Advanced Machinery Dynamics course

This course is designed for:

• Engineers desiring to advance their machinery vibration diagnostics skills.
• Engineers involved in the design, acceptance testing, and maintenance of rotating machinery.
• Post-graduate engineering participants.
• Academic researchers and professors involved in rotor dynamics.

Prerequisites:

Prior to this course, participants should have completed the Machinery Diagnostics course or be ISO category 3 certified.
The Machinery Diagnostics course will be offered the week before for those who do not yet meet the prerequisite.
Although we will not refuse persons who do not meet the prerequisites, the Advanced Machinery Dynamics course will start where the Machinery Diagnostics course leaves off.
Without the prerequisites, participants will not get the expected return on their investment.

Main Themes, Topics and Course Objectives:

Rotor modeling as a Machinery Diagnostics tool:

In this module participants will be able to identify the design parameters that determine the rotor dynamic behavior. In workshops they will build a rotor model and verify its correctness on an actual machine model. Several case histories will show the practical use of rotor modeling.

- Machine design: rotors, bearing and supports
- Single rotor modeling
- Coupled system machine trains
- Torsional modeling
- Synchronous Dynamic Stiffness Testing
- Case histories

Understanding Anisotropic Systems:

In this topic the participants will be introduced to anisotropic systems, be able to recognize machine behavior due to anisotropy and be aware of the implications for balancing and determination of the SAF.

- Causes and effects of anisotropy.
- Virtual probe rotation and forward and reverse polar plots
- Case histories

Balancing Machines:

Participants will be able to differentiate between the various balancing methods and to state their advantages and drawbacks. In a hands-on workshop they will perform multiplane balance. Several case histories will give the participants some “field experience”.

- High-speed vs. low speed
- Shop vs. field balancing.
- Balancing methods:
    - Influence vectors
    - Static / coupled
    - Polar. (modal method)
- Thermal effects
- Case histories

Rotor to stator rubs:

After a short review of rub fundamentals, the students will be presented with various case histories, after which they will be able to recognize machine rubs.

Cases presented:

- Rub on a steam turbine
- 1X rotating phase on Generator and Gas Turbine

Diagnose and Control of Fluid Induced Instabilities:

Participants will review how to recognize fluid instabilities, be able to explain the root cause of this malfunction, and show their understanding of design changes to prevent this malfunction.

- Review Fluid Induced Instabilities Of Rotors: Whirl And Whip
- Diagnose And Control Fluid Induced Instabilities
- Instabilities with torsional vibration (two case histories)
- Surge, rotating stall, fluid recirculation and cavitation
- Shunt holes, swirl breakers, and other fixes.
- Case histories

Shaft crack:

Diagnosis of shaft crack will be revisited by the participants. After this they will be able to recognize the symptoms in the presented case histories.

Cases presented:

- Steam turbine shaft crack.
- Shaft crack on a reactor recirculation pump.

Gear Forces and Frequencies:

Participants will be able to recognize the different types of gears, be able to state their advantages and drawbacks, list the normal gear force directions and calculate the five discrete gear frequencies.

- Gearbox design parameters
- Gears forces
- The five discrete gear frequencies
- Gearbox case histories

Basics of rolling element bearings

Participants will receive an introduction to rolling element bearing faults and how to detect these using vibration analysis methods. The topic will discuss typical causes and pattern of bearing damage, various stages of bearing failure and present signal processing considerations for rolling element bearing diagnostics.

- Causes and pattern of rolling element bearing damage
- Rolling element bearing geometry and fault frequencies
- Signal processing for bearing diagnostics with emphasis on envelope analysis and demodulation
- Rolling element bearing diagnostics case histories

Introduction to Impact testing and analysis with case history

Participants will be introduced to structural testing and the basics of modal analysis and shown how to use impact testing for the identification of component natural frequencies. An introduction to operating deflection shape (ODS) and mode shape analysis with a case history will also be presented.

- Basics of modal analysis and concepts of mode frequency, shape and damping
- Impact testing and measurement considerations
- ODS analysis
- Case histories on determination of natural frequencies and mode shapes.