Course Code: **15EMDC701**	Course Title: **Failure Analysis and Design**	
L-T-P: 4:0:0	Credits: 4	Contact Hrs: 4 / week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 180 min

No	Content	Hrs
1	**Introduction:** 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.	**06**
2	**Fatigue of Materials**: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.	**06**
3	**Surface Failure:** Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.	**08**
4	**Stress-Life (S-N) Approach:** S-**N** curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.	**06**
5	**Strain-Life (ε-N)approach**: 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.	**06**
6	**Notches and their effects:** Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.	**08**
7	**Fatigue from Variable Amplitude Loading:** Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.	**05**
8	**Load Determination:** Loading classes, Load analysis, Vibration loading, Impact loading, Beam loading.	**05**

Reference Book:

1. Metal Fatigue in engineering, Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens, Henry o. Fuchs, John wiley Newyork, Second edition. 2001.
2. Machine Design, An Integrated Approach, Robert L. Norton, Pearson. Second edition. 2000.
3. Failure of Materials in Mechanical Design, Jack A Collins, John Wiley & Sons; Second edition. 1993.
4. Fatigue of Materials, S. Suresh. Cambridge University Press; Second edition. 1998.

Course Code: **15EMDC703**	Course Title: **Finite Element Practice in Machine Design**	
L-T-P: 4:0:0	Credits: 4	Contact Hrs: 4 / week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 180 min

No	Content	Hrs
1	**Introduction:** Introduction to FEA, General FEM procedure, • Approximate solutions of differential equations: FDM method, W-R technique, collocation least square sub-domain and Galerkin method Numerical integration, Gauss quadrature in 2-D and 3-D, Structure of FEA program, Pre and Post processor, commercially available, standard packages, and desirable features of FEA packages, • Principal of minimum total potential, elements of variational calculus, minimization of functional, Rayleigh-Ritz method, Formulation of elemental matrix equation, and assembly concepts.	**10**
2	**One Dimensional FEM:** Coordinate system: Global, local, natural coordinate system, Shape functions: Polynomial shape functions, Derivation of shape functions, Natural co-ordinate and coordinates transformation, Linear quadratic and cubic elements, Shape functions using Lagrange polynomials. Convergence and compatibility requirement of shape functions, One dimensional field problems: structural analysis (step-bar, taper-bar), Structural analysis with temperature effect, Thermal analysis, heat transfer from composite bar, fins.	**10**
3	**Two Dimensional FEM** Trusses, Thermal effects in truss members, Beams, Two dimensional finite elements formulations, Three noded triangular element, Four-noded rectangular element, Four-noded quadrilateral element, derivation of shape functions: natural coordinates, triangular elements, and quadrilateral elements, Six-noded triangular elements, Eight-noded quadrilateral elements, Nine noded quadrilateral element, Strain displacement matrix for CST element	**10**
4	**Three dimensional elements**: Tetrahedron, Rectangular prism (brick), Arbitrary hexahedron, Three Dimensional polynomial shape functions, Natural co-ordinates in 3D, Three dimensional Truss(space trusses), Introduction to material models: Introduction to plasticity (Von-Mises Plasticity), Hyper –elasticity. Generating and using experimental data to model material behaviour, Errors in FEA, sources of errors, method of elimination, Patch test.	**10**
5	**Penalty Method,** Lagrange methods, Multipoint Constraints, Concept of Master/Slave entities, Examples of Contact problems, Iso-parametric concepts, basic theorem, Iso-parametric, super-parametric, sub-parametric elements, Concept of Jacobian. Finite element formulation of Dynamics, application to free-vibration problems, Lump and consistent mass matrices, Eigen value problems, Transient dynamic problems in heat transfer and solid mechanics, Convergence, Impact of Mesh quality on convergence.	**10**

Reference Book:

1. Reddy J. N., “Finite Element Method”, McGraw-Hill
2. S.S.Rao, “The Finite Element Method in Engineering” , 4th Edition, Academic Press, Elsevier
3. Desai and Abel, “Introduction to Finite Elements Methods”, CBS Publication
4. Tirupati R. Chandrupatla and Ashok D.Belegundu, “Introduction to Finite Elements in Engineering”
5. David Hutton, “ Fundamentals of Finite Element Analysis”, Tata McGrawHill, 2005
6. Kenneth Huebner, Donald Dewhirst, Douglas Smith and Ted Byrom, “The Finite Method for Engineers”, Wiley-India Edition, 2009

Course Code: **15EMDC705**	Course Title: **Dynamics and Mechanism design**	
L-T-P: 4:1:0	Credits: 5	Contact Hrs: 6 / week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 180 min

