COURSE OVERVIEW ME0172
Industrial Equipment: Compressors, Pumps, Motors & Variable Speed Drive: Selection, Sizing & Application

Course Title
Industrial Equipment: Compressors, Pumps, Motors & Variable Speed Drive: Selection, Sizing & Application

Course Date/Venue
September 22-26 2024/Meeting Plus 8, City Centre Rotana Doha, Doha, Qatar

Course Reference
ME0172

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

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.

Maximum efficiency, reliability, and longevity of pumps, compressors, turbines, bearings and motors are of great concern to many industries. These objectives can only be achieved by understanding the characteristics, selection criteria, sizing calculations, sealing arrangements, common problems, troubleshooting, repair techniques, preventive and predictive maintenance of those turbo machineries.

This course is a MUST for anyone who is involved in the selection, calculations, sizing, applications, troubleshooting or maintenance of pumps, compressors, turbines, bearings or motors. It covers how this equipment operates and provides the guidelines and rules that must be followed for a successful application.

Their basic design, specification and selection criteria, sizing calculations as well as all maintenance issues including troubleshooting, vibration analysis, and used oil analysis are covered in detail.

This course is designed to provide delegates with a detailed and up-to-date overview of the fluid mechanic fundamentals and operating practice of pumps, compressors, turbines and motors. It will address aspects of both axial and centrifugal compressors. Upon the successful completion of this course, participants will have acquired the practical knowledge to enable them not only to choose the correct device for a particular application but also be in a position to resolve many commonly occurring operating problems.

This course is ideal for those personnel in the oil, gas, petrochemical, chemical, power and other process industries who require a wider and deeper appreciation of pumps, compressors, turbines and motors, including their design, performance and operation. No prior knowledge of the topic is required. Participants will be taken through an intensive primer of turbo-machinery principles, using the minimum of mathematics, and will learn how to solve the many and varied practical industrial problems that are encountered. The course makes use of an extensive collection of VIDEO material.

Course Objectives

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

- Apply an in-depth knowledge and skills in various industrial equipment and turbomachines including pumps, compressors, turbines and motors
- Implement systematic techniques on selection, sizing, application, operation, testing, troubleshooting and maintenance of various industrial equipment and turbomachineries
- Identify the various types of compressors, performance measurement and preventive maintenance
- Illustrate the operation and characteristics of centrifugal and axial compressors as well as compressor systems calculations
- Define and categorize pumps and discuss centrifugal pump theory, general performance and basic components
- List types of bearings and explain statistical nature of bearing life
- Demonstrate viscosity of lubricants and oil analysis
- Describe the characteristics of induction motors including their speed control, maintenance, troubleshooting techniques and diagnostic testing for failures in three-phase stator windings.
- Illustrate vibration instrumentation and analysis, the cause of vibration and predictive maintenance
- Implement proper techniques and procedures of turbomachinery maintenance and troubleshooting
- Recognize the root causes of machine failure like the vibration and employ the proper steps to troubleshoot anomalies
- Employ troubleshooting techniques in accordance with the turbomachinery API & ISO standards and specifications

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 industrial equipment and turbomachinery for those who are involved in the selection, sizing, applications, operation, testing, troubleshooting, maintenance and failure analysis of pumps, compressors, turbines and motors. Engineers, supervisors, foremen and other technical staff dealing with industrial equipment, turbomachinery and rotating equipment will benefit from this course.

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 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.

Accommodation

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

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: -

- 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.

- 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.

