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COURSE BROCHURE

Advanced Machinery Dynamics and Rotor Vibration Training Course

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Registered in the United Kingdom and Saudi Arabia

Advanced Machinery Dynamics and Rotor Vibration Training Course

Advanced Machinery Dynamics and Rotor Vibration is a 2-week training course for rotating equipment engineers, vibration analysts and machinery reliability specialists, ending with a machinery dynamics diagnosis that links vibration evidence to a correction plan. Compressor trains, pumps and turbines run longer between overhauls, so misread spectra now cost unplanned trips and damaged bearings. Jupiter Prime Training delivers this course for rotating equipment teams.

Why Machinery Dynamics and Rotor Vibration Matters Now

Three pressures shape rotor behaviour work today. Process plants push compressors, pumps and steam turbines to higher speeds and longer run lengths, so rotors spend more time near critical speeds and stability margins. Online condition monitoring now streams proximity probe and accelerometer data continuously, yet many sites lack analysts who can turn orbits and phase into a root cause. Operations and maintenance leaders also expect a clear case before they stop a train. A site that reads rotor dynamics well corrects faults in planned windows; one that reads them badly replaces parts repeatedly. The course rests on recognised international machinery vibration standards and rotor dynamics practice, described in general terms.

Who Gains Most from Machinery Dynamics and Rotor Vibration

- Engineers who specify, accept and modify critical rotating trains
- Analysts who collect and interpret vibration spectra, orbits and phase data
- Specialists who set alarm limits and machinery protection philosophy
- Engineers who plan balancing, alignment and bearing replacement during turnarounds
- Reliability leads who rank recurring machinery faults for elimination

A rotating equipment group gains most when its machinery engineer, senior analyst and turnaround planner attend together and share one diagnostic language.

Machinery Dynamics and Rotor Vibration Capabilities

Participants leave able to connect a vibration signature to the rotor, bearing and support behaviour that produces it.

- Calculate critical speeds and separation margins from rotor models — acceptance of new or rerated trains
- Assess unbalance, misalignment and looseness from spectra, phase and orbits — maintenance actions during the next window
- Weigh fluid-film bearing and seal effects on stability — design changes with the original equipment manufacturer
- Apply modal testing and operating deflection shapes — structural resonance fixes for baseplates and piping
- Test torsional vibration risks in motor and gear trains — coupling selection and start-up procedures
- Communicate a diagnosis with evidence and confidence level — operations managers deciding whether to run or stop

Key Machinery Dynamics and Rotor Vibration Terms

- Critical speed — a shaft speed at which rotor excitation coincides with a natural frequency, amplifying vibration sharply.
- Separation margin — the gap between operating speed and the nearest critical speed, used to judge acceptable running.
- Orbit — the path a shaft centreline traces within its bearing clearance, plotted from two perpendicular proximity probes.
- Unbalance — uneven mass distribution about the axis of rotation, producing a once-per-revolution force.
- Logarithmic decrement — a measure of damping that indicates how quickly a rotor mode decays and how stable it is.
- Torsional natural frequency — the frequency at which a shaft train twists freely, excited by motors, gears or reciprocating loads.

Machinery Dynamics and Rotor Vibration Day by Day

Day 1: Rotating Machinery in Plant Reliability

- Criticality Ranking of Compressor and Pump Trains — Where Diagnosis Effort Pays Back
- Failure Modes of Rotors, Bearings and Seals — Linking Symptoms to Causes
- Machinery Protection Philosophy — Alarm and Trip Limits for Each Train
- Condition Monitoring Architectures — Online Systems Against Periodic Routes
- Vibration Severity Zones in International Standards — Acceptance of Running Machines

Day 2: Rotor Dynamics Fundamentals

- Single-Degree-of-Freedom Models — Resonance, Damping and Phase Lag
- Jeffcott Rotor Behaviour — Response Around the First Critical Speed
- Gyroscopic Effects and Overhung Rotors — Forward and Backward Whirl
- Mode Shapes of Flexible Rotors — Probe Location and Balancing Planes
- Campbell Diagrams — Separating Running Speeds from Natural Frequencies

Day 3: Critical Speeds and Stability

- Undamped Critical Speed Maps — Bearing Stiffness Effects on Modes
- Damped Unbalance Response Analysis — Amplification Factor and Margin Checks
- Rotor Stability and Logarithmic Decrement — Subsynchronous Whirl Risk
- Aerodynamic Cross-Coupling in Compressors — Stability Limits at High Pressure
- Rerate and Speed Increase Studies — Approving Changes to Existing Trains

