

## Rotating Equipment Design, Selection, Operation & Maintenance

### Course general description:

The rotating equipment (turbomachinery) are very important facilities in many industries, power plants, sea ships, air crafts and military applications. Turbomachinery family includes centrifugal/axial pumps, centrifugal/axial compressors and gas/steam turbines, where all are based on the principle of turbo-action where a shaft with blades is rotating to impart or extract energy to or from a fluid (gas or liquid). This course will present a scientific & practical background/knowledge to refresh and correlate the theory with the practical applications regarding design basis, operation, maintenance & troubleshooting showing the possible and potential reasons behind the energy losses and problems may face the operation staff and how to analyze them to define the proper solutions and troubleshooting based on science, experience and recommended practices.

### Audience:

This course is designed for:

1. Professionals dealing with the operation and maintenance of rotating equipment
2. New technicians who wish to improve knowledge and skills
3. Those who are involved in condition monitoring of machines
4. Maintenance technicians who are in charge of correcting the turbomachinery problems.
5. Engineers and maintenance planners involved in turbomachinery design and machine's condition monitoring.

### Course objectives:

By the end of the training, participants will be able to:

- Understand the basics of design, selection of turbomachinery
- Understand how power imparted or extracted to/from a turbomachinery
- Classify the turbomachinery families
- Deep understanding of centrifugal & axial pumps basics and reasons behind losses and possible troubles and how to deal with them scientifically
- Deep understanding of centrifugal & axial compressors basics and reasons behind losses and possible troubles and how to deal with them scientifically
- Understanding roto-dynamic pump cavitation
- Understanding roto-dynamic compressor surge
- Understanding topping & bottoming
- Understanding steam turbine thermodynamic cycle, latent heat & useful work taken from the steam
- Understanding the gas turbine thermodynamic cycle, useful work taken from the combustion hot gases
- Heat recovery in steam & gas turbines

### Course duration:

5 days

### Course location:

Cairo-Dubai-Istanbul

**Course contents:**

**Day-1**

- Pretest
- Review of important fluid mechanics, first & second laws of thermodynamics
- Introduction & turbomachinery equipment families
- Theory of centrifugal pump
- Classification of centrifugal pump family
- Momentum and velocity triangles
- Euler's power equations
- Single stage centrifugal pump components & construction
- Radial & axial loads in centrifugal pump
- Losses in centrifugal pump that change H-Q curve from linearity to curved shape
- Multistage centrifugal pump & axial loads reduction techniques (holes, back vanes, balancing drum,...etc)
- Centrifugal pump performance & pump operation optimization
- Centrifugal pump maintenance & troubleshooting scientific practical way

**Day-2**

- Theory of centrifugal compressor
- Classification of centrifugal compressor family
- Single stage centrifugal compressor components & construction
- Radial & axial loads in centrifugal compressor
- Multistage centrifugal compressor & axial loads reduction techniques
- Surge & how to deal with it
- Centrifugal compressor performance & compressor operation optimization
- Centrifugal compressor maintenance & troubleshooting scientific practical way

**Day-3**

- Steam turbine cycle
- Types of steam turbines
- Topping & bottoming & thermal/electrical ration concept
- Steam turbine in power generation
- Steam turbine as pump & compressor prime-mover
- Steam turbine in sea ship liners for propelling purpose
- Cogeneration & waste heat recovery
- Steam turbine maintenance & troubleshooting

**Day-4**

- Gas turbine cycle
- Types of gas turbines
- Gas turbine in power generation
- Gas turbine as pump & compressor prime-mover
- Gas turbine in air crafts
- Gas turbines in military applications

- Gas turbine impulse & reaction
- Gas turbine maintenance & troubleshooting

#### **Day-5**

- Couplings overview
- Bearings overview
- Equipment failure modes (bathtub curve)
- Maintenance policies & which is suitable for our turbomachine
- An application of a centrifugal pump design (piping diameters, impeller dimensions, blade angles, pump shaft & pump electric motor HP)
- Posttest

#### **Methodology:**

- 50% lectures & concepts
- 10% Videos
- 10% Case studies
- 10% Exercises
- 10% Discussions
- 10% Software (if applicable or examples)

**Course code: (TEME035)**