No	**Content**	**Hrs**
1	**Geometry of Motion:** Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms**:** Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method.	**08**
2	**Synthesis of Linkages:** Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle.	**10**
3	**Graphical Methods of Dimensional Synthesis:** Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages.	**08**
4	**Ana1ytical Methods of Dimensional Synthesis:** Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.	**06**
5	**Spatial Mechanisms:** Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles	**04**
6	**Generalized Principles of Dynamics:** Fundamental laws of motion, Generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum.	**10**
7	**Lagrange's Equation:** Lagrange's equation from D'Alembert's principles, Examples, Hamiltons equations, Hamiltons principle, Lagrange's, equation from Hamiltons principle, Derivation of Hamiltons equations, Examples.	**04**

Reference Book:

1. Theory of Machines and Mechanism - E.Shigley & J.J.JickerMcGraw Hill company.
2. Machines and Mechanisms - David H. Myszka, PearsonEducation, 2005.
3. Greenwood “Principles of Dynamics”, Prentice Hall of India, 1988.
4. Erdman Sandor “Advanced Mechanism Design” Prentice Hall.
5. Soni A.H “Mechanism synthesis and analysis”, McGraw Hill.

Course Code: **15EMDC706**	Course Title: **Theory of Vibrations with Application**	
L-T-P: 4:0:0	Credits: 4	Contact Hrs: 4 / week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 180 min

No	Content	Hrs
1	**Fundamentals of Vibration** Importance of the Study of Vibration; Basic Concepts of Vibration-Vibration, Elementary Parts of Vibrating Systems, Number of Degrees of Freedom, Discrete and Continuous Systems; Classification of Vibration-Free and Forced Vibration, Un-damped and Damped Vibration, Linear and Nonlinear Vibration, Deterministic and Random Vibration; Vibration Analysis Procedure; Harmonic Analysis-Fourier Series Expansion, Numerical Computation of Coefficients;	**08**
2	**Free Vibration of Single-Degree-of-Freedom Systems** Introduction; Free Vibration of an Un-damped Translational System- Equation of Motion Using Newton's Second Law of Motion, Equation of Motion Using Other Methods, Equation of Motion of a Spring-Mass System in Vertical Position, Solution, Harmonic Motion; Free Vibration of an Un-damped Torsional System-Equation of Motion, Solution; Free Vibration with Viscous Damping-Equation of Motion, Solution, Logarithmic Decrement, Energy Dissipated in Viscous Damping, Torsional Systems with Viscous Damping, Solution;	**08**
3	**Harmonically Excited Vibration** Introduction; Equation of Motion; Response of an Undamped System under Harmonic Force-Total Response, Beating Phenomenon; Response of a Damped System under Harmonic Force- Total Response, Quality Factor and Bandwidth; Response of a Damped System Under Damped System Under the Harmonic Motion of the Base- Force Transmitted, Relative Motion; Response of a Damped System Under Rotating Unbalance;	**10**
4	**Two-Degree-of-Freedom Systems** Introduction; Equations of Motion for Forced Vibration; Free Vibration Analysis of an Un-damped System; Torsional System; Coordinate Coupling and Principal Coordinates; Forced-Vibration Analysis; Semi definite Systems;	**04**
5	**Multi degree-of-Freedom Systems- Determination of Natural Frequencies and Mode Shapes** Introduction; Influence Coefficients-Stiffness Influence Coefficients, Flexibility Influence Coefficients, Inertia Influence Coefficients; Dunkerley's Formula; Rayleigh s Method-Properties of Rayleigh s Quotient, Computation of the Fundamental Natural Frequency, Fundamental Frequency of Beams and Shafts; Holzer's Method- Torsional Systems, Spring-Mass Systems; Matrix Iteration Method-Convergence to the Highest Natural Frequency, Computation of Intermediate Natural Frequencies, Jacobi s Method, Standard Eigenvalue Problem-Choleski Decomposition;	**10**
6	**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- Vibration Isolation System with Rigid Foundation, Vibration Isolation System with Base Motion, Vibration Isolation System with Flexible Foundation, Vibration	**06**

	Isolation System with Partially Flexible Foundation, Shock Isolation, Active Vibration Control; Vibration Absorbers- Undamped Dynamic Vibration Absorber, Damped Dynamic Vibration Absorber;	
7	**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- Subharmonic Oscillations, Superharmonic Oscillations; Systems with Time-Dependent Coefficients (Mathieu Equation); Stability of Equilibrium States-Stability Analysis, Classification of Singular Points, Limit Cycles	**04**

