - Advantages - Applications. Extrusion Based System: Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations.

POWDER BED FUSION AND DIRECT ENERGY DEPOSITION: Powder Bed Fusion: Selective Laser Sintering (SLS): Process – Powder Fusion Mechanism – Process Parameters – Typical Materials and Application. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Materials – Process - Advantages and Applications. Beam Deposition Process: Laser Engineered Net Shaping (LENS)- Process -Material Delivery - Process Parameters -Materials -Benefits -Applications.

OTHER ADDITIVE MANUFACTURING PROCESSES: Binder Jetting: Three Dimensional Printing - Materials -Process - Benefits and Limitations. Material Jetting: Multijet Modeling- Materials - Process - Benefits. Sheet Lamination Process: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding – Thermal Bonding- Materials-Application and Limitation.

REFERENCE BOOKS

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015.
4. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011.
5. Chua, C K, Leong, K F and Lim CS, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2003.

COURSE OUTCOMES:

On completing this course students will be able to:

1. Recognize the development of AM technology and opportunities for transforming a concept into product development.
2. Elaborate the vat polymerization and material extrusion processes and its applications.
3. Acquire knowledge on process and applications of powder bed fusion and direct energy deposition.
4. Evaluate the advantages, limitations, applications of binder jetting, material jetting and laminated object manufacturing processes.

MEPE35 – COMPUTER AIDED DESIGN AND DRAFTING

Course Code:	MEPE35	No. of Credits:	03
Course Name:	Computer Aided Design and Drafting	Prerequisite:	MEIR12

COURSE LEARNING OBJECTIVES

1. To introduce the student to the basic tools of computer-aided design (CAD) and computer-aided manufacturing (CAM).
2. To expose the student to contemporary computer design tools for aerospace and mechanical engineers.
3. To prepare the student to be an effective user of a CAD/CAM system.

COURSE CONTENT

CAD hardware - Product cycle - CAD tools, CAD systems; system evaluation, CAD specific I/O devices.

CAD software - Graphic standards – Modes of graphics operation, Software Modules.

Geometric modeling – Types and mathematical representation and manipulation of curves and surfaces.

Solid modeling- fundamentals, feature based modeling manipulations of solid models. Transformation of Geometric models and visual realism - Animation.

REFERENCE BOOKS:

1. Zeid, I., CAD/CAM Theory and Practice, Tata McGraw-Hill, 2nd Edition, 2009.
2. Rogers, D.E and Adams, J.A., Mathematical Elements for Computer Graphics, 2nd ed. McGraw-Hill, 2002.
3. Anupam Saxena and Birendra Sahay, Computer Aided Engineering Design, by ISBN-13: 978-1402025556, Springer, 2005.

COURSE OUTCOMES

At the end of the course student will

1. Explain lifecycle of a product and the role of computer-aided design (CAD) in product development.
2. Describe the concepts of geometric and solid modelling.
3. Visualize geometric models through animation and transform them into real world systems

MEPE36 – POWER PLANT ENGINEERING

Course Code:	MEPE36	No. of Credits:	03
Course Name:	Power Plant Engineering	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. Describe sources of energy and types of power plants
2. Analyze different types of steam cycles and estimate efficiencies in a steam power plant
3. Describe basic working principles of gas turbine and diesel engine power plants. Define the performance characteristics of such power plants
4. List the principal components and types of nuclear reactors.

COURSE CONTENT

Thermal plant layout – working – Auxiliaries - Rankine cycle – improvement and limitations - Boiler types, circulation systems – Efficiency calculation - supercritical boilers – Fluidized bed boilers - Fuel and ash handling – combined cycle power generation.

Gas turbine power plants – Thermodynamic fundamentals, application, combined cycle configurations, cogeneration, major components, factors influencing performance of GT plants.

Hydro Electric Power Plant – Essential features, classification and operation. Prime mover – types and selection, Draft tubes – types. Ways to avoid cavitation.

Nuclear Power plants – Power reactors – Fuel cells – Current generation power reactors – Breeder reactors – components - Safety aspects.

Diesel power plants – layout – working, Different systems – Fuel system, lubrication system, Air intake system, Exhaust system, cooling system. Starting system.

Solar thermal plants and wind mills – Operation & recent developments. Power plant economics.

REFERENCE BOOKS

1. Arora, S.C. and Domkundwar, S., A Course in Power Plant Engineering, Dhanpat Rai & Sons, 2016.
2. El Wakil, M.M., Power Plant Technology, Tata McGraw-Hill, 2nd Ed, 1984.
3. Nag. P.K., Power Plant Engineering, Tata McGraw-Hill, 4th Ed, 2014.

COURSE OUTCOMES

At the end of the course student will

1. Summarize the layout and components in a power plant.

2. Enumerate and classify the types of power plants available.
3. Recognize the steam cycles on pressure-volume and temperature diagram.
4. Outline the scenario of entire business of power plants along with performance parameters, load curves and tariff calculations.
5. Extend their knowledge to power plant economics and environmental hazards

MEPE37 – RADIATIVE HEAT TRANSFER

Course Code:	MEPE37	No. of Credits:	03
Course Name:	Radiative Heat Transfer	Prerequisite:	MEPC19

COURSE LEARNING OBJECTIVES

1. Understands the physical mechanisms involved in radiation heat transfer. Each student can calculate total, hemispherical radiative properties of real surfaces from their spectral, directional counterparts.
2. Calculate radiation heat transfer between black body surfaces and gray body surfaces.
3. To identify, formulate, solve engineering problems and to use the techniques, skills, and modern engineering tools necessary for engineering practice

COURSE CONTENT

Introduction - Blackbody radiation - Properties of real surfaces - Spectral and directional variations. Review of radiation principles - laws of thermal radiation - surface properties – Review on radiative heat exchange among diffuse, gray and non-gray surfaces separated by non-participating media – Review on gas radiation and radiation transfer in enclosures containing absorbing and emitting media – Review on interaction of radiation with conduction and convection.

Shape factor - Triangular enclosure - Evaluation of shape factors - Radiation in enclosures - Electrical analogy – Applications - Non-gray enclosures - Enclosure with Specular surfaces - Integral method for enclosures.

Introduction to gas radiation - Plane parallel model - Diffusion approximation - Radiative equilibrium - Optically thick limit - Radiation spectroscopy - Isothermal gas emissivity - Band models - Total Emissivity method.

Isothermal gas enclosures - Well-stirred furnace model - Gas radiation in complex enclosures - Interaction between radiation and other modes of heat transfer - Radiation heat transfer during flow over flat plate.

Radiation and Climate – Radiative - convective equilibrium - Radiative equilibrium with scattering - Radiation measurement - Radiation with internal heat source - Particle scattering - Scattering in the atmosphere - Non-isotropic scattering - Approximate methods in scattering - Monte Carlo method.

REFERENCE BOOKS

1. Siegel, R. and Howell, J., Thermal Radiation Heat Transfer, Taylor and Francis 2002.
2. Fundamentals of heat transfer by Grober, Erk and Grigull, McGraw-Hill.
3. Fundamentals of heat transfer by Incropera and Hewitt.
4. Conduction heat transfer by Schneider, Eddison Wesley.
5. Radiation heat transfer by Sparrow and Cess, McGraw-Hill.
6. Radiation heat transfer by H.C. Hottel and A.F. Sarofin.

MEPE38 – QUALITY CONTROL

Course Code:	MEPE38	No. of Credits:	03
Course Name:	Quality control	Prerequisite:	Nil

COURSE CONTENT

Introduction to quality control and total quality system

Philosophies of quality control: Deming's philosophy, Crosby's philosophy, Juran's philosophy. Comparison of three philosophies.

Tools for continuous quality Improvement: Pareto Diagrams, Flow charts, Cause effect diagrams, scatter plots, Multivariable charts, Failure Mode and effects criticality analysis.

Statistical foundations Review: Population and sample, Probability, Normal, Poisson, binomial, Hypergeometric distributions, Inferential statistics

Data analysis and sampling, validating distribution assumptions, transformation to achieve normality, analysis of count data, concepts of sampling

Statistical process control: Basics of Control charts, Control charts of variables, control charts for attributes, process capability analysis, acceptance sampling plans

Product and process design: Reliability, experimental design and Taguchi method

REFERENCE BOOKS:

1. Fundamentals of Quality control and Improvement, Amitava Mitra, Third edition, Wiley student edition

MEPE39 – INDUSTRIAL SAFETY ENGINEERING

Course Code:	MEPE37	No. of Credits:	03
Course Name:	Industrial Safety Engineering	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To imbibe knowledge on safety management functions and its techniques.
2. To imbibe knowledge on accident reporting & investigation procedure.
3. To imbibe knowledge on safety education & training evaluation of safety performance in an organization.
4. To imbibe knowledge on workplace hazards & its control

COURSE CONTENT

Evolution of modern safety concept- Safety management functions - safety policy - Safety Organization - Safety Committee - budgeting for safety - Behaviour based Safety.

Safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign

Concept of an accident, reportable and non-reportable accidents, reporting to statutory authorities

– principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – cost of accident.

Machine Guarding, Guarding of hazards, Machine Guarding types and its application – Safety in welding and Gas cutting – Safety in Manual and Mechanical material handling- Safety in use of electricity

Toxicity- TLV- Types of Chemical Hazards-Occupational diseases caused by dust, fumes, gases, smoke and solvent hazards- control measures

Fire triangle- Types of fire - first aid firefighting equipment – flammability limit- LPG safety - Hazard identification and Risk Analysis.

Overview of factories act 1948 – ISO-45001

REFERENCE BOOKS:

1. Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982
2. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973
3. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.

4. Krishnan N.V. “Safety Management in Industry” Jaico Publishing House, Bombay, 1997.
5. John Ridley, “Safety at Work”, Butterworth & Co., London, 1983.
6. Deshmukh, L. M. Industrial Safety Management. Tata McGraw-Hill Education, 2017.

COURSE OUTCOMES

At the end of the course student will

1. Apply principles of safety management, its functions and technique in any organization,
2. Classify and categorize the factors contributing to accident,
3. Formulate accident investigation program in an organization, practice and develop accident reporting system within an organization and calculate accident indices for monitor ing safety performances,
4. Apply material handling and machine guarding principles in industrial applications
5. Realize chemical hazards, toxicity, fire and explosion in the work place and involve to take various control measures to prevent hazards.

MEPE40 – OPERATIONS RESEARCH

Course Code:	MEPE40	No. of Credits:	03
Course Name:	Operations Research	Prerequisite:	Nil

COURSE LEARNING OBJECTIVES

1. To provide knowledge and training in using optimization techniques for engineering problems.
2. To understand different optimization model adopted in engineering industry

COURSE CONTENT

Linear programming – Graphical Method – Simplex algorithm – Duality formulation – Sensitivity analysis.

Transportation Assignment Models – Traveling Salesman problem – Networks models – Shortest route – Minimal spanning tree – Maximum flow models – CPM and PERT networks – Critical path scheduling – Sequencing models.

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models

Queueing models– Single server and multi-server models – Poisson input – Exponential service – Constant rate service – Infinite population

Decision models – Game theory – Graphical and Algebraic solution – Linear Programming solution – Replacement models – Models based on service life – Economic life – Single / Multi variable search technique – Dynamic Programming

REFERENCE BOOKS:

1. Taha H.A., "Operations Research", Sixth Edition, Prentice Hall of India, 2003.
2. Shennoy G.V. and Srivastava U.K., "Operation Research for Management", Wiley Eastern, 1994.
3. Bazara M.J., Jarvis and Sherali H., "Linear Programming and Network Flows", John Wiley,1990.
4. Philip D.T. and Ravindran A., "Operations Research", John Wiley, 1992.
5. Hillier and Libeberman, "Operations Research", Holden Day, 1986
6. Budnick F.S., "Principles of Operations Research for Management", Richard D Irwin, 1990.
7. Tulsian and Pasdey V., "Quantitative Techniques", Pearson Asia, 2002.

