SDM COLLEGE OF ENGINEERING AND TECHNOLOGY, DHARWAD
Department of Mechanical Engineering

List of courses having focus on employability/ entrepreneurship/ skill development offered by the institution during the last five years:

Sl.No.	Name of the Course	Course Code
1	Automation Technologies	value added course
2	Basic Engineering Skills Lab	18UESL100
3	Computational Methods in Engineering	18PEADC100
4	Advanced Fluid Dynamics	18PEADE125
5	Design Engineering Lab – I	18PEADL131
6	Seminar	18PEADL132
7	Automobile System Design	18PEADC200
8	Computational Fluid Dynamics	18PEADC201
9	Power Plant Design	18PEADE226
10	Design Engineering lab -II	18PEADL231
11	Seminar	18PEADL232
12	Experimental Techniques	18PEADC300
13	Design of Heat Exchangers	18PEADE326
14	Internship in Industry/R&Dorganization /Elective 8	18PEADL328
15		
16	Project phase 1	18PEADL329
17	Project phase-II	18PEADL425
18	Machine Drawing	18UMEC304
19	Materials Science & Material Testing Lab	18UMEL305
20	Foundry & Forging Lab	18UMEL306
21	Measurements Lab	18UMEL405
22	Thermal Engg. Lab - I	18UMEL406
23	Introductory Project-2	18UMEL407
24	Management, Economics &Intellectual Property Rights	18UHUC500
25	Design of Machine Elements-II	18UMEC501
26	Turbo machines	18UMEC502
27	Renewable Energy Technology	18UMEC503
28	Fundamentals of Automobile Design (Ready Engineer by TATA Technologies)	18UMEE527
29	Machine shop Practice	18UMEL504
30	Thermal Engg. Lab - II	18UMEL505
31	Minor Project-1	18UMEL506
32	Soft skills/Aptitude	18UHUL507
33	Internal Combustion Engines	18UMEE624
34	Tool Design Engg.	18UMEE631
35	Advanced Automobile Design	18UMEE637
36	(Ready Engineer by TATA Technologies)	

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37	Total Quality Management	18UMEE642
38	Introduction to Scientific programming	18UMEE647
39	Computer Aided Engineering Analysis Lab	18UMEL602
40	Thermal Engg. Lab - III	18UMEL603
41	Minor Project-2	18UMEL604
42	Soft skills/Aptitude	18UHUL605
43	Research Methodology and IPR	20PRMIC100
44	Hybrid Vehicle Technology	18UMEE723
45	Computational Fluid Dynamics	18UMEE724
46	Introduction to Aircraft Industry & Aircraft Systems	18UMEO731
47	Project Management	18UMEO732
48	Dynamics Laboratory	18UMEL702
49	Major Project Phase-1	18UMEL703
50	Internship	18UMEL704
51	Fluid Power Control	18UMEC800
52	Tribology & Bearing Design	18UMEE834
53	Industry 4.0 & Artificial intelligence	18UMEE837
54	Technical Seminar / Independent study	18UMEL801
55	Major Project Phase-2	18UMEL802

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18UESL100/18UESL200	Basic Engineering Skills Lab	(0-0-2) 1

Contact Hours: 25

Course Learning Objectives (CLOs):

The student is expected to acquire basic minimum engineering skills with hands on in multiple disciplines of engineering like Civil, Mechanical, Electrical, electronics, computer Science etc. Further, the student will come to know about the role of different streams of engineering in practical systems.

Course Outcomes (COs):

ID	Description of the Course Outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Recite the general Engineering principles, laws and applications		1,2	
CO-2	Perform skill exercises to implement simple engineering systems in Civil, Mechanical, Electrical, electronics, computer Science and demonstrate the working	4	3	9
CO-3	Use computer skills to generate/prepare technical write up/report.			10

PO's	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO10**	**PO11**	**PO12**
Mapping Level	2.0	2.0	2.0	3.0					1.0	1.0		

Contents:

Skill Exercises:

1) Acquire the skills of soldering, develop scheme to charge battery employing transformer & conversion circuits, and make observations using suitable display equipments.

2) Acquire the skills of setting up of simple circuits with power control, measure electrical quantities, understand electrical behavior of different types of load along with safety and protection aspects.

3) Acquire the skills to set up a circuit to run 3 phase electrical motor and demonstrate the operation with load, record the speed and establish the relation

between speed and load.

4) Acquire engineering skills to select sensors (temperature, flow, level etc.), develop an application set up to demonstrate the use of sensors.

5) To Calculate area of a given map/ plan

6) To understand and carry out plumbing activity

7) To prepare a building plan, given requirements

8) To make a fit from given raw material as given in the model drawing.

9) To make sheet metal model using GI sheet as given in development drawing.

10) Disassembling and assembling of components of a given system

Demonstration:

11) Demonstration of working of Public Address (PA) system, different electrical appliances, report generation using word, Excel and interfacing of computer peripherals (Demonstration only).

12) To determine water quality of the given sample of water

13) Demonstration of welding process

Reference Material/Books:

1) Write up prepared by the Departments

2) E. Hughes - Electrical Technology, 8th edition, Pearson, 2006.

Mode of carrying out the skill exercises:

1. There shall be three faculty members one each from Civil, Mechanical and Circuit stream (preferably from Electrical &Electronics Engineering department) to train the students.
2. The contents are developed taking inputs from Chemical, Civil, Mechanical, E&E, E&C, Computer Science & Engg., Information Science & Engineering.
3. There shall be 10 skill exercises and 2 demonstration sessions
4. Three exercises from Civil, three exercises from Mechanical and four exercises from circuit streams form the list of 10 exercises. One each from circuits and Mechanical / Civil will form demonstration list.
5. A common facility shall be created in the department of Mechanical Engineering to carry out this course.
6. Preparation to carry out all 10 exercises shall be done and kept ready for the students to work
7. A batch of about 35 students will come to this lab once in every week during the allotted time of 2.5 hrs as per the time table.
8. A batch will be divided in to 10 sub batches each batch consisting of 3 to 4 students
9. All the 10 exercises shall be implemented in cyclic fashion.
10. A total of three faculty members, one each from Civil, Mechanical and Electrical will train the students in their related skill exercise.

11. The students shall prepare the report on the skill exercises conducted using word / excel (computer skills) and submit at the end of the semester for evaluation.
12. There shall be Semester End Examination consisting of one examiner from Civil, one from Mechanical and one from Electrical Engineering. Preferably the examiners shall be the faculty involved in training the students.
13. The students are expected to wear boiler suit and should use insulated shoes.

18PEADC100	Computational Methods in Engineering	(4-0-0) 4

Total 50 Hrs

Course Learning Objectives (CLOs):

1. Formulation of mathematical models to simple physical systems.
2. Establishing numerical solutions based on extensive computational mathematics for the mathematical models developed.
3. Forming the basic algorithms for framing the basis for computer based solutions in modern systems science.

Course Outcomes (COs):

Description of the course outcome: At the end of the course the student will be able to:		Mapping to POs (1-5)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Formulate mathematical models for the simple physical systems and evaluate the errors due to approximations.	3	4	5,1
CO-2	Determine the roots of nonlinear equations and polynomials in Science and Engineering problems.	3	2	5
CO-3	Establish numerical solutions for differentials and integrals functions.	3	2	4
CO-4	Apply the fundamentals of linear algebra for engineering problems.	3	2	4
CO-5	Establish the numerical solutions for ordinary differential equations and partial differential equations.	3	2	4

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CO-6	Apply the concepts of optimization for constrained and un-constrained engineering problems.	3	2	5

POs	PO-1	PO-2	PO-3	PO-4	PO-5
Mapping Level	1	2	3	1.25	1

Course content:

1 Mathematical modelling & Error analysis: Mathematical modelling in engineering problem solving, approximations & round-off errors – error definition, accuracy, precision, round-off errors, truncation errors. Use of programing skills and software for engineering computations. **8 Hrs**

2 Roots of equations:
Mathematical background, Solution of non-linear algebraic equations- Bracketing method, graphical method, bisection method, Newton's Rapson method, Secant method. Use of programming skills and software for establishing the numerical solutions for simple problems. **10Hrs**

3 Numerical Differentiation & Integration: Mathematical background, Numerical Differentiation and Numerical Integration: Newton's forward and back ward difference formula. Newton –Cotes and Gauss Quadrature Integration formulae, Integration of Equations, Romberg integration. **8 Hrs**

4 Linear algebra Numerical Methods in Linear Algebra: Direct and iterative solution techniques for simultaneous linear algebraic equations – Gauss elimination, Gauss-Jordon, LU Decomposition, QR Method, Jacobi and Gauss-Seidel Method, Eigenvalues and Eigenvectors – Power and inverse power method, householder transformation, physical interpretation of eigenvalues and eigenvectors. - **10 Hrs**

5 Numerical solutions for differential equations: Mathematical basis, need for numerical solutions, Numerical solution of differential equations Ordinary Differential Equations – Euler, Heun's method and Stability criterion, second order, third and fourth order Runge-Kutta methods, Partial Differential Equations – Classification of PDEs, Elliptic equations, Parabolic equations (Transient diffusion equation). **8 Hrs**

6 Optimization – One dimensional unconstrained optimization – Golden section search Newton's method, Constrained optimization- Linear programming, and non-linear constrained optimization. **6 Hrs**

Reference Books:

1. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
2. Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata McGraw Hill, 4th Ed, 2002.
3. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engineering Computation, New Age International, 2003.

4. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
5. David C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.
6. Joe D Hoffman, Numerical Methods for Engineers and Scientists, Second Edition, Marcel Dekker (2001)
7. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge Press-2007.

18PEADE125 Advanced Fluid Dynamics (4-0-0) 4

Contact Hours: 50

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

1. Fluid and its properties, laws governing fluid flow and mathematical interpretation.
2. Fluid flow concepts, velocity potential, ideal fluid flow concepts and stream functions.
3. Fluid dynamics continuity equation, Navier stokes equation and application of it.
4. Low Reynolds number flow and viscous flow.
5. Compressible flow, sonic velocity Mach number isentropic flow.

Course Outcomes (COs):

Description of the course outcome: At the end of the course the student will be able to:		Mapping to POs(1-5)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Define and Explain the fluid properties, derive the governing equations of fluid flow of 2D and 3D.	**3**		
CO-2	Analyze viscous flow through circular pipe, between parallel plates, and unsteady flow.	**2**		
CO-3	Derive equations for velocity and thermal boundary layer thickness and solve related equations and problems, convection	**4**		
CO-4	Analyze low Reynolds's number flows past cylinder and sphere and solve the problem related lift and drag.	**3**		**1**
CO-5	Explain integral flow equation, flow measurement using flow meters, pressure probes, hot wire manometer and wind tunnel.	**5**		

POs	PO 1	PO 2	PO 3	PO 4	PO 5
Mapping Level	1	3	3	3	3

Pre requisites: Basic thermo dynamics, Basic Science, Engineering Mechanics, Fluid mechanics and fluid flow dynamics, Applied Mathematics.

Course contents:

1. **Review of fluid mechanics:** Fluid properties, Continuity equation 2D &3D(Cartesian, cylindrical and spherical co-ordinates derivation and problems) Nevier Stokes equation (3D Cartesian co-ordinates). Elementary inviscid flows; superposition. **10 Hrs**
2. **Viscous flow:** Steady flow Hagen Poseuille problem, plane poiseuille problem, unsteady flow; impulsively started plate. **8 Hrs**
3. **Hydrodynamic & Thermal Boundary Layer theory:** Definitions, Hydrodynamic boundary layer, boundary layer thickness, displacement, momentum & energy thickness, (Derivations and problems) Blasicus equation, von karman integral equation separation of flow thermal boundary layer. **8 Hrs**
4. **Low Reynolds number flow:** Lubrication theory (Reynolds equation), flow past immersed bodies; lift & drag. **6 Hrs**
5. **Integral flow Analysis:** Reynolds transport theorem, continuity, momentum equation Energy equations. **4 Hrs**
6. **Flow measuring devices:** Classification, flow meters, notches pressure probes, Hot wire anemometer & Wind tunnels. **8 Hrs**
7. **Special topics:** Natural and forced convection, stability theory and introduction to turbulent flows. **6 Hrs**

Reference Books:

1. K Muralidhar& G. Biswas, “Advanced Engineering Fluid Mechanics” 2nd edition, Narosa Publisher, 2013
2. S.W Yuan, “Foundation of fluid mechanics” SI Unit Edition 1988.
3. Dr. R.K.Bansal, “ A text book of Fluid Mechanics and Hydraulic machines” 9th Edition, Laxmi Publications, 2005
4. K L Kumar “Engineering Fluid Mechanics” S Chand & Co Ltd – 2017.

