Vibration Fundamentals Training System (VFT)

Hands-On Turnkey System for
Teaching Vibration Fundamentals

Along with

Wireless Sensors and
Data Acquisition
and analysis

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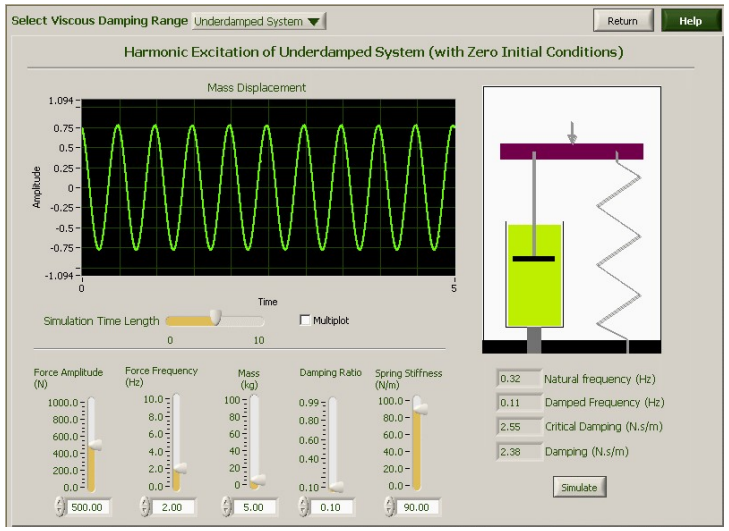
Vibration Fundamental Training System (VFT)

An integrated turnkey system with simulation software, guided hands-on experiments, wireless sensors and data acquisition and signal analysis



Simulation

+

Hands-on experiments &
Data Acquisition and analysis

VFT Benefits

- Clarify difficult concepts of vibration theory by performing hands-on controlled experiments
- Validate theoretical predictions of natural frequencies, mode shapes, and frequency response as a function of frequency, boundary conditions, geometry, and materials
- Validate theoretical concepts by comparing experimental results with the computer simulation of the vibration theory
- Determine the detrimental effects of vibration load transmission to the support structure and component fatigue life
- Learn to control vibration amplitude using tuned mass dampers and damping treatments
- Learn vibration measurement transducers, signal processing, data acquisition and data analysis
- Use wireless sensors to minimize effects of cable damping

VFT Features

- Fully integrated turn-key package consisting of comprehensive experimental device, data acquisition instrumentation, analysis software, wireless transducers, course curriculum, exercise book, and simulation software for virtual experimentation
- Robust, user friendly, modular, and compact bench-top device for performing controlled experiments
- Experimental setup for single and two-degrees of freedom spring-mass system (with and without damping), torsional vibration, beam with different boundary conditions, and tuned-mass-damper
- Full experimental setup for beams with different boundary conditions, material, geometry, and length to understand effects on natural frequency and mode shapes
- User friendly software with pre-defined experiments integrated with data acquisition and data analysis

VFT Experimental Capabilities

- VFT is capable of a wide range of experiments covering all vibration concepts

Lumped System Experiments

- Simple pendulum
- Spring-Mass-Damper system: 1 & 2 DOF
  - Free and forced vibration
  - Damped and undamped vibration
  - Viscous damping calculation
  - Transient vibration
  - Vibration transmissibility
  - Frequency Response Function (FRF)
- Torsional Ssystem: 1 to 3 DOF

Continuous System Experiments

- Beam with different boundary conditions
  - Free and forced vibration
  - Damped and undamped vibration
  - Transient vibration
  - Vibration transmissibility
  - Frequency Response Function (FRF)
  - Modal analysis
  - Operating Deflection Shape (ODS)

Vibration Control Experiments

- Spring-Mass vibration absorber
- Beam vibration absorber
- Viscoelastic Layer Damping (VLD) sandwich structure
- Constraining Layer Damping (CLD) sandwich structure

VFT Simulator

- Consists of five individual modules
  - Pendulum (not shown)
  - Spring-Mass-Damper ❶
  - Torsional Vibration ❷
  - Beam Vibration ❸
  - Vibration Control ❹

