L-2/T-2/CHE **Date : 06/07/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **CHE 205** (Fluid Mechanics)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1\. (a) A Newtonian fluid is in laminar flow in a narrow slit formed by two parallel walls at distance 2B apart as shown in Fig. Q. 1(a). It is understood that B<<W, so that "edge effects" are unimportant. Make a differential momentum balance, and obtain the following expressions for the momentum-flux and velocity distributions: **(20)**

(i) $\tau_{xz} = \left(\dfrac{P_o - P_L}{L}\right)x$

(ii) $v_z = \dfrac{(P_o - P_L)B^2}{2\mu L}\left[1 - \left(\dfrac{x}{B}\right)^2\right]$

In these expressions $P = p + \rho g h = p - \rho g z$.

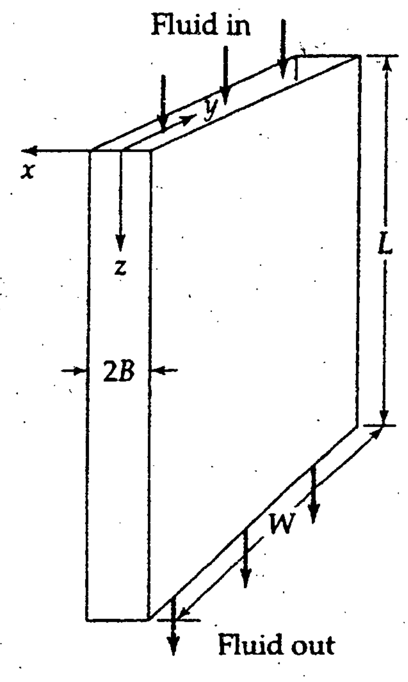

fig. Q-1(a)

(b) Two concentric cylinders of radii R and kR are rotating with two different angular velocities in the same direction. The annular space between the rotating cylinders is filled by a Newtonian fluid. Using the equations of continuity and motion, derive an appropriate expression to represent the velocity of the fluid in the annular space. Draw the velocity profile of the fluid in the annular space. You are allowed to make the necessary crucial assumptions. **(15)**

Contd P/2

2. (a) Write-down the Navier-Stokes equation. State the fundamental assumption(s) made in the derivation of Navier-Stokes equation. State the physical significance of each component of the Navier-Stokes equation. Can you say from the Navier-Stokes equation that momentum balance is completely equivalent to Newton's Law of motion? Write-down a practical application of Navier-Stokes equation. **(10)**

(b) Write-down the mechanism and causes of "Boundary Layer Separation". **(7)**

(c) Briefly discuss the applications, principles and limitations of the following fluid measurement devices: **(6×3=18)**

(i) Tube-type viscometer
(ii) Hot-film anemometer
(iii) Orifice meter

3. (a) Two reservoirs X and Y are connected with a long pipe which has characteristics such that the head loss through the pipe and associated fittings is expressible as $h_L = 1.5 \times 10^5 Q^2$, where h_L is in metres and Q is the flow rate in L/s. The liquid surface elevation in reservoir Y is 15 m above that in reservoir X. Two identical pumps are available for use to pump the liquid from X to Y. The characteristic curve of the pump when operating at 2800 rpm is given in the following table. **(26)**

Operation at 2800 rpm	
Head (m)	Flow rate (L/s)
30	0
27	6.9
24	11.4
18	15.8
12	18.9

At the point of operation the pump delivers 13.6 L/s at a head of 21.5 m. Determine the specific speed n_s of the pump and find the rate of flow under the following conditions:

(i) A single pump operating at 2800 rpm;
(ii) two pumps in series, each operating at 2800 rpm;
(iii) two pumps in parallel, each operating at 2800 rpm.

Also what will happen with the flow if the liquid surface elevation in reservoir Y is more than 30 m above that in reservoir X?

(b) What are the various energy losses in a centrifugal pump under operation? State the cause(s) for each kind of energy loss. Make a quantitative comparison among the losses with a clear sketch. **(9)**

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4. (a) State the benefits, limitations and requirements of dimensional analysis. By dimensional analysis determine the expression for small flow rates over a spillway as shown in Fig. Q. 4(a), in the form of a function including dimensionless quantities. The parameters involved are height of spillway P, head on the spillway H, acceleration due to gravity g, viscosity of liquid μ, density of liquid ρ and surface tension σ. **(6+18=24)**

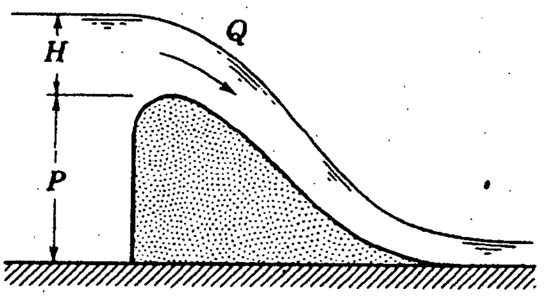

fig. Q-4(a)

(b) What are the crucial points or considerations to perform Model-Prototype studies? **(6)**

(c) Shortly state the criteria for 'kinematic similarity' and 'dynamic similarity' in the context of Model-Prototype studies. **(5)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Write the difference between vapor and gas. What is 'no-slip condition' for viscous fluids? **(4)**

(b) Classify different types of fluids according to shearing stress-shear rate characteristics. Give specific example of each type. **(8)**

(c) Gas flows at a steady rate in a 120 mm diameter pipe that enlarges to a 180 mm diameter pipe. **(8)**

At a certain section of the 120 mm pipe the density of the gas is 165 kg/m^3 and the velocity is 15 m/s. At a certain section of 180 mm pipe the velocity is 10 m/s. What must be the density of the gas at that section?