18PEADL131	Design Engineering Lab - 1	(0-0-3) 2

Contact Hours: 36

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

1. Introduction to Finite Element analysis.

2. Introduction to Thermal and CFD analysis
3. Fabrication and testing of Composite Materials
4. MATLAB coding for finding Stress invariants and control systems.

Course Outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-5)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Ability to analyze the product by use of FEM software	1,5	2,4	3
CO-2	Identifying the advanced materials and fabricate it.	1	2	3, 4, 5
CO-3	Ability to formulate and analyze Thermal and CFD problems	1,4	2,5	3
CO-4	Ability to design, analyze and simulation of simple control systems.	1,4	2	3,5

PO s	PO 1	PO 2	PO 3	PO 4	PO 5
Mapping Level	3	2	1	2.25	1.4

Prerequisites:

1. Finite Element Method, Theory of Elasticity, Ansys, MATLAB
2. Heat Transfer, Advanced Fluid Dynamics, Composite Materials

Course contents:

Experiment #1
Numerically Calculation and MATLAB Simulation
Part A: Invariants, Principal stresses and strains with directions
Part B: Maximum shear stresses and strains and planes, Von- Mises stress

Experiment #2
Stress analysis in Curved beam in 2D
Part A: 2D Photo elastic Investigation.
Part B:Modelling and Numerical Analysis using FEM.

Experiment #3

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Stress analysis of rectangular plate with circular hole under i. Uniform Tension and ii. shear
Part A: Modelling of plate geometry under chosen load conditions and study the effect of plate geometry.
Part B: Numerical Analysis using FEA package.

Experiment #4
Single edge notched beam in four point bending.
Part A: Modeling of single edge notched beam in four point bending.
Part B: Numerical Studies using FEA..

Experiment #5
Torsion of Prismatic bar with Rectangular cross-section
Part A: Elastic solutions, MATLAB Simulation
Part B: Finite Element Analysis of any chosen geometry.

Experiment #6
Vibration Characteristics of a Spring Mass Damper System.
Part A: Analytical Solutions.
Part B: MATLAB Simulation.

Experiment #7
Modelling and Simulation of Control Systems using MATLAB.
Experiment #8
Experimental analysis of advanced materials subjected to tension, compression and bending.

Experiment #9
Study of microstructure for advanced materials.

Experiment #10
Thermal analysis:
Part A: Square Plate with Temperature Prescribed on one edge and opposite edge insulated.
Part B: Thermal analysis of a Thick Square Plate with the Top Surface exposed to a Fluid at high temperature, Bottom Surface at room temperature, Lateral Surfaces Insulated

Reference Books:
1. T. R. Chandrupatla and A. D. Belegundu, “Introduction to Finite Elements in Engineering”, Prentice Hall,Ed, 2002.
2. Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant “Experimental Stress Analysis”, Tata McGraw Hill, 1984. “Foundations of fluid mechanics”- S. W. Yuan,SI Unit edition,1988
3. V. P. Singh, DhanpatRai and Company Advanced Mechanics ofsolids, L. S. Srinath “Mechanical Vibrations”, Tata Mc. Graw Hill, 2009.

4. Katsuhiko Ogata “Modern Control Engineering”,5th Edition
5. Derek P. Atherton “Control Engineering: An introduction with the use of Matlab”, Book boon Publishers.
6. Huei-Huang Lee “Finite Element Simulations with ANSYS Workbench 14” , SDC Publication
7. Finite Element Analysis Using Ansys 11.0 Paperback – 2010 by Srinivas, Datti
8. Introduction to Ansys 16.0 Paperback – Import, 2 Feb 2017 by R.B.Choudary
9. Tadeusz Stolarski, Y. Nakasone,S.Yoshimoto “Engineering Analysis with ANSYS Software”,

18PEADL132	Seminar	(0-0-2)1

Contact hours: 36

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

1. The latest trends in engineering and research.
2. Presentation skills.
3. Communication skills.
4. Art / techniques of Report preparation.

Course Outcomes (COs):

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

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
Mapping Level	-	3	-	1.5	1	

Every student has to present a seminar on thrust areas in Mechanical Engineering suitably selecting the topic in consultation with a guide. The seminar will be evaluated by a faculty committee consisting two members.

18PEADC200 Automobile System Design (4-0-0)4

Contact Hours: 50

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

1. The stages involved in automobile system design.

2. Industrial practices in design of various systems of an automobile.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs (1-5)		
		Substantial Level(3)	Moderate Level(2)	Slight Level(1)
CO-1	Define and explain basic parts of automobile and understand basic fuel injection principles.	1	3	2,5
CO-2	Design the different engine parts like piston, crankshaft, cylinder head, camshaft,etc	1,4	5	2,3
CO-3	Design of springs and combustion chamber	1,4	5	2,3
CO-4	Explain different transmission and suspension parts of automobile,	1	3	2,4,5
CO-5	Understand different cooling and emission principles in automotive.	-	1,2	3,4,5

POs	PO 1	PO 2	PO 3	PO 4	PO 5
Mapping Level	2.8	1.2	1.4	2	1.4

Course contents:

1. **Body Shapes:** Aerodynamic Shapes, drag forces for small family cars. Fuel Injection: Spray formation, direct injection for single cylinder engines (both SI & CI) and energy audit. 1**2 Hrs**

2. **Design of I.C. Engine I**: Combustion fundamentals, combustion chamber design, cylinder head design for both SI & C. I. Engines. **8 Hrs**

3. **Design of I.C. Engine II**: Design of crankshaft, camshaft, connecting rod, piston & piston rings for small family cars (max up to 3 cylinders). **10 Hrs**

4. **Transmission System**: Design of transmission systems – gearbox (max of 4-speeds), differential. Suspension System: Vibration fundamentals, vibration analysis (single & two degree of freedom, vibration due to engine unbalance, application to vehicle suspension. **10 Hrs**
5. **Cooling System**: Heat exchangers, application to design of cooling system (water cooled). Emission Control: Common emission control systems, measurement of missions, exhaust gas emission testing. **10 Hrs**

Reference Books:

1. Turns- Introduction to combustion
2. N.K.Giri “Automobile Mechanic” Khanna Publications, 1994
3. Maleev “I.C. Engines” McGraw Hill book company, 1976
4. Heldt P.M. “Diesel engine design” Chilton company New York.
5. V.M. Faires&Wingreen “Problems on design of machine elements” McMillan Company., 1965

6. John Heywood "Design of I.C.Engines" TMH
7. A .Kolchin& V. Demidov "Design of Automotive Engines", MIR Publishers, Moscow
8. Newton steeds &Garratte"The motor vehicle" , Iliffee& sons Ltd., London
9. Edward F Obert "I.C. Engines", International text book company.

18PEADC201	Computational Fluid Dynamics	(4-0-0) 4

Contact Hours: 50

Course Learning Objectives (CLOs): This course will enable students to

1. To understand fundamentals of computational fluid dynamics to solve fluid flow and heat transfer problems.
2. To understand dimensionless form of governing equations of fluid flow and heat transfer.
3. Explain FDM and FVM.
4. Solve linear algebraic equations in CFD using numerical methods.
5. Solve fluid flow and heat transfer problems using commercial CFD codes.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to Pos (1-5)		
		Substantial Level(3)	Moderate Level(2)	Slight Level(1)
CO-1	Explain the fundamentals of CFD applied to fluid flow and heat transfer and also discuss on partial differential equations and mathematical flow models used in CFD.	3	---	---
CO -2	To examine fluid flow and heat transfer problems by using Finite Difference method and also error propagation.	1,3	---	---
CO-3	Explain Finite Volume method and analyze fluid flow and heat transfer problems by using Finite Volume method.	1,3	---	---
CO-4	Explain the implicit, explicit, ADI methods and solve the problems using implicit/explicit or ADI method.	3	---	----
CO-5	Explain the essentials of numerical method for CFD.	3	---	---
CO-6	Investigate the fluid flow and heat transfer problems by using theoretical approach and also by using commercial CFD software.	5,3	4	1,2

POs	PO 1	PO 2	PO 3	PO 4	PO 5
Mapping Level	2.3	1	3	2	3

Pre requisites: Fluid mechanics, Partial differential equations, Numerical Methods, Heat transfer**.**

Course Content:

1. **Introduction and Basic Concepts:** Need of CFD as a design and research tool, applications and advantages of CFD,Governing equations (Only discussion on continuity, momentum and energy equations),Dimensionless form of equations; Simplified mathematical models; Hyperbolic, Parabolic & Elliptic systems; Properties of numerical solutions (Consistency, Stability, Conservation, Convergence and Accuracy). Grid generation: structured grids, unstructured grids. **10 Hrs**
2. **Finite Difference Methods**: A differential to algebraic formulation for governing Partial Differential Equations and Boundary conditions, application of FDM to

CFD, error propagation. Solution of One-dimensional heat conduction steady state and unsteady state, Two-dimensional steady state heat conduction using FDM. **10 Hrs**

3. **Finite volume method:** Surface & volume integrals; Interpolation & differentiation; Boundary conditions; Central difference and upwind schemes applied to 1-D situation involving convection and diffusion terms, Solution of One-dimensional heat conduction steady state and unsteady stateusing FVM. Calculation of flow field: staggered grid, SIMPLE algorithm. Implicit & Explicit Schemes, Alternate Direction Implicit (ADI) method. **14 Hrs**
4. **Essentials of Numerical Methods for CFD;** Iterative solution of linear algebraic equations for a flow property, iterative methods, applications of iterative methods to CFD, Tridiagonal Systems, under relaxation. **8 Hrs**
5. **Use of commercial software**: Solution of 2D and 3D fluid flow and Heat transfer problems using commercial software. **8 Hrs**

Reference Books:

1. T. J. Chung "Computational Fluid Dynamics" Cambridge Univ. Press, 2002.
2. Farlow "Partial Differential Equations for Scientists and Engineers" John Wiley, 1982.
3. J.H. Ferziger& M. Peric "Computational Methods for Fluid Dynamics", 3rd edition -, Springer, 2002.
4. G.D. Smith, Numerical Solutions of Partial Differential Equations, Finite Difference methods, 3rd ed., -, Oxford University Press. 1986.
5. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, Washington, D. C., 1980.
6. H. Versteeg, W. Malalasekra, An Introduction to Computational Fluid Dynamics, 2nd ed., Pearson Education Ltd. 1995.
7. John D. Anderson, Jr., Computational Fluid Dynamics: The basics with applications, McGraw Hill Education (India) Private Limited, New Delhi.1995.
8. Atul Sharma, Introduction to Computational Fluid Dynamics: Development, Applications and Analysis, Ane Books Pvt Ltd, New Delhi. 2017.
9. C. Hirsch, Numerical Computation of Internal & External Flows: The fundamentals of Computational Fluid Dynamics, Elsevier India PvtLtd New Delhi.2012.
10. K. Muralidhar, T. Sundararajan, Computational Fluid Flow and Heat Transfer, 2nd ed., Narosa Publishing House, New Delhi. 1995.

18PEADE226	Power Plant Design	(4-0-0) 4

Contact Hours: 52

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

1. Thermal Power Plant Operation, basic thermodynamic cycles, modern boilers, and power plant economics cost of generation and revenue per year.
2. Design of surface condensers, chimney and cooling towers in thermal power plants, knowledge of other accessories, numerical on surface condenser, chimney and cooling tower design.
3. Analyze combined cycle power plant and evaluation of the performance of combined cycle power plant.

