MERCURY

Advanced Rotordynamics and Machinery Dynamics Training Course

14 – 18 March 2027
Manama (Bahrain)



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Ref: 35_1082289 **Date:** 14 – 18 March 2027 **Location:** Manama (Bahrain) **Fees:** 5500 Euro

The Advanced Rotordynamics and Machinery Dynamics Training Course is a one-week course for mechanical integrity engineers, rotating equipment specialists, and plant vibration analysts addressing instability, resonance, and dynamic rotor deflection in critical turbomachinery trains. Working with industry analytical standards and monitoring data, you develop a complete Rotordynamic Analysis and Vibration Audit Dossier. Mercury Training Center delivers this course to help you optimize machinery reliability.

About This Course

Uncontrolled shaft vibration, rotor-stator rubs, and fluid-film instability cause catastrophic equipment trips and structural fatigue in high-energy turbomachinery. To follow this course, you must already understand basic vibration analysis, shaft alignment, and rotating machinery operations. Through practical modeling exercises, you evaluate critical speeds, determine bearing dynamic stiffness, assess unbalance responses, and establish diagnostic criteria for industrial machinery trains.

Who It Is For

- Professionals responsible for modeling lateral and torsional dynamic behavior across multi-stage pumps, compressors, and turbine trains
- Professionals responsible for diagnosing root causes of excessive industrial machinery vibration, resonance, and rotor instability
- Professionals responsible for specifying and auditing machinery protection systems, proximity probe arrangements, and sensor instrumentation
- Professionals responsible for balancing flexible and rigid rotors and establishing dynamic acceptance baselines during commissioning

This course is not for entry-level lube technicians seeking basic lubrication and grease packing routines, nor is it for civil structural inspectors requiring static concrete foundation testing courses.

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Competencies You Will Build

- Lateral Rotordynamic Modeling: Simulating shaft deflections, bearing stiffness, and undamped critical speed maps to prevent operational resonance.
- Rotor Stability Assessment: Evaluating logarithmic decrement, cross-coupled stiffness, and fluid-film bearing damping to suppress subsynchronous whirl and whip.
- Torsional Train Analysis: Calculating torsional natural frequencies and interference margins across motor, gearbox, and compressor shaft couplings.
- Dynamic Response Evaluation: Measuring unbalance amplification factors and shaft orbits against standard mechanical integrity limits.
- In-Situ Rotor Balancing: Executing multi-plane balancing calculations using influence coefficient methods to meet balance quality grade tolerances.
- Machinery Protection Configuration: Aligning vibration transducer placement and alarm thresholds with standard machinery protection practices.

What You Will Be Able to Do

By the end of the course you will be able to:

- From rotor geometry and bearing specifications, construct finite-element lumped-parameter shaft models to plot Campbell diagrams and critical speed separation margins.
- Given proximity probe orbital data and cascade spectrums, diagnose rotor rub, fluid-film instability, and misalignment in high-speed rotating equipment.
- Using API TR 684 and API 617 criteria, calculate rotor stability margins and logarithmic decrement values under aerodynamic cross-coupling forces.
- From torsional excitation frequencies and drive torque profiles, tune flexible coupling stiffness parameters to eliminate resonance in gear-driven machinery trains.
- Given vibration amplitude and phase readings, calculate single-plane and multi-plane balance correction weights using influence coefficient vectors.
- Using ISO 20816 severity guidelines and API 670 sensor requirements, establish operational vibration trip limits and monitoring baselines for critical machines.

Course Content

Day 1: Lateral Rotordynamic Modeling and Critical Speeds

- Timoshenko Beam and Finite-Element Lumped-Parameter Rotor Modeling Techniques
- Undamped Critical Speed Map Generation and Support Stiffness Variation Analysis
- Campbell Diagram Formulation for Natural Frequency Identification Across Operating Speeds
- Bearing Damping and Stiffness Coefficient Calculations for Fluid-Film Journal Bearings
- Separation Margin Verification for Centrifugal Compressors and Pumps Under API 610 and API 617

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Day 2: Rotor Stability, Whirl, and Dynamic Unbalance Response

- Damped Eigenvalue Analysis and Logarithmic Decrement Calculation Under API TR 684
- Fluid-Film Bearing Instability Mechanisms Covering Oil Whirl and Oil Whip Phenomena
- Cross-Coupled Aerodynamic Stiffness Evaluation and Destabilizing Force Mitigation
- Lateral Unbalance Response Calculations and Amplification Factor Assessment
- Vibration Severity Evaluation Across Rotating Shafts Using ISO 20816 Zone Criteria