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:

Dr. Faysal Eliyan, PhD, MSc, BSc, is a **Senior Engineer** with extensive years of experience within the **Power & Water Utilities** and other **Energy Sectors**. His expertise widely covers in the areas of **District Cooling**, **District Cooling** Technologies, **Cooling Towers** Selection, Operation & Maintenance, Fundamentals of **Heating**, **Ventilation** & **Cooling Systems** for Engineers, **Air-Conditioning & Cooling Systems**, **Heat Exchangers & Cooling Water System** in Power Plant, Planning & Implementation of District Cooling Systems (**DCS**), **Concrete Structural Design**, **Concrete Maintenance & Reliability Analysis**, **Civil Engineering** Drawings, Standards & Codes, **Civil Engineering** Design, Petrochemical Plant Structure Design & Remediation, Elements of **Applied Civil Engineering**, **Dynamic Analysis of Rotating Equipment** Foundations **& Structural Steel Piperacks**, **Concrete & Structural Steel Design**, **Steel Structure Design**, Advanced **Building Construction Technology**, **Structural Engineering** Techniques, **Structural Renovation of Buildings**, **Earthwork & Structural Maintenance**, **Surface Drainage**, **Drainage System**, **Building Envelopes & Finishes**, **Landscaping & Roofing** System, **Seismic Design** for Buildings, **AutoCAD**, Advanced **Seismic & Wind Design of Reinforced Concrete**, **Structural** Systems & Components, Design of **Concrete Columns & Beam Frames**, Design of **Foundations & Equipment Footings**, **Maintenance of Concrete Structure**s, **Structural Reliability Assessment**, **Codes & Structural Reliability**, Probabilistic Evaluation of Existing Structures, **Structural Steel**, **Precast Concrete** and **Reinforced Polymer Layered Steel**. Further, he is also well-versed in **Gas Turbines**, **Steam Turbines, Heat Exchangers** Inspection, Testing & Overhaul Cleaning, Heating, Ventilation & Air Conditioning (**HVAC**), **Fans & Blowers**, **Heaters** & **Boilers**, **Compressors**, **Maintenance Planning & Scheduling**, **Pumps & Compressors** Operation & Maintenance, **Valves Technology** Selection, Installation & Troubleshooting, **Cooling Towers**, **Rotating Equipment**, **Turbomachinery**, **Condition Monitoring** & **Diagnostics**, **Hydraulic** & **Pneumatic Systems** Maintenance & Troubleshooting, **Piping Systems**, **Corrosion Control** & **Materials Selection** in Oil and Gas and Water Systems, **Machinery Alignment** & **Balancing**, **Maintenance Management**, **Operational Problems & Failure Analysis**, **Energy Performance Assessment** of **Powerplants**, **Plant Operations**, **Project Management**, **Six Sigma** and **Health**, **Safety** & **Environment**.

During his career life, Dr. Faysal has gained his practical and field experience through his various significant positions and dedication as the **Assistant Professor**, **Senior Consultant**, **Laboratory Instructor**, **Lecturer**, **Tutor**, **Mentor**, **Advisor**, **Trainer**, **Engineering Manager**, **Senior Engineer**, **Senior Project Engineer**, **Engineer** and **Adjudicator** from various institutions and universities such as the Community College of Qatar, American University of the Middle East, McMaster University, The University of British Columbia, The University of British Columbia, Qatar University and General Electric, just to name a few.

Dr. Faysal has **PhD**, **Master's** and **Bachelor's** degree in **Engineering** from the **University of British Columbia** (**Canada**). He is a **Certified Instructor/Trainer**, a member of the **Chamber of Civil Engineers**, **Structural Stability Research Council**, **American Institute of Steel Construction** and **American Society of Civil Engineers** (**ASCE**), **USA**. He also **published numerous books**, **researches** and **scientific papers** and received several awards and recognitions for **Journal of Materials Engineering and Performance** and has further delivered numerous trainings, courses, seminars, workshops and conferences internationally.