4. Highlight the need of cogeneration and its benefits in terms of improved thermodynamic efficiency and revenue thorough case studies available in the literature
5. Environmental and safety aspects of power plant operation.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-4)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO 1	Calculate thermodynamic efficiency of Rankine cycle and load factors of a power plant. and cost of power generation.	1, 3	--	--
CO 2	Explain boiler inspection methods, and evaluate rating and sizing problems related to surface condensers, cooling tower and chimney	1	3	--
CO 3	Calculate thermodynamic efficiency of combined cycle power plant and explain various possibilities of combined cycle power plant	1	3	--
CO 4	Evaluate the thermodynamic efficiency of cogeneration plants and explain topping and bottoming cycle cogeneration plants with case studies	1	3	2
CO 5	Explain environmental and safety aspects of power plants.	3	--	--

POs	PO1	PO2	PO3	PO4
Mapping Level	3	2	3	-

Pre requisites: Basic and applied thermodynamics, heat transfer, engineering economics

Course contents:

1. **Thermal Plant**: Review of thermodynamics; vapor power cycles; regeneration; reheat cycles; furnace design; heat transfer; design estimation of net plant heat rate. Power plant economic-cost of generation per kwh. Effect of load factor on cost per kwh. **10 Hrs**

2. **Boilers and Steam Turbine**: Modern boilers and their features, Boiler Inspection Methods. Classification; design of multi stage power plant turbine, Mollier chart, velocity diagrams; governing; instrumentation; lubrication; estimation of specific steam consumption. **9 Hrs**

3. **Design of surface condensers and cooling towers:** Requirements of modern surface condensers, classification of condensers. estimation of size; feed water heaters; mechanical and natural draft cooling towers, use of psychometric chart for evaluation of performance of cooling towers; cooling water treatment different methods. **12 Hrs**

4. **Combined cycle power plant** (STAG): Gas and steam power plant, Nuclear based combined cycle power plant Performance of combined cycle power plants. **8 Hrs**

5. **Cogeneration technology and systems** ; Topping cycle and bottoming cycle plants cogeneration applied to various industry viz. sugar petrochemical, textile, paper etc. Enhancement of plant efficiency, reduction in costs due to cogeneration, case studies. **7 Hrs**

6. **Environmental aspects in power plant & pollution control.** Introduction; Air pollution and control strategieswater pollution and control strategies. Safety features in power plant **6 Hrs**

Reference books:

1. Power Plant Engg. Domkundwar& Arora, DhanpatRai& Sons
2. P.K.Nag, Power plant engineering, 2nd Ed. Tata McGraw Hill, 2002
3. E.E.Khalil , Power design, 2 nd edition, Gorden and Breach Scince publishers Switzerland 1990
4. Principles of energy conversion, Culp Jr. McGraw Hill
5. Power Plant Engg. R.J.Rajput, Laxmi Publications New Delhi
6. Power plant technology, El Wakel M.M McGraw Hill 621.016 E52
7. Steam Turbine Cycles, K.J.Salisbury
8. Steam Turbine Theory & Practice, W.S.Keerton

18PEADL231	Design Engineering lab – 2	(0-0-3)2

Contact Hours: 36

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

1. Introduction to Finite Element analysis.
2. Introduction to Complex models and Dynamic analysis
3. Fabrication and testing of Composite Materials
4. Design of mechanisms and synthesize different models.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:	Mapping to POs (1-5)		
	Substantial Level (3)	Moderate Level (2)	Slight Level (1)

CO-1	Ability to analyze the product by use of FEM software	1,5	2,4	3
CO-2	Identifying the advanced materials and fabricate it.	1	2	3, 4, 5
CO-3	Ability to formulate and analyze Complex models for dynamic analysis	1,4	2,5	3
CO-4	Ability to design, analyze and simulation of Mechanisms	1,4	2	3,5

PO s	PO 1	PO 2	PO 3	PO 4	PO 5
Mapping Level	3	2	1	2.25	1.4

Course contents:
Experiment #1
Structural Analysis
Part A: FE modeling of a stiffened Panel using a commercial preprocessor.
Part B: Buckling, Bending and Modal analysis of stiffened Panels.

Experiment #2
Design Optimization
Part A: Shape Optimization
Part B: Topology Optimization

Experiment #3
Thermal Stress Analysis
Part A: A Thick Walled Cylinder with specified Temperature at inner and outer Surfaces.
Part B: A Thick Walled Cylinder filled with a Fluid at high temperature and Outer Surface exposed to atmosphere.

Experiment #4
CFD Analysis
Part A: CFD Analysis of aerodynamic blade
Part B: Laminar Flow Analyses in a 2-D Duct

Experiment #5
Fracture toughness measurement for advanced materials using experimental and numerical approach.

Experiment #6
Simulation of crank rocker mechanism, crank-crank mechanism, crank rocker mechanism, rocker-rocker mechanism using software

Experiment #7
Static force analysis – four bar mechanism, slider crank mechanism (Analytical And Numerical)

Experiment #8
Natural frequency determination for suspension system using analytically and numerically.

Experiment #9
Dynamic analysis:
Part A: Harmonic Analysis of Cantilever beam
Part B: Dynamic analysis of bar subjected to forcing function

Experiment #10
Corner anglebracket analysis using finite element analysis.

Reference Books:
1. T. R. Chandrupatla and A. D. Belegundu, “Introduction to Finite Elements in Engineering”,
Prentice Hall,Ed, 2002.
2. Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant “Experimental Stress Analysis”,
Tata McGraw Hill, 1984. “Foundations of fluid mechanics”- S. W. Yuan,SI Unit edition,1988
3. V. P. Singh, DhanpatRai and Company Advanced Mechanics ofsolids, L. S. Srinath
“Mechanical Vibrations”, Tata Mc. Graw Hill, 2009.
4. Katsuhiko Ogata “Modern Control Engineering”,5th Edition
5. Derek P. Atherton “Control Engineering: An introduction with the use of Matlab”, Bookboon Publishers.
6. Huei-Huang Lee “Finite Element Simulations with ANSYS Workbench 14” , SDC Publication
7. Finite Element Analysis Using Ansys 11.0 Paperback – 2010 by Srinivas, Datti
8. Introduction to Ansys 16.0 Paperback – Import, 2 Feb 2017 by R.B.Choudary
9. Tadeusz Stolarski, Y. Nakasone,S.Yoshimoto “Engineering Analysis with ANSYS Software”.

18PEADL232	Seminar	(0-0-2)1

Contact Hours: 36

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

1. The latest trends in engineering and research.
2. Presentation skills.
3. Communication skills.
4. Art / techniques of Report preparation.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to Pos (1-5)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Refer to the learning resources, recognize and collect the required information.	2	--	5
CO-2	Describe the usefulness of information and make effective oral presentation using ppt.	2	--	4
CO-3	Compile the information published	2	--	-

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	and prepare a technically sound report.			
CO-4	Justify the technical solutions presented and draw the concluding remarks.	2	4	5

POs	PO 1	PO 2	PO 3	PO 4	PO 5
Mapping Level	-	3	-	1.5	1

Every student has to present a seminar on thrust areas in Mechanical Engineering suitably selecting the topic in consultation with a guide. The seminar will be evaluated by a faculty committee consist two members.

18PEADC300 Experimental Techniques (4-0-0) 4

Contact Hours: 52

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

1. Basic concepts of measurement methods, uncertainty associated with it.
2. Order of the instrument & its response for various inputs.
3. Experimental methods, measurement system application & design.
4. Data acquisition systems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-4)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO 1	Outline the basis of measurement methods and present experimental results by curve fitting / regression techniques.	2,3	--	1
CO 2	Demonstrate the model solving ability for a given measurement system.	3	--	--

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CO 3	Analyze various conventional / optical techniques of temperature measuring systems and explain various methods of humidity measurement.	3	--	--
CO 4	Describe the principles, analysis and applications of Flow and velocity measuring methods.	3	--	--
CO 5	Describe the principles, analysis and applications of speed, torque and air pollution measuring techniques.	3	--	--
CO 6	Identify data converters and describe computer interfacing of digital instrument with data acquisition system.	--	3	4

POs	PO1	PO2	PO3	PO4
Mapping Level	1	3	3	1

Prerequisites: Partial differentiation, Electrical circuits, Mechanical measurements, Fluid mechanics, Basic statistics.

Course Contents:

1. **Introduction**: Basic concepts of measurement methods, uncertainty curve fitting and regression analysis. **7 Hrs**
2. **Modeling and simulation of measurement system**: Lumped analysis first order and second order systems: frequency response and time constant calculation. **7 Hrs**
3. **Temperature Measurement Design**: Construction and analysis of liquid and gas thermometers, resistance thermo meter with wheat stone bridge. Thermoelectric effect. Thermocouples and thermopiles. Analysis of effect of bead size and shielding on time constant. Optical techniques pyrometers radiation thermometers and interferometers. **8 Hrs**
4. **Humidity measurement**: Conventional methods, electrical transducers; Dunmore humidity and microprocessor based dew point instrument. **4 Hrs**
5. **Flow and velocity measurement**: Industrial flow measuring devices positive displacement flow meters, application of Bernoulli's principles – orifice meter, venture meter, pitot tubes, pitot static tubes; Hot – wire anemometer; 2D/3D flow measurement and turbulence measurement. Laser application in flow measurement. Flow visualization techniques. Pressure measurement; analysis of liquid manometer, dynamics of variable area and inclined manometer. Pressure transducers design and analysis. **11 Hrs**
6. **Speed and torque measurement**: Principles and analysis of speed and torque measuring instruments; application in IC engines (Dynamo meter). **4 Hrs**
7. **Air pollution sampling and measurement**: Units for pollution measurement, gas sampling techniques, particulate sampling technique, and gas chromatography.

5 Hrs

8. **Data acquisition systems**: Fundamentals of digital signals and their transmission, A/D and D/A converters basic components of data acquisition system. Computer interfacing of digital instrument and data acquisition system.

6 Hrs

Reference Books:

1. Holman J. P., "Experimental methods for engineers" 8th Ed., McGraw Hill, 2012.
2. Doeblin E. A., "Measurement systems application and design" 4th (S.I.) Ed. McGraw Hill, New York, 1990.
3. B. C. Nakra and K. K. Chaudhary "Instrumentation, measurements and analysis" 4th Ed., TMH, 2005.
4. D. S. Kumar, "Measurement systems application and design", 6th Ed., Metropolitan, 2002.

18PEADE325	Design of Heat Exchanger	(4-0-0) 4

Contact Hours: 52

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

1. Heat exchangers, Basic design parameters and solve Rating and sizing problems.
2. Constructional features of Double Pipe Heat Exchangers, Applications, Design Parameters. Correlations for tube side pressure drop and heat transfer coefficients.
3. Design of shell and heat exchanger and use of Correlations for pressure drop and heat transfer coefficients.
4. Constructional features of Compact Heat Exchangers and their rating and sizing problems.
5. Constructional features of Air-Cooled Heat Exchangers and Furnaces and Combustion Chambers and their rating and sizing problems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-4)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO 1	Compute heat rate and heat transfer area for heat exchanger and evaluate the heat transfer coefficient and pressure drop using the correlations	1	3	--

	in data hand book			
CO 2	Classify double pipe heat exchanger, and evaluate rating and sizing problems	1	--	3
CO 3	Evaluate the rating and sizing of shell and tube heat exchanger using correlations for heat transfer coefficient and pressure drop.	1	3	--
CO 4	Evaluate the heat transfer coefficient, sizing and rating of evaporators and condensers using appropriate correlations in data hand book	1	--	3
CO 5	Apply correlations to evaluate heat transfer coefficient and pressure drop in compact heat exchanger and air cooled heat exchanger	1	3	--
CO 6	Explain constructional features of different furnaces and their applications and methods used for the design of furnace	1	--	--

POs	PO1	PO2	PO3	PO4
Mapping Level	3	-	1.6	-

Prerequisites: Basic heat transfer, use of Heat transfer and hand book

Course Contents:

1. **Classification of Heat exchanger and basic design**: Types of heat exchangers and their applications: Flow arrangements and temperature distributions in transfer type of heat exchangers. Overall heat transfer coefficient: Basic design methods Mean temperature difference Concept: LMTD for parallel flow and counter flow arrangement, correction factor for LMTD for cross flow and multi-pass heat exchangers. Effectiveness-NTU method for heat exchanger design /analysis. **6 Hrs**
2. **Forced convection correlations, pressure drop correlations and pumping power:** Introduction, laminar, turbulent flow through heat exchanger. Tube side pressure drop pressure drop in tube bundles in cross flow, pressure drop in bends and fittings, heat transfer and pumping power relations. **6 Hrs**
3. **Double Pipe Heat Exchangers**: Introduction. Applications, Design Parameters Tube side and shell side film coefficients, fin efficiency, overall heat transfer coefficient, mean temperature difference, available surface area, fin geometry, fin height , number of fins, tube side and shell side pressure drop, calculation procedure for the design/analysis of double pipe heat exchanger. **7 Hrs**

