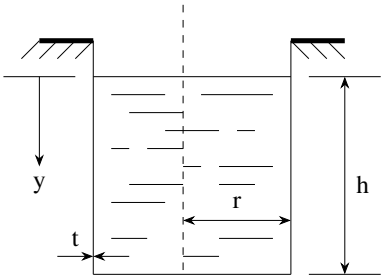
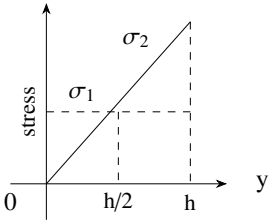
GateAssignment9

EE24BTECH11048-NITHIN.K

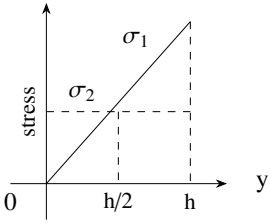
1 Q.36 to Q.65 carry TWO marks Each

1) The figure shows a thin-walled open-top cylindrical vessel of radius r and wall thickness t. The vessel is held along the brim and contains a constant-density liquid to height h from the base. Neglect atmospheric pressure, the weight of the vessel and bending stresses in the vessel walls.
Which one of the plots depicts qualitatively CORRECT dependence of the magnitudes of axial wall stress (σ_1) and circumferential wall stress (σ_2) on y?

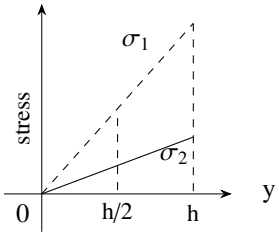




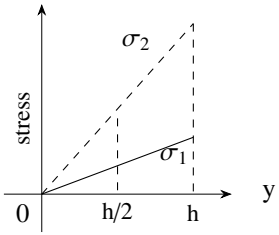
a)



b)



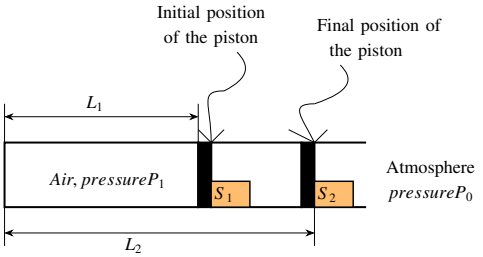
c)



d)

2) Which one of the following statements is FALSE?
   a) For an ideal gas, the enthalpy is independent of pressure.
   b) For a real gas going through an adiabatic reversible process, the process equation is given by PV^{γ} = constant, where P is the pressure, V is the volume and γ is the ratio of the specific heats of the gas at constant pressure and constant volume.
   c) For an ideal gas undergoing a reversible polytropic process $PV^{1.5}$ = constant, the equation connecting the pressure, volume and temperature of the gas at any point along the pro cess is $\frac{P}{R} = \frac{mT}{V}$, where R is the gas constant and m is the mass of the gas.
   d) Any real gas behaves as an ideal gas at sufficiently low pressure or sufficiently high temperature.

3) Consider a fully adiabatic piston-cylinder arrangement as shown in the figure. The piston is massless and cross-sectional area of the cylinder is A. The fluid inside the cylinder is air (consid ered as a perfect gas), with γ being the ratio of the specific heat at constant pressure to the specific heat at constant volume for air. The piston is initially located at a position L_1. The initial pressure of the air inside the cylinder is $P_1 >> P_0$, where P_0 is the atmospheric pressure. The stop S_1 is instantaneously removed and the piston moves to the position L_2, where the e quilibrium pressure of air inside the cylinder is $P_2 >> P_0$.
   What is the work done by the piston on the atmosphere during this process?

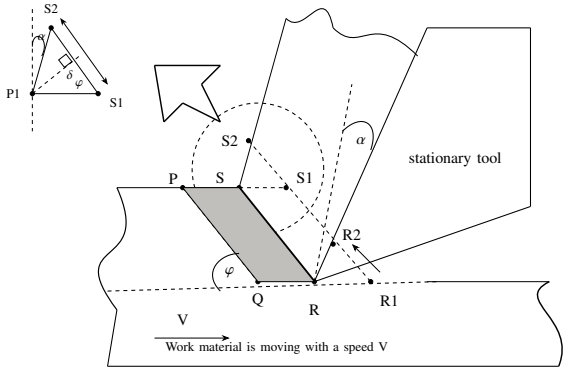


a) 0
b) $P_0A\,(L_2 - L_1)$
c) $P_1AL_1 \ln \frac{L_1}{L_2}$
d) $\frac{(P_2L_2 - P_1L_1)}{(1-\gamma)}$

4) A cylindrical rod of length h and diameter d is placed inside a cubic enclosure of side length L. S denotes the inner surface of the cube. The view-factor F_{S-S} is

a) 0
b) 1
c) $\frac{(\pi dh + \pi d^2/2)}{6L^2}$
d) $1 - \frac{(\pi dh + \pi d^2/2)}{6L^2}$