Reference Book:

1. Mechanical Vibrations, - S. S. Rao., fourth edition, Pearson Education, 2005.
2. Theory of Vibration with Application, - William T. Thomson, Marie Dillon Dahleh, Fifth edition, Pearson Education, 2003.
3. Mechanical Vibrations-S Graham Kelly, Adapted by: Shashidhar K Kudari, Schaum’s outlines, The McGraw-Hill Companies, 2007.
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: **15EMDC801**	Course Title: **Machine Tool Design and Analysis**	
L-T-P: 4:0:0	Credits: 4	Contact Hrs: 4 / week
CIE Marks: 50	SEE Marks: 50	Total Marks: 100
Teaching Hrs: 50		Exam Duration: 180 min

No	Content	Hrs
1	Machine design fundamentals, CAD tools-Training on modeling & drafting practice, Limits ,fits & tolerance, Materials & Heat treatment, Metal cutting Theory, CNC Machine Tools and Trends, M/c Design exercise, Design of Spindle Assembly, Design of Spindle Assembly with work holding, Design of hydraulics, Design of X & Z axis assembly of CNC Lathe, Ball Screw & L M guide ways, Design of X & Z Axes assembly, Overall machine Design, FEA approach, Manufacturing drawing, Power requirement Calculations & Controller Selection, Electrical switch gear elements, PLC Programming and Ladder Diagram, Electrical diagram, Vibration analysis, Final Test & evaluation.	50

Reference Book:

1. CMTI Machine Tool Design hand book, Tata McGraw-Hill, 1982.
2. Design of Machine Tools by S K Basu, 5th edition, 2008
3. Fanuc drives, spindle motors and servo motors.
4. Material prepared and compiled by Mechanical Engineering department (Machine Design).

Course Code: **15EMDI801**	Course Title: **Internship/Industrial Training[#]**	
L-T-P: 0-0-2	Credits: 2	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
		Exam Duration: 120 min

Content

Each student has to undergo internship/industrial training for a period of 6 weeks at a reputed industry/R&D institution after the completion of III semester ESA. At the organization where the student is undergoing training, the student shall be assigned to work under the supervision of a Project Supervisor assigned for this purpose by the Head of the Department / institution. Student is expected to learn about the organization where the student is undergoing training in terms of its vision, mission, objectives, organizational structure, operations etc. At the end of the training, student must submit a report based on training.

The Project Supervisor at the industry shall award In Semester Assessment (ISA) marks out of a maximum of 50. The Department will conduct the End Semester (ESA) for a maximum of 50 marks.

Course Code: **15EMDW801**	Course Title: **Minor Project/Project Work Phase I*#**	
L-T-P: **0-0-8**	Credits: 8	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
		Exam Duration: 120 min

Contents

Minor Project: The Guide shall define the problem statement for the Project work. The student shall execute the Minor Project within three months duration during the 3rd semester. The student who has opted **Minor Project** shall opt **Major Project** in IV semester. However, Minor Project is independent of Major Project.

Project Work Phase I:

Student must select a research project in consultation with the Guide. Student should identify the problem and conduct an exhaustive literature survey in Project Work Phase I and shall continue the project in IV semester in Phase II. Student has to submit the report at the end of the III Semester based on the following:

- Back ground and significance of the Research Project
- Problem statement
- Objectives and scope of the project
- Literature review
- Methodology
- Future plan of action

Course Code: **15EMDW802**	Course Title: Major Project/Project Work Phase II*	
L-T-P: **0-0-20**	Credits: 20	
ISA Marks: 50	ESA Marks: 50	Total Marks: 100
		Exam Duration: 180 min

Contents

The student who has opted **Minor Project** should opt **Major Project** in IV semester. The **Major Project** shall be carried out by the student under the supervision of guide for a period of 6 months. For successful completion of this course the student should be able to identify the problem, define the objectives of the work as specific points indicating the scope within which the work is to be carried out, conduct the comprehensive literature survey, demonstrate the use of methodology adopted, analyze and interpret the experimental/numerical results obtained.

Project Work Phase II:

The student who has opted **Project Work Phase I** shall continue the project in IV semester in **Phase II**.

Phase II is assessed based on the following:

- Quality of literature survey and demonstration of creativity in the research problem
- Clarity in the objectives and scope of the research
- Clarity in the problem definition and feasibility in the problem solution
- Relevance to the current research/industrial trends
- Quality of work
- Analysis and Interpretation of results
- Quality of oral and written presentation
- Publication based on the research work in reputed national/international conference/journal.