4. **Shell and Tube Heat Exchangers**: Basic components Constructional features. Applications, Correlations for tube side pressure drop and heat transfer coefficients. Pressure drop and heat transfer coefficient correlations for shell side flow. Calculation procedure for Shell and Tube Heat Exchanger. Heat balance equations; LMTD; Reference temperature calculation; evaluation of fluid properties; flow assignments; tube side flow parameters calculations; Shell side heat transfer area calculations:-shell side equivalent diameter, calculation of shell side heat transfer coefficient, evaluation of wall temperature. Evaluation of overall heat transfer coefficient, calculation of surface area, calculation of tube side and shell side pressure drops, specifications of other details as per TEMA standards. **8 Hrs**
5. **Condensers and Evaporators:** Introduction, Shell and Tube Condensers, Steam turbine exhaust Condensers, Plate condensers, Air-cooled condensers, Direct contact condensers, Thermal design of Shell and Tube condensers, condenser for Refrigeration and air-Conditioning, Evaporators for Refrigeration and air-conditioning. **7 Hrs**
6. **Compact Heat Exchangers**: Introduction; Definition of Geometric Terms: Plate fin surface geometries and surface performance data; correlation of heat transfer and friction data; Goodness factor comparisons; specification of rating and sizing problems. **6 Hrs**
7. **Air-Cooled Heat Exchangers**: Air as coolant for industrial processes; Custom-built units; Fin-tube systems for air coolers; Fin-tube bundles; Thermal rating; tube side flow arrangement; cooling air supply by fans; cooling air supply in natural draft towers. **6 Hrs**
8. **Furnaces and Combustion Chambers**: Introduction; Process heaters and boilers; Heat transfer in furnaces: - Heat source; Heat sink; Refractory surfaces; Heat transfer to the sink; Design methods: - Method of Lobo and Evans; Method of Wilson, Lobo and Hottel; the Orrok-Hudson equation; Wohlenberg simplified method. **6 Hrs**

Reference Books:

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

18PEADL328 Internship in Industry/R&D organization (0-0-8) 3

Duration: 4 Weeks

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

1. Skill development
2. Personal development
3. Communication skills
4. Professional skills.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs (1-5)		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO 1	Analyze the process involved in the organization/industry.	--	3	1
CO 2	Relate practical/real time systems knowledge to theoretical concepts.	--	3	
CO 3	Apply engineering design systems to solve practical problems.	--	4	5
CO 4	Analyze the mechanical engineering systems involved in industry/ R&D organization	--	4	1
CO 5	Able to write a technical report and communicate effectively	2	--	--

POs	PO-1	PO-2	PO-3	PO-4	PO-5
Mapping Level	1	3	2	2	1

Contents:

Every student has to undergo internship training in the 3rd semester for 2 weeks in a repented company /Industry. The students have to submit the internship report with the standard format of the department after completion of the internship.

The report will be evaluated by the faculty committee consists of 3 members.

18PEADL329	Project Phase – I	(0-0-15) 15

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

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

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-5)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO 1	Identify, formulate and solve a problem using basic engineering principles.	1,2,3		
CO 2	Recognize the need and able to design and fabricate the machine parts, components of a system that meets particular requirement.	1,2,3		
CO 3	Use the software tools to prepare and analyze models or prototypes and conduct simulation using it.	1,2,3		
CO 4	Use the machine tools to prepare models or prototypes.	1,2,3		
CO 5	Work individually and communicate effectively for completion of projects in time.	1,2,3		

CO 6	Prepare a report based on their project and present the concept using ppt.	1,2,3			

POs	PO-1	PO-2	PO-3	PO-4	PO-5
Mapping Level	3	3	3		

Contents:

The student will take up a project in consultation with a guide of his choice in thrust areas of **Mechanical Engineering**. (In house / outside) This project will be continued as **Phase I** in III semester. The evaluation will be made as per the departmental recommendation and guidelines.

18PEADL425 Project Phase – II (0-0-30) 25

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

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

Course Outcomes (COs):

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

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POs	PO-1	PO-2	PO-3	PO-4	PO-5
Mapping Level	3	3	3	--	--

Contents:

The student will take up a project in consultation with a guide of his choice in thrust areas of **Mechanical Engineering**. (In house / outside) This project will be continued as **Phase II** in IV semester. The evaluation will be made as per the institute/departmental recommendation and guidelines, along with external examiner.

18UMEC304 Machine Drawing (2-0-2) 3

Total Hrs: 39

Course objectives: The objective of this course is to make the student aware of:

1. Importance of making drawings of machine parts as per standards.
2. Detailed drawings of machines parts from assembly drawing and vice versa.
3. Geometrical dimensioning & tolerancing
4. Solid modeling of Screw Jack, Plummer Block, Machine Vise.

Course outcomes:

ID	Description of the course outcome	Mapping to POs (1-12)/PSOs (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Convert the given pictorial views in to orthographic projections of machine parts/objects using drawing conventions	-	1	-
CO-2	Draw or sketch the thread forms & fasteners / draw or sketch the orthographic views of fastener used in fastening two plates.	-	1	-
CO-3	Represent the dimensions on given part with tolerances for fits / and dimensions depicting tolerances for control of geometrical features.	-	1	-
CO-4	Create the parts drawings/assembly drawings in (sectioned) 2D of simple mechanical devices.	-	1	-
CO-5	Create the 3D models of mechanical parts and relevant assembly using the software.	-	5	-

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

Mapping Level	2	-	-	-	2	-	-	-	-	-	-	-	-	-

Pre requisites: Engineering Drawing, Modeling software awareness, Engineering Materials, Elements of Mechanical Engineering.

Course Contents:

1. **Orthographic views (2D):** BIS conventions. Conversion of pictorial views into orthographic projections of **simple machine parts** with and without section. **6Hrs**
2. **Thread forms and threaded fasteners: S**ectional views of threads, ISO Metric (Internal & External), and square threads. Assembly of two plates using Hexagonal headed bolt and nut with washer, simple assembly using stud with nut and washer. **6Hrs**
3. **GD & T:** Part drawings of a press tool representing various geometrical features and their tolerances. **3Hrs**
4. **Couplings (2D) :** Protected type flange coupling assembly. **3Hrs**
5. **Assembly Drawings (2D): A**ssembly drawing of– Screw jack (Bottle type) and simple jig. **12Hrs**
6. **Computer aided 3D modelling: (Solid edge)**
   3D modeling of Screw jack, Plummer block. **9Hrs**

Reference Books:

1. N.D.Bhatt, 'Machine Drawing', 45th edition, Charotar Publishers, 2008
2. K.R.Gopalkrishna, 'Machine Drawing', 22nd Edition, Subhas Publication 2013
3. 'A Primer on Computer Aided Machine Drawing-2007`, VTU, Belgaum
4. Sham Tickoo,N. Siddeshwar, P. Kanniah, V.V.S. Sastri, 'Auto CAD 2006, for engineers and designers', Dream tech 2005, Tata McGraw Hill, 2006.
5. K C John 'Text Book Of Machine Drawing' PHI Learning Pvt Ltd,2009.

18UMEL305 Materials Science & Material Testing Lab (0-0-3) 1.5

Total Hrs: 25

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

1. Diverse activities involved with material science.
2. Basic concepts regarding structure-property-processing relations across all material classes.
3. Formation, properties and significance of the alloys.
4. Modern materials like – Special steels, Super alloys and Composites.
5. Many factors that ultimately determine a material selection for a given application.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Characterize the properties of materials subjected to tension, compression and shear.	1, 4, 9	2	3, 6
CO-2	Determine the impact strength of given specimen.	1, 4, 9	2	3, 6
CO-3	Find the hardness of metals using different methods.	1, 4, 9	2	3, 6
CO-4	Identify the different materials by observing microstructure.	1, 4, 9	3	-
CO-5	Detect cracks and flaws on metals using non-destructive tests.	1, 4, 9	3	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14
Mapping Level	3	2	1.4	3	-	1	-	-	3	-	-	-	-	-

Prerequisites: Engineering physics, chemistry, Strength of materials

Course Contents:

1) Preparation of specimen for metallographic examination of engineering materials and study the microstructure of plain carbon steel, tool steel, gray C.I, SG iron,

Brass, Bronze.

2) Heat treatment: Annealing, normalizing (demonstration only), hardening and tempering of steel & to study their Rockwell hardness.

3) Testing of metals

- Tensile test
- Shear test
- Compression test
- Torsion and bending test
- Izod test
- Charpy test

4) Testing of non-metals like wood composites etc.

5) Experiment on Wear Study.

6) Brinell, Rockwell and Vicker's Hardness tests.

7) Fatigue Test

8) Non-destructive test experiments

(a) Ultrasonic flaw detector,

(b) Magnetic crack detector,

(c) Dye penetrant testing.

18UMEL306	Foundry & Forging Lab	(0-0-3) 1.5

Total Hrs: 25

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

1. Diverse tests involved with materials.
2. Basic concepts regarding structure-property-processing relations across all material classes.
3. Formation, properties and significance of the alloys.
4. Modern materials like – Special steels, Super alloys and Composites.
5. Many factors that ultimately determine a material selection for a given application.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Classify the various foundry sands and prepare the sand suitable for mold making.	1	--	--
CO-2	Conduct tests on foundry sands to determine properties for different ingredient compositions.	1,2	--	--
CO-3	Identify the various foundry tools and operations.	1,2	4	5
CO-4	Illustrate the applications of foundry tools and operations in preparing various patterns and molds.	2,3	--	1
CO-5	Identify the various tools and operations used in forging process.	1,2	--	5
CO-6	Prepare forging models using appropriate tools and operations.	3	9	1,2

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	P 1
Mapping Level	2.6	2.6	3	2	1	--	--	--	2	--	--	--	--	-

Prerequisites: Material Science

Course Contents:

1) Testing of moulding sand and Core sand:

- Compression test, shear test and tensile test
- Permeability test

- Core hardness &Mould hardness tests
- Grain fineness test
- Clay content test

2) **Foundry Practice:** Use of foundry tools and other equipment's. Preparation of moulds (ready to pour) using two boxes, use of split pattern, match plate pattern and Cores.
3) **Forging Models:** Preparing minimum three models involving upsetting, drawing and bending operations.

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18UMEL405	Measurements Lab	(0-0-3) 1.5

Contact Hours: 25

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

1. Importance/need of mechanical measurements and metrology in day to day practical life.
2. Different measurements systems and the errors associated with them.
3. Importance of calibration of measurement instruments.
4. Various Sensors, traducers and strain gauges employed in measuring system.
5. Linear and angular measurements and calibration.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Calibrate various measurement devices like pressure gauge, thermocouple, LVDT, load cell etc.	1	-	3
CO-2	Measure linear dimensions using vernier, micrometer, LVDT etc.	-	1,4,	-
CO-3	Measure angular dimensions using bevel protractor, sine bar etc.	-	1,4	-
CO-4	Measure screw thread parameters by 3-wire method and gear tooth parameters by gear tooth micrometer.	-	1,4	-
CO-5	Use tool maker microscope and profile projector to measure angle, dimensions, profiles, radii of machine components.	-	1,4	-
CO-6	Determine modulus of elasticity using strain gauges.	-	1,4	-

POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	P 1
Mapping Level	2.2	-	1	2	-	-	-	-	-	-	-	-	-	-

Prerequisites: Mechanical measurements and Metrology

Course Contents:

1. Calibration of Pressure Gauge.
2. Calibration of Thermocouple.
3. Calibration of LVDT.

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4. Calibration of Load cell.
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.
6. Measurements using Optical Projector/Tool maker's Microscope.
7. Measurements of angle using Sine Center / Sine bar / bevel protractor.
8. Measurements of alignment using Autocollimator / roller set.
9. Measurements of Screw thread parameters using two wire / three wire method.
10. Measurements of Surface roughness using Taly surf / mechanical Comparator.
11. Measurements of gear tooth profile using gear tooth vernier / gear tooth micrometer.
12. Calibration of a micrometer using slip gauges.
13. Measurement using Optical Flats.
14. Checking of circular components for roundness.
15. Setting the snap gauges for the given tolerance grade and checking the components.
16. Use of ring gauges and plug gauges for inspection of components.

