1.1.2: Syllabus Revised Courses of PG Machine Design

Course Code: **16EMDC706**	Course Title: **Theory of Vibrations with Application**	
L-T-P-SS:**4-1-0-0**	Credits:**05**	Contact Hrs: **50**
ISA Marks: **50**	ESA Marks: **50**	Total Marks: **100**
Teaching Hrs: **50**		Exam Duration: **03 Hours**

No.	Content	Hrs
1	**Review of Mechanical Vibrations** Undamped and damped free vibrationsof single degreeof freedom systems: Importance of the study of vibration, Classification, Free vibration of an undamped translational systems, Equation of motion and natural frequency of systems, Types of damping, Response of single degree freedom viscous damped systems, Logarithmic decrement, Systems with Coulomb damping.	**07**
2	**Harmonically Excited Vibration** Introduction, Response of a viscous damped system under harmonic force, Response of a system under the harmonic motion of the base, Relative motion, Response of a system under rotating and reciprocating unbalance, Vibration isolation, transmissibilityandForce transmitted.	**06**
3	**Transient Vibrations of Single Degree of Freedom Systems** Impulse excitation, Arbitrary excitation, Laplace transform formulation, step input, Pulse excitation, Shock response spectrum, Shock isolation.	**06**
4	**Multi Degree-of-Freedom Systems** Introduction, Two degree-of-freedom systems:Free vibration analysis of an un-damped system, Torsional system, Coordinate coupling. Influence Coefficients, Natural frequencies using Matrix Iteration Method, Fundamental frequency usingDunkerley'smethod and Rayleigh's Method, Torsional Systems, Standard Eigenvalue problem-Choleskidecomposition.	**07**
5	**Vibration Control** 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:Undampedanddamped dynamic vibration absorber.	**06**
6	**Nonlinear Vibration** Introduction; Examples of nonlinear vibration problems-Simple pendulum, Mechanical chatter, Belt friction system, Variable mass system, Exact methods, Approximate analytical methods-Basic philosophy, Lindstedt s Perturbation method, Iterative method, Ritz-Galerkinmethod, Subharmonic and Superharmonic Oscillations, Systems with time-dependent coefficients (Mathieu equation), Stability of equilibrium states-Stability analysis, Classification of singular points, Limit cycles.	**06**
7	**Vibration Measurement and Condition Monitoring** Introduction, Transducers, Vibration pickups, Frequency measuring instruments. Signal analysis: Spectrum analyzers, Bandpass filter. Dynamic testing of machines and structures, Experimental modal analysis: Exciter, Transducer, Signal conditioner and analyzer. Machine condition monitoring and diagnosis: Vibration severity criteria, Machine maintenance techniques, Machine condition monitoring techniques, Vibration monitoring techniques.	**06**
8	**Continuous Systems** Vibrating string, Longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.	**06**

References:

1. Mechanical Vibrations, - S. S. Rao, Fifth edition, Pearson Education, 2011.
2. Theory of Vibration with Applications, - William T. Thomson, Marie Dillon Dahleh and ChandramouliPadmanabhan, Fifth edition, Pearson Education, 2008.
3. Mechanical Vibrations: Theory and applications -S Graham Kelly, Cengage Learning , 2012.
4. Vibrations Problem Solving Companion- Rao V. Dukkipti, J. Srinivas, Narosa, 2007
5. Mechanical Vibration Practice with Basic Theory- V. Ramamurti, Narosa, 2000

Course Code: 16EMDP702	Course Title: Design 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: 24		Exam Duration: 120 min

Content	Hrs
➢ Kinematic Analysis of basic mechanisms using Multi body dynamic software. ➢ Fabrication and mechanical testing of Natural fiber reinforced Polymer Composite Materials (PMC). ➢ Machine condition monitoring. ➢ Real time collision detection system to detect ➢ Vibration overload.	**48**

***Materials and Resources Required*:**

1. S. S. Rao, **Mechanical Vibrations**, Pearson Education, 4th edition, 2004.
2. R. A. Caollacatt Chapman "**Mechanical Fault Diagnosis and Condition Monitoring**"- Chapman and hall 1977.
3. Robert M.Jones - **Mechanics of Composite Materials,** McGraw Hill Kogakusha Ltd.1998.