Spring-Mass-Damper Module-Vertical Arrangement

- Possible Experiments
  - 1-DOF free and forced vibration, with or without damping
  - 2-DOF free and forced vibration, with or without damping
  - Damping effect comparisons and measurement of viscous fluid
  - Rotating unbalance
  - Base excitation
  - Frequency Response Function (FRF) measurement
  - Displacement and force transmissibility

Torsional Vibration Module

- Possible Experiments
  - 1-DOF free and forced vibration, with or without damping
  - 2-DOF free and forced vibration, with or without damping
  - Damping effect comparisons and measurement of viscous fluid
  - Frequency Response Function (FRF) measurement

Torsional Vibration Module

- Available Hardware
  - 3 rods of different diameters
  - 3 discs of different mass and inertia
  - 1 dashpot with 3 types of viscous fluid (optional)
  - 2 Rate accelerometers for torsional vibration measurement
  - 1 unbalanced motor with controller for excitation

Beam Vibration Module

- Possible Experiments
  - First three natural frequency and modal shape
  - Free and forced vibration response
  - Influence of boundary condition: cantilever, simply supported, overhung
  - Influence of beam length
  - Operating Deflection Shape (ODS) study

Beam Vibration Module

- Available Hardware
  - 3 beams: two thickness steel, one aluminum, one plastic
  - 2 end supports configurable as cantilever or simply support
  - 4 mass blocks
  - 3 wireless accelerometers
  - 1 unbalanced motor with controller for excitation

Vibration Control Module

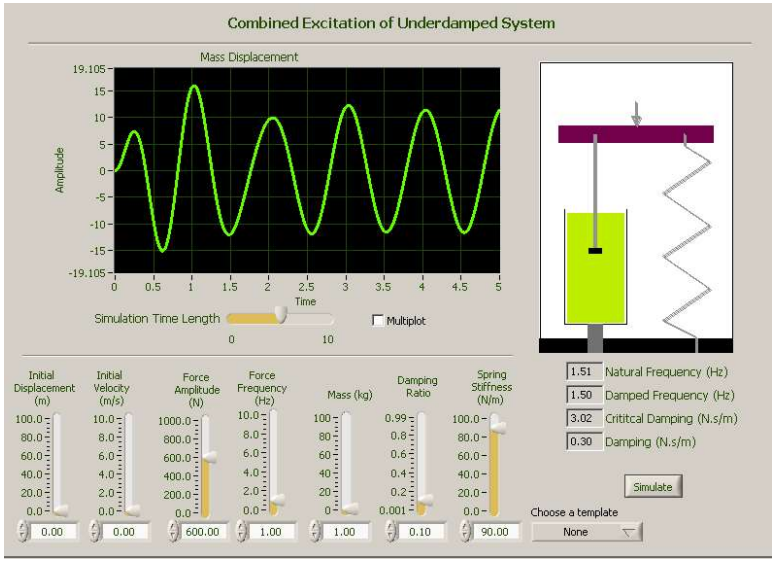
- Possible Experiments
  - Spring-Mass vibration absorber
  - Beam vibration absorber
  - Beam with free layer damping (viscoelastic)
  - Beam with constraining layer damping (CLD) study

