B.E. (Mechanical Engineering)
3rd and 4th Semester
Curriculum Structure & Syllabus
2020 – 24 Batch

Semester: III

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration
---	15EMAB231	Calculus & Integral Transforms **(Diploma Students)**	BS	4-0-0	4	4	50	50	100	3 hours
1	15EMAB201	Statistics and Integral Transforms								
2	15EMEF201	Mechanics of Materials	ES	3-1-0	4	5	50	50	100	3 hours
3	15EMEC201	Manufacturing Processes	PSC	4-0-0	4	4	50	50	100	3 hours
4	15EMEC202	Engineering Thermodynamics	PSC	3-0-0	3	3	50	50	100	3 hours
5	19EMEC201	Control Systems	PSC	2-1-0	3	4	50	50	100	3 hours
6	16EMEP201	Manufacturing Processes Lab	PSC	0-0-1	1	2	80	20	100	2 hours
7	19EMEP201	Control Systems Lab	PSC	0-0-2	2	4	80	20	100	2 hours
8	18EMEP203	Machine Drawing Lab	PSC	0-0-1	1	2	80	20	100	2 hours
			TOTAL	**16-2-4**	**22**	**28**				

ISA: In Semester Assessment, **ESA**: End Semester Assessment, **L**: Lecture, **T**: Tutorials, **P**: Practical. **PSC**: Program Specific Core, **BS**: Basic Science, **ES**: Engineering Science,

Semester: IV

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration
---	15EMAB241	Vector Calculus & Differential Equations **(Diploma Students)**	*BS*	*4-0-0*	*4*	*4*	*50*	*50*	*100*	*3 hours*
1	19EMAB206	Numerical Methods and Partial Differential Equations	BS	3-1-0	4	5	50	50	100	3 hours
2	15EMEC203	Fundamentals of Machine Design	PSC	3-1-0	4	5	50	50	100	3 hours
3	15EMEC204	Machines & Mechanisms	PSC	4-0-0	4	4	50	50	100	3 hours
4	15EMEF202	Engineering Materials	ES	4-0-0	4	4	50	50	100	3 hours
5	19EMEC202	Mechatronics	PSC	2-0-0	2	2	50	50	100	3 hours
6	18EMEP201	Manufacturing Processes-II Lab	PSC	0-0-2	2	4	80	20	100	2 hours
7	15EMEP204	Machines & Mechanisms Lab	PSC	0-0-1	1	2	80	20	100	2 hours
8	15EMEP202	Engineering Materials Lab.	PSC	0-0-1	1	2	80	20	100	2 hours
9	19EMEP202	Mechatronics Lab	PSC	0-0-2	2	4	80	20	100	2 hours
			TOTAL	**16-2-6**	**24**	**32**				

ISA: In Semester Assessment, **ESA**: End Semester Assessment, **L**: Lecture, **T**: Tutorials, **P**: Practical. **PSC**: Program Specific Core, **BS**: Basic Science, **ES**: Engineering Science,

III Semester Bachelor of Engineering (Mechanical Engineering)

Curriculum Content

Course Code: 15EMAB201 **Course Title: : Statistics and Integral transforms**

L-T-P: 4-0-0 Credits: 04 Contact Hours: 4 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hours: 50 Examination Duration: 3hrs

Unit – 1

1. Curve fitting and regression 5 Hrs

Introduction to method of least squares, fitting of curves y = a + bx, $y = ab^x$, $y=a + bx +cx^2$, correlation and regression. Applications to civil Engineering problems

2. Probability 8 Hrs

Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule. (no proof) Discrete and continuous random variables- PDF-CDF- Binomial, Poisson and Normal distributions (Problems only).

3. Tests of hypothesis-1 7 Hrs

Sampling, Sampling distribution, Standard error, Null and alternate hypothesis, Type -I and Type- II errors, Level of significance. Confidence limits, testing of hypothesis for single mean and difference of means (large samples). Applications to civil Engineering problems

Unit – 2

4. Tests of hypothesis-2 10 Hrs

t-test (test for single mean, paired t-test), Chi Squared distribution, analysis of variance (one-way and two-way classifications). Case studies of designs of experiments (CRD, RBD). Applications to civil Engineering problems

5. Laplace Transforms 10 Hrs

Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions.
Inverse Transforms- properties- Initial and Final value theorems, examples, Convolution Theorem. Applications to differential equations.

Unit – 3

6. Fourier Series 5 Hrs

Fourier series representation of a function, Even and odd functions, half range series, Practical Harmonic Analysis

7. Fourier Transform 5 Hrs

Exponential Representation of non-periodic functions, Existence of Fourier transforms properties of Fourier Transform: Fourier Sine and Cosine transforms.

Text Books

1 Gupta S C and Kapoor V K, Fundamentals of Mathematical Statistics, 9ed, Sultan Chand & Sons, New Delhi, 2002
2 J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 4th Ed, TATA McGraw-Hill Edition 2007.
3 Kreyszig, E, Advanced Engineering Mathematics, 8ed, John Wiley & sons, 2003.

Reference Books:

1. Kishor S Trivedi, probability and statistics with reliability queuing and computer science applications, PHI, 2000.
2. Miller, Freud and Johnson, Probability and Statistics for Engineering by, 5ed, PHI publications, 2000.
3. Potter M C, Jack Goldberg and Aboufadel E F, Advanced Engineering Mathematics, 3ed, Oxford Indian Edition, 2005.

Curriculum Content

Course Code: 15EMAB231 **Course Title: Calculus and Integral transforms**

L-T-P: 4-0-0 Credits: 04 Contact Hours: 4 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hours: 50 Examination Duration: 3hrs

Unit – 1

1. Differential Calculus 5 Hrs

Differentiation of standard functions of first and higher orders, Taylor's and Maclaurin's series expansion of simple functions for single variable.

2. Integral Calculus 7 Hrs

Evaluation of integrals, properties, Beta and Gamma functions, relation between Beta and Gamma functions simple problems , Approximate integration- Trapezoidal rule, Simpson's 1/3 rule

3. Fourier Series 10 Hrs

Fourier series, Evaluation of Fourier coefficients, Waveform symmetries as related to Fourier co-efficient, Exponential form of the Fourier series, half range Fourier series. Practical Harmonic Analysis.

Unit – 2

4. Fourier Transform 8 Hrs

Exponential Representation of non-periodic signals, Existence of Fourier transforms properties of Fourier Transform: symmetry, scaling, shifting, Fourier transform of Sine and Cosine Convolution theorem.

5. Laplace Transforms 10 Hrs

Definition, transforms of elementary functions- transforms of derivatives and integrals- Properties. Periodic functions, Unit step functions and Unit impulse functions. Inverse Transforms- properties- Initial and final value theorems and examples***;*** Convolution Theorem. Applications to differential equations

Unit – 3

6. Ordinary differential equations of first order 5 Hrs

Introduction, order and degree of equation, Solution of first order first-degree differential equations –variable separable methods, Linear differential equations, Bernoulli's equations, Initial value problems

7. Complex analysis 5 Hrs

Function of complex variables. Limits, continuity and differentiability. Analytic functions, C-R equations in Cartesian and polar forms, construction of Analytic functions (Cartesian and polar forms).

Text Books:

1. Grewal B S, Higher Engineering Mathematics, 38ed, Khanna Publication, New Delhi, 2001
2. Bali and Iyengar, A text book of Engineering Mathematics, 6ed, Laxmi Publications(p) Ltd, New Delhi,2003

Reference Books:

1. Calculus- James Stewart, Early Transcendentals Thomson Books, 5e 2007

Curriculum Content

Course Code: 15EMEF201 **Course Title: Mechanics of Materials**

L-T-P: 3-1-0 Credits: 4 Contact Hrs: 5 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Unit I

1. Stresses and Strains 10 Hrs

Normal and shear stress, bearing stress, strain, deformation, stress-strain diagram, Hooke's law, working stress and factor of safety, analysis of bars of constant and varying sections, principle of super position, Saint-Venant's principle, stresses in composite section, volumetric strain, elastic constants, statically indeterminate structures, thermal stresses.

2. Shear Force and Bending Moment in Beams 5 Hrs

Types of beams, supports and loads, shear force and bending moment diagrams for simply supported, overhanging and cantilever beams subjected to point loads, uniformly distributed load, uniformly varying load and couple.

Unit II

3. Stresses in Beams 5 Hrs

Bending stress, flexure formula, section modulus, bending stresses in beams of different cross sections, economic sections, shear stresses in beams, shear stress across rectangular, I and T sections.

4. Torsion and Buckling 5 Hrs

Torsion of circular shafts, torsional equation, power transmitted by solid and hollow circular shafts. Buckling: Elastic instability, critical load, Euler's equation for columns with different end conditions, Rankine's formula.

5. Compound stresses 5 Hrs

State of stress at a point, transformation of plane stress, principal planes and principal stresses, analytical method for determining principal stresses, maximum shear stress and their planes, Mohr's circle for plane stress.

Unit III

6. Deflection of Beams 5 Hrs

Deflection and slope of a beam, differential equation of the elastic curve, equations for deflection, slope and moment, double integration and Macaulay's method, deflection and slope for simply supported, overhanging and cantilever beams subjected to point loads, uniformly distributed load and couple.

7. Thin and Thick Cylinders 5 Hrs

Thin walled pressure vessels, cylindrical vessels; hoop stress, longitudinal stress and maximum shear stress, change in dimensions of cylinder (diameter, length and volume), spherical vessels, thick cylinders subjected to internal and external pressures (Lame's equation).

Text Books:

1. Andrew Pytel and JaanKiusalaas, Mechanics of Materials, 2nd Edition, Cengage Learning, 2012.
2. R.C. Hibbeler, Mechanics of Materials, 9th Edition, Pearson Education, 2018.

Reference Books:

1. James M. Gere and Barry J. Goodno, Mechanics of Materials, 8th Edition, Nelson Engineering International Edition, 2012.
2. Ferdinand Beer, Jr. E. Russell Johnston, John Dewolf and David Mazurek, Mechanics of Materials, 7th Edition, McGraw-Hill Education, 2014.

Curriculum Content

Course Code: 15EMEC201 **Course Title: Manufacturing Processes**

L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Unit I

1. Introduction to Manufacturing Processes 2 Hrs

Definition of manufacturing, Manufacturing sectors and their significance to the economy of a country, Classification of production processes and systems, Criteria for selection of a process for production, Sustainable manufacturing.

2. Casting & special casting processes 12 Hrs

Casting: Introduction, Green sand molding, Pattern & core making: Pattern types, allowances and materials, Core & core making methods, Molding methods and machines, Principles of gating, Risers and gating ratio. Special Casting Processes: CO2 molding, Shell molding, Investment casting, Die casting, Centrifugal casting processes and Continuous casting process. Melting Furnaces: Crucible furnaces, Electric arc furnaces, Induction furnaces. Defects in castings, Cleaning and fettling operations, Testing methods.

3. Fabrication Processes 6 Hrs

Classification of joining processes, Soldering, Brazing, Mechanical fastening, Welding, Preparation of base metal and joint. Arc welding, Gas welding, TIG, MIG, FCAW, Thermit welding, Spot, seam and projection welding, Ultrasonic welding, Electron beam welding and Laser welding.

Unit II

4. Machine Tool Operations 5 Hrs

Principles of metal cutting, Introduction to Lathes, Drilling and Milling machines, Constructional features, Operations, Machining time calculations. Grinding, Super finishing, Honing and Lapping methods; Constructional features, Operations and types.

5. Mechanics of Machining 10 Hrs

Geometry of cutting tools, Cutting tool materials, Mechanism of chip formation, Merchant's circle diagram, Velocity and force relationships, Cutting fluids, Thermal aspects of machining, Types of tool wear & wear mechanisms, Tool life, Machinability & its criteria, Numerical on force analysis and tool life.

6. Forming Processes 5 Hrs

Bulk deformation processes: Forging, Rolling, Extrusion and Drawing. Sheet metal working processes, Selection of equipment, Numerical on die design.

Unit III

7. Advanced Manufacturing Processes 5 Hrs

Non-traditional Machining Processes: Mechanical, Thermal, Electrochemical and Chemical machining processes. Micro-machining and Additive manufacturing.

7. Digital Manufacturing 5 Hrs

Introduction to Digital Manufacturing & Design, Digital Thread: Components & Implementation, Advanced Manufacturing Process Analysis, Intelligent Machining, Advanced Manufacturing Enterprise, Cyber Security in Manufacturing, Model-Based Systems Engineering, Roadmap to Industry 4.0.

Text Books:

1. Kalpakjian S., and Schmid S.R., Manufacturing Engineering & Technology, 7th edition, Pearson Education, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing, 5th edition, John Wiley & Sons, 2012.

Reference Books:

1. Juneja B. L. and Sekhon G. S., Fundamentals of Metal Cutting and Machine Tools, 3rd edition, New Age International Limited, 2008.
2. Rosenthal, P., Heine L., Principles of Metal Casting, Tata McGraw Hill, 1997.
3. John A. Schey, Introduction to Manufacturing Processes, 3rd edition, Tata McGraw Hill, 1999.
4. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th edition, Prentice Hall, 2014.
5. Pandey P. C. and Shan H. S., Modern Machining Processes, 1st edition, Tata McGraw Hill, 2013.
6. Rao P. N., Manufacturing Technology: Volume-1, 3rd edition, Tata McGraw Hill, 2008.
7. Rao P. N., Manufacturing Technology: Volume-2, 3rd edition, Tata McGraw Hill, 2013.
8. Ustundag Alp, and Cevikcan Emre, Industry 4.0: Managing the Digital Transformation, Springer series in Advanced Manufacturing, 2018.

B.E. (Mechanical Engineering) Curriculum structure & Syllabus 2020 – 24 Batch

Curriculum Content

Course Code: 15EMEC202 **Course Title: Engineering Thermodynamics**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Introduction 7 Hrs

Basic concepts, Zeroth law, 1st law of thermodynamics applied to non flow system and flow system, Thermodynamic processes.

2. Second Law of Thermodynamics 8 Hrs

Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficient of performance. Classical statements of second law of thermodynamics, PMM I and PMM II, factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot theorem, thermodynamic temperature scale.

Unit II

3. Entropy 6 Hrs

Entropy a property of a system, Clausius theorem and Clausius inequality, Principle of increase of entropy, calculation of entropy change during various processes, Tds relations, Exergy and energy, Exergy analysis.

4. Gas and Vapor Power Cycles 9 Hrs

Gas power cycles: Otto, Diesel, Dual and Stirling cycles, expression for mean effective pressure and cycle efficiency, comparison of Otto, Diesel and Dual cycles. Vapor power cycle: Carnot cycle, work done and cycle efficiency, draw backs, ideal and actual Rankine cycle, network done, cycle efficiency and work ratio.

Unit III

5. Reciprocating air compressor 5 Hrs

Classification, work done in single stage and multi stage compressor, intercooling, efficiencies of air compressor, condition for minimum work, numerical on single and multistage compressor.

6. Refrigeration 5 Hrs

Vapor compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP. Refrigerants and their desirable properties:. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle. Vapor absorption refrigeration system.

Text Books:

1. Michael J Moran & Howard N Shapiro, Fundamentals of engineering thermodynamics, 9th Edition, Wiley Stud, 2018.
2. Yunus A. Cengel, Michael A. Boles, Mehmet Kanoglu, Thermodynamics an Engineering approach, 9th Edition, Tata McGraw, 2019

Reference Books:

1. Jean-Paul Duroudier, Thermodynamics, 1st Edition, ISTE Press - Elsevier, 2016.
2. Yousef Haseli, Entropy Analysis in Thermal Engineering system, 1st Edition, Academic Press, 2019.

Curriculum Content

Course Code: 19EMEC201 **Course Title: Control Systems**

L-T-P: 2-1-0	Credits: 3	Contact Hrs: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 30		Exam Duration: 3 hrs

Unit – 1

1. Introduction to Control System 3 hrs

Generalized configurations and functional description of control systems. Control system design. Examples of Control System. Introduction to Linear, Nonlinear, Time Variant and Time Invariant systems.

2. Modeling of Physical Systems: 8 hrs

Introduction, Differential equations of physical systems, The Laplace Transform, Order of system; The transfer function of linear and rotational Mechanical systems, Gear Train, Electrical systems, Electro-mechanical System, Thermal systems, Hydraulic System; Block representation of system elements and Reduction of block diagrams.

Unit – 2

3. System Response 6 hrs

Introduction, Poles, Zeros, and System Response. First-order system response to step, ramp and impulse inputs. Second-order system response to step input; Un-damped, Under damped, Critical damped and Over damped systems, Time response specifications. Design of 1st and 2nd order system.

4. System Stability 5 hrs

Introduction to stability. Stability analysis by time response, S-plane and Routh-Hurwitz Criterion. Effect of gain adjustment, addition of pole and addition of zero on system response and system stability. Defining the Root locus, General rules for constructing root loci, Sketching the Root locus.

Unit – 3

5. Frequency Domain Analysis 4 hrs

Nyquist stability criteria, Bode Plots. Stability analysis using bode plots.

6. Control Action 4 hrs

Introduction to PID controller design. Types of Controllers, Mathematical modeling of PID, ON-OFF controller, Effect of Proportional, Derivative and Integral elements on system behavior, Design of Controller for given simple applications. Controller Design using root locus.

Text Book:

1. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 12th edition, Addison Wesley
2. A. Anandkumar, Control Systems, 2nd edition, PHI Learning Private Limited, 2014.

Reference Book:

1. Katsuhiko Ogata, Modern Control Engineering, 5th edition, Pearson Publications.
2. Norman S. Nise, Control. Systems, 6th edition, John Wiley & Sons

Curriculum Content

Course Code: 16EMEP201 **Course Title: Manufacturing Processes Lab**

L-T-P: 0-0-1	Credits: 1	Contact Hrs: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 26		Exam Duration: 2 hrs

Content

Lab Exercises

1. Machining practices involving machining time calculation and estimation of machining cost for the jobs for turning, taper turning, threading, knurling.	6 Hrs
2. To manufacture and assemble parts for ball valve which involves turning, milling, tapping/slot milling, etc.	14 Hrs
3. Design, Modeling and Analysis of Bulk deformation and Sheet Metal forming processes.	4 Hrs
4. Demonstration of CNC machines and Non-traditional machines such as laser cutting, plasma cutting, electro-discharge machine.	2 Hrs

Text Books:

1. Kalpakjian S., and Schmid S.R., Manufacturing Engineering & Technology, 7th edition, Pearson Education, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing, 5th edition, John Wiley & Sons, 2012.

Reference Books:

1. Juneja B. L. and Sekhon G. S., Fundamentals of Metal Cutting and Machine Tools, 3rd edition, New Age International Limited, 2008.
2. Rosenthal, P., Heine L., Principles of Metal Casting, Tata McGraw Hill, 1997.
3. John A. Schey, Introduction to Manufacturing Processes, 3rd edition, Tata McGraw Hill, 1999.
4. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th edition, Prentice Hall, 2014.
5. Pandey P. C. and Shan H. S., Modern Machining Processes, 1st edition, Tata McGraw Hill, 2013.

Curriculum Content

Course Code: 19EMEP201 **Course Title: Control Systems Lab**

L-T-P: 0-0-2 Credits: 2 Contact Hrs: 4 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 48 Exam Duration: 2 hrs

Experiment Number	Experiments	No of sessions
01	Scaffolding exercises to explore MATLAB / Simulink software package.	04
02	Modelling of physical systems and its response analysis	06
03	Design and investigate the effects of various controllers on a system.	03
04	Comparative study of Time response, root locus and Bode plot with respect to stability.	02
05	Control system analysis: Case Studies ✓ Hydraulic Lift ✓ DC servo motor	06
06	Case Study (Open Ended)	03

Text Book:

1. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 12th edition, Addison Wesley
2. A. Anandkumar, Control Systems, 2nd edition, PHI Learning Private Limited, 2014.

Reference Book:

1. Katsuhiko Ogata, Modern Control Engineering, 5th edition, Pearson Publications.
2. Norman S. Nise, Control. Systems, 6th edition, John Wiley & Sons.
3. Data sheets provided by manufactures.

Curriculum Content

Course Code: 18EMEP203		**Course Title: Machine Drawing Lab**
L-T-P: 0-0-1	Credits: 1	Contact Hrs: 2 hrs/week
ISA Marks: 80	ESA Marks:20	Total Marks: 100
Teaching Hrs: 26		Exam Duration: 2 hrs

Laboratory Content

1. Sectional views 8 Hrs

Sectional views of machine parts involving half section, full section, offset section, revolved section and local section (use 1st and 3rd angle of projection).

2. Threaded Fasteners 6 Hrs

Drawing of bolts, nuts, screws and their conventional representation.

3. Part and Assembly Drawing 8 Hrs

Drawing of part and assembly drawing of machines such as:
(1) Screw Jack. (2) Protected type flanged coupling. (3) Pipe vice. (4) Clapper box. (5) Non-return valve. (6)Universal coupling. (7) Pin and cotter joints.

4. Assembly Drawing using CAD tool 4 Hrs

Assembly drawing of machines such as:
(1) Screw Jack. (2) Protected type flanged coupling. (3) Pipe vice. (4) Clapper box. (5) Non-return valve. (6)Universal coupling. (7) Pin and cotter joints.

Text Books:

1. Machine Drawing by K. R. Gopalakrishna, Subhas Publications, 22nd Edition - 2013.
2. Machine Drawing by N. D. Bhat & V. M. Panchal, Charotar Publishing House.
3. A Text Book of Computer Aided Machine Drawing, S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007 Edition.

Reference Books:

1. Engineering drawing practice for schools and colleges SP 46:2003 (BIS).

IV Semester Bachelor of Engineering (Mechanical Engineering)

Curriculum Content

Course Code: 19EMAB206 **Course Title: Numerical methods and Partial differential equations**

L-T-P: 3-1-0	Credits: 04	Contact Hours: 65
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 40		Examination Duration: 3hrs

Unit - 1

1. Interpolation techniques 8 Hrs

Finite differences, Forward, Backward and central difference operators. Newton Gregory forward and backward interpolation formulae. Sterling's and Bessel's formulae for central difference, Newton's divided difference formula for un equal intervals. Heat transfer problem, gas law problem-shear stress problem-using interpolation.

Python: Interpolation problems related to Mechanical engineering

2. Matrices and System of linear equations 7 Hrs

Introduction to system of linear equations, Rank of a matrix by elementary row transformations. Consistency of system of linear equations, solution of system by Direct methods-Gauss elimination, Gauss Jordon method. Solution of homogenous system AX=0, Eigenvalues and Eigenvectors of a matrix.

Python: Matrices, system of linear equations by Gauss elimination, Gauss Jordon and eigenvalue problems

Unit - 2

3. Numerical solution of linear equations 5 Hrs

Solution of system of equations by Iterative methods- Guass-Seidal method. Largest Eigenvalue and the corresponding Eigenvector by power method. Spring mass system Falling parachutist using system of equations.

Python: Application problems on mechanical engineering

4. Partial differential equations 10 Hrs

Introduction, classification of PDE, Formation of PDE, Solution of equation of the type Pp + Qq = R, Solution of partial differential equation by direct integration methods, method of separation of variables. Modeling: Vibration of one-dimensional string-wave equation and heat equation. Laplace equation. Solution by method of separation of variables.