If these same data were given for the case of unsteady flow at a certain instant, could the problem be solved? Discuss.

(d) A smooth pipe consists of 12 m of 180 mm diameter pipe followed by 75 m of 550 mm diameter pipe, with an abrupt change of cross section at the junction. The entrance is flush and the discharge is submerged. If it carries water at 15°C with a velocity of 5.7 m/s in the smaller pipe, what is the total head loss? **(15)**

Contd P/4

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6. (a) Write short note on Bourdon gage describing its working principle with a clear diagram. **(8)**

(b) Floating vessels usually store liquid ballast or fuel oil in tanks or bulkhead compartments. What is the reason behind it? Explain your answer according to the center of gravity and center of buoyancy of a floating body with necessary diagrams. **(10)**

(c) Find the difference in pressure between tanks A and B in figure for Q. 6(c). Here, $d_1 = 330$ mm, $d_2 = 160$ mm, $d_3 = 480$ mm, $d_4 = 230$ mm. **(7)**

(d) The Utah-shaped plate shown in figure for Q. 6(d) is submerged in oil (SG = 0.94) and lies in a vertical plane. Find the magnitude and location of the hydrostatic force acting on one side of the plate. **(10)**

7. (a) Derive general energy equation for steady flow of any fluid. **(15)**

(b) Express Bernoulli's equation in 3 different ways using **(6)**

(i) Energies (ii) Pressures (iii) Heads

(c) A liquid with a SG of 1.26 is being pumped from A to B through the pipeline in figure for Q. 7(c). At point A, the pipe diameter is 25 inch and the pressure is 50 psi. At point B, the pipe diameter is 15 inch and pressure is 55 psi. Point B is 3 ft lower than point A. Find the flow rate if the pump puts 16 kW into the flow. Neglect head loss. **(14)**

8. (a) Give definitions of hydraulic radius and hydraulic diameter. What is the meaning of wetted perimeter? **(6)**

(b) What is stagnation pressure? Explain how it can be measured. **(7)**

(c) Two pipes, one circular and one square, have the same cross sectional area. Which one has the larger hydraulic radius and by what percentage? **(7)**

(d) Referring to the figure 8(d), A is at elevation of 30 ft and the pipe characteristics are as follows: **(15)**

Pipe B is 5000 ft long of 3 ft diameter with f = 0.035. Pipe C is 5000 ft long of 3 ft diameter with f = 0.025 and pipe E is 4500 ft long of 2 ft dia with f = 0.035.

When the pump develops 30 ft of head the velocity of flow in pipe C is 5 fps. Neglecting minor losses, find—

(i) The flow rates in cubic feet per second in pipes B and E under these conditions.

(ii) The elevation of the discharge end of pipe E.

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§B.1 NEWTON'S LAW OF VISCOSITY (continued)

Cylindrical coordinates (r, θ, z):

$$\tau_{rr} = -\mu\left[2\frac{\partial v_r}{\partial r}\right] + (\tfrac{2}{3}\mu - \kappa)(\nabla \cdot \mathbf{v}) \quad \text{(B.1-8)}^a$$

$$\tau_{\theta\theta} = -\mu\left[2\left(\frac{1}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_r}{r}\right)\right] + (\tfrac{2}{3}\mu - \kappa)(\nabla \cdot \mathbf{v}) \quad \text{(B.1-9)}^a$$

$$\tau_{zz} = -\mu\left[2\frac{\partial v_z}{\partial z}\right] + (\tfrac{2}{3}\mu - \kappa)(\nabla \cdot \mathbf{v}) \quad \text{(B.1-10)}^a$$

$$\tau_{r\theta} = \tau_{\theta r} = -\mu\left[r\frac{\partial}{\partial r}\left(\frac{v_\theta}{r}\right) + \frac{1}{r}\frac{\partial v_r}{\partial \theta}\right] \quad \text{(B.1-11)}$$

$$\tau_{\theta z} = \tau_{z\theta} = -\mu\left[\frac{1}{r}\frac{\partial v_z}{\partial \theta} + \frac{\partial v_\theta}{\partial z}\right] \quad \text{(B.1-12)}$$

$$\tau_{zr} = \tau_{rz} = -\mu\left[\frac{\partial v_r}{\partial z} + \frac{\partial v_z}{\partial r}\right] \quad \text{(B.1-13)}$$

in which

$$(\nabla \cdot \mathbf{v}) = \frac{1}{r}\frac{\partial}{\partial r}(r v_r) + \frac{1}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{\partial v_z}{\partial z} \quad \text{(B.1-14)}$$

[a] When the fluid is assumed to have constant density, the term containing $(\nabla \cdot \mathbf{v})$ may be omitted. For monatomic gases at low density, the dilatational viscosity κ is zero.

