# **MECHANICAL VIBRATIONS**

| VI Semester: ME     |                             |                        |   |   |         |                   |     |       |
|---------------------|-----------------------------|------------------------|---|---|---------|-------------------|-----|-------|
| Course Code         | Category                    | Hours / Week           |   |   | Credits | Maximum Marks     |     |       |
| AME524              | Elective                    | L                      | Т | Р | С       | CIA               | SEE | Total |
|                     |                             | 3                      | - | - | 3       | 30                | 70  | 100   |
| Contact Classes: 45 | <b>Tutorial Classes: 15</b> | Practical Classes: Nil |   |   |         | Total Classes: 60 |     |       |

#### **OBJECTIVES:**

#### The course should enable the students to:

- I. Understand basic concepts of mechanical vibrations and phenomena of transmissibility
- II. Analyze mechanical systems with/ without damping for 1/ multi degrees of freedom environment.
- III. Application of vibration measuring instruments and machine monitoring systems.
- IV. Develop competency in analytical methods in solving problems of vibrations along with mode shapes.

#### **Course Outcomes (CO'S):**

- CO 1. Understand the equations of motion of single degree of freedom systems.
- CO 2. Understand the equations of motion of two degree of freedom systems.
- CO 3. Understand the equations of motion of multi degree of freedom systems.
- CO 4. Explore the concept of frequency domain of vibration analysis.

CO 5. Explore the natural frequencies by using numerical methods.

### **COURSE LEARNING OUTCOMES (CLOs):**

- 1. Understand the degree of freedom of systems.
- 2. Understand the simple harmonic motion of various systems..
- 3. Understand the undamped and damped free vibrations Understand a problem and apply the fundamental concepts and enable to solve problems arising in metal removal process.
- 4. Understand the forced vibrations and columb damping
- 5. Understand the vibration isolation and transmissibility
- 6. Compute the natural frequency of single degree of freedom systems
- 7. Understand the non periodic excitations.
- 8. Understand the two degree of freedom systems.
- 9. Determine the mode shapes of two degree of freedom systems.
- 10. Understand the multi degree of freedom systems.
- 11. Determine the Eigen values.
- 12. Determine the normal modes and their properties.
- 13. Determine the free and forced vibration by Modal analysis.
- 14. Understand the vibration measuring instruments
- 15. Understand the frequency domain vibration analysis.
- 16. Understand the trending analysis of various systems.
- 17. Understand the Raleigh"s method of multi degree of freedom system.
- 18. Understand the matrix iteration method of multi degree of freedom system.
- 19. Understand the Raleigh"s Ritz method of multi degree of freedom system.
- 20. Understand the Holzerd's method of multi degree of freedom system.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS

Classes: 09

Single degree of freedom systems: Undamped and damped free vibrations; forced vibrations coulomb damping; Response to excitation; rotating unbalance and support excitation; vibration isolation and transmissibility, response to non Periodic Excitations: Unit impulse, unit step and unit ramp functions; response to arbitrary excitations, the convolution integral; shock spectrum; System response by the laplace transformation method.

UNIT IITWO DEGREE FREEDOM SYSTEMSClasses: 09

Two degree freedom systems: Principal modes, undamped and damped free and forced vibrations; undamped vibration absorbers.

UNIT III MULTI DEGREE FREEDOM SYSTEMS

Classes: 09

Multi degree freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis. Method of matrix inversion; Torsional vibrations of multi-rotor systems and geared systems; DiscreteTime systems; Vibration measuring instruments: Vibrometer, velocity meters and accelerometers.

UNIT IV F

FREQUENCY DOMAIN VIBRATION ANALYSIS

Classes: 09

Classes: 09

Frequency domain vibration analysis: Overview, machine train monitoring parameters, data base development, vibration data acquisition, trending analysis, failure node analysis, root cause analysis.

UNIT V NUMERICAL METHODS

Numerical methods: Raleigh's stodola's, Matrix iteration, Rayleigh- Ritz Method and Holzer's methods.

# **Text Books:**

1. Singiresu S Rao, "Mechanical Vibration", 4<sup>th</sup> Edition, 2013.

2. G. K. Grover, "Mechanical Vibration", Nemchand & Brothers, 8<sup>th</sup> Edition, 2009.

3. J.S. Rao and K. Gupta, "Introductory Course On Theory & Practice Of Mechanical Vibrations", New Age International (p) Ltd , 2<sup>nd</sup> Edition, 2012

Leonard Meirovitch, "Elements of vibration analysis", Tata McGraw-Hill, 2<sup>nd</sup> Edition, 2007.
John S. Mitchell, "Introduction to Machinery Analysis and Monitoring", Pennwell books, 2nd Edition, 1993.

### **Reference Books:**

1.Singh V. P, "Mechanical Vibration", Dhanpat Rai & Co (p) Ltd, 3<sup>rd</sup> Edition, 2012.

2. AD Dimarogonas, SA Paipetis, "Analytical Methods In Rotor Dynamics", Applied Science Publishers London, 1983.

3. J. S. Rao, "Rotor Dynamics", New Age International (p) Ltd., 3<sup>rd</sup> Edition, 2012.

4. B.C. Nakra and K. K. Chowdary, "Mechanical Measurements", 2<sup>nd</sup> Edition, Tata McGraw-Hill, New Delhi, 2004.

5. Collacott, R.A., "Mechanical Fault Diagnosis and Condition Monitoring", 1<sup>st</sup> Edition, Chapman and Hall, London, 1977.

### Web References:

1. http://www.math.psu.edu/tseng/class/Math251/Notes-MechV.pdf 2.

2.https://engineering.purdue.edu/~deadams/ME563/notes\_10.pdf 3.

3.http://nptel.ac.in/courses/112103111/# 4.

4.https://engfac.cooper.edu/pages/tzavelis/uploads/Vibration%20Theory.pdf 5.

5.http://vdol.mae.ufl.edu/CourseNotes/EML4220/vibrations.pdf

# **E-Text Books:**

1. http://sv.20file.org/up1/541\_0.pdf 2.

2.https://aerocastle.files.wordpress.com/2012/10/mechanical\_vibrations\_5th-edition\_s-s-rao.pdf 3. 3.http://freshersclub.in/mechanical-vibrations-by-v-p-singh-pdf/