COURSE OVERVIEW ME0109
Advanced Machinery Dynamics

Course Title
Advanced Machinery Dynamics

Course Date/Venue
July 20-24, 2025/Meeting Plus 9, City Centre Rotana, Doha, Qatar

Course Reference
ME0109

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

3.0 CEUs (30 PDHs) AWARD

H-STK© INCLUDED

Course Description

This practical and highly-interactive course includes various practical sessions and exercises. Theory learnt will be applied using our state-of-the-art simulators.

This course is designed to provide participants with a detailed and up-to-date overview of Advanced Machinery Dynamics. It covers the definitions and scope of dynamics in rotating and reciprocating machinery and applications in turbines, compressors, pumps and gearboxes; the vibration theory, mass, stiffness and damping characteristics, rotordynamics basics, modeling mechanical systems and measurement tools and instrumentation; the rotor dynamic instabilities, balancing of rotating equipment, journal and rolling element bearings, critical speed analysis and shaft alignment and its dynamic implications; the types of lateral vibrations and effects on bearings and structure; and troubleshooting high lateral vibration.

During this interactive course, participants will learn the torsional vibration dynamics, coupling dynamics and influence, advanced modal analysis, noise and vibration control techniques and machinery fault diagnosis using vibration; the gearbox vibration and noise, reciprocating machinery dynamics, finite element analysis in machinery and turbomachinery vibration and blade dynamics; the transient dynamic analysis, condition monitoring integration, advanced signal processing techniques and fault detection and root cause analysis; and the active vibration control, optimize dynamic performance and digital twin and simulation in dynamics.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply and gain an advanced knowledge on machinery dynamics
- Explain the definitions and scope of dynamics in rotating and reciprocating machinery and applications in turbines, compressors, pumps and gearboxes
- Discuss vibration theory, mass, stiffness and damping characteristics, rotordynamics basics, modeling mechanical systems and measurement tools and instrumentation
- Identify rotor dynamic instabilities, balancing of rotating equipment, journal and rolling element bearings, critical speed analysis and shaft alignment and its dynamic implications
- Recognize the types of lateral vibrations, effects on bearings and structure and troubleshoot high lateral vibration
- Discuss torsional vibration dynamics, coupling dynamics and influence, advanced modal analysis, noise and vibration control techniques and machinery fault diagnosis using vibration
- Determine gearbox vibration and noise, reciprocating machinery dynamics, finite element analysis in machinery and turbomachinery vibration and blade dynamics
- Carryout transient dynamic analysis, condition monitoring integration, advanced signal processing techniques and fault detection and root cause analysis
- Discuss active vibration control, optimize dynamic performance as well as identify digital twin and simulation in dynamics

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides an overview of all significant aspects and considerations of advanced machinery dynamics for mechanical engineers, maintenance and reliability engineers, plant engineers and technicians, vibration analysts and condition monitoring specialists, equipment designers and OEM engineers, technical consultants, operations supervisors and managers and other technical staff.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Fee

