Mechanical Shock Techniques

Course No. 142

APPLICATIONS The effects of shock are important in many engineering applications ranging from appliances to computers to ships to automobiles, trucks and military vehicles to high-performance aircraft and missiles. Shock is often part of the service and/or transportation environment. Military Standards such as MIL-STD-810 call for shock testing.

The possible effect of shock must be considered for almost every product that has to be shipped and handled. Care can be taken in a controlled environment but during the transportation phase the product within its package must be designed and tested to withstand the anticipated environment.

FOR WHOM INTENDED Most engineers need specialized education in order to properly measure, quantize and analyze this generally unfamiliar environment, and to reproduce it in environmental test laboratories. This course is for packaging designers, test laboratory managers, engineers and technicians. It also helps quality and reliability specialists and acquisition personnel in government and military activities and contractors.

Instrumentation specialists who will measure transportation, service and laboratory shock need this course. Metrologists learn about shock calibration of accelerometers and systems. Project personnel, structure and packaging engineers learn about developmental shock testing. Product assurance and acquisition specialists learn to evaluate shock test facilities and methods, and to interpret shock test specifications. This course is designed to serve the varied needs of scientists, engineers, aides and senior technicians. The instructor maintains good balance between practical training and theory.

BRIEF COURSE DESCRIPTION The course commences with a review of basic dynamic theory and then covers natural frequencies and modes before discussion system response to shock. The Shock Response Spectrum (SRS) is discussed as it relates to shock measurement and testing, as well as design. The relative merits of various types of shakers and shock test machines are briefly considered before covering various shock test methods, including pyrotechnic shock testing. The course then covers shock measurements, also calibration. Shock resistant design is discussed, including the selection and use of isolators.

The theory and practice of package and product fragility analysis are covered in some detail, including the use of the damage boundary plot and the selection and testing of cushioning materials. Some typical shock test procedures and specifications are described, both military and commercial.

DIPLOMA PROGRAMS This course is required for TTi's Dynamic Test Specialist (DTS) diploma. It may be used as an elective for any of TTi's Specialist Diploma programs.

RELATED COURSES See course 142-4.

PREREQUISITES Prior participation in TTi's "Fundamentals of Vibration" would be helpful. Participants will need first-year college mathematics (or equivalent experience) and some facility with fundamental engineering computations. Some familiarity with electrical and mechanical measurements and vibration will be helpful.

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 OnDemand Internet Complete Course 142 features thirteen hours of video as well as more in-depth reading material. All chapters of course 142 are also available as OnDemand Internet Short Topics. See our on-line course outline for details.

Course Outline

Introduction—What is Shock ?
Review of Dynamics and Theory of Materials
- Basic concepts: weight, mass, density, specific gravity
- Definitions of terms • Friction, wear • Work, power, energy
- Engineering materials • Stress and Strain • Elasticity • Shear
- Stiffness • Mass • Spring-Mass Model • Degrees of Freedom

Vibration Theory
- Degrees of Freedom • Natural frequency (resonance)
- Displacement, Velocity and Acceleration • Transmissibility
- Damping • Critical Frequencies • Random Vibration
- Gaussian Random Signal • Spectral Density

System Response to Shock
- Natural Frequencies • SDoF Transient Response
- The Transient Response Problem • Free, Forced Response

A Closer Look at Shock
- Terminology • Input Pulse and Response of a Sprung Mass
- Typical Complex Shock Pulses • Haversine Pulse
- Classical Shock Pulse Shapes • Examples
- Critical Frequency Response • Response to Shock Pulse

Shock Response Spectrum (SRS)
- Shock Measurement • Definitions • SRS Mechanical analogy
- How SRS is developed during shock testing • Maximax values
- Maximum Response Spectra for Various Shock Pulse Shapes
- Damping and SRS • Damped Spectra • Designing with SRS
- SRS in shock test specifications • Shock spectrum analyzers

Shock Testing: Shock Test Machines
- Drop test machines • Impact machines • MIPS tables
- Electrodynamic, Electrohydraulic and Piezoelectric shakers
- Shaker Optimized Cosine (SHOC) • Pyroshock simulation
- Problem Areas • Pendulum and Free-fall machines

Shock Measurements
- Sensors for Force, Displacement, Velocity, Acceleration
- Seismic transducers • Dynamic calibration of motion sensors
- Sensor attachment • Cabling • Accelerometer loading effects

Designing for Shock: Shock Resistant Design
- Isolation Methods • Isolators which approach the ideal
- Shock isolation vs. Vibration Isolation • Isolator selection

Package/Product Fragility Analysis—Theory and Practice
- Determination of fragility: methods and equipment

Protective Packaging: Potentially Harmful Environments
- Package design tradeoffs • Design drop heights
- Product Fragility • Damage boundary theory
- Step velocity and step acceleration
- Cushion materials • Cushion performance curves
- Vibration in package testing • Frequency response
- Multiple Drop Testing • Package verification test procedures

Fragility Assessment Theory and Test Procedure
Typical Shock Test Specifications
- MIL-STD-810G, Method 516.6 Shock
- Typical Free Fall Shock Test Specification
- Table-Top Drop Shock Test
- Drop Shock and Vibration Test Specification for Disk Drives

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)
International Tel. 805-845-5050
E-mail: Training@ttiedu.com
www.ttiedu.com