

ME3437E EXPERIMENTAL VIBRATION ANALYSIS

L	T	P	O	C
2	0	2	5	3

Prerequisite: Nil

- CO1: Apply vibration theory and signal processing for experimental data analysis.
CO2: Use sensors and software tools for vibration testing and data acquisition.
CO3: Identify system parameters using regression and frequency response methods.
CO4: Perform modal analysis and interpret natural frequencies, mode shapes, and damping.

Total Sessions: 26L+26P

Introduction & Basics – Introduction to the course, Introduction to experimental vibration analysis; Fundamentals of signals and systems; Introduction to lab setup; **LabVIEW & MATLAB** – Introduction to LabVIEW; Introduction to MATLAB; Data acquisition using LabVIEW and MATLAB; **Data Acquisition & Signal Processing** – Basics of data acquisition; Introduction to MATLAB, Signal processing tools in MATLAB; Data acquisition practice; Discrete Fourier Transform (DFT); Application of Fast Fourier Transform (FFT); Filtering (low-pass, band-pass, etc.); Application of filter and FFT Analysis in MATLAB.

Free Vibration of Single-Degree-of-Freedom (SDOF) – Free vibration theory; Logarithmic decrement; Free vibration test of SDOF system; **System/Parametric Identification** – Curve fitting using least square regression; Least square, regression, pseudo-inverse; Determining spring stiffness, parameter estimation; **Forced Vibration of SDOF** – Forced vibration theory; frequency response function (FRF); Determination of damping from FRF; Forced vibration of SDOF system; FRF & damping estimation; **Base Excitation** – Base excitation response, transmissibility; Free vibration of a two DOF system; Experiment: Base-excited vibration; **Vibration of two DOF (TDOF)** – Free Vibration of a TDOF system; Dynamic vibration neutralizers; Experiment: Vibration of a TDOF system.

Modal Analysis of Beams – Derivation of governing equation of Euler-Bernoulli beam; Method of modal projection, Solution of eigenvalue problem for cantilever beam in bending; Experiment: Finding natural frequencies and mode shapes of a cantilever beam; **Vibrations of Beams** – Forced vibrations of cantilever beams; Base-excited vibrations of cantilever beams; Experiment: Vibrations of cantilever beams; Analyzing the data acquired from experiments on vibrations of cantilever beams; Forced vibrations of simply-supported beams; Experiment: Forced vibrations of a simply-supported beam; Analyzing the data acquired from experiments on forced vibrations of simply-supported beam; **Impact Hammer Test** – Impulse response theory & basics of impact testing; Experiment: Impact hammer test of cantilever beam.

References

1. Ewins, D. J., 2009, *Modal Testing: Theory, Practice and Application*, 2e, Wiley.
2. Modak, S. V., 2023, *Analytical and Experimental Modal Analysis*, 1e, CRC Press.
3. Thomson, W.T., Dahleh, M.D., Padmanabhan, C., 2008, *Theory of Vibration with Applications*, Pearson.
4. Meirovitch, L., 1986, *Elements of Vibration Analysis*, McGraw-Hill.
5. Rao, S. S., 2018, *Mechanical Vibrations*, 6e, Pearson.
6. Proakis, J. G., and Manolakis, D. G., 2025, *Signal Processing: Principles, Algorithms and Applications*, 5e, Pearson.
7. Oppenheim, A. V., and Schaffer, R. W., 2022, *Discrete-Time Signal Processing*, 3e, Pearson.
8. Ingle, V. K., and Proakis, J. G., 2012, *Essentials of Digital Signal Processing using MATLAB*, 3e, Cengage Learning.
9. Clark, C. L., 2005, *LabVIEW Digital Signal Processing and Digital Communications*, 1e, McGraw-Hill.
10. Brunton, S. L., and Kutz, J. N., 2019, *Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control*, Cambridge University Press.
11. Keesman, K. J., 2011, *System identification - An introduction*, 1e, Springer.
12. Asadi, F., 2024, *Signals and Systems with MATLAB® and Simulink®, Springer.*