US$ 6,000 per Delegate. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Mr. Karl Thanasis, PEng, MSc, MBA, BSc, is **Senior Mechanical & Maintenance Engineer** with over **45 years** of extensive industrial experience. His wide expertise includes **Piping & Pipeline**, Maintenance, Repair, **Shutdown**, **Turnaround & Outages**, **Maintenance & Reliability** Management, **Mechanical Maintenance** Planning, Scheduling & Work Control, Advanced Techniques in **Maintenance** Management, **Predictive & Preventive** Maintenance, **Maintenance & Operation Cost Reduction** Techniques, Reliability Centered Maintenance (**RCM**), **Machinery Failure** Analysis, **Rotating Equipment Reliability** Optimization & Continuous Improvement, **Material Cataloguing**, **Mechanical & Rotating Equipment** Troubleshooting & Maintenance, **Root Cause Analysis & Reliability** Improvement, **Condition** Monitoring, **Root Cause Failure Analysis** (RCFA), **Steam Generation**, **Steam Turbines**, **Power Generator Plants**, **Gas Turbines**, **Combined Cycle Plants**, **Boilers**, **Process Fired Heaters**, Air Preheaters, Induced Draft Fans, All Heaters Piping Work, Refractory Casting, Heater Fabrication, Thermal & Fired Heater Design, **Heat Exchangers**, Heat Transfer, Coolers, **Power Plant** Performance, Efficiency & Optimization, **Storage Tank** Design & Fabrication, **Thermal Power Plant** Management, **Boiler & Steam** System Management, **Pump** Operation & Maintenance, **Chiller & Chiller Plant** Design & Installation, **Pressure Vessel**, **Safety Relief Valve** Sizing & Selection, **Valve** Disassembling & Repair, Pressure Relief Devices (**PSV**), **Hydraulic & Pneumatic** Maintenance, Advanced **Valve** Technology, **Pressure Vessel** Design & Fabrication, **Pumps**, Turbo-Generator, Turbine **Shaft Alignment**, **Lubrication**, Mechanical **Seals**, Packing, **Blowers**, **Bearing** Installation, **Couplings**, **Clutches** and **Gears**. Further, he is also versed in **Wastewater Treatment** Technology, **Networking** System, **Water Network Design**, Industrial **Water Treatment** in Refineries & Petrochemical Plants, **Piping** System, Water Movement, Water Filtering, Mud Pumping, **Sludge Treatment** and **Drying**, **Aerobic Process** of **Water Treatment** that includes **Aeration**, **Sedimentation** and **Chlorination Tanks**. His strong background also includes **Design** and **Sizing** of all **Waste Water Treatment Plant Associated Equipment** such as **Sludge Pumps**, **Filters**, **Metering Pumps**, **Aerators** and **Sludge Decanters**.

Mr. Thanasis has acquired his thorough and practical experience as the **Project Manager**, **Plant Manager**, **Area Manager - Equipment Construction**, **Construction Superintendent**, **Project Engineer** and **Design Engineer**. His duties covered **Plant Preliminary Design**, **Plant Operation**, **Write-up** of **Capital Proposal**, **Investment Approval**, **Bid Evaluation**, **Technical Contract Write-up**, **Construction** and **Sub-contractor Follow up**, **Lab Analysis**, **Sludge Drying** and **Management** of **Sludge Odor** and **Removal**. He has worked in various companies worldwide in the **USA**, **Germany**, **England** and **Greece**.

Mr. Thanasis is a **Registered Professional Engineer** in the **USA** and **Greece** and has a **Master's** and **Bachelor's** degree in **Mechanical Engineering** with **Honours** from the **Purdue University** and **SIU** in **USA** respectively as well as an **MBA** from the **University of Phoenix** in **USA**. Further, he is a **Certified Internal Verifier/Trainer/Assessor** by the **Institute of Leadership & Management** (**ILM**) a **Certified Instructor/Trainer** and has delivered numerous trainings, courses, seminars, workshops and conferences worldwide.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the workshop for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1: ***Sunday, 20th of July 2025***

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Introduction to Machinery Dynamics*** *Definitions and Scope of Dynamics in Rotating and Reciprocating Machinery • Importance in Reliability, Safety, and Performance • Historical Development and Advancements • Applications in Turbines, Compressors, Pumps and Gearboxes*
0930 – 0945	*Break*
0945 – 1030	***Vibration Theory Refresher*** *Simple Harmonic Motion and Damped Systems • Free versus Forced Vibrations • Resonance and Natural Frequency Concepts • Vibration Modes and Critical Speeds*
1030 – 1130	***Mass, Stiffness & Damping Characteristics*** *Influence on System Behavior • Methods of Estimation and Measurement • Role in Design and Diagnostics • Dynamic Stiffness and its Frequency Dependence*
1130 – 1215	***Rotordynamics Basics*** *Jeffcott Rotor Model • Whirling Phenomena and Stability • Critical Speed Maps and Campbell Diagrams • Unbalance Response*
1215 – 1230	*Break*
1230 – 1330	***Modeling Mechanical Systems*** *Lumped versus Distributed Parameter Models • Finite Element Method (FEM) Overview • Modal Analysis Introduction • Simulation Tools Used in Industry*
1330 – 1420	***Measurement Tools & Instrumentation*** *Proximity Probes and Accelerometers • Data Acquisition Systems • Signal Conditioning Basics • Calibration and Installation Best Practices*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day One*

