Strength of Materials: Stress Analysis, Shaft Torsion, Beam Bending and Failure Theories

4 – 8 January 2027
Paris - Right Bank business hotel



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Ref: 811_20168 **Date:** 4 – 8 January 2027 **Location:** Paris - Right Bank business hotel **Fees:** 23500 SAR

Introduction:

Strength of materials errors reach the plant floor as sheared pins, twisted shafts, bent brackets, torn lifting lugs and loose bolts, usually because nobody checked the stress by hand before a part was modified or replaced. This Core Concept course gives mechanical, maintenance and design engineers a practical routine for stress analysis: free-body diagrams, axial, torsional and bending stresses, deflection, Mohr's circle, Tresca and von Mises yield checks, thin shells, notches, fatigue and column buckling. Participants assemble a Component Stress Check Calculation Pack for a set of case plant components.

Course Objectives:

- Calculate normal, shear and thermal stresses and elongations in bars, pins, rods and tie members from free-body diagrams and tensile test properties
- Size solid and hollow shafts for transmitted torque and angle of twist, and check keys and couplings for shear and bearing
- Construct shear force and bending moment diagrams and compute bending stress, transverse shear stress and deflection in beams and brackets
- Combine axial, bending and torsional stresses, find principal stresses with Mohr's circle and apply Tresca and von Mises criteria with a factor of safety
- Assess thin-walled cylinders, notched parts, cyclically loaded parts and slender struts using hoop stress, Kt factors, S-N curves with Goodman correction and Euler buckling loads
- Compile a traceable hand calculation pack that records loads, assumptions, formulas, utilisation ratios and the accept or modify decision for each component

Target Audience:

- Mechanical engineering staff who size or modify shafts, brackets, supports and machine parts
- Maintenance and reliability engineering staff who approve repairs, substitutions and field modifications to plant components
- Design and drafting engineering staff who produce component drawings and need hand checks behind the dimensions
- Rotating and static equipment engineering staff who review vendor calculations for couplings, bolting and pressure parts
- Workshop and fabrication engineering staff who verify lifting lugs, pins and temporary rigging attachments

Course Outline:

Day 1: Stress, Strain, Elastic Behaviour and Tensile Test Properties

- Free-Body Diagram Construction and Static Equilibrium of Plant Components
- Normal Stress, Shear Stress and Bearing Stress in Pins, Clevises and Lugs
- Engineering Stress-Strain Curve: Proportional Limit, Yield Point, Ultimate Strength and Ductility
- Hooke's Law, Young's Modulus, Shear Modulus and Poisson's Ratio Relationships
- Allowable Stress and Factor of Safety Selection Worksheet

Day 2: Axial Loading, Thermal Stress and Torsion of Shafts

- Axial Elongation of Stepped Bars and Statically Indeterminate Tie Rods
- Restrained Thermal Expansion and Temperature-Induced Axial Force
- Torsion Formula for Solid and Hollow Circular Shafts and Polar Moment of Inertia
- Angle of Twist, Torsional Stiffness and Shaft Sizing from Power and Speed
- Key, Spline and Flanged Coupling Checks for Shear and Crushing

Day 3: Beam Bending, Transverse Shear and Deflection

- Shear Force and Bending Moment Diagrams for Cantilevers and Simply Supported Beams
- Flexure Formula, Neutral Axis, Second Moment of Area and Section Modulus
- Transverse Shear Stress Distribution in Rectangular, I and Hollow Sections
- Beam Deflection by Double Integration and Superposition Tables
- Bracket, Lifting Beam and Platform Member Hand Checks

Day 4: Combined Stresses, Failure Theories and Problem Cases

- Combined Bending and Torsion in Line Shafts and Overhung Pulleys
- Plane Stress Transformation and Mohr's Circle for Principal and Maximum Shear Stress
- Tresca Maximum Shear Stress and von Mises Distortion Energy Yield Checks
- Thin-Walled Cylinder and Sphere Hoop and Longitudinal Stress with Stress Concentration Factor Kt
- S-N Curve Reading, Endurance Limit, Goodman Mean Stress Line and Euler Column Buckling

Day 5: Modelling Build: Component Stress Check Calculation Pack

- Bolted Joint Preload, Tensile Stress Area and Shear Plane Checks
- Case Component Set Briefing: Pump Shaft, Lifting Lug, Support Bracket, Strut and Receiver Shell
- Spreadsheet Calculation Template Build with Units, Inputs and Utilisation Ratios
- Peer Cross-Check of Load Paths, Assumptions and Governing Failure Mode
- Component Stress Check Calculation Pack Presentation and Accept or Modify Decisions

Skills You Will Gain:

- Free-Body Load Path Analysis
- Shaft Torsion Sizing
- Beam Bending and Deflection Calculation
- Principal Stress Determination
- Yield Criterion Application
- Fatigue Life Screening
- Column Stability Checking
- Engineering Calculation Documentation

Why Attend This Course:

- Leave with a Component Stress Check Calculation Pack covering a shaft, lug, bracket, strut and shell that can be reused as a template
- Challenge vendor and contractor calculations by reproducing their key stresses by hand in minutes
- Approve field modifications and replacement parts with a documented utilisation ratio instead of rule of thumb
- Compare hand calculation practice with engineers from oil and gas, power, water, mining and manufacturing plants

Conclusion:

Sound component decisions start with a correct load path and a stress calculation that someone else can follow. The week moves from free-body diagrams, stress, strain and tensile properties, through axial, thermal and torsional loading, to beam bending, shear and deflection, then to combined stresses, Mohr's circle, yield criteria, thin shells, notches, fatigue and buckling. The final day builds and peer checks a Component Stress Check Calculation Pack for case plant components, ready for use on the next modification or repair.