COURSE OUTCOME

At the end of the course student will be able to use the optimization techniques for engineering and Business problems

MEPE41 – MECHANICAL VIBRATIONS

Course Code:	MEPE41	No. of Credits:	03
Course Name:	Mechanical Vibrations	Prerequisite:	MEPC20

COURSE LEARNING OBJECTIVES

1. To understand the fundamentals of vibration.
2. To develop the two degree of freedom systems.
3. To formulate the multi degree of freedom systems.
4. To study the vibration test & measurements and devise the vibration controlling methods.

COURSE CONTENT

Fundamentals of Vibrations - Harmonic and periodic motions, Vibration terminology, Vibration model - Equations of motion - Energy method - Rayleigh method - Principle of virtual work, Damping models - Viscously damped free vibration, Special cases: oscillatory, non-oscillatory and critically damped motions, Logarithmic decrement, Forced harmonic vibration - Magnification factor – Transmissibility.

Two degree – Normal mode analysis – Translational system - Rotor system - Lagrangian energy method - Coordinate coupling.

Multi degree - Eigen value and vector - Linear system - Matrix method - Influence coefficients - Stiffness - Flexibility, Numerical methods - Holzer's method - Rayleigh's Approach - Dunkerley's method.

Experimental modal analysis - Free and Forced vibration tests - Frequency response function (FRF), Methods of vibration control - Excitation reduction at source, Balancing of rotating machines - single plane - double plane - Dynamic properties and Selection of structural materials - Viscoelastic materials, Vibration absorbers - Tuned absorber - Tuned and damped absorber, Untuned viscous damper, Vibration isolation techniques - Active control - passive control.

REFERENCE BOOKS:

1. Thomson, W.T., Theory of Vibration and its Applications, 5th Edition, Prentice Hall, New Delhi, 2001.
2. Rao, S.S., Mechanical Vibrations, 4th Edition, Pearson Education Inc. Delhi 2009.
3. Meirovitch, L., Elements of Vibration Analysis, 2nd Edition, Mc Graw-Hill Book Co., New York, 1993.
4. Ramamurthi, V., Mechanical Vibration Practice with Basic Theory, 1st edition, Narosa Publishing House, Chennai, 2000.
5. Dukkipati, R.V., Advanced Mechanical Vibrations, Narosa Publications, 2008.

COURSE OUTCOMES

At the end of the course student will

1. Review the fundamentals of vibration and formulate the differential equations of the given vibration models.
2. Develop the equation of motion for the two degrees of freedom system.
3. Model the equation of motion for the multi degrees of freedom system based on various numerical methods.
4. Study the vibration tests, measurements and control of the machinery components.

MEPE42 – INTRODUCTION TO FRACTURE MECHANICS

Course Code:	MEPE42	No. of Credits:	03
Course Name:	Introduction to Fracture Mechanics	Prerequisite:	MEPC12

COURSE LEARNING OBJECTIVES

1. To introduce the basic concepts of fracture mechanics
2. To import knowledge on linear elastic fracture mechanics
3. To study the behaviour of the elastic plastic fracture mechanics
4. To understand the experimental testing of plain strain fracture toughness and crack repair methodologies.

COURSE CONTENT

Basic concepts of Fracture Mechanics, History of fracture mechanics, Modes of loading, Classification of fracture mechanics – LEFM - EPFM, Fracture mechanics approach to design – Energy criterion – Stress intensity approach – Time dependent crack growth and damage tolerance.

Linear Elastic Fracture Mechanics (LEFM) - Griffith theory, Energy release rate, Instability and R-curve, Stress analysis of cracks - Stress intensity factor, Relationship between K and global behaviour, Crack tip stress analysis.

Elastic Plastic Fracture Mechanics (EPFM) - Crack tip opening displacement (CTOD), J-integral, relationship between J and CTOD.

Experimental determination of plane strain fracture toughness, K- R curve testing, J measurement, CTOD testing, Failure assessment diagram, Crack arrest and repair methodologies.

REFERENCE BOOKS:

1. Anderson, T.L., Fracture Mechanics: Fundamentals and Applications, Taylor & Francis Group, 2005.
2. Evalds, H.L. and Warnhil, R.J.H., Fracture Mechanics, Edward Arnold Ltd, Baltimore,1984.
3. Prashant Kumar, Elements of Fracture Mechanics, Wheeler Publishing, 1999.
4. Campbel, J.E., Underwood, J.H, and Gerberich,W.W., Applications of Fracture
1. Mechanics for the selection of Materials, American Society for Metals, Metals Park Ohio, 1982.
5. Fracture Mechanics Metals Handbook, ninth edition, vol. 8 437-491, American Society of Metals Metal Park ohio, 1985
6. Kare Hellan, Introduction of Fracture Mechanics, McGraw-Hill Book Company, 1985.

COURSE OUTCOMES

At the end of the course student will

1. Understand the fundamental concepts of fracture mechanics.
2. Derive the governing equations for the linear elastic fracture mechanics
3. Formulate the relationship between J-integral and CTOD.
4. Learn to know how to experimentally testing the plain strain fracture toughness and crack repair methodologies.

MEPE43 – THEORY OF ELASTICITY

Course Code:	MEPE43	No. of Credits:	03
Course Name:	Theory of Elasticity	Prerequisite:	MEPC12

COURSE LEARNING OBJECTIVES

1. To impart concept of stress and strain analysis in solids
2. To familiarize 2D problems in elasticity and its solutions
3. To imbibe knowledge of elastic problems in polar coordinates
4. To acquaint with the solution of advanced bending problems
5. To understand torsional problems in elasticity

COURSE CONTENT

Stress and Strain: Introduction to stress analysis in elastic solids - Stress at a point – Stress tensor – Stress components in rectangular coordinate systems - Cauchy's equations – Stress transformation – Principal stresses and planes - Hydrostatic and deviatoric stress components - Octahedral stress - Equations of equilibrium - Displacement field – engineering strain - strain tensor– analogy between stress and strain tensors - Strain-displacement relations – Compatibility conditions – Principal strains

Constitutive Equations: Generalized Hooke's law - Stress -Strain relations for isotropic materials - Elastic constants - Relation between elastic constants - St. Venant's principle for end effects – Uniqueness theorem - Castigliano's Theorem.

2D Problems in Elasticity: Plane stress and plane strain problems – Stress compatibility equation - Airy's stress function and equation – Polynomial method of solution – Solution for bending of a cantilever beam with an end load.

Elastic Problems in Polar Coordinates: Analogy between polar and rectangular coordinates – Equilibrium equations – Airy's stress function in polar coordinates – Application in Stress Concentration problems – Axisymmetric problems – Thick walled cylinder and rotating discs.

Unsymmetrical bending: Unsymmetrical bending of straight beams – Curved beams - Shear center of thin walled open sections with one axis of symmetry.

Torsion: Torsion of non-circular bars - Solutions for circular and elliptical cross-sections using St. Venant's theory and Prandtl's method – Torsion of thin walled tubes – Shear flow.

REFERENCE BOOKS

1. Timoshenko and Goodier, "Theory of Elasticity"-'McGraw Hill Book Company.
2. L S Srinath "Advanced Mechanics of Solids "- Tata Mcgraw Hill Company.

3. Dym C. L and Shames. I. H, “Solid Mechanics : A variational Approach”, McGralHilll New York-1973.
4. Sadhu Singh ," Theory of Elasticity"- Khanna publisher.

COURSE OUTCOMES

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

1. Apply concepts of stress and strain analyses in solids.
2. Solve 2D problems in elasticity.
3. Estimate the stress field in axisymmetric problems.
4. Solve general bending problems.
5. Solve torsional problems of arbitrary cross sections.

MEPE44 – INDUSTRIAL NOISE AND VIBRATION CONTROL

Course Code:	MEPE44	No. of Credits:	03
Course Name:	Industrial Noise and Vibration Control	Prerequisite:	MEPC14, MEPC17

COURSE LEARNING OBJECTIVES

1. To understand the fundamentals of noise and vibration control.
2. To familiarize with the measurements of noise and vibration.
3. To introduce the practices of design for quietness.

COURSE CONTENT

Noise and its measurement
Waves as moving disturbances; frequency range of human ear and human speech; octave and one-third octave bands; plane waves; spherical waves, wave solution, wave character; sound power level, intensity level, sound pressure level, particle velocity, far field and near field, inverse square law; anti-logarithmic addition and subtraction of levels; A-weighting; sound level meter, intensity meter, etc.

Vibration and its measurement
Oscillation, basic dynamical elements, state variables; degrees of freedom; single DOF system; damping; Multi-DOF system, transmissibility, computation of natural frequencies and modes; critical speeds, electromechanical and electro-acoustic analogies; electrical analogous circuits; principle of impedance mismatch; accelerometer and vibrometer, instrumentation for vibration measurements.

Vibration Control
Vibration isolators; dynamic absorbers; damping and dampers; impedance mismatch; control of structure-borne sound; free-layer damping and constrained-layer damping; vibration control at the source; active vibration control; shock absorber.

Acoustic enclosures, hoods, wrappings and barriers
Basic principles; insertion loss, noise reduction and transmission loss; flanking transmission; acoustic leaks; acoustic lagging.

Mufflers and Silencers
Silencer performance metrics; silencer selection factors; electroacoustic modelling; cascading of muffler elements; multiply connected mufflers; dissipative silencers; acoustic materials; combination mufflers; pressure drop considerations; break-out noise.

Strategies for noise control
Control of noise at the source, in the path, and at the receiver end; noise control of an existing facility; environmental impact assessment (EIA)

REFERENCE BOOKS:

1. Munjal, M. L., Noise and Vibration Control, World Scientific Press in association with IISc Press, Singapore, 2013.
2. Beranek, L. L., “Noise and Vibration Control”, Wiley, 2008.
3. Bies, D. A., Hansen, C. H. and Howard, C. O., Engineering Noise Control, 5th Edition, CRC Press, 2018.

COURSE OUTCOMES

1. The fundamentals and applications taught in this course will prepare the students to work on project works related with Noise and Vibration Control
2. Students will be acquainted with knowledge of Noise and Vibration Control to work as NVH (Noise, Vibration and Harshness) Engineers.

b. OPEN ELECTIVE

MEOE11 – FINITE ELEMENT METHOD

Course Code:	MEOE11	No. of Credits:	03
Course Name:	Finite Element Method	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. The objective of the course is to apprise the students about the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems in solid mechanics.
2. Different application areas will be dealt with after introducing the basic aspects of the method.
3. The analysis methodologies for 1-D, 2-D and 3-D problems with the advantages and disadvantages clearly spelt out.
4. It is expected that once the students are exposed to the course, they will be in a position to develop computer codes for any physical problem using Finite Element technique

COURSE CONTENT

Introduction - Illustration using spring systems and simple problems - Weighted residual methods Galerkin's method - Variational approach - Rayleigh-Ritz method.

One-dimensional finite element analysis; bar element, beam element, frame element - Heat transfer problems.

Two-dimensional finite element analysis; types of elements, shape functions, natural coordinate systems.

Applications to structural mechanics - Numerical integration - Solution of finite element equations.

Fluid flow problems - Dynamic problems.

REFERENCE BOOKS:

1. Seshu, P., Textbook of Finite Element Analysis, Prentice-Hall, India, 2003.
2. Segerlind, L.J., Applied Finite Element Analysis, John Wiley, 1987.

COURSE OUTCOMES

At the end of the course student will

1. Illustrate the basic concepts of finite element systems through spring systems and by solving problems.
2. Interpret one-dimensional and two-dimensional finite element analysis with examples.
3. Apply finite element methods to real world problems and obtain solutions.

