ASSESSMENT TRAINING

Mechanical Engineering

Practice Test 01

Instructions

Work Through This Test Carefully

This practice test is designed to help prepare for technical interviews and engineering assessments in mechanical engineering.

The focus is on technical understanding and analytical thinking rather than calculation speed.

Each problem presents an independent engineering challenge and can be solved without reference to the other problems.

How to Use the QR Codes

Detailed solution videos are published on YouTube over time.

- **Printed version:** Scan the QR code to open the corresponding video.
- **Digital version:** Click the QR code to open the corresponding video.

The videos can be used both while working through the problems and for review afterward.

Watch Detailed Solutions on YouTube

Engineering | With Erwin

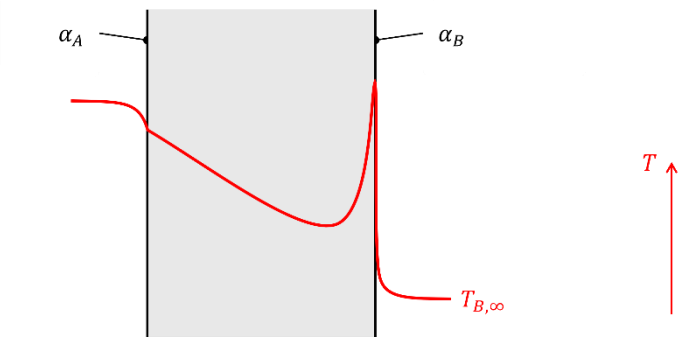
Contents

Questions

Question 1A – Interpreting Temperature Profiles

The figure shows the steady-state temperature distribution across an exterior wall. Point A is located on the interior side, and point B on the exterior side.

Under which conditions would this temperature profile most likely occur? Justify your choice briefly.



a) A cold winter night without solar radiation

b) A cold but sunny winter day

c) Strong solar loading during summer

d) Rainy summer conditions with low solar input

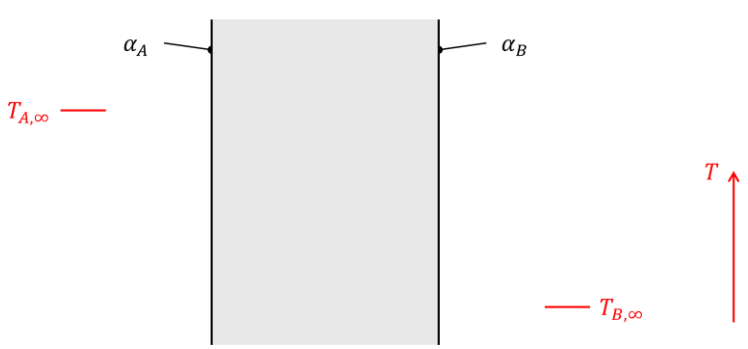
Question 1B – Sketching Temperature Profiles

The figure shows the steady-state temperature distribution across an exterior wall. Point A is located on the interior side, and point B on the exterior side. Heat transfer occurs through convection at the wall surfaces and conduction through the wall material. The convective heat transfer coefficients on both sides are equal.

Sketch one possible temperature profile for:

a) a material with low thermal conductivity

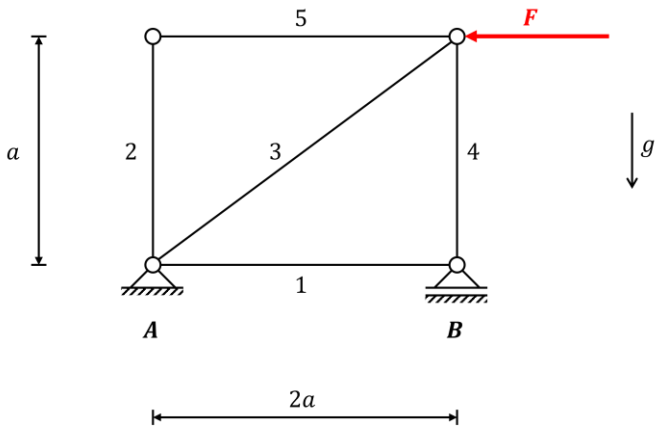
b) a material with high thermal conductivity



Question 2 – Truss Analysis

Determine all support reactions and member forces for the truss shown.

Indicate whether each member is in tension or compression.



Question 3 – Stress and Deformation of a Stepped Bar

A fixed-end stepped bar is subjected to an axial force F, as shown. The geometry and material properties are given in the figure. Neglect the self-weight of the bar. Assume linear-elastic behavior and small deformations.

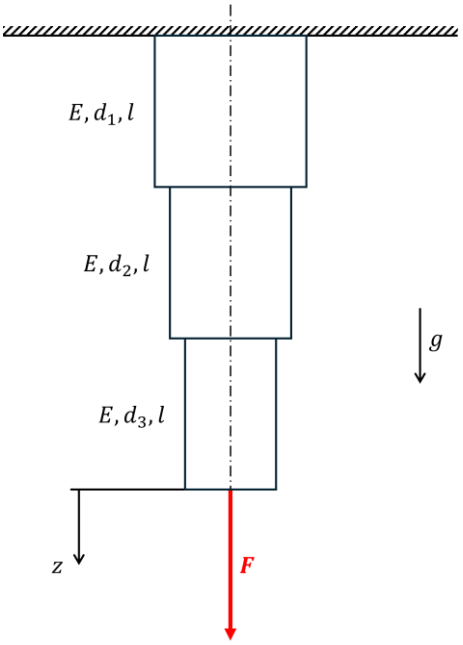
Determine:

a) the maximum normal stress $\sigma_{\max}$ in the bar

b) the axial displacement Δz at the loaded end

Express both results in terms of the given quantities.