Day 2: **Monday, 21st of July 2025**

0730 – 0830	***Rotor Dynamic Instabilities*** *Oil Whip and Oil Whirl • Cross-Coupled Stiffness Effects • Instability Thresholds • Bearing-Induced Instability*
0830 – 0930	***Balancing of Rotating Equipment*** *Types of Balancing (Static, Dynamic, Couple) • Balancing Machines and Field Balancing • Influence of Keyphasors and Run-Up/Down • ISO Balance Quality Grades*
0930 – 0945	*Break*
0945 – 1100	***Journal & Rolling Element Bearings*** *Dynamic Behavior and Fluid Film Modeling • Bearing Selection and Stiffness/Damping Contributions • Orbit Plots and Interpretation • Faults and Diagnostics*
1100 – 1215	***Critical Speed Analysis*** *Determining Critical Speeds Theoretically and Practically • Mode Shapes and Modal Testing • Effects of Gyroscopic Moments • Campbell Diagrams Interpretation*
1215 – 1230	*Break*
1230 – 1330	***Shaft Alignment & its Dynamic Implications*** *Types of Misalignment (Angular, Parallel, Combined) • Effects on Vibration Levels • Alignment Tools and Methods • Influence on Bearing and Seal Life*
1330 – 1420	***Case Studies in Rotordynamics*** *High-Speed Turbine Vibration • Compressor Unbalance Troubleshooting • Rotor Bow Detection • Shaft Crack Monitoring Techniques*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Two*

Day 3: **Tuesday, 22nd of July 2025**

0730 – 0830	***Lateral Vibration Behavior*** *Types of Lateral Vibrations • Effects on Bearings and Structure • Troubleshooting High Lateral Vibration • Field Measurement Examples*
0830 – 0930	***Torsional Vibration Dynamics*** *Torque Transmission and Shaft Twist • Torsional Natural Frequencies • Resonance and Damping • Torsional Vibration Measurement Methods*
0930 – 0945	*Break*
0945 – 1100	***Coupling Dynamics & Influence*** *Types of Couplings and Their Dynamic Behavior • Torsional Stiffness and Damping • Backlash and Misalignment • Design Considerations*
1100 – 1215	***Advanced Modal Analysis*** *Experimental Modal Testing • Mode Identification and Separation • Operational Deflection Shapes (ODS) • Software-Based Modal Extraction*
1215 – 1230	*Break*
1230 – 1330	***Noise & Vibration Control Techniques*** *Active versus Passive Damping • Isolation Systems • Tuned Mass Dampers • Dynamic Absorbers*

1330 – 1420	***Machinery Fault Diagnosis Using Vibration*** *Spectral Signatures of Common Faults • Sidebands, Harmonics and Beat Frequencies • Enveloping Techniques • Use of FFT and Time-Domain Correlation*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Three*

Day 4: Wednesday, 23rd of July 2025

0730 – 0830	***Gearbox Vibration & Noise*** *Gear Mesh Frequency and Modulation • Backlash and Alignment Effects • Lubrication Influence on Dynamics • Detection of Gear Defects*
0830 – 0930	***Reciprocating Machinery Dynamics*** *Piston Slap, Connecting Rod Dynamics • Inertia Unbalance and Gas Forces • Cylinder Pressure Effects • Crosshead and Crankshaft Vibration*
0930 – 0945	*Break*
0945 – 1100	***Finite Element Analysis in Machinery*** *Meshing Techniques for Rotating Machinery • Boundary Conditions and Constraints • Coupled Dynamic Simulations • Validation with Field Data*
1100 – 1215	***Turbomachinery Vibration & Blade Dynamics*** *Blade Natural Frequencies and Campbell Diagram • Mistuning Effects • Blade Crack Detection • Blade Tip Timing Methods*
1215 – 1230	*Break*
1230 – 1330	***Transient Dynamic Analysis*** *Start-Up and Shutdown Events • Sudden Load or Speed Changes • Simulation and Instrumentation • Time-Varying Signal Analysis*
1330 – 1420	***Condition Monitoring Integration*** *Real-Time Monitoring Systems • Trend Analysis and KPIs • Sensor Placement Strategies • Predictive Maintenance Case Studies*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Four*

