Unit 3 - Week 1

Assignment 1

The due date for submitting this assignment has passed. Assignment submitted on 2019-02-08, 13:47 IST

1) Consider a material for which the temperature dependence of the thermal conductivity may be represented as, \( k(T) = k_0 + aT \), where \( k_0 \) is a positive constant and \( a \) is a coefficient that may be positive or negative. Which is the correct sketch of the steady-state temperature distribution associated with the heat transfer in a plane wall (length \( L \)) for three cases corresponding to \( a < 0 \), \( a = 0 \), \( a > 0 \)?

No, the answer is incorrect.
Score: 0

Accepted Answers:

2) Steady-state, one-dimensional conduction occurs in a rod of constant thermal conductivity \( k \) and variable cross-section area, \( A_x(x) = A_0e^{ax} \), where \( A_0 \) and \( a \) are the constants. The lateral surface of the rod is well insulated. Choose the correct option which gives temperature distribution \( T(x) \) and qualitative sketch for \( T(0) > T(L) \). Take the integration constant as \( C_1 \) and \( C_2 \).

Hint: Use an expression for the conduction heat rate, \( q_x(x) \)

No, the answer is incorrect.
4) In a manufacturing process, a transparent film is being bonded to a substrate as shown in the sketch. To cure the bond at a temperature \( T_0 \), a radiant source is used to provide a heat flux \( q'_0 (W/m^2) \), all of which is absorbed at the bonded surface. The back of the substrate is maintained at \( T_s \) while the free surface of the film is exposed to air at \( T_\infty \) and a convection heat transfer coefficient \( h \). Assume the following conditions: \( T_\infty = 20^0C \), \( h = 50 W/m^2K \), and \( T_s = 30^0C \). Calculate the heat flux \( q''_0 (W/m^2) \) that is required to maintain the bonded surface at \( T_0 = 60^0C \).

**Hint:** Use thermal resistance method.

\[
q''_0 = 10816.7 W/m^2 \\
q'_0 = -2833.3 W/m^2 \\
q''_0 = -10816.7 W/m^2 \\
q''_0 = 2833.3 W/m^2
\]

No, the answer is incorrect.
Score: 0

Accepted Answers:
\( q''_0 = 2833.3 W/m^2 \)

5) The wind chill, which is experienced on a cold, windy day, is related to increased heat transfer from exposed human skin \( (k = 0.2 W/mK) \) to the surrounding atmosphere. Consider a layer of fatty tissue that is 3 mm thick and whose interior surface is maintained at a temperature of \( 36^0C \). On a calm day the convection heat transfer coefficient at the outer surface is \( 25 W/m^2K \) but with \( 30 km/h \) winds it reaches \( 65 W/m^2K \). In both cases the ambient air temperature is \(-15^0C\).

(a) What is the ratio of the heat loss per unit area from the skin for the calm day to that for the windy day?

(b) What will be the skin outer surface temperature for the calm day? For the windy day?

\[
\frac{q_{c, calm}}{q_{w, windy}} = 0.55, T_{s, calm} = 295.09K, T_{s, windy} = 283.82K \\
\frac{q_{c, calm}}{q_{w, windy}} = 0.55, T_{s, calm} = 303.27K, T_{s, windy} = 298.63K
\]
No, the answer is incorrect.
Score: 0

Accepted Answers:
$q''_{calm}/q''_{windy} = 0.55, T_s_{calm} = 295.09 K, T_s_{windy} = 283.82 K$