
Fundamentals of Vibration for Design Applications

Course No. 117

FOR WHOM INTENDED This course is for design engineers and project managers. It also helps quality and reliability specialists, also personnel in any industry where equipment problems may be encountered during the shipment and use of their product. Project personnel, structural and packaging engineers learn how to take vibration and shock into account in the design process.

BRIEF COURSE DESCRIPTION The course commences with an introduction to vibration and its effects and then proceeds to cover the basic theory needed to understand the material covered during the three days. While mathematics is kept to a minimum, it is necessary to cover a sufficient amount so that the concepts of vibration can be understood. The use and application of decibels (dB) is described, then the theory of dynamics is covered including the relationships between displacement, velocity and acceleration. Videotaped physical demonstrations show how structures behave when mechanically excited. Damping theory is addressed: its effect on transmissibility ratio and resonance stacking and on product design.

Various types of vibration exciters or shakers are discussed next. Random vibration theory, including power spectral density theory, is discussed and video demonstrations show the effects of sinusoidal and random vibration. Some basic theory of spectral analysis, filters and vibration measurement systems provides a background for understanding data acquisition and analysis topics. The course touches on test fixture design for vibration testing.

Different types of sinusoidal and random vibration testing are discussed next. Material fatigue and the correct use of S-N curves for designing product life testing and developing accelerated product development testing procedures are covered. An introduction to modal analysis and testing theory and application is addressed and its use for product design. Mechanical shock applications, including design to withstand shock, are discussed in some detail. Finally, standards and specifications applicable in product design to meet various environmental conditions are discussed, along with methods for tailoring of requirements for the test department.

RELATED COURSES [Course 116, Fundamentals of Vibration for Test Applications](#), covers some of the same topics as Course 117, but places less emphasis on design and more emphasis on testing. [Course 116-117](#) combines both courses. [Course 310](#) contains design theory but omits 117's testing content, adding advanced examples and applications.

DIPLOMA PROGRAMS This course may be used as an elective for any [TTi Diploma Program](#).

PREREQUISITES There are no definite prerequisites. Supervisors are invited to telephone or e-mail TTI on prospective attendees' backgrounds and needs.

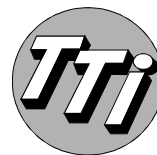
TEXT Each student will receive 180 days access to the on-line electronic course workbook. Renewals and printed textbooks are available for an additional fee.

COURSE HOURS, CERTIFICATE AND CEUs Class hours/days for on-site courses can vary from 14–35 hours over 2–5 days as requested by our clients. Upon successful course completion, each participant receives a certificate of completion and one Continuing Education Unit (CEU) for every ten class hours.

ON-DEMAND Most chapters of course 117 are available as OnDemand Internet Short Topics. See our [on-line course outline](#) for details and ordering.

Course Outline

- Introduction to Vibration
- Understanding Decibels (dB) and Octaves
- Electronic Filters & Measurement Systems
 - Low-pass, High-pass and Bandpass Networks
 - RMS • Complex and Random Signals
- Dynamic Force and Motion
 - Laws of Motion, Weight vs. Mass • Gravity • Force, Mass and Acceleration • Work, Power, Energy
 - Degrees of Freedom • Natural Frequency • Harmonic Waves
 - Transmissibility • Isolation • Damping
- Vibration Exciters (Shakers):
 - Electrohydraulic (EH), Electrodynamical Shakers
 - Force Rating and Available Acceleration
 - Table Expanders and Oil-Slip Tables
- Random Vibration and Spectral Analysis: Power Spectral Density
 - Time & Frequency Domain, Spectral Analysis
 - Fourier Transforms, FFT, Spectrum Analyzers
 - Correlation, Auto- and Cross-Correlation
 - Developing RMS G from Spectral Plot
- Fixtures: Materials, Fabrication methods
- Vibration Measurement: Displacement Sensing
 - Strain Gages • Accelerometers
- Vibration Testing: Types of Testing:
 - Development, Qualification, Acceptance, Screening, Reliability, Life Control System Function • Function generators
 - Sine Vibration Testing: Sine Sweeps
 - Resonant Search • Crossover Frequency
 - Random Vibration Testing:
 - Calculating RMS from PSD • Gaussian Random Signal
 - Standard Deviation
 - Statistical Degrees of Freedom, Random Vibration Control
 - Fatigue: How Materials Behave: The S-N Curve
 - Failure Models & Mechanisms • Crack Growth • Miner's Hypothesis
 - Accelerated Testing • Durability and Functional Tests
- Modal Analysis: Modes • Theoretical Approach
 - Structural Dynamic Equations, Modal Testing
- Accelerated Testing:
 - Linear vs. Non-linear product response • Margins • Assumptions
 - Coffin-Manson Inverse Power Law • Cautions
 - Synergistic Failure Exaggeration • Cycles
- Mechanical Shock: Shock Testing on various types of machines
 - SRS in Shock Testing
- Design to Withstand Shock
 - Shock Isolation vs. Vibration Isolation • Shock Isolation Example
 - Protective Packaging
 - Product Fragility • Damage Boundary Theory
- Standards vs. Specifications
- Summary, Final Review
- Award of certificates for successful completion



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