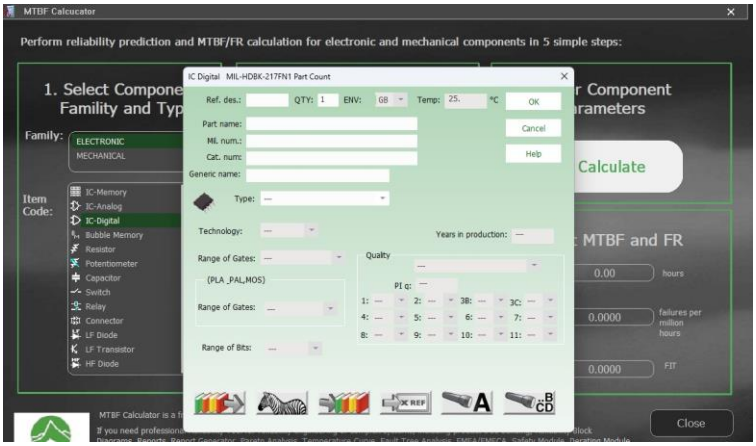
Day 5: Thursday, 24th of July 2025

0730 – 0830	***Advanced Signal Processing Techniques*** *Wavelet Transforms • Cepstrum and Envelope Analysis • Order Tracking • Data Fusion and Statistical Tools*
0830 – 0930	***Fault Detection & Root Cause Analysis*** *Machine Learning in Diagnostics • Fault Tree and FMEA • Integrated Diagnostics Platforms • Reliability-Centered Maintenance (RCM)*
0930 – 0945	*Break*
0945 – 1100	***Active Vibration Control*** *Piezoelectric and Magnetic Actuators • Feedback and Feedforward Strategies • Digital Signal Processing • Case Studies in Rotating Equipment*
1100 – 1215	***Optimization of Dynamic Performance*** *Design Parameter Sensitivity • Tuning for Minimal Dynamic Amplification • Damping Optimization • Material and Geometry Considerations*
1215 – 1230	*Break*

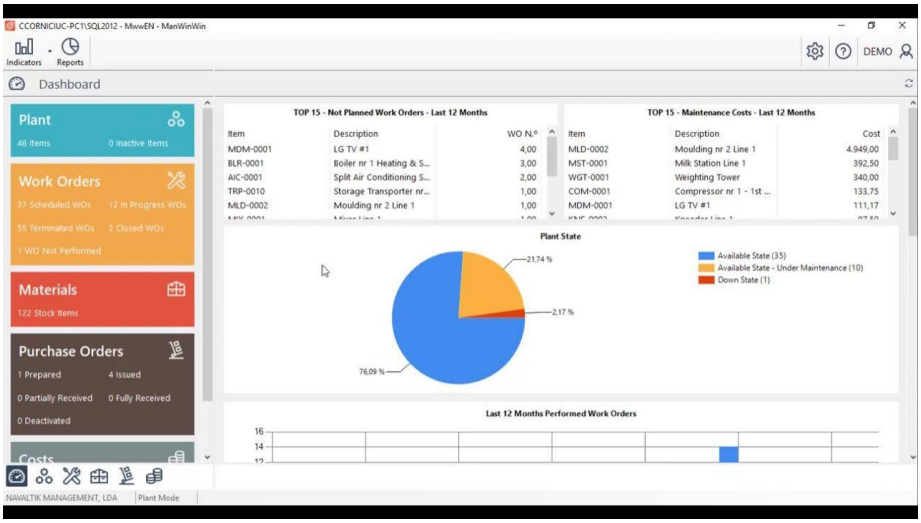
1230 – 1345	***Digital Twin & Simulation in Dynamics*** *Building Digital Replicas for Dynamic Modeling • Sensor Integration and Real-Time Updates • Simulation of Wear and Fault Propagation • Future Applications in AI-Driven Diagnostics*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about t Topics that were Covered During the Course*
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulator (Hands-on Practical Sessions)

Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using the state-of-the-art simulator "MTBF Calculator" and "ManWinWin Express CMMS Software".



MTBF Calculator



ManWinWin Express CMMS Software

Course Coordinator

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