



## COURSE OVERVIEW ME0398 Pumps, Compressors, Turbines & Troubleshooting

### Course Title

Pumps, Compressors, Turbines & Troubleshooting

### Course Reference

ME0398

### Course Duration/Credits

Five days/3.0 CEUs/30 PDHs



### Course Date/Venue

Session(s)	Date	Venue
1	October 20-24, 2024	Horus Meeting Room, Holiday Inn & Suites Maadi, Cairo, Egypt
2	December 15-19, 2024	
3	February 16-20, 2025	

### 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 delegates with a detailed and up-to-date overview of the fluid mechanic fundamentals and operating practice of pumps, compressors and turbines. 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.



The 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 and turbines, 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 a comprehensive knowledge in pumps, compressors & turbines and troubleshoot rotating equipment in a professional manner
- Identify the different types of turbomachinery including basic design aspects and highlighted problem areas
- Minimize the compressor work by understanding the processes involved and identifying their efficiency
- Discuss the axial flow compressor and the corresponding velocity triangles including torque and power calculations
- List the different types of centrifugal machines including their design, installation, operation, maintenance, re-rate/retrofit and troubleshooting
- Recognize the various beneficial design aspects of turbomachines and understand the crucial process of cavitation in pumps
- Carryout the proper methods of centrifugal pumps installation, operation, maintenance and troubleshooting

### Who Should Attend

This course provides an overview of all significant aspects and considerations of pumps, compressors and turbines for those who are involved in the design, selection, maintenance or troubleshooting of such equipment. This includes maintenance, reliability, integrity, engineering, production and operations managers, engineers and other technical staff. Project managers and engineers will also benefit from this program.

### 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\$ 5,500** per Delegate + **VAT**. This rate includes H-STK® (Howard 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: -

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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.

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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:



**Mr. Mohamed Refaat**, MSc, BSc, is a **Senior Mechanical & Maintenance Engineer** with almost **30 years** of extensive experience in **Rotating Equipment** and **Machinery** including **Pumps, Compressors, Turbines, Motors, Turbo-expanders, Gears**, etc. His wide experience also covers **Centrifugal Compressor & Steam Turbine, Centrifugal Pump, Pump Technology, Gas Turbine Technology, Heat Exchanger, Turbines & Motors, Variable Speed Drives, Seals, Control Valves, Advanced Valve Technology, Dry Seal, Fired Heaters, Air Coolers, Crude Desalter, Process Vessels & Valves, Industrial Equipment & Rotating Machinery, Mechanical Engineering, Mechanical Equipment & Turbomachinery, Piping, Pipelines, Valves, Lubrication Technology, Vibration Analysis, Power System Hydraulics, Security Detection Systems & Operation, Process Plant Equipment, Troubleshooting Process Operations, Maintenance Management Best Practices, Rotating Equipment Reliability Optimization, Practical Machinery Vibration, Vibration Techniques, Effective Reliability Maintenance, Excellence in Maintenance & Reliability Management, Preventive & Predictive Maintenance, Machinery Failure Analysis (RCFA), Reliability Optimization & Continuous Improvement, Maintenance Planning, Scheduling & Work Control, Maintenance Management Strategy, Mechanical & Rotating Equipment Troubleshooting, Preventive Maintenance, Predictive Maintenance, Reliability Centered Maintenance (RCM), Condition Based Monitoring (CBM), FMEA** and Troubleshooting of machinery and rotating equipment including turbines, bearings, compressors, pumps etc. He is currently the **Mechanical Maintenance Section Head** of the **Arab Petroleum Pipelines Company** where he is in charge of planning, scheduling & managing the execution of preventive & corrective mechanical maintenance activities for all equipment. He is responsible for executing the scheduled inspections & major overhauls for gas turbines, valves & pumps, carrying out off-line vibration monitoring plans, troubleshooting, fault diagnosing & investigating failures of machinery.

During his career life, Mr. Mohamed was able to modify the gas turbines self cleansing system to improve its maintainability and extend the air filters' lifetime. He was responsible for defining & updating the equipment codes and parameters for replacing the old **CMMS** with **MAXIMO**. He also worked as the Operations Supervisor wherein he was closely involved with the operation of the crude oil internal **pipeline** system between the tankers and tank farm, operation & control of the booster pumps for pumping crude oil for main pipelines and the development & implementation of the plans & procedures for draining the main terminal internal lines for maintenance purposes. He also held the position of Measurement Engineer where he was responsible for the crude oil custody transfer, performing loss control analysis and operating the crude oil automatic sampler & related equipment. Prior to that, he was the Design Engineer responsible for the design phase of the Truck Mixer Manufacturing Project of the Mechanical Design Department.

Mr. Refaat has **Master** and **Bachelor** degrees in **Mechanical Engineering** and a General Certificate of Education (**GCE**) from the **University of London, UK**. Further, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management (ILM)** and a member of the Engineering Syndicate of Egypt. He has further delivered numerous training, courses, workshops, seminars and conferences worldwide.