Python: Solution of Partial differential equations

Unit – 3

5. Finite difference method. 10 Hrs

(a) Finite difference approximations to derivatives, finite difference solution of parabolic PDE explicit and Crank-Nicholson implicit methods. Engineering Problems: Temperature distribution in a heated plate

(b) Hyperbolic PDE-explicit method, Elliptic PDE-initial-boundary value problems. Vibration of a stretched string, steady-state heat flow.

Python: Finite difference solution of Partial differential equations.

Text Books

1. Kreyszig E., Advanced Engineering Mathematics, 8ed, John Wiley & sons, 2003.
2. Potter M C, Jack Goldberg and Aboufadel E F, Advanced Engineering Mathematics, 3ed, Oxford Indian Edition, 2005.
3. Grewal B S, Higher Engineering Mathematics, 38ed, TATA McGraw-Hill, 2001.

Reference Books:

1. Burden R L and Douglas Faires J, Numerical Analysis, 7ed, Thomson publishers, 2006.
2. Simmons G F and Krantz S G, Differential Equations, TATA McGraw-Hill, 2007.
3. Sastry S S, Introductory method for numerical analysis, 3ed, PHI, 2003
4. Chapra S C and Canale R P, Numerical methods for Engineers, 5ed, TATA McGraw-Hill, 2007.

Curriculum Content

Course Code: 15EMAB241	**Course Title:**	**Vector Calculus and Differential equations**
L-T-P: 4-0-0	Credits: 4	Contact Hours: 4 hrs/week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hours: 50		Examination Duration: 3hrs

Unit - 1

1. Vector Algebra 6 Hrs

Vectors, Vector addition, multiplication (Dot and Cross products), Triple products, Vector functions, Vector differentiation, Velocity and Acceleration of a vector point function

2 Partial differentiation 7 Hrs

Function of several variables, Partial derivatives, Chain rule, Errors and approximations

3 Multiple integrals 7 Hrs

Double integral, Evaluation by change of order, change of variables, simple problems, Triple integrals simple problems

Unit - 2

4 Vector Calculus 13 Hrs

Vector fields, Gradient and directional derivatives, Line and Surface integrals. Independence of path and potential functions. Green's theorem, Divergence of vector field, Divergence theorem, Curl of vector field. Stokes theorem

4 Differential equations of second order 7 Hrs

Differential equations of second and higher orders with constant coefficients, method of variation of parameters.

Unit – 3

6 Partial differential equations 10 Hrs

(a) Introduction, classification of PDE, Formation of PDE, Solution of equation of the type Pp + Qq = R, Solution of partial differential equation by direct integration methods, method of separation of variables.

(b) **Modeling**: Vibration of one-dimensional string-wave equation and heat equation. Laplace equation. Solution by separation of variables method

Text Books

1. Grewal B S, Higher Engineering Mathematics, 38ed, Khanna Publication, New Delhi, 2001
2. Bali and Iyengar, A text book of Engineering Mathematics, 6ed, Laxmi Publications(p) Ltd, New Delhi,2003

Reference Books:

1. Early Transcendentals Calculus- James Stewart, Thomson Books, 5e 2007

Curriculum Content

Course Code: 15EMEC203 | **Course Title: Fundamentals of Machine Design**

L-T-P: 3-1-0 | Credits: 4 | Contact Hrs: 5 hrs/week

ISA Marks: 50 | ESA Marks: 50 | Total Marks: 100

Teaching Hrs: 40 | Exam Duration: 03

Unit I

1. Introduction to Machine Design 4 Hrs

Machine Design, Basic Procedure of Machine Design, Design of Machine elements, Traditional design methods, Design synthesis, Use of Standards in Design, Selection of prepared sizes, Aesthetic considerations in design, Ergonomic considerations in design, Concurrent Engineering.

2. Design against Static Load 6 Hrs

Modes of failure, factor of safety, eccentric axial loading, design of machine parts, Stress Concentration, Stress Concentration Factors, Reduction of Stress Concentration. Theories of Elastic failure, Maximum Principal Stress Theory, Maximum Shear Stress Theory, Distortion-Energy Theory, Selection and use of failure Theories.

3. Design against Reversing load 5 Hrs

Fluctuating Stresses, Fatigue Failure, Endurance Limit, Low cycle, and High Cycle Fatigue, Notch Sensitivity, Endurance Limit- Approximate Estimation, Reversed Stresses-Design for Finite and Infinite Life

Unit II

4. Design against Fluctuating load 4 Hrs

Cumulative Damage in Fatigue, Soderberg and Goodman equations. Fatigue design under combined stresses. Impact Stresses.

5. Design of Belt Drives 5 Hrs

Introduction to Belt drives, Materials for Belts, Advantages, and disadvantages of V belts over flat belt drives, Dimensions of standard V grooved pulley, Power transmission, Number of belts, Centre distance, Pitch length of the belt, Ratio of driving tensions, Design procedure of V belts.

6. Shafts and Keys 7 Hrs

Transmission Shafts, Shaft Design on Strength Basis, Shaft Design on Torsional rigidity Basis, ASME Code for shaft design, Design of Shafts subjected to combined bending and twisting. Keys, Saddle and Sunk keys, Design of square and flat Key.

Unit III

7. Temporary Joints 5 Hrs

Bolted joint –simple analysis, eccentric load perpendicular to the axis of the bolt, eccentric load parallel to the axis of bolt

8. Permanent Joints 5 Hrs

Welded Joints, Strength of Butt Welds, Strength of Parallel fillet Welds, Strength of Transverse Fillet Welds, Eccentric Loaded welded joints, Riveted Joints, Types of riveted joints, Types of failures, Design of butt and lap joints for Boilers.

Text Books:

1. V.B. Bhandari, Design of Machine Elements, Fourth Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2017.

Reference Books:

1. T. Krishna Rao, Design of Machine Elements (Volume I), Second Edition, I K International Publishing House Pvt. Ltd., New Delhi, 2015.
2. Farazdak Haideri, Mechanical Engineering Design (Volume I), Second Edition, Nirali Prakashan, Pune, 2012.
3. K. Mahadevan and Balaveera Reddy, Design Data Hand Book, CBS Publication, Fourth Edition. 2016.

Curriculum Content

Course Code: 15EMEC204 **Course Title: Machines & Mechanisms**

L-T-P: 4-0-0	Credits: 4	Contact Hrs.: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs.: 50		Exam Duration: 3 hrs.

Unit I

1. Kinematics Fundamentals 10 Hrs

Links, pairs, mechanisms, machines, structure, and inversions. Identifying types of links, pairs, drawing kinematic diagram and finding mobility of linkages. Inversions of four bar mechanism, single slider crank mechanism, and double slider crank mechanism. Steering gear mechanisms, Intermediate motion mechanisms, Hook's joint analysis with examples.

2. Kinematic Analysis of Mechanisms 10 Hrs

Locating instantaneous centers for simple mechanisms. Velocity and Acceleration of four bar mechanisms, slider crank mechanisms by relative velocity method. Velocity and acceleration analysis of four bar mechanism and slider crank mechanism by complex algebra method. Numericals.

Unit II

3. Static and Dynamic analysis of Mechanisms 8 Hrs

Static force analysis of four bar mechanisms, slider cranks mechanisms. Inertia forces and torque, inertia forces on engine mechanism, TMD for different machines. Fluctuation of energy, design of flywheel. Numericals.

4. Kinematic analysis of Gear and Gear Trains 6 Hrs

Classification and terminology of gears, Involutometry, backlash in gears, Law of gearing, velocity of siding, length of path of contact, arc of contact, contact ratio, Numericals. Different types of gear trains, Numericals on Epicyclic gear train.

5. Balancing of masses 6 Hrs

Necessity of balancing, Static and Dynamic balancing, Balancing of revolving masses in single and multiple planes. Balancing of reciprocating masses, Balancing of multi cylinder inline engine. Numericals.

Unit III

6. Cams 5 Hrs

Introduction, classification of followers and cams. Construction of Displacement diagrams, velocity and acceleration diagrams with designing the cam profile for disc cam and roller follower combination for the following cases: Simple Harmonic Motion (SHM), Uniform Acceleration and Retardation , Numericals.

7. Gyroscope 5 Hrs

Gyroscopic couple and precessional motion, effect of gyroscopic couple on airplane and ship during steering and rolling. Stability of two wheels and four wheel drives taking turn. Numericals

Text Books:

1. R. L. Norton, Kinematics and Dynamics of Machinery, 2nd ed, Tata McGraw Hill, New Delhi.
2. David Myszka, Machines and Mechanisms- Applied Kinematic Analysis, 3rd ed, PHI, New Delhi.

Reference Books:

1. John Uicker , Gordon Pennock , Joseph Shigley, Theory of Machines and Mechanisms, 4th ed, Oxford University Press-NEW DELHI.
2. S. S. Rattan, Theory of Machines, 2nd ed, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Curriculum Content

Course Code: 15EMEF202 **Course Title: Engineering Materials**

L-T-P : 4-0-0 Credits:4 Contact Hrs: 4hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 50 Exam Duration: 03hrs

Unit I

1. Introduction 5 Hrs

An overview of materials science and engineering, classes of engineering materials, functional and advanced materials, Materials history and character, Design-limiting properties, Material property charts, Matching materials to design, Selection strategy-translation, screening, ranking and documentation.

2: Structures of Metals and ceramics: 5 Hrs

Macro-Micro-Nano: The scale of structures, Crystal Structures- BCC, FCC, HCP structures; coordination number, atomic packing factor, Imperfections in solids and their roles in affecting the behavior of materials., Plastic deformation of single crystal by slip and twinning, dislocation theory.

3: Mechanical Behavior of materials: 10 Hrs

Stress-strain diagrams to show ductile and brittle behavior of materials, linear and nonlinear elastic behavior of materials, mechanical properties in elastic and plastic range, Effect of strain rate and temperature on tensile properties, **Fatigue**: Types of fatigue loading with example, mechanism of fatigue, fatigue properties, fatigue testing and SN diagram; **Creep**: Description of phenomenon with examples, stages of creep, creep properties, stress relaxation; **Fracture**: Failure of engineering materials.

Unit II

4: Solidification and phase diagrams: 7 Hrs

Mechanism of solidification, Homogeneous and heterogeneous nucleation, crystal growth, cast metal structures, Solid solutions, Hume Rothery rules, substitutional and interstitial solid solutions, intermediate phases, Gibbs phase rule, construction of equilibrium diagrams, equilibrium diagrams involving complete and partial solubility, lever rule, Iron carbon equilibrium diagram, description of phases, solidification of steels and cast irons, invariant reactions, Numericals.

5: Ferrous and Nonferrous materials: 7 Hrs

Properties, composition and uses of cast irons and steels, AISI and BIS designation of steels. Aluminum, Magnesium and Titanium alloys.

6: Heat treatment of metals: 6 Hrs

Objectives, Annealing and its types, normalizing, hardening, tempering, austempering, martempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening; Age hardening of Aluminum -Copper alloys. Time-temperature-transformation (TTT) curves, continuous cooling curves.

Unit III

7: Ceramic and Polymer Materials: 5 Hrs

An overview of ceramic materials, mechanical and thermal properties of ceramics, An overview of polymeric materials, thermoplastics and thermosets, elastomers, engineering applications of ceramic and polymer materials.

8: Advanced materials: 5 Hrs

The need for advanced materials; Composite materials- classification, types of matrix materials and reinforcements, fundamentals of production of FRP's and MMC's, applications of composites, Smart materials, Nano materials and Exotic alloys.

Text Books:

1. William Callister, Materials Science and Engineering, John Wiley & Sons. Inc., 10th Edition, January 2018 (ISBN: 978-1-119-40549-8).
2. Michael Ashby and D R H Jones, Engineering Materials: An Introduction to Properties, Applications and Design- 5th Edition, Butterworth-Heinemann, December 2018.

Reference Books:

1. Donald Askeland and Pradeep Phule, The Science and Engineering of Materials Thompson Learning, 7th Edition, CENGAGE Learning, 2019.
2. George Murray, Charles V. White, Wolfgang Weise, Introduction to Engineering Materials, 2nd Edition, CRC Press, 07-Sep-2007

Curriculum Content

Course Code: 19EMEC202		**Course Title: Mechatronics**
L-T-P: 2-0-0	Credits: 2	Contact Hrs: 2 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 30		Exam Duration: 3 hrs

Unit – 1

1. Introduction to Mechatronics: Definition & overview of Mechatronics, Key elements, Real time Simulation, Mechatronics Design approach, examples of mechatronic systems. 3 hrs

2. Signal conditioning: Introduction, Amplification, Filtering, Isolation and Protection, Linearization, Multiplexing, De-multiplexing Encoder, Decoder, ADC and DAC Process; Data Acquisition System (DAQ). 4 hrs

3. Sensors and transducers: Introduction, Motion measurement – Displacement, Position, Velocity, Acceleration and proximity measurements. Temperature, Force, Torque and Power measurement, Pressure and Flow rate measurement. 4 hrs

Unit – 2

4. Basics of Computational systems: Latch, Flip Flop(SR, JK, D, T), Registers, Counters; Analog and Digital circuits for Computational system realization, Memory Hierarchy, Typical working of a Digital Computational system, Fundamentals of Micro-controller/ Microprocessor and FPGA: Timer, Counter, interrupts; Different Architectures. 6 hrs

5. PLC and its programming: Introduction, PLC hardware and its architecture, Basics of ladder diagram, Concepts of Latching, interlocking, timer and counter. Applications. 5 hrs

Unit – 3

6. Electro-Mechanical Actuators : Relay, Solenoid, DC motor, Stepper motor, AC and DC Servo motor, Drive Circuits. Characteristics and selection of Actuators. 4 hrs

7. **User Interface and communication system:** Introduction, Hardware's for user interface like joystick, display; Software as User Interface like command-line, menu driven and graphical user interface (GUI). Data transmission medium; Basics of serial and Parallel Communication, Basics of network topologies; Other communication protocols. 4 hrs

Text Book:

1. W. Bolton, “Mechatronics”, 2nd edition , Pearson Ed, 2001
2. SABRI CETINKUNT “Mechatronics with Experiments” , 2nd edition, John Wiley & Sons Ltd, 2015
3. Petruzella D Frank, “Programming Logic Controllers”, 3rd edition, Mc Graw Hill Education, 2010

Reference Book:

1. Devdas Shetty, Richard Kolk, “Mechatronics System Design”, 2nd edition,
2. Robert H. Bishop, “MECHATRONICS an Introduction”, 1st edition, Taylor & F, 2006.

Curriculum Content

Course Code: 18EMEP201 **Course Title: Manufacturing Processes - II Lab**

L-T-P: 0-0-2	Credits: 2	Contact Hrs: 4 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 48		Exam Duration: 2 hrs

Content

Processing of plastics & rubber goods:

Production of sheet and film, fiber and filament production, injection molding, blow molding & rotational molding, thermoforming, casting, product design considerations

Rubber processing & shaping, manufacture of tires & other rubber products, product design considerations

Rapid prototyping processes:

Fundamentals of rapid prototyping, relationship between reverse engineering and rapid prototyping, subtractive processes, additive processes

Design of jigs/fixtures:

Difference between jigs and fixtures, General consideration in design of drill jigs, Drill bushing

Non-conventional machining processes:

Mechanical and thermal machining processes

Lab Exercises

1. Injection molding: Produce a component in injection molding process for given component drawing.	2 Hrs
2. FRP: Prepare a component by hand layup process for FRP product.	2 Hrs
3. Rubber processing: Conduct the rubber manufacturing processes for given component drawing.	2 Hrs
4. Non-conventional machining: Study the effect of process parameters in electric-discharge machining, laser cutting and plasma arc machining for a given geometry.	6 Hrs
5. RPT (3D printing): Build a product in 3D printing machine for given component drawing.	4 Hrs
6. CNC machining: Prepare CNC program and conduct turning & milling machining for a given component.	20 Hrs
7. Jigs/Fixtures: Design a jig/fixture for given application.	12 Hrs

Text Books:

1. Kalpakjian S., and Schmid S.R., Manufacturing Engineering & Technology, 7th edition, Pearson Education, 2014.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing, 5th edition, John Wiley & Sons, 2012.

Reference Books:

1. Tadmor Zehev, Gogos Costas G., Principles of Polymer Processing, 2nd edition, A John Wiley & Sons, Inc., Publication, 2006.
2. Chee Kai Chua, Kah Fai Leong, Chu Sing Lim, Rapid Prototyping: Principles and Applications, 3rd edition, World Scientific Pub Co Inc, 2010.
3. Rahaman M. N., Ceramic Processing, 2nd edition, CRC Press, 2003.

Curriculum Content

Course Code: 15EMEP204 **Course Title: Machines & Mechanisms Lab**

L-T-P: 0-0-1 Credits: 1 Contact Hrs: 2 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 24 Exam Duration: 2 hrs

S.No	Experiments	Hrs
1	Introduction to software and exercises	4
2	Determination of the Mobility of linkages	2
3	Velocity and Acceleration analysis on applications of slider crank mechanisms	2
4	Velocity and Acceleration analysis on applications of 4 bar mechanisms	2
5	Kinematic analysis of a Epicyclic Gear Train	2
6	Determination of gyroscopic couple and verification of gyroscopic law	2
7	Balancing of a system of rotating masses in a single plane	2
8	Balancing of a system of rotating masses in a Multiple planes	2
9	Kinematic analysis of a cam follower pair for specific inputs	4
10	Construction of the best suited mechanism and analysis of the mechanism using traditional and/or modern tools for a specific application	2

Text Books:

1. David Myszka, **Machines and Mechanisms- Applied Kinematic Analysis**, 3rdEdition, PHI, New Delhi,

Reference Books:

1. John Uicker, Gordon Pennock, Joseph Shigley, Theory of Machines and Mechanisms, 4th Edition, Oxford University Press, New Delhi
2. A brief introduction to MSC.ADAMS-user manual, McNeil Schindler Corp (MSC), USA.
3. "Make it Kit", An educational Mechanism construction kit.

Curriculum Content

Course Code: 15EMEP202 **Course Title: Engineering Materials Lab**

L-T-P: 0-0-1	Credits: 1	Contact Hrs: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 24		Exam Duration: 2 hrs

Expt. No.	Brief description about the experiment	No. of Lab. Slots
01	Introduction to the Laboratory-Overview of Destructive and Non Destructive Testing methods. (Awareness about the ASM hand books and ASTM standards)	01
02	Non destructive test experiments a. Ultrasonic flaw detection. b. Magnetic particle inspection. c. Dye penetration testing, To study the defects of castings and welded specimens.	01
03	Evaluation of the tensile strength, Compression strength, Shear strength,	01
04	Bending/ Torsion strength and Impact strength. Ex: Should be able to Describe the differences between the tensile behavior of the metal sample and that of polymer sample, considering that the student performs the test on two different materials family.	01
05	To study wear characteristics of ferrous, non-ferrous and composite materials for different loading. Computation of wear parameters: wear rate, wear resistance, specific wear rate, frictional force, coefficient of friction, wear coefficient.	01
06	To study the microstructure of the ferrous and nonferrous alloy and to perform grain size analysis and volume fraction analysis. • Familiarization with the procedure for preparation of a material specimen for microscopic examination. • Familiarization with compound optical microscopes and metallography. • Examination of surface characteristics of engineering materials. • Grain size determination of metals and analysis.	01
07	To analyze given SEM Micrographs (Microstructure and fracture surface morphology) and conclude on the structure and mode of fracture. (Familiarization with the advanced characterization of metals by Scanning electron microscopy).	01
08	Computer Modeling of Stress Concentration, Crack Opening and Crack	01

	Propagation Understand the occurrence of stress concentration at geometrical discontinuities. Determine the stress concentration factor at a geometrical discontinuity.	
09	Design an experiment to investigate the spring characteristics of any given spring.	02
10	Synthesize a novel composite material which is reinforced with a natural fiber in a polymer matrix and perform the mechanical characterization for investigation of mechanical properties, which is desirable for specified engineering applications. Perform a parametric analysis which affects the mechanical properties of prepared composites using a statistical approach and find the correlation of those parameters with properties of composites.	02

Curriculum Content

Course Code:19EMEP202 **Course Title: Mechatronics Lab**

L-T-P: 0-0-2 Credits: 2 Contact Hrs: 4 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 48 Exam Duration: 2 hrs

Experiment Number		Experiments	No. of sessions
01	a)	Design appropriate Signal conditioning for given sensor to be interfaced with controller.	02
	b)	To study the frequency response of Active and Passive Low Pass Filter	01
	c)	Experimentally acquire the strain and Present result using Industry Standard Graphical Programming Software and its associated hardware.	04
02	a)	Measurement of physical Variables (eg. temperature, displacement) and displaying the data on serial monitor.	02
	b)	Read Sensor data and display the data on a LCD using I2C protocol	02
03	a)	Simulate 2 bit Registers, Counters and Arithmetic and Logical Unit(ALU)which are basic blocks of CPU	02
04	a)	Development of Application using Model Based Design and implementation by interfacing Target Hardware (Arduino and Raspberry Pi) with Industry Standard Software.	05
05	a)	Simulate basic programming concepts using PLC software.	02
	b)	Building applications using PLC Hardware	02

Text Books

1. Tilak Thakur, Mechatronics, 1st edition, Oxford Higher Education, 2016.
2. Petruzella D Frank, “Programming Logic Controllers”, 3rd edition, Mc Graw Hill Education, 2010

References

1. W. Bolton, “Mechatronics”, 2nd edition , Pearson Ed, 2001

Manuals:

1. Mechatronics Lab Manual prepared by Lab-incharge.

Others:

Relevant Manuals and data sheets of different device/equipment manufacturers

B.E. (Mechanical Engineering)

5th and 6th Semester

Curriculum Structure & Syllabus

2019 – 23 Batch

B.E. (Mechanical Engineering) Curriculum structure & Syllabus 2019 – 23 Batch

Semester: V

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration
-	19EMAB301	Numerical methods and Statistics **(Diploma Students)**	BS	3-0-1	4	4	50	50	100	3 hours
1	15EMEC301	Fluid Mechanics & Hydraulic Machines	PSC	4-0-0	4	4	50	50	100	3 hours
2	15EMEC304	Design of Machine Elements	PSC	3-1-0	4	5	50	50	100	3 hours
3	19EMEC301	Finite Element Methods	PSC	3-0-0	3	3	50	50	100	3 hours
4	15EMEE3XX	Program Elective - 1	PE	3-0-0	3	3	50	50	100	3 hours
5	19EMEP301	CAD Modeling & PLM Lab	PSC	2-0-2	4	6	80	20	100	2 hours
6	15EMEP303	Automation Lab	PSC	0-0-2	2	4	80	20	100	2 hours
7	19EMEP302	FEM Lab	PSC	0-0-1	1	2	80	20	100	2 hours
8	15EMEW301	Mini Project	PRJ	0-0-3	3	6	50	50	100	3 hours
				15-1-8	**24**	**33**				

ISA: In Semester Assessment, **ESA**: End Semester Assessment, **L**: Lecture, **T**: Tutorials, **P**: Practical. **PSC**: Program Specific Core, **PRJ**: Project work, **PE:** Program Elective