Day 4: Bearings, Seals and Supports

- Fluid-Film Journal Bearing Coefficients — Stiffness and Damping Selection
- Tilting-Pad Against Fixed-Geometry Bearings — Stability Trade-Offs
- Oil Whirl and Oil Whip Mechanisms — Recognising Self-Excited Instability
- Labyrinth, Damper and Gas Seal Effects — Rotor Response Changes
- Pedestal and Foundation Stiffness — Support Resonance Near Running Speed

Day 5: Measurement and Signal Processing

- Proximity Probes, Velocity Sensors and Accelerometers — Choosing the Right Transducer
- FFT Resolution, Windowing and Averaging — Reliable Spectra for Diagnosis
- Phase Measurement and Once-per-Turn Reference Signals — Reference for Every Vector
- Orbit, Shaft Centreline and Waveform Plots — Reading Rotor Motion
- Bode and Polar Plots from Run-Up and Coast-Down — Locating Resonances

Day 6: Unbalance, Misalignment and Looseness

- Once-per-Revolution Signatures — Separating Unbalance from Bent Shafts
- Single-Plane and Two-Plane Influence Coefficient Balancing — Trim Weight Decisions
- Angular and Parallel Misalignment Spectra — Coupling and Thermal Growth Effects
- Laser Alignment and Hot Alignment Checks — Targets for Running Conditions
- Mechanical Looseness and Soft Foot — Harmonic Patterns and Corrections

Day 7: Lateral and Torsional Vibration

- Lateral Response of Multi-Bearing Trains — Coupled Mode Behaviour
- Torsional Natural Frequency Calculation — Motor, Gearbox and Driven Machine
- Variable Frequency Drive Excitation — Torsional Risk at Start-Up
- Gear Mesh and Sideband Analysis — Tooth Wear and Eccentricity Evidence
- Reciprocating Compressor Pulsation and Torque — Shaft Fatigue Concerns

Day 8: Modal Analysis and Structural Response

- Impact Hammer Modal Testing — Natural Frequencies of Casings and Frames
- Operating Deflection Shape Analysis — Visualising Running Distortion
- Frequency Response Functions — Mobility and Coherence Checks
- Structural Modification Options — Stiffening, Mass and Damping Choices
- Piping and Baseplate Resonance — Fixes Without Rotor Changes

Day 9: Fault Diagnosis Cases and Trends

- Rolling Element Bearing Defect Frequencies — Envelope Spectrum Evidence
- Rub, Crack and Thermal Bow Signatures — Startup and Shutdown Clues
- Electrical Faults in Motors — Separating Electrical from Mechanical Sources
- Trend and Transient Data Review — Rate of Change Against Alarm Limits
- Diagnostic Confidence Grading — When Evidence Supports a Shutdown

Day 10: Practising the Machinery Dynamics Diagnosis

- Machine Data Pack for a Selected Train — Speeds, Bearings and History
- Spectrum, Orbit and Phase Interpretation — Applying Fault Signatures
- Critical Speed and Stability Check — Confirming Margin Against Operating Range
- Correction Options Comparison — Balancing, Alignment, Bearing or Support Changes
- Machinery Dynamics Diagnosis — Vibration Evidence and Correction Plan

Applying Machinery Dynamics and Rotor Vibration After the Course

- Lead a coast-down data capture on one critical compressor or turbine, building Bode and polar plots to confirm its critical speeds against the original design report.
- Run an impact test on a pump baseplate with recurring high vibration and propose a stiffening or mass change based on its frequency response.

Machinery Dynamics and Rotor Vibration Questions FAQ

What is machinery dynamics and rotor vibration, and why does it matter now?

Machinery dynamics and rotor vibration is the study of how shafts, bearings, seals and supports respond to running forces. It matters now because plants run machines faster and longer, while continuous monitoring produces more data than many teams can interpret.

Which roles gain most from advanced machinery dynamics and rotor vibration training?

Rotating equipment engineers, vibration analysts and machinery reliability specialists gain most. They decide whether a train keeps running, how it is balanced or aligned, and which bearing, seal or support changes remove a recurring fault.

How does advanced machinery dynamics and rotor vibration differ from a basic vibration analysis course?

It goes beyond spectrum reading into rotor models. Participants calculate critical speeds, judge stability and damping, test torsional risk and use modal methods, so a diagnosis explains why a machine vibrates, not only that it does.

What do you bring back from machinery dynamics and rotor vibration training?

You bring back a diagnosis of a train you know. It holds the machine data, interpreted spectra, orbits and phase, a critical speed and stability check, and a ranked set of correction options.

Machinery Dynamics and Rotor Vibration: The Way Forward

The machinery dynamics diagnosis first informs whether a train can run to its next planned window or needs balancing, alignment or bearing work sooner. Machinery engineers, analysts and operations leaders use it to agree that call. After the first correction, revisit the separation margins and alarm limits it relied on, because post-repair coast-down data will show whether the rotor model was right.