

Bearings Plus Inc. Offers

MACHINERY VIBRATION AND ROTORDYNAMICS SHORT COURSE

January 9-13, 2012, Hilton Houston Hobby Airport
8181 Airport Blvd, Houston, Texas 77061.
Tel: (713) 645-3000, Fax: (713) 645-1409

Registration Fee: \$1,795

Call Mona Ibanez 1-800-500-6819 or 713-944-1005 email mibanez@bearingsplus.com

Course Description

The course will begin with a review of vibration theory followed by an introduction to rotordynamics. Rotordynamics terminology in common use will be defined and explained, including critical speeds, the critical speed inversion, unbalance response, and rotordynamic instability. The influence of rotordynamics on different types of turbomachinery design will be illustrated. Case studies of rotordynamic instability and critical speed problems will be presented. The occurrence and importance of backward whirl will be explained. Causes of bearing problems and failures will be described. Several new seals and bearing dampers with significant damping and stabilizing properties will be described. The following topics in rotordynamics will be covered: force coefficients for bearings, seals, impellers, turbine wheels, and squeeze film dampers; troubleshooting oil film bearings, the finite element and transfer matrix methods for rotordynamic analysis, building realistic rotordynamic computer models, making computer models agree with measurements.

Who Should Attend

The course offers concepts and techniques to engineers involved in design, operation, and maintenance of rotating equipment. Participants should have some experience with rotating machinery. For sessions of vibrations analysis and computer simulation, a Bachelor's degree or equivalent knowledge of basic college-level mathematics is assumed.

Instructors

Dr. Dara Childs is the Director of the Turbomachinery Laboratory and holder of the Jordan Chair in Mechanical Engineering at Texas A&M University. He is an ASME Fellow and was awarded the ASME Henry R. Worthington medal. He is the author of the book *Turbomachinery Rotordynamics* and is the world leader in research on turbomachinery seals and their rotordynamic coefficients.

Dr. Brian Murphy is conducting research at the Center for Electromechanics (CEM) in Austin, Texas, focusing on advanced electromechanical rotating machinery, including ultra-high energy motors and generators and high-speed flywheel batteries. Prior to his appointment at CEM he was involved in the development of advanced turbomachinery for liquid rocket engines while employed at Rocketdyne. Dr. Murphy has developed rotordynamics algorithms and software (XLRotor™) that are widely used by rotating machinery engineers in industry.

Dr. John M. Vance recently retired from Texas A & M University where he was Professor of Mechanical Engineering and carried out research on rotordynamics, bearing dampers, and damper seals in the Turbomachinery Laboratory. He received his B.S.M.E. (1960), M.S.M.E. (1964), and Ph.D. (1967) degrees from The University of Texas at Austin. He has published more than seventy-five technical articles and reports on rotordynamic instability, squeeze film bearing dampers, damper seals, vibration isolators, and related subjects. His book entitled Rotordynamics of Turbomachinery (John Wiley, 1988) has sold more than three thousand copies and is used by turbomachinery engineers around the world. He is an active consultant to industry and government and held twelve summer appointments at Pratt & Whitney Aircraft, USARTL (Helicopter Propulsion Lab, Ft. Eustis), Southwest Research Institute, Shell Development Co., and the UT Center for Electromechanics. He supported the development of a new turboprop aircraft engine through full-scale rotordynamic testing in the Turbomachinery Laboratory and conducted stiffness testing of the ball bearings used in liquid rocket engine turbopumps. Dr. Vance served on the Advisory Committee for the Turbomachinery Symposium from 1983 to 2007. He is an inventor on several patents relating to rotating machinery and vibration reduction. His patented "TAMSEAL" has been retrofitted to solve vibration problems in a number of high-pressure industrial compressors. He is an ASME Fellow, and a registered professional engineer in the State of Texas.

Dr. Luis San Andres is a Professor of Mechanical Engineering at Texas A & M University. He conducts computational and experimental research in fluid film bearings, seals and squeeze film dampers. Dr. San Andres is well known for his fast computational codes predicting the static and dynamic forced response of gas and liquid bearings and seals. He has also developed reliable in-situ techniques for estimation of bearing support parameters. Since 2000, Dr. San Andres conducts research towards the deployment of inexpensive gas bearings enabling oil-free turbomachinery for micro-power generation and automotive turbochargers.

