Week 10 Assessment

The due date for submitting this assignment has passed. **Due on 2020-04-08, 23:59 IST.**
As per our records you have not submitted this assignment.

1) For the steady heat conduction from a heated spherical particle maintained at constant temperature into a conducting medium, which of the following statements is **not** true. 

- The heat flux is independent of distance from the particle.  
- The heat transfer rate across any surface enclosing the particle is a constant.  
- The heat flux is independent of time.  
- The heat transfer rate is independent of time.

No, the answer is incorrect.
Score: 0
Accepted Answers: 
*The heat flux is independent of distance from the particle.*

2) Consider a circular inclusion of conductivity \( k_p \) placed in a matrix of conductivity \( k_m \) in two dimensions, as shown in figure 1. A uniform temperature gradient \( T = T_0 + T'x \) is imposed on the system far from the inclusion. Calculate the temperature field near the inclusion as follows. Assume the solution of the conduction equation \( \nabla^2 T = 0 \) in two dimensions is of the form

\[
T_p - T_0 = (A_pr + B_pr^{-1})\cos(\theta) \\
T_m - T_0 = (A_mr + B_mr^{-1})\cos(\theta)
\]

where \( T_m \) is the temperature of the matrix and \( T_p \) is the temperature of the inclusion, \( r \) is the distance from the center of the inclusion, and \( \theta \) is the polar angle made by the radius vector with the x axis.
Forced convection.

Forced & natural convection.

- Diffusion equation: Effective conductivity of a composite. (unit? unit=90&lesson=91)
- Diffusion equation: Spherical harmonic solutions. (unit? unit=90&lesson=92)
- Diffusion equation: Conduction from a point source. (unit? unit=90&lesson=93)
- Diffusion equation: Method of Greens functions. (unit? unit=90&lesson=94)
- Diffusion equation: Method of images. (unit? unit=90&lesson=95)
- Diffusion equation: Equivalence of spherical harmonics and multipole expansion. (unit? unit=90&lesson=96)

Quiz: Week 10 Assessment (assessment? name=119)

Natural convection.

Transport in turbulent flows.

Text Transcripts

\[ T = T_0 + T'x \text{ as } r \rightarrow \infty \]

![Diagram](https://onlinecourses.nptel.ac.in/noc20_ch10/unit?unit=90&lesson=91)

From the condition that the temperature is finite at the center of the inclusion, we can infer that,

- \( A_p = 0 \)
- \( B_p = 0 \)
- \( A_m = 0 \)
- \( B_m = 0 \)

No, the answer is incorrect.
Score: 0
Accepted Answers: \( B_p = 0 \)

3) For the system in Question 2, from the condition that \( T = T_0 + T' r \cos(\theta) \), we can infer that,

- \( A_p = T' \)
- \( B_p = T' \)
- \( A_m = T' \)
- \( B_m = T' \)

No, the answer is incorrect.
Score: 0
4) What are the matching conditions at the interface between the inclusion and the matrix at $r = R$ for the system in Question 2?

- $T_m = T_p$, & $\frac{\partial T_m}{\partial r} = \frac{\partial T_p}{\partial r}$
- $T_m = T_p$, & $\frac{\partial T_m}{\partial \theta} = \frac{\partial T_p}{\partial \theta}$
- $T_m = T_p$, & $k_m \frac{\partial T_m}{\partial r} = k_p \frac{\partial T_p}{\partial r}$
- $T_m = T_p$, & $k_m \frac{\partial T_m}{\partial \theta} = k_p \frac{\partial T_p}{\partial \theta}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$T_m = T_p$, & $k_m \frac{\partial T_m}{\partial r} = k_p \frac{\partial T_p}{\partial r}$

5) Using the matching conditions in Question 3, what is the solution for the temperature field in the matrix for the system in Question 2? In the expressions below, $k_r = (k_p/k_m)$.

- $T_m - T_0 = \left( T' r + \frac{T' R^2}{r} \right) \cos(\theta)$
- $T_m - T_0 = \left( T' r + \frac{(1 - k_r)T' R^2}{r(1 + k_r)} \right) \cos(\theta)$
- $T_m - T_0 = \left( T' r + \frac{(1 - k_r)T' R^2}{r(2 + k_r)} \right) \cos(\theta)$
- $T_m - T_0 = \left( T' r + \frac{(2 - k_r)T' R^2}{r(2 + k_r)} \right) \cos(\theta)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$T_m - T_0 = \left( T' r + \frac{(1 - k_r)T' R^2}{r(1 + k_r)} \right) \cos(\theta)$

6) Using the matching conditions from Question 3, what is the solution for the temperature field in the inclusion for the system in Question 1? In the expressions below, $k_r = (k_p/k_m)$.
$T_p - T_0 = T' r \cos(\theta)$

$T_p - T_0 = \frac{T' r \cos(\theta)}{1 + k_r}$

$T_p - T_0 = \frac{2T' r \cos(\theta)}{1 + k_r}$

$T_p - T_0 = \frac{T' r \cos(\theta)}{1 - k_r}$

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

$T_p - T_0 = \frac{2T' r \cos(\theta)}{1 + k_r}$

7) The solution for a point source of heat in two dimensions is

$T - T_\infty = -\frac{Q \log(r)}{2\pi}$

where $Q$ is the source strength, $r$ is the distance from the source and $T_\infty$ is the temperature far from the source. Use the following expansion $\log(1 + e) = e - (e^2/2) + (e^3/3) + \cdots$ for $e \ll 1$. Consider a source and a sink of equal strength $Q$ separated by a distance $L$ along the $x$ axis in two dimensions, as shown in figure 2. What is the temperature field when the distance $r$ from the origin is much larger than
8) Consider two sources and two sinks equal strength $Q$ separated by distances $L$ as shown in Figure 3. What is the temperature when the distance from the origin is much larger than $L$? Use the

$\frac{2LQ \log(r)}{2\pi}$

$\frac{2LQ \cos(\theta)}{2\pi r}$

$\frac{2LQ \cos(\theta)}{2\pi r^2}$

$\frac{2L^2Q \cos(\theta)^2}{2\pi r^2}$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$\frac{2LQ \cos(\theta)}{2\pi r}$

https://onlinecourses.nptel.ac.in/noc20_ch10/unit?unit=90&assessment=119
solution for a point source of heat as mentioned in Question 7.

Figure 3:

\[
\begin{align*}
2LQ \log(r) & \quad \frac{2LQ \cos(\theta)}{2\pi r} \\
2LQ \cos(2\theta) & \quad \frac{2L^2Q \cos(2\theta)^2}{2\pi r^4}
\end{align*}
\]

No, the answer is incorrect.
Score: 0
Accepted Answers:
\[
\frac{2LQ \cos(2\theta)}{2\pi r^2}
\]

9) Consider a point source of heat placed next to two perfectly insulating walls as shown in figure 3.
Which of the following configurations without walls but with image sources and sinks results in the same temperature field as that in the above configuration?
No, the answer is incorrect.
Score: 0
Accepted Answers:
In Question 9, if the distance from the source $r$ is large compared to the distance of the source from the walls, the temperature decays proportional to

- $\frac{1}{r}$
- $\frac{1}{r^2}$
- $\frac{1}{r^3}$

None of the above

No, the answer is incorrect. 
Score: 0
Accepted Answers:
$\frac{1}{r}$