18UMEL406	Thermal Engineering lab - I	(0-0-3) 1.5

Contact Hours: 25

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

1. Different types of oils used in energy conversion devices and their application.
2. Fuel properties such as calorific value, viscosity and flash and fire point.
3. Parameters affecting the Internal Combustion Engine performance and their measurement.
4. Parameters to know performance of Internal Combustion Engine.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO1	Determine flash and fire point using different apparatus	-	1,2	4
CO2	Determine the viscosity of given oil and calorific value of fuel using concerned apparatus	-	1,2	3,4
CO 3	Carryout performance test on Multi cylinder engine	-	1,2	4,9
CO 4	Carry out performance test on VCR engine and 2 stroke petrol engine	1	2	4,9

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

Pre-requisites: Basic thermodynamics, applied thermodynamics, Basic Science, Flow analysis,

Course Contents:

1. Determine the flash point and fire point of a given oil using Cleveland open cup apparatus.
2. Determine the flash point of given oil using Pensky-Martin closed cup apparatus.
3. Determine the flash point of given oil using Abels closed cup apparatus.
4. Determine the viscosity of oil using Red wood viscometer.
5. Determine the viscosity of oil using Say-bolt viscometer.
6. Determine the area of irregular shape using Planimeter.
7. Performance test on four stroke IC engine and Heat balance sheet.
8. Performance test on VCR engine and Heat balance sheet.
9. Performance test on 2 stroke Bajaj engine.

18UMEL407	Introductory Project	(0-0-2) 1

Contact Hours: 13

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

1. Practical significance of projects.
2. Engineering concepts and its application to real world problems.
3. Literature review for engineering problems
4. Existing solutions to engineering problems.

Course outcomes (COs):

ID	Description of the course outcome: At the end of the course the student will be able to:	Mapping to POs (1-12)/PSO (13-14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Perform literature review for given topic	1,2	-	-
CO-2	Identify problem from literature review	1,2	-	-
CO-3	Establish objectives and methodology for the problem defined.	1,2	3,4	-
CO-4	Analyze the existing solution for the identified problem.	1,2	3,4	5,6,7,12, 14
CO-5	Prepare a report and present their findings using PPT.	10	9	8,12

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

Course Contents:

Introductory project is introduced with an objective of understanding and identifying the community expectation in terms of possible Engineering solutions by applying the fundamental knowledge of basic sciences and basic engineering courses. The project shall be engineering oriented in terms of problem definition, related literature survey and existing solutions. The team consisting of 10-12 students shall be asked to identify the problems related to community and try to propose a solution. The faculty members handling the courses for that semester shall guide the students. A committee consisting of minimum 3 faculty members shall evaluate at the end for CIE. There is no SEE for introductory project

18UMEC500 Theory of Machines (3-2-0) 4

Contact Hours: 52

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

student to learn:

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

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

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain working of mechanisms, inversions of kinematic chains with or without relevant sketches and derivations	1	-	-
CO-2	Determine the velocity, accelerations, forces of various members of the mechanisms by graphical or analytical method.	1	2	-
CO-3	Draw cam profiles with relevant calculations	1	-	3
CO-4	Evaluate the various gear parameters with or without derivations, speeds / forces / torques on gears found in gear trains.	1	2	-
CO-5	Calculate the necessary balancing masses for rotary/ reciprocating systems / assess the imbalance.	1	-	-
CO-6	Analyze the effects of gyroscopic couples / forces on vehicles/mechanical systems.	1	2	-

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

erequisites: Nil

Course Contents:

Unit - I

Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions,

QRMs, Intermittent motion mechanisms, straight line motion mechanisms and

Steering mechanisms used in automobiles. **7L+2T Hrs**

Unit - II

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

Force analysis of planar mechanisms: Static force analysis of four bar mechanism and slider crank mechanism, Introduction to Inertia force analysis.

7L+3THrs

Unit - III

Gears: Spur Gears – Terminology, Law of gearing, velocity of sliding, contact ratio, path of contact, arc of contact, interference in gears, minimum number of teeth to avoid interference, comparison between involute and cycloidal profile, helical and bevel gear terminology and applications. Force analysis in spur gear trains.

Gear trains: Types of gear trains, epicyclic gear trains, speed and torques in epicyclic gear trains. **8L+4T Hrs**

Unit - IV

Balancing- Balancing for rotating and reciprocating machines by graphical or analytical method.

Gyroscope: Gyroscopic forces and couples in aero planes, four wheel and two wheel vehicles. **9L+3T Hrs**

Unit - V

Cams: Types of cams and followers, follower motion analysis, Layout of cam profiles for different follower motions. **7L+2T Hrs**

Text Book:

1) S S Rattan, "Theory of Machines", TATA McGraw Hill publishing company Ltd, New Delhi, 3rd edition,2009.

Reference Books:

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

18UMEC501	Design of Machine Elements - II	(3-2-0) 4

Contact Hours: 52

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

1. Different types of engineering materials used in power transmission elements.
2. Concepts of designing various machine elements and also power transmission elements
3. Use of design data handbook and BIS standards.

4. Designing commonly used power transmission elements such as gears, belts, chains and bearings.

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Design helical coil and leaf springs subjected to various conditions of static and fatigue loading.	1,3,	-	10
CO-2	Solve problems on design of curved beams of different cross sections.	1,3	-	10
CO-3	Design spur, helical, bevel and worm gears used for power transmission.	2,3	12	-
CO-4	Design and select various power transmitting machine elements.	2,3	12	-
CO-5	Design and choose suitable bearing based on various loading conditions.	1,3	9,12	10

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

Prerequisites: Strength of materials.

Course Contents:

Unit - I

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

Curved beams: Comparison between straight and curved beams, problems in crane hook and C-clamp (No derivations) – expression for stress.**8 + 2T Hrs**

Unit - II

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

Helical gears: Terminology formative number of teeth, Design of Helical gears Problems. **7+ 4T Hrs**

Unit - III

Bevel gears: Terminology – Final design equations (No derivation) problems.
Worm gears: Terminology Strength equations, Heat dissipation considerations Efficiency, design problems **7 + 2T Hrs**

Unit - IV

Belt & Chain drives: Flat belt: problems – (no derivations) calculations of width & thickness with centrifugal tension. V-Belt: Selection of V – belt. Chain drives: Selection of chains – Power transmitting chains**.**
Clutch drives: Concept of uniform pressure & wear – determination of Torque & Power for single & multi-plate clutches – Cone clutches (no derivation) – problems.
7 + 4T Hrs

Unit - V

Brakes: Band brake for different configurations –Shoe brake- problems. **Bearings:** Journal bearings - Mechanism of Hydrodynamic Lubrication – Heat generated & Heat dissipated, Sommerfeld number, bearing modulus – problems.
Ball bearings: Classification – concept of equivalent load, life determination, problems.
Power Screw: Screw jack design & drawing.
Engine parts: Connecting rod for an IC engine design & drawing.
7 + 4T Hrs

Text Book:

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

Reference Books:

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

Design Data Hand Book:

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

18UMEC502	Turbo Machines	(2-2-0) 3

Contact Hours: 39

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

1. Concepts and construction of turbo machine.
2. Euler’s turbine equation degree of reaction, and terms related to performance of turbo machines.
3. Velocity diagrams for turbines and pumps and compressors and evaluate performance parameters.
4. General mechanisms for flow through passages

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain basic terms and concepts of turbo machines.	-	1	-
CO-2	Derive Euler equation for turbo machines with velocity triangles.	-	1,2	-
CO-3	Analyze different performance parameters and characteristic curves of water turbines	-	1,2	3
CO-4	Explain the effect of exit blade angles on the performance of power absorbing machines and their characteristics.	-	1,2	-
CO-5	Analyze different performance parameters of steam turbines and nozzles.	1,2	-	3

POs/PSOs	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Mapping Level	2.2	2.3	1	-	-	-	-	-	-	-	-	-	-	-

e requisites: Basic Thermodynamics concepts, Fluid Mechanics

ɔurse Contents:

Unit - I

Introduction: Classification of Turbo machines, Positive displacement machines and comparison, Static & stagnation properties- efficiencies of expansion & compression processes, Dimensional analysis concern to turbo machines specific speed and its significance in the design of Turbo machines (with numerical problems). **6L+2T Hrs**

Unit - II

Energy Exchange in a Turbo machine: Euler's equation for a Turbo machine Impulse & Reaction machines- Axial flow and radial flow machines- utilization factor, degree of reaction & efficiencies of Turbo machines significance of blade discharge angle in turbo machines (with numerical problems).

6L+2T Hrs

Unit - III

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

5L+2T Hrs

Unit – IV

Centrifugal Pumps: Main Parts of centrifugal pump, basic terms and definitions,

work done, minimum speed for starting centrifugal pump, Classifications- Performance characteristics of centrifugal pumps. Multistage pumps characteristic curves.

Centrifugal Blowers & Compressors: Centrifugal blower - types- size & speed- vane shape & efficiency- vane shape & stresses- vane shape & characteristics- actual performances characteristics- slip. **6L+1T Hrs**

Unit - V

Flow Through Nozzles & Blade Passages: Steady flow through nozzles- area changes- effect of friction- characteristics of converging- diverging nozzles (with numerical problems).

Steam and gas Turbines: Impulse turbines, Staging - expression for work done in a 2 stage velocity compounded turbine- effect of blade & nozzle losses- Reaction staging- reheat factor- performance characteristics, problems using Mollier's chart & introduction to gas turbines. **7L+2T Hrs**

ext Books:

1) V Kadambi & Manohar Prasad, "Energy conversion". vol 3,Turbomachinery, Tata McGraw Hill, 2008.
2) D. G. *Shepherd*, "Principles of Turbo machinery", The Macmillan Company, 1964.

eference Books:

1) M.S. Govindgouda and Dr,A.M. Nagaraj "Text book of Turbo machines", 5th Edition 2015.
2) B U Pai "Turbo machines" Wiley Publication, 2018.
3) R.K. Bansal "A text book of fluid mechanics and hydraulic machines", Ninth edition, Laxmi publication New Delhi, 2016.
4) Dixon S.L, "Fluid Mechanics & Thermodynamics of Turbo machinery", 5th edition, Elsevier, 2005.

18UMEC503	Renewable Energy Technology	(3-0-0) 3

Contact Hours: 39

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

1. Significance of renewable energy sources in present energy scenario of India.
2. Solar radiation geometry solar incident flux.
3. Working of renewable energy systems.
4. Utilization of renewable energy sources in different modes and applications.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain concepts of non-conventional and renewable energy	1	-	7

	systems.			
CO-2	Compute solar radiation flux and power from wind machines	1	2	3, 6
CO-3	Explain the working principles of solar thermal devices.	1	-	7
CO-4	Discuss the working principles of photovoltaic, wind machines and their characteristics	1	-	7
CO-5	Describe the working of biomass gasification, biogas generation and hydrogen energy production storage with applications.	1	-	6, 7

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

erequisites: Nil

ɔurse Contents:

Unit - I

Introduction: Energy sources, India's production and reserves of commercial energy sources, need for non-conventional energy sources, energy alternatives, solar, thermal, water power, wind, bio-mass, OTEC, tidal and waves, geothermal, nuclear (Brief descriptions).

Solar Radiation & Geometry: Extra-Terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuses and global radiation, solar radiation data. Latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, local apparent time, day length. **8 Hrs**

Unit - II

Solar Radiation on flat and tilted surface: Flux on plane surface, expression for the angle between the incident beam and normal to plane surface (no derivation). Beam, diffuse and reflected radiation, expression for flux on a titled surface (no derivations). Numerical examples**.** Measurement of Solar Radiation: Pyranometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working.

Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters, concentrating collectors (cylindrical, parabolic, paraboloid) sensible heat storage, latent heat storage, General description, collector geometry. **8 Hrs**

Unit - III

Wind Energy: Availability of wind energy in India, Power from wind; Site selection, wind machines; Types of wind machines and their characteristic, horizontal and vertical axis wind mills, elementary design principles; coefficient of performance of wind mill rotor, aerodynamic considerations of wind mill design, numerical examples.
Hydrogen Energy: Production, storage and application. **7 Hrs**

Unit - IV

Energy from biomass: Biochemical route: Biogas generation, factors, types of biogas plants **thermo chemical route**. Updraft, down draft and cross draft gasifier. **7 Hrs**

Unit - V

Applications of Renewable energy technologies: Solar water heating. Space heating and cooling; power generation, and refrigeration, Distillation, solar cooker, solar pond, principle of working, Description, principle of working and characteristics, PV cells and applications (Qualitative). **9 Hrs**

ext Books:

1) S.P.Sukatme 'Solar Energy' – TATA McGraw Hill, 1996
2) S. Rao & Dr B.B Parulekar, Energy Technology, 3rd edition, Khanna Publishers, Delhi, 2007.

eference Books:

1) G.D.Rai "Non-Conventional Energy Sources", 4th edition, Khanna Publishers, New Delhi, 2011.
2) Kreith & Goswami, "Solar Energy", Taylor & Francis, 1999.

18UMEL504	Machine Shop Practice	(0-0-3) 1.5

Contact Hours: 36

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

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

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

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Measure and mark dimensions using suitable instruments.	1	9	3
CO-2	Perform basic turning operations on Lathe	1	9	-
CO-3	Carry out the basic machining operations on milling and shaping machines.	1	-	4
CO-4	Write NC programs to perform machining operation on CNC milling machine.	1	5	3

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

erequisites: Nil

Course Contents:

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

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18UMEL505	Thermal Engineering Lab - II	(0-0-3) 1.5

Contact Hours: 36

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

1. Knowledge of the fluid mechanics and turbo machinery.
2. Fluid flow measuring devices
3. Performance assessment, main and operating characteristics of Turbo machines

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Conduct experiments on flow measuring devices to determine the rate of flow.	-	2	1,3
CO-2	Determine experimentally the different losses in pipe flow.	-	1, 2	3

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CO-3	Conduct experiments on turbines, blowers, pumps and draw characteristic curves.	-	2, 4	1,3,9
CO-4	Calculate force exerted by the jet on vanes.	2	1	-

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

erequisites: Nil

ourse Content:

Measurement of pressure using Manometers (high and low pressure measurements).
Determine the co-efficient of discharge of Venturimeter.
Determine the co-efficient of discharge of Orifice meter.
Determine the co-efficient of discharge of Notch.
Determine the minor losses & major losses.
Impact of Jet.
Performance test on Reciprocating Pump.
Performance test on centrifugal pump (table top).
Performance test on centrifugal pump (high discharge).
Performance test on Pelton turbine.

.. Performance test on Kaplan turbine.
2. Performance test on Francis turbine.
3. Performance test on centrifugal blower.
4. Flow visualization using Wind tunnel.

18UMEL506	**Minor Project - I**	**(0-0-2) 1**

Contact Hours: 26

Course Learning Objectives (CLOs):

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

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:	**Mapping to POs(1-12)/ PSOs (13,14)**		
	Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**

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

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

erequisites: Nil

Minor project – 1 is undertaken to focus on the domain related problem definitions, building prototypes which can lead to take up the project in the higher semester. The work based on the core courses studied shall be used to formulate the problem. The team consisting of 10-12 students shall be asked to identify the problems related to community and try to propose the solution. A faculty members handling one of the courses for that semester shall guide the students. A committee consisting of minimum 3 faculty members shall evaluate at the end for CIE. There is no SEE for minor project-1.

18UHUL507	**Soft Skills / Aptitude**	**(0-0-2) 1**

Contact Hours: 26

Course Learning Objectives (CLOs):

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

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the significance of communication in the profession.	-	10	-
CO-2	Use the English language with proficiency	-	10	12
CO-3	Solve Aptitude related problems	-	9	12
CO-4	Demonstrate the competency in the placement activities.	-	9	-

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

Prerequisites: Nil

Contents:

Training on communication skills, proficiency in English language and aptitude ability involving the internal and external resource.

Soft skills/Aptitude: This is included with an objective of improving the communication skills, proficiency in English language and aptitude ability of the student. This is a credit course and aimed to enhance the employability. Both the internal and external resource persons shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component. The mode of evaluation shall be as per the guidelines by the central authorities.

18UMEE527	**Fundamentals of Automobile Design** (Ready Engineer by TATA Technologies)	(2-0-2) 3

Contact Hours: 39

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

5. Theoretical concepts of automotive industry.
6. Design and development automotive systems.
7. Die and Fixtures Design.
8. Explain Industrial Design and its importance

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the importance of design and styling for Automotive Product Development	1	-	-
CO-2	Apply fundamental concepts on the bonnet design	-	2	-
CO-3	Investigate the concept of FEA and NVH in the process of model creation and analysis.	3	-	-
CO-4	Investigate the Die and fixture	3	-	-

	design process			
CO-5	Discuss on different methods of sheet metals process and its use in automobile.	-	2	-
CO-6	Describe various methods of operations performed on sheet metals fixtures	-	2	-

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

Prerequisites: Nil

ɔurse Contents:

Unit - I

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

Practical sessions:

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

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

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

4L+3P Hrs

Unit - II

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

Updating and Production Release.

Practical sessions:

Session 1: CAD design of a bonnet - 1

Session 2: CAD design of a bonnet – 2

Session 3: Application of CAE simulation on bonnet CAD (air flow, water flow, etc) **4L+3P Hrs**

Unit - III

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

Practical sessions

Session 1: Application of CAE simulation on bonnet CAD (strength & stiffness, debt resistance)
Session 2: Fixture design
Session 3: Assembly& disassembly considerations for components (after sales, service) **4L+3PHrs**

Unit - IV

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

Practical sessions:

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

Session2: Bench marking a bonnet by studying competitor data (2 or 3 examples) **8L+2PHrs**

Unit - V

Die design: Requirements, Sheet metal parts and their operation like Cutting,

Non-cutting etc., Presses, and Various elements used in die design. Function of each element, Different types of dies, working of dies .Real life 3D experience of Die design.

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

Practical sessions:

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

Session 2: Example DFMEA practical 2 - how to analyse risk & define counter measures. **6L+2P Hrs**

Reference Books:

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

18UMEL602	**Computer Aided Engineering Analysis Lab**	**(0-0-3)1.5**

Contact Hours: 36

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

1. Simulation tools.
2. Computer Aided Engineering (CAE)
3. CAM simulation

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:	**Mapping to POs(1-12)/ PSOs (13,14)**		
	Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**

CO-1	Use FEA tool to solve loaded bars and trusses.	-	-	3, 4
CO-2	Analyze the behavior of beams under different loading patterns.	5	-	4
CO-3	Validate stresses in 2D structural and thermal problems.	5	-	3,4
CO-4	Determine the natural frequency of bars and beams.	-	5	3, 4
CO-5	Use CAM simulation packages for tool path generation.	-	-	5

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

Prerequisites: Nil

Course Contents:

PART - A

Study of a FEA package and modeling stress analysis of

1. Bars of constant cross section area, tapered cross section area and stepped bar
2. Trusses – (Minimum 2 exercises)
3. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 4 exercises)

PART - B

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

Reference Books:

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

18UMEL603	Thermal Engineering Lab - III	(0-0-3) 1.5

Contact Hours: 36

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

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

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Determine performance parameters for different modes of heat transfer.	-	1, 2	4, 9
CO-2	Calculate the efficiency of different types of fins.	-	1, 2	4, 9
CO-3	Evaluate heat transfer coefficient related to film & drop wise condensation.	-	1, 2	3, 9
CO-4	Evaluate time and temperature relation for lumped system.	-	1	3, 9
CO-5	Conduct performance test on VCR refrigeration, heat exchanger and air conditioning.	-	1, 2	3

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

Prerequisites: Nil

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

ıta Hand Book:

1) Heat Transfer data hand book by C P Kothandaraman, S Subramanyan, 8th edition, New Age International Publisher Delhi.

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18UMEL604	Minor Project - 2	(0-0-4) 2

Contact Hours: 52

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

5. Practical significance of projects.
6. Engineering concepts and its application to real world problems.
7. Manufacturing problems associated with fabrication.
8. Creativity as an essential component of engineering application.

Course outcomes (COs):

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

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

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Mapping level	3	2.4	3	2	3	1	2	2	2	2.5	2	1.4	3	3

Prerequisites: Nil

ɔurse Contents:

Every student is advised to conduct a mini project covering relevant thrust areas of Mechanical Engineering and to device and analyze the problem in consultation with a faculty guide of his choice. There will be at least 3 presentation phases culminating with a final project presentation to the examiners.

Note: Activities for self-study to be initiated by the guide.

18UHUL605	**Soft Skills/Aptitude**	**(0-0-2) 1**

Contact Hours: 26

Course Learning Objectives (CLOs):

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

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the significance of communication in the profession.	-	10	-
CO-2	Use the English language with proficiency	-	10	12
CO-3	Solve Aptitude related problems	-	9	12
CO-4	Demonstrate the competency in the placement activities.	-	9	-

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

Prerequisites: Nil

ɔurse Contents:

Training on communication skills, proficiency in English language and aptitude ability involving the internal and external resource.

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Soft skills / Aptitude: This is included with an objective of improving the communication skills, proficiency in English language and aptitude ability of the student. This is a credit course and aimed to enhance the employability. Both the internal and external resource persons shall be engaged in imparting the related knowledge and shall have only CIE as the evaluation component as. The mode of evaluation shall be as per the guidelines by the central authorities.

18UMEE624	Internal Combustion Engines	(3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Discuss fuel-air cycles and combustion phenomena in SI engines.	1	2	-
CO-2	Explain air-fuel ratios and combustion phenomena in CI engines.	1	2	-
CO-3	Describe the need for spray pattern in CI engines and working of Electric, Hybrid and Autonomous vehicles	1, 3	2	-
CO-4	Compare effect of alternative fuel properties on the performance of IC engine and fossil fuels.	-	1	-
CO-5	Evaluate emission characteristics and methods used to reduce emission.	1	2, 6	-

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

Prerequisites: Nil

Course Contents:

Unit - I

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

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

7 Hrs

Unit - II

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

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

Unit - III

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

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

Unit - IV

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

Alternative Fuels for an I. C. engine: SI and CI Engine fuels properties. Alternative fuels for SI and CI engine. Performance of SI and CI engine when operated on alternative fuels. Dual fuel engine, factors affecting combustion of

dual fuel engine, Advantages of Dual fuel engine. Homogeneous charged compression ignition engines. **8 Hrs**

Unit - V

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

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

Text Book:

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

Reference Books:

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

18UMEE631	Tool Design Engineering	(3-0-0) 3

Contact Hours: 39

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

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

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

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the basic concepts of press tool principles and parameters.	1	-	-
CO-2	Illustrate the method of locating and clamping of work pieces.	-	1	-
CO-3	Illustrate the working of drill jigs, mould, press tools and milling fixtures.	-	1	-
CO-4	Draw the strip lay out as related to press tools.	-	1	-
CO-5	Design press tools, jigs, fixtures, and moulds with sketches and drawings.	1	3	2
CO-6	Calculate the parameters required for designing the tools.	1	-	-

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

Prerequisites: Nil

Course Contents:

Unit - I

Introduction to tool design: Tooling, requirements of a tool designer, General

tool design procedure, Drafting and Design techniques, Tool Making practice,

Locating and clamping methods: Introduction, Basic principles of location, Locating methods and Locator pins/plugs, Basic principles of clamping, Types of clamps. **7 Hrs**

Unit - II

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

7 Hrs

Unit - III

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

Unit - IV

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

Unit – V

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

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

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

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

Text Book:

1) C. Donaldson, G.H.LeCain, V.C. Goold, “Tool design”, Third Edition, Tata McGraw Hill Pubication.1976.

Reference Books:

1) M H A Kempster, “Introduction to Jig and Tool Design”, ELBS, 1974.
2) J.R. Paquin & R.E. Crowley, “Die Design Fundamentals”, Industrial Inc Press
3) R.G.W. Pye; “Injection Mould Design”, 3rd Edition, Godwin Books, 1983.