Electives:

Design Electives	Product Design Electives	Manufacturing Electives	Thermal Electives
Mechanical Vibration 15EMEE301	Product Innovation 15EMEE304	Advanced Machining Processes 15EMEE305	Turbo Machines 18EMEE303

CAE Electives	PLM Electives	Machine Learning
Advanced CAE – I 18EMEE301 (0-0-3) (80:20)	Programming 18EMEE302 (0-0-3) (80:20)	Advanced Statistics and Machine Learning 19EMEE302

B.E. (Mechanical Engineering) Curriculum structure & Syllabus 2019 – 23 Batch

Semester: VI

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration
1	16EHSC301	Professional Aptitude & Logical Reasoning	PSC	3-0-0	3	3	50	50	100	3 hours
2	15EMEC305	Heat and Mass Transfer	PSC	3-0-0	3	3	50	50	100	3 hours
3	15EMEC302	Metrology and Quality Engineering	PSC	4-0-0	4	4	50	50	100	3 hours
4	15EMEE3XX	Program Elective - 2	PE	3-0-0	3	3	50	50	100	3 hours
5	15EMEE3XX	Program Elective - 3	PE	3-0-0	3	3	50	50	100	3 hours
6	15EMEP301	Metrology and Quality Engineering Lab	PSC	0-0-1	1	2	80	20	100	2 hours
7	18EMEW301	Minor Project	PRJ	0-0-6	6	6	50	50	100	2 hours
				16-0-7	**23**	**24**				

ISA: In Semester Assessment, **ESA**: End Semester Assessment, **L**: Lecture, **T**: Tutorials, **P**: Practical. **PSC**: Program Specific Core, **PRJ**: Project work, **PE:** Program Elective

Electives:

Design Electives	Product Design Electives	Manufacturing Electives	Thermal Electives
Failure Analysis in Design 15EMEE302	Product Design & Development 19EMEE303	Computer Integrated Manufacturing 15EMEE306	HVAC Systems 15EMEE308
Applications of Vibrations and Acoustics 19EMEE308			

CAE Electives	PLM Electives	E – Mobility Electives	Machine Learning
Advanced CAE – II 19EMEE304 (0-0-3) (80:20)	PLM Technical 19EMEE305 (0-0-3) (80:20)	Vehicle Structure and Design Optimization 19EMEE301 (0-0-3) (80:20)	Machine Learning Applications 19EMEE307 (0-0-3) (80:20)

V Semester Bachelor of Engineering (Mechanical Engineering)

Curriculum Content

Course Code: 19EMAB301 **Course Title: Numerical methods and Statistics**

L-T-P: 3-0-1 Credits: 04 Contact Hours: 6 hrs/week

CIE Marks: 50 SEE Marks: 50 Total Marks: 100

Teaching Hours: 40 Examination Duration: 3hrs

Unit I

1. Numerical Methods 8 hrs

Introduction to numerical methods. Roots of equations using Bisection Method, Newton- Raphson Method, Finite differences, Forward, Backward Operators. Newton Gregory forward and backward interpolation formulae. Newton's divided difference formula for un equal intervals. Numerical solution of first order ODE, Euler's and Modified Euler's method, Runge Kutta 4^{th} order method. Implementation using python-programming

2. Matrices and System of linear equations 8 hrs

Introduction to system of linear equations, Rank of a matrix by elementary row transformations. Consistency of system of linear equation solution of system by (i) Direct methods-Gauss elimination, Gauss Jordon method (ii) Iterative methods- Guass-Seidal method. Eigenvalues and Eigenvectors of a matrix. Largest Eigenvalue and the corresponding Eigenvector by power method. Implementation using python-programming.

Unit II

3. Curve fitting and regression 5 hrs

Introduction to method of least squares, fitting of curves $y = a + bx$, $y = ab^x$, $y=a + bx + cx^2$, correlation and regression.

4. Probability 9 hrs

Definition of probability, addition rule, conditional probability, multiplication rule, Baye's rule. (no proof) Discrete and continuous random variables- PDF-CDF- Binomial, Poisson and Normal distributions (Problems only).

Unit III

5. Sampling distributions 10 hrs

(a) Sampling, Sampling distribution, Standard error, Null and alternate hypothesis, Type-I and Type- II errors, Level of significance. Confidence limits for means (large sample).

(b) Testing of hypothesis for means. large and small samples and student's t- distribution and Confidence limits for means (small sample).

Text Books

1. Bali and Iyengar, A text book of Engineering Mathematics, 6ed, Laxmi Publications(p) Ltd, New Delhi,2003
2. Chapra S C and Canale R P, Numerical methods for Engineers, 5ed, TATA McGraw-Hill, 2007
3. Gupta S C and Kapoor V K, Fundamentals of Mathematical Statistics, 9ed, Sultan Chand & Sons, New Delhi, 2002

Reference Books:

1. Sastry S S, Introductory method for numerical analysis, 3ed, PHI, 2003.
2. J. Susan Milton, Jesse C. Arnold, Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, 4th Ed, TATA McGraw-Hill Edition 2007.

Curriculum Content

Course Code: 15EMEC301	**Course Title: Fluid Mechanics and Hydraulic machines**	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Unit I

1. Basic Concepts and Fluid properties 6 Hrs

Introduction, Application Areas of Fluid Mechanics, The No-Slip Condition, Classification of Fluid Flows, System and Control Volume, Properties of fluids, Energy and Specific Heats, Viscosity, Surface Tension and Capillary Effect.

Fluid statics: Pressure and its measurements, Hydrostatic forces on surfaces.

2.Fluid Kinematics 6 Hrs

Lagrangian and Eulerian Descriptions, Fundamentals of Flow Visualization, Streamlines and Stream tubes, Path lines, Streak lines, Timelines, Continuity equation, Velocity and acceleration of fluid flow, Velocity potential function and stream function

3. Mass, Bernoulli and Energy Equations 8 Hrs

Mass and Volume Flow Rates, Conservation of Mass Principle, Moving or Deforming Control Volumes, Mass Balance for Steady-Flow Processes, Mechanical Energy and Efficiency, Euler's equation of motion along a streamline, Bernoulli's equation, Navier-Stokes equation of motion, The momentum equation, General Energy Equation, Energy Analysis of Steady Flows.

Unit II

4. Flow in Pipes 6 Hrs

Laminar and Turbulent Flows, Reynolds Number, Boundary Layer, Laminar Flow in Pipes, Pressure Drop and Head Loss, Inclined Pipes, Turbulent Flow in Pipes, Major and Minor Losses, Flow Rate and Velocity Measurement.

5. Dimensional analysis 6 Hrs

Dimensions and Units, Dimensional Homogeneity, Non-dimensionalization of Equations, Dimensional Analysis and Similarity, Rayleigh's method and the Buckingham Pi Theorem, Dimensionless numbers.

6. Flow over Bodies 8 Hrs

Drag and Lift, Friction and Pressure Drag, Reducing Drag by Streamlining, Flow Separation, Drag Coefficients of Common Geometries, Drag Coefficients of Vehicles, Parallel Flow over Flat Plates, Friction Coefficient, Flow over Cylinders and Spheres, Lift, End Effects of Wing Tips, Lift Generated by Spinning

Unit III

7. Hydraulic Pumps 5 Hrs

Centrifugal pumps – Work done, Heads and efficiencies, Priming, specific speed, NPSH, Cavitation, Multistage centrifugal pumps.

Reciprocating pumps: Working principle, discharge, work done and power, slip, Air vessels.

8. Hydraulic Turbines 5 Hrs

Classification, Heads and efficiencies of turbines, Pelton, Francis and Kaplan turbines, Velocity triangles and work done, specific speed, Unit quantities, Draft tube, Characteristic curves.

Text Books:

1. Yunus A Cengel, John. M Cimbala: Fluid Mechanics – Fundamentals and Applications 2nd Edition, Mac Graw Hill Publications, 2017

Reference Books:

1. White F M: Fluid Mechanics, 8th Edn, McGraw Hill International Publication, 2015.
2. R.K. Bansal: Fluid Mechanics and Hydraulic Machines, 10th Edn, Laxmi Publications, 2018

Curriculum Content

Course Code: 15EMEC304 **Course Title: Design of Machine Elements**

L-T-P: 3-1-0 Credits: 4 Contact Hrs: 5 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 50 Exam Duration: 3 hrs

Unit I

Chapter 1: Spur Gears 8 Hrs

Mechanical Drives, Gear Drives, Classification of Gears, Selection of Type of Gears, Terminology of Spur Gear, Standard Systems of Gear Tooth, Force Analysis, Gear Tooth Failures, Selection of Material, Number of Teeth, Face Width, Beam Strength of Gear Tooth, Permissible Bending Stress, Effective Load on Gear Tooth, Estimation of Module Based on Beam Strength, Wear Strength of Gear Tooth, Estimation of Module Based on Wear Strength

Chapter 2: Helical and Bevel Gears 7 Hrs

Helical Gears, Terminology of Helical Gears, Virtual Number of Teeth, Tooth Proportions, Force Analysis, Beam Strength of Helical Gears, Effective Load on Gear Tooth, Wear Strength of Helical Gears. Bevel Gears, Terminology of Bevel Gears, Force Analysis, Beam Strength of Bevel Gears, Wear Strength of Bevel Gears, Effective Load on Gear Tooth.

Unit II

Chapter 3: Springs 8 Hrs

Types of springs, Terminology of Helical spring, styles of end, stress and deflection equations, series and parallel connections, spring materials, Design of helical springs, spring design –trial and error method, design against fluctuating load, optimum design of helical spring, surge in spring, multi-leaf springs, nipping of leaf springs.

Chapter 4: Friction Clutches and Brakes 7 Hrs

Clutches, Torque Transmitting Capacity, Multi-disk Clutches, Friction Materials, Breaks, Block Brake with short shoe and Band Brakes

Unit III

Chapter 5: Rolling Contact Bearings 5 Hrs

Bearings, Types of Rolling Contact Bearings, Selection of Bearing Type, Static Load Carrying Capacity, Dynamic Load Carrying Capacity, Equivalent Bearing Load, Load-Life Relationship, Selection of Bearing Life, Load Factor, Selection of Bearing From Manufacturer's Catalogue, Bearing failure – Causes and Remedies.

Chapter 6: Sliding Contact Bearings 5 Hrs

Basic Modes of Lubrication, Viscosity, Measurement of Viscosity, Viscosity Index, Petroff's Equation, Mckee's Investigation, Bearing Design- Selection of Parameters, Comparison of Rolling and sliding Contact Bearings, Bearing failure – Causes and Remedies

Text Books:

1. Machine Design, An Integrated Approach, Robert L. Norton, Pearson Education, 2004
2. Design of Machine Elements: V.B. Bhandari, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

Reference Books:

1. Machine Design: Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., New Delhi, Special Indian Edition, 2008.
2. Design of Machine Elements- K Ganesh Babu and K Srithar, McGRAW-HILL EDUCATION (INDIA) Pvt Ltd, Chennai, 2009
3. K. Mahadevan and Balaveera Reddy, Design Data Hand Book, CBS Publication, Fourth Edition. 2016.

Curriculum Content

Course Code: 19EMEC301 **Course Title: Finite Element Methods**

L-T-P : 3-0-0 Credits: 03 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 03

Unit I

1. . Introduction to FEM: 7 Hrs

FEM paradigm : History, present/future, Research, Application, stress at a point, stress components on arbitrary plane, Equilibrium equations, compatibility equations, Generalized Hook's law, Plane stress and plain strain, principle of minimum potential energy and virtual work, RR method, FEM steps, Advantages , disadvantages and limitations.

2. Interpolation Functions For General Element Formulation : 8 Hrs

Discreatisation process, types of elements, size of elements, location of node, node numbering scheme and mesh requirements in finite element method, Galerkin's methods with Numericals, polynomial form of interpolation functions, convergence requirements

Unit II

3. FEA analysis: 8 Hrs

Pascal triangle, shape functions (1D, 2D, LST, CST, Quad, Higher order elements), Stiffness matrix and its properties. Elimination approach, Penalty approach and Thermal effect based practical engineering problems.

4. Advanced FEA analysis: 7 Hrs

Multi-point constraint, Iso-parametric and Axi-symmetric elements. Practical aspects of industrial machine components, Field issues related to structural applications using higher order polynomials.

Unit III

6. Post processing techniques: 4 Hrs

Validate and interpret the results, Average and Un-average stresses, Special tricks for post processing, Design modification, CAE Reports

7. Experimental Validation and Data Acquisition: 4 Hrs

Strain gauge, Photo elasticity, Load cells, Torque Sensors/Transducers, Dynamic tests, Acceleration test, Fatigue life measurement, Natural Frequency measurements.

Text Books:

1. K. H. Huebner, D. L. Dewhirst, D. E. Smith and T. G. Byrom, The Finite Element Method for Engineers, 4th edition, Wiley, New York, 2001.
2. T. R. Chandraputala and A. D. Belegundu, Introduction to Finite Elements in Engineering, Third Edition, Prentice Hall of India, 2004.
3. Nitin Ghokale, Practical finite element analysis, Finite to infinite, 2008.

Reference Books:

1. Introduction to the Finite Element Method, by N. S. Ottosen and H. Peterson. Prentice-Hall, Englewood Cliffs, 1992.
2. S. S. Rao, Finite Element Method in Engineering , Fourth Edition, Elsevier Publishing, 2007.

Curriculum Content

Course Code: 19EMEP301 **Course Title: CAD modelling and PLM Lab**

L-T-P: 2-0-2 Credits: 4 Contact Hrs:15

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 180 Exam Duration: 2 hrs

Content	Hrs
1. Sketcher Brief introduction on Sketcher work bench environment Structure of users and saving of files. Exercises on SketchTools, Profile Tool bar and Constraint Tool bar: Generate the following 2D sketches and make them Iso-constrained	75
2. Part Design Exercise on 3d models using pad, slot, shaft, groove, hole ,rib and stiffener commands, cut revolve, Dress up commands like chamfer, fillets etc. **(**Multi-Sections Solid and Removed Multi-Sections Solid Commands)	225
3. Generative shape design (GSD) Exercises using GSD to generate complicated surfaces using sub tool bars: Extrude-Revolution, Offset Variable and Sweep Extrude, Revolve, Trim, Transformation and Fillet tools Exercises on Surfaces and Operations Tool bar: (Conversion of Surface model into Solid model)	225
4. Assembly Design Introduction to Assembly Design Work bench; Bottom-Up and Top-Down assembly approaches Invoking existing components into assembly work .Exercise to demonstrate Top-Down assembly approach.	150
5. Drafting Converting existing 3D models into 2d drawings with all relevant details, sectional views, sheet selection, indicating GD&T symbols and dimensioning**.**	150
6. Enovia Introduction to CATIA 3D experience PLM Import the existing CATIA 3D experience data and store in Search and identify the data located in 3D experience database Modify the data in any PLM process Sharing information with users Analyze and Identify impacts of modifications Save the modifications into database	75

Reference Material:

1. Training material given by EDS on 3D experience

Curriculum Content

Course Code: 15EMEP303 **Course Title: Automation Lab**

L-T-P: 0-0-2 Credits: 2 Contact Hrs: 4 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 48 Exam Duration: 2hrs

Unit – I

1. Automation Using Hydraulic Systems 8 Hrs

Introduction to Fluid Power, Advantages and application of Fluid Power, Types of Fluid Power System, Properties and Types of Fluids. Pascal's Law, Continuity Equations, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping Theory, Pump Classification, Gear Pumps, Vane Pumps, Piston Pumps, Pump Selection, Hydraulic Actuators and Motors. Control Components In Hydraulic Systems: Symbolic representation as per ISO 1219 and ISO 5599. Directional Control Valves – Symbolic representation, Constructional features, pressure control valves, flow control valves.

Hydraulic Circuit Design (Simulation of circuits in Automation studio): 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, cylinder synchronizing circuits, speed control of hydraulic cylinder, accumulator circuits.

2. Automation using Pneumatic Systems 5 Hrs

Choice of working medium, characteristics of compressed air. Structure of Pneumatic control system. Linear cylinders, Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling, use of quick exhaust valve. Signal processing elements: Use of Logic gates – OR and AND gates pneumatic applications.

Unit – II

3. Automation Using Electronic Systems 5 Hrs

Control of hydraulic and pneumatic elements through PLC, Electro-hydraulic servo valve, Electro-pneumatic servo, Programmable automation controllers(PAC)

4. Robot programming & Control 5 Hrs

Programming languages description of ABB (RAPID Programming), Manual teaching, lead through teaching, (simple examples).

Sl. No	Name of Experiments	Duration (in hrs)
1	Characteristic Curve of Variable Displacement Hydraulic Pump	1
2	Carryout pressure intensification of a single-rod cylinder	1
3	Carryout Meter-in and Meter-out circuits using Single-rod cylinder and 4/2 DCV	1
4	Center Configuration of 4/3 DCV	1
5	Application of Regenerative Circuit	2
6	Direct control of Double Acting Cylinder	1
7	Indirect control of Double Acting Cylinder	1
8	Speed Control of Single Acting Cylinder	1
9	Position Dependent Control of a Double Acting Cylinder with Mechanical Limit Switches	1
10	Design of PLC system to control single acting cylinder, double acting cylinder, meter-in, meter-out and regenerative action.	2
11	To control extension/retraction with or without delay using ladder logic	2
12	Design of PLC system for, i. Clamping and punching operation (punching press machine) ii. Clamping and movement of tailstock (CNC machine)	2
13	To build and simulate arc/spot welding process in robotic environment	2
14	To build and simulate pick and place mechanism in robotic environment	2
15	Structured Enquiry experiment	2
16	Open ended experiment	2

Text Books :

1. Mikell.O. Groover , Automation, Production system and Computer Integrated Manufacturing, 2nd, PHI, 2002
2. Anthony Esposito, Fluid power with applications, 5th, Pearson Ed, 2000
3. Mikell P. Groover& Mitchell Weiss, Industrial Robotics, 2nd, Mc Graw H, 2003
4. William Bolton, Programmable Logic Controllers, 4th, Newnes, 2006

Reference Book:

1. S R Majumdar, Hydraulic systems, Principles and Maintenance, 5th, TMH, 2002
2. S R Majumdar, Pneumatic Systems, 2nd, TMH, 1995
3. Laboratory manual prepared by inhouse team.

Curriculum Content

Course Code:19EMEP302 **Course Title: FEM Lab**

L-T-P: 0-0-1 Credits: 1 Contact Hrs: 2 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 24 No of Sessions: 12 Exam Duration: 2 hrs

Category: Demonstration		**No. of Lab. Sessions per batch (estimate)**
1	Scientific Research Exposure (Research Education): Methods to search/extract Journal papers (Reputed journal paper), Referring papers, Drafting a paper. Introduction to ANSYS Workbench and familiarity. Real time Current/future field issues : Problem Identification	**03**
Category: Exercises		
Expt./Job No.	**Experiment/job Details**	**No. of Lab. Sessions per batch (estimate)**
1.	Static Structural analysis a) Uniform bar, b) Bracket, c) Machine Components	01
2.	Linear Buckling a) Columns & Struts (Different Boundary Conditions) b) Machine component	01
3.	Non-Linear Structural Analysis a) Geometric Nonlinearity b) Material Nonlinearity c) Contact Nonlinearity	02
4.	Dynamic Analysis (Modal/Harmonic/Transient Analysis) a) Beam (Different Boundary Conditions) b) Machine components	01
5.	Thermal Analysis a) Fins b) Heat Exchangers c) Machine component	01
6.	Drop Test & Impact Analysis a) Mobile drop test b) TV, Refrigerator etc.	01

7.	Optimization	01
8.	Model Test	01

Category: Structured Enquiry

Execute all the FEM Analysis modules which are dealt under the lab exercise.

Identify the component (Sub-assembly need have Minimum 3 to 4 components)
Start from scratch

- Measure the dimensions of component
- Generate the Solid Modeling of components with overall assembly (In any of the CAD Software)
- Import the model in neutral form to ANSYS Workbench
- Collection of data relevant to Material Properties
- Understand the physics of the problem (Working Principle with load's and boundary conditions)
- Interpretation of Results with conclusion.

Category: Open ended

1. Identify field issue pertaining to any component/product in today's industry.
2. Collect the information/literature on earlier worked project through external/internal search (Journal Paper/Patent/reports)
3. Comprehend the physics of the problem with working principle.
4. Prepare the abstract and apply to a national/international conference
5. Identify material properties, boundary conditions and load steps.
6. Carryout the analysis as per the FEA steps.
7. Provide engineering solutions to the identified sub assembly (deformation and stresses, material change, weight reduction, increasing load bearing capacity, fatigue life calculation, prediction of endurance limit of component and damage factor).
8. Prepare the draft on the worked out problem and apply to a national/international conference

Materials and Resources Required:

1. Books/References: Nitin Ghokale, Practical finite element analysis
2. Manuals: Sham Tickoo, ANSYS for Engineers and Designers

Curriculum Content

Course Code: 15EMEW301 **Course Title: Mini Project**

L-T-P: 0-0-3 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs.: 36 Exam Duration: 3 hrs

The mini project is designed to help students develop practical ability and knowledge in reverse engineering. Every batch of 5 students are required to select an equipment such as Table fan, toy car, pump, bicycle etc. They have to dismantle the complete assembly and take measurements using various measuring instruments such as vernier calipers, micrometer, profile projector,3D imager, portable CMM etc. Good sketches are to be made and converted into 3D part using 3D -Experience software. From then on the complete assembly in 3D, 2D assembly and BOM have to be prepared.

36 Hrs

The students will have to develop proficiency in 2D and 3D modeling,. Special emphasis is given on incorporating Geometrical dimensioning & tolerancing on the 2D manufacturing drawings. He/she should be well versed in material selection based on applications and develop assembly and part drawings as per industry standard, In addition students have to include one innovative idea in their project. And incorporate the same in the design.

Individual team has to prepare final model in 2D and 3D with proper documentation for the entire project. Progress of the project work will be presented by student's periodically to the panel of reviewers

Phases of mini Project Work:

- Students in batches will first select a product to carry out reverse engineering.
- Dismantle the assembly into individual parts.
- Take dimensions and make good legible sketches.
- Carry out 3D models of all the parts In 3D experience software (Catia).
- Assemble the parts in software to see a complete assembly.
- Render the product and show it in an actual environment.
- Convert it into 2d assembly with ballooning and BOM.
- Part drawings to be converted into 2D manufacturing parts as per industry standards, with GD&T symbols wherever necessary.
- Students have to include an Innovative idea and incorporate the same in their project.
- Prepare a final detailed report explaining the various stages and give a presentation. as a team.

VI Semester Bachelor of Engineering (Mechanical Engineering)

Curriculum Content

Course Code: 16EHSC301 **Course Title: Professional Aptitude & Logical Reasoning**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Introduction:

Campus placements play a major role in shaping up the career goals of students. It is the dream of every engineering student to get placed in a top organization visiting their campus for recruitment. Recruiters visiting engineering colleges seek for candidates who are ready for the industry and have the etiquettes necessary for the corporate world.

During campus placements, recruiters test for an array of skill sets in their potential employees. In addition to being knowledgeable in their core subjects, students should also possess great aptitude, reasoning and soft skills.

