



[Home Page](#)

Learning Machinery Vibration Analysis using SpectraQuest Fault Simulators

Hands-on Courses on Machinery Fault Diagnosis

Emphasis is on a hands-on approach, backed up with lectures as well as demonstration of the basic concepts in vibration analysis and fault diagnosis, and machinery maintenance, using SpectraQuest simulators and training packages. The hands-on approach involves a classroom with several workstations set up for carrying out controlled exercises. Each workstation consists of a Machinery Fault Simulator (MFS) and/or other simulators with different machine fault kits, a multi-channel data acquisition system with simulation/training/diagnosis/analysis software, fully wired sensors, and necessary accessories such as tachometer, strobe, etc. All the PCs are connected to a client-server type network for free exchange of data and enhanced discussion.

Dates: October 1~ 3 2008

Location: Holiday Inn RICHMOND-CENTRAL
3207 NORTH BLVD.
RICHMOND, VA 23230 UNITED STATES
Hotel Front Desk: 1-804-3599441

For Reservation, Speak to David/Nancy in sales to get special rate of \$79.95/night

Speakers: Dr. Suri Ganeriwala, Dr. Eric Li

Schedule at a Glance

Day 1	Session 1 Introduction to Vibration Analysis
	Session 2 Workshop on Vibration Basics
	Session 3 Transducers
	Session 4 Signal Processing
	Session 5 Data Acquisition and Simulator Configuration
	Session 6 Baseline Vibrations and Dynamics
	Session 7 Data Presentation and Interpretation
	Session 8 Workshop on Misalignment
	Session 9 Workshop on Unbalance
Day2	Session 10 Workshop on Bearing Faults
	Session 11 Workshop on Bearing Faults (cont.)
	Session 12 Fluid Film Bearing and Whirl/Whip Phenomena
	Session 13 Workshop on Resonance and Critical Speed
Day3	Session 14 Workshop on Belt Drive
	Session 15 Workshop on Gearbox Vibration
	Session 16 Workshop on Mechanical Rub and Looseness Vibration
	Session 17 Workshop on Induction Motor Faults

Registration Form

Attendee's Name _____ Phone _____

Job Title _____ Fax _____

Affiliation _____ Email _____

Address _____

City _____ State _____ Zip _____

Mode of Payment: Credit Card Check

Registration fee

\$1,195.00 for those registered before September 15, 2008.

\$1,295.00 for those registered after September 15, 2008.

The prices include breakfast and coffee break (in lecture hall), three lunches, and one dinner.

*Attendees will get free copy of **Vibration Fundamentals and Simulation Software** (\$495 value).*

We accept credit cards.

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Day 1

Morning Session

8:00 – 8:45 AM Session 1 Introduction

Nature of machinery vibration, modeling machine as a dynamic system, concepts of forces, motion, spring-mass model, natural frequency, mode shape, amplitude and phase, frequency response, resonance, damping, linear vs. non-linear system responses. Use computer simulation to learn these concepts.

8:45 – 9:15 Session 2 Workshop on Vibration Basics – Demonstration

Vibration fundamentals, including types of vibration, amplitude, phase, frequency, resonance, mass-spring system, free vibration, damped vibration, forced vibration, force transmissibility.

Exercises with a cantilever beam: natural frequency excited by unbalance force, resonance characteristics, phase and amplitude, effects of mass and stiffness on natural frequency, effect of damping on resonance amplitude, frequency response measurement. Use computer simulation to learn vibration.

9:45 – 10:00 Coffee Break

10:30 – 11:15 Session 3 Transducers

Describe principles of accelerometers, proximity probes, and velocity transducers, and their mounting techniques, sensitivity, frequency response, calibration, advantages and drawbacks.

11:15 – 12:00 Session 4 Signal Processing

An overview of: time signal, Fourier series/transform, frequency domain representation, digitizing, windowing, FFT, spectral resolution, FFT bin size, aliasing and leakage, signal noise and averaging.

Computer simulation and exercises involving: different waveforms, addition/subtraction with different phase, frequency spectra, resolution, frequency lines, aliasing, effects of leakage and ways to compensate, various window functions and uses, data smoothing by averaging.

12:00 – 1:00 PM LUNCH

Afternoon Session

1:00 – 3: 45 PM Session 5 Data Acquisition and Simulator Configuration

Measurement chain, signal conditioning, considerations in data acquisition, and interface technologies.

Install option kits on simulators to configure simulators for different experiments. Install sensors, data acquisition system. Configure MFS for baseline data acquisition, review data acquisition and analysis software, acquire baseline data and discuss the results.

2:45 – 3:00 Coffee Break

3:45 – 5:00 Session 6 Baseline Vibrations and Dynamics

Acquire data on a fault free MFS without loader and belt drive. Determine effects of speed on spectral peaks, compare amplitude and phase. Repeat above exercises with loader and belt drive, compare data of different configurations. Discuss how to determine sources of spectral peaks.