Course Program

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

Day 1: ***Sunday, 22nd of September 2024***

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Turbo Machinery-Introduction*** *Centrifugal Compressors • Centrifugal Pumps • Turbines*
0930 – 1030	***Compressors*** *Compressor Types and Performance Measurement • Positive Displacement Compressors, Reciprocating Compressors, Trunk Piston Compressors, Sliding Crosshead Piston Compressors, Diaphragm Compressors, Bellows Compressors*
1030 – 1045	*Break*
1045 – 1145	***Compressors (cont'd)*** *Rotary Compressors, Rotary Screw Compressor, Lobe Type Air Compressor, Sliding Vane Compressors, Liquid Ring Compressors • Dynamic Compressors, Centrifugal Compressors, Axial Compressors • Air Receivers, Compressor Control, Unloading System • Intercoolers and Aftercoolers, Filters and Air Intake Screens • Preventive Maintenance and Housekeeping*
1145 – 1245	***Centrifugal & Axial Compressors*** *Operation and Characteristics • Surging, Choking, Bleed Valves, Variable Stator Vanes, Inlet Guide Vanes*
1245 – 1300	*Break*
1300 – 1400	***Compressor Systems Calculations*** *Calculations of Air Leaks, Annual Cost of Air Leakage • Centrifugal Compressor Power Requirement • Compressor Selection, Calculations of Air System Requirements • Characteristics of Reciprocating Compressors, Blowers • Selection of Compressor Drive • Selection of Air Distribution System, Water Cooling Requirements • Sizing of Compressor System Components, Sizing of Air Receiver • Calculations of Receiver Pump-Up Time*
1400 – 1420	***Turbines*** *Types of Turbines • Industrial Heavy Duty Gas Turbines • Major Turbine Components*
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, 23rd of September 2024***

0730 – 0830	***Turbines (cont'd)*** *Performance Characteristics • Performance Calculations*
0830 – 0930	***Gas Turbine Cycles*** *Reversible Cycles with Ideal Gases • Combustion Processes • Stoichiometric*
0930 – 0945	*Break*

0945 – 1045	***Pumps*** *Definition & Categories: Dynamic & Displacement, Reciprocating & Rotary ● Centrifugal Pumps: Theory of Operation, Casings and Diffusers, Radial Thrust, Hydrostatic Pressure Tests*
1045 – 1145	***Pumps (cont'd)*** *Impeller, Axial Thrust, Axial Thrust in Multistage Pumps, Hydraulic Balancing Devices, Balancing Drums, Balancing Disks*
1145 – 1245	***Pumps (cont'd)*** *Mechanical Seals, Bearings, Couplings, Bedplates, Minimum Flow Requirement ● Centrifugal Pumps General Performance Characteristics, Cavitation, Net Positive Suction Head*
1245 – 1300	*Break*
1300 – 1420	***Centrifugal Pump Mechanical Seals*** *Basic Components, Temperature Control, Seal Lubrication/Leakage, Typical Single Inside Pusher Seal ● Recommended Maintenance, Vibration Analysis, Equipment Condition*
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, 24th of September 2024***

0730 – 0830	***Bearings*** *Types of Bearings, Ball and Roller Bearings, Stresses during Rolling Contacts ● Statistical Nature of Bearing Life, Materials and Finish, Sizes of Bearings, Types of Rolling Bearings, Thrust Bearings*
0830 – 0930	***Lubrication*** *Viscosity of Lubricants, Flow Through Pipes, Variation of Viscosity with Temperature and Pressure, Viscosity Index ● Non-Newtonian Fluids, Greases, VI Improved Oils, Variation of Lubricant Viscosity with Use, Oxidation Reactions, Physical Reactions, Housing and Lubrication, Lubrication of Antifriction Bearings ● Oil Analysis: Lube Oil Sampling Technique, Test Description and Significance, Visual and Sensory Inspections, Chemical and Physical Tests, Water Content, Viscosity, Emission Spectrographic Analysis, Infrared Analysis, Total Base Number (TBN), Total Acid Number (TAN), Particle Count*
0930 – 0945	*Break*
0945 – 1100	***Pump Selection*** *Engineering of System Requirements, Fluid Type, System Head Curves, Alternate Modes of Operation, Margins, Wear, Future System Changes ● Selection of Pump and Driver, Pump Characteristics, Code Requirements, Fluid Characteristics, Pump Materials, Driver Type ● Pump Specification, Specification Types, Data Sheet, Codes and Standards, Bidding Documents, Technical Specification, Commercial Terms, Special Considerations, Performance Testing, Pump Drivers ● Special Control Requirements, Drawing and Data Requirements Form, Quality Assurance and Quality Control, Bidding and Negotiation*
1100 – 1230	***Pumping System Calculations*** *Pumps in Series, Pumps in Parallel, Driver Speed Selection, Affinity Laws, Centrifugal Pump Selection, Performance of the Prototype Pump, Suction Specific Speed, Centrifugal Pump Capacity/Efficiency/Operating Speed, Pump Head, Friction Losses, Power Requirement, Pump Selection & Evaluation*