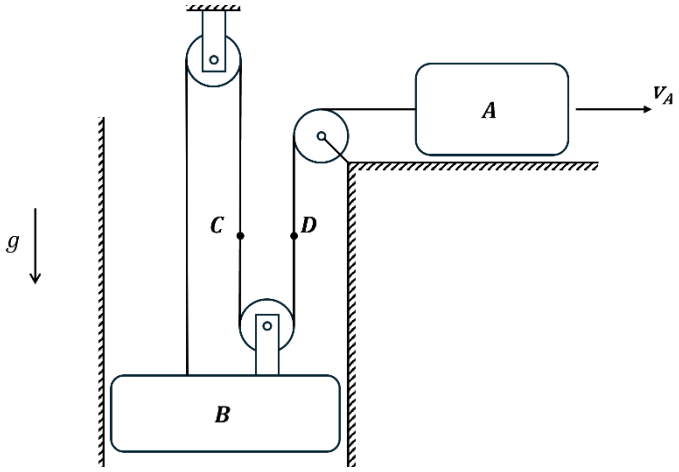
Given: $E,\ d_1,\ d_2,\ d_3,\ l,\ F$



Question 4 – Kinematics of a Pulley System

Blocks A and B are connected through the frictionless pulley system shown. Block A moves with velocity v_A.

Determine v_B, v_C, and v_D in terms of v_A.

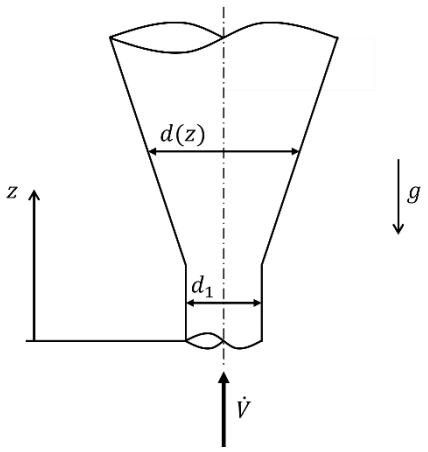


Question 5 – Flow in a Variable-Area Duct

An incompressible fluid with volumetric flow rate $\dot{V}$ flows vertically through a duct with varying cross-sectional area.

Assuming steady, inviscid flow, determine the diameter profile $d(z)$ required to maintain constant static pressure throughout the duct.

Given: $d_1,\ g,\ \dot{V}$



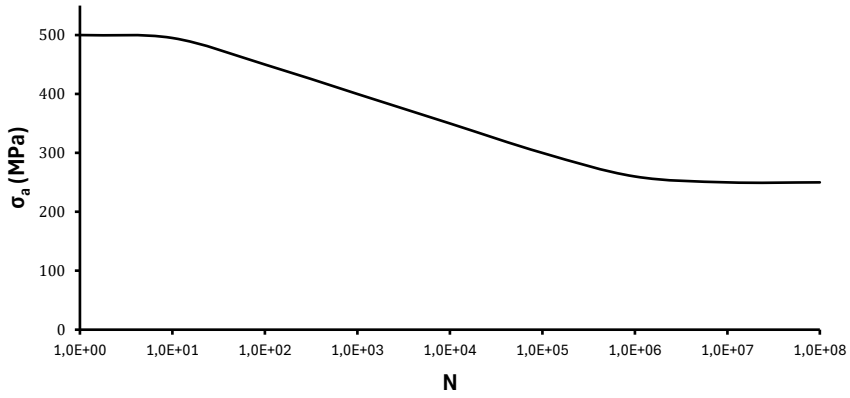
Question 6 – Fatigue Analysis Using S–N Curves

A round steel bar is subjected to fully reversed axial loading. The corresponding S–N curve is shown.

Determine the minimum required diameter for:

a) 5×10^3 load cycles under a load amplitude of 50 kN

b) infinite fatigue life under the same loading condition



Answer Key

Question 1A – Interpreting Temperature Profiles

b) A cold but sunny winter day

Question 1B – Sketching Temperature Profiles

See detailed video solution

Question 2 – Truss Analysis

$$A = \sqrt{\frac{5}{4}} \cdot F, \qquad B = \frac{F}{2}$$

Question 3 – Stress and Deformation of a Stepped Bar

$$\sigma_{\max} = \frac{4 \cdot F}{\pi \cdot {d_3}^2}, \qquad \Delta z = \frac{4 \cdot F \cdot l}{\pi \cdot E} \cdot \sum \frac{1}{{d_i}^2}$$

Question 4 – Kinematics of a Pulley System

$$v_B = \frac{1}{3} \cdot v_A, \qquad v_C = \frac{1}{3} \cdot v_A, \qquad v_D = v_A$$

Question 5 – Flow in a Variable-Area Duct

$$d(z) = \sqrt[4]{\frac{1}{\frac{1}{{d_1}^4} - \frac{g \cdot z}{8} \cdot \left(\frac{\pi}{\dot{V}}\right)^2}}$$

Question 6 – Fatigue Analysis Using S–N Curves

a) $d_{\min} = 13\ \text{mm}$

b) $d_{\min} = 16\ \text{mm}$

Engineering | With Erwin

Watch. Practice. Master.

YouTube – Watch Solutions Step by Step

Downloads – Get Additional Worksheets and Resources

www.witherwin.com