
Mechanical Fundamentals for Process Plant Teams: Materials, Machines and Heat Transfer Course

8 – 12 February 2027
Tokyo





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Programme Summary

Mechanical fundamentals for process plant teams is the subject of this one-week training course for engineers from other disciplines, project managers and operations and technical managers, ending in a mechanical equipment briefing file for one process unit. Many plant decisions turn on stress, materials, rotating machines and heat exchange, yet colleagues from other disciplines must still judge them. The programme moves from forces and stress, through diagnosis of how equipment fails, to design of material, machine and heat transfer choices, then applies them to one unit. Mars Training Centre UK delivers this mechanical fundamentals programme for mixed-organisation cohorts.

The Business Case

When non-mechanical staff cannot follow a mechanical argument, they either defer without challenge or reject sound advice. Equipment is then specified from catalogues, failures are explained in vague terms, and project reviews miss weak points in materials, machines and heat exchangers. Teams that share a basic mechanical language ask sharper questions, read vendor proposals with care and agree repair or replacement decisions faster.

- Specification Quality: Improves as materials, loads and duties are stated in plain mechanical terms.
- Repeat Equipment Failures: Fall as failure mechanisms are named and matched to causes.
- Review Efficiency: Rises as colleagues from different disciplines question designs on a common basis.

Principles and Evidence Base

- Newton's laws of motion: They underpin the statics and load path work in Session 1.
- Hooke's law: It links stress and strain in the calculations of Sessions 1 and 3.
- Bernoulli's equation: It explains head, pressure and flow in the pump and compressor work of Session 4.
- Fourier's law of heat conduction: It guides the heat loss and exchanger duty estimates in Session 4.

Intended Participants

- Process, electrical and instrument engineers who must review mechanical proposals.
- Project managers who approve equipment specifications and design changes.
- Operations managers who decide how to respond to equipment faults.
- Technical managers who brief senior colleagues on plant condition.
- Procurement and inspection staff who read vendor drawings and data sheets.

Typical sectors include oil and gas, power generation, chemical processing and water treatment.



Learning Outcomes

1. Participants will be able to construct a free-body diagram and estimate stress and strain for a simple plant component.
2. Participants will be able to diagnose fatigue, wear, creep and corrosion from failure evidence.
3. Participants will be able to evaluate material selection options for a stated fluid, temperature and load.
4. Participants will be able to select shafts, bearings, couplings and fasteners suited to a stated duty.
5. Participants will be able to estimate a heat exchanger duty and a pump head from plant data.
6. Participants will be able to present a mechanical equipment briefing file for one process unit to colleagues.

Programme Structure

Day 1: Mechanical Fundamentals: Forces, Stress and Strain

How do loads act on plant equipment and what do they do to it?

- Free-Body Diagram Sketch
- Load Path Review
- Stress and Strain Calculation Sheet
- Safety Factor Table
- Thin-Wall Vessel Stress Estimate

Day 2: Diagnosing Mechanical Failure

How is a failed component read to show why it failed?

- Failure Mode Classification Chart
- Corrosion Mechanism Map
- Fatigue Crack Initiation Sketch
- Vibration Symptom Guide
- Failure Evidence Photo Log

Day 3: Selecting Materials and Machine Elements

Which materials and machine elements suit a stated duty?

- Material Property Comparison Table
- Corrosion Allowance Worksheet
- Shaft and Bearing Selection Chart
- Gear and Coupling Duty Check
- Bolted Joint Review Sheet



Day 4: Machines and Heat Transfer in the Plant

How do machines move fluid and heat through a process unit?

- Pump Head Calculation
- Compressor Duty Sketch
- Heat Loss Estimate
- Heat Exchanger Duty Calculation
- Fouling and Approach Temperature Check

Day 5: Applying Mechanical Fundamentals to One Process Unit

Does the mechanical briefing hold when tested on one unit?

- Applying the Session 1 Load Path Review to the Unit
- Testing the Session 2 Failure Chart on Unit Records
- Checking Session 3 Material Choices Against Duty
- Verifying Session 4 Duty Estimates with Peers
- Completing the Mechanical Equipment Briefing File

Methodology

The programme uses a structured exercise method built on anonymised drawings, data sheets, failure photographs and short written cases from oil and gas, power and chemical plants. Participants work in small groups on one process unit, explain their reasoning to peers from other disciplines, and receive facilitator feedback on each work product, including every stress and duty estimate.

- Suggested activity: Estimating the stress in a pipe support from a hand sketch.
- Suggested activity: Reading a fractured shaft and naming the failure mode.
- Suggested activity: Comparing two exchanger quotations on duty and fouling margin.

Capstone Output

Each participant completes a mechanical equipment briefing file for one process unit. It holds a load path sketch, a failure mode chart, a material and machine element table and a duty estimate sheet. The file is used at work to brief colleagues, question vendor proposals and frame repair or replacement decisions.

Frequently Asked Questions

Is mechanical fundamentals suitable for engineers from non-mechanical disciplines?

Yes. Mechanical fundamentals is taught from first principles and assumes basic mathematics and plant familiarity, not earlier study of mechanical engineering.



Which principles do mechanical fundamentals rest on in this programme?

Mechanical fundamentals here rest on Newton's laws of motion, Hooke's law, Bernoulli's equation and Fourier's law of heat conduction.

How is the mechanical fundamentals briefing file used at work?

You use the file to brief colleagues, question vendor proposals and frame repair or replacement decisions for your own unit.

How do mechanical fundamentals differ from a programme on process chemistry?

Mechanical fundamentals centre on loads, materials, machines and heat transfer, while process chemistry centres on reactions, separations and material balances.