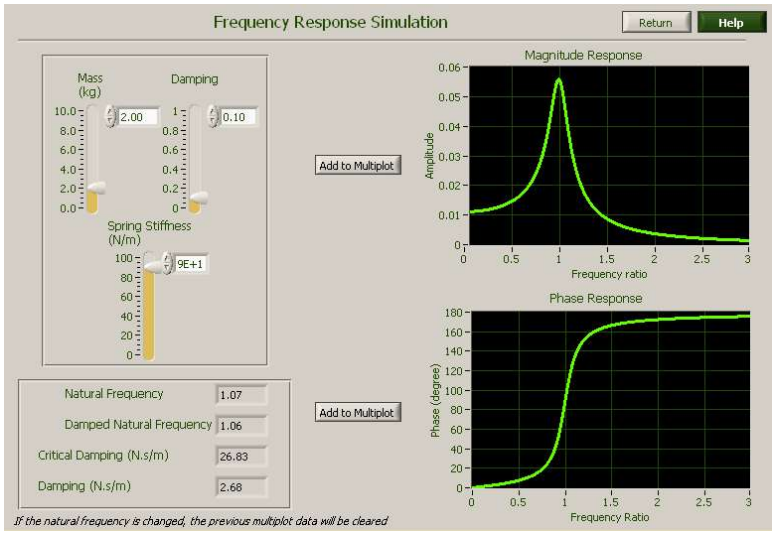
Vibration Control Module

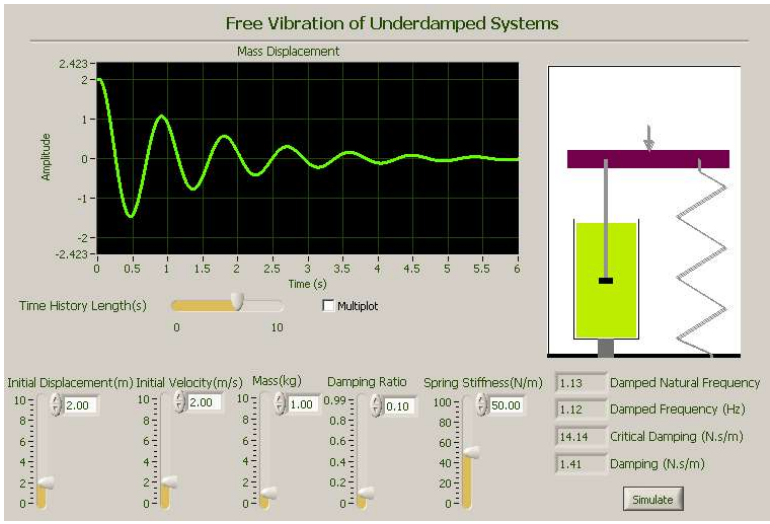
- Available Hardware for Spring-Mass Absorber
  - 3 different stiffness springs
  - 3 stackable mass blocks
  - 1 proximity probe for displacement vibration measurement
  - 1 unbalanced motor with controller for excitation
- Available Hardware for Beam Absorber
  - 4 mass blocks
  - 4 accelerometers
  - 1 unbalanced motor with controller for excitation
  - 1 tuned mass damper beam
- Available Hardware for Layer Damping
  - 3 beams: one base, one viscoelastic (FLD), and one Constrained Layer Damping (CLD)

Simulation/Animation Software

- Basic concepts simulated in user selected input parameters
- Vivid visualization to enhance learning and clarification
- Input condition controllable by user