Course Code: 16EMDC801	Course Title: Machine Tool Design and Analysis	
L-T-P-S: 4-0-0-0	Credits: 4	Contact Hrs: 4
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 4		Exam Duration: 3 hrs

Content	Hrs
Unit - 1	
Chapter No. 1. Machine tool basics Introduction to machine tools, Design of shafts, keys, splines, poly V-belts, gears. Calculation of forces in lathe and milling machines. Calculation of motor power for a given application. Theory of metal cutting. Standards for bought out items like cap screws, hex bolts, nuts, washers etc. Selection of preferred sizes, Renard series.	10 hrs
Chapter No. 2. Elements of CNC Steels, CI used in M/C tools & heat treatment of steels, Surface finish and methods of improving them. GD&T and how to represent them in drawings. Types of ball and roller bearings, Spindle assemblies of turning and VMC machines, IS standards for various Lathe and CNC milling standards. Design of spindles for rigidity, speed, lubrication etc	10 hrs
Chapter No. 3. SQC & Testing of CNC Cp, Cpk calculations and their importance in CNC machines. How to establish positioning and repeatability by JIS method. Elements of CNC machines and introduction to CNC machines. Testing of CNC lathes and VMC machines.	7 hrs
Chapter No. 4. Selection of CNC elements Ballscrews, LM guide ways-types, accuracy, and method of selection for CNC machines. Calculation of static and dynamic loads etc. Servomotors, spindle motors and selection of the same for a specific application. Principle of operation of incremental and absolute encoders	6 hrs
Chapter No. 5. Hydraulics in CNC Design of hydraulic system for a lathe. Introduction to X, Y and Z assembly and how to compensate for thermal expansion of ballscrews.	7 hrs
Chapter No. 6. CNC assemblies Headstock, axes table, Declamping mechanisms of a tool in VMC. Ergonomics and aesthetics of machine tool	4 hrs
Chapter No. 7. Electrical & Electronics of CNC Basic electronics for mechanical engineers. Electricals for mechanical engineers-explanation of switch gear elements used in machine tools. Reading electrical diagrams and design of electrical system for CNC machines. PLC programme and ladder logics.	6 hrs

Course Code: **17EMDP701**	Course Title: **Finite Element Analysis 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: 120 min

Content	**Hrs**
➢ Modeling of any automotive engine component using modeling software as two and three dimensional. ➢ Static analysis of above modelled components using different possible types of elements and materials. ➢ Non-Linear Analysis of 3D model created for any possible Nonlinearity criteria viz - Geometric, Material, and Contact. ➢ Dynamic Analysis of 3D model created by Modal or Harmonic or Transient for different Boundary Conditions. ➢ Thermal analysis of 3D model created. ➢ Fatigue Analysis & Fatigue life Prediction of created 3D model. ➢ Using theoretical concepts validation of the above analysis to be carried out. ➢ Report to be submitted in the prescribed format.	**24**

***Materials and Resources Required*:**

1. Nitin S. Ghokale, Sanjay Deshapande, Sanjeev Bedekar, “Practical Finite Element Analysis”, Vikas Book house, Pune, 2008
2. Sham Tickoo, “Ansys Workbench 14.0 for Engineers and Designers-,A Tutorial Approach”, Dream Tech Press, 2013
3. Liu G. R. and Quek S. S., “The Finite Element Method” A practical Course, 2nd Edition, Elsevier, 2014.
4. http://148.204.81.206/Ansys/150/ANSYS%20Mechanical%20Users%20Guide.pdf
5. http://abaqus.software.polimi.it/v6.12/pdf_books/CAE.pdf

Course Code: 17EMDC707	Course Title: Fracture Mechanics	
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: 180 min