Dr. Fouad Zeidan is a consultant with Waukesha Bearings. He was the previous owner/president of KMC/Bearings Plus, Inc. Prior to joining KMC, he held positions at Amoco Research Center, IMO Industries CentriMarc Division, and Qatar Fertilizer where he worked in maintenance and trouble shooting of rotating machinery, bearing design and failure analysis, vibration and rotordynamic analysis. Dr. Zeidan holds seven U.S. Patents for integral squeeze film dampers, and high performance journal and thrust bearings. He has published more than 30 technical papers and articles on various turbomachinery topics. Dr. Zeidan holds a B.S., M.S., and Ph.D. degrees from Texas A&M University.

SYLLABUS

- Four 1.5 hour sessions each day: Two in the morning 8:30-12:00 and two in the afternoon 1:30-5:00, 20 Total Sessions including one computer simulation.
- Refreshments provided during the ½ hour coffee breaks each morning and afternoon and in-class deli sandwiches at 12:00 on Friday.

Monday

- 3:30 **Basic Techniques for Reducing Machinery Vibrations**, Dr. Vance, Reviews basic vibration theory and shows how it is used in diagnostics and trouble shooting machinery vibrations.
- 10:30 **Introduction to Rotordynamics**, Dr. Vance, The Jeffcott model, Critical speeds and Natural Frequencies

- 1:30 **More Material on Rotordynamics**, Dr. Childs, Bent shaft, Orthotropic supports, Parametric Excitation, Newkirk and Morton effect
- 3:30 **Design and Application of Fluid Film Bearings**, Dr. Brian Murphy, Fluid film bearing fundamentals, advantages and disadvantages of different bearing configurations.

Tuesday

- 3:30 **Direct and Cross-Coupled Stiffness and Damping Coefficients and Their Effect on Rotordynamics**, Dr. Vance, cross-coupling and fractional frequency whirl, effect of support stiffness
- 10:30 **Liquid Seals and Their Effect on Pump Rotordynamics**, Dr. Childs.
- 1:30 **Gas Seals and Their Effect on Steam Turbine and Compressor Rotordynamics**, Dr. Childs
- 3:30 **Introduction to Computer Modeling of Rotordynamics**, Dr. Brian Murphy

Wednesday

- 3:30 **Rotordynamic Instability Explained and Vibration Damping Devices for Turbomachinery**, Dr. Vance, includes demonstrations of internal friction and aerodynamic negative damping, squeeze film dampers, wire mesh, and TAMSEALS™
- 10:30 **Computer Modeling of Transient Rotordynamics**, Dr. Brian Murphy
- 1:30 **Torsional Vibrations Overview and Analysis**, Dr. John Vance
- 3:30 **Rotordynamics Overview, API Requirements and Analysis**, Dr. Brian Murphy

Thursday

- 3:30 **Planning and Making Rotordynamic Measurements**, Dr. Vance
- 10:30 **Squeeze Film Dampers**, Types, Design, Operations, and Technical Issues. Dr. Luis San Andres
- 1:30 **Oil Free Bearings for Turbomachinery**, Dr. Luis San Andres
- 3:30 **Making Analysis and Measurements Work Together**, Dr. John Vance
Case studies of an automotive turbocharger and an aircraft turbine engine

Friday

- 3:30 **Torsional Dynamics Overview with Steady State and Transient Analysis**, Dr. Brian Murphy
- 10:30 **Fluid Film Bearing Failures, Identification and Corrections**, Dr. Fouad Zeidan
Journal and thrust bearing failures, identification and suggestions for correction
- 12:30 **Computer Modeling Demonstration for Typical Problems**, Dr. Brian Murphy

Deleted: Transient Vibration Data and Interpretation, Robert Eisenmann, Sr.¶
2:15 .

The course syllabus shown is based on the information available at the drafting of this outline. Instructors and/or course lectures may change.

TO REGISTER OR MORE INFORMATION

Call, Write, Fax, or E-mail

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E-mail mrocha@bearingsplus.com

You can also log on/click on the link below to fill the registration form and submit

<http://www.bearingsplus.com/services/training.htm>

LODGING: A block of rooms have been reserved for short course attendees/instructors at \$89.99 per night, full breakfast buffet included. You must contact the Hilton Houston Hobby Airport directly at Tel: (713) 645-3000, Fax: (713) 645-1409 or log on/click on the link below.

<http://www.hilton.com/en/hi/groups/personalized/HOUHAHF-MVB-20100109/index.jhtml>