MEOE12 – COMPOSITE MATERIALS

Course Code:	MEOE12	No. of Credits:	03
Course Name:	Composite Materials	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

COURSE CONTENT

Classification and characteristics of composite materials - Types of fiber and resin materials, functions and their properties – Application of composite to aircraft structures-Micromechanics-Mechanics of materials, Elasticity approaches-Mass and volume fraction of fibers and resins-Effect of voids, Effect of temperature and moisture.

Hooke's law for orthotropic and anisotropic materials-Lamina stress-strain relations referred to natural axes and arbitrary axes.

Governing equations for anisotropic and orthotropic plates- Angle-ply and cross ply laminates-Analysis for simpler cases of composite plates and beams - Interlaminar stresses.

Manufacture of glass, boron and carbon fibers-Manufacture of FRP components- Open mould and closed mould processes. Properties and functions of resins.

Netting analysis- Failure Criteria-Flexural rigidity of Sandwich beams and plates – composite repair-AE technique.

REFERENCE BOOKS:

1. R.M. Jones, "Mechanics of Composite Materials", 2nd Edition, Taylor & Francis, 1999
2. L.R. Calcote, "Analysis of laminated structures", Van Nostrand Reinhold Co., 1989.
3. Autar K. Kaw, Mechanics of Composite Materials, CRC Press LLC, 1997
4. G.Lubin, "Hand Book on Fibre glass and advanced plastic composites", Van Nostrand Co.,New York, 1989.
5. B.D. Agarwal and L.J. Broutman, "Analysis and Performance of fiber composites", John-Wiley and Sons, 1990.
6. Daniel, Isaac M., Ori Ishai, Issac M. Daniel, and Ishai Daniel. Engineering mechanics of composite materials. Oxford university press, 2006.

COURSE OUTCOMES

At the end of the course student will

1. Given a type of material, be able to qualitatively describe the bonding scheme and its general physical properties, as well as possible applications.
2. Given a type of bond, be able to describe its physical origin, as well as strength. Be able to qualitatively derive a material's Young's modulus from a potential energy curve.

MEOE15 – OPTIMIZATION IN ENGINEERING DESIGN

Course Code:	MEOE15	No. of Credits:	03
Course Name:	Optimization in Engineering Design	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. Earn how MSDO can support the product development process of complex, multidisciplinary engineered systems
2. Learn how to rationalize and quantify a system architecture or product design problem by selecting appropriate objective functions, design parameters and constraints
3. Subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model

COURSE CONTENT

Introduction - Optimization techniques.

Single and multi-variable optimization.

Constrained optimization.

Specialized algorithms - Integer, geometric.

Nontraditional algorithms.

REFERENCE BOOKS:

1. Deb, Kalyanmoy, Optimization for Engineering Design, Prentice - Hall, 1995.
2. Rao. S.S., Optimization Theory and Applications, Wiley Eastern Ltd., 1998.

COURSE OUTCOMES

At the end of the course student will

1. Enumerate the necessity of optimization in engineering design.
2. Identify the various optimization techniques pertaining to design oriented problems.
3. Solve problems with single and multi – variable.
4. Formulate constrained optimization problems.
5. Distinguish between integer and geometric specialized algorithm
6. Apply non-traditional algorithms for optimization of typical problems requiring their application.

MEOE17 – ENERGY CONSERVATION AND MANAGEMENT

Course Code:	MEOE17	No. of Credits:	03
Course Name:	Energy Conservation and Management	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To learn the present energy scenario and the need for energy conservation
2. To understand the monitoring / targeting aspects of Energy
3. To study the different measures for energy conservation and financial implications of various thermal utilities

COURSE CONTENT

Energy Scenario - Basics of Energy and its various forms - Energy Management and Audit - Material and Energy Balance -Energy Action Planning-Financial Management -Project Management -Energy Monitoring and Targeting -Global Environmental Concerns

Energy Efficiency in Thermal Utilities - Fuels and Combustion-Boilers-Steam System-Furnaces - Insulation and Refractory -FBC Boilers -Cogeneration -Waste heat recovery

Energy Efficiency in Electrical Utilities-Electrical Systems-Electric Motors-Compressed Air System-HVAC and Refrigeration System-Fans and Blowers-Pumps and Pumping System. Cooling Tower-Lighting System-Diesel Generating System-Energy Efficient Technologies in Electrical Systems

Energy Performance Assessment for Equipment and Utility systems -Boilers-Furnaces Cogeneration, Turbines (Gas, Steam)- Heat Exchangers-Electric Motors and Variable Speed Drives-Fans and Blowers-Water Pumps-Compressors

HVAC Systems-Lighting Systems-Performing Financial Analysis-Applications of Non-Conventional and Renewable Energy Sources-Waste Minimization and Resource Conservation.

REFERENCE BOOKS:

1. Guide book for National Certification Examination for Energy Managers and Energy Auditors, Bureau of energy efficiencies, 2005.
2. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980
3. Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington, 1988

COURSE OUTCOMES

1. Students will be familiar with Energy Conservation scenario in general and will be mastering the thermal energy auditing technologies / procedures
2. Financial aspects also will be made clear to them as far as Energy Conservation Schemes are concerned. In short, students will become knowledgeable on techno – economic aspects of Energy Conservation

MEOE18 – ENERGY STORAGE TECHNOLOGY

Course Code:	MEOE18	No. of Credits:	03
Course Name:	Energy Storage Technology	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To develop the ability to understand / analyse the various types of energy storage.
2. To study the various applications of energy storage systems

COURSE CONTENT

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications

Thermal storage – Types – Modelling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of Transys

Fundamental concept of batteries – measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide and modern batteries for example (i) zinc - Air (ii) Nickel Hydride, (iii) Lithium Battery

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis –advantage and drawback of each type.

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications

REFERENCE BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002
2. Fuel cell systems Explained, James Larminie and Andrew Dicks, Wiley publications, 2003.
3. Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, Wiley publications, 2012

COURSE OUTCOME

Able to analyze various types of energy storage devices and perform the selection based on techno-economic view point

MEOE20 – LOW TEMPERATURE TECHNOLOGY

Course Code:	MEOE20	No. of Credits:	03
Course Name:	Low Temperature Technology	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To understand the fundamental principles of refrigeration, air conditioning and cryogenics.
2. To select the right insulation for a particular cooling application.
3. To understand the behavior of properties at different low temperatures.

COURSE CONTENT

Basics of thermodynamic processes, introduction to refrigeration, air conditioning and cryogenics.

Refrigeration, Vapor compression systems: Ideal and actual cycles, Vapor absorption systems: Refrigerant – absorbent combinations.

Psychrometry – Definitions for properties. Introduction to cooling load calculations. Comfort conditions. Air-conditioning systems.

Cryogenic fluids, properties, behavior of cryogenics fluids, storage of cryogenic fluids, Properties of materials at cryogenic temperatures, Insulation techniques, different types, vacuum techniques.

REFERENCE BOOKS:

1. Arora, R.C., Refrigeration and Air Conditioning, PHI Pvt Ltd, 2010
2. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
3. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press New York, 1989.

COURSE OUTCOMES

1. Explain and apply the concepts of refrigeration, air conditioning and cryogenics.
2. Understand the properties of materials at low temperatures
3. Apply different insulation and vacuum techniques for low temperature systems.

MEOE21 – WASTE TO ENERGY CONVERSION TECHNIQUES

Course Code:	MEOE21	No. of Credits:	03
Course Name:	Waste to Energy Conversion Techniques	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. The course focuses on bio-Energy and in particular on the exploitation of biomass.
2. To study about the thermochemical Conversion processes (gasification, pyrolysis)
3. To distinguish the factors influencing biofuels/energy-related environmental, economics, & social issues.
4. To study about the impacts of biofuel utilization and application and LCA assessment on biofuel Production.

COURSE CONTENT:

Introduction to energy from waste- Chemical composition, properties of biomass – Energy plantations, Size reduction, Briquetting, Drying, Storage and handling of biomass.

Thermo-chemical conversion of lignocellulose biomass, Thermochemical principles: Combustion, Chemistry of gasification, types, comparison, Pyrolysis - Classification, Incineration, process governing parameters and Typical yield rates, Mathematical model, Energy and Economic analysis using Aspen plus.

Biochemical conversion of biomass to alcohol, Biodiesel production from oilseeds, waste oils and algae, Fischer tropsch synthesis, gas to liquid conversion technologies.

Combustion of biomass and cogeneration systems, combustion of woody biomass, theory calculation and design of equipment, fuel cell, gas turbine, Electricity generation, case studies.

Role of energy in economic development and social transformation. Energy Consumption in various sectors and its changing pattern Life Cycle Analysis of biofuels, Techno-economic features of bio-fuels, Energy Economics - Simple Payback Period, Time Value of Money, IRR, NPV, Life Cycle, Costing

REFERENCE BOOKS:

1. D.L. Klass and G.M. Emert, Fuels from Biomass and Wastes, Ann Arbor Science publ.Inc. Michigan, 1985.com
2. Chakraverthy A, "Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes", Oxford & IBH publishing Co, 1989.
3. Rezaiyan. J and N. P. Cheremisinoff, "Gasification Technologies, A Primer for Engineers and Scientists", Taylor & Francis, 2005.
4. Mann MK, Spath PL. Life cycle assessment of a biomass gasification combined-cycle power system. National Renewable Energy Lab., Golden, CO (US); 1997 Dec 1.

COURSE OUTCOME:

At the end of the course, students will be able to understand

1. Characterization techniques of the biomass and Effective utilization of biomass from Wastes
2. Practical knowledge in the Thermochemical conversion techniques.
3. Power generation from bioenergy and the applications.
4. Techno-economic analysis of thermochemical conversion and LCA assessment

MEOE22 – NON-DESTRUCTIVE TESTING

Course Code:	MEOE22	No. of Credits:	03
Course Name:	Non-Destructive Testing	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To understand the basic principles, testing procedures and limitations of various NDT methods.
2. To study the codes, standards or specifications related to each testing method.
3. To identify the types of equipment used for each non-destructive examination for various industrial applications.

COURSE CONTENT

Overview of NDT: Introduction to destructive and non-destructive testing, Significance of testing materials, properties of engineering materials. Scope, characteristics and Limitations of NDT, Visual examination methods – Different visual examination aids.

Surface Methods: Visual Inspection – Dye/Liquid Penetrant Testing – Magnetic Particle Inspection.

Volumetric Methods: Electro-Magnetic Methods – Acoustical Methods – Radiographic Methods – Thermal Methods – Optical Methods.

Applications in Engineering Industry: Dimensional Measurement, Estimation of Mechanical and Physical properties of materials, Analysis of quality of weldments, Leak and pressure testing of pressure vessels.

COURSE OUTCOME

1. Be able to select appropriate NDT methods for flaw detection.
2. Be able to use the various Testing methods for understanding the defects and characterization of industrial components.
3. Be able to perform non-destructive examinations of weldments.
4. Acquire the knowledge to identify strengths and weaknesses in materials used in fabrication.

REFERENCE BOOKS

1. Charles, J. Hellier, “Handbook of Non-destructive evaluation”, McGraw Hill, New York 2001.
2. Paul E Mix, “Introduction to Non-destructive testing: a training guide”, Wiley, 2nd Edition New Jersey, 2005
3. ASM Metals Handbook, “on-Destructive Evaluation and Quality Control”, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
4. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.

MEOE23 – POLLUTION AND CONTROL

Course Code:	MEOE23	No. of Credits:	03
Course Name:	Pollution and Control	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To impart knowledge on the atmosphere and eco-legislations
2. To classify air, water and land pollutants and sources
3. To understand hazardous waste management
4. To learn pollution sampling and analysis
5. To study the various methods of controlling pollution

COURSE CONTENT

Air pollution – sources, concentration and effects, Air quality management - indoor air quality. Measurement and control of air pollution - emission standards. Atmospheric dispersal of pollutants and modelling of air pollution.

