



Course Introduction, Details, Speakers and Agenda

Machinery Fault Diagnosis and Advanced Signal Processing Techniques

A Practical Course on Advanced Machinery Fault Diagnosis taught by world recognized expert **Professor Bob Randall**, University of New South Wales, Australia
Assisted by Dr Suri Ganeriwala, Spectra Quest, Inc



MFPT is offering a practical course on Machine Diagnostics with emphasis on signal processing techniques, including FFT methods, Hilbert methods via FFT and related amplitude, phase and frequency demodulation, cepstrum, order tracking and time synchronous averaging. Rather than giving pure theory, it would be illustrated at all stages with diagnostic examples and demonstrations using SpectraQuest Machinery Fault Simulators. The



concept of cyclostationarity with principal application to bearing diagnostics will be provided. The course will cover a range of techniques for bearing diagnostics, as well as for gear diagnostics. It will also cover IC engines using a number of techniques, including simple torsional vibration analysis by frequency demodulation of shaft encoder signals using SpectraQuest bearing wear and gearbox dynamics simulators.



The course will provide a hands-on approach, with theory/lectures followed by real-life examples as well as demonstration of novel techniques for fault diagnosis. The approach will involve a classroom with several workstations set up for carrying out controlled exercises. Each workstation will comprise a Machinery Fault Simulator with different machine fault kits, a multi-channel data acquisition system, simulation/training/diagnosis/analysis software, fully wired sensors, and necessary accessories such as tachometer, strobe, etc. All the PCs will be connected to a client-server type network for free exchange of data and enhanced discussion.

Details

- Date:** November 2-6, 2009
- Venue:** Holiday Inn, 3207 North Boulevard, Richmond, VA
- Who Should Attend?** This course covers advanced material which a Category III or IV Vibration Analyst will be able to understand. Category II analysts who believe they are ready to sit the Category III examination would also benefit from the course, although it is not designed to cover the Vibration Institute examination syllabus. It will, however, count as credit for Vibration Institute recertification. We recommend you study the detailed agenda to help you make a decision on whether you are qualified to attend. If you have any questions, please e-mail [Rick Wade](mailto:Rick.Wade@Sqi.com) or call him on 937 256 2285 (Ext 2#).
- Cost:** \$1,695.00 if registering prior to 1 October, 2009
\$1,895.00 after 1 October, 2009

The cost will cover all coffee breaks, lunches, and one dinner at a popular local restaurant. Attendees will receive a free copy of the 'Signal Processing Fundamentals and Simulation' software (\$495 value) along with class notes. Register now on at www.mfpt.org/Courses/Register.htm.

Speakers

Professor R. B. Randall, University of New South Wales, Australia is a world-recognized expert on machinery fault diagnostics and prognostics, especially bearings and gearboxes. He has pioneered numerous signal processing techniques for analyzing complex machinery signals such as helicopter gearboxes, IC engines, reciprocating machines etc. He has published extensively on signal processing and diagnostics. Professor Randall is a frequent invited keynote speaker at conferences and symposia. He worked in industry for over 10 years in Australia, Canada, and Europe before becoming a senior fellow at Brüel & Kjær for 17 years. He has been teaching at the University of New South Wales, Australia for the last 20 years. Bob is well known all over the world for introducing innovative signal processing techniques for complex machinery fault diagnosis and prognosis.

Dr. Suri Ganeriwala is the founder and president of Spectra Quest, Inc. He has over 25 years' of industrial and academic experience in machinery vibration diagnostics and control, signal processing, and visco-elastic materials characterization. He has developed a unique method of instruction using the Spectra Quest Machinery Fault Simulator (MFS), which is his brainchild from concept to completion. 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.



Preliminary Course Agenda

Day 1 – AM

Introduction, basic signal processing – Fourier analysis – Hilbert transforms – practical FFT analysis – demodulation – cyclostationarity and spectral correlation– introduction to cepstrum analysis – time-frequency analysis, STFT, Wigner-Ville distribution, wavelets.

Day 1 – PM

Exercises

Day 2 – AM

Rolling element bearing vibrations – fault diagnostics through envelope analysis – applications of cyclostationarity, local faults and extended faults – spectral kurtosis (SK) for determining optimum frequency band for demodulation– minimum entropy deconvolution (MED) to remove smearing effect of transmission path – combination for semi-automated process.

Day 2 – PM

Exercises

Day 3 – AM

Gear vibrations – separation of gear and bearing signals by self adaptive noise cancellation (SANC), discrete/random separation (DRS), linear prediction – order tracking (angular sampling) – synchronous averaging of individual gear signals – residual analysis – cepstrum analysis – amplitude and phase demodulation of gearmesh signal- transmission error (TE) measurement using shaft encoders.

Day 3 – PM

Exercises

Day 4 – AM

Reciprocating machine vibrations – time (crank angle) vs frequency representations – spectrogram comparison for detecting change – torsional vibration (angular velocity) measurement for irregular combustion – determination of angular velocity by phase demodulation of encoder signal followed by differentiation in the frequency domain (simultaneously removing irrelevant high and low frequency noise) – determination of angular velocity by encoder pulse timing with a high frequency clock – benefits of instantaneous (Wigner-Ville) spectrum after removal of periodic components – determination of cylinder pressure (or pressure torque) from external acceleration and/or torsional vibration measurements.

Day 4 – PM

Exercises

Day 5 – AM

Dynamic structural response – introduction to experimental modal analysis (EMA) and operational deflection shape (ODS) – simple structural response measurements with a single accelerometer, first used to measure and adjust force frequency range by changing impact pad, then responses at different locations – determination of excited frequency range from mass of hammer and stiffness of impact pad – ODS using a fixed and a roving accelerometer - exercises (time permitting).

Day 5 – PM

Category III examination - optional (candidates must contact the [Vibration Institute](#) stating that they wish to Register to sit the examination following the MFPT Course, and paying the necessary fee, at least two weeks before attending Course).