Fundamentals of Vibration for Test Applications

Course No. 116

APPLICATIONS Random vibration and shock are important in most engineering applications where the product is exposed to transportation and to possible vibration and shock during service. An understanding of vibration and shock is crucial to improving the reliability of today's products, wherever electronic components appear.

FOR WHOM INTENDED Many engineers need specialized education to properly measure, quantify, and analyze this generally unfamiliar environment and to reproduce it in environmental test laboratories. This course is for test laboratory managers, engineers and technicians. It also helps quality and reliability specialists and acquisition personnel in government and military activities and their contractors. It is designed to serve the needs of personnel in a wide range of industries where equipment problems may be encountered during the shipment and use of their product.

BRIEF COURSE DESCRIPTION This course covers a wide range of topics associated with vibration and shock applications in order to enable the course participants to acquire a basic understanding of the complex field of vibration and shock. Each of the subject areas covered in this course have expanded coverage in their own three day courses for those individuals who need a more thorough understanding for their application.

Lectures and videotaped physical demonstrations show for example: how structures behave when mechanically excited, how to use pickups to sense input and response forces and motions, how to read out and evaluate the resulting electrical signals.

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 course. Mathematics are kept to the minimum necessary for the concepts of vibration to be understood. The theory of dynamics is covered, including the relationships between displacement, velocity and acceleration. Electronic filters are covered, and then random vibration theory. Test equipment is discussed next, including the various types of vibration exciters, along with test fixtures and power amplifiers.

The course next presents some basic theory of measurement systems before addressing vibration measurement and data acquisition. Spectral analysis and transforms are discussed before covering sine and random vibration testing, mechanical shock applications and dynamic test standards and specifications.

DIPLOMA PROGRAMS This course is required for TTi's Environmental Engineering Specialist (EES) and Dynamic Test Specialist (DTS) Diploma Programs and may be used as an optional course for any other TTi Diploma Program.

RELATED COURSES Course 116-117 includes content from this course and Course 117, Fundamentals of Vibration for Design Applications. These courses (or any TTi course) may be presented onsite at your organization, for a group.

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.

ONDEMAND INTERNET COURSE 116 features over fourteen hours of video as well as more in-depth reading material. All chapters of course 116 are also available as OnDemand Internet Short Topics. See the on-line course outline for details.

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.

Course Outline

Introduction to Vibration
Basic Concepts and Terminology: Spectra • Transfer Functions
  Understanding Decibels (dB) and Octaves • ⅓ Octave Bands
Dynamic Force and Motion: Laws of Motion, Weight vs. Mass
  Gravity • Force, Mass, Acceleration • Work, Power, Energy
  Degrees of Freedom • Natural Frequency
  Harmonic Waves • Transmissibility • Isolation • Damping
  Vibration Considerations for Design Engineers
Electronic Filters & Measurement Systems
  Low-pass, High-pass and Bandpass Networks
  Understanding RMS • Complex Signals, Random Signals
Random Vibration: Statistics • Probability Distributions
  Random Data Spectrum • Normal Distribution Curve
  Power Spectral Density • Deriving RMS G from Spectral Plot
Vibration Exciters (Shakers)
  Electrohydraulic (EH) Shakers • Electrodynamic Shakers
  Force Rating and Available Acceleration
  Table Expanders and Oil-Slip Tables
Fixtures: Materials, Fabrication methods
Power Amplifiers, Effects of Resonance
Vibration Measurement: Velocity, Displacement Sensing
  Strain Measurement • Wheatstone Bridges • Accelerometers
  Mounting, Cabling • Signal Conditioning • Charge Amplifiers
Basics of Spectral Analysis: Time and Frequency Domain
  Spectral Analysis • Windowing • Forcing Measured Data
Vibration Testing: Types of Testing: Development, Qualification,
  Acceptance, Screening, Reliability, Life
  Accelerated Testing • Designing Accelerated Durability Tests
  Applied Environment ... Philosophy • Closed Loop Control
  Shaker Control—Input or Response • Accelerometer Location
  Unwanted Table Movement • Resonant Distortion of Table
  Slip Tables • Axial Resonance • Notching • Strobe Light
  Multiple DoF Testing • "Quasi-Random" • 3-axis Testing
Sine Vibration Testing: Closed Loop Control • Sine Sweeps
  Effect of Sweep Speed • Slow Rates • Crossover Frequency
  Control of Vibration Systems
Random Vibration Testing: Calculating RMS from PSD
  Gaussian Random Signal • Standard Deviation
  Statistical Degrees of Freedom • Accuracy/Confidence
  Time and Frequency Domain Terminology • Spectral Plots
  Transfer Functions • Sine on Random, Random on Random •
  Overtest & Vibration Protection
Mechanical Shock: Causes, effects and remedies of shock
  Shock Testing machines: Pneumatic, Freefall, Drop, MIPS
  Sample shock test procedures • Shock Response Spectrum
  Transient Tests: Definition, Types, Analysis Options
  SRS Mechanical Analog • SRS Analysis Procedure
Dynamic Test Standards and Specifications
Summary, Final Review
Award of certificates for successful completion

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