Background of the Proposal for Open Elective on Professional Aptitude and Logical Reasoning

The National Board of Accreditation has proposed a 3-D framework for competencies for the development of a young budding technologist from an engineering institution. The three dimensions in this 3-D Framework are:

1. Attitudes and Perceptions
2. Meaningful Usage, Acquisition and Extension of Knowledge
3. Productive Habits of the Mind

In the second and third dimension some of the competencies mentioned are:

1. Ability to apply knowledge
2. Design skills
3. Problem solving skills
4. Analytical skills
5. Attention to details
6. Critical thinking
7. Creativity and idea initiation

8. Numerical ability

Objective of the Subject

At the end of this course a student will be able to improve some of the habits of the mind. The student will be able to:

1. Develop a deep sense of analysis towards solving a problem
2. Supplement his/her problem solving skills
3. Develop critical thinking
4. Boost his/her ability to work with numbers
5. Augment a student's attention to detail

Other Advantages of the Elective

This subject will help in developing the ability to solve situations and problems in exams such as Common Aptitude Test (conducted by the IIMs), GRE, GMAT and the aptitude part of GATE.

Process

PALR is 3 credit course offered to 3rd year engineering students of all branches except t architecture. After their 6th semester start facing campus interview. So as to make them placement ready / employable. The course has been introduced at a starch to all the departments like Automation and Robotic, Automobile, Biotechnology, Computer Science, Civil, Electrical and Electronics, Electronics and communication, Industrial and Production, Information Science, Instrumentation Technology & Mechanical.

Unit 1 focuses on the development of sense of analysis, numerical ability and arithmetical reasoning. It helps develops the ability of students to logically deduct inferences. Chapter 2 in this unit develops the problem solving skills and improves the ability to apply given information.

Unit 2 works on improving the attention to detail and critical reasoning/thinking of the student.

Unit 3 helps in the improvement of the student's ability to think creatively and generate new ideas. It also helps improve a student's design skills

Curriculum Content

Course Code: 15EMEC305 **Course Title: Heat & Mass Transfer**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Introductory concepts and definitions 6 Hrs

Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity; convective heat transfer coefficient; radiation heat transfer combined heat transfer mechanism, Mass transfer: Definition and terms used in mass transfer analysis, Fick's first law of diffusion. Boundary conditions of 1st, 2nd and 3rd kind Conduction: General 3D- heat conduction equation in Cartesian coordinate, discussion on 3-D conduction in cylindrical and spherical coordinates (No derivation). 1-D conduction through plane and composite walls. Overall heat transfer coefficient. Mathematical formulation

2. One dimensional Steady State Conduction 5 Hrs

Heat flow and temperature distribution in plane wall. Critical thickness of insulation, Thermal resistance concept. Steady state conduction in slab, cylinder and spheres with heat generation. Heat transfer in extended surfaces of uniform cross-section without heat generation [No Derivations], Fin efficiency and effectiveness. Numerical Problems

3. One-dimensional transient conduction 4 Hrs

Conduction in solids with negligible internal temperature gradient (Lumped system analysis), Use of Transient temperature charts (Heisler charts) for transient conduction in slab, long cylinder and sphere, Numerical Problems

Unit II

4. Concepts and basic relations in boundary layers 5 Hrs

Flow over a body velocity boundary layer, general expressions for drag coefficient and drag force, thermal boundary layer. general expression for local heat transfer coefficient; Average heat transfer coefficient; Nusselt number. Flow inside a duct, Numerical problems based on empirical relation given in data handbook.

Free or Natural Convection: Dimensional analysis for free convection- significance of Grasshoff number, correlations for free convection over vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres.

5. Forced Convection 5 Hrs

Dimensional analysis for forced convection, significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Correlations for hydrodynamically and thermally developed duct flows, Correlations for flow over flat plate, cylinder and sphere.

6. Heat Exchangers 5 Hrs

Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems

Unit III

7. Condensation and Boiling 5 Hrs

Types of condensation (discussion only) Nusselt's theory for laminar condensation on a vertical flat surface [No Derivation]; use of correlations for condensation. Regimes of pool boiling pool boiling correlations [Theory].

8. Radiation heat transfer 5 Hrs

Thermal radiation; definitions of various terms used in radiation heat transfer; Stefan-Boltzmann law, Kirchhoff's law, Planck's law and Wein's displacement law. Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces, intensity of radiation and solid angle; Lambert's law; radiation heat exchange between two finite surfaces configuration factor or view factor. Numerical problems

Text Books:

1. Necati Ozisik - Heat transfer-A basic approach, 2nd Edn, Tata Mc Graw Hill, 2002
2. M.Tirumaleshwar – Fundamentals of Heat & Mass Transfer, 1st Edn, Pearson education 2009

Reference Books:

1. Yunus A. Cengel - Heat transfer, a practical approach, 4th Edn, Tata Mc Graw Hill, 2011
2. Frank Kreith, Raj M. Manglik, Mark S. Bohn, Principles of heat transfer, 7th Edn., Cengage Learning, 2011
3. Frank P. Incropera and David P. Dewitt- Fundamentals of Heat and mass transfer, 7th Edn, John Wiley, 2011
4. P.K. Nag - Heat and Mass transfer, 3rd Edn., Tata Mc Graw Hill, 2011

Curriculum Content

Course Code: 15EMEC302		**Course Title: Metrology and Quality Engineering**
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Unit I

1. Fundamentals of Metrology 6 Hrs

Objectives of Metrology, Standards of physical quantities (mass, length, time, temperature, force, Velocity, density) types of standards, line and end standard, Slip gauges, Angle Gauges, Linear and Angular Measurements, Performance characteristics of measuring instruments, Calibration of instruments, The Process of Measurement, Significance of Measurement process , Methods of measurement, generalized measurement system, errors in measurement, gauges, comparators (mechanical and optical), Numerical

2. Dimensional Metrology 7 Hrs

Measurement of screw thread parameters, Terminology of screw threads, types of threads , Toolmakers microscope, profile projector, Gear terminology, Measurement of gear parameters. Gear tooth Vernier, Introduction to Surface Texture, Terminology as per Indian standard, Methods of measurement of surface finish, Working of Tomlinson surface meter, Taylor-Hobson Talysurf, Analysis of surface traces (RMS value, CLA value)

3. Limits, Fits and Gauges 7 Hrs

Introduction, limits, tolerance, and fits, types of fits, allowance. Hole basis and shaft basis systems, Indian standard system for limits and fits (IS 919-2709), types of gauges, Taylor's principle and gauge design. Numerical

Introduction to GD&T Terminology, Maximum Material control (MMC) & Least Material Control (LMC), Form and orientation tolerances in detail with application examples, Interpretation of drawings with GD & T and Exercises

Unit II

4. Advanced Metrology 7 Hrs

CMM(Coordinate Measuring Machine) : Co-ordinate Metrology, CMM configurations, hardware components, Software, Probe sensors, Displacement devices, applications

Laser Metrology : Free electron laser – optical alignment, measurement of distance – interferometry, reversible counting, refractive index correction, reversible counting, refractive index correction, surface topography and optical component testing

5. Analysis of Experimental Data 7 Hrs

Causes and Types of Experimental Errors, Error Analysis on a Common sense Basis, Uncertainty Analysis and Propagation of Uncertainty, Evaluation of Uncertainties for Complicated Data Reduction, Statistical Analysis of Experimental Data, Probability Distributions, The Gaussian or Normal Error Distribution, Comparison of Data with Normal Distribution, The Chi-Square Test of Goodness of Fit, Method of Least Squares, The Correlation Coefficient, Multivariable Regression, Standard Deviation of the Mean, Students t-Distribution

6. Quality Engineering 7 Hrs

Quality concepts, Dimensions of quality, Inspection, Objectives of Inspection Difference between Inspection & Quality Control,7 QC tools, Statistical methods for quality control and improvement Basic Principles of Control charts, Control charts for variables, process capability and six sigma

Unit III

7. Control charts for Attributes and Acceptance sampling 5 Hrs

Control chart for fraction non-conforming, variable sample size, Number of defective chart, Control chart for Non conformities (defects) and Control chart for defects Average number of nonconformities. Types of sampling plans, operating characteristic (OC) curves

8. Introduction to TQM 5 Hrs

Basic approach, TQM framework, TQM principles-Leadership, Employee involvement, Empowerment, Team and Teamwork, Quality circles ,Continuous process improvement – PDCA cycle, 5S, Kaizen – Supplier partnership – Partnering, TQM techniques- Bench marking, FMEA, QFD, TPM

Text Books:

1. Beckwith Marangoni and Lienhard, Mechanical Measurements, 6th Edition, Pearson Education 2007
2. Doeblin E.O., Measurements Systems, Applications and Design, 5th Edition McGraw –Hill,2003
3. Montgomery D. C., Introduction to Statistical Quality Control, 8th Edition John Wiley & Sons, Inc2019

Reference Books:

1. Holman J P, Experimental Methods for Engineers, 8th Edition McGraw-Hill Publications 2011
2. Connie. L. Dotson, Fundamentals of Dimensional Metrology, 6th Edition Cengage Publications 2015
3. Bosch J A, Giddings and Lewis Dayton, Marcel Dekker, Co-Ordinate Measuring Machines and Systems 2nd Edition CRC press 2015
4. Grant and Leavenworth, Statistical Quality Control, 7th Edition , McGraw-Hill Publications 1996

Curriculum Content

Course Code: 15EMEP301	**Course Title: Metrology and Quality Engineering Lab**	
L-T-P: 0-0-1	Credits: 1	Contact Hrs: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 24		Exam Duration: 3 hrs

Expt. No	Brief description about the Experiments	No. of Lab Slots
1	Introduction to the Laboratory-Standards of measurement for Linear and angular dimensions.	1
2	Analysis of performance characteristics of measuring instruments using Hypothesis testing.	1
3	Analysis of Repeatability and Reproducibility using gauge R& R test.	1
4	Measurement of Screw thread and Gear parameters, surface roughness	1
5	Machine Tool Alignment Test (Lathe, Drilling, Milling).	1
6	Measurement of Dimensions and GD&T parameters of given components using CMM (Coordinate Measuring Machine).	2
7	Reverse engineering of the given component by extraction of 2-Dimensions of the given part using 3D scanner.	1
8	Testing the goodness of fit for the given quality characteristics by Chi- Square test.	1
9	Construction of control chart for variables and Analysis of process capability for the different components manufacturing.	1
10	Construction and Analysis of control charts for defectives.	1
11	Open Ended experiment- Error analysis, Gauge Design.	1

Reference Books:

1. Montgomery D. C., Introduction to Statistical Quality Control, 8th Edition John Wiley & Sons, Inc 2019
2. Hume K.J. & Sharp G.H, Practical metrology , 1st Edition ELBS &Macdonald 1970
3. Juran J.M. & F.M. Gryna, Quality Planning & Analysis, 3rd Re edition TMH Publications 1993

Curriculum Content

Course Code: 15EMEE301 **Course Title: Mechanical Vibrations**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Undamped Free Vibrations 6 Hrs

Introduction, Importance of vibration and its physical significance, Types of vibrations, Mechanical system components, Equivalent stiffness of spring combinations, Derivation of differential equation and Natural frequency for undamped free vibrations of single degree freedom systems, Newton's method and Energy method, Torsional vibrations, Transverse vibrations of beams.

2. Damped Free Vibrations 5 Hrs

Introduction, types of damping, study of response of single degree freedom viscous damped systems for cases of under damping, critical damping and over damping, Logarithmic decrement, Torsional system with viscous damping.

3. Whirling of Shafts 5 Hrs

Introduction, Whirling of shafts with and without damping, Discussion of speeds above and below critical speeds, Introduction to Noise.

Unit II

4. Forced Vibrations 7 Hrs

Introduction, Forced vibrations of single degree freedom viscous damped system due to harmonic excitation, Response of a rotating and reciprocating unbalance system, Support excitation, Vibration isolation and transmissibility.

5. Two Degree of Freedom Systems 7 Hrs

Introduction, Principal modes and Normal modes of vibration, Vibrations of undamped systems, Torsional vibrations, Forced harmonic vibration, Systems with damping, Co-ordinate coupling; applications in vehicle suspension, Dynamic vibration absorber.

Unit III

6. Multi Degree of Freedom Systems 5 Hrs

Introduction, Influence coefficients, Maxwell reciprocal theorem, Orthogonality principle, Matrix iteration method to determine all the natural frequencies of multi degree freedom systems, Dunkerley's method, Rayleigh's method.

7. Vibration Measurement and Condition Monitoring 5 Hrs

Introduction, Vibrometer and accelerometer, Frequency measuring instruments. Signal analysis: Spectrum analyzers, Dynamic testing of machines and structures, Experimental modal analysis, Machine maintenance techniques, Machine condition monitoring techniques, Vibration monitoring techniques.

Text Books:

1. Singiresu S. Rao, Mechanical Vibrations, 6th Edition, Pearson Education, 2018.
2. W.T. Thomson and Marie Dillon Dahleh, Theory of Vibrations with Applications, 5th Edition, Pearson Education,2014.

Reference Books:

1. S. Graham Kelly, Mechanical Vibrations: Theory and Applications, Cengage Learning, SI Edition, 2012.
2. M. L. Munjal, Noise and Vibration Control, World Scientific Publishing Co, Pvt. Ltd., 2013

B.E. (Mechanical Engineering) Curriculum structure & Syllabus 2019 – 23 Batch

Curriculum Content

Course Code: **15EMEE302**		Course Title: **Failure Analysis in Design**
L-T-P : 3-0-0	Credits: 03	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 03

Unit – I

1. Introduction 8 Hrs

Study of Failure criteria and its importance, Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.

2. Surface Failure 7 Hrs

Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Numerical examples.

Unit – II

3. Fatigue of Materials 5 Hrs

History of failure due to fatigue loads and development of fatigue failure, Concepts and terminology, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.

4. Stress-Life (S-N) Approach 6 Hrs

S-N curves, Statistical nature of fatigue test data, General S-N behavior, Different factors influencing S-N behavior, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach, Case study.

5. Strain-Life (ε-N)approach 5 Hrs

Monotonic stress-strain behavior , Strain controlled test methods, Cyclic stress-strain behavior ,Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.

Unit – III

6. Creep deformation 5 Hrs

The evolution of creep damage, primary, secondary and tertiary creep. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Numerical examples.

7. Buckling Analysis of rectangular plates 4 Hrs

Governing differential equation and boundary conditions, plate with all edges simply supported, plates with other boundary conditions, buckling under in-plane shear, post buckling analysis.

Text Books :

1. Ralph I. Stephens, Ali Fatemi, "Metal Fatigue in Engineering", John Wiley New York, 2nd edition, 2001.
2. Jack A Collins, Failure of Materials in Mechanical Design John Wiley & Sons, 1993.

3. Gambhir, M.L, Stability Analysis and Design of Structures, Springer-Verlag, 2004.

Reference Book:

1. Robert L. Norton, Pearson, "Machine Design- An Integrated Approach", 2nd edition, 2000.

Curriculum Content

Course Code: 15EMEE303 **Course Title: Piping systems Design**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Unit - I

1. Introduction to piping 2 Hrs

Role of piping design engineers, Inputs and outputs of piping department, Scope and prospects in various industries, trends in piping industry.

2. Piping systems Basics 3 Hrs

Process Design, Block Flow diagrams, Process flow diagrams (PFD), Piping and Instrumentation Diagrams(P&ID's), Commonly used symbols in PFD and P & ID, Lines/signals, Piping: services, equipments, Fluid codes (process), Insulation.

3. Codes and Standards 2 Hrs

Standards, major organizations for standards, Design code-ASTM standards, ASME standards

4. Piping elements and symbolic representations 4 Hrs

Fittings used to join pipes, Fittings used to change pipe direction, Fittings used to join different sizes of pipes, Fittings used for various purposes –such as flange, gaskets, Fittings used for branching, special fittings used for Branching.

Unit - II

5. Valves 3 Hrs

Types of valves, control valves, safety valves, constructional features. Criteria for selection. Piping components, pressure relieving devices, constructional features, selection criteria. Gate valve, globe valve, ball valve, check valve, Butterfly valve, Diaphragm Valves, Needle valve, Piston valve, Knife Gate valve.

6. Process Equipments used in plants 3 Hrs

Pumps, storage tanks, vertical vessels, Horizontal dryer, Heat Exchangers, filters, blowers, Industrial boilers, steam turbines, compressors,

7. Process Instruments 3 Hrs

Pressure Gauge, Temperature Gauge, Level indicators, flow metering/indicators, Safety valves, breather valves.

8. Plot Plan Development 2 Hrs

Plot plan development, Basic data, steps to be considered while developing the plot plan. Layout of Liquid storage, Layout considerations for explosive tank farm, Layout of gas Storage.

Unit - III

9. Piping Layouts 3 Hrs

Introduction to P&I Diagrams, process flow diagrams, standard symbols and notations. Introduction to various facilities required. Guidelines for plot plan/ plant layout. Introduction to equipment layout, piping layout, piping isometrics and bill of material. Typical piping system layout considerations. Piping arrangements, clearances and access, pipe rack, valve location, tower piping,

10. Conversion of orthographic to isometric view 3 Hrs

Introduction to isometric view, symbolic representation of elements in isometric environment, Pipe layout exercises,

11. Plant Layout Design software - LAB 12 Hrs

Introduction to CADMATIC Software, 15 most important shortcut commands and practice Construction of Pipe line Route, 4 (Pipe D)(refer to the drawing in the next subsequent pages), Construction of Pipe line Route 6 (Pipe F) , Construction of Pipe line Route 8.(Pipe H) , Construction of Pipe line Route 9(Pipe I), Construction of Pipe line Route 11 (Pipe K), Construction of Pipe line Route No 14 (Pipe M). Construction of Pipe line Route No 3, 1, 2, (Pipe C, A, B) , Construction of Pipe line Route No 5 ,7, 10,(Pipe E, G, J) , More features of software namely ladder, pipeline rack, and cable tray construction. Construction of all the pipeline network and Practice session

Text Books:

1. Ed. Baushbacher, Roger Hunt, Process Plant Layout and Piping Design, 1993, Prentice Hall , 1993

Reference Book :

1. Suvidya Institute of Technology Pvt. Ltd, Manual on Piping Engineering, Suvidya Institute of Technology Pvt. Ltd. Mumbai
2. Yunus A. Cengel, John M. Cimbala,, Fluid Mechanics Fundamental and Applications, 2nd, MGH,, 2006

Curriculum Content

Course Code: 15EMEE304 **Course Title: Product Innovation**

L-T-P: 2-1-0	Credits: 3	Contact Hrs: 4 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 24	Tutorial Hrs : 24	Exam Duration: 3 hrs

Unit I

1. Technological Innovation: 8 Hrs

Introduction, Sources of Innovation, Types and Patterns of Innovation, drivers for innovation, Innovation enablers, Innovation culture, Innovation Metrics, Challenges for Innovation, innovation Success stories, New product Innovation Process, Innovation progression, growth through Innovation, Idea generation, Idea Screening, Proof of Concept, team formation, Reality check.

2.Customer Analysis: 6 Hrs

Customer Needs Analysis, Big Problem, W's of Customers, Target Customer Segments, Consumer customer segmentation, Customer Value realization, Capture Customer Needs, Classification of needs, Standards Battles and Design dominance, Timing of entry

Unit II

3.Market Analysis: Innovation Opportunity, Environmental Analysis, 9 Hrs

Fore-sighting, S-curve for technology and consumer, Porters 5 forces, market Capacity, Evaluation of opportunity, Volume for casting,Competition Analysis: W's of Competition, Tools to compare products, sources for Competitive information.

4.Tools for Innovation: 5 Phases, Divergent and Convergent thinking, demographics, Contextual maps, Progression curve, Janus Cone, Generational arcs, Go to Market With innovation 7 Hrs

Unit III

5.Innovation Processes and Methods: 10 Hrs

TRIZ – Theory of innovative problem solving, ToC – Theory of Constraints, 8 Steps of Innovation

References:

1. Playbook for strategic foresight and Innovation – Stanford University
2. 8 Steps of Innovation – R. T. Krishnan and V. Dabholkar
3. TRIZ and ToC – Handouts
4. A Unified Innovation Process Model for Engineering Designers and Managers (In Design Thinking) Skogstad, P., Leifer, L.edited by Meinel, C., Leifer, L., Plattner, H. Springer Berlin Heidelberg. 2011: 19–43

Curriculum Content

Course Code: 19EMEE303		**Course Title: Product Design & Development**
L-T-P: 2-1-0	Credits: 3	Contact Hrs: 5 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 24	Tutorial Hrs : 24	Exam Duration: 3 hrs

Unit – I

1. VoC to Product Specifications

QFD methods to develop product specification from VoC

Concept development methods – Functional Analysis, Mock-ups, Concept selection methods (Pugh Matrix, Customer Focus Groups, Delphi method), Gap analysis, Rapid prototyping techniques, First Order analysis of concepts.

2. Design Methods

12 Hrs

1. Knowledge based engineering design techniques
2. Design Optimization techniques, Robust design methods overview,
3. Design for Six Sigma (Quality) methodology
4. Design for "X" –(X = Cost, Manufacturability, Assembly, Sustainability)
5. CAE led design techniques
6. Bio-inspired design

Unit -II

3. Product Development Process

Program Management, Design and functional review methods (DFMEA), Assembly process and virtual builds, Quality goals and control plans

6 Hrs

4. Product Verification and Validation

Load goals and duty cycle definition, Reliability and durability goals, Virtual prototyping techniques, Accelerated product verification methods

Unit - III

5. Product family management

Product lifecycle management; Evolution of product models and families, Modeling of product family lifecycle, Product Strategy, Product market positioning, Product positioning – psychological, Brand, customer segment.

6. Technology management

6 Hrs

Technology management methods, Technology as a competitive tool, Critical Component Development Process, Technology Development Process

Reference Book:

1. Karl Ulrich and Steven Eppinge, Product Design and Development
2. Kenneth B. Kahn, The PDMA Handbook of New Product Development, Second Edition
3. Six Sigma Guide

Curriculum Content

Course Code: 19EMEE308 **Course Title: Applications of Vibrations and Acoustics**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Unit I

1. Response of Mechanical Systems to Vibrations and Shocks 5 Hrs

Characteristics of vibration and shock, response of linear mechanical systems to vibrations, response properties of non-linear systems, response of mechanical systems to stationary random vibrations, shock response and shock spectra, vibrations in structures.

2. Vibration Measuring Instrumentation and Techniques 5 Hrs

Introduction, displacement, velocity and acceleration transducers, smart sensors and transducers, electronic data sheets, selection of accelerometer, calibration and system performance checks, practical considerations in mounting accelerometers, sensor design technique (FEA), sensor selection, mounting, cabling practices and signal conditioning, sensor and signal analysis.

3. Fundamentals of Signal Analysis 5 Hrs

Data acquisition and processing, signal operations, frequency domain analysis, sampling of continuous time signals, Fast Fourier transform, FFT analyser setup, leakage and windowing, averaging, real-time analysis of stationary and transient signals.

