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TRANSPORT PHENOMENA (SEMESTER - 8)

CS / B.Tech(CHE-New) / SEM-8 / CHE-801 / 09

1. ....
Signature of Invigilator

2. ....
Signature of the Officer-in-Charge

Reg. No. | | | | | | | | | | | | | | | |

Roll No. of the Candidate | | | | | | | | | | | | | | | |

CS / B.Tech(CHE-New) / SEM-8 / CHE-801 / 09

ENGINEERING & MANAGEMENT EXAMINATIONS, APRIL – 2009

TRANSPORT PHENOMENA (SEMESTER - 8)

Time : 3 Hours] [Full Marks : 70

INSTRUCTIONS TO THE CANDIDATES :

1. This Booklet is a Question-cum-Answer Booklet. The Booklet consists of **32 pages**. The questions of this concerned subject commence from Page No. 3.
2. a) In **Group – A**, Questions are of Multiple Choice type. You have to write the correct choice in the box provided **against each question**.
   b) For **Groups – B & C** you have to answer the questions in the space provided marked 'Answer Sheet'. Questions of **Group – B** are Short answer type. Questions of **Group – C** are Long answer type. Write on both sides of the paper.
3. **Fill in your Roll No. in the box** provided as in your Admit Card before answering the questions.
4. Read the instructions given inside carefully before answering.
5. You should not forget to write the corresponding question numbers while answering.
6. Do not write your name or put any special mark in the booklet that may disclose your identity, which will render you liable to disqualification. Any candidate found copying will be subject to Disciplinary Action under the relevant rules.
7. **Use of Mobile Phone and Programmable Calculator is totally prohibited in the examination hall.**
8. You should return the booklet to the invigilator at the end of the examination and should not take any page of this booklet with you outside the examination hall, **which will lead to disqualification**.
9. Rough work, if necessary is to be done in this booklet only and cross it through.

No additional sheets are to be used and no loose paper will be provided

FOR OFFICE USE / EVALUATION ONLY

Marks Obtained

	Group – A										Group – B			Group – C				
Question Number																	***Total Marks***	***Examiner's Signature***
Marks Obtained																		

....
Head-Examiner / Co-Ordinator / Scrutineer

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ENGINEERING & MANAGEMENT EXAMINATIONS, APRIL – 2009

TRANSPORT PHENOMENA

SEMESTER - 8

Time : 3 Hours] [Full Marks : 70

Graph sheet is provided on Page 31.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

i) Diagonal component of a unit tensor is

a) unity b) 0

c) infinity d) – 1.

ii) Cross or Vector product of two identical vectors is

a) 1 b) 0

c) infinity d) – 1.

iii) Flow behavior index (*n*) of pseudoplastic fluid is

a) 0 b) < 1

c) > 1 d) infinity.

iv) For falling film system average velocity is

a) 2/3 of maximum velocity b) 3/4 of maximum velocity

c) 1/2 of maximum velocity d) 3/5 of maximum velocity.

v) Toothpaste is

a) Thixotropic fluid b) Rheopectic

c) Bingham plastic fluid d) Pseudoplastic fluid.

vi) The three dimensional form of Fourier's Law of heat conduction in an isotropic material is equal to

a) $-k \nabla T$ b) $k/\rho C_p$

c) $-k \, dT/dy$ d) none of these.

vii) The laminar-turbulent transition usually occurs for length Reynolds number being of the order of

a) $10^2 - 10^5$ b) $10^5 - 10^6$

c) $10^6 - 10^8$ d) $10^8 - 10^{10}$.

viii) Molecular momentum flux tensor is

a) τ b) $\rho u u$

c) $\tau + p\delta$ d) $\tau + p\delta + \rho u u$.

ix) K_{lg} for penetration theory is

a) $2\sqrt{(D_{AB}/\pi\theta)}$ b) $\sqrt{(D_{AB}\, s)}$

c) D_{AB} / δ d) D_{AB} .

x) A_{kl}^{qst} are the components of a mixed tensor of

a) rank 2 b) rank 6

c) rank 5 d) rank 3.

xi) If $\vec{v} = \vec{w} \times \vec{r}$, where $\vec{w}$ is a constant vector, then $\vec{w}$ is

a) $\frac{1}{2}$ curl $\vec{v}$ b) $\frac{1}{2}$ grad $\vec{v}$

c) curl $\vec{v}$ d) div curl $\vec{v}$.

xii) If ambient temperatue be T_a, radius of a cylindrical fin be R and thermal diffusivity α, the expression for unsteady state heat transfer for a cylindrical fin may be given as (the symbols are of usual singificances)

a) $\rho \pi R^2 \Delta x C_p \frac{\partial T}{\partial t} = -K \pi R^2 \frac{\partial T}{\partial x} - \left[-K \pi R^2 \frac{\partial T}{\partial x} + \frac{\partial}{\partial x}\left(-K \pi R^2 \frac{\partial T}{\partial x} \right) \Delta x \right] - h 2 \pi R \Delta x (T - T_a)$

b) $\rho \pi R^2 C_p \frac{\partial T}{\partial t} = K \pi R^2 \frac{\partial^2 T}{\partial x^2} - h 2 \pi R (T - T_a)$

c) $\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2} - \frac{2h}{R \rho C_p} (T - T_a)$

d) All of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Show that Fick's law of diffusion, Newton's law of viscosity and Fourier's law of thermal coductivity are similar in the light of transport phenomenon.

