Unit 5 - Week 3

Assignment 3

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment. Due on 2019-02-20, 23:59 IST.

1) A bonding operation utilizes a laser to provide a constant heat flux, $q_0''$, across the top surface of a thin adhesive backed, plastic film to be affixed to a metal strip as shown in the sketch. The metal strip has a thickness $d = 1.25mm$, and its width is large relative to that of the film. The thermal resistance of the plastic film of width $w_1 = 40mm$ is negligible. The upper and lower surfaces of the strip (including the plastic film) experience convection with air at $25^\circ C$, and a convection coefficient of $10W/m^2K$. The strip and film are very long in the direction normal to the page. Assume the edges of the metal strip are at the air temperature $T_{\infty}$. If the heat flux provided by the laser is $10,000W/m^2$, determine the temperature of the plastic film at the center ($x = 0$) and its edge ($x = w_1/2$).

Given: Metal strip: $\rho = 7850kg/m^3, C_p = 435J/kgm^3, k = 60W/mK$

Hint: Derive an expression for the temperature distribution in the portion of the steel strip with the plastic film $\left(-\frac{w_1}{2} \leq x \leq +\frac{w_1}{2}\right)$.

$T(x = 0) = 437.3K, T(x = \frac{w_1}{2}) = 418.1K$

$T(x = 0) = 164.3K, T(x = \frac{w_1}{2}) = 145K$

$T(x = 0) = 104.9K, T(x = \frac{w_1}{2}) = 67.58K$

$T(x = 0) = 797.9K, T(x = \frac{w_1}{2}) = 548.0K$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$T(x = 0) = 437.3K, T(x = \frac{w_1}{2}) = 418.1K$

2) Turbine blades mounted to a rotating disc in a gas turbine engine are exposed... 3 points
allowable blade temperature and the rate at which heat is transferred from each blade to the coolant?

\[
T(L) = 1037K, \quad q_b = -508.4W
\]
\[
T(L) = 1473K, \quad q_b = 517.0W
\]
\[
T(L) = 1200K, \quad q_b = -517W
\]
\[
T(L) = 1310K, \quad q_b = 508.4W
\]

No, the answer is incorrect.
Score: 0
Accepted Answers:

3) Consider the two-dimensional rectangular plate \((W = 1, L = 2)\) having a thermal conductivity of \(50W/mK\). Beginning with the exact solution for the temperature distribution, derive an expression for the heat transfer rate per unit thickness from the plate along the lower surface \((0 \leq x \leq 2, y = 0)\) and evaluate the heat rate considering the first five nonzero terms of the infinite series.

\[
q_{out} = 5611.9W/m
\]
\[
q'_{out} = 551.4W/m
\]
\[
q_{out} = -5611.9W/m
\]
\[
q'_{out} = -551.4W/m
\]

No, the answer is incorrect.
Score: 0
Accepted Answers:

4) A coated niobium sphere of \(10mm\) diameter is removed from a furnace at \(900^\circ C\) and cooled to a temperature of \(300^\circ C\). The properties of the niobium are, \(\rho = 8600kg/m^3\), \(C_p = 290J/kgK\), and \(k = 63W/mK\). The sphere is immersed in an inert gas stream for which \(T_\infty = 25^\circ C\) and \(h = 200W/m^2K\). Calculate the Biot number (Bi) and the time required for cooling.

\[
Bi = 0.032, \quad t = 4s
\]
\[
Bi = 0.032, \quad t = 24s
\]
\[
Bi = 0.19, \quad t = 4s
\]
\[
Bi = 0.19, \quad t = 11s
\]
No, the answer is incorrect.
Score: 0
Accepted Answers:
\( Bi = 0.032, \ t = 24s \)