1230 – 1245	*Break*
1245 – 1315	***Centrifugal Pump Maintenance, Re-rate & Retrofit*** *Case Gasket ● Checking for Wear Clearance ● Oil Change ● Storage ● Impeller Cut ● NPSH ● De-Staging ● Electric Motor Sizing ● Viscosity Changes*
1315 – 1420	***Centrifugal Pump Troubleshooting*** *Bearing Failures ● Bearing Housing Oil Leakage ● Cavitation Noise and Damage ● Impeller Cavitation/Erosion ● Vibration ● Cracked Volute Tongues ● NPSH ● Viscosity Effects*
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, 25th of September 2024

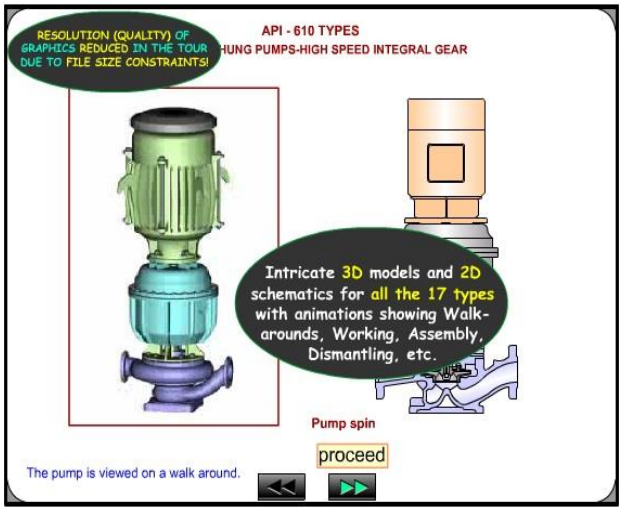
0730 – 0830	***Motors*** *Construction, Concepts, Rotor Slip and Electrical Frequency, the Equivalent Circuit, the Rotor Circuit Model, Losses and the Power-Flow Diagram ● Torque-Speed Characteristics and Curves, Squirrel-Cage Rotor Design, Deep Bar and Double-Cage Rotor Designs. ● Starting Induction Motors ● Line Frequency, Line Voltage, Rotor Resistance ● Solid-State Drives, Motor Protection ● Induction Generator, Induction Motor Ratings ● Characteristics, Enclosures & Cooling Methods, Insulation ● Failures in Three-Phase Stator Windings, Predictive Maintenance, Troubleshooting, Diagnostic Testing ● Stator Insulation Tests, DC Tests, Windings, Insulation Resistance and Polarization Index ● Failures in Three-Phase Stator Windings*
0830 – 0930	***Maintenance Planning*** *Selecting Maintenance Approaches ● Inspection Regimes ● Analytical On-Line Condition Monitoring*
0930 – 0945	*Break*
0945 – 1100	***Vibration–Possible Causes*** *Turbine Misalignment ● Unbalanced Turbine ● Rubbing Parts ● Lubrication Problems ● Cracked or Worn Parts*
1100 – 1230	***Monitoring & Diagnostic Systems*** *Pressure Measurement ● Temperature Measurement ● Vibration Measurement*
1230 – 1245	*Break*
1215 – 1300	***Vibrations & Predictive Maintenance*** *Aerodynamic Flow-Induced Vibrations ● Interpretation of Collected Data ● Establishing Safe Operating Limits for Turbo Machinery ● Predictive Maintenance*
1300 – 1420	***Problems with Centrifugal Compressors & Pumps*** *Operating Limits*
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, 26th of September 2024

