COURSE TITLE	**ADVANCED MACHINE DESIGN**
COURSE CODE	**01CA1102**
COURSE CREDITS	**3**

Objective:

1 The course is intended to strengthen fundamentals of applied mechanics of solids and build understanding of design and analysis of machine components under dynamic loading. The course introduces loading design and analysis of machine components at elevated temperature. The course also includes fundamentals and application of fracture mechanics and surface failures in machine component design.

2 To design mechanical components subjected to static and dynamic loading along with fracture mechanics and incorporate the effect of crack and creep in the design of the mechanical component.

Course Outcomes: After completion of this course, student will be able to:

1 Design mechanical components subjected to static loading.

2 Design and evaluate mechanical components subjected to dynamic loading.

3 Design and analyze mechanical components subjected to effect of crack and creep.

4 Design and analyze mechanical components subjected to effect of fracture.

5 Analyze surface failure based on different influencing parameters.

Pre-requisite of course: Machine design, Strength of materials

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	0	50	30	20	0	0

Contents : Unit	Topics	Contact Hours
1	**Review of Stresses and Strains** Introduction, Plane Stress, Rotation of Coordinate Axes, Generalized Plane Stress, Principal Stresses and Maximum Shear Stress, 3D state of stress, Stresses on Octahedral plane, Plane strain, Strain gage rosettes, Introduction to basic Constitutive Relations and Rheological Models, Elastic, Plastic Hooke's Law, Anisotropic and Orthotropic Hooke's Law, Modified Mohr's theory, Role of failure prevention analysis in mechanical design, Modes of mechanical failure	9

Contents : Unit	Topics	Contact Hours
2	**Fracture Mechanics** Introduction, Rise in stresses due to crack, Crack tip opening displacement, LEFM: Effect of crack on strength of ductile and brittle material, Crack opening modes and Griffith theory, Concept of SIF and K Crack Tip Plasticity, Use of K in design and analysis, Determination of plastic zone , size and shape, Limitations of LEFM	9
3	**Fatigue** Introduction, factors affecting fatigue behavior, Theoretical stress concentration factor and notch sensitivity factor, Fatigue under complex stresses, cumulative fatigue design, Linear damage (Miner's Rule), Manson's method, Fatigue crack propagation and life estimation for constant amplitude stress, Fatigue crack propagation and life estimation for variable amplitude stress, Strain Based Approach to Fatigue: Strain Vs Life Curve, Mean stress effect, Strain Life Equation, Life estimate for structural components	10
4	**Surface Failures** Introduction, Surface geometry, Mating surface, oil film and their effects, Friction: Rolling, Effect of roughness, velocity and lubrication on friction, Wear: Adhesive, Abrasive and Corrosive, Surface Fatigue, Contact Stresses: Spherical, Cylindrical, General and Dynamic, Surface Fatigue Strength, design to avoid surface fatigue	7
5	**Creep and Damping** True stress and true strain, Creep phenomenon, Creep Curve, Creep parameters, time-temperature parameters and life estimate: Sherby-Dorn, life estimate: Larson-Miller, Stress relaxation. Stress-Strain-Time relation, Creep deformation under varying stress, Component stress-strain analysis, Energy dissipation in materials	7
Total Hours		**42**

Textbook :

1 Design of Machine Elements 4th Edition, V B Bhandari, McGraw Hill Education India Private Limited Next, 2017

2 Machine Design: An Integrated Approach 5th Edition, R L Norton , Pearson Education., 2013

References:

1 Fundamentals of Machine Component Design, Fundamentals of Machine Component Design, Robert C. Juvinall & Kurt M. Marshek, John Wiley & Sons, 2011

2 Mechanical Design of Machine Elements and Machines: A failure prevention perspective, 2nd edition, Mechanical Design of Machine Elements and Machines: A failure prevention perspective, 2nd edition, J A Collins, H Busby and G Stabb, Wiley India, 2009

3 Metal Fatigue in Engineering 2nd Edition, Metal Fatigue in Engineering 2nd Edition, R I Stephens, A Fatemi, R R Stephens and H O Fuchs, John-Wiley, 2000

References:

4 Elements of Fracture Mechanics , Elements of Fracture Mechanics , Prashant Kumar, McGraw-Hill., 2017

5 Mechanical Behavior of Materials 2nd Edition, Mechanical Behavior of Materials 2nd Edition, T H Courney, McGraw-Hill Publishing Co., 2000

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	10.00	20.00	15.00	25.00	20.00

Instructional Method:

1 Lecture and Discussion

Supplementary Resources:

1 https://nptel.ac.in/courses/112/106/112106137/

2 https://amesweb.info/Calculators.aspx