

# PHMAP 17

Asia Pacific Conference of the Prognostics and Health Management Society 2017

July 12 (Wed) - 15 (Sat), 2017

Ramada Plaza Jeju Hotel, Jeju, Korea



## Short Course

### "Advanced Machine Diagnostics and Condition Monitoring"

July 10 (Mon) - 11 (Tue), 2017 | Ramada Plaza Jeju Hotel, Jeju, Korea

(Short Course Fellow)



**Prof. Robert B. Randall**  
University of New South Wales  
Australia

PHMAP17 offers this two-day intensive short course titled "Advanced Machine Diagnostics and Condition Monitoring" on July 10-11, 2017 in Jeju, Korea right before the conference. The course gives an overview of the most up-to-date techniques in machine condition monitoring and diagnostics by vibration analysis and signal processing.

### Course Synopsis

The course gives an overview of the most up-to-date techniques in machine condition monitoring and diagnostics by vibration analysis and signal processing.

#### Who should attend

The course on Advanced Machine Diagnostics and Condition Monitoring is intended for researchers and engineers, active in the field of machine design, maintenance, monitoring and diagnostics, who wish to update their knowledge on recent topics in vibration based condition monitoring. No detailed knowledge of the related topics is required; some general background in the field of machine monitoring is however advantageous.

#### Reference

Vibration-based Condition Monitoring: Industrial, Aerospace and Automotive Applications, R. B. Randall

#### Programme

The course on Advanced Machine Diagnostics and Condition Monitoring will include, among others, the following topics.

- **Vibration monitoring techniques and applications**  
Transducers and their application areas; introduction to all three phases of condition monitoring, i.e. fault detection, diagnosis and prognosis.
- **Basic vibration analysis**  
Interpretation of vibrations as an interplay of spring and inertial forces, and the effects of damping forces, primarily near resonances. Graphical impedance/mobility methods (Salter) and importance of whether force or motion is common to the spring/mass/damper elements. Extension to multi degree of freedom (MDOF) systems.
- **Vibration signatures and signal types**  
Signal classification – stationary, slowly varying, transient, deterministic, random, cyclostationary; Fault signatures – low harmonics of shaft speed (e.g. unbalance, misalignment); faults in gears, bearings, bladed machines, electrical machines, reciprocating machines.

- **Basic signal processing**

Fourier analysis, including the importance of dimensions, units and scaling of the different forms of the Fourier transform; graphical methods based on the convolution theorem; Hilbert transforms and applications to amplitude and phase demodulation; cepstrum analysis applied to harmonic and sideband families, separation of source and transfer function effects, and detection of echoes; order tracking and angular sampling for variable speed; time/frequency analysis; cyclostationarity and spectral correlation.

- **Specific application areas**

Gears and rolling element bearings and their signal separation by a range of methods – a semi-automated bearing diagnostic technique for cases varying from a high speed gas turbine bearing to the main bearing of a radar tower – IC engines – misfires by torsional vibration – time/frequency analysis.

- **Fault simulation**

With a view to generating data to train neural networks without having to experience vast numbers of actual failures. Illustrated by application to IC engines.

### Certificate

A PHM Society Certificate will be provided to each participant completing the course.

### Registration Fee

Categories	Pre-registration (Until May 19, 2017)	Late/Onsite (After May 19, 2017)
Professional with Conference Registration	USD 550	USD 700
Professional Standalone	USD 800	USD 950
Student with Conference Registration	USD 350	USD 450
Student Standalone	USD 500	USD 600

### ❖ Session Chairs

- Gyunyoung Heo (Kyung Hee University)
- Jeff Bird (TECNos)

For more details, please visit the official website: [www.phmap.org](http://www.phmap.org) or contact the conference secretariat at [info@phmap.org](mailto:info@phmap.org).

### Short Course Schedule

DAY 1 - Monday, July 10th		
Time Slot	Title	Contents Notes
08:30 – 09:00	Welcome and Introductions	All participants
09:00 – 09:30	Introduction to vibration - based condition monitoring	Transducers and their application areas; introduction to all three phases of condition monitoring, i.e. fault detection, diagnosis and prognosis; online vs intermittent monitoring
09:30 – 10:30	Basic vibration analysis	Interpretation of vibrations as an interplay of spring, damping and inertial forces. Graphical impedance/mobility methods (Salter) and importance of whether force or motion is common to the spring/mass/damper elements. Extension to multi degree of freedom (MDOF) systems. Introduction to convolution.
10:30 – 10:45	<i>Break</i>	
10:45 – 12:00	Vibration signatures and signal types	Signal classification – stationary, slowly varying, transient, deterministic, random, cyclostationary; Fault signatures – low harmonics of shaft speed (e.g. unbalance, misalignment);

		faults in gears, bearings, bladed machines, electrical machines, reciprocating machines.
12:00 – 13:00	<i>Lunch</i>	
13:00 – 14:00	Signal processing - Frequency analysis	Fourier analysis, including the importance of dimensions, units and scaling of the different forms of the Fourier transform; graphical methods based on interpretation of Fourier analysis in terms of rotating vectors and the convolution theorem.
14:00 – 14:45	Signal processing - Hilbert transform	Hilbert transform and calculation by FFT; Amplitude and phase/frequency demodulation; application to envelope analysis, gear diagnostics.
14:45 – 15:00	<i>Break</i>	
15:00 – 16:00	Signal separation and enhancement	Separation of gear and bearing signals by a variety of methods; enhancement of bearing signals using the kurtogram and spectral correlation.
16:00 – 17:00	Bearing diagnostics	A semi-automated method for a wide range of situations and speeds, based on envelope analysis of an optimum demodulation band after separation of bearing signals.
17:00 – 17:15	Group discussion	
18:00 -	Dinner (Networking for all participants)	

**DAY 2 - Tuesday, July 11th**

<b>Time Slot</b>	<b>Title</b>	<b>Contents Notes</b>
08:30 – 09:30	Signal processing - Cepstrum analysis	Cepstrum analysis applied to harmonic and sideband families, separation of source and transfer function effects, and detection of echoes
09:30 – 10:30	Signal processing - Time/frequency analysis	STFT; wavelet analysis; wavelet packet analysis; Wigner-Ville distribution (WVD); Wigner-Ville Spectrum (WVS)
10:30 – 10:45	<i>Break</i>	
10:45 – 11:15	Order tracking	Phase/time map; angular resampling; phase demodulation method
11:15 – 12:00	Gear diagnostics	TSA and residual analysis; cepstrum analysis; harmonic and sideband cursor (blind determination of tooth numbers)
12:00 – 13:00	<i>Lunch</i>	
13:00 – 13:45	Variable speed	Gear and bearing diagnostics with varying speed
13:45 – 14:30	Reciprocating machines	IC engine misfire by torsional vibration analysis; time/frequency methods
14:30 – 14:45	<i>Break</i>	
14:45 – 15:45	Fault simulation	Generating data to train neural networks without having to experience vast numbers of actual failures; Illustrated by application to IC engines
15:45 – 16:15	Final discussion	All participants