Unit II

4. Vibration Monitoring and Analysis Techniques 5 Hrs

Transducer considerations, vibration data collection errors, time domain analysis, statistical descriptors of vibration signals, Lissajous pattern, frequency domain analysis, quefrency domain analysis, demodulation technique, advanced fault diagnostic techniques.

5. Modal Analysis 5 Hrs

Experimental aspects of modal testing, FRF data of SDOF and MDOF systems, Classical, OMA, ODS, SRS & FE Correlation, vibration and shock testing, examples of vibration and acoustics – automotive, aerospace and defence, engineering and white goods, research.

6. Vibration Control 5 Hrs

Introduction; Vibration Nomo graph and vibration criteria; Reduction of vibration at the source, Control of vibration; Control of natural frequencies, Introduction of damping, Vibration isolation for different types of foundation, Shock isolation, Active vibration control, Vibration absorbers: Undamped and damped dynamic vibration absorber.

Unit III

7. Fundamentals of Sound 5 Hrs

Sensor selection, measurement techniques, applications-environmental, product noise: sound power and sound pressure, noise source identification: intensity and acoustic holography, building acoustics, sound quality.

8. Standards for Noise and Vibration 5 Hrs

Standards for sensors, frequency analysis, sound level meter, sound power measurement, sound intensity measurement, vibration measurement, measurement of damping.

Text Books:

1. C. Sujatha, Vibration and Acoustics, Tata McGraw-Hill Education, 2010
2. Singiresu S. Rao, Mechanical Vibrations, 6th Edition, Pearson Education, 2018.

Reference Books:

1. M. L. Munjal, Noise and Vibration Control, World Scientific Publishing Co, Pvt. Ltd., 2013
2. Bruel and Kjaer, Mechanical Vibration and Shock Measurements, 2nd Edition, Larsen & son, 1984.

Curriculum Content

Course Code: 15EMEE305 **Course Title: Advanced Machining Processes**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit – I

1: Introduction to Advanced Machining Processes 3 Hrs

Introduction to new methods of production; Need and Capability analysis of various processes, Classification and Selection of Non-Traditional Machining Technologies, Hybrid Processes, Cases.

2: Mechanical Advanced Machining Processes 12 Hrs

Abrasive Jet Machining (AJM): Machining setup, parametric analysis, Process capabilities. Ultrasonic machining (USM): Machining setup, Mechanics of Cutting - Model Proposed by Shaw, Parametric analysis, Process capabilities, Abrasive Flow Machining, Magnetic Abrasive Finishing. Water jet cutting (WJC).

Unit – II

3: Thermal Advanced Machining Processes 8 Hrs

Plasma Arc Machining (PAM): Working System, Elements of PAM, Process Performance, PAM Parameters, Process Characteristics, Safety Precautions, Electric Discharge Machining (EDM): Working Principle, Analysis, Process Variables, Process Characteristics, Applications

4: Thermo-electric Advanced Machining Processes 7 Hrs

Electron Beam Machining (EBM): Working Principle, Process Parameters, Characteristics of The Process, Application of EBM, Laser Beam Machining (LBM): Working Principle, Types of Laser, Process Characteristics, Applications, Ion Beam Machining (IBM): Working Principle, Process Parameters, Applications

Unit – III

5: Chemical Machining Processes 6 Hrs

Chemical Machining: Elements of process, Process Characteristics of CHM. Electro Chemical Machining: Elements and Characteristics and Theory of ECM

6: Hybrid Processes 5 Hrs

Electro chemical grinding (ECG), Electrochemical spark machining (ECSM), electrochemical arc machining (ECAM) and electro discharge abrasive grinding (EDAG).

Text Books:

1. Jain V. K. "Advanced Machining Processes", Allied Publishers, Private Limited.
2. Pandey P. C. and Shan H. S., "Modern Machining Processes", TATA McGraw Hill Publishing Company Limited, New Delhi.

Reference Book:

1. HMT, "Production Technology", TATA McGraw Hill.
2. Adithan M, "Modern Machining Methods", S. Chand & Company, New Delhi.

Curriculum Content

Course Code: 15EMEE306 **Course Title: Computer Integrated Manufacturing**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit – I

1: Manufacturing operations: 8 Hrs

Production system facilities, manufacturing support systems, automation in production systems, manual labor in production systems. Automation principles and strategies, manufacturing industries and products, product/production relationships, production concepts and mathematical models, costs of manufacturing operations

2: Manufacturing systems: 8 Hrs

Components, classification, manufacturing process functions, single station manufacturing cells, applications. Group Technology Part families, classification and coding, production flow analysis

Unit – II

3: Cellular Manufacturing, Flexible Manufacturing Systems: 5 Hrs

Cellular manufacturing quantitative analysis in cellular manufacturing, FMS components, planning and implementation, quantitative analysis of FMS

4: Material handling and storage: 5 Hrs

Material handling equipment, considerations in material handling system design, principles of material handling, material transport systems:, storage systems: automated storage systems, automatic data capture, automatic identification methods

5: PLM and IIoT: 5 Hrs

Areas of Product Life cycle Management (PLM), phases of product life cycle and technologies, benefits of PLM.

Definition of Industrial Internet of Things (IIoT), Evolution, Enablers for IIoT platform, drivers, Benefits, protocols, challenges, future

Unit – III

6: Robot fundamentals: 5 Hrs

Robot anatomy and related attributes, classification, robot control systems, end effectors, sensors in robotics, robot programming

7: Robot kinematics: 5 Hrs

Matrix representation, Homogeneous transformation matrices, Representation of transformations, Inverse transformation matrices, forward and inverse kinematics of robots, D-H representation of forward kinematic equations, degeneracy and dexterity

Text Books:

1. Grover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prantice Hall, India.
2. Chris McMahon & Jimmie Browne, "CAD & CAM Principles", Practice & Mfg. Mngt.', Pearson Education.

Reference Books:

1. Radhakrishnan P., "CAD/CAM/CIM", New Age International Private Limited.
2. Zeid Ibrahim, "CAD/CAM", McGraw Hill International.
3. Rao P.N., 'CAD/CAM Principles and Applications', Tata McGraw-Hill.
4. Vajpayee S. K., "Principles of CIM", Prentice Hall of India.
5. Saeed B. Niku, "Introduction to Robotics", Prentice Hall of India.

Curriculum Content

Course Code: 18EMEE303		**Course Title: Turbo machines**
L-T-P: 3-1-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Unit – 1

1. Principles of Turbo Machinery 5 Hrs

Definition of turbo machine, Comparison with positive displacement machine, Classification; Application of first and second law to turbo-machines, Efficiencies. Dimensionless parameters and their physical significance, Effect of Reynolds number, Specific speed, Illustrative examples on dimensional analysis and model studies.

2. Energy Exchange In Turbo Machine 5 Hrs

Euler Turbine equation, Alternate form of Euler turbine equation-components of energy transfer, Degree of reaction, General Analysis of a turbo machine-effect of blade discharge angle on energy transfer and degree of reaction, General analysis of centrifugal pumps and compressors-effect of blade discharge angle on performance, Theoretical head-capacity relationship.

3. General Analysis of Turbo Machines 6 Hrs

Axial flow compressors and pumps-general expression for degree of reaction, velocity triangles for different values of degree of reaction, General analysis of axial and radial flow turbines-utilization factor and degree of reaction, Condition for maximum utilization factor-optimum blade speed ratio for different types of turbines.

Unit – II

4. Compressible Flow Fundamentals 5 Hrs

Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility

5. Centrifugal Compressors 6 Hrs

Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging, stalling and prewhirl. Expression for pressure ratio developed in a stage, work done factor, efficiencies, Problems.

6. Axial flow Compressors

Axial Flow Compressors: Basic operations, elementary theory, factors affecting stage pressure ratio, Blockage in the compressor annulus, degree of reaction, three-dimensional flow, design process, blade design, calculation of stage performance, compressibility effects, off-design performance**.**

Unit – III

7. Flow through Variable Area Ducts 4 Hrs

Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

8. Steam Turbines 4 Hrs

Classification, single stage impulse turbine, condition for maximum blade efficiency, stage efficiency. Compounding-need for compounding, method of compounding, impulse staging- condition for maximum utilization factor for multi stage turbine with equiangular blades, effect of blade and nozzle losses, Reaction turbine, Parson's reaction turbine, condition for maximum blade efficiency, reaction staging, Problems on single stage turbines only.

Text Book:

1. Shepherd D.G., Principals of Turbo Machinery, Macmillan Publishers,1st Edn.1964
2. Yadav R., (2007) 'Steam & gas turbines and power plant engineering', Central Publishing House Allahabad, Vol. 1,
3. S. M. Yahya, Turbines, Compressors & Fans,Tata McGraw Hill Co. Ltd., 2nd edition, 2002.
4. E Rathakrishnan, Gas Dynamics, PHI- 2nd edition, 2009.

Reference Book :

1. Kadambi V. Manohar Prasad, An Introduction to Energy Conversion, Vol-III Turbo Machinery, New Age International, 1st Edn, 2006.
2. Saravanamutto H.I.H, Rogers G.F.C., Cohen H, Gas Turbine Theory, 5th edn., Pearson Education, 2006.

Curriculum Content

Course Code: 15EMEE308 | **Course Title: HVAC Systems**

L-T-P: 3-0-0 | Credits: 3 | Contact Hrs: 3 hrs/week

ISA Marks: 50 | ESA Marks: 50 | Total Marks: 100

Teaching Hrs: 40 | Exam Duration: 3 hrs

Unit – I

1: Introduction to HVAC Systems and Psychrometry 5 hrs

Purpose, applications, definition and components of air conditioning - Need and methods of ventilation. Evolution of air properties and psychrometric chart - Basic processes such as sensible heating/cooling, humidification/dehumidification and their combinations, steam and adiabatic humidification, adiabatic mixing, etc. - Bypass factor and Sensible heat ratio, Numerical problems.

2: Human Comfort, Summer and winter AC 5 hrs

Heat transfer from body, convection, radiation, conduction, evaporation, clothing resistance, activity level - Concept of human comfort - Thermal response - comfort factors - Environmental indices - Indoor air quality. - Simple summer AC process, Room sensible heat factor, Coil sensible heat factor, ADP - Precision AC - Winter AC.

3: AC Systems and Equipment 6 hrs

Classification of air conditioning systems, Filters, types, efficiency – Fan laws, cooling coils and heating coils, sizing and off design performance - Cooling and dehumidifying coil, dry and wet, sizing, performance.

Unit – II

4: Heat Transfer 3 hrs

Heat transfer in wall and roof, sol-air temperature, insulation, cooling load temperature difference - Fenestration, types of glass, sun shade, shading coefficient, maximum radiation, cooling load factor

5: Cooling load and heating load estimation 7 hrs

Thermodynamics of human body and mathematical model, Human comfort chart, Design conditions, outdoor, indoor - External load, wall, roof, glass - Internal load, occupancy, lighting, equipments - Ventilation, air quantity, loads - Load estimation methods. Vapour transfer in wall, vapour barrier, load estimation basics.

Introduction to AutoCAD REVIT software

6: Air distribution, diffusion and Ventilation 6 hrs

Ducts, types, energy equation for pipe flow, friction chart, methods of sizing, air distribution systems, ADPI, outlet/inlet selection.

Need, threshold limits of contaminants, estimation of ventilation rates, decay equation, air flow round buildings, Natural, wind effect, stack effect, combined effect - Mechanical, forced, exhaust, combined - Displacement ventilation

Unit – III

7: Ventilation system design 4 hrs

Exhaust ducts, filters, blowers, hoods, chimney, etc.

8: Industrial ventilation 4 hrs

Steel plants, car parks, plant rooms, mines, etc.

Text Book:

1. Faye C. McQuiston, Jerald D. Parker, Jeffrey D. Spitler, Heating, Ventilating and Air Conditioning: Analysis and Design, 6th Edition, July 2004,
2. W P Jones, Air Conditioning Engineering ELBS 3rd edn Edward Arnold (Publishers) ltd. Londan.

Reference Book:

2. Harris, Modern Air Conditioning Practice 3nd Edn McGraw Hill Book Company
3. S. N. Sapali, Refrigeration and air conditioning 2nd Edn, PHI learning pvt ltd, Delhi 2016
4. C P Arora, Refrigeration and air conditioning 3rd edn

Curriculum Content

Course Code: 18EMEE301 **Course Title: Advanced CAE - I**

L-T-P: 0-0-3 Credits: 3 Contact Hrs: 6 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 80 Exam Duration: 2 hrs

1. **Introduction** to Finite Element Method and Altair Hyper works. 3 Hrs
2. **Hypermesh workbench** 6 Hrs
   Getting started with Hypermesh
   Interacting with panels
3. **Geometry Clean up - Theory** 12 Hrs
   Tools used to geometry clean up
   (Edge edit, Create Surface and Surface edit, Line and Line Edit, Delete …..)
   Theory and Demo Exercise – 04 No
4. **2-D mesh Explanation -Theory** 18 Hrs
   Auto mesh and Different types of auto mesh
   Types of 2 D mesh (Ruled, Spline, Rotate……)
   Quality Parameters checking.
   Normal's and Edge Checking and adjusting.
   Theory and Demo Exercise – 04 No
5. **3-D mesh Explanation -Theory** 18 Hrs
   Volume mesh Creation
   Types of 3 D mesh (Hexa Penta Type, Tetra mesh……)
   Quality Parameters checking.
   Normal's and Edge Checking and adjusting.
   Theory and Demo Exercise - 03 No
6. **1-D mesh Explanation -Theory** 9 Hrs
   Creation of 1 D elements (Bar, Beam Mass….)
   Creation of Rigid elements (Rbe2 and Rbe3)
   Creation of Weld elements between two adjacent components
   Demo Exercise - 03 No
7. **Execute Linear Static Analysis** using optistruct solver 3 Hrs
   Theory and Demo Exercise - 01 No
   Assignment - 01 No
8. **Perform Buckling Analysis** using optistruct solver 2 Hrs
   Theory and Demo Exercise - 01 No
9. **Carryout Modal Analysis** using optistruct solver 2 Hrs
   Theory and Demo Exercise - 01 No
10. **Analyze Thermal Analysis** using optistruct solver 2 Hrs
    Theory and Demo Exercise - 01 No
11. **Execute Non Linear Analysis** using optistruct solver 5 Hrs

(Geometry, Material and Contact Non-Linear)

Theory and Demo Exercise - 03 No

Reference Books:

1. Nitin S Ghokale , Practical Finite Element Analysis , 3rd Edition, Finite to Infinite, 2015.

Curriculum Content

Course Code: 19EMEE304 **Course Title: Advanced CAE- II**

L-T-P: 0-0-3 Credits: 3 Contact Hrs: 6 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 80 Exam Duration: 2 hrs

Experiment wise plan

List of exercises planned to meet the requirements of the course.

Serial No.	Details	Category	No. of Sessions
1.	Finite Element Methods: A conceptual introduction, Failure criteria of materials	Demonstration	01
2.	Ansys workbench ➢ Getting started with Ansys ➢ Interacting with panels Case Study: Beam, Pneumatically Actuated PDMS Fingers, Spur Gears and Micro gripper etc.	Exercise/Tutorial	02
3.	Design Modeler Geometry clean-up tools: De-features, Projection. Case Study: Bar, Beam, Triangular plate.	Exercise/Tutorial	02
4.	Case study on One dimensional/Two dimensional/Three dimensional components ➢ 1D: Rod, Bar, Link, Spring, Beam ➢ 2D: Bellows Joints, Gearbox etc. ➢ 3D: Beam bracket, Cover of pressure cylinder, Lifting fork and LCD display support.	Exercise/Tutorial	03
5.	Convergence study in FEA Quality parameters for 1D/2D/3D elements, Convergence Study of 2D and 3D Solid Elements ➢ Pneumatic fingers ➢ Cover of pressure cylinder	Exercise/Tutorial	03
6.	Case study on Static structural analysis ➢ Refrigerator handle ➢ Shell –Automotive panels (Fender, Bonnet) Assignments ➢ Wooden chair ➢ Crain hook	Exercise/Tutorial	03

7.	Case study on Modal analysis ➢ Compact disk ➢ Machine tool structures- Bed, Column. ➢ Guitar string Assignments ➢ Human skeleton ➢ Car chassis ➢ Engine housing	Exercise/Tutorial	02
8.	Case study on Structural dynamic Analysis ➢ Lifting fork ➢ Ball and rod ➢ Base of compressor in Refrigerator Assignments ➢ Leaf spring ➢ Steering wheel ➢ Railway track	Exercise/Tutorial	03
9.	Case study on Non linear analysis Geometry, Material and Contact analysis ➢ Fisher rod(Geometry) ➢ snap lock(Material) ➢ Translational joint(Contact) Assignments ➢ Gasket(Contact) ➢ Advanced metal plasticity(Material) ➢ Visco-plasticity(Material)	Exercise/Tutorial	04
10.	Case study on Explicit Dynamics ➢ High-Speed Impact : Bird Crash	Exercise/Tutorial	01
11.	Case study on Buckling and Stress stiffening ➢ 3D Truss ➢ Beam Bracket Assignments ➢ Machine column(Milling/ Drilling) ➢ Dovetail guide way	Exercise/Tutorial	02
12.	Case study on Thermal analysis Steady state thermal analysis Transient thermal analysis ➢ Heat exchanger ➢ Fin Assignments ➢ PCB Panel ➢ Telephone/power cables	Exercise/Tutorial	02
13.	Case study on Fatigue Analysis Stress based approach Strain based approach ➢ Connecting rod ➢ Fin Assignments ➢ Radial tire ➢ Battery of laptop/mobile	Exercise/Tutorial	04
14.	Case study on Sub-Modeling ➢ Motor cover	Demo	01
15.	Case study on Multi Body Dynamics (MBD)	Exercise/Tutorial	03

	➢ Applications of Four bar mechanism ➢ Sun planet gear mechanism Assignments ➢ Power cylinder in a diesel engine ➢ Screw jack		
16.	Analysis of Composite ➢ Applications on automotive components(fender, hood, dashboard) ➢ Applications on aerospace components (wings, window panels, tale) Assignments ➢ Polymer matrix composite ➢ Metal matrix composite	Exercise/Tutorial	01
17.	Case study on Optimization ➢ Triangular plate ➢ Flexible gripper Assignments ➢ Electronic Fuse ➢ Radiating system ➢ Tractor trailer	Exercise/Tutorial	01
18.	Case study on Couple Field Analysis ➢ Electromagnetic-thermal (Induction heating) ➢ Electromagnetic-thermal-structural (Peltier coolers) ➢ Electrostatic-structural, electrostatic-structural-fluidic (MEMS)	Demo	02

Text Book :

1. Nitin Ghokale, Practical finite element analysis, Finite to infinite, 2008.

Reference Book :

1. Chen, Xiaolin_ Liu, Yijun-Finite Element Modeling and Simulation with ANSYS Workbench-CRC Press (2014)
2. Erdogan Madenci, Ibrahim Guven (auth.)-The Finite Element Method and Applications in Engineering Using ANSYS®-Springer US (2015)
3. Barbero, Ever J.-Finite Element Analysis of Composite Materials Using ANSYS®-CRC Press (2013)

Curriculum Content

Course Code: 18EMEE302		**Course Title: Programming**
L-T-P: 0-0-3	Credits: 3	Contact Hrs: 6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 74		Exam Duration: 2 hrs

Introduction to java: 6 Hrs

History and Features of Java, Internals of Java Program, Difference between JDK, JRE and JVM, Variable and Data Type, Naming Convention, JDK installation and configuration

OOP Concepts: 12 Hrs

Advantage of OOPs, Object and Class, Method Overloading, Constructor, static variable, method and block, this keyword, Package and Access Modifiers, Encapsulation, Object class, Java Array, call by Value and Call by Reference, Inheritance, Method Overriding, final keyword, Runtime Polymorphism, static and Dynamic binding, Abstract class and Interface, down casting with instance of operator.

String Handling: 5 Hrs

String, Immutable String, String Comparison, String Concatenation, Substring, Methods of String class, String Buffer class, String Builder class, to String method, String Tokenizer class.

Exception Handling: 10 Hrs

Introduction, try and catch block, Multiple catch blocks, Nested try, finally block, throw keyword, Exception Propagation, throws keyword, Exception Handling with Method Overriding, Custom Exception

Collection framework: 5 Hrs

Array List class, Linked List class, List Iterator interface, HashSet class, Linked HashSet class, Tree Set class, Priority Queue class, ArrayDeque class, Map interface, HashMap class.

Database concepts: 10 Hrs

SQL (DDL, DML), PL-SQL, JDBC Drivers, steps to connect to the database, Connectivity with DB, Driver Manager, Connection interface, Statement interface, Result Set interface, PreparedStatement, ResultSetMetaData.

HTML: 5 Hrs

Tags, Attributes and Elements, Links, Images, Tables, Forms.

CSS: 5 Hrs

CSS basics, styles, CSS syntax

JSP: 5 Hrs

JSP - Overview, JSP - Lifecycle, JSP - Syntax, JSP - Directives, JSP - Actions, JSP - Client Request, JSP - Server Response.

JavaScript/JQuery: 5 Hrs

JavaScript Output, JavaScript Statements, JavaScript Syntax, JavaScript Variables, JavaScript Operators, JavaScript Arithmetic, JavaScript Strings, JavaScript Events, JavaScript Loop, JavaScript Objects, JavaScript functions.

Design patterns: 6 Hrs

Singleton pattern, Factory pattern

Reference Books:

1. Guide to the Project Management Body of Knowledge (PMBOK Guide), Sixth Edition and Agile Practice Guide Bundle **by:** Project Management Institute

Reference Mannuals:

1. Studio Modeling Platform: Business Modeler Guide3DEXPERIENCE R2018x
2. Studio Modeling Platform: Embedding MQL Guide3DEXPERIENCE R2018x
3. Studio Modeling Platform: Matrix Navigator Guide3DEXPERIENCE R2018x
4. Dassault Systemes Studio Customization Toolkit 3DEXPERIENCE R2018x
5. Dassault Systemes Documentation 3DEXPERIENCE R2018x

Curriculum Content

Course Code: 19EMEE305 **Course Title: PLM -Technical**

L-T-P: 0-0-3	Credits: 3	Contact Hrs: 6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 74		Exam Duration: 2 hrs

1. **Fundamentals:** 10 Hrs

   Introduction to ENOVIA Components: Matrix Navigator, Business Modeler, System Manager, MQL Business Objects Attribute, Type, Relationship, Policy User Management: Person, Group, Role, Association Document Management: Files and File Format, File Check-in and Check-out Icon Mail Automating Processes: Triggers & JPOs Vaults & Stores Introduction to 3DEXPERIENCE ENOVIA Modules ENOVIA Architecture ENOVIA Licensing

2. **Installation:** 8 Hrs

   Difference between CAS & No-CAS Setup Installation Procedure for No-CAS Mode: Installation of Database (SQL Server), Creation of Tables & User in Database, Installation of Studio Modelling Platform, Installation of 3DSpace, Installation of ENOVIA Modules, No-CAS Deployment of ENOVIA, Post Installation Configurations, Working with ENOVIA Services

3. **Business Modeler:** 10 Hrs

   Attribute: Attribute Types & Ranges Dimension Type Policy: Policy States, Access, Signature User Management: Person, Role, Group, Association Relationship Interface

4. **Matrix Navigator:** 9 Hrs

   Search Business Objects Create Business Objects Modify & Delete Business Objects Connect Business Objects Expand Business Objects View Business Object Basics & Attributes Promote & Demote Business Object Business Object File Check-in and Check-out Business Object Signature Approvals

5. **MQL:** 10 Hrs

   Queries for Admin Objects: List, Create, Modify Queries for Business Objects: temp query, print, expand, add, delete, connect, disconnect, promote, demote, eval expression Help Commands

   Schema/Data Model: Understanding ENOVIA OOTB Schema Model: PnO, Project Management, Common Document Model Schema Design Symbolic Names & Registration Understanding ENOVIA Access Precedence Auto-Naming Configuration

6. **UI Configuration:** 8 Hrs

   Command Menu Categories/Tree Menu Portals & Channels Inquiry Tables: Flat Tables & Structure Browser Tables Editable Tables Settings for Table Columns Web Forms Settings for Web Form Fields Configuration of Create, Edit & View Business Object Details using Web Form

7. **ADK:**

   Understanding ENOVIA Business Object & Domain Object classes ENOVIA

String List & Map List classes ENOVIA APIs for Business Object Creation, Modification, Deletion ENOVIA APIs for business object querying, for getting business object details, for getting the connected business objects & their details — 5 Hrs

8. **JPOs:** — 4 Hrs

   Creating JPOs Exporting & Importing JPOs JPO Macros JPO Method Invocation from JSP, from JPO and from UI Component settings JPO Compilation & Debugging

9. **Triggers:** — 4 Hrs

   Trigger Configuration in Policy Creation of OOTB Trigger objects Understanding OOTB Events Understanding check, override and action triggers Disabling Triggers

10. **Data Model Customization**: — 6 Hrs

    Understanding Unified Typing Principles Specialize Data Model: Packages, Types & Customer Extensions Administrate Data Model Importing & Exporting Packages.