18UMEE637	**Advanced Automobile Design** (Ready Engineer by TATA Technologies)	(2-0-2) 3

Contact Hours: 39

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

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

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify requirements, PLM and importance of BIW parts	1	-	-
CO-2	Investigate Design process of BIW and TRIMS parts and the study of different materials and grades	-	2	-
CO-3	Identify Trim materials and its applications Understand various methods involved in Manufacturing of plastic trims	1	-	-
CO-4	Analyse the Design Failure Mode and Effect Analysis (DFMEA) methodology and verification of process	3	4,5,6	2
CO-5	Analyze Noise Vibration and Harshness (NVH) using CAE tool and its importance	3	4,5,6	-
CO-6	Identify different methods of test validation and Assessment of Vehicles	-	-	2

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

Prerequisites: Nil

ɔurse Contents:

Unit - I

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

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

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

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

Practical sessions:

Session 1: Exercise to obtain the outer surface Computer Aided Styling (CAS) of a bonnet based on car style.

Session 2: Writing the Requirement Specification of car bonnet (idea is to provide this as input to source a supplier)

Session 3: Basic introduction to CAD & suitable software (Siemens NX, Catia)

4L+3P Hrs

Unit - II

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

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

Practical sessions:

Session 1: CAD design of a bonnet – 1

Session 2: CAD design of a bonnet - 2

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

4L+3P Hrs

Unit – III

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

GD & T - Simulation of Datums for inspections BIW Examples and case studies.

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

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

Practical sessions:

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

Session 2: Fixture design.

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

4L+3P Hrs

Unit - IV

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

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

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

Practical sessions:

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

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

8L+2P Hrs

Unit - V

DFMEA (Design Failure Mode and Effect Analysis): Concept, Objectives of DFMEA. Overview of DFMEA process, Benefits of DFMEA, Prerequisites of DFMEA, DFMEA Flow, DFMEA team, DFMEA inputs & Outputs, DFMEA Methodology, Logical relationship between DFMEA. DFMEA S/O/D/ rating**.**

Introduction to Design Verification. Concept of Design Verification. Process of

verifying Design. Commonly used verification methods like Demonstration, Inspection, analysis, Similarity, Testing. Preparation of verification activities. Conducting verification activities. Gateway support for Design verification.
CAE methods for Design verification of BIW viz. Structural Analysis, Fatigue life Prediction, Noise and vibration, Crash Impact analysis, Multibody Dynamics, Thermal analysis, CFD. Verification and Validation with respect to FEA
CAE Analysis: NVH, Crash & Durability: Concept of CAE & FEA. NVH Analysis, Load cases for NVH analysis: Static Bending stiffness, Static torsion stiffness, Natural frequency and normal modes, Crashworthiness, Crash Analysis: Full vehicle level: Frontal, Side and rear Impact, Component Level: Seating and roof crush., Durability analysis: Various load cases like Front and Rear Recovery analysis, Trailed towing analysis, Luggage retention hook analysis, Floor pan fatigue, Roof and Body side oil canning, Vehicle jacking analysis, Vehicle hoisting analysis, Fatigue analysis of BIW.
Design of Plastic part: Overview, Wall thickness, Radii, Draft angle, Ribs,
Bosses, Snaps,
Design verification: CAE methods and Gateway supports: Automotive interior trim, Automotive exterior trim, CAE Load cases for Interior Trims: Interior Head impact analysis, Airbag deployment, Side occupant protection, Interior trims durability, Mould flow analysis. Gateway support.
Manufacturing Processes: Vacuum Forming, Injection Moulding, Heat Staking, Extrusion Blow moulding along with their applications characteristics and limitations.
Test Validation & Assessment: Vehicle physical testing, Crash test requirements, Frontal Crash test, Rear and side impact testing, Pedestrian head impact test and roll over. Four post durability tests. Wind tunnel testing
Manufacturing - Sequence (after validation): Welding, Assembly sequence Body shop, Paint Shop, Trim- chassis, Final assembly.
Future Trends in BIW: Energy Storing Body Panels, light Weight Vehicle Technology, Latest Joining Technologies Used in BIW
Practical sessions:
Session 1: Example DFMEA practical 1 - how to analyze risk & define counter measures.
Session 2: Example DFMEA practical's 2 - how to analyze risk & define counter measures. **6L+2P Hrs**

Reference Books:

1) Morello, L., Rosti Rossini, L., Pia, G., & Tonoli, A. (2010). The Automotive Body: Volume I: Components Design (Mechanical Engineering Series). Retrieved from http://www.springer.com/1161---A2
2) Huang, M. (2002). Vehicle crash mechanics. CRC Press.-A2
3) Boljanovic, V. (2004). SHEET METAL FORMING PROCESSES AND DIE DESIGN. A1 and A2
4) Morello, L., Rosti Rossini, L., Pia, G., & Tonoli, A. (2010). The Automotive Body: Volume II: System Design (Mechanical Engineering Series). Retrieved from http://www.springer.com/1161-A2
5) Weber, J. (2009). Automotive development processes: Processes for successful customer oriented vehicle development. Automotive Development

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

18UMEO642	Total Quality Management	(3-0-0)3

Contact Hours: 39

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

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

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	List the basic tools of quality control and experimental design	-	1,2	-
CO-2	Describe scientific techniques and tools of total quality management	1,2	-	-
CO-3	Demonstrate practical knowledge through case studies.	-	2	-
CO-4	Solve engineering problems using experimental design and modern engineering tools	4, 5	1,2	-
CO-5	Interpret control charts to facilitate quality control	1,2	4	-
CO-6	Differentiate between Taguchi and Deming's philosophy of quality	-	1	2

	engineering			

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

Prerequisites: Nil.

Course Contents:

Unit - I

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

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

Unit - II

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

Unit - III

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

Unit - IV

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

Unit - V

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

Text Book:

1) Dale H Besterfield, Carol Besterfield, Glen H Besterfield, Mary Besterfield, "Total Quality Management", 3rd Edition, Pearson Education, 2008.

Reference Books:

1) Douglas C. Montgomery, "Statistical Quality Control", John Wiley & Sons; 7th

Edition edition, 2012.
2) K. Shridhara Bhat, “Total Quality Management Texts cases”, Himalaya Publishing House, 2010.
3) P. L. Jain, “Quality Control and Total Quality Management”, Tata McGraw hill Publishing Co. Ltd., New Delhi, 2001.
4) Shoji Shiba, Alan Graham & David Walden, “A New Amercian TQM – Four Practical Revolutions in Management”, Productivity Press, Portland (USA) 2000.

18UMEO647 Introduction to Scientific programming (3-0-0) 3

Contact Hours: 39

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

1. To improve their ability in solving mathematical problems using Python software
2. To develop skills in handling errors, functions and loops in program, enhance problems solving capability.
3. To emphasize signification of plotting graphs and interpreting the data’s in Python software.
4. To gain knowledge in scientific methods and familiarize with application of differential equation and integration to solve engineering problems.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1,12) / PSO (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Develop program by analyzing problem and handling errors in Python software.	5	1,2	3
CO-2	Use data structures in programming approach.	5	1,2	3
CO-3	Apply function features to develop realistic programs.	5	1,2	3
CO-4	Develop Python Programs using NumPy array and matplotlib for solving problems	5	1,2	3
CO-5	Use various package’s and libraries SciPy, ODEINT to solve a	5	1,2	3

	mathematical problem.			

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

Prerequisites: Nil

ɔurse Contents:

Unit - I

Introducing Python: Working with the Python Interactive, Python Installation, Working with the Python Interpreter, Working with the Python Shell, Simple Python Scripts, Python Syntax Variables Values , Assigning Variables , Reserved Words ,Python Keywords , Variable Assignment and Variable Naming Conventions User Input, Comments. **7 Hrs**

Unit - II

Introduction Numerical Data: Operators, Order of Operations, Arithmetic Operators, Strings String Operations and Methods Indexing, Slicing, String Methods, Working with Strings Escape Sequences , Manipulating Strings, Lists, List Operations ,Working with Lists Booleans Comparison Operators Logical Operators Membership Operators .

Introduction Control Statements: Program Flow, Control Statement, if Statement, working with the if Statement, Loops, The while Statement, Working with the while Statement, The for Loop, The range Function, Nesting Loops, The break Statement, The continue Statement. The pass Statement.

8 Hrs

Unit - III

Functions: Introduction function, Built-In Functions, User-Defined Functions. Calling a Function. Global and Local Variable, Return Using main() Function, Arguments, Required Arguments, Keyword Arguments, Default Arguments, Variable Number of Arguments, Creating a Lambda Function,

Lists and Tuples Introduction: List Syntax, List Methods, Tuple Syntax, Using Indexing, Slicing, Tuple Methods, Dictionaries and Sets Introduction: Working with Dictionaries, Adding Data to a Dictionary, The Basics of Sets.

8 Hrs

Unit - IV

Array Computing and Curve Plotting: Basic array methods, Reading and writing an array to a file, Polynomials, Linear algebra, Matrices, computation with matrix, dot product, cross product, inverse matrix. **Matplotlib:** Introduction, Matplotlib

basics, Contour plots, 3D plots. **8 Hrs**

Unit - V

Differential Equations and Integration: The Simplest Case, ordinary differential equation and partial differential equation, Integration and double integration, initial value problems, optimization. **8 Hrs**

Activity Beyond Syllabus: working with simple real-time application in Python software.

ext Books:

1) Allen B. Downey, “Think Python”, 2nd Edition, O’Reilly Publication, 2015.
2) Christian Hill, “Learning Scientific Programming with Python”, Cambridge University Press, 2015.

eference Books:

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

20PRMIC100	**Research Methodology and IPR**	**(2-0-0) 2**

Contact Hours: 26

Course Learning Objectives (CLOs): The students are expected to learn about the need and types of research, problem formulation, literature review, measurement, scaling, data collection, testing of hypothesis, result interpretation and report writing. Further, the students shall know about the intellectual property rights, copy rights, trademarks, patents, patents filing procedure, infringement & remedies and information technology act etc.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1 to 4)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	**Formulate** the research problem, carryout literature survey and decide the methodology.	-	1	-
CO-2	**Use** measurement and scaling and **carryout** data collection.	-	1	-

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CO-3	**Test** the hypothesis, **interpret** & **analyze** the results and **write** the report.	2	3	-
CO-4	**Explain** the need of IPR, copy right, patents, trademarks, & the filing procedure and know about infringement, remedies and regulatory framework.	-	2	-

POs	PO-1	PO-2	PO-3	PO-4
Mapping Level	2	2.5	2	-

Prerequisites: Nil

Contents:

1) **Research Methodology:** Introduction, meaning of research, objectives of research, motivation in research, types of research, research approaches, significance of research, research methods versus methodology, research and scientific method, importance of knowing how research is done, research process, criteria of good research and problems encountered by researchers in India. **2 Hrs**

   Defining the Research Problem: Research problem, selecting the problem, necessity of defining the problem, technique involved in defining a problem, an illustration. **1 Hrs**

2) **Reviewing the literature:** Importance of the literature review in research, How to review the literature, searching the existing literature, reviewing the selected literature and writing about the literature reviewed. **2 Hrs**

   Research Design: Meaning of research design, need for research design, features of a good design, important concepts relating to research design, different research designs, basic principles of experimental designs, important experimental designs. **3 Hrs**

3) **Measurement and Scaling:** Measurement in research, measurement scales, sources of error in measurement, scaling, meaning of scaling and important scaling techniques **2 Hrs**

   Data Collection: Collection of primary data, observation method, interview method, collection of data through questionnaires, collection of data through schedules, difference between questionnaires and schedules, collection of secondary data. **2 Hrs**

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

hypotheses. **2 Hrs**

5) **Interpretation and Report Writing:** Meaning of interpretation, technique of interpretation, precaution in interpretation, significance of report writing, different steps in writing report, layout of the research report, types of reports, oral presentation and mechanics of writing a research report, precautions for writing research reports, plagiarism and its significance. **3 Hrs**
6) **Introduction to Intellectual Property Rights:** Meaning and conception of IPR, competing, rationale for protection, international conventions, world court. **1 Hrs**

Copy right: Historical evolution of the law on copy right, meaning, content, substance, ownership, primary, special rights, obligations, period, assignment and relinquishment of copy rights. License and application for registration of copy right.

