VI. Learning outcome

The student will be able to understand the concept of vibrations, analyze the mathematical modeling of the multidegree freedom systems and able to design vibration isolators.

VII. Lecture Schedule

S.No.	Topic	No. of Lectures
1.	Vibration motion and its terminology.	2
2.	Undamped free vibrations, equations of motion- natural frequency.	2
3.	Energy method, Rayleigh method; effective mass principle of Virtual work.	2
4.	Equivalent spring stiffness in parallel and in series.	1
5.	Harmonic analysis and Fourier Series.	2
6.	Damping - viscous, solid, coulomb equivalent dampers.	3
7.	Viscosity damped free vibrations, Logarithmic decrement	3
8.	Forced vibrations with harmonic excitation and rotating unbalance	2
9.	Energy dissipated by damping. Forced vibration with damping,	3
10.	Vibration isolation and force and motion transmissibility.	2
11.	Two degree of freedom systems. Principal modes of vibration co-ordinate coupling	3
12.	Vibration absorbers,	2
13.	Free vibration equation of motion for multi-degree of freedom systems.	2
14.	Influence coefficients and Maxwell's reciprocal theorem, stiffness coefficients.	3
15.	Numerical methods for finding natural frequencies for multi-degree of freedom systems.	3
16.	Vibration of lumped parameter systems and continuous systems.	3
17.	Lagrange equations. Vibration measuring instruments, Vibrometers, velocity pickups	3
18.	Accelerometer and frequency measuring instruments.	2
19.	Applications of vibrations. Vibration control, balancing of rotating and reciprocating machines	3
20.	Design of vibration isolators.	2
	Total	**48**

VIII. Suggested Reading

- V.P. Singh.2014. *Mechanical Vibrations*. Dhanpat Rai and Comopany, New Delhi
- Rao S S. 2010.*Mechanical Vibrations*. Pearson Education, Delhi
- Srinivas P.1983. *Mechanical Vibration Analysis*. Tata McGraw Hill Company
- Limited, New Delhi
- Daniel J Inman.2013. *Engineering Vibration*. Prentice Hall, New Jersey

I. Course Title : Fatigue Design

II. Course Code : ME 507

III. Credit Hours : 2+1

IV. Aim of the course

The course provides an understanding on fatigue design considerations of mechanical components. The causes of fatigue in brittle and ductile materials are taught with focus on crack initiation, propagation and fracture.

V. Theory

Unit I

Theories of failure, maximum normal stress, maximum shear stress and distortion energy theory, failure of ductile materials, failure of brittle materials.

Unit II

Stress concentration and its evaluation, stress concentration of ductile and brittle materials under static loading and under dynamic loading, determining geometric stress concentration factors, designing to avoid stress concentration.

Unit III

Fatigue of machine components, mechanism of fatigue failure, fatigue failure models and their considerations in design of machine elements, fatigue loads. Fatigue testing and presentation of fatigue data. Influence of stress conditions on fatigue strength/endurance limit of metals. Low and high cycle fatigue

Unit IV

Cumulative fatigue damage. Designing for finite and infinite life. Improving fatigue resistance of machine elements. Stress corrosion. Corrosion fatigue.

Practical Fatigue tests on testing machine(s) for specimens of different materials having different discontinuities/stress raisers and various surface conditions. Determination of correlation between fatigue limit and ultimate strength of material. Problems in fatigue design of common machine component.

VI. Learning outcome

The students is able to understand technical aspects and principles of fatigue design. The student can design the engineering product having good durability and long fatigue life

VII. Lecture Schedule

S.No.	Topic	No. of Lectures
1	Introduction to cyclic loading and Fatigue Design	1
2	Types of Loads and Stresses, Different theories of Failure like maximum normal stress, maximum shear stress and distortion energy theory etc.	3
3	Determining stress concentration based on geometric stress concentration factors, Design considerations to avoid stress concentration of ductile and brittle materials.	3
4	Mechanical failure. Macroscopic failure modes, Behavior of brittle and ductile materials in fatigue and stress concentration. Fracture in brittle and ductile materials, characteristics of fracture surfaces, inter-granular and intra-granular failure.	4
5	Cleavage and micro-ductility, growth of fatigue cracks, The ductile/brittle fracture transition, temperature for notched and unnotched components. Fracture at elevated temperature.	3
6	Fatigue of machine components, mechanism of fatigue failure. Low and high cycle with examples mean stress R ratio, strain and load control. S-N curves.	4
7.	Goodman's rule and Miners rule. Micro-mechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance.	3

S.No.	Topic	No. of Lectures
8.	Fatigue loads and mathematical models. Fatigue testing and presentation of fatigue data, Influence of stress conditions on fatigue strength/endurance limit of metals.	3
9.	Total life and damage tolerant approaches to life prediction. Fatigue failure models and their considerations in design of machine elements. Cumulative fatigue damage and Designing for finite and infinite life	2
10.	Methods to improve fatigue resistance of machine elements. Improvement of fatigue strength by chemical/metallurgical processes such as nitriding, flame hardening, case carburizing. Fatigue strength enhancement by mechanical work, cold rolling, peening, shot peening.	3
11.	Environmental Assisted Cracking: Stress corrosion cracking, Hydrogen embrittlement, Corrosion fatigue. Creep: Creep curves, Mechanisms of creep, Stress rapture test, Life prediction, High temperature alloys.	3
	Total	**32**

VIII. List of Practicals

S.No.	Topic	No. of Practicals
1.	Load measurement using Load indicator, Load Cells	1
2.	Strain measurement using Strain Gauge	1
3.	Stress measurement using strain rosette	1
4.	Determination of Fatigue strength measurement of S45C or alike material under same loading condition for different stress concentrations factors (like holes, notches, sharp corners for at least 5 different samples). Comparison to be listed.	5
5.	Study to improvement Fatigue Design based on at least 5 different processes like flame hardening, case carburizing, nitriding, shot peening, peening etc or alike processes.	5
6.	Determination of correlation between fatigue limit and ultimate strength of commercially available S45C material for three different samples	3
	Total	**16**

IX. Suggested Reading

- Lessells, J.M. 1955. *Strength and resistance of metals*. John Wiley & sons, Michigan.
- T.L. Anderson. 2005. *Fracture Mechanics Fundamentals and Applications*. CRC press, Boca Raton.
- Bhandari V.B.2019. *Design of Machine Elements*. Mcgraw Hill Education Pvt Ltd, New Delhi
- Peterson, R.E. 1953 *Stress Concentration Design Factors*. John Wiley & Sons, New York.
- Meguid, S.A.1989 Engineering *Fracture Mechanics*. John Wiley & Sons, New York
- Kare Hellan.1985. *Introduction to Fracture Mechanics*. Mc Graw Hill Book Co, New York.

I. Course Title : Computer Aided Design

II. Course Code : ME 515

III. Credit Hours : 2+1

IV. Aim of the course

The **course** provides an understanding on computer aided design. It provides in depth knowledge about 2-d drawing, 3-D Modeling and finite element analysis for optimum product design.