Reference Books:

1. Guide to the Project Management Body of Knowledge (PMBOK Guide), Sixth Edition and Agile Practice Guide Bundle **by:** Project Management Institute

Reference Mannuals:

1. Studio Modeling Platform: Business Modeler Guide3DEXPERIENCE R2018x
2. Studio Modeling Platform: Embedding MQL Guide3DEXPERIENCE R2018x
3. Studio Modeling Platform: Matrix Navigator Guide3DEXPERIENCE R2018x
4. Dassault Systems Studio Customization Toolkit 3DEXPERIENCE R2018x
5. Dassault Systems Documentation 3DEXPERIENCE R2018x

Curriculum Content

Course Code: 19EMEE301 | **Course Title: Vehicle Structure and Design Optimization**

L-T-P: 0-0-3 | Credits: 3 | Contact Hrs: 3 hrs/week

ISA Marks: 80 | ESA Marks: 20 | Total Marks: 100

Teaching Hrs: 80 | Exam Duration: 2 hrs

PART A
(Study of Vehicle Structure)

Sl. No.	Content	Teaching Hours
1	Brief explanation of different types of Loads and its effect; Different types of stresses- Static and Thermal, Different types of beams, Struts and Columns, thick and thin cylinders;	02
2	Understanding vehicle structure based on application; (e.g: 3box, load body and chassis)	04
3	Choices for Preparation of Virtual Model (1D, 2D, 3D representation);	03
4	Importance of Joinery;	02
5	Common performance measures for vehicle structures; (Stiffness, Modal, Durability)	03
6	Understanding Data and Assumptions; (e.g. nominal and tolerance, etc.)	02
7	Baseline data; (Initial collection of data which serves as a basis for comparison with the subsequently acquired data.)	02
8	Quality control in virtual environment;	03
9	Example case of static stiffness of BIW, Chassis; (BIW (short for Body in White) is a stage in automotive design and manufacturing. BIW refers to the body shell design of an automotive product such as cars. It is just a sheet metal welded structure. BIW will not have doors, engines, chassis or any other moving parts.)	05
10	Understanding effect of thermal loads on structure;	02
11	Understanding how to compute life based on stress results;	02
	Total-Theory	**30**
	Hands on Session	
01	Demonstrate importance of geometric parameters on performance of structure	05
02	Demonstrate importance of cross members on performance of structure	05
	Total-Hands-on	**10**
	TOTAL	**40**

PART B
(Design Optimization)

Sl. No.	Content	Teaching Hours
1	Optimization in the Design Process, Engineering Design Practice, Characteristics of Different Industries, CAE and the Design Cycle, The impact of optimization on CAE, What is an Optimum Design?, Optimization terminology in a nutshell, Finding an Optimum, Formulation of an Optimization problem;	02
2	What is optimization in the context of EV structure;	02
3	Different types of design optimization;	02
4	How to plan and approach giving design guidance;	02

5	What is concept level design guidance (generative designs);	03
6	How to handle design guidance at a detailed design stage;	03
7	Examples - design guidance for stiffness attribute;	04
8	Examples - design guidance for durability attribute;	04
9	What is MDO, its application; (Medium density overlay-MDO is produced with a high-quality thermosetting resin-impregnated fiber surface bonded to one or both sides under heat and pressure to create an exterior-grade plywood panel.)	02
10	Watch-outs during design guidance process;	02
11	Examples - design guidance for NV & crash attribute;	04
	Total-Theory	**30**

Hands on Session

01	Optimize front control arm of a vehicle for all its performance criteria. FAW up by 10%	05
02	Optimize B-Pillar for roof crush if GVW goes up by 20% due to electrification Effect of wheel base increase on chassis stiffness and how to bring it back, Section optimization using morphing.	05
	Total-Hands-on	**10**
	TOTAL	**40**

Text Books/Reference Books:

1. Dr. N.K. Giri, Automotive Mechanics, 8th Edition,2008, Khanna Publication, New Delhi.
2. Practical Aspects of Structural Optimization, Altair University, 3rd Edition.
3. Robin Hardy, Iqbal Husain, "Electric and Hybrid Vehicles". CRC Press, ISBN 0-8493-1466-6.
4. Ron Hodkinson and John Fenton, "Lightweight Electric/ Hybrid Vehicle Design". SAE International
5. John M. Miller, Propulsion Systems for Hybrid Vehicles" Institute of Electrical Engineers, London, ISBN0 863413366.
6. Automobile Electrical and Electronic systems, Tom Denton, Third Edition, 2004, SAE International, SAE ISBN 0 7680 147 2, Society of Automotive Engineers. Inc 400 common wealth Drive, Warrendale, PA 15096-0001 USA.

PROJECTS:

Part A

Objective: To carry out Baseline Performance, Virtual Testing and Design Countermeasures

Sl. No.	Content
01	Battery case for EV;
02	Motor compartment / Passenger compartment - improve performance;

Part B

Objective: To Provide design guidance

Sl. No.	Content
01	Battery case for EV (Metal vs Composite);
02	Motor compartment / Passenger compartment - improve performance;

Curriculum Content

Course Code:19EMEE302 **Course Title: Advanced Statistics and Machine Learning**

L-T-P: 0-0-3 Credits: 3 Contact Hrs: 6 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 80 Exam Duration: 2 hrs

Unit - I

1. Introduction to Machine Learning 25 Hrs

Introduction to Supervised, Unsupervised, and Reinforcement Learning; Statistics for ML; Exploratory Data Analysis; Use of Python and working with CSV/XLS files.

Python hands on: Installation, Introduction to Python libraries (Pandas, Numpy, matplotlib and so forth)

Unit - II

2. Applied Statistics 15 Hrs

Statistics for ML; Data Wrangling; Exploratory Data Analysis; Visualization; Use of Python and working with CSV/DB

Hands on: Preprocessing techniques

18 Hrs

3. Machine Learning Methods

Introduction to ML Life Cycle; Regression – Predictive Modeling; Regularization; Feature Selection; Metrics for Prediction; Visualization;

Unit - III

4. ML – Classification 22 Hrs

Introduction to Classification; Logistic Regression; Random Forests; Metrics for Classification; Visualization; Use of Python and DB

Text Books

1. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, “The Elements of Statistical Learning: Data Mining, Inference, and Prediction”, Springer, 2017.
2. Roger D Peng, “R Programming for Data Science”, Learn pub, 2015.

References

1. Geetha James, Trevor Hastie, Daniela Whitten, Robert Tibshirani, “An Introduction to Statistical Learning with Applications in R”, Springer, 2017.
2. Andrew Ng, “Machine Learning Yearning”, https://www.mlyearning.org/.
3. Michael Nielsen, “Neural Networks and Deep Learning”, http://neuralnetworksanddeeplearning.com/.

Curriculum Content

Course Code: 19EMEE307 **Course Title: Machine Learning Applications**

L-T-P: 0-0-3 Credits: 3 Contact Hrs: 6 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 80 Exam Duration: 2hrs

Unit - 1

1. Unsupervised Learning 18 Hrs

Refresher week, Introduction to Unsupervised Learning, Clustering Analysis: K-Means, K-Medoid, DBSCAN, Hierarchical Clustering.

Unit - 2

2. Introduction to Deep Learning Frame-Work 15 Hrs

Introduction to DL, Exploring the popular DL frameworks, Getting started with TensorFlow, Introduction to Keras, Setting up the environment.

21 Hrs

3. Introduction to Deep Neural Network (DNN)

Introduction- What is Deep Learning, Why Deep Learning and Why now, Mathematical building blocks of NN, Examples on Regression, Classification.

Unit - 3

4. Deep Learning in practice 12 Hrs

Introduction to Convnets, Understanding Recurrent NN, Examples

Text Books

1. Deep Learning, Ian Goodfellow, Yoshua Bengio et.al
2. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer, 2017
3. Deep Learning with Python, Francois Chollet

References

1. Andrew Ng, "Machine Learning Yearning", https://www.mlyearning.org/.
2. Michael Nielsen, "Neural Networks and Deep Learning", http://neuralnetworksanddeeplearning.com/.

B.E. (Mechanical Engineering)

7th and 8th Semester

Curriculum Structure & Syllabus

2018 – 22 Batch

B.E. (Mechanical Engineering) Curriculum structure & Syllabus 2018 – 22 Batch

Semester: VII

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration
1	15EMEC401	Operations Research	PSC	3-1-0	4	5	50	50	100	3 hours
2	15EMEC402	Design of Thermal Systems	PSC	3-0-0	3	3	50	50	100	3 hours
3	19EMEC401	IC Engines	PSC	2-0-0	2	2	50	50	100	3 hours
4	19EMEP401	Thermal Engineering Lab	PSC	0-0-1	1	2	80	20	100	2 hours
5	15EMEE4XX	Program Elective – 4	PE	3-0-0	3	3	50	50	100	3 hours
6	15EMEE4XX	Program Elective – 5	PE	3-0-0	3	3	50	50	100	3 hours
7	20EMEW401	Senior Design Project	PW	0-0-6	6	6	50	50	100	3 hours
8	15EHSA401	CIPE/EVS	CNC	Audit	0	2	50	50	100	3 hours
				14-1-7	**22**	**26**				

ISA: In Semester Assessment, **ESA**: End Semester Assessment, **L**: Lecture, **T**: Tutorials, **P**: Practical. **PSC**: Program Specific Core, **PRJ**: Project work, **PE:** Program Elective

Electives

Design Electives			E – Mobility Electives
Mechanics of Composite Materials 15EMEE401	Design of Automotive Power Train 15EMEE402	Design & Analysis of Experiments 15EMEE403	Dynamics & Durability of Vehicles 19EMEE401

Manufacturing Electives		
Operations Management 15EMEE405	Supply Chain Management 15EMEE406	Modern Trends in Manufacturing 15EMEE417

Thermal Electives	
Computational Heat Transfer and Fluid Flow 15EMEE407	Fundamentals of Gas Turbines 15EMEE408

Semester: VIII

No	Code	Course	Category	L-T-P	Credits	Contact Hours	ISA	ESA	Total	Exam Duration
1	15EMEE4XX	Program Elective - 6	PE	3-0-0	3	3	50	50	100	3 hours
2	15EMEO45X	Open Elective	OE	3-0-0	3	3	50	50	100	3 hours
3	18EMEI493	Internship – Training (Optional In place of 1 & 2)		0-0-6	6	----	80	20	100	3 hours
4	20EMEW402 / 20EMEW494	Capstone Project / Internship - Project	PW	0-0-11	11	11	50	50	100	3 hours
				6-0-17	**17**	**17**				

ISA: In Semester Assessment, **ESA**: End Semester Assessment, **L**: Lecture, **T**: Tutorials, **P**: Practical. **PSC**: Program Specific Core, **PRJ**: Project work, **PE:** Program Elective

Electives

Design Electives	Manufacturing Electives	Thermal Electives	
Aircraft Systems and Design ---- 15EMEE413	Industrial Engineering: Methods & Practices---- 15EMEE414	Advanced Energy technology---- 15EMEE415	Thermal Management of Electronic Equipment---- 15EMEE416

Open Electives

Introduction to Nano-Science & Nano Technology ----- 15EMEO401	Nano Technology ----- 15EMEO402	Design of Experiments ----- 15EMEO403	Engine Management Systems ----- 15EMEO404

VII Sem Bachelor of Engineering (Mechanical Engineering)

Curriculum Content

Course Code: 15EMEC401 **Course Title: Operations Research**

L-T-P: 3-1-0	Credits: 4	Contact Hrs: 5 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Introduction to Operations Research 3 Hrs

System orientation, Use of interdisciplinary teams in OR, Necessity of OR in business and industry, Scope of OR in modern management, OR and Decision making

2. Linear Programming 12 Hrs

Formulation, Identification of decision variables, Constructing Objective Functions and Constraints, Assumptions ,Practical Examples ,Methods of Solution, Graphical Method, Simplex method (Big M and 2-phase methods), By computer, Examples

Unit II

3. Duality Theory and Sensitivity Analysis 7 Hrs

Duality theory, Existence of Dual of a LP problem, Economic interpretation of duality Primal Dual relationships in formulation and their solutions, Sensitivity Analysis or Post Optimality Analysis, Dual Simplex Method, Changes affecting feasibility, Changes affecting optimality, Examples

4. Transportation Models 8 Hrs

The transportation algorithm, Formulation as a LP problem, Determination of initial solution, Stepwise improvement to obtain optimal solution, Special cases such as multiple, unbalanced, degeneracy etc. The assignment model, Formulation as a LP problem, The Hungarian method of solution, Examples

Unit III

5. Network Models 5 Hrs

The maximal flow problems, The shortest route problem, The minimal spanning tree problem, Critical Path Method(CPM) and Program Evaluation & Review Technique, Network representation of simple projects, Critical path Crashing of project duration, Examples

6. Game Theory 5 Hrs

Formulation of games, Two person zero sum game, Dominance property ,Games with and without saddle point, Graphical solutions (2 x n, m x 2 game)

Text Books:

1. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Edition, McGraw Hill, India, 2017.
2. H.A. Taha, Operations Research: An Introduction, 10th Edition, Pearsonl, 2017.

Reference Books:

1. Vohra N. D, Quantitative Techniques in Management, 5th Edition, Mcgraw Higher Ed.,2017
2. R. Panneerselvam, Operations Research, 2nd Edition, Phi Learning Pvt. Ltd, 2009.

Curriculum Content

Course Code: 15EMEC402 **Course Title: Design of Thermal Systems**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Heat exchangers Classification and Selection: 5 Hrs

Introduction, Recuperation and Regeneration, Transfer process, Geometry and Construction, - Tubular Heat Exchanger, Plate Heat Exchanger, Extended Surface heat exchanger, Heat Transfer Mechanisms, Flow arrangements, Applications and Selection of Heat Exchangers.

2. Design of Shell and Tube heat exchanger 10 Hrs

Construction of shell and tube exchanger, specifications and classification of S&T Heat Exchanger, some Typical operating limits for heat exchangers of S&T Type, Design of Shell and Tube Heat Exchangers.

Unit II

3. Condensers : Classification of condensers, various types of condensers and their applications, Shell and tube condensers : Analysis and design, special consideration in Reflux Condensers: Flooding , Condensers for mixtures , Design of shell and tube Exchangers, compact condensers, air cooled condensers , direct contact condensers , numerical problems 5 Hrs

4. Modeling of Thermal Equipment: 6 Hrs

Counter flow heat exchanger, Evaporators and Condensers, Heat exchanger effectiveness, Effectiveness of a counter flow heat exchanger, NTU, Pressure drop and pumping power, Numerical Problems.

5. Optimization: 4 Hrs

Mathematical representation of optimization problems, A water chilling system, Optimization procedure, Setting up the mathematical statement of the optimization problem.

Unit III

6. **Lagrange Multipliers:** 5 Hrs

The Lagrange multiplier equations, unconstrained optimization, Constrained optimization.

7. Dynamic Programming: 5 Hrs

Characteristic of the Dynamic programming solution, Apparently constrained problem, Application of Dynamic programming to energy system problems.

Text Books:

1. W.F.Stoecker, Design of Thermal Systems, 3 ed., MGH, 1989.
2. Sarit K. Das., Process heat transfer, Narosa Publishing House 1st Edition, 2005

3. Sadik Kakac, Hongtan Liu, Heat Exchanger Selection, Rating and Thermal Design, 2 ed., CRC Press, 2002.

Reference Books:

1. Yogesh Jaluria, Design and Optimisation of Thermal Systems, 2nd ed., CRC Press,2008
2. Hodge B.K., Analysis and Design of Thermal Systems, 1 ed., PHI, 1990.

Curriculum Content

Course Code: 19EMEC401 **Course Title: I C Engines**

L-T-P: 2-0-0 Credits: 2 Contact Hrs: 2 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 26 Exam Duration: 3 hrs

Unit I

1. Introduction to I C Engines 5 Hrs

Internal Combustion Engine Classification, Operating Cycles, Spark Ignition and Compression-Ignition Engines.

Combustion in Spark Ignition Engines

Ignition limits, Normal combustion, Thermodynamic Analysis of SI Engine Combustion - stages, ignition lag, and effect of engine variables on ignition lag Causes of Cycle-by-Cycle and Cylinder-to-Cylinder Variations and flame propagation phase, detonation, Abnormal Combustion: Knock Fundamentals and fuel factors, Factors affecting knock.SI engine combustion chambers.

2. Combustion in Compression Ignition Engines 5 Hrs

Types of Diesel Combustion Systems, Direct and Indirect-Injection Systems, Comparison, Combustion Efficiency, Normal combustion – stages, delay period, variables affecting delay period. Diesel knock, comparison between diesel and petrol engine knocks. CI engine combustion chambers, Fuel spray behavior. HRR analysis.

Unit II

3. Engine Exhaust Emission Control 5 Hrs

Formation of NOX, HC/CO mechanism , Smoke and Particulate emissions, Green House Effect, Methods of controlling emissions , Three way catalytic converter and Particulate Trap, Emission (HC, CO, NO and NOX) measuring equipments, Smoke and Particulate measurement, Indian Driving Cycles and emission norms.

4. Overall Engine Performance 6 Hrs

Alternate fuels, Operating Variables that Affect SI Engine Performance, Efficiency, and Emissions: Spark Timing, Mixture Composition, Load and Speed, Compression Ratio. Variables that Affect CI Engine Performance, Efficiency, and Emissions: Load and Speed, Fuel-Injection Parameters.

Unit III

5. Recent Trends in IC Engines 5 Hrs

Dual fuel Engine, Common Rail Direct Injection Diesel Engine (CRDI), Homogeneous Charge Compression Ignition Engine (HCCI), Reactivity controlled compression ignition engine (RCCI) Lean Burn Engine, Surface Ignition alcohol CI Engine, VVT engines, Gasoline Direct Injection Engine.

Text Books:

1. John B Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw-Hill, 1988
2. Heinz Heisler, “Advanced Engine Technology”, SAE International Publications, USA, 1998
3. Patterson D.J. and Henein N.A, “Emissions from combustion engines and their control”, Ann ArborScience, publishers Inc, USA, 1978

Reference Books:

1. Ganesan V. "Internal Combustion Engines", Third Edition, Tata Mcgraw-Hill, 2007.
2. Gupta H.N, "Fundamentals of Internal Combustion Engines", Prentice Hall of India, 2006.
3. Ultrich Adler, "Automotive Electric / Electronic Systems", Published by Robert Bosh GmbH, 1995.

Curriculum Content

Course Code: 19EMEP401 **Course Title: Thermal Engineering Lab**

L-T-P: 0-0-1	Credits: 1	Contact Hrs: 2 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 100
Teaching Hrs: 24		Exam Duration: 2 hrs

1. **Fluid mechanics and hydraulic machines**
   i. To obtain the performance characteristics of centrifugal blower
   ii. To study the effect of speed on the performance of centrifugal pump
   iii. To study the effect of speed / gate opening on the performance of Pelton turbine
   iv. To study the effect of speed / gate opening on the performance of Francis turbine

2. **Heat transfer**
   i. To determine the emissivity of given surface
   ii. To determine the thermal conductivity of metal bar and to study the effect of temperature on thermal conductivity
   iii. To study the performance of pinfin
   iv. To study the performance of vapour compression refrigeration (VCR) system

3. **I C Engines**
   i. To study the performance of two stroke engine
   ii. To obtain the performance characteristics of multicylinder engine using Morse test
   iii. To study the effect of engine operating variables (Injection pressure/ injection timing/ compression ratio)

Materials and Resources Required:

1. White, F.M., Fluid Mechanics, 5ed., McGraw Hill International, 2003
2. Nicati Ozisik - Heat transfer-A basic approach, Tata Mc Graw Hill, 2002
3. Yunus A. Cengel - Heat transfer, a practical approach, Tata Mc Graw Hill, 4th Edn, 2011
4. John B. Heywood, Fundamentals of Internal Combustion Engines, McGrawHill, Singapore.
5. Ganesan.V, Internal Combustion Engines, Tata McGraw Hill, 2nd Edition, 2003
6. Manuals: Lab manual prepared by the Department

Curriculum Content

Course Code: 15EMEE401 **Course Title: Mechanics of Composite Materials**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

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Unit - I

1: Introduction to Composite Materials 5 Hrs

Introduction, Matrix materials-polymers, metals and ceramics; Reinforcements, Interfaces-wettability, interactions at the interface, types of bonding at the interface, optimum interfacial bond strength.

2: Polymer Matrix Composites 5 Hrs

Types, characteristics ,processing of PMCs, Layup and curing, fabricating process, open and closed mould process, hand layup techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

3: Metal and Ceramic Matrix Composites 5 Hrs

Types of MMCs, base metals selection; important metallic matrices; processing-liquid state and solid state processes; interfaces in MMCs; Need for production of MMC's and its applications; Types of CMCs, processing of CMCs-cold pressing and sintering, hot pressing, reaction bonding processes, liquid infiltration, directed oxidation, in-situ chemical reaction techniques, sol-gel and polymer pyrolysis, applications of CMCs.

Unit – II

4: Macro Mechanics of a Lamina 8 Hrs

Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Invariant properties. Numerical problems.

5: Micro Mechanics of a Lamina: 7 Hrs

Introduction, volume and weight fractions, Assumption and limitations of micromechanical analysis, Elastic properties of a lamina, longitudinal strength and stiffness, Transverse young's modulus, major Poisson's ratio and in-plane shear modulus. Problems on micromechanical analysis.Numerical problems.