No	Content	Hrs
1	**Introduction:** History andoverview, Fundamental concepts, Fracture mechanics in Metals, Ductile fracture, Cleavage, The Ductile-Brittle transition, Inter-granular fracture, Modes of Fracture Failure;	**04**
2	**Energy Release Rate:** Introduction, The Griffith energy balance, The energy release rate, Instability and the R-Curve, Thin plate vs Thick plate, Critical Energy release rate;	**06**
3	**Stress Intensity Factor:** Introduction, Stress analysis of cracks, The stress Intensity Factor, Relationship between K and Global behavior, Effect of Finite size, Principle of superposition, Weight Functions, Relationship between K and G, Crack tip plasticity, Plane stress versus plane strain, K as a failure criterion, Mixed mode fracture	**08**
4	**Elastic Plastic Fracture Mechanics:** Crack tip opening displacement**,** The J Contour Integral, Relationships between J and CTOD, Crack growth resistance curves, J-controlled fracture, Crack tip constraint under large scale yielding, HRR field;	**08**
5	**Mixed Mode fracture:** A simple Elliptical Model, Maximum Tensile Stress Criterion, Strain Energy Density Criterion, Maximum Energy Release Rate Criterion, Experimental Verifications;	**04**
6	**Fracture Toughness testing of metals:** General Considerations, K_{IC} testing, K-R Curve testing, J testing of metals, CTOD testing, Dynamic and crack arrest toughness, Fracture testing of weldments.	**06**
7	**Fatigue Crack Propagation** Similitude in fatigue, Empirical fatigue crack growth equations, Crack Closure, Variable amplitude loading and retardation, Growth of short cracks, Micro-mechanisms of fatigue, Experimental measurement of fatigue crack growth, Damage Tolerance.	**08**
8	**Dynamic and Time-DependentFracture** Dynamic Fracture and Crack Arrest, Rapid Loading of a Stationary Crack, Rapid Crack Propagation and Arrest, Crack Speed, Elasto dynamic Crack-Tip Parameters, Dynamic Toughness, Crack Arrest, Dynamic Contour Integrals, Creep Crack Growth, The C* Integral, Short-Time vs. Long-Time Behavior, The Ct Parameter , Primary Creep	**06**

Reference Book:

1. T.L.Anderson, “Fracture Mechanics -Fundamentals and Applications”, CRC Press, 2nd Edition, 1995.
2. Prashant Kumar, “Elements of Fracture Mechanics”, Tata McGraw-Hill Education Pvt. Ltd. New Delhi, 2010.
3. David Broek, ArtinusNijhoff , “Elementary Engineering Fracture Mechanics” , London, 1999.
4. J. F. Knott, “Fundamentals of Fracture Mechanics”, Bureworth, 2000.
5. C.T.Sun and Z.H.Jin , “Fracture Mechanics”, Elsevier, 2012.

Course Code: **17EMDC708**	Course Title: **Research Methodology**
L-T-P: 2-1-0	Contact Hrs: 4 hrs / week
ISA Marks: 100	Total Marks: 100
Teaching Hrs:25	Credits: 3

Content	**Hrs**
Research: Definition, Characteristics and Objectives; Types of Research, Research Methodology, Research Process, Literature Review, Review concepts and theories, Formulation of Hypothesis, Research design, Data collection, Processing and analysis of data collected, Interpretation of data, Computer and internet: Its role in research, Threats and Challenges to research, Writing a research paper, research project, Thesis, Research ethics, Citation methods and rules. Case studies.	**25**

Reference Book:

1. Kothari C. R. "Research Methodology – Methods & Techniques", VishwaPrakashan, A Division of New Age International Pvt. Ltd., 2008.
2. Ranjit Kumar, "Research Methodology – A step by step guide for Beginners", 3rd Edition, Pearson Edition, Singapore, 2011.
3. Dawson Catherine, "Practical Research Methods", UBS Publishers, New Delhi, 2002.

Course Code: **17EMDE707**	Course Title: **Mechanical Behavior of Materials**	
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: 180 min

No	**Content**	**Hrs**

1	**Introduction:** Materials in design , The evolution of engineering materials , Fundamental Characteristics of Composites, Interfaces in Composites, Fracture in Composites, , Functionally Graded Materials. Macro Mechanics of a Lamina**:** Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Numerical problems.	**10**
2	**Plastic Deformation and Dislocation Theory:** Lattice defects, deformation in a perfect lattice, dislocation in crystal and deformation, strain hardening of single crystal, low angle grain boundaries, Stress field of a dislocation, forces between dislocations, dislocation climb and jog, interaction with vacancy and impurity. Multiplication of dislocation and pile-up; Plastic Deformation in Tension, Plastic Deformation in Compression Testing, Plastic Deformation of Polymers.	**10**
3	**Behavior under Tensile loading:** Engineering and true stress-strain curves, yield point and strain ageing, strength coefficient and strain hardening exponent, necking or instability in tension, Effect of gauge length on strength and elongation, Effect of strain rate and temperature on tensile properties. Yield point phenomenon. Fracture under tension and torsion; Solid-Solution Strengthening, Mechanical Effects Associated with Solid Solutions.	**10**
4	**Deformation under cyclic loading:** Stress cycle, fatigue curve, fatigue fracture characteristics. Fatigue testing and testing machines, determination of fatigue strength. Factors affecting fatigue- contact under pressure. Under stressing, coaxing and overstressing. Effect of metallurgical impurities;	**10**
5	**Deformation under high temperature and Superplasticity of Metals**: Creep strain and creep-time curves, low temperature and high temperature creep theories. Fracture at elevated temperature, Stress rupture, Creep-Induced Fracture, Creep in Polymers, Heat-Resistant Materials, Superplasticity, Creep parameters and practical applications. Effect of metallurgical variables and materials for high temperature applications;	**10**

