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), Electrodynamic 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

Technology Training, Inc.
(a tti group company)
Toll-free tel: 866-884-4338 (866-TTi-4edu)
Tel. 805-845-5050
E-mail: Training@ttiedu.com
www.ttiedu.com