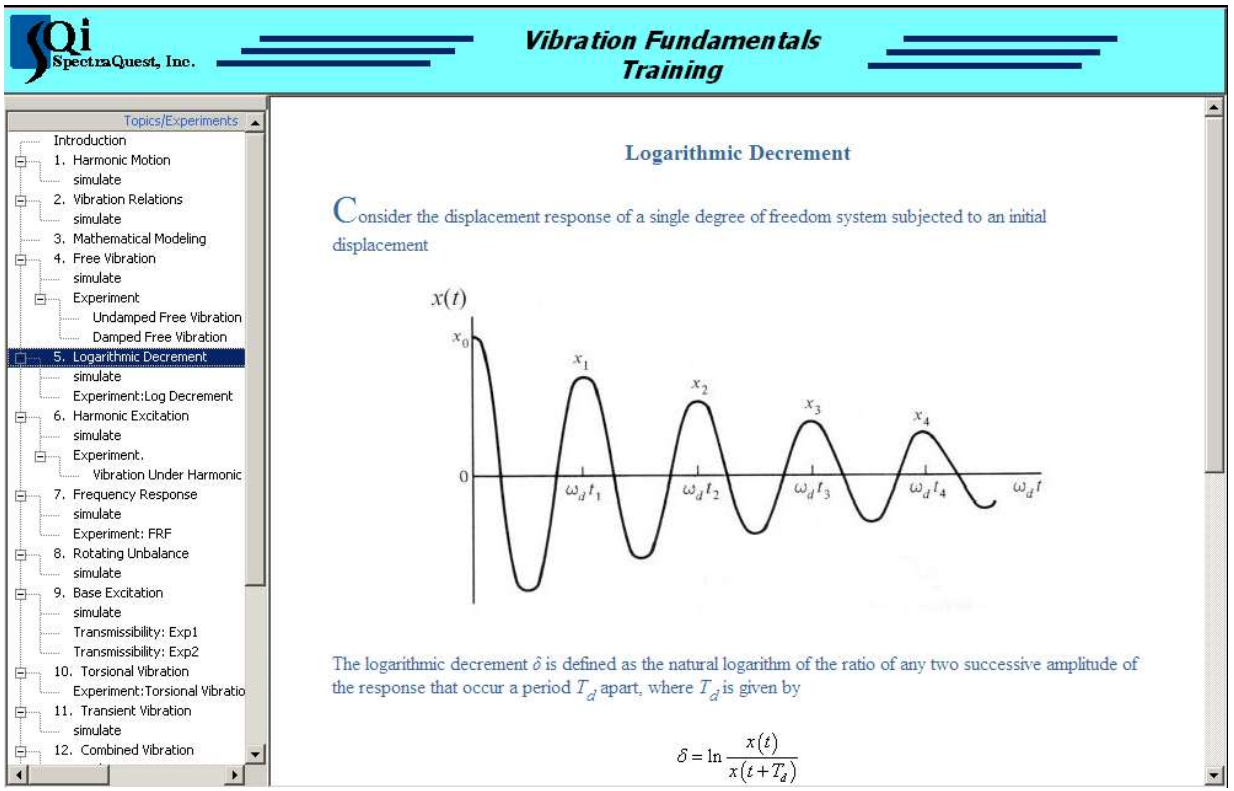
Simulation/Animation Software

- Topics Covered
  - Simple harmonic motion as represented by a Spring-Mass system
  - Sinusoidal relationship of amplitude, velocity and acceleration
  - Mathematical modeling of dynamical system using equivalent mass and spring
  - Free vibration of undamped, underdamped and overdamped systems
  - Logarithmic decrement
  - Harmonic excitation of undamped, underdamped systems
  - Frequency response function
  - Rotating Unbalance
  - Base excitation - Displacement transmissibility and force transmissibility
  - Torsional vibration
  - Transient response of underdamped systems - Step input and impulse input
  - Combined vibration - Harmonic excitation with initial displacement and velocity
  - General forced response - Delayed step input and rectangular pulse input
  - Two degrees of freedom system - Free vibration
  - Two degrees of freedom system - Harmonic excitation
  - Tuned mass damper
  - Beam vibration

All Major Vibration Concepts

Simulation/Animation Software

- For each topics covered, the simulation software includes a theoretical summary along with all key equations for quick reference
- Most topics also include a predefined hands-on experiment to be performed on VFT



Experimental Curriculum Book

- Comprehensive experimental book
- More than 20 pre-designed experiments
- Step by step detailed instruction
- Extended exercises help student learning

Specifications

Base VFT	
Dimensions	36”w x 35”h x 15”d (94 cm x 90 cm x 40 cm)
Weight	100 lb (45 Kg)
Excitation motor	Software/manual driven variable speed motor with built-in unbalance load.
Vibration isolation	Four rubber feet
Vertical Spring-Mass Module	
Spring	Three different stiffness, stackable for 2 DOF
Mass	Three weights, stackable
Beam Vibration Module	
Beam	one thickness steel, one aluminum, one plastic
Mass	Three weight blocks
Supports	User configurable: cantilever or simply supported, adjustable length
Torsional Vibration Module	
Shaft	Three different diameters
Rotor	Three rotors of different mass and inertia
Sensor Kit	
Accelerometer	Two single axis wireless accelerometers and rotational sens

Specifications

Vibration Control Module	
Tuned mass damper	Hardware for mass-spring absorber, and hardware for beam absorber
Beam with damping treatment	One viscoelastic layer and one constrained layer
Torsional Damper	One dashpot and three fluids
Torsional Motion Module	
Flywheel Module	Mounting structures, weight set, solid and hollow cylinders, stop watch, string
Spiral Spring Module	
Spiral Spring Module	Mounting bracket, Spiral spring, Stop watch, Shaft with sliding weights.
Vibration Transmissibility Module	
Vibration Transmissibility Module	Once force transducer and signal conditioner, transmissibility software
Data Acquisition	
Number of channels:	6
DAQ specifications	USB connection
Software	
DAQ and analysis software	Time waveform, spectrum, FRF, motor control
Electrical	
Power Source	110 V/220 V 50/60Hz