### 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

0730 – 0800	Registration & Coffee
0800 – 0815	Welcome & Introduction
0815 – 0830	<b>PRE-TEST</b>
0830 – 0930	<b>Introduction to Turbomachinery</b> Highlighted Problem Areas
0930 – 0945	Break
0945 – 1000	<b>Ideal Gas Equation &amp; Practical Application</b> Isentropic Processes • Property Diagrams Involving Entropy
1000 – 1100	<b>Isentropic Processes of Ideal Gases</b> Constant Specific Heats • Relative Pressure and Relative Specific Volume
1100 – 1230	<b>Minimizing Compressor Work</b> Polytropic Processes • Multi-Stage Compression with Inter-Cooling • Isentropic Efficiency of Turbines • Isentropic Efficiency of Compressors and Pumps
1230 – 1245	Break
1245 – 1330	<b>Momentum &amp; Bernoulli's Relations</b> General Relationship • Relationships for Incompressible Fluids
1330 – 1420	<b>VIDEO: Basic Pump Types &amp; Technology</b>
1420 – 1430	<b>Recap</b> 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

0730 – 0800	<b>General Description of Turbomachines</b> Centrifugal Pump • Centrifugal Turbine • Centrifugal Air Compressor
0800 – 0830	<b>Impulse Turbine</b> Velocity Triangles
0830 – 0900	<b>Axial Flow Compressor</b> Velocity Triangles • Torque Calculation and Torque Coefficient • Power Calculation and Power Coefficient
0900 – 0930	<b>Centrifugal Machines</b> Torque Calculation • Head Coefficient • Flow Coefficient • Torque Coefficient
0930 – 0945	Break
0945 – 1015	<b>Performance Curves</b>
1015 – 1100	<b>Centrifugal Pump</b> Centrifugal Multistage Pump • Mixed Flow Machines • Centrifugal Air Compressor
1100 – 1130	<b>Affinity Laws</b> Effect of Impeller Speed • Effect of Impeller Diameter
1130 – 1200	<b>Specific Speed</b>
1200 – 1230	<b>Specific Radius</b>
1230 – 1245	Break
1245 – 1315	<b>Hydraulic Turbines</b>





1315 - 1330	<b>VIDEO: Fundamentals of Pump Performance 1</b>
1330 - 1400	<b>Design Aspects of Turbomachines</b> Linear Cascades • Radial Cascades • Three- Dimensional Aspects of Axial- Flow Machines •Elementary Design Considerations
1400 - 1420	<b>Cavitation</b>
1420 - 1430	<b>Recap</b> 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**

0730 - 0930	<b>Centrifugal Pumps Basics</b> Types of Centrifugal Pumps • Self- Priming Pumps • Specific Speeds • Suction Specific Speed • Best Efficiency Point • Affinity Laws
0930 - 0945	Break
0945 - 1100	<b>Centrifugal Pump Design</b> Balancing Disc • Impeller NPSHR • Impeller Centre-Rib • Mechanical Seals • Velocity Head
1100 - 1230	<b>Pump Sales</b> Affinity Laws •Pump Software • Suction Lift • Viscosity • Re-Rate/Retrofit • Head-Rise • Radial/Horizontal Split Case
1230 - 1245	Break
1245 - 1330	<b>Centrifugal Pump Installation</b> Foundation • Soft Foot • Suction Pipe • Suction Strainer
1330 - 1420	<b>VIDEO: Fundamentals of Pump Performance 2</b> Discussion Forum
1420 - 1430	<b>Recap</b> 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**

0730 - 0930	<b>Centrifugal Pump Operation</b> Start-Up • Minimum Flow • Maximum Pump RPM • Motor Amps/Specific Gravity • Entrained Gas
0930 - 0945	Break
0945 - 1100	<b>Centrifugal Pump Operation (cont'd)</b> Operation at Shut Off • Temperature-Rise • Thermal Shock
1100 - 1230	<b>Centrifugal Pump Maintenance</b> Case Gasket • Checking for Wear Clearance • Oil Change • Storage
1230 - 1245	Break
1245 - 1315	<b>Centrifugal Pump Re-Rate/Retrofit</b> Impeller Cut • NPSH • De-Staging • Electric Motor Sizing • Viscosity Changes
1315 - 1420	<b>VIDEO: Hydraulic Loads, Critical Speed &amp; Torque</b> Discussion Forum
1420 - 1430	<b>Recap</b> 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