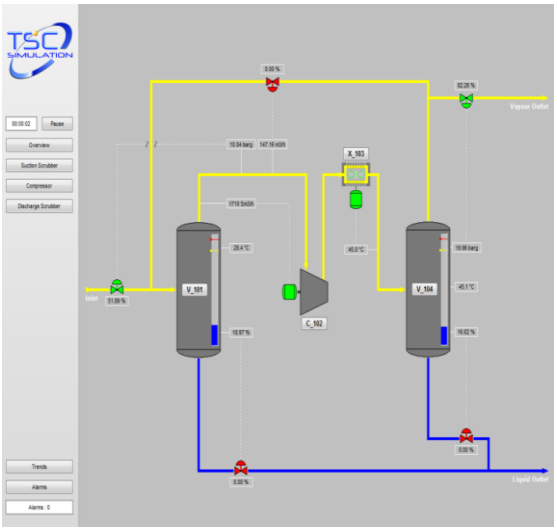
0730 – 0830	***Troubleshooting as an Extension of Failure Analysis*** *Causes of Machine Failures • The "7-Cause Category Approach" to Root Cause Failure Analysis*
0830 – 0930	***Troubleshooting as an Extension of Failure Analysis (cont'd)*** *Techniques • The Matrix Approach • The Cause and Effect Principle*
0930 – 0945	*Break*
0945 – 1045	***Troubleshooting as an Extension of Failure Analysis (cont'd)*** *Bearings • Journal and Tilt-Pad Thrust Bearings • Patterns of Load Paths and their Meaning in Bearing Damage • Noise Signature Recordings*
1045 – 1145	***Troubleshooting as an Extension of Failure Analysis (cont'd)*** *Action Planning and Decision-Making*
1145 – 1230	***Video Presentation*** *Mechanical Troubleshooting of Auxiliary Steam Turbine (Cleaning Turbine Parts, Adjusting Nozzle Clearance)*
1230 – 1245	*Break*
1300 – 1345	***Turbo Machinery Standards*** *Applicable API Standards • ISO Standards • Specifications*
1345 – 1400	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course 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)

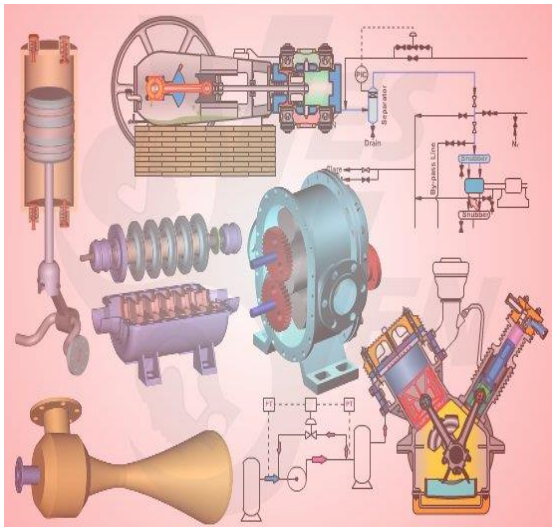
Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using our state-of-the-art simulators "Centrifugal Pumps and Troubleshooting Guide 3.0", "SIM 3300 Centrifugal Compressor" and "CBT on Compressors".



Centrifugal Pumps and Troubleshooting Guide 3.0



SIM 3300 Centrifugal Compressor Simulator



CBT on Compressors

Course Coordinator

Jaryl Castillo, Tel: +974 4423 1327, Email: jaryl@haward.org