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: **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 and overview, 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-Dependent Fracture** 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, Artinus Nijhoff , "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: **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.

<table>
<tr><td>Course Code: 18EMDP701</td><td colspan="2">Course Title: CAD Modelling Lab</td></tr>
<tr><td>L-T-P: 0-0-5</td><td>Credits: 5</td><td>Contact Hrs: 10 hrs / week</td></tr>
<tr><td>ISA Marks: 80</td><td>ESA Marks: 20</td><td>Total Marks: 100</td></tr>
<tr><td></td><td></td><td>Exam Duration: 02 hrs</td></tr>
</table>

Content	Hrs
➢ Introduction to CAD / CAM / CAE Software's ➢ Brief introduction to CATIA Software and Industrial applications ➢ Introduction to Work benches ➢ Brief introduction on Sketcher work bench environment ➢ Structure of users and saving of files. ➢ Part Design ➢ Generative Sheet Metal Design (GSMD) Workbench ➢ Assembly Design Workbench ➢ Drafting Workbench	**120**

***Materials and Resources Required*:**

1. Material prepared by School of Mechanical Engineering, KLETU-Hubballi.
2. Sham Tickoo, "Catia V5R20 for Engineers and Designers-,A Tutorial Approach",CAD CIM Technologies , 2009.

Course Code: 18EMDP702		Course Title: Advanced CAE
L-T-P: 0-0-3	Credits: 3	Contact Hrs: 6 hrs/week
ISA Marks: 80	ESA Marks: 20	Total Marks: 80
Teaching Hrs: 120		Exam Duration: 2 hrs

Sl. No.	Contents	No of Slots
01	**Over View of Abaqus** A First Look at Abaqus Linear Static Analysis of a Cantilever Beam	02
02	**Working with Geometry (Part 1)** Working with Native Geometry Creating Native Geometry: Pipe Creep Model	01
03	**Working with Geometry (Part 2)** Generating a Shell From a Thin Solid Import and Geometry Repair of Intersecting Pipes Importing and Editing an Orphan Mesh Importing and Editing an Orphan Mesh: Pump Model	02
04	**Material and Section Properties** Creating Materials and Assigning Sections Material and Section Properties: Pipe Creep Model Material and Section Properties: Pump Model	01
05	**Assemblies in Abaqus** Creating an Assembly Pump Model Assembly	01
06	**Steps, Output, Loads, & Boundary Conditions** Creating Steps Using the Load Module Step Definition and Loads: Pipe Creep Model Step Definition and Loads: Pump Model	01
07	**Meshing Imported and Native Geometry** Using the Mesh Module Structured Hex Meshing: Pipe Creep Model Free and Swept Meshing: Pump Model Meshing of Intersecting Pipes	01
08	**Job Management and Results Visualization** Using the Keywords Editor Creep of a Pipe Intersection	01
	Linear and Nonlinear Problems	

09	**Analysis Procedures (Part 1)** Nonlinear Static Analysis Linear Analysis of a Skew Plate Nonlinear Analysis of a Skew Plate	02
10	**Analysis Procedures (Part 2)** Multiple Load Cases Linear Static Analysis of a Cantilever Beam	02
11	**Analysis Procedures (Part 3)** Dynamic Analysis of a Skew Plate Pipe Whip Analysis	02
12	**Analysis Continuation Techniques** Unloading Analysis of a Skew Plate	01
13	**Constraints and Connections** Defining a Rigid Body Tie Constraints: Pump Model	01
14	**Contact** Using Automatic Contact Detection and General Contact Nonlinear Static Analysis of a Pump Assembly	02
	Total	20
15	**Case studies and Various analysis of components (Both created and imported models)**	60

Reference books:

1. Material prepared by School of Mechanical Engineering, KLETU-Hubballi.
2. Nitin S. Gokhale, Sanjay S Deshpande, Sanjeev V Bedekar, Anand N thite, “Practical Finite Element Analysis”, Finite To Infinite, 2008.
3. Bryan J Mac Donald “Practical Stress Analysis with Finite Elements”, 2nd Edition, Glasnevin Publishing, 2011
4. Abaqus 6.14 documentation, http://abaqus.software.polimi.it/v6.14/index.html
5. http://ivt-abaqusdoc.ivt.ntnu.no:2080/v6.14/pdf_books/CAE.pdf

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.

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 Introduction, thermoelastic stress–strain relations, thin circular disk; temperature symmetrical about centre, long circular cylinder, normal stresses in straight beams due to thermal loading.	**05**
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. Sitharam andL. 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.