Unit – III

6: Macro Mechanics of Laminate 5 Hrs

Macro Mechanics of Laminate: Introduction, Laminate code, Stress–Strain Relations for a Laminate, Classical Lamination theory, assumptions of CLT, Stress- Strain equation and variation in a laminate, force and moment resultants related to midplane strains and curvatures , Numerical problems.

7:Applications: 5 Hrs

Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment, future potential of composites.

Text Books:

1. Krishan K. Chawla, Composite Materials - Science and Engineering, 3rd Edition, Springer, 2012.
2. Robert M.Jones, Mechanics of Composite Materials, 2nd Edition, Tailor & Francis Inc. 1999.

Reference Books:

1. D. Hull and T. W. Clyne, An Introduction to Composite Materials (Cambridge Solid State Science Series), 2nd Edition, Cambridge University Press, 1996.
2. Autar K. Kaw, Mechanics of Composite Materials, 2nd Edition, CRC Press, Taylor and Francis Group, 2006.

Curriculum Content

Course Code: 15EMEE402 **Course Title: Design of Automotive Power Train**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Unit I

1: Vehicle Performance Parameters 5 Hrs

Vehicle drag, power for propulsion, resistances to vehicle motion, traction and tractive effort, relation between engine revolutions and vehicle speed, road performance curves(acceleration, grade ability and drawbar pull), numericals.

2. General Considerations in Engine Design 5 Hrs

General Design Consideration, Selection of type: Process, Cycle, Number of Cylinders, Arrangement of Cylinders, Single and Double acting, Engine Speed, Piston Speed, Stroke to Bore Ratio.

3. Cylinder, Cylinder Head and Piston 6 Hrs

Function, construction, materials and design of cylinder, cylinder head and piston, piston pin and piston rings.

Unit II

4. Connecting Rod and Crankshaft 5 Hrs

Function, construction, materials and design of connecting rod, design of crankshaft and its types.

5. Flywheel 5 Hrs

Function, construction, material, types. Stresses in flywheel rim and arms. Design of flywheel.

6. Power Transmission- Manual Gearbox 5 Hrs

Necessity of gear box, Sliding mesh gear box, Constant mesh gear box, Synchromesh gearbox, gear synchronization and engagement.

Unit III

7. Power Transmission- Automatic Gearbox 5 Hrs

Architecture, fundamental design and operation principles of Torque convertors, Epicyclic geartrains and Dual Clutch Transmission.

8. Power Transmission- Drive Shaft, Final Drive and Differential 5 Hrs

Construction & types of propeller/drive shafts, Final drive, Differential-principle, open and non-slip differentials, differential lock. Electronic limited slip differential. Four wheel drive arrangements.

Text Books:

1. Dr. N.K. Giri, Automotive Mechanics, 8th Edition,Khanna Publication, New Delhi,2008.
2. Sharma and Aggarwal, Machine Design, 12th Edition, S.K.Kataria & Sons, New Delhi, 2012.

Reference Books:

1. Heinz Heisler, Advanced Vehicle Technology, 2nd Edition, Butterworth Heinemann, 2002.
2. Heywood, John B. Internal Combustion Engine Fundamentals, McGraw-Hill, New York 1988.

Curriculum Content

Course Code:15EMEE403 **Course Title: Design and Analysis of Experiments**

L-T-P: 3-0-0	Credits:3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3hrs

Unit I

1. Introduction

Need for Research, Need for Design of Experiments, Experimental Design Techniques, Applications of Experimental Design. — 4 Hrs

2. Taguchi's Approach to Quality

Taguchi's Approach to Quality and Quality loss function, Noise Factors and Average Quality Loss, Exploiting Non Linearity, Classification of Parameters, Exercises. — 4 Hrs

3. Analysis of Variance

Test of Hypothesis using t-test, Z –test, Chi square and F-tests, No-Way and One-Way ANOVA, Exercises. — 8 Hrs

Unit II

4. Full Factorial Design of Experiments

Two-Factor Complete Factorial Experiments, Complete Factorial experiment with Three Factors and 2^n Factorial Experiments, Exercises. — 8 Hrs

5. Fractional Factorial Design of Experiments

Half Fraction of 2^2 Factorial Experiments, Half Fraction of 2^3 Factorial Experiments, Half Fraction of 2^4 Factorial experiments, Exercises. — 4 Hrs

6. Robust Design

Control Factors and their Levels, Matrix Experiment and Data Analysis Plan, Conducting the Experiment using Orthogonal Array and Data analysis, Exercises. — 4 Hrs

Unit – III

7. Response Surface Methodology

Central Composite Design and Box-Behnken Design, Case Studies — 4 Hrs

8. Signal to Noise Ratio

Relationship between Signal to Noise Ratio and quality loss after adjustment, Signal to Noise Ratios for static problems, Signal to Noise Ratios for dynamic problems, Exercises. — 4 Hrs

Text Books:

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley and Sons.
2. Madhav S. Phadke, "Quality Engineering using Robust Design", Prentice Hall PTR, Englewood Cliffs, New Jersey.

3. R. Panneerselvam, "Design and Analysis of Experiments- R PHI Learning Private Limited ,New Delhi.

Reference Books:

1. R. H. Myers and D. C. Montgomery and Anderson-Cook C. M. "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", John Wiley & sons, Inc., New York.
2. Philips .J. Ross, "Taguchi Techniques for Quality Engineering", McGraw Hill, New York.

Curriculum Content

Course Code: 15EMEE405 **Course Title: Operations Management**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Operations management & operations decision making 8 Hrs

Introduction, importance of operations management in manufacturing and service industries, Information and Non-manufacturing systems. Factors affecting productivity. The environment of operations. Characteristics of decisions, framework for decision-making, decision methodology, decision support systems, economic models and statistical models. Numericals

2. Forecasting demand 6 Hrs

Forecasting objectives and uses, forecasting variables, opinion and judgmental methods, time series methods, exponential smoothing, regression and correlation methods, application and control of forecasts. Numericals

3. Aggregate planning and master scheduling 4 Hrs

Introduction- Planning and scheduling, objectives of aggregate planning and Aggregate planning methods, master scheduling objectives, master scheduling methods, Numericals

Unit II

4. Material and Capacity Requirements Planning 4 Hrs

Overview: MRP and CRP, MRP: Underlying concepts, System parameters, MRP logic, System refinements, Capacity management, and CRP activities. MRP, MRP-II and ERP, Numericals

5. Scheduling, single machine scheduling & flow –shop & Job shop scheduling 12 Hrs

Production activities, PAC objectives and data requirements, concept, measures of performance, SPT rule, Weighted MFT, EDD rule, minimizing the number of tardy jobs. Numerical problems, Johnson's rule for 'n' jobs on 2 and 3 machines. Numericals

Job-shop scheduling: Types of schedules, heuristic procedure, scheduling 2 jobs on 'm' machines. Numericals

Unit III

6. Lean manufacturing 5 Hrs

Introduction, Japanese concept of continuous improvement (Kaizen), innovation concept of improvement, need for continuous improvement, steps in implementing continuous improvement, 5S principles, Lean manufacturing history

7. Just in time- an introduction 5 Hrs

Spread of JIT movement, the new production system research association of Japan, core Japanese practices of JIT, creating continuous manufacture, Enabling JIT to occur, basic element of JIT, benefits of JIT

Text Books:

1. William J Stevenson "Operations Management" Mc Graw Hill,2018,12th Edition
2. Krajewski E. J. and Ritzman, 'Operations Management', Strategy and Analysis, Pearson Education, 2018.

Reference Books:

1. Monks, J.G., Operations Management, McGraw-Hill International Edition, 1987.
2. Pannerselvam. R., Production and Operations Management, Prentice Hall India, 2003
3. Chary, S.N., 'Production and Operations Management', Tata-McGraw HilI, 2004
4. Nicholas J. Aquilano, 'Fundamental of Operations Management', Irwin/McGraw-Hill; 4th edition.

Curriculum Content

Course Code: 15EMEE406 **Course Title: Supply Chain Management**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit – 1

1: Understanding Supply Chain - Meaning of SCM, Supply chain stages, Decision phases in supply chain (SC), Process view of SC, Examples of supply chain, Competitive and supply chain strategies, Achieving Strategic Fit and Expanding Strategic Scope. 5 Hrs

2: Supply Chain Drivers and Metrics - Drivers of SC performance, framework for structuring drivers, Facilities, Transportation, Information, Inventory, Obstacles to achieve Strategic Fit. 5 Hrs

3: Designing the Supply Chain Network - Role of distribution in SC, Factors influencing distribution network design, Design options for a distribution network, Role of network design in SC, Factors influencing network design decisions. 5 Hrs

Unit – 2

4: Sourcing in Supply Chain - Role of sourcing in SC, Supplier scoring and assessment, Supplier selection and assessment, Design collaboration. 4 Hrs

5: Transportation in Supply Chain - Role of transportation in SC & factors affecting transportation decisions, Modes of transportation and their performance characteristics, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation. 6 Hrs

6: Co-ordination in Supply Chain - Lack of SC Co-ordination & the Bullwhip Effect, Effect of lack of co-ordination on performance, Obstacles to co-ordination in the SC, Managerial levers to achieve co-ordination, Building a strategic partnership & trust within a supply chain and spot customers. 5 Hrs

Unit – 3

7: Role of Technology in Supply Chain - Role of IT in supply chain, Supply chain IT framework, Customer Relationship Management, Internal SCM, SRM. 5 Hrs

8: Emerging Concepts in Supply Chain - Role of E-Business in SC, E-Business frame work, Reverse Logistics; Reasons, Activities, Role, RFID Systems; Components, applications, implementation. 5 Hrs

Text Books:

1. Sunil Chopra and Peter Meindl'Supply Chain Management – Strategy, Planning and Operation, ' II ed 2003, Pearson Education Inc. ISBN: 81-297-0172-3.
2. Douglas Lambert and James Stock, Strategic Logistics Management", ', IV Ed, Irwi McGraw Hill. ISBN: 0-07-118122-9.

Reference Books:

1 Michael Hugos, 'Essentials of Supply Chain Management, ', Ed 2003, John Wiley and Sons.

2 Robert B. Handfield and Ernest L. Nichols, Supply Chain Redesign-Transforming Supply Chain into Integrated Value Systems, ed 2002, Pearson Education Inc. ISBN: 81- 297-0113-8.

3 Jeremy F. Shapiro and Duxbury, Modeling the Supply Chain", Ed 2002, Thomson Learning. ISBN: 0-534-37363.

4 Kapoor, Marketing Logistics: A Supply Chain Approach", Pearson Education Pvt Ltd. ISBN-8129702444.

Curriculum Content

Course Code: 15EMEE417 **Course Title: Modern Trends in Manufacturing**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit - I

1. Systematic Approach for Manufacturing Strategy: 4 Hrs

Seven Losses Regarding Productivity and Profitability, Feasibility Study of Productivity Improvement, Four Levels of Manufacturing Strategy.

2. Management and Productivity in Engineering: 8 Hrs

Definition of Engineering, Management and Management Engineering, Industrial Engineering and Productivity, Necessity of Facts and Work Measurement.

Productivity, Purpose of Productivity Improvement, Engineering Approach for Productivity, Three Levels of Improvement, Points of Successful Productivity, Relationship of Methods, Performance, and Utilization to Standard Time.

3. Concurrent Engineering: 3 Hrs

Introduction, importance of CE ,building blocks of CE, Important factors in concurrent engineering process , communication models, benefits and its tools.

Unit – II

4. Continuous Process Improvement: 8 Hrs

Introduction, Japanese concept of continuous improvement (kaizen), innovation concept of improvement, need for continuous improvement, tools for continuous improvement, steps in implementing continuous improvement, three pillars of continuous improvement, standardization, quality circles, suggestion systems, kaizen and management, kaizen umbrella, TPM, Six sigma, FMEA and discussion of few case studies**.**

5. Pull Production Systems: 7 Hrs

Introduction to TPS, KANBAN system, difference between pull and push system, other types of kanban, kanban rules, adapting to fluctuation in demand through kanban, a detailed kanban system example, supplier kanban and sequence schedule for kanban.

Unit - III

6. Quality Management Systems: 5 Hrs

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits. Occupational Health & Safety Management (OSHAS -18001) standards, Environmental Management Certification (ISO 14001) and its benefits to stakeholders.

7. **Six sigma:** 5 Hrs

Principles of Six sigma, project selection for six sigma, six sigma problem solving, design for six sigma, six sigma in service and small organization, six sigma and lean production, statistical thinking and application, statistical foundation, statistical methodology, design of experiments, analysis of variances

Text Books:

1. Masaki Imai, 'KAIZEN', McGraw Hill International.
2. Shigeyasu Sakamoto , "Beyond World-Class Productivity", Springer-Verlag London Limited 2010.
3. Dale H. Besterfield, "Total Quality Management", Pearson Education, Asia.

Reference Books:

1. Richard J. Schonberger, 'Japanese Manufacturing Techniques', The Free Press – Macmillan Publication.
2. James R. Evans and William M. Lindsay, 'The Management and Control of Quality'.

Curriculum Content

Course Code: 15EMEE407	**Course Title: Computational Heat transfer and Fluid Flow**	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit - I

1. Computational Fluid Dynamics (CFD) Solution Procedure: 7 Hrs

CFD applications in Research and Design, CFD Problem set-up-Creation of geometry, Mesh generation, Specification of boundary conditions. CFD Solver- Initialization and Convergence monitoring. Post Processor-Plots, data reports and Animation

2. Governing Equations for CFD: 8 Hrs

Continuity Equation, Momentum Equation, Energy Equation- Physical Interpretation and comments. The additional equations for turbulent flow, Generic form of Governing equations, Physical Boundary conditions

Unit – II

3. CFD Techniques: 7 Hrs

Discretization of Governing Equations- Finite difference method, Finite volume method, Converting governing equations into algebraic equations, Direct and Iterative solutions, Pressure- velocity coupling-SIMPLE scheme

4. CFD Solution Analysis: 8 Hrs

Consistency, Stability, Convergence, Accuracy and Efficiency of CFD solutions. Accelerating convergence, controlling solution errors, verification and Validation. Case studies related to fluid flow through channel and pipe bend

Unit - III

5. Practical Guidelines for CFD Simulation and Analysis: 5 Hrs

Grid generation- Guidelines on grid quality and grid design, Local refinement and solution adaption. Guidelines on Boundary conditions – Setting inlet, outlet and wall boundary conditions. Symmetric and Periodic Boundary conditions. Turbulence Modelling- Approaches, selection strategies, Case study: modeling of hydrofoil flows

6. Advanced Topics in CFD: 5 Hrs

Advances in Numerical methods and Techniques- Moving grids, Multigrids, Parallel Computing and Immersed boundary methods. Advances in computational models- Direct numerical Simulation(DNS), Large Eddy Simulation(LES), RANS-LES, Lattice Boltzmann method, Monte-Carlo method, Particle methods

Text Books:

1. Jiyuan Tu, Guan Heng Yeoh, Chaoqun, Computational Fluid Dynamics, Butterworth-Heinemann, 1st Edition 2008
2. Dale A. Anderson, John C. Tannehill and Richard H. Platcher.. Computational Fluid Mechanics and Heat Transfer; McGraw Hill Book Company, 2001

Reference Books:

1. Suhas V. Patankar, Numerical Fluid flow and Heat transfer, Hemisphere Series on Computational Methods in Mechanics and Thermal Science, 2nd Edn. 2000
2. Joel H. Ferziger and Milovan Peric, Computational Methods for Fluid Dynamics, 3rd Edition, Springer-Verlag, Berlin, 2001
3. Anderson J D, Computational Fluid Dynamics- The Basics with Applications, MGH, 2nd Ed. 2001

Curriculum Content

Course Code: 15EMEE408 **Course Title: Fundamentals of Gas Turbines**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit - I

1 Principles of Gas Turbine and Applications 4 Hrs

Introduction to turbo machines, history of gas turbines, gas turbine cycles and applications – (Land, Water/Marine and Air/Aero) Components of Gas Turbines (Compressors, Combustors, Turbines, Exhaust systems). Working of Gas Turbines.

2 Compressor 7 Hrs

Types of compressors, (Centrifugal and Axial), relative merits and demerits, Criteria for selecting type of compressors.

Centrifugal Compressors: Principle of operation, work done and pressure rise diffuser, compressibility effects, compressor characteristics and design procedures.

Axial Flow Compressor: Basic operations, elementary theory, factors affecting stage pressure ratio, Blockage in the compressor annulus, effect of compressibility, pre-whirl, supersonic flow, degree of reaction, design process, blade design, calculation of stage performance, off-design performance.

3 Fuel System 4 Hrs

Fuel specifications, Properties, Manual and automatic control, Fuel control systems, Fuel spray nozzles, Fuel heating, Effect of a change of fuel, Gas turbine fuels, Fuel requirements, Vapor locking and boiling, Fuel contamination control.

Unit – II

4 Combustion System 5 Hrs

Introduction, Combustion process, Enthalpy of formation, Fuel supply, Types of combustion chamber, Can-annular combustion chamber, Tube-annular combustion chamber, Annular combustion chamber, Combustion chamber performance, Combustion intensity, Combustion efficiency, Combustion stability Emissions, Materials.

5 Axial Flow Turbines 5 Hrs

Types of Turbines, spool shafts in aero engines, Advantages and disadvantages, Turbine geometry, Thermodynamic and Aerodynamic theory, velocity diagrams, Impulse turbine, turbine blade cooling. **Exhaust System**: Introduction, Exhaust gas flow, environmental considerations, construction and materials.

6 Prediction of Performance of Simple Gas Turbines 5 Hrs

Component characteristics, off design operation of the single shaft gas turbine, off-design operation of free turbine engine.

Unit - III

7 Cooling, Seals and Lubrication System 5 Hrs

The cooled turbine, methods of blade cooling, **Seals**: Non contacting seals - labyrinth seals, ring seals, Mechanical seals, Seal system, and dry gas seals, attrition coatings. **Lubrication Systems:** Basic oil system, lubrication management program, selection, oil contamination, filter selection, cleaning and flushing, oil sampling and testing

8 Materials of Gas turbine and Maintenance 5 Hrs

Introduction, Super alloys-Nickel based iron-nickel, Cobalt, Thermal barrier coating for jet engine alloys, advanced materials for jet engines**. Maintenance:** Introduction, On-wing maintenance, Scheduled maintenance, Unscheduled maintenance, Condition monitoring, Flight deck indicators, In-flight recorders, Ground indicators, Maintenance precautions, Trouble shooting, Adjustments, Ground testing.

Text Books:

1. Rolls Royce - "The Jet Engine" 5th edition, ISBN 0 902121 2 35, © Rolls-Royce plc 1986
2. Saravanamutto H.I.H, Rogers G.F.C., Cohen H, Gas Turbine Theory, 5th Edn., Pearson 2006

Reference Books:

1. Meherwan P. Boyce "Aircraft Propulsion and Gas Turbine Engines", CRC press, Taylor and Francis Group, London New York.ISBN 978-0-8493-9196-5
2. Meherwan P. Boyce "Gas Turbine Engineering Handbook (Fourth Edition)", 2012, Elesevier, ISBN-978-0-12-383842-1

Curriculum Content

Course Code:19EMEE401 **Course Title: Dynamics & Durability of Vehicles**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 80 ESA Marks: 20 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

PART A
(Dynamics of Vehicles)

Sl. No.	Content	Teaching Hours
1	Introduction - Kinematics & Compliance in vehicles;	02
2	Introduction to Roads and Loads;	02
3	Introduction to Durability in industry;	02
4	Data and Assumptions for multi-body systems - quality control;	03
5	Loads mapping for downstream use with examples;	03
6	Example applications using Multi-Body Dynamic Systems;	03
7	Introduction - Flex Body;	02
8	Durability example with and without Flex body;	03
9	Control systems in Multi-Body;	04
	Total-Theory	**24**
	Hands on Session	
01	Build a 2/3 wheeler suspension system to carry out K&C	08
02	Build a 3 wheeler suspension system to carry out loads extraction for durability	08
	Total-Hands-on	**16**
	TOTAL	**40**

PART B
(Durability of Vehicles)

Sl. No.	Content	Teaching Hours
1	Conduction, Convection, Steady state, Transient flows, Turbulence and its significance	02
2	Importance of BTMS, Current state of thermal management in EV	02
3	Types of battery packs for xEV	02
4	Heat load calculation for battery packs	02
5	How to approach design assessment of power pack for thermal management	02
6	Importance of data & assumptions (includes baselining)	02
7	Example case of using AcuSolve to assess a design	03
8	How to improve the thermal performance of a power pack design	02
9	Importance of Drag co-eff for vehicles moving at high speeds	02
10	Fast assessment of A-Surface design for drag using VWT	02
11	Introduction to thermal management in electronic circuits	03
	Total-Theory	**24**
	Hands on Session	
01	Assume 2 different designs and compare the thermal performance	07
02	Prepare 2 vehicle designs (external surface) and compute drag	07
	Total-Hands-on	**16**
	TOTAL	**36**

Text Books/Reference Books:

1. Dr. N.K. Giri, Automotive Mechanics, 8th Edition, 2008, Khanna Publication, New Delhi.
2. Nitin Ghokale, Practical finite element analysis, Finite to infinite, 2008.
3. Practical Aspects of Structural Optimization, Altair University, 3rd Edition.
4. Robin Hardy, Iqbal Husain, "Electric and Hybrid Vehicles". CRC Press, ISBN 0-8493-1466-6.
5. Ron Hodkinson and John Fenton, "Lightweight Electric/ Hybrid Vehicle Design". SAE International
6. John M. Miller, Propulsion Systems for Hybrid Vehicles" Institute of Electrical Engineers, London, ISBN0 863413366.
7. Automobile Electrical and Electronic systems, Tom Denton, Third Edition, 2004, SAE International, SAE ISBN 0 7680 147 2, Society of Automotive Engineers. Inc 400 common wealth Drive, Warrendale, PA 15096-0001 USA.

PROJECTS:

Part A

Objective: To carry out Dynamic and Durability of different chassis

Sl. No.	Content
01	Compare durability of conventional ICE chassis with Electric version

Part B

Objective: To carry out to analyze the heat produced during EV operation and streamline external airflow

Sl. No.	Content
01	Compute Delta T for a chosen EV battery pack
02	Improve drag performance of a chosen external vehicle element

Curriculum Content

Course Code: 20EMEW401 **Course Title: Senior Design Project**

L-T-P: 0-0-6 Credits: 6 Total Marks: 100

ISA Marks: 50 ESA Marks: 50 Exam Duration: 3 hrs

About The Course:

Senior Design project course uses User experience design (UX) approach to solve complex engineering problems. In this course students are challenged to solve frontier complex engineering problems in the field of smart manufacturing, green engineering, Design engineering and advanced materials. The objective of the course is to infuse life long qualities in students such as research, design thinking, innovation and entrepreneurial qualities. After this course students are capable to convert customer pain points into business solution.