Day 2

Morning Session

8:00 – 8:15 AM

Review of topics covered on Day 1

8:15 – 9:20

Session 7 Data Presentation and Interpretation

Learn how to interpret different data presentation formats, such as Bode plots, waterfall plots, polar plots, color maps, in order to extract information for diagnosis.

9:20 – 9:30

Coffee Break

9:30 – 10:50

Session 8 Workshop on Misalignment

Introduce calibrated misalignment and perform tests to determine effects of speed, types of misalignment, and coupling stiffness on spectral amplitude and phase. Compare misalignment force-vibration data and discuss complexities of misalignment.

10:50 – 11:00

Coffee Break

11:00 – 12:00

Session 9 Workshop on Unbalance

Perform unbalance tests to study effects of speeds and unbalance mass, compare phase and amplitude at motor, bearing housings in horizontal and vertical directions, and discuss data using spring-mass model. Describe common balancing techniques and conduct a balancing exercise.

12:00 – 1:00 PM LUNCH

Afternoon Session

1:00 – 2:30

Session 10 Workshop on Bearing Faults

Install 5/8" dia. shaft kit with inner and outer race faulted bearings, collect data on both bearing housings for different spectral resolutions and averaging, analyze spectra and time wave forms.

2:30 – 2:45

Coffee Break

2:35 – 3:45 PM

Session 11 Workshop on Bearing Faults (cont.)

Install 1" dia. shaft with inner and outer race faulted bearings, collect data on both bearing housings for different spectral resolutions and averaging, analyze spectra and time wave forms,

demonstrate the difficulty of bearings faults diagnosis using typical spectral analysis, determine the effects of averaging, resolution and leakage.

3:45 – 4:00 *Coffee Break*

4:00 – 5:00 **Session 12** **Fluid Film Bearing and Whirl/Whip Phenomena**

Use proximity probe to collect vibration data from fluid bearings. Study how to use orbit, Bode and polar plots to interpret data. Observe oil whirl and oil whip phenomena.

Day 3

Morning Session

8:00 – 8:15 AM **Review of topics covered on Day 2**

8:15 – 9:45 **Session 13** **Workshop on Resonance and Critical Speed**

Install resonance kit on MFS, collect data during speed up and coast down tests with three equally spaced rotors, determine critical speed, dwell near resonance and examine phase shift and amplitude effect near the critical speed, change rotor locations and determine shift in critical speeds, discuss responses below and above critical speed, discuss the shift in critical speeds due to change in effective mass and stiffness.

9:45 – 10:00 *Coffee Break*

10:00 – 10:45 PM **Session 14** **Workshop on Belt Drive**

Install intact bearings and belt drive using a bearing block. Experiment with loose belts at different speeds; determine belt speed using strobe; and repeat tests to examine belt tension effects; introduce misalignment and eccentric sheave and determine effects on vibration spectra; excite and check for belt resonances. Discuss the results.

10:45 – 12:00 PM **Session 15** **Workshop on Gearbox Vibration**

Configure MFS with 5/8" shaft, intact bearings and belt drive with gearbox. Perform experiments to determine effects of load and speed on gearbox vibration spectra, gear-mesh frequency, side bands and harmonics. Examine time waveform. Discuss results and other signal processing techniques for bearings and gearbox faults diagnostics.

12:00 – 1:00 PM *LUNCH*

Afternoon Session

1:00 – 2:15 PM Session 16 Workshop on Mechanical Rub and Looseness

Vibration

Remove belts and any other loading, collect baseline data. Loosen one bolt on a bearing housing base and collect data at different speeds, introduce a small unbalance and repeat experiments. Compare spectra at different locations and directions obtained using both test conditions. Install rub kit and conduct rub experiments

2:15 – 2:30 *Coffee Break*

2:30 – 3:30 Session 17 Workshop on Induction Motors

Describe induction motor basic principle and faults. Install a couple of faulted motors, acquire vibration and motor current data, perform motor current signature analysis (MCSA) and compare the results with vibration data.

3:30 – 4:00 Closing

Review and discuss fault diagnosis in real-life situations

Question/Answer Session – field questions from participants on the course and related topics.

Speakers

Dr. Suri Ganeriwala is the founder and president of Spectra Quest, Inc. He has over twenty-five years of industrial and academic experience in machinery vibration diagnostics and control, signal processing, and visco-elastic materials characterization. Suri has worked for Philip Morris, Firestone, and Martin Marietta Aerospace. He has developed a unique method of instruction using the Spectra Quest Machinery Fault Simulator (MFS), which is his brainchild from concept to completion. The MFS has been sold over 35 countries and has become an industry standard for studying rotor dynamics issues and learning machinery fault signature. He has authored over thirty papers and articles in journals, magazines, and books. He obtained a Ph.D. in Mechanical Engineering from the University of Texas at Austin.

Dr. Eric Li is a research and development engineer at Spectra Quest Inc. He received a B.S. degree in theoretical and applied mechanics from Lanzhou University in 1996. He obtained the Ph.D. degree in mechanical engineering from Florida International University in 2008. His research interests include vibration, smart materials and structures. He has extensive teaching experiences for six years in vibration and dynamics.