Water pollution - sources of contamination - water quality and standards - chemical pollution of the aquatic environment - regulation of direct discharge - sewage treatment processes - sludge treatment and disposal. Sources and types of toxic wastes - treatment of toxic wastes - disposal of toxic wastes. Pollution in marine environment - sources, movement and behavior of pollutants.

Soil pollution and Land contamination - sources - properties - consequences of soil pollution - solid waste management - recycling and reuse. Radioactivity in environment - types of radiation - effects of radiation - radioactive waste treatments and disposal.

Noise pollution - sources and effects - Noise level measurement and analysis. Noise emission standards - Industries - Automotive. Active and Passive Noise Control.

Clean technologies - Integrated design for pollution prevention and control - case studies - Legal control of pollution – trends and issues.

REFERENCE BOOKS:

1. Roy M. Harrison, Pollution causes, effects and control, 4th Edition, Royal Society of Chemistry, 2001.
2. Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill International Edition, McGraw-Hill book Co, Singapore, 2000.
3. Arcadio P Sincero and G.A. Sincero, Environmental Engineering – A Design Approach, Prentice Hall of India Pvt Ltd, New Delhi, 2002.
4. Rao, CS, “Environmental pollution engineering, Wiley Eastern Limited, New Delhi, 1992.
5. Mahajan, S.P., “Pollution control in process industries”, Tata McGraw Hill PublishingCompany, New Delhi, 1993.
6. Masters, G, Introduction to Environmental Engineering and Science Prentice Hall of India Pvt. Ltd, New Delhi, 2003.

COURSE OUTCOMES

At the end of the course student will be able to

1. Understand the atmospheric pollutants and eco-legislations
2. Classify air, water and land pollutants and sources
3. Manage hazardous wastes in industries
4. Measure and Analyse various pollutants
5. Understand various methods of controlling pollution

Department of Mechanical Engineering, National Institute of Technology, Tiruchirappalli

MEOE24 – WELDING TECHNOLOGY

Course Code:	MEOE24	No. of Credits:	03
Course Name:	Welding Technology	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

To study the different types of welding process and its application in various fields

COURSE CONTENT

Classification of welding processes: heat sources. Weld joint design - Weldability of steels and other materials - Weld defects.

TIG / A-TIG Welding, gas metal arc welding, Submerged arc welding, Friction welding, Explosive welding, Plasma arc welding

Electron beam welding, Laser beam welding - advantages and limitations, process variables and their effects,

Friction welding process - effects of speed and pressure –Types- Explosive welding –Process Parameters-Plasma arc welding

Cold pressure welding - Ultrasonic welding - Recent Advances in welding - Modeling and optimization of welding process.

REFERENCE BOOKS:

1. Parmar,R.S., “Welding Processes and Technology”, Khanna Publishers, 1997.
2. Heine,R.W., Loper,C.R. and Rosenthal,P.C., "Principles of Metal casting", Tata McGraw- Hill, 1994.
3. Lancaster J.F, ‘The Physics of Welding’, Pergamon Press, 1984
4. American Society of Welding, "Hand book of Welding", Vol.I to V.
5. Jain,P.L., “Principles of Foundry Technology”, Tata McGraw Hill, 2003.
6. Weman,K., “welding processes hand book”, CRC Press,2003.
7. Nadkarni S.V., ‘Modern Arc Welding Technology’, Oxford and IBH Publishing, 1996

COURSE OUTCOMES

At the end of the course student will be able to get the knowledge about newly developed welding process and its parameters

V. MINOR (MI) COURSES

MEMI10 – BASICS THERMODYNAMICS

Course Code:	MEMI10	No. of Credits:	03
Course Name:	Basics Thermodynamics	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To achieve an understanding of principles of thermodynamics and to be able to use it in accounting for the bulk behavior of the simple physical systems.
2. To provide in-depth study of thermodynamic principles, thermodynamics of state, basic thermodynamic relations, Principle of psychrometry & properties of pure substances
3. To enlighten the basic concepts of vapor power cycles.

COURSE CONTENT

Concept of continuum - thermodynamic systems. Property - state - path and process, quasi-static process, work - types of work, Zeroth law of thermodynamics, First law applied to control mass, control volumes. Steady flow energy equation - applications of SFEE

Second law of thermodynamics – statements of second law. Reversibility and irreversibility, Carnot theorem - Carnot cycle, Coefficient of performance. Clausius inequality - concept of entropy - entropy of ideal gas - principle of increase of entropy, Availability.

Properties of pure substances – Thermodynamic properties of pure substances in solid, liquid and vapor phases - phase rule - PVT surfaces, thermodynamic properties of steam. Calculations of work done and heat transfer in non-flow and flow processes.

Gas mixtures – properties ideal and real gases, equation state, Avogadro's Law, Vander Waal’s equation of state, compressibility factor, compressibility chart – Dalton’s law of partial pressure, exact differentials, Maxwell’s relations, Clausius Clapeyron equations, Joule–Thomson coefficient.

Psychrometry, property calculations of air vapor mixtures. Psychrometric process – Sensible heat exchange processes. Latent heat exchange processes.

REFERENCE BOOKS:

1. Nag P.K., Engineering Thermodynamics, Tata McGraw-Hill,New Delhi, 1998.
2. Cengel Y.A., Thermodynamics – An Engineering Approach, Tata McGraw Hill, 2003
3. Borgnakke C Sonntag R.E., Fundamentals of Thermodynamics, John Wiley & Sons, 2009.
4. Jones J.B and Dugan R.E., Engineering Thermodynamics, Prentice-Hall of India, 1998.
5. Arora C.P., Engineering Thermodynamics, Mcgraw Hill Education, 2012.

COURSE OUTCOMES

At the end of the course student will

1. Analyze any engineering problem based on the basic concepts and logical sequences
2. Define the fundamental laws of thermodynamics and explain their application to a wide range of systems.
3. Analyze the work and heat interactions associated with a prescribed process path and to perform analysis of a flow system.
4. Apply the principle of efficient operation on energy utilization and value its impact on the personal and national economy
5. Evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.

MEMI11 – FUNDAMENTALS OF THERMAL ENGINEERING

Course Code:	MEMI11	No. of Credits:	03
Course Name:	Fundamentals of Thermal Engineering	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To integrate the concepts, laws and methodologies from the first course in thermo dynamics into analysis of cyclic processes
2. To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning systems

COURSE CONTENT

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency

Classification - Components and their function - Valve timing diagram and port timing diagram - Comparison of two stroke and four stroke engines - Carburettor system, Diesel pump and injector system.

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow, Impulse and Reaction principles, compounding, speed regulations – Governors.

Classification and working principle of various types of compressors, work of compression, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency, multistage air compressor and inter cooling

Vapour compression refrigeration cycle- super heat, sub cooling – Performance calculations - working principle of vapour absorption system, Ammonia – Water, Lithium bromide –water systems, Psychrometry, Psychrometric chart and mollier diagram.

REFERENCE BOOKS:

1. Sarkar, B.K,"Thermal Engineering" Tata McGraw-Hill Publishers, 2007
2. Kothandaraman.C.P., Domkundwar.S,Domkundwar. A.V., "A course in thermal engineering,"Dhanpat Rai &sons ,Fifth edition, 2002
3. Rajput. R. K., "Thermal Engineering" S.Chand Publishers , 2000
4. Arora.C.P,"Refrigeration and Air Conditioning ," Tata McGraw-Hill Publishers 1994
5. Ganesan V." Internal Combustion Engines", Third Edition, Tata Mcgraw-Hill 2007
6. Rudramoorthy, R, "Thermal Engineering ",Tata McGraw-Hill, New Delhi,2003

COURSE OUTCOMES

At the end of the course student will

1. Define the basic concepts of units and dimensions, systems (open and closed systems and control volumes) and its boundaries, properties, state, process, cycle, quasi-static process etc.- required as foundation for development of principles and laws of thermodynamics
2. Develop Intuitive problem solving technique
3. Use & Practice two property rule and hence thermodynamic tables, thermodynamic diagrams and concept of equation of state, also their simple application.
4. Explain heat, work and first law of thermodynamics. Application of energy balance

MEMI12 – FLUID MECHANICS AND MACHINERY

Course Code:	MEMI12	No. of Credits:	03
Course Name:	Fluid Mechanics and Machinery	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. The student is introduced to the mechanics of fluids through a thorough understanding of the properties of fluids.
2. The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy.
3. The student is introduced with various types of hydraulic machines and its performance.

COURSE CONTENT

Units & Dimensions. Properties of fluids – Fluid properties. Fluid statics: Pressure in a fluid - force on submerged planes - buoyancy - equilibrium of floating bodies.

Types of Fluid Flow - one dimensional continuity, momentum and Energy equations-Flow measurement - Orificemeter - Venturimeter, Pitot tube, orifices, mouthpieces, notches and weirs

Laminar and turbulent flows - Flow through pipes - Dimensional and Model analysis. Boundary layer concepts.

Pump - Centrifugal pump - types - specific speed - efficiencies. Reciprocating pumps, Indicator diagrams, Work saved by air vessels. Rotary pumps. Classification. Working and performance curves

Turbines - Hydraulic turbines - types - specific speed - Pelton - Francis and Kaplan turbines - Calculation of power output efficiencies.

REFERENCE BOOKS

1. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 1983.
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.
3. Ramamritham. S, Fluid Mechanics, Hydraulics and Fluid Machines, Dhanpat Rai & Sons, Delhi, 1988.
4. Kumar. K.L., Engineering Fluid Mechanics (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 1995.
5. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi.

COURSE OUTCOMES

At the end of the course student will

1. Understand the properties of fluids and basic principles of fluid mechanics
2. Ability to analyze the fluid flow problems with the application of the mass, momentum and energy equations.
3. Determine flow through hydraulics machines and pipes

MEMI13 – FUNDAMENTALS OF HEAT AND MASS TRANSFER

Course Code:	MEMI13	No. of Credits:	03
Course Name:	Fundamentals of Heat and Mass Transfer	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. To learn various modes of heat transfer and understand the basic concepts of mass transfer.
2. To understand the applications of various experimental heat transfer correlations in engineering applications.
3. To discuss the thermal analysis and sizing of heat exchangers.

COURSE CONTENT

Conduction - general 3-D equation – one dimensional steady state heat conduction in simple geometries – plane wall – cylinder and sphere – composite walls – critical thickness of insulation –types and applications – fin efficiency and effectiveness - unsteady state heat conduction.

Convection - boundary layer theory – conservation equation of mass – momentum and energy for laminar flow over a flat plate – turbulent flow over a flat plate – flow over cylinders – spheres –natural convection – vertical - inclined and horizontal surfaces.

Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect.

Boiling and condensation – pool boiling regimes and correlations – critical heat flux flow boiling – correlations- Nusselt's theory

Heat exchangers - Fouling factor, LMTD and NTU methods - Mass transfer - Fick's law - analogy between heat and mass transfer

REFERENCE BOOKS:

1. Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 5th ed., John Wiley, 2002.
2. Holman, J.P., Heat Transfer, 9th ed., Tata McGraw-Hill, 2004.
3. Ozisik, M.N., Heat Transfer - A Basic Approach, McGraw-Hill, 1985.
4. Cengel, Y.A., Heat Transfer - A Practical Approach, McGraw-Hill, 1998.
5. R.C. Sachedva(2001) fundamentals of heat and mass transfer, New age international.

COURSE OUTCOMES

At the end of the course student will

1. Explain about the real time applications of heat transfer in both solids and fluids.
2. Describe the fundamentals of natural and forced convective heat transfer process.
3. Design the heat exchange equipment.
4. Explore the real time applications of radiation mode of heat transfer.
5. Relate the mass transfer concepts for various industrial applications.