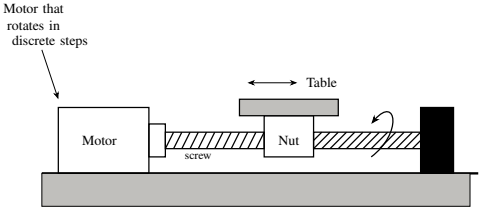
5) In an ideal orthogonal cutting experiment (see figure), the cutting speed V is 1 m/s, the rake angle of the tool $\alpha = 5°$, and the shear angle, ϕ, is known to be 45° .
Applying the ideal orthogonal cutting model, consider two shear planes PQ and RS close to each other. As they approach the thin shear zone (shown as a thick line in the figure), plane RS ge ts sheared with respect to PQ (point R1 shears to R2, and S1 shears to S2).
Assuming that the perpendicular distance between PQ and RS is $\delta = 25\mu m$, what is the value of shear strain rate $\left(\text{in } s^{-1}\right)$ that the material undergoes at the shear zone?



a) 1.84×10^4
b) 5.20×10^4

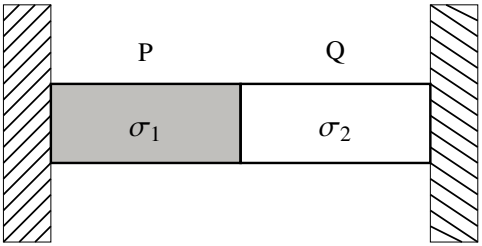
c) 0.71×10^4
d) 1.30×10^4

6) A CNC machine has one of its linear positioning axes as shown in the figure, consisting of a motor rotating a lead screw, which in turn moves a nut horizontally on which a table is mounted. The motor moves in discrete rotational steps of 50 steps per revolution. The pitch of the screw is 5 mm and the total horizontal traverse length of the table is 100 mm. What is the total number of controllable locations at which the table can be positioned on this axis?



a) 5000
b) 2
c) 1000
d) 200

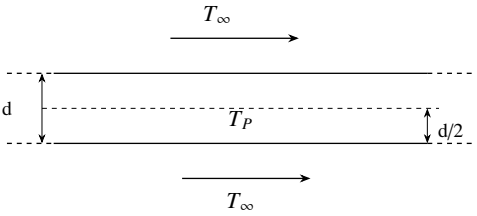
7) Cylindrical bars P and Q have identical lengths and radii, but are composed of different linear elastic materials. The Youngś modulus and coefficient of thermal expansion of Q are twice the corresponding values of P. Assume the bars to be perfectly bonded at the interface, and their weights to be negligible.
The bars are held between rigid supports as shown in the figure and the temperature is raised by ΔT. Assume that the stress in each bar is homogeneous and uniaxial. Denote the magnitudes of stres s in P and Q by σ_1 and σ_2 , respectively.
Which of the statement(s) given is/are CORRECT?



a) The interface between P and Q moves to the left after heating
b) The interface between P and Q moves to the right after heating
c) $\sigma_1 < \sigma_2$
d) $\sigma_1 = \sigma_2$

8) A very large metal plate of thickness d and thermal conductivity k is cooled by a stream of air at temperature T_∞ = 300 K with a heat transfer coefficient h, as shown

in the figure. The centerlin e temperature of the plate is T_P. In which of the following case(s) can the lumped parameter model be used to study the heat transfer in the metal plate?



a) $h = 10Wm^{-2}K^{-1}, k = 100Wm^{-1}K^{-1}, d = 1mm, T_P = 350K$
b) $h = 100Wm^{-2}K^{-1}, k = 100Wm^{-1}K^{-1}, d = 1m, T_P = 325K$
c) $h = 100Wm^{-2}K^{-1}, k = 1000Wm^{-1}K^{-1}, d = 1mm, T_P = 325K$
d) $h = 1000Wm^{-2}K^{-1}, k = 1Wm^{-1}K^{-1}, d = 1m, T_P = 350K$

9) The smallest perimeter that a rectangle with area of 4 square units can have is _____ units.
(Answer in integer)

10) Consider the second-order linear ordinary differential equation

$$x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} - y = 0, x \geq 1$$

with the initial conditions

$$y(x = 1) = 6, \left.\frac{dy}{dx}\right|_{x=1} = 2.$$

The value of y at x = 2 equals _____.
(Answer in integer)

11) The initial value problem

$$\frac{dy}{dt} + 2y = 0, y(0) = 1$$

is solved numerically using the forward Eulerś method with a constant and positive time step of Δt.
Let y_n represent the numerical solution obtained after n steps. The condition $|y_{n+1} \leq |y_n|$ is satisfied if and only if Δt does not exceed _____.
(Answer in integer)

12) The atomic radius of a hypothetical face-centered cubic (FCC) metal is ($\sqrt{2}$/10) nm. The atomic weight of the metal is 24.092 g/mol. Taking Avogadroś number to be 6.023×10^{23} atoms/mol, the density of the metal is _____ kg/m^3.
(Answer in integer)

13) A steel sample with 1.5 wt.% carbon (no other alloying elements present) is slowly cooled from 1100 °C to just below the eutectoid temperature (723 ° C). A part of the iron-cementite phase diagram is shown in the figure. The ratio of the pro-eutectoid cementite content to the total cementite content in the microstructure that develops

just below the eutectoid temperature is _____.
(Rounded off to two decimal places)