Reference Book:

1. Marc Andre Meyers and Krishan Kumar Chawla: “Mechanical Behavior of Materials”, Cambridge University Press, 2nd Edition 2008.
2. Norman Dowling, “Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture and Fatigue”, Prentice Hall, 4th Edition 2012.
3. G.E. Dieter: “Mechanical Metallurgy”. McGraw-Hill, 3rd Edition 1988.
4. Keith Bowman, “Mechanical Behavior of Materials”, Wiley international edition, 2003.
5. Thomas Courtney, “Mechanical Behavior of Materials”, Waveland Press Inc; 2nd Edition, 2005.
6. J. Roesler, H. Harders, M. Baeker, “Mechanical Behavior of Engineering Materials”, 1st Edition, Springer, 2007
7. W.F. Hosford, “Mechanical Behavior of Materials”, 2nd Edition, Cambridge University Press, 2009.

Course Code: 19EMDE702	**Course Title: Mechanics of Solids**	
L-T-P: 4-0-0	Credits: 4	Contact Hrs: 5
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 3 hrs

Contents	**hrs**
1. Analysis of stress Introduction, body force, surface force and stress vector, the state of stress at a point, rectangular stress components, stress components on an arbitrary plane, equality of cross shears, differential equations of equilibrium, principal stresses, Mohr's circles for the three-dimensional state of stress, octahedral stresses, decomposition into hydrostatic and pure shear states.	**07**
2. Analysis of Strain Introduction, deformation, strain displacement relations, state of strain at a point, strain tensors, cubical dilatation, principal strains, spherical and deviator strain tensors, octahedral strains, compatibility conditions.	**07**
3. Stress-Strain Relations for Linearly Elastic Solids Generalized Hooke's law, stress–strain relations for isotropic materials, transformation of compatibility condition from strain components to stress components, relations between the elastic constants, Saint Venant's principle and uniqueness theorem.	**06**
4. Two Dimensional Problems in Cartesian Co-ordinates Plane stress and plane strain problems, Airy's stress function, solution of two-dimensional problems by the use of polynomials, pure bending of a beam, bending of a narrow cantilever beam under end load, simply supported beam subjected to point load and uniformly distributed load, use of Fourier series to solve two dimensional problems.	**07**
5. Two Dimensional Problems in Polar Co-ordinates General equations, biharmonic equation, stress distribution symmetrical about an axis, strain components in polar co-ordinates, thick-walled cylinders, rotating disks of uniform thickness, effect of circular holes on stress distribution in plates.	**07**
6. Torsion of Prismatic Bars Introduction, general solution of the torsion problem, torsion of circular, elliptical and equilateral triangular cross section bar, membrane analogy, torsion of thin tubes.	**06**
7. Thermal Stresses	**05**

Introduction, thermoelastic stress–strain relations, thin circular disk; temperature symmetrical about centre, long circular cylinder, normal stresses in straight beams due to thermal loading.	
8. Introduction to Plasticity Mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, theories of plastic flow, Tresca and Von Mises yield criteria, discussion of plasticity conditions, experimental evidence for yield criteria.	**05**

Reference Books:

1. L S Srinath, Advanced Mechanics of Solids, 3rd Edition, Tata Mcgraw Hill Company, 2009.
2. T.G. SitharamandL. Govindaraju,Elasticity for Engineers,I K International Publishing House, 2016.
3. Dr. Sadhu Singh, Theory of Plasticity and Metal Forming Process, 3rd Edition, Khanna Publishers, 2011.
4. J. Chakraborty, Theory of Plasticity, 3rd Edition, Butterworth-Heinemann, 2006.