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MEMI15 – FUNDAMENTALS OF AUTOMOTIVE TECHNOLOGY

Course Code:	MEMI15	No. of Credits:	03
Course Name:	Fundamentals of Automotive Technology	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. To understand the construction and working principle of various parts of an automobile.
2. To have the practice for assembling and dismantling of engine parts and transmission system

COURSE CONTENT

Types of automobiles, vehicle construction and different layouts, chassis, frame and body

Electronically controlled gasoline injection system for SI engines, electronically controlled diesel injection system, Electronic ignition system, Turbo chargers, Catalytic converter

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel –torque converter, propeller shaft, slip joints, universal joints

Steering geometry and types, types of Front Axle, Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System and Traction Control

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternative fuels. EV and Hybrid vehicles

REFERENCE BOOKS:

1. Kirpal Singh, " Automobile Engineering Vol 1 & 2 ", Standard Publishers, Seventh Edition,1997, New Delhi
2. Jain,K.K.,and Asthana .R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2002
3. Newton ,Steeds and Garet," Motor Vehicles ", Butterworth Publishers,1989
4. Joseph Heitner, "Automotive Mechanics,", Second Edition ,East-West Press ,1999
5. Martin W. Stockel and Martin T Stockle , " Automotive Mechanics Fundamentals," The Good heart –Will Cox Company Inc, USA, 1978
6. Heinz Heisler , 'Advanced Engine Technology," SAE International Publications USA,1998
7. Ganesan V." Internal Combustion Engines" , Third Edition, Tata McGraw-Hill ,2007

COURSE OUTCOMES

At the end of the course student will

1. To develop electronically modified injection systems
2. Identify the use of fuels and its emission characteristics
3. To perform both hydraulic and pneumatic braking systems
4. To identify the type of transmission of motion in vehicles

MEMI17 – FUNDAMENTALS OF REFRIGERATION AND AIR CONDITIONING

Course Code:	MEMI17	No. of Credits:	03
Course Name:	Fundamentals of Refrigeration and Air Conditioning	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. To understand the principles of refrigeration and air conditioning.
2. To design and implement refrigeration and air conditioning systems using standards.

COURSE CONTENT

Introduction about Refrigeration – Definitions of various terms.

Methods of refrigeration. Air refrigeration system. Bell – Coleman cycle. Introduction about Air craft Air-Conditioning.

Analysis of Vapour compression cycle, Modifications to basic cycle

Psychrometry – Definitions for properties. Introduction to cooling load calculations

Air-conditioning systems – discussion about the central plant with direct evaporator and chiller applications, Ice plant, refrigerators.

REFERENCE BOOKS:

1. Arora, C.P., Refrigeration and Air Conditioning, 2nd ed., Tata McGraw-Hill, 2000
2. Dossat R.D., Principle of Refrigeration, 4th ed., Prentice-Hall, 1997.
3. Manohar Prasad, Refrigeration and Air Conditioning, New Age International, 2004.

COURSE OUTCOMES

At the end of the course student will

1. Illustrate the basic concepts of refrigeration system.
2. Explain the components of vapour compression system.

3. Demonstrate the use of psychrometry in analyzing refrigeration systems.
4. Discuss the theory and concept of air-conditioning systems.

MEMI18 – PRINCIPLES OF TURBOMACHINERY

Course Code:	MEMI18	No. of Credits:	03
Course Name:	Principles of Turbomachinery	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. To understand the operating principles of various turbomachines and analyse their use for various engineering applications.

COURSE CONTENT:

Classification of Turbomachines. Energy transfer between fluid and rotor - Euler equation and its interpretation.

Velocity triangles. Thermal, Mechanical and overall efficiencies. Polytropic efficiency. Degree of reaction.

Dimensionless parameters for Turbomachines.

Centrifugal Fans and Blowers

Centrifugal and Axial Flow Compressors

Axial and Radial Flow Turbines

REFERENCE BOOKS:

1. Yahya, S.H., Turbines, Compressor and Fans, 3rd Edition, Tata McGraw Hill, 2005.
2. Ganesan, V., Gas Turbines, Tata McGraw Hill Pub. Co.2010.
3. Saravanamutto HIH, Cohen H., Rogers CEC. & Straznicky PV, Gas Turbine Theory, 6th Edition, Printice Hall, 2009.

COURSE OUTCOME

At the end of the course student will able to explain the various systems, principles and applications and different types of turbo machinery components

MEMI19 – FUNDAMENTALS OF INTERNAL COMBUSTION ENGINES

Course Code:	MEMI19	No. of Credits:	03
Course Name:	Fundamentals of Internal Combustion Engines	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. To understand the underlying principles of operation in different IC Engines and components.
2. To provide knowledge on pollutant formation, control, alternate fuel etc.

COURSE CONTENT

Spark ignition Engine mixture requirements – Fuel and injection systems – Mono point, Multipoint injection, direct injection – Stages of combustion. Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems– Combustion chambers

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – common Rail direct Injection Systems – Hybrid Electric vehicles – fuel Cells.

REFERENCE BOOKS:

1. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2002.
2. R.B. Mathur and R.P. Sharma, Internal Combustion Engines.
3. V. Ganesan, Internal Combustion Engines, II Edition, TMH, 2002.
4. Duffy Smith, Auto Fuel Systems, The Good Heart Willox Company, Inc., 1987

COURSE OUTCOME:

At the end of the course student will impart the fundamental knowledge of Internal Combustion Engines

MEMI20 – ENGINE POLLUTION AND CONTROL

Course Code:	MEMI20	No. of Credits:	03
Course Name:	Engine Pollution and Control	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. To create an awareness on the various environmental pollution aspects and issues.
2. To give a comprehensive insight into the pollution in engine and gas turbines.
3. To impart knowledge on pollutant formation and control.
4. To impart knowledge on various emission instruments and techniques.

COURSE CONTENT

Atmospheric pollution from Automotive and Stationary engines and gas turbines, Global warming– Greenhouse effect and effects of I.C. Engine pollution on environment. 100

Formation of oxides of nitrogen, carbon monoxide, hydrocarbon, aldehydes and Smoke, Particulate emission. Effects of Engine Design - operating variables on Emission formation – Noise pollution.

Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer and flame ionization detector, smoke meters – Noise measurement and control

Engine Design modifications, fuel modification, evaporative emission control, EGR, air injection, thermal reactors, Water Injection, catalytic converters, application of microprocessor in emission control. Common rail injection system, Particulate traps, NOx converters, SCR systems. GDI and HCCI concepts

Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards

REFERENCE BOOKS:

1. Crouse William, Automotive Emission Control, Gregg Division /McGraw-Hill,1980
2. Ernest,S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 1980.
3. George Springer and Donald J.Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum press, 1972.
4. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, 1980.
5. Degobert, Paul. "Automobiles and Pollution, Society of Automotive Engineers." Inc., Warrendale, PA 146 (1995).

COURSE OUTCOME

At the end of the course student will

1. Learn about pollution formation in engines, and its control
2. The ways and means to protect the environment from various types of pollution

MEMI22 – DYNAMICS

Course Code:	MEMI22	No. of Credits:	03
Course Name:	Dynamics	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

By the end of the course, you should be able to do the following:

1. Create mathematical models of dynamic systems (point mass and rigid bodies)
2. Analyze the kinematics of point mass and rigid body systems.
3. Determine the motion of point mass and rigid body systems in space and time.
4. Use engineering software tools such as Mathcad or Mathematica to solve problems of point mass and rigid body systems kinematics and dynamics

COURSE CONTENT

Rectilinear Translation
Kinematics of rectilinear motion-Principles of dynamics-Differential equation of rectilinear motion-Motion of a particle acted upon by a constant force-Force as a function of time-Force proportional to displacement: free vibrations-D' Alembert's principle-Momentum and impulse-Work and energy-Ideal systems: conservation of energy-Impact.

Curvilinear Translation
Kinematics of curvilinear motion-Differential equations of curvilinear motion-Motion of a projectile-D'Alembert's principle in curvilinear motion-Moment of momentum-Work and energy in curvilinear motion.

Rotation of a Rigid Body about a Fixed Axis
Kinematics of rotation-Equation of motion for a rigid body rotating about a fixed axis-Rotation under the action of a constant moment-Torsional vibration-The compound pendulum-General case of moment proportional to angle of rotation-D'Alembert's principle in rotation-Resultant inertia force in rotation-The principle of angular momentum in rotation -Energy equation for rotating bodies-Gyroscopes.

Plane Motion of a Rigid Body
Kinematics of plane motion-Instantaneous center-Equations of plane motion-D' Alembert's principle in plane motion-The principle of angular momentum in plane motion-Energy equation for plane motion.

Relative Motion

Kinematics of relative motion-Equations of relative motion- D' Alembert's principle in relative motion.

REFERENCE BOOKS:

1. Timoshenko S, and Young D.H, “Engineering Mechanics”, Tata Mcgraw Hill 2006

COURSE OUTCOMES

1. Developed a clear understanding of the basic principles that govern the dynamics of particles and rigid bodies and
2. The ability to apply the knowledge and tools to solve engineering problems

MEMI23 – FUNDAMENTALS OF MECHANICAL DESIGN

Course Code:	MEMI23	No. of Credits:	03
Course Name:	Fundamentals of Mechanical Design	Prerequisite:	-Nil-

COURSE LEARNING OBJECTIVES

1. Intended to provide an introduction to the design process.
2. Impart the Fundamental information on materials in selecting the most appropriate materials, processes and methods to transform his ideas into a successful product.
3. To understand the effect of various loads and corresponding deformation and stresses in mechanical components.
4. To learn the procedure to design various mechanical components such as shafts, springs, bearing etc.,

COURSE CONTENT

Introduction to Mechanical Engineering Design, Materials – Significance of Materials properties, Strength and Stiffness, Hardness, Impact strength, Thermal effects, Ferrous and Non-ferrous metals, Plastics and Composites, Material Selection.

Load and Stress Analysis – Equilibrium and Free-body diagrams, Shear force and Bending moments in beams, Stress and Strains, Deflection and Stiffness – Spring rates, Tension, Compression and Torsion, Deflection due to bending, Strain Energy.

Failures resulting from Static Loading – Static Strength, Stress Concentration, Failure theories.

Design of Mechanical Elements – Shaft and Shaft Components, Screws, Fasteners, Springs – Helical and leaf springs, Rolling contact bearings, Gears – Spur and Helical gears.

REFERENCE BOOKS:

1. Shigley, Mechanical Engineering Design, Ninth Edition in SI Units, Tata McGraw Hill Education Pvt. Ltd., Special Indian Edition, 2011.
2. Robert L. Nortonm Machine Design – An Integrated approach, Pearson Education, 2011
3. U.C. Jindal, Machine Design, Pearson Education India, 2010

COURSE OUTCOMES

After the successful completion of this course, a student can

1. Describe the design process, material selection, calculation of stresses and stress concentrations under static loading.
2. Differentiate various modes of failures in mechanical components.
3. Design the basic mechanical components like shafts, fasteners, Springs and Bearings
4. Summarize the knowledge in Gears, Types of gears and its applications.
5. Select an appropriate machine element for suitable applications.

VI. HONORS (HO) COURSES

MEHO10 – ADVANCED HEAT TRANSFER

Course Code:	MEHO10	No. of Credits:	04
Course Name:	Advanced Heat Transfer	Prerequisite:	MEPC19

COURSE LEARNING OBJECTIVES

1. To use Heisler and Grober charts and to discuss about transient heat conduction
2. To compare and optimize longitudinal fin of rectangular, triangular and parabolic profiles
3. To understand boundary layers and to formulate pool and flow boiling correlations
4. To discuss thermal radiation, view factor, gas radiation and the effect of radiation on temperature measurement.

COURSE CONTENT

Transient heat conduction – Exact solution – Use of Heisler and Grober charts–Semi-infinite solids – Multidimensional systems.