VIII Sem Bachelor of Engineering (Mechanical Engineering)

Curriculum Content

Course Code: 15EMEE413 **Course Title: Aircraft Systems and Design**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Aircraft industry overview 3 Hrs

Evolution and History of Flight, Types Of Aerospace Industry, Key Players in Aerospace Industry, Aerospace Manufacturing, Airline deregulation, Structure of the industry, Airline economics, Aircraft design process, Aerospace Industry Trends.

2.Introduction to Aircrafts 5 Hrs

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.

3. Introduction to Aircraft Mechanical Systems 8 Hrs

Types of Aircraft 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.

Unit II

4. Basic Principles of Flight 6 Hrs

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. Aero foil Nomenclature, Types of Aero foil, Wing Section-Aerodynamic Center, Aspect Ratio, Effects of lift, Drag, speed, Air density on drag,

5. Overview of the Aircraft Design Process 7 Hrs

Introduction, Phases of aircraft Design, Aircraft conceptual Design Process, Conceptual stage, Preliminary Design, Detailed Design, Design Methodologies. Aerodynamic loads, Inertial loads, Loads due to engine, Actuator loads, maneuver loads, VN diagrams, Gust loads, Ground loads, Ground conditions, Miscellaneous loads. Sample problems.

6. Aircraft materials 3 Hrs

Introduction, Basic construction, material forms- Metallic materials and forms. Alloy designations, Mechanical properties- strength, static, stress strain curves, fatigue properties, crack growth.

Unit III

7. Analysis of plates 4 Hrs

Theory of plates- Analysis of plates for bending, stresses due to bending, plate deflection under different conditions, Plate buckling, Compression buckling, shear buckling and buckling due to in plane bending moments. Sample exercises.

8.Analysis of Beams 4 Hrs

Theory of beams- Symmetric beams in pure bending, deflection of beams, Unsymmetrical beams in bending. Sample exercises. Torsion in closed section beams, torsion in open section beams, multi cell sections. Sample exercises.

Text Books:

1. Daniel P Raymer, “Aircraft Design- A conceptual Approach”, 6, AIAA education series, 2012
2. T.H.G.Megson, “Aircraft Structures for Engineering Students”, 5, Elsevier science publications, 2012.

Curriculum Content

Course Code: 15EMEE414 **Course Title: Industrial Engineering Methods and Practices**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit I

1. Industrial engineering and productivity 6 Hrs

Evolution of industrial engineering, industrial engineering functions, recent advances in industrial engineering, productivity of materials, land, buildings, machines and manpower, measurement of productivity, factors affecting the productivity.

2. Methods engineering: 4 Hrs

Objective and scope of work-study and method-study, human factor in work-study, work-study and management, work-study and supervisor, work-study and worker.

3. Methods analysis techniques: 6 Hrs

Types of recording techniques, process chart symbols, construction of charts (operation process chart, flow process chart, two hand process chart, multiple activity chart, travel chart, string diagram etc.), applications of various charts with examples.

Unit II

4. Micro motion study: 5 Hrs

Purpose of micro motion study, fundamental hand motions, therbligs, micro motion study equipments, cycle graph and chronocyclegraph, simo-chart construction, memo motion study.

5. Work measurement & time Study practice: 6 Hrs

Concept of human work, terminology used in work measurement, theory of work measurement, work measurement techniques, definition of time study , time study equipments, basic time study procedure, conducting the time study

6. Performance rating & computing standard time: 5 Hrs

Necessity of performance rating, factors influencing rating, rating systems and their details, allowances and their details, problems in time study and time standards, standard time computation with examples.

Unit III

7. Ergonomics: 4 Hrs

Areas of study under ergonomics, system approach to ergonomics model, man-machine system, work capabilities of industrial worker, general principles for carrying out physical activities.

8. Design of man-machine system interface: 4 Hrs

Concept of fatigue in industrial worker, relationship between controls and displays, design of work place and effect of environment (influence of climate on human efficiency, influence of noise, vibrations and lighting system).

Text Books:

1. Jhamb L. C, Work Study & Ergonomics, 16th Edition Everest Publishing House 2009

Reference Books:

1. ILO, Introduction to Work Study, 4th Revised Edition International Labour Office 1992
2. Suresh Dalela and Sourabh,, Work Study and Ergonomics, 6th edition Standard

Publishers Distributors 2017

3. Vijay Sheth, Industrial Engineering Methods and Practices, 5th Edition 2012 Penram International Publishing (India) Pvt.Ltd.

Curriculum Content

Course Code: 15EMEE415 **Course Title: Advanced Energy Technology**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Unit - I

1. Solar Radiation, Measurement of Solar Radiation, Solar Radiation Geometry 8 Hrs

Energy source, India's production and reserves of commercial energy sources, need for non-conventional energy sources. Solar Radiation : Extra-Terrestrial radiation, spectral distribution of extra terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. Measurement of Solar Radiation : Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. Solar Radiation Geometry : Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time. Apparent motion of sum, day length, numerical examples.

2. Radiation Flux on a Tilted Surface, Solar Thermal Conversion 8 Hrs

Radiation Flux on a Tilted Surface : Beam, diffuse and reflected radiation, expression for flux on a tilted surface (no derivations) numerical examples. Solar Thermal Conversion : Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic, paraboloid) (Quantitative analysis); sensible heat storage, latent heat storage, application of solar energy water heating. Space heating and cooling, active and passive systems, power generation, refrigeration. Distillation (Qualitative analysis) solar pond, principle of working, operational problems.

Unit – II

3. Solar Photovoltaic Energy Conversion and PV System Applications 8 Hrs

Principles - Physics and operation of solar cells. Classification of solar PV systems, Solar cell energy conversion efficiency, I-V characteristics, effect of variation of solar insolation and temperature, losses. Solar PV power plants.Building-integrated photovoltaic units, grid-interacting central power stations, standalone devices for distributed power supply in remote and rural areas, solar cars, aircraft, space solar power satellites. Socio-economic and environmental merits of photovoltaic systems.

4. Fuel Cell Technology 8 Hrs

Fuel cell electrochemistry - Reaction rate - Butler Volmer equation-implications and use of fuel cell polarization curve - Conversion of chemical energy in electricity in a fuel cell. Cogeneration - Fuel cell electric vehicles - Fuel cell vehicles - Motor cycles and bicycles-airplanes - Fueling stations - Fuel cell power plant structure - Fuel processor and fuel cell

stack. Advantages and disadvantages. Problems with fuel cells. Research related to fuel cell development in the world and in India.

Unit - III

5. Energy Storage 4 Hrs

Introduction, energy demand, energy storage devices, types of battery, basic principle, components, cathode and anode materials, effect of nano-size on energy storage and electrode materials performance, electrochemical energy storage, super-capacitors, advantage of nanotechnology in energy storage devices.

6. Energy Policy 4 Hrs

Energy policy issues - Fossil Fuels, renewable energy, power sector reforms, restructuring of energy supply sector, energy strategy for future. Energy conservation act and National electricity policy and plan.

Reference Books:

1. David Merick, Richard Marshall, (2001), Energy, Present and Future Options, Vol. I and II, John Wiley and sons.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1986
3. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill,2007
4. Bagotsky .V.S, "Fuel Cells", Wiley, 2009.
5. Ibrahim Dincer and Marc A. Rosen, "Thermal Energy Storage Systems and Applications", 2nd Edition, John Wiley and Sons Ltd., 2011.

Curriculum Content

Course Code: 15EMEE416	**Course Title: Thermal Management of Electronic Equipment**	
L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit - I

1. Introduction 5 Hrs

Semiconductor Technology Trends, Temperature-Dependent Failures, Importance of Heat Transfer in Electronics, Thermal Design Process, Energy and Work, Macroscopic and Microscopic Energies, Energy Transfer and Heat Transfer, Equation of State.

2. Thermal Resistance Network 5 Hrs

Thermal Resistance Concept, Series Thermal Layers, Parallel Thermal Layers,
General Resistance Network, Thermal Contact Resistance, Thermal Interface Materials, Spreading Thermal Resistance, Thermal Resistance of Printed Circuit Boards (PCBs).

3.Thermal Specification of Microelectronic Packages 5 Hrs

Importance of Packaging, Packaging Types, Thermal Specifications of Microelectronic Packages, Package Thermal Resistance Network, Parameters Affecting Thermal Characteristics of a Package.

Unit – II

4. Cooling methods 10 Hrs

Conduction Cooling, Convection Cooling, Selection Of Fan, Liquid Immersion Cooling, Flow-Through Cooling Of CCAs, Cold wall Cooling, Cold Plates, Jet Impingement Cooling, Synthetic Jet Cooling, Thermoelectric Or Solid State Coolers, Cooling Using Phase Change– Cooling With PCM Materials, Micro/Mini Channel Cooling, Cooling Using Heat Pipes– Working Principle, Selection Of Heat Pipe Working Fluid; Selection Of Cooling Technique– Ranges Of Cooling Rates Of Different Cooling Methods, Selection Criteria.

5. Fins and Heat Sinks 5 Hrs

Fin Equation, Fin Thermal Resistance, Effectiveness, and Efficiency, Fins with Variable Cross Sections, Heat Sink Thermal Resistance, Effectiveness, and Efficiency, Heat Sink Manufacturing Processes.

Unit - III

6. Experimental Techniques and Thermal Design 5 Hrs

Flow Rate Measurement Techniques, System Impedance Measurement, Fan and Pump Curve Measurements, Velocity Measurement Methods, Temperature Measurement Techniques, Acoustic Noise Measurements, Importance of Experimental Measurements in Thermal Design.

7. Computer Simulations and Thermal Design 5 Hrs

Heat Transfer and Fluid Flow Equations: A Summary, Fundamentals of Computer Simulation, Turbulent Flows, Solution of Finite-Difference Equations
Commercial Thermal Simulation Tools, Importance of Modeling and Simulation in Thermal Design.

Text Books:

1. Younes Shabany, Heat Transfer: Thermal Management of Electronics, CRC Press Inc, 2010.
2. Ravi Kandasamy and Arun S. Mujumdar, Thermal Management of Electronic Components, Lambert Academic Publishing, 2010.

Reference Books:

1. Dave S. Steinberg, Cooling Techniques for Electronic Equipment, Wiley, 1991.
2. Sung Jin Kim, Sang Woo Lee, Air Cooling Technology for Electronic Equipment, Taylor & Francis, 1996.
3. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw-Hill, 2001.
4. Yunus A. Cengel, Heat Transfer: A Practical Approach. McGraw-Hill, 2003.

Curriculum Content

Course Code: 15EMEO401 **Course Title: Introduction to Nanoscience and Nanotechnology**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit - I

1 Introduction: 5 Hrs

Nanotechnology, Frontier of future- an overview
Length scales, Variation of physical properties from bulk to thin films to nanomaterials, - confinement of electron energy states (LDOS) in 0D, 1D,2D and 3D systems (qualitative treatment) ; Surface, size, shape and assembly effects.
Bonding and crystal structure in solids, colloids and core-shell structures. Chemical and molecular interaction, functionalziation, basis for biological self-assembly and self-organization.

2 Synthesis of nanomaterials: 6 Hrs

Top-down approach: Lithography and soft processes, Ball milling, chemical stamping.
Bottom-Up approach: Chemical Routes for Synthesis of Nanomaterials, Solvo-thermal and Sol-gel synthesis; Microemulsions, micelles and reverse micelles; Physical and Chemical Vapour Deposition, Sputtering, Laser ablation, Epitaxy.
Biological Methods: Role of plants and bacteria in metal (magnetic and non-magnetic) nanoparticle synthesis

3 Characterization: 5 Hrs

Electron Microscopy (SEM/TEM); Scanning Probes (STM, AFM), X-ray Photoelectron Spectroscopy (XPS), Optical Spectroscopy –IR/UV/VIS, Raman, Photoluminescence, X-ray Diffraction (including Debye-Scherrer method), Particle Size Analyser-light Scattering, Electrical (I-V and C-V), Porosity (BET method), Zeta potential, nano-indentation.

Unit – II

4 Properties: 6 Hrs

- Electronic and optoelectronic properties: Ballistic transport, Coulomb blockade, Diffusive transport,
- Dielectric properties: Polarisation, Ferroelectric behavior.
- Optical Properties: Photoconductivity, Optical absorption & transmission, Plasmons and Excitons, Luminescence and Phosphorescence.
- Magnetic properties: Nanomagnetism, magneto-resistance; Super Para Magnetism
- Thermal and Mechanical properties: changes in thermal transport, thermal transition temperatures, and interfaces with dissimilar materials. Improved hardness and toughness of metals and alloys

Biological: Permeability through biological barriers, molecular recognition and biological assemblies.

5 General Applications: 5 Hrs

- Electrical, Electronics & Photonics- Switching glasses, Semiconductor devices including LEDs and Solar Cells, Photonic Crystals.
- Computer Science- Storage devices and Quantum computing etc
- Mechanical and Civil: Composites and their properties.
- Environmental and Chemical: Porous materials, Catalysis, tracers etc
- Biotechnology- Interaction between bimolecular and nanoparticle surface, nano-bio assemblies, Nanosensors etc

Unit - III

6 Specific Applications: 13 Hrs

Part of this can be implemented as a student project that involves: literature-survey, project report and a Seminar (Power-Point) Presentations by groups of two students each (applications and students to be identified by teachers and monitored by one teacher each):

- Carbon and its allotropes: Fullerenes (C_{60}), Carbon nanotubes and Graphene:
- Applications of Carbon Nanotubes: Field emission, Fuel Cells, Display devices, Hydrogen storage.
- Nano-Medicine: Developments and protocols for diagnostics, drug delivery and therapeutics.
- Nanotribology: Friction at nanoscale, Nanotribology and wear-resistance, MEMS and NEMS
- Photo-electronics: Merger of photonics and electronics at nanoscale dimensions
- Single electron devices, molecular circuits
- Nanocomposites (i.e. metal oxide, ceramic, glass and polymer and core-shellbased);
- Biomemitics and Biomaterials, synthetic nanocomposites for bone, teeth replacement, DNA scaffolding.
- Nanosensors: Temperature Sensors, Chemical and gas Sensors, Light and radiation sensors

7 Demonstration through experiments: 4 Hrs

1. Chemical synthesis of Au and Ag nanoparticles and characterization by Optical spectroscopy of size dependence band-gap
2. Debye Scherrer analysis of XRD data of nanoparticles of different sizes.
3. Surface area and Pore size distribution of the BET data from a nano-porous material.
4. Some experiment to study mechanical strength of nanocomposites (nano-indentation)

8 Guest lectures from industries and research laboratory personnel: 1 Hrs

Societal issues of Nanotechnology: Prospects and Dangers; Commercial aspects, emerging industry and employment opportunities.

Text Books:

References:

1. Nano Materials- A.K.Bandyopadhyay/ New Age Publishers.
2. Nanocrystals: Synthesis, Properties and Applications.
3. C. N. R. Rao, P. John Thomas and G. U. Kulkarni, Springer Series In Materials Science.
4. Nano Essentials- T.Pradeep/TMH.
5. Plenty of Room for Biology at the Bottom-An introduction to bio-nanotechnology, E. Guzit, Imperial College Press

Books Recommended for extra reading:

1. Introduction to Nanotechnology, C P Poole & F J Owens, Wiley, 2003.
2. Understanding Nanotechnology, Scientific American 2002.
3. Nanotechnology, M Ratner & D Ratner, Prentice Hall 2003.
4. Nanotechnology, M Wildon, K Kannagara G Smith, M Simmons & B Raguse, CRC Press Boca Raton 2002.

Apart from the above, in view of the course being of advanced nature, the content of course will be supplemented with course material from the course instructors.

Curriculum Content

Course Code: 15EMEO402 **Course Title: Nanotechnology**

L-T-P: 3-0-0 Credits: 3 Contact Hrs: 3 hrs/week

ISA Marks: 50 ESA Marks: 50 Total Marks: 100

Teaching Hrs: 40 Exam Duration: 3 hrs

Unit - I

1. An overview of Nanoscience & Nanotechnology: 4 Hrs
Historical background – nature, scope and content of the subject – multidisciplinary aspects – industrial, economic and societal implications

2. Experimental Techniques and Methods: 5 Hrs
For investigating and manipulating materials in the nano scale – electron microscope – scanning probe microscope – optical and other microscopes

3. Fullerenes: 6 Hrs
Discovery, synthesis and purification – chemistry of fullerenes in the condensed phase – orientational ordering – pressure effects – conductivity and superconductivity – ferromagnetism – optical properties.
Carbon Nanotubes – synthesis and purification – filling of nanotubes – mechanism of growth – electronic structure – transport properties – mechanical and physical properties – applications

Unit – II

4. Self-assembled Monolayers: 5 Hrs
Monolayers on gold – growth process – phase transitions – patterning monolayers – mixed monolayers – applications

5. Semiconductor Quantum Dots: 5 Hrs
Synthesis – electronic structure of nanocrystals – how quantum dots are studied – correlation of properties with size – uses

6. Monolayer-protected Metal Nanoparticles: 5 Hrs
Method of preparation – characterization – functionalized metal nanoparticles –applications – superlattices

Unit - III

7. Nanobiology: 5 Hrs
Interaction between biomolecules and nanoparticle surfaces – materials used for synthesis of hybrid nano-bio assemblies – biological applications – nanoprobes for analytical applications – nanobiotechnology – future perspectives

8. Molecular Nanomachines:
Covalent and non-covalent approaches – molecular motors and machines – other molecular devices – single molecular devices – practical problems involved

Text Books:

1. T Pradeep (Professor, IIT Madras);NANO: The Essentials – Understanding Nanoscience and Nanotechnology; Tata McGraw-Hill India (2007)

Reference Books:

1. Richard Booker & Earl Boysen; Nanotechnology: Wiley (2005).
2. Di Ventra, Introduction to Nanoscale Science and Technology [Series: Nanostructure Science andTechnology]: et al (Ed); Springer (2004).
3. Demystified: Linda Williams & Wade Adams; Nanotechnology McGraw-Hill (2007)
4. Charles P Poole Jr, Frank J Owens, Introduction to Nanotechnology: Wiley India Pvt. Ltd., New Delhi, 2007

Curriculum Content

Course Code: 15EMEO403 **Course Title: Design of Experiments**

L-T-P: 3-0-0	Credits:3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40 hrs		Exam Duration: 3hrs

Unit I

Chapter 1. Introduction 04 Hrs

Strategy of experimentation, applications of experimental design, basic principles, guidelines for designing the experiments.

Chapter 2. Taguchi's approach to quality 04 Hrs

Definition of quality, Taguchi's quality philosophy, Quality loss function, off-line and on-line quality control, Signal and Noise Factors.

Chapter 3. Motivation for using ANOVA 08 Hrs

Introduction to analysis of variance (ANOVA), test of hypothesis, limitations of testing of hypothesis for difference between the means of two samples, testing of hypothesis using chi-square, t-test and F-test, one-way ANOVA examples.

Unit II

Chapter 4. Factorial Experiments 08 Hrs

Two-Factor Factorial Design, General Factorial Design, 2^2, 2^3 and 2^4 Full Factorial Designs, Exercises

Chapter 5. Fractional Factorial Designs 04 Hrs

One half fraction of 2^k Design, One quarter fraction of 2^k Design, General 2^{k-p} Fractional Factorial Design , Exercises

Chapter 6. Regression Approach 04 Hrs

Simple Regression and Multiple regressions, Types of designs, Central composite design and Box-Behnken design, Exercises

Unit – III

Chapter 7. Orthogonal Array Experiments 04 Hrs

Introduction, Design of Orthogonal arrays, ANOVA for Orthogonal Array.

Chapter 8. Robust Parameter Design 04 Hrs

Introduction, Signal-to-Noise ratio, ANOVA for S/N ratio, Steps of S/N approach.

Text Books:

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley and Sons.
2. Madhav S. Phadke, "Quality Engineering using Robust Design", Prentice Hall PTR, Englewood Cliffs, New Jersey.
3. R. Panneerselvam, "Design and Analysis of Experiments- R PHI Learning Private Limited,New Delhi.

Reference Books:

1. Robert H. Lochner and Joseph E. Matar, "Designing for Quality- an Introduction Best of Taguchi and Western Methods or Statistical Experimental Design", Chapman and Hall.
2. Philips .J. Ross, "Taguchi Techniques for Quality Engineering", McGraw Hill, New York.

Curriculum Content

Course Code: 15EMEO404 **Course Title: Engine Management Systems**

L-T-P: 3-0-0	Credits: 3	Contact Hrs: 3 hrs/week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Unit - I

1 Basics of Gasoline (SI) Engine 6 Hrs

Introduction, Operating concept, Valve timing, Stages of combustion, Combustion knock, Effect of engine variables on knock, Torque and power, Engine efficiency, Specific fuel consumption, Fuels for spark ignition engines.

2 Gasoline engine management 4 Hrs

Technical requirement, Cylinder charge control, Air-charge control, Variable valve timing, controlled charge flow, A/F –mixture formation, Ignition- Battery ignition systems, Electronic ignition system, Inductive ignition system, Ignition coils, Spark plugs.

3 Gasoline fuel injection 5 Hrs

Fuel supply for manifold injection, Operating concept, Electromagnetic fuel injectors, Types of fuel injection, Fuel supply for gasoline direct injection, Operating concept, Rail, High pressure pump, Pressure control valve, High pressure injector, Combustion process, A/F mixture formation, Operating modes

Motronic engine management, ME-Motronic, MED-Motronic.

Unit – II

4 Basics of Diesel Engine 5 Hrs

Method of operation, Stages of combustion, Operating statuses, Fuel-injection system, Combustion chambers-Di and IDI, Diesel fuels-properties, Alternative fuels- Alcohols, Vegetable oils.

Cylinder Charge Control - Intake air filters, Swirl flaps, Superchargers & Turbochargers, Exhaust Gas Recirculation.

5 Diesel fuel injection 5 Hrs

Requirements of ideal fuel injection system, Basic Principles of fuel supply - Mixture distribution, Start of fuel injection and delivery, Injected fuel quantity, Injection characteristics, Injection pressure, Injection direction and number of injection jets. Fuel supply system.

6 Fuel injection pumps 5 Hrs

Design and method of operation of in-line fuel injection pump systems, Distributor fuel injection pump systems, Unit injector system and unit pump system, Common rail system.

Nozzles and Nozzle holders - Pintle nozzles, Hole type nozzles, future development.

Unit - III

7 Engine Exhaust Emission Control 5 Hrs

Formation of NO_X, HC/CO mechanism , Smoke and Particulate emissions, Methods of controlling emissions- Thermal converter, Catalytic converter and Particulate Trap, Diesel Smoke and its control, Emission (HC, CO, NO and NO_X) measuring equipments, Emission norms.

8 Recent Trends in IC Engines 5 Hrs

Dual fuel Engine, Homogeneous Charge Compression Ignition Engine (HCCI), Reactivity controlled compression ignition engine (RCCI), Lean Burn Engine, VVT engines,

Text Books:

1. Robert Bosch Gmbh, 2004, Gasoline Engine Management – 2nd Edition
2. Robert Bosch Gmbh, 2004, Diesel Engine Management " 3rd Edition

Reference Books:

1. Mathur and Sharma, Dhanpal Rai & sons, A Course in I.C.Engine –New Delhi
2. John B. Heywood, Internal Combustion Engine Fundamentals –McGraw- Hill