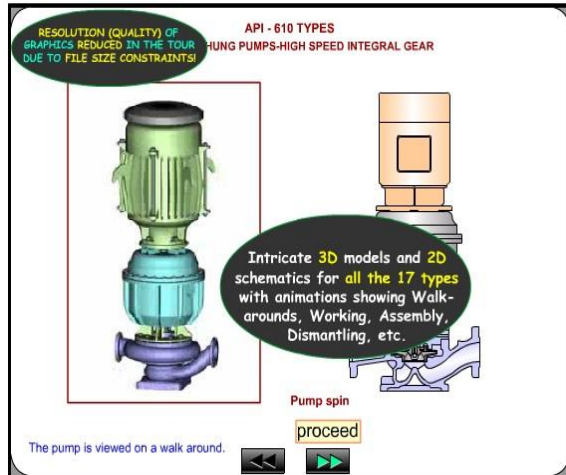
**Day 5**

0730 – 0830	<b>Centrifugal Pump Troubleshooting</b> <i>Bearing Failures • Bearing Housing Oil Leakage • Cavitation Noise and Damage</i>
0830 – 0930	<b>VIDEO: Bearings, Seals &amp; Couplings</b>
0930 – 0945	Break
0945 – 1100	<b>Centrifugal Pump Troubleshooting (cont'd)</b> <i>Impeller Cavitation/Erosion • Vibration • Cracked Volute Tongues • NPSH • Viscosity Effects</i>
1100 – 1230	<b>Group Discussions</b>
1230 – 1245	Break
1245 – 1345	<b>VIDEO: Special Pump Topics &amp; Final Discussion</b>
1345 – 1400	<b>Course Conclusion</b> <i>Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course</i>
1400 – 1415	<b>POST-TEST</b>
1415 – 1430	<i>Presentation of Course Certificates</i>
1430	<i>Lunch &amp; End of Course</i>

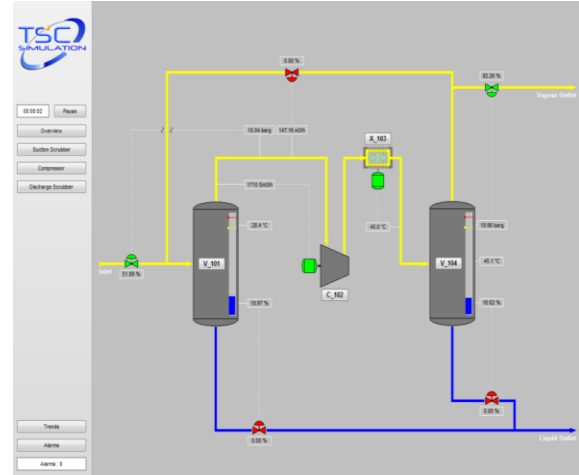


### Simulator (Hands-on Practical Sessions)

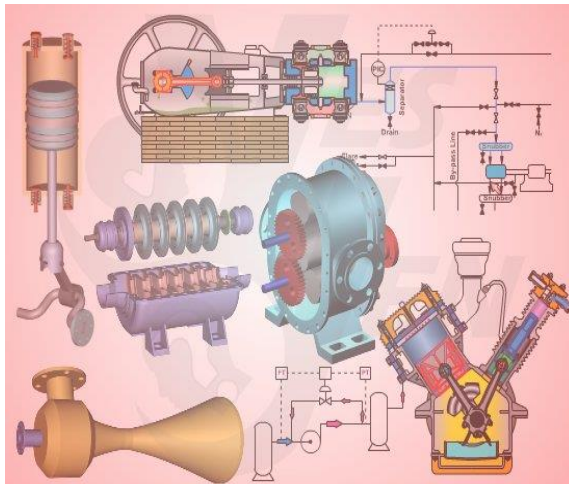
Hands-on practical sessions will be arranged for all participants throughout the course duration using “Centrifugal Pumps and Troubleshooting Guide 3.0”, “SIM 3300 Centrifugal Compressor Simulator”, “CBT on Compressors” and “Steam Turbine & Governing System CBT” simulators.



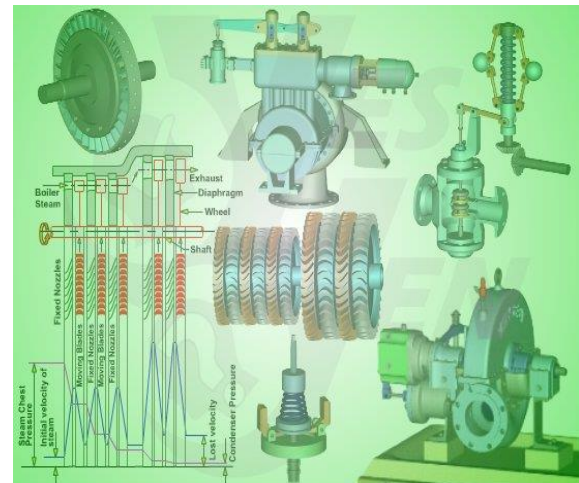
**Centrifugal Pumps and Troubleshooting Guide 3.0**



**SIM 3300 Centrifugal Compressor Simulator**



**CBT on Compressors**



**Steam Turbine & Governing System CBT**

### Course Coordinator

Mari Nakintu, Tel: +971 2 30 91 714, Email: [mari1@haward.org](mailto:mari1@haward.org)