3. a) What is Reynolds' transport theorem ? Where is it used ? 3

   b) What is RANS theorem ? 2

4. Discuss different types of time independent and time dependent non-Newtonian fluid with graph.

5. Parabolic velocity profile for the flow through a vertical circular tube of radius R and length L is given by

$$v_z = \frac{(\surd_0 - \surd_L) R^2}{4 \mu L} \left[1 - \left(\frac{r}{R} \right)^2 \right]$$

Where, $\surd$ is the combined effect of static pressure and gravity force, μ is the viscosity of the fluid, then show that $v_{avg} = \frac{v_{max}}{2}$.

6. Define boundary layer thickness.

   Calculate the thinkness of the boundary layer at a distance of 8mm, from the leading edge of a flat surface over which water at 30°C (μ = 1 cp) is flowing at a velocity 10·5 m/s.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Prove from continuity equation for a incompressible fluid div.u = 0. 7

b) Using Nevier-Stokes equation in cylindrical coordinate, derive the velocity profile for laminar flow of liquid in a tube. 8

The Navier-Stokes equations in cylindrical coordinate are given below (the symbols are of usual significances) :

$$\rho\left(\frac{\partial u_r}{\partial t}+u_r\frac{\partial u_r}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_r}{\partial \theta}+u_z\frac{\partial u_r}{\partial z}-\frac{u_\theta^2}{r}\right)$$

$$=-\frac{\partial p}{\partial r}+\mu\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial u_r}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 u_r}{\partial \theta^2}+\frac{\partial^2 u_r}{\partial z^2}-\frac{u_r}{r^2}-\frac{2}{r^2}\frac{\partial u_\theta}{\partial \theta}\right]+\rho g_r$$

$$\rho\left(\frac{\partial u_\theta}{\partial t}+u_r\frac{\partial u_\theta}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_\theta}{\partial \theta}+u_z\frac{\partial u_\theta}{\partial z}+\frac{u_r u_\theta}{r}\right)$$

$$=-\frac{1}{r}\frac{\partial p}{\partial \theta}+\mu\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial u_\theta}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 u_\theta}{\partial \theta^2}+\frac{\partial^2 u_\theta}{\partial z^2}+\frac{2}{r^2}\frac{\partial u_r}{\partial \theta}-\frac{u_\theta}{r^2}\right]+\rho g_\theta$$

$$\rho\left(\frac{\partial u_z}{\partial t}+u_r\frac{\partial u_z}{\partial r}+\frac{u_\theta}{r}\frac{\partial u_z}{\partial \theta}+u_z\frac{\partial u_z}{\partial z}\right)$$

$$=-\frac{\partial p}{\partial z}+\mu\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial u_z}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 u_z}{\partial \theta^2}+\frac{\partial^2 u_z}{\partial z^2}\right]+\rho g_z$$

8. a) Find the expression for flow of viscous Newtonian fluid between two parallel plates located at $y = 0$ and $y = h$ where the upper plate is moving with velocity u. 7

b) Find an expression for creeping flow around a sphere. 8

9. a) Show that for diffusion into a falling liquid film (gas absorption)

$$v_{max}=\left[1-\left(\frac{x}{b}\right)^2\right]\frac{\partial C_A}{\partial z}=D_{AB}\frac{\partial^2 C_A}{\partial x^2}$$

Where the symbols have their usual significance. 8

b) Estimate the rate at which gas bubbles of A are absorbed by liquid B as the gas bubbles rise at their terminal velocity u_t, through a clean quiescent liquid. 7

10\. a) Briefly discuss about the significance of convective heat transfer coefficient. 5

b) A solid slab occupying the space between $y = -b$ and $y = +b$ is initially at temperature T_0. At time $t = 0$ the surfacec at $y = \pm b$ are suddenly raised to T_1. and maintained there. Find $T(y, t)$. 10

11\. a) Derive the relevant expressions for the heat flux distributions in fissionable sphere and in spherical-shell cladding. 9

b) A thermocouple, inserted in a cylindrical well, is placed into a gas stream for measuring the gas temperature of the flowing gas through the pipe. Estimate the true temperature of the gas stream from the following supplied data : 6

Temperature indicated by thermocouple	=	260°C
Pipe wall temperature	=	176·6°C
Heat transfer coefficient	=	587·546 kcal/hr.m^2.°C
Thermal conductivity of well wall	=	293·773 kcal/hr.m.°C
Thickness of well wall	=	$0{\cdot}2032 \infty 10^{-2}$ m.
Length of well	=	0·06096 m.

END