Extended surfaces – Steady state analysis and optimization – Longitudinal fin of rectangular, triangular and parabolic profile radiating to free space – Radial fins.

Thermal boundary layers – Momentum and energy equations – Internal and external flows – Forced convection over cylinders, spheres and bank of tubes, turbulent convection.

Heat transfer with phase change – Condensation and boiling heat transfer – Heat transfer in condensation, Condensation outside and inside horizontal tubes, Effect of non-condensable gases in condensing equipment – Pool and flow boiling correlations. Flow regimes in two phase flow – Dryout phenomenon – Heat Transfer at Supercritical pressure

Thermal radiation – View factor – Gas radiation– Transmitting, reflecting and absorbing media – Flame radiation in furnaces – Radiation exchange between two gray surfaces – Radiation from LNG Fires– Radiation effect on temperature measurement.

REFERENCE BOOKS

1. Ozisik, M.N., Heat Transfer - A Basic Approach, McGraw-Hill, 1987.
2. Incropera, P.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 5th ed., John Wiley, 2002.
3. Bejan, A., Heat Transfer, John Wiley & Sons Inc., 1993.

4. Kakac, S. and Yener, Y., Convective Heat Transfer, CRC Press, 1995.
5. Kraus, A.D., Aziz, A., and Welty, J., Extended Surface Heat Transfer, John Wiley, 2001.

COURSE OUTCOME

At the end of the course student will

1. Understand the transient heat conduction and the usage of Heisler and Grober charts
2. Analyze and optimize various fins like rectangular, triangular and parabolic profiles for heat transfer applications.
3. Understand thermal boundary layers, momentum and energy equations
4. Describe condensation and boiling heat transfer and estimate pool and flow boiling heat transfer
5. Analyze thermal and gas radiation in heat transfer equipment.

MEHO11 – ADVANCED FLUID MECHANICS

Course Code:	MEHO11	No. of Credits:	04
Course Name:	Advanced Fluid Mechanics	Prerequisite:	MEPC14

COURSE LEARNING OBJECTIVES

1. To familiarize with the fundamental concepts of fluid dynamics.
2. To formulate and analyze problems related to exact solutions of N-S equations
3. To approximate N-S equations and solve them for special cases
4. To differentiate between stable and unstable flows
5. To analyze and apply models of turbulence

COURSE CONTENT

Review of Basic concepts- Reynold's transport theorem, Body and surface forces, stress tensor. Scalar and vector fields, Eulerian and Lagrangian description of flow. Motion of fluid element; translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential. Constitutive equations, derivation of Navier-Stokes equations, sign of dynamic viscosity.

Exact solutions of Navier-Stokes equations: plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stokes first and second problems, Hiemenz flow, flow near a rotating disk, flow in convergent-divergent channels.

Creeping flow: Stokes and Oseen's approximation, theory of hydrodynamic lubrication. Thin-film equations.

Boundary layer: derivation, exact solutions, Blasius, Falkner-Skan, series solution and numerical solutions. Approximate methods: momentum integral method. Two dimensional and axisymmetric jets.

Introduction to Hydrodynamic stability: linear stability of plane Poiseuille flow, Orr-Sommerfeld equation. Description of turbulent flow, velocity correlations, Reynolds stresses (RANS), Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution. Concepts of closure model, eddy viscosity models of turbulence- zero equation, one equation and two-equation models.

REFERENCE BOOKS:

1. Currie, LG., Fundamental Mechanics of Fluids, 3rd ed., CRC Press, 2002.
2. White, P.M., Viscous Fluid Flow, 2nd ed., McGraw-Hill, 1991.
3. Ockendon, H. and Ockendon, J., Viscous Flow, Cambridge Uni. Press, 1995.
4. A first course in turbulence, Tennekesse and Lumley
5. Fluid mechanics, Kundu and Cohen
6. An Introduction to Fluid Dynamics, G K Bachelor

COURSE OUTCOMES

At the end of the course student will

1. Identify and obtain the values of fluid properties and relationship between them and understand the principles of continuity, momentum, and energy as applied to fluid motions.
2. Recognize these principles written in form of mathematical equations.
3. Solve the N-S equations to obtain solutions for varied types of flows.

MEHO12 – SIMULATION OF IC ENGINES

Course Code:	MEHO12	No. of Credits:	03
Course Name:	Simulation of IC Engines	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. Calculate basic engine parameters of significance for the operation of an engine and the effect of varying them on performance and fuel economy.
2. Simulate engine operation through the use of ideal air cycle models, ideal air exchange models, fuel air processes with chemical equilibrium and time dependent models that include heat transfer and time dependent combustion.
3. Use simple models to describe the combustion processes in spark ignition and diesel engines
4. Evaluate the effect of the air exchange process on engine performance, fuel economy and other basic engine characteristics for 4-stroke engines

COURSE CONTENT

First and second laws of thermodynamics – Estimation of properties of gas mixtures - Structure of engine models – Open and closed cycle models - Cycle studies

Chemical Reactions, First law application to combustion, Heat of combustion – Adiabatic flame temperature, Chemical Equilibrium and calculation of equilibrium composition - – Heat transfer in engines – Heat transfer models for engines.

Combustion in SI engines, Flame propagation and velocity, Single zone models – Multi zone models – Mass burning rate, Turbulence models – One dimensional models – Chemical kinetics modeling – Multidimensional models.

Combustion in CI engines Single zone models – Premixed-Diffusive models – Wiebe' model – Whitehouse way model, Two zone models - Multizone models- Meguerdichian and Watson's model, Hiroyasu's model, Lyn's model – Introduction to Multidimensional and spray modeling

Thermodynamics of the gas exchange process - Flows in engine manifolds – One dimensional and multidimensional models, Flow around valves and through ports Models for scavenging in two stroke engines – Isothermal and non-isothermal models.

REFERENCE BOOKS:

1. Ashley S. Campbell, Thermodynamic Analysis of Combustion Engines, John Wiley and Sons, 1980.
2. V.Ganesan, Computer Simulation of Spark Ignition Engine Processes, Universities Press, 1995.
3. V.Ganesan, Computer Simulation of Compression Ignition Engine Processes, Universities Press, 2002.
4. Gordon P. Blair, The Basic Design of two-Stroke engines, SAE Publications, 1990.
5. Horlock and Winterbone, The Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol. I & II, Clarendon Press, 1986.
6. J.I.Ramos, Internal Combustion Engine Modeling, Hemisphere Publishing Corporation, 1989.
7. J.N.Mattavi and C.A.Amann, Combustion Modeling in Reciprocating Engines, Plenum Press, 1980.

COURSE OUTCOMES

At the end of the course student will

1. Conversant with Basic Concept of Modeling
2. To develop modeling of IC engines.
3. To develop of Laminar Flow modeling
4. Understands Simulation of IC Engines and its new concepts

MEHO13 – DESIGN AND ANALYSIS OF TURBOMACHINES

Course Code:	MEHO13	No. of Credits:	03
Course Name:	Design and Analysis of Turbomachines	Prerequisite:	MEPC14

COURSE LEARNING OBJECTIVES

1. Provide students with opportunities to apply basic flow equations;
2. How to compare and chose machines for various operations.

COURSE CONTENT

Basics of isentropic flow – static and stagnation properties – diffuser and nozzle configurations - area-ratio – mass flow rate – critical properties. Energy transfer between fluid and rotor velocity triangles for a generalized turbomachines - velocity diagrams. Euler's equation for turbomachines and its different forms. Degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, overall and polytropic

Centrifugal compressor - configuration and working – slip factor - work input factor – ideal and actual work - pressure coefficient - pressure ratio. Axial flow compressor – geometry and working– velocity diagrams – ideal and actual work – stage pressure ratio - free vortex theory – performance curves and losses

Basics of combustion. Structure and working of combustion chamber – combustion chamber arrangements - flame stability – fuel injection nozzles. Flame stabilization - cooling of combustion chamber

Elementary theory of axial flow turbines - stage parameters- multi-staging - stage loading and flow coefficients. Degree of reaction - stage temperature and pressure ratios – single and twin spool arrangements – performance. Matching of components. Blade Cooling. Radial flow turbines.

Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles for power plants. Working of Turbojet, Turbofan, Turboprop, Ramjet, Scramjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, and specific fuel consumption, thermal and propulsive efficiencies.

REFERENCE BOOKS:

1. Ganesan, V., Gas Turbines, Tata McGraw-Hill, 2011.
2. Khajuria P.R and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003
3. Cohen, H., Rogers, G F C and Saravanmotto, H I H, Gas Turbine Theory, John Wiley, 5th Edition 2001.

4. Hill P G and Peterson C R, Mechanics and Thermodynamics of Propulsion, Addition-Wesley, 1970.
5. Mattingly J D, Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition. 1997

COURSE OUTCOMES

At the end of the course student will

1. Explain basic concepts of turbomachines and visualize dimensional analysis.
2. Describe the working of Pelton, Francis and Kaplan along their performance parameters.
3. Discuss the operation of centrifugal pumps, centrifugal and axial compressors.
4. Associate the effect of cavitation in turbines and pumps.
5. Express the basic cycles and calculations involved in the operation of steam and gas turbines.

MEHO14 – ADVANCED ENGINEERING MATERIALS

Course Code:	MEHO14	No. of Credits:	04
Course Name:	ADVANCED ENGINEERING MATERIALS	Prerequisite:	MEPC18

COURSE LEARNING OBJECTIVES

1. Distinguish various classes of advanced materials, their processing, properties and applications
2. Interpret new terms and information on ultra-light materials, Biomaterials, coatings and thin films, composites, and high temperature refractory materials for aerospace applications.
3. Distinguish materials suitable for application at elevated temperatures and identify coatings suitable for protection applications
4. Introduction and application of Smart materials and meta-materials.

COURSE CONTENT

Ultralight materials and metallic foams, material definition and processing, characterization of cellular metals, material properties

Composite materials, classifications, properties and applications.

Advanced materials - coatings and high- temperature materials, Shape memory Alloys, Piezoelectric, Bio-Materials, Thin Films, Liquid crystals.

Smart Materials: Stimuli responsive materials, Light actuators, Heat actuators, etc.

Meta-Materials: Introduction to structural, vibrational and acoustic Meta-materials. Granular meta-materials

Multi-scale modelling: Introduction to Microscale (Molecular dynamics), Meso-Scale, Macroscale (continuum) modelling methods of materials.

REFERENCE BOOKS:

1. Handbook of Cellular metals, Production, processing, Application, Edited by Hans Peter Degischer and Brigitte Kriszt, Wiley - VCH, 2002.
2. Biomaterials Science, An Introduction to Materials in Medicine, Edited by B.D. Ratner, A.S. Hoffman, F.J. Sckoen, and J.E.L Emons, Academic Press, second edition, 2004.
3. Handbook of Materials for Medical Devices, Edited by J. R. Davis, ASM international, 2003.

COURSE OUTCOMES

At the end of the course student will

1. Some understanding of types, manufacturing processes, and applications of advanced materials
2. A recognition of the need for and an ability to engage in life-long learning and knowledge of contemporary issues
3. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

MEHO15 – DESIGN OF HEAT EXCHANGERS

Course Code:	MEHO15	No. of Credits:	04
Course Name:	Design of Heat Exchangers	Prerequisite:	MEPC19

COURSE LEARNING OBJECTIVES

1. To learn the thermal and stress analysis on various parts of the heat exchangers
2. To analyze the sizing and rating of the heat exchangers for various applications

COURSE CONTENT

Types of heat exchangers, shell and tube heat exchangers – regenerators and recuperators Temperature distribution and its implications - Parts description, Classification as per Tubular Exchanger Manufacturers Association (TEMA)

Heat transfer correlations, Overall heat transfer coefficient, analysis of heat exchangers – LMTD and effectiveness method. Sizing of finned tube heat exchangers, U tube heat exchangers, Design of shell and tube heat exchangers, fouling factors, pressure drop calculations.