Day 3: Torsional Dynamics and Machinery Protection Architecture

- Lumped-Mass Torsional Train Modeling for Motor, Gear, and Compressor Shaft Systems
- Torsional Natural Frequency Calculations and Interference Diagram Construction
- Flexible Coupling Selection and Dynamic Stiffness Tuning for Torsional Damping
- Transient Torsional Response Modeling During Motor Start-Up and Electrical Faults
- Machinery Protection System Architecture and Sensor Siting Protocols Under API 670

Day 4: Vibration Diagnostics and Multi-Plane Field Balancing

- Orbit Analysis and Shaft Centerline Trajectory Tracking in Hydrodynamic Bearings
- Polar, Bode, and Full Spectrum Diagnostics for Rotor Rub and Dynamic Bow Identification
- Single-Plane and Multi-Plane Rotor Balancing Using Influence Coefficient Matrix Methods
- Residual Unbalance Tolerances and Balance Quality Grade Selection Under ISO 21940-11:2016
- Machinery Condition Monitoring and Fault Diagnosis Integration Following ISO 13373

Day 5: Diagnostic Synthesis and Rotordynamic Audit Delivery

- Exercise on Campbell Diagram Verification and Separation Margin Optimization
- Exercise on Hydrodynamic Bearing Stability and Logarithmic Decrement Calculation
- Exercise on Multi-Plane Dynamic Balancing and Vibration Response Correction
- Exercise on Machinery Protection Alarm Threshold and Trip Logic Verification
- Finalization of the Rotordynamic Analysis and Vibration Audit Dossier

Case Studies and Exercises

These suggested activities provide practical application of rotordynamic analysis and dynamic troubleshooting across industrial facilities:

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- Case study: A multi-stage boiler feed pump in a power generation facility where you analyze excessive subsynchronous vibration, evaluate bearing wear, and redesign bearing clearances to eliminate fluid-induced instability.
- Case study: A motor-driven centrifugal synthesis gas compressor train in a chemical processing plant where you construct a torsional model, evaluate gear mesh excitation, and select an elastomeric coupling to resolve torsional resonance.
- Exercise: An industrial refining facility where you analyze Bode and polar plots from a steam turbine trip, identify critical speed transitions, and calculate field balance weights using multi-plane influence coefficients.
- Exercise: A pipeline pumping station where you audit proximity probe arrangements and verify machinery protection interlocks against standard vibration trip thresholds.

What You Take Back

The Rotordynamic Analysis and Vibration Audit Dossier provides structured calculation sheets, diagnostic workflows, and validation templates to support your machinery integrity assessments during your first month back at work. You will use it to audit OEM rotordynamic design reports, verify critical speed separation margins, and calculate field balancing solutions.

- Lateral and torsional rotordynamic modeling templates with Campbell diagram plotting sheets
- Bearing stability evaluation workbook incorporating logarithmic decrement and cross-coupling calculators
- Multi-plane dynamic balancing calculation tool based on influence coefficient vectors
- Machinery vibration audit checklist incorporating ISO 20816 evaluation zones and API 670 sensor standards

Quick Answers FAQ

What background is required before attending the Advanced Rotordynamics and Machinery Dynamics Training Course?

You need practical familiarity with rotating equipment operations, basic vibration measurement concepts, and mechanical engineering fundamentals. Experience with plant maintenance or rotating machinery condition monitoring allows you to apply rotordynamic modeling and diagnostic workflows directly to plant equipment.

How does the Advanced Rotordynamics and Machinery Dynamics Training Course differ from general machinery maintenance courses?

General machinery maintenance courses focus on physical repair routines, lubrication practices, and component replacement. This course concentrates specifically on analytical rotordynamics, mathematical modeling of critical speeds, fluid-film bearing stability, torsional resonance calculations, and advanced multi-plane balancing for high-energy turbomachinery trains.

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Why is rotordynamic stability evaluation critical for high-pressure compressors?

High-pressure centrifugal compressors generate severe aerodynamic cross-coupling forces that can destabilize the rotor shaft. Evaluating logarithmic decrement and fluid-film bearing damping ensures the machine maintains positive dynamic stability across all operating loads, preventing destructive oil whip and catastrophic internal component contact.

What does the Rotordynamic Analysis and Vibration Audit Dossier include?

The dossier contains lateral and torsional modeling worksheets, logarithmic decrement calculation templates, influence coefficient balancing sheets, and machinery protection audit checklists. It provides ready-to-use analytical frameworks to evaluate turbomachinery vibration data and audit OEM engineering submissions upon returning to your facility.

For Your Manager

Your team member will return equipped to evaluate rotordynamic design submissions, troubleshoot complex turbomachinery vibration issues, and perform precise multi-plane field balancing. Using the Rotordynamic Analysis and Vibration Audit Dossier, they can immediately audit critical speed margins, assess fluid-film bearing stability, and review machinery protection settings, minimizing unplanned trips and avoiding costly rotating asset failures.