Course Code: **16EMDC706**	Course Title: **Theory of Vibrations with Applications**	
L-T-P: **4:1:0**	Credits: 5	Contact Hrs: 4 / week
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 180 min

No	Content	Hrs
1	**Review of Mechanical Vibrations** Undamped and damped free vibrations of single degree of 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, transmissibility and Force transmitted.	**06**
3	**Transient Vibrations of Single Degree of Freedom Systems** Impulse excitations, 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 using Dunkerley's method and Rayleigh's Method, Torsional Systems, Standard Eigenvalue problem-Choleski decomposition.	**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: Undamped and damped 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-Galerkin method, 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,	**06**

	Machine maintenance techniques, Machine condition monitoring techniques, Vibration monitoring techniques.	
8	**Continuous Systems** Vibrating string, Longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams.	**06**

Reference Book:

1. S. S. Rao, "*Mechanical Vibrations*", 5th edition, Pearson Education, 2011.
2. William T. Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, "*Theory of Vibration with Applications*", 5th edition, Pearson Education, 2008.
3. S Graham Kelly, "*Mechanical Vibrations: Theory and applications*", Cengage Learning, 2012.
4. V. Dukkipti, J. Srinivas, "*Vibrations Problem Solving Companion*", Alpha Science International Ltd, 2005.
5. V. Ramamurti, "*Mechanical Vibration Practice with Basic Theory*" Narosa, 2000.

Course Code: **16EMDP702** Course Title: **Design Lab**

L-T-P: 0-0-2 Credits: 2.0 Contact Hrs: 4 hrs/week

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

Teaching Hrs: 24 Sessions (2 Hours Each) Exam Duration: 3 Hours

No	Experiment Title	Hours Required.
1	Fabrication and mechanical testing of Polymer Composite Materials (PMC)	**14**
2	Machine condition monitoring includes 1. Spindle imbalance 2. Machine leveling	**04**
3	Real time collision detection system to detect 1. Collisions 2. Vibration over load	**04**
4	Preparation and fracture toughness of CT specimen	**02**

***Materials and Resources Required*:**

Books/References:

1. Robert M.Jones, "*Mechanics of Composite Materials",* McGraw Hill, Kogakusha Ltd.1998.
2. R. A. Caollacatt Chapman "Mechanical Fault Diagnosis and Condition Monitoring"- Chapman and Hall 1977.
3. Prashant Kumar, "*Elements of Fracture Mechanics*", Tata McGraw-Hill Education Pvt. Ltd. New Delhi, 2010.

Course Code: **16EMDC801**	Course Title: **Machine Tool Design and Analysis**	
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	**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**
2	**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**
3	**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.	**07**
4	**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	**06**
5	**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.	**07**
6	**Chapter No. 6. CNC assemblies** Headstock, axes table, Declamping mechanisms of a tool in VMC. Ergonomics and aesthetics of machine tool	**04**
7	**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.	**06**

Reference Book:

1. CMTI, Machine tool design hand book, Tata McGraw-Hill, 1982
2. HMT, Mechatronics, Tata McGraw-Hill, 1998
3. Fanuc, Fanuc drives, spindle motors and servo motors manual
4. Material prepared and compiled by Mechanical Engg dept,, KLE-Tech Hubballi-31, 2016.

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 component 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: **17EMDC708**	Course Title: **Research Methodology**	
L-T-P: 2-1-0	Credits: 3	Contact Hrs: 4 hrs / week
ISA Marks: 100		Total Marks: 100
Teaching Hrs:40		

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.	**24**

Reference Book:

1. Kothari C. R. "Research Methodology – Methods & Techniques", Wishwa Prakashan, 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:**19EMDC701**	Course Title: **Computational Methods in Engineering Analysis**	
L-T-P: 3-1-0	Credits: 4	Contact Hrs: 5
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
Teaching Hrs: 40		Exam Duration: 3 hrs

Contents	**Hrs**
1.Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modelling and Engineering problem solving: Simple mathematical model, Conservation Laws of Engineering.	**06**
2.Roots of Equations: Bracketing methods-Graphical method, Bisection method, False position method, Newton- Raphson method, Secant Method. Multiple roots, Simple fixed point iteration.	**06**
3.Roots of polynomial- Polynomials in Engineering and Science, Muller's method, Bairstow's Method Graeffe's Roots Squaring Method.	**06**
4.Numerical Differentiation and Numerical Integration: Newton –Cotes and Guass Quadrature Integration formulae, integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae.	**06**
5.System of Linear Algebraic Equations and Eigen Value Problems: Introduction, Direct methods, Cramer's Rule, Gauss Elimination Method, Gauss-Jordan Elimination Method, Triangularization method, Cholesky Method, Partition method, error Analysis for direct methods, iteration Methods.	**06**
6.Eigen values and Eigen Vectors: Bounds on Eigen Values, Jacobi method for symmetric matrices, Givens method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method, Inverse power method.	**05**
7.Linear Transformation: Introduction to Linear Transformation, The matrix of Linear Transformation, Linear Models in Science and Engg.	**05**

Reference Books:

1. Erwin Kreyszig , Advanced Engineering Mathematics, 10th Edition , Willely India, 2016.
2. S.S.Sastry, Introductory Methods of Numerical Analysis, PHI, 2005.
3. Steven C. Chapra, Raymond P.Canale, Numerical Methods for Engineers, Tata Mcgraw Hill, 4th Ed, 2002.
4. M K Jain, S.R.K Iyengar, R K. Jain, Numerical methods for Scientific and engg computation, New Age International, 2003.
5. Pervez Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
6. David. C. Lay, Linear Algebra and its applications, 3rd edition, Pearson Education, 2002.