Types- Merits and Demerits- Design of compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations. Polymer heat exchangers

Design of surface and evaporative condensers, Shell and Tube condensers - condensers for low temperature applications, design correlations for condensers –cooling tower – performance characteristics

Cryogenic heat exchangers – Tubular heat exchangers, matrix heat exchangers, coiled tube heat exchangers, Giaque Hampson heat exchangers.

REFERENCE BOOKS:

1. Sadik Kakac and Hongtan Liu, "Heat Exchangers Selection," Rating and Thermal Design, CRC Press, 2002.
2. Shah,R. K., Dušan P. Sekulić, "Fundamentals of heat exchanger design", John Wiley & Sons, 2003.
3. Robert W. Serth, "Process heat transfer principles and applications", Academic press, Elsevier, 2007.
4. Sarit Kumar Das, "Process heat transfer", Alpha Science International, 2005
5. John E. Hesselgreaves, "Compact heat exchangers: selection, design, and operation," Elsevier Science Ltd, 2001.
6. Kuppan. T., "Heat exchanger design hand book", New York : Marcel Dekker, 2000.
7. Kays, W.M., and London, A.L., "Compact heat exchangers", Krieger Pub Co., Subsequent edition, 1998.

COURSE OUTCOME

At the end of the course student will apply the mathematical knowledge for thermal and stress analysis on various parts of the heat exchangers components

MEHO16 – DESIGN AND OPTIMIZATION OF THERMAL ENERGY SYSTEMS

Course Code:	MEHO16	No. of Credits:	04
Course Name:	Design and Optimization of Thermal Energy Systems	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES

1. To learn basic principles underlying piping, pumping, heat exchangers; modeling and optimization in design of thermal systems.
2. To develop representational modes of real processes and systems.
3. To optimization concerning design of thermal systems.

COURSE CONTENT

Introduction to Energy System Design - Regression analysis and Equation fitting

Modeling of thermal equipment - heat exchangers, evaporators, condensers, turbomachines, distillation equipment. Absorber, generator, GAX.

System simulation - Application of successive method and Newton Raphson Method to Energy Systems

Mathematical Representation for Optimization Problems in Energy Systems, Genetic Algorithms – using MATLAB, Inverse problems in heat transfer -Applications of various search methods to Energy Systems - Waste Heat Recovery System - design of energy recovery systems

Cost analysis by present worth-annual cost-Evaluating potential Investments-Forecasting Techniques-Economic Factors in Energy Systems-Examples

Thermo-economic Analysis and Evaluation: Fundamentals of Thermoconforms, Exergy Costing, Aggregation Level for Applying Exergy Costing, Cost Rates, Auxiliary Relations, and Average Costs, Associated with Fuel and Product, Costing of Exergy Loss Streams, Non-Exergy-Related Costs for Streams and Matter, Costing Chemical and Physical Exergy, Thermoeconomic Evaluation.

REFERENCE BOOKS:

1. Hodge, B.K. and R.P. Taylor, Analysis and Design of Energy Systems, 3rd Edition, Prentice Hall, 1999.
2. Stoecker, W.F., Design of Thermal Systems, McGraw-Hill, 1989,
3. Burmeister, L.C., Elements of Thermal-Fluid System Design, Prentice Hall, 1998.
4. Jaluria, Y., Design and Optimisation of Thermal Systems, McGraw-Hill, 1998.
5. Janna, W.S., Design of Fluid Thermal Systems, PWS-Kent Publishing, 1993.

COURSE OUTCOME:

At the end of the course student will learn the modelling and optimization of thermal system with various equipment like piping, heat exchangers and pumping.

MEHO17 – HEAT TRANSFER EQUIPMENT DESIGN

Course Code:	MEHO17	No. of Credits:	03
Course Name:	Heat Transfer Equipment Design	Prerequisite:	MEPC19

COURSE LEARNING OBJECTIVES:

1. To discuss the types of heat transfer equipment and various flow patterns.
2. To study shell and tube heat exchanger and other types of heat exchangers for special services
3. To understand the design procedure of air pre-heaters, economizers, super heaters, condensers and cooling towers for thermal power plants
4. To design plate and compact heat exchangers for industrial applications

COURSE CONTENT:

Classification of heat transfer equipment - Design of shell and tube heat exchanger - Finned surface heat exchanger –Heat exchangers for special services – Fired heaters

Plate and spiral plate heat exchanger – plate heat exchanger for Dairy industry – Heat Pipes

Thermal design of heat exchange equipments such as Air pre-heaters , Economizer – Super heater and condensers.

Selection of compact heat exchangers. Analysis and design of cooling towers.

REFERENCE BOOKS:

1. Ganapathy, V., Applied Heat Transfer, Pennwell Books, 1982.
2. Kays, W.M. and London, A.L., Compact Heat Exchangers, McGraw-Hill, 1998.
3. Dunn, P. and Reay, D.A., Heat Pipes, Pergamon, 1994.
4. Kakac, S. and Liu, H., Heat Exchangers, CRC Press, 2002.
5. Arthur P. Frass, Heat Exchanger Design, John Wiley & Sons, 1988.
6. Hewitt G.F., Shires G.L. and Bott T.R., Process Heat Transfer, CRC Press, 1994.
7. Nicholas Cheremisioff, Cooling Tower, Ann Arbor Science Pub 1981.
8. Sekulic D.P., Fundamentals of Heat Exchanger Design, John Wiley, 2003.
9. TaborekT., Hewitt.G.F. and Afgan N., Heat Exchangers, Theory and Practice, McGraw-Hill Book Co. 1980.
10. Walker, Industrial Heat Exchangers - A Basic Guide, McGraw Hill Book Co., 1980.
11. Coulson and Richardson, Chemical Engineering Design, Volume 6, Elsevier Butterworth – Heinemann, 2005.

COURSE OUTCOME:

At the end of the course student will be able to

1. Classify the various heat transfer equipment
2. Design various heat exchangers viz. shell and tube, finned surface & special purposes for thermal engineering industries.
3. Analyze the performance of air pre-heaters, economizers, super heaters and condensers for power plants.
4. Design compact heat exchangers and cooling towers.
5. Select a suitable heat exchanger for any given application.

MEHO18 – ANALYSIS AND DESIGN OF PRESSURE VESSELS

Course Code:	MEHO18	No. of Credits:	03
Course Name:	Analysis and Design of Pressure Vessels	Prerequisite:	MEPC12

COURSE LEARNING OBJECTIVES:

1. To impart basic knowledge of design of pressure vessels and piping system.
2. To introduce use of various standards used for the pressure vessel design.
3. To analyze the general applications of pressure vessels
4. To understand the development of cracks, fracture mechanism and corrosion
5. To perform finite element analysis on high pressure and temperature components

COURSE CONTENT:

Establishment of design conditions – Fracture Mechanics – Heads, Basic shell thickness - Reinforcement of openings – Special components like flange, tube plate, supports.

Cylindrical shells – Thick cylinders- Lame's solution - Theories of breakdown of elastic action – Unrestrained solution – Lateral loading – General loading. Axisymmetric loading - Membrane solutions - Edge bending solutions - Flexibility matrix.

Application of general analysis – Flat closure plates –conical heads and reducers – hemispherical and torispherical, ellipsoidal heads.

Development of cracks - Fracture mechanics - Corrosion - Selection of working stress for ductile and brittle materials.

Finite element analysis for high pressure and high temperature components.

REFERENCE BOOKS:

1. Bickell, M.B. and Ruiz, c., Pressure Vessel Design and Analysis, MacMillan, London, 1967.
2. Den Hartog, J.P., Advanced Strength of Materials, McGraw-Hill, 1949.
3. Timoshenko, S., Strength of Materials, Van Nostrand, 1986.

COURSE OUTCOME:

At the end of the course student will be able to

1. Analyze thin plates and shells for various types of stresses.
2. Design shells, end closures and nozzles of pressure vessels using ASME codes.
3. Analyze the general applications of pressure vessel
4. Understand the fracture and corrosion mechanism
5. Analyze the FEM models on high pressure and temperature components

MEHO19 – ANALYSIS OF THERMAL POWER CYCLES

Course Code:	MEHO19	No. of Credits:	03
Course Name:	Analysis of Thermal Power Cycles	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES:

1. To describe sources of energy and types of power plants.
2. To analyze different types of steam cycles and estimate efficiencies in a steam power plant.
3. To define the performance characteristics and components of power plants.
4. To study and analyze various refrigeration cycles

COURSE CONTENT:

Steam power plant cycle - Rankine cycle - Reheat cycle - Regenerative cycle with one and more feed heaters - Types of feed heaters - Open and closed types - Steam traps types.

Cogeneration - Condensing turbines - Combined heat and power - Combined cycles - Brayton cycle Rankine cycle combinations - Binary vapour cycle.

Air standard cycles - Cycles with variable specific heat - fuel air cycle - Deviation from actual cycle.

Brayton cycle - Open cycle gas turbine - Closed cycle gas turbine - Regeneration - Inter cooling and reheating between stages.

Refrigeration Cycles - Vapour compression cycles - Cascade system - Vapour absorption cycles - GAX Cycle.

REFERENCE BOOKS:

1. Culp, R., Principles of Energy Conversion, McGraw-Hill, 2000.
2. Nag. P.K., Power Plant Engineering, 2nd Tata McGraw-Hill, 2002.
3. Nag. P.K., Engineering Thermodynamics, 3rd ed., Tata McGraw-Hill, 2005.
4. Arora, C.P., Refrigeration and Air Conditioning, 2nd ed., Tata McGraw-Hill, 2004.

COURSE OUTCOME:

At the end of the course student will be able to

1. Understand various energy resources and conversion methods and equipments
2. Derive efficiency calculation for various power cycles.
3. Understand different refrigeration cycles.

MEHO20 – FUELS COMBUSTION AND EMISSION CONTROL

Course Code:	MEHO20	No. of Credits:	04
Course Name:	Fuels Combustion and Emission Control	Prerequisite:	MEPC17

COURSE LEARNING OBJECTIVES:

1. To study fuels and their properties combustion chemistry and stoichiometry.
2. To solve simplified conservation equations for reacting flows and to compare different types of FBCs.
3. To distinguish the factors influencing flame velocity and thickness flame stabilization.
4. To understand the emission norms and standards

COURSE CONTENT:

Types of fuels and their properties - Coal characterization - Combustion chemistry - Stoichiometry Heat of reaction - Calorific value - Adiabatic flame temperature - Equilibrium - Mass transfer.

Chemical kinetics - Important chemical mechanisms - Simplified conservation equations for reacting flows - Laminar premixed flames - Simplified analysis.

Factors influencing flame velocity and thickness flame stabilization - Diffusion flames - Introduction to turbulent flames.

Coal combustion systems – Liquid fuel atomizers - FBC - Different types of FBCs - Models for droplet and Carbon particle combustion.

Emissions - Emission index - Corrected concentrations - Control of emissions for premixed and non-premixed combustion.

Fuel chemical kinetic simulations with detailed and reduced reaction mechanism – Numerical simulation of simplified combustion problems using CFD package

REFERENCE BOOKS:

1. Sharma, S.P. and Mohan, C., Fuels and Combustion, Tata McGraw-Hill, 1987.
2. Sarkar. S., Fuels and Combustion, Orient Longman, 2005.
3. John B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Book, 2018.
4. Obert, E.F., Internal Combustion Engine and Air Pollution, International Text Book Publishers, 1983.

COURSE OUTCOME:

At the end of the course student will be able to

1. Recall fuels and their properties combustion chemistry and stoichiometry.
2. Construct simplified conservation equations for reacting flows.
3. Choose the factors influencing flame velocity and thickness flame stabilization.
4. Discuss emissions, emission index and control of emissions for premixed and no premixed combustion.