Patents: Meaning of Patent, purpose and policy object of patent law, gains to inventor, application of patents, joint application, discovery and invention, patentable and non-patentable inventions, publications and public use, priority date and its purpose, procedure for obtaining patent. Stages of procedure, refusal to grant patent - consequence, protection period, drafting if claims, grant of patent and significance of date of patent and date of ceiling. Services available with patent office, jurisdiction, appellate authorities, powers and obligations of central government, patent agent and controller – not a civil court. **4 Hrs.**

Industrial design: Concepts & Significance **1 Hrs**

Trademarks: Definitions and conceptions of Trademark, advantages of registration, marks which are not registrable, known and well-known trade marks, application for registration and procedure for registration, procedure and certification of Trademarks. **1 Hrs**

Infringement and Remedies: Meaning of infringement, acts of infringements, suit against infringement and defence against infringement, reliefs and certificate of validity. **1 Hrs**

The information Technology Act: Definitions, certifying authority, meaning of compromise of digital signature, offences and penalties, applicability of IPRs, cybercrimes, adjudicating officer, violation, damages and penalties, Cyber regulation appellate tribunal, World Wide Web and domain names and cyber flying. Self-Study. **1 Hrs**

Text Book:

1) C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques, New Age International, 4th Edition, 2018.

Reference Books:

1) Ranjit Kumar, Research Methodology a step-by-step guide for beginners, SAGE

Publications, 3rd Edition, 2011.
2) Fink A, Conducting Research Literature Reviews: From the Internet to Paper, Sage Publications, 2009.
3) N. K. Acharya, Text book on Intellectual Property Rights, 4th Edition, Asia Law House, Hyderabad.

18UMEE723 Hybrid Vehicle Technology (3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

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

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

Mapping Level	3	2	1	-	-	2	1	-	-	-	-	-	-	-

Prerequisites: Nil

Contents:

Unit - I

Conventional Vehicles: Introduction to conventional internal combustion engines, Basics of vehicle performance, vehicle power source, Power transmission, Fuel economy characteristics of internal combustion engine. **Introduction to Hybrid Electric Vehicles:** History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, Merits and demerits of electric and hybrid vehicles. **8 Hrs**

Unit - II

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

8 Hrs

Unit - III

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

8 Hrs

Unit - IV

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

Unit - V

Sizing the drive system: Matching the electric drive and ICE, Transmission

selection and gear step selection. Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

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

Reference Books:

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

18UMEE724 Computational Fluid Dynamics (3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs (1-12)/PSO (13-14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain the need, advantages and disadvantages and steps involved in CFD.	-	1	-
CO-2	Derive governing equations of fluid flow and explain the scope and applicability of such equations.	--	1,2	-

CO-3	Discretize governing equations of fluid flow using finite difference/finite volume method.	1,2	-	-
CO-4	Explain Maccormach's and SIMPLE Scheme of solving fluid flow problems.	-	1,2	-
CO-5	Solve set of algebraic equation using numerical methods	-	1,2	-

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

Pre requisites: Nil

Contents:

Unit - I

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

7 Hrs

Unit - II

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

8 Hrs

Unit - III

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

CFD techniques: Discretisation of governing equations by FDM, converting governing equations to algebraic equation system, implicit and explicit approaches. **8 Hrs**

Unit - IV

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

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

Unit - V

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

CFD solution analysis: Consistency, stability, convergence, accuracy and efficiency, sources of solution errors, verification and validation. **8 Hrs**

Text Book:

1) Anderson, J. D. Jr., "Computational Fluid Dynamics-The Basics with Applications", McGraw-Hill, New York, 1995.

Reference Books:

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

18UMEO731 Introduction to Aircraft Industry & Aircraft Systems (3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Identify the manufacturing requirements of aircraft industry & global scenario of airline industry.	-	1, 2	-
CO-2	Explain basic components of aircraft and design configurations	-	1	3, 9
CO-3	Discuss different aircraft systems.	1	-	-

CO-4	Analyze principles of flight & its parameters	1,2	3	-
CO-5	Explain basics of flight mechanics.	-	1,2	-

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

Pre requisites: Nil

Contents:

Unit - I

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

8 Hrs

Unit - II

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

8 Hrs

Unit - III

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

8 Hrs

Unit - IV

Basic Principles of Flight: Significance of speed of Sound, Air speed and Ground Speed, Properties of Atmosphere, Bernoulli's Equation, Forces on the

airplane, Airflow over wing section, Pressure Distribution over a wing section, Generation of Lift, Drag, Pitching moments, Types of Drag, Lift curve, Drag Curve, Lift/Drag Ratio Curve, Factors affecting Lift and Drag, Center of Pressure and its effects. Aerofoil Nomenclature, Types of Aerofoil, Wing Section-Aerodynamic Center, Aspect Ratio, Effects of lift, Drag, speed, Air density on drag. **8 Hrs**

Unit - V

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

Text Books:

1) A.C Kermode, “Flight without Formulae”, 10th edition, Pearson Education. 2004.
2) A.C Kermode, “Mechanics of Flight”, 11th edition, Pearson Education, 2009.

Reference Books:

1) Dave Anderson, “Introduction to Flight”, McGraw Hill Education, 6th edition, 2017.
2) Richard S. Shevell, “Fundamentals of Flight”, Pearson, 2nd edition, 1988.

Note: The assignments for Electives could include the following,

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

18UMEO732	Project Management	(3-0-0) 3

Contact Hours: 39

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

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

Course outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:	**Mapping to POs(1-12)/ PSOs (13,14)**		
	Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**

CO-1	Explain various aspects of project management, project stakeholders, project life cycle phases, tools & techniques.	1	11	-
CO-2	Analyze the influence of project organizational structures on project management.	11	-	-
CO-3	Explain the importance of contracting and tendering in project management.	-	11	-
CO-4	Apply PERT & CPM to evaluate project time and cost trade- off.	11	5,14	1, 2
CO-5	Apply the concepts of economics and project finance to estimate project feasibility.	11	14	1

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

Prerequisites: Nil

Contents:

Unit - I

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

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

Unit - II

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

Unit - III

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

selection of contractor sequential steps.

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

Unit - IV

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

Unit - V

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

8 Hrs

Text Book:

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

References Books:

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

18UMEL702	Dynamics Laboratory	(0-0-2) 1

Contact Hours: 26

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Contents:

Part A

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

PART B

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

1. Modeling of crank-rocker, double lever and crank-crank mechanisms using Grashoff's law.
2. Kinematic analysis of slider crank mechanism.- 1 exercise
3. Kinematic analysis of four bar mechanism. - 1 exercise.
4. Static force analysis of slider crank mechanism – 2 exercises.

5. Static force analysis of four bar mechanism – 1 exercise.
6. Dynamic force analysis of slider crank mechanism – 1 exercise.
7. Dynamic force analysis of four bar mechanism – 1 exercise.
8. Modeling of single DOF spring mass system.
9. Modeling of multi DOF spring mass system.

Reference Books:

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

18UMEL703	**Major Project Phase - 1**	**(0-0-4) 2**

Contact Hours: 60

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

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

Course outcomes (COs):

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

CO-5	Prepare a report based on their project and present the concept using ppt.	13, 14	9,10,11	-

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

Prerequisites: Nil

Course Contents:

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

18UMEL704 Internship (4 Weeks) 2

Contact Hours: 4 Weeks

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Contents:

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

18UMEC800 Fluid Power Control (4-0-0) 4

Contact Hours: 52

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

1. Types of Hydraulic power actuators, motors and concepts of circuit design.
2. Maintenance of fluid power systems.
3. Various actuators, valves, control signal processing elements and multi cylinder applications.

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		Mapping to POs(1-12)/ PSOs (13,14)		
		Substantial Level (3)	Moderate Level (2)	Slight Level (1)
CO-1	Explain the construction and working of various positive displacement pumps and hydraulic principles.	-	1, 2	-
CO-2	Discuss different types of actuators and their performance parameters.	-	1, 2	-

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CO-3	Explain various control components used in fluid power systems.	-	1,2	-
CO-4	Design hydraulic circuits with various hydraulic components for mechanical applications.	1	2,3	-
CO-5	Discuss working principles & maintenance procedures of pneumatic & electro pneumatic components and design application circuits.	1	2,3	-

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

Prerequisites: Nil

Contents:

Unit - I

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

The Source of Hydraulic power: Pumping theory, Classification, Principle of working and constructional details of Gear Pump, Vane Pump, Axial and Radial Piston Pumps, Variable displacement Pumps, Power and Efficiency calculations, Pump Selection for hydraulic power transmission. **10 Hrs**

Unit – II

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

10 Hrs

Unit - III

Control Components in fluid power:

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

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

Direction Control Valves: Check valves, types of D.C. Valves : Two way two position, four way three position, four way two position valves, open center, close center tandem center valves, method of actuation of valves, manually operated solenoid operated, pilot operated etc. **10 Hrs**

Unit - IV

Hydraulic Circuit Design and Analysis:

Control of Single and Double -Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Hydraulic circuit for force multiplication, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits.

10 Hrs

Unit - V

Basic Pneumatic control and Electro pneumatics: Physical properties in pneumatics, DC valves, linear and rotary actuators, flow control valves, pneumatic symbols and control element description, Symbols, Impulse operation, Speed control, sequencing of motion, vacuum handling. Introduction, actuating magnets, construction of electromagnet, contactors and switches, relays, limit switch, electro pneumatic circuits, single acting and double acting cylinder control examples.

Maintenance and Troubleshooting: Maintenance need of pneumatic systems, common problems in pneumatic systems, maintenance schedule of pneumatic system, trouble shooting and maintenance tips. **12 Hrs**

Text Book:

1) Anthony Esposito, “Fluid Power with applications”, 7th edition, PHI, 2009.

Reference Books:

1) S. R. Majumdar, “Pneumatic systems”, Tata McGraw Hill New Delhi, 2010.
2) F. Don Norvelle “Fluid Power Technology”, West Publishing Company, Minneapolis, 1995.
3) S. R. Majumdar, “Oil hydraulic systems”, PHI, 2010.

18UMEE834	Tribology and Bearing Design	(3-0-0) 3

Contact Hours: 39

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

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

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Explain laws of fluid flow and different lubrication methods.		1	2
CO-2	Compute power losses and frictional forces in hydrodynamic bearings.	1	2	-
CO-3	Explain different fluid film formation mechanisms in bearings.	-	1	-
CO-4	Analyze pressure distribution around the hydrostatic journal bearing.	1	-	2
CO-5	Discuss different wear mechanisms and advanced bearings and its components.	-	1, 2	-

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

Pre requisites: Nil.

Contents:

Unit - I

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

Unit - II

Hydrodynamic Lubrication: Tower's experiments, Petroff's equation, friction forces, power losses in lightly loaded bearings, mechanism of pressure development in an oil film, numericals on Petroff's equation and oil flow through capillary. **8 Hrs**

Unit - III

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

Unit - IV

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

8 Hrs

Unit - V

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

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

Reference Books:

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

18UMEE837	Industry 4.0 & Artificial Intelligence	(3-0-0) 3

Contact Hours: 39

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

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

Course Outcomes (COs):

Description of the Course Outcome: At the end of the course the student will be able to:		**Mapping to POs(1-12)/ PSOs (13,14)**		
		Substantial Level (3)	**Moderate Level (2)**	**Slight Level (1)**
CO-1	Develop real life IIoT applications using hardware and software.	1	2	-
CO-2	Explain various IIoT Layers and their relative importance.	-	1,2	-
CO-3	Realize the importance of Data Analytics in IIoT	-	1,2	-
CO-4	Identify appropriate representation & algorithm for an AI problem domain.	-	1,2	-
CO-5	Explain various learning techniques to solve AI problems.	-	1,2	-

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

Pre requisites: Nil

Contents:

Unit - I

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

Unit - II

IIoT-Introduction, Industrial IoT: Business Model and Referece Architerture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

Big Data Analytics and Software Defined Networks, Machine Learning and Data Science. **8 Hrs**

Unit - III

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

Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries. **7 Hrs**

Unit - IV

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

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

8 Hrs

Unit - V

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

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

8 Hrs

Reference Books:

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

18UMEL801	**Technical Seminar**	**(0-0-2) 1**

Contact Hours: 26

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Contents:

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

Procedure to conduct technical Seminar:

- All the students are informed to select a topic from the field of their interest from their branch or relevant to their branch and register the topic with the faculty (ies) In charge of Seminar.

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

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

18UMEL802	Major Project Phase - 2	(0-0-12) 7

Contact Hours: 100

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

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

Course outcomes (COs):

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

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

Prerequisites: Nil

Contents:

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

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

Reference materials / Books:

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

HOD - ME

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