MEHO21 – FINITE ELEMENT METHOD IN MECHANICAL ENGINEERING

Course Code:	MEHO21	No. of Credits:	04
Course Name:	Finite Element Method in Mechanical Engineering	Prerequisite:	MEPC19

COURSE LEARNING OBJECTIVES:

1. To Understand the concepts behind variational methods and weighted residual methods in FEM.
2. To Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements.
3. To learn the theory and characteristics of finite elements that represent engineering structures.
4. To apply Suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
5. To identify how the finite element method expands beyond the structural domain, for problems involving heat transfer and vibrational analysis.

COURSE CONTENT:

Introduction, Weighted Residual Methods, Shape functions, Coordinate systems, Numerical Integration.

Integral Formulation for Numerical Solutions, Coordinate systems, Galerkin"s Approach for one dimensional and two-dimensional problems

Potential Energy Formulations – Axial Force Member, Truss, Beam and Plane frame elements.

Plane stress, plane strain and axisymmetric problems. Isoparametric elements and Lagrangian interpolation polynomial.

Finite Element Analysis in Steady State and Transient problems. Solution Techniques to Vibrational analysis

Laboratory Experiments

1. Basic problems in Structural Mechanics and Heat Transfer Analysis using Finite element codes
2. 1D, 2D and 3D field problems
3. Conduction and Convection based problems
4. Transient analysis
5. Vibration analysis

REFERENCE BOOKS:

1. Daryl L. Logan, *A First Course in the Finite Element Method*, Cengage Learning, 2011.
2. K.J. Bathe, Finite Element Procedures, Klaus-Jurgen Bathe, 2007
3. Reddy, JN., and Gartling DK., The Finite Element Method in Heat Transfer and Fluid Dynamics, CRC Press; 2nd edition, 2000.
4. David V. Hutton, Fundamentals of Finite element analysis, McGraw Hill, 2004.

COURSE OUTCOMES

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

1. Understand the concepts behind variational methods and weighted residual methods in FEM.
2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element.
3. Develop element characteristic equation procedure and generation of global stiffness equation will be applied.
4. Apply Suitable boundary conditions to a global structural equation, and reduce it to a solvable form.
5. Identify how the finite element method expands beyond the structural domain, for problems involving heat transfer and vibrational analysis.

MEHO22 – SMART MATERIALS AND STRUCTURES

Course Code:	MEHO22	No. of Credits:	04
Course Name:	Smart Materials and Structures	Prerequisite:	MEPC13

COURSE LEARNING OBJECTIVES:

1. To understand the interdisciplinary material properties for sensors and actuators applications.
2. To familiarize the working principles of various sensors for different applications.
3. To describe the role of actuators and actuator materials.
4. To introduce the basic concepts of piezoelectric energy harvesting.
5. To discuss the various measurements and signal processing techniques for structural dynamic applications.

COURSE CONTENT

Introduction to Smart Materials, Structures and Products Technologies - Smart materials (Physical Properties) Piezoelectric Materials, Elecrostrictive Materials, Magnetostrictive Materials, Magneto electric Materials, Magnetorheological Fluids, Electrorheological Fluids, Shape Memory Materials.

Smart Sensors and Technologies - Smart Sensors: Accelerometers - Force Sensors- Load Cells, Torque Sensors, Pressure Sensors, Microphones, Impact Hammers- MEMS Sensors – Fiber Optic Sensors.

Smart Actuator and its Techniques – Role of Actuators and Actuator materials – Piezoelectric and Electrostrictive Materials – Magneto-structural Materials – Shape Memory Alloys – Electro rheological fluids – Electromagnetic actuation.

Introduction to Piezoelectric Energy harvesting - Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modelling - piezoelectric generators, Piezoelectric energy harvesting applications.

Measurement and Signal Processing Techniques – Static and Dynamic Measurement Methods- Signal conditioning devices; Structural dynamics and Identification techniques; Passive, Semi -active and Active control; Feedback and feed forward/control strategies.

REFERENCE BOOKS:

1. Srinivasan, A. V. and Michael McFarland, D., “Smart Structures: Analysis and Design”, Cambridge University Press, 2009.
2. Gandhi, M. V. and Thompson B.S., “Smart Materials and Structures” Chapman and Hall, London, 1992.
3. Michelle Addington and Daniel L. Schodek, “Smart Materials and Technologies: For the Architecture and Design Professions”, Routledge 2004.

4. Brain Culshaw, “Smart Structure and Materials”, Artech House – Borton. London,1996.
5. L. S. Srinath, “Experimental Stress Analysis”, Tata McGraw-Hill, 1998.
6. J. W. Dally and W. F. Riley, “Experimental Stress Analysis”, Tata McGraw-Hill, 1998.
7. Gauenzi, P., “Smart Structures,” Wiley, 2009

COURSE OUTCOMES

At the end of the course student will be able to
1. Make use of various smart materials properties for sensors and actuators applications.
2. Apply the working principles of sensors for various applications.
3. Identify the suitable actuators for corresponding applications.
4. Model the piezoelectric effect for energy harvesting.
5. Demonstrate the measurement and signal processing techniques for structural dynamics testing.

MEHO23 – FUNDAMENTALS OF BIOMECHANICS

Course Code:	MEHO23	No. of Credits:	04
Course Name:	Fundamentals of Biomechanics	Prerequisite:	MEPC10

COURSE LEARNING OBJECTIVES:

1. To study the biomechanical concepts in living systems.
2. To describe the biological, mechanical, and neurological mechanisms by which muscles produce movement.
3. To write and solve equations of motion for simple models of human movement.

COURSE CONTENT

Introduction to Biomechanics- Review of the principles of mechanics, Vector mechanics, biomechanics, anatomical terminology, Anthropometry, motion in the human machine.

Biomechanics of Joints- Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle, Introduction to bio fluid Mechanics, Rheological properties of blood, laminar flow, couette flow and Hagen poiseuille equation, turbulent flow.

Hard and Soft Tissue- Bone structure, composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, maxwell & voight models, Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modeling of soft tissues, Hills’s muscle model.

Cardiovascular and Respiratory Mechanics– Cardiovascular system, artificial heart valves, biological and mechanical valves development, testing of valves, Blood Flow Models, Blood Vessel Mechanics, Heart valve dynamics, prosthetic valve dynamics. Mechanism of air flow, respiratory cycle, lung ventilation model, methods of determining pressure, flow rate and volume spirometry.

Applied Biomechanics and Biomechanics of Implants- Engineering approaches to standing, sitting and lying, Biomechanics of gait, application of gait and locomotion analysis, Fluid mechanics and energetics: Forms of energy and energy transfer, Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.

REFERENCE BOOKS:

1. Ronald Huston, Principles of Biomechanics, 1st Edition, CRC Press, 2008.
2. Susan J.Hall, Basic Bio Mechanics, 6th Edition, McGraw -Hill Publishing Co, Newyork, 2012.
3. Valdimir M. Zatsiorsky, Kinematics of Human Motion, Human Kinetics publishers, 1998.
4. Valdimir M. Zatsiorsky Zatsiorsky, Kinetics of Human motion, Human Kinetics publishers, 2002.
5. Zatsiorsky and Prilutsky, Biomechanics of Skeletal muscles, Human Kinetics publishers, 2012.

COURSE OUTCOMES:

At the end of this course, the student will be able to:

1. Understand the biomechanics principles and gait analysis of human locomotion
2. Derive the joint force and muscle force for various biomechanical systems in the human body.
3. Explain the application of basic mechanical principles in human motion.

MEHO24 – COMPUTATIONAL METHODS IN ENGINEERING

Course Code:	MEHO24	No. of Credits:	04
Course Name:	Computational Methods in Engineering	Prerequisite:	-NIL-

COURSE LEARNING OBJECTIVES

1. To provide an introduction to the numerical methods to solve various kinds of equations that students encounter in the field of engineering.
2. Numerical methods for solving ODEs and PDEs
3. Students able to develop his/her own programs/subroutines for the numerical schemes taught in the course.

COURSE CONTENT

Introduction: Numerical precision in digital computing and its effect on numerical calculations, Taylor series and truncation, Rounding off errors, Introduction to programming

System of Equations and Eigen values: Review of solution methods to system of linear equations, Computation of Eigen values, solution of algebraic equations (univariate and multivariate non-linear equations, root finding and optimization), Well-conditioned and ill conditioned system, Matrix and vector norms,

Interpolation, differentiation and integration: Interpolation (polynomial, Lagrange interpolation, error estimates, piecewise polynomial, Hermite, Spline, 2D (rectangle and triangle)), Curve Fitting/Regression, Numerical Differentiation, Numerical Integration (Simpson's rule, Guass Quadrature)

Ordinary Differential Equations: Initial value problems (Euler Method, RK methods, Predictor corrector methods), Boundary Value Problems (Shooting method, FDM, FEM, Weighted residuals, FVM).

Partial Differential Equations - Introduction to PDEs, classification of PDEs, Numerical solutions methods, Laplace and Poisson Equations, Iterative methods (Jacobi, Guass-Seidal, steepest decent and conjugate gradient)

Laboratory: Coding the above iterative methods in MATLAB/C++/Fortran

REFERENCE BOOKS:

1. S. P. Venkateshan, Prasanna Swaminathan, Computational Methods in Engineering, Ane Books
2. Steven C. Chapra, Numerical Methods for Engineering, Mc-Graw Hill Education
3. Joe D Hoffman, Numerical Methods for Engineers and Scientists, Second Edition, Marcel Dekker (2001)
4. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge Press

COURSE OUTCOMES

On completion of course students should be able to

1. Numerically compute solution of system of equations through programing
2. Compute numerical solution for ODE and PDE using coding
3. Evaluate various iterative methods using computer programming.
4. Perform curve fitting and regression analysis
5. Solve BVP and IVP numerically

VII. ONLINE COURSES

The online NPTEL courses offered are dynamic and change with time, Hence, the students can opt for online courses relevant to the branch of study every semester. The departmental committee will finalize and recommend selective courses from the list and further submit for institute approval.

List of NPTEL Courses Recommended:

Sl. No	Course Title	Duration	Website Link
1	UAV Design - Part II	8 Weeks	https://onlinecourses.nptel.ac.in/noc20_ae04/preview
2	Space Flight Mechanics	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_ae06/preview
3	Aircraft Structures - I	8 Weeks	https://onlinecourses.nptel.ac.in/noc20_ae08/preview
4	Introduction to Aerospace Engineering	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_ae12/preview
5	Introduction to Air breathing Propulsion	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_ae13/preview
6	Introduction to Aircraft Design	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_ae14/preview
7	Functional and Conceptual Design	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_de10/preview
8	Introduction to robotics	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_de11/preview
9	Rapid Manufacturing	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_me50/preview
10	Heat Exchangers: Fundamentals and Design Analysis	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_me52/preview
11	Mechanism And Robot Kinematics	8 Weeks	https://onlinecourses.nptel.ac.in/noc20_me53/preview
12	Automation in Manufacturing	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_me58/preview

13	Finite Element Method: Variational Methods to Computer Programming	12 Weeks	https://onlinecourses.nptel.ac.in/noc20_me60/preview
14	High Performance Computing for Scientists and Engineers	8 Weeks	https://onlinecourses.nptel.ac.in/noc20_me61/preview
15	Introduction to Mechanical Vibration	8 Weeks	https://onlinecourses.nptel.ac.in/noc20_me66/preview
16	Advanced Machining Processes	8 Weeks	https://onlinecourses.nptel.ac.in/noc20_me76/preview
17	Mechatronics	8 Weeks	
18	Steam Power Engineering	8 Weeks	https://onlinecourses.nptel.ac.in/noc20_me87/preview
19	Aircraft Propulsion	12 weeks	https://onlinecourses.nptel.ac.in/noc20_me90/preview