Spherical coordinates (r, θ, ϕ):

$$\tau_{rr} = -\mu\left[2\frac{\partial v_r}{\partial r}\right] + (\tfrac{2}{3}\mu - \kappa)(\nabla \cdot \mathbf{v}) \quad \text{(B.1-15)}^a$$

$$\tau_{\theta\theta} = -\mu\left[2\left(\frac{1}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_r}{r}\right)\right] + (\tfrac{2}{3}\mu - \kappa)(\nabla \cdot \mathbf{v}) \quad \text{(B.1-16)}^a$$

$$\tau_{\phi\phi} = -\mu\left[2\left(\frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi} + \frac{v_r + v_\theta \cot\theta}{r}\right)\right] + (\tfrac{2}{3}\mu - \kappa)(\nabla \cdot \mathbf{v}) \quad \text{(B.1-17)}^a$$

$$\tau_{r\theta} = \tau_{\theta r} = -\mu\left[r\frac{\partial}{\partial r}\left(\frac{v_\theta}{r}\right) + \frac{1}{r}\frac{\partial v_r}{\partial \theta}\right] \quad \text{(B.1-18)}$$

$$\tau_{\theta\phi} = \tau_{\phi\theta} = -\mu\left[\frac{\sin\theta}{r}\frac{\partial}{\partial \theta}\left(\frac{v_\phi}{\sin\theta}\right) + \frac{1}{r\sin\theta}\frac{\partial v_\theta}{\partial \phi}\right] \quad \text{(B.1-19)}$$

$$\tau_{\phi r} = \tau_{r\phi} = -\mu\left[\frac{1}{r\sin\theta}\frac{\partial v_r}{\partial \phi} + r\frac{\partial}{\partial r}\left(\frac{v_\phi}{r}\right)\right] \quad \text{(B.1-20)}$$

in which

$$(\nabla \cdot \mathbf{v}) = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(v_\theta \sin\theta) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi} \quad \text{(B.1-21)}$$

[a] When the fluid is assumed to have constant density, the term containing $(\nabla \cdot \mathbf{v})$ may be omitted. For monatomic gases at low density, the dilatational viscosity κ is zero.

§B.3 FICK'S (FIRST) LAW OF BINARY DIFFUSION[a]

$$[\mathbf{j}_A = -\rho\mathscr{D}_{AB}\nabla\omega_A]$$

Cartesian coordinates (x, y, z):

$$j_{Ax} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial x} \quad \text{(B.3-1)}$$

$$j_{Ay} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial y} \quad \text{(B.3-2)}$$

$$j_{Az} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial z} \quad \text{(B.3-3)}$$

Cylindrical coordinates (r, θ, z):

$$j_{Ar} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial r} \quad \text{(B.3-4)}$$

$$j_{A\theta} = -\rho\mathscr{D}_{AB}\frac{1}{r}\frac{\partial\omega_A}{\partial\theta} \quad \text{(B.3-5)}$$

$$j_{Az} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial z} \quad \text{(B.3-6)}$$

Spherical coordinates (r, θ, φ):

$$j_{Ar} = -\rho\mathscr{D}_{AB}\frac{\partial\omega_A}{\partial r} \quad \text{(B.3-7)}$$

$$j_{A\theta} = -\rho\mathscr{D}_{AB}\frac{1}{r}\frac{\partial\omega_A}{\partial\theta} \quad \text{(B.3-8)}$$

$$j_{A\phi} = -\rho\mathscr{D}_{AB}\frac{1}{r\sin\theta}\frac{\partial\omega_A}{\partial\phi} \quad \text{(B.3-9)}$$

[a] To get the molar fluxes with respect to the molar average velocity, replace $\mathbf{j}_A$, ρ, and ω_A by $\mathbf{J}_A^*$, c, and x_A.

§B.4 THE EQUATION OF CONTINUITY[a]

$$[\partial\rho/\partial t + (\nabla\cdot\rho\mathbf{v}) = 0]$$

Cartesian coordinates (x, y, z):

$$\frac{\partial\rho}{\partial t} + \frac{\partial}{\partial x}(\rho v_x) + \frac{\partial}{\partial y}(\rho v_y) + \frac{\partial}{\partial z}(\rho v_z) = 0 \quad \text{(B.4-1)}$$

Cylindrical coordinates (r, θ, z):

$$\frac{\partial\rho}{\partial t} + \frac{1}{r}\frac{\partial}{\partial r}(\rho r v_r) + \frac{1}{r}\frac{\partial}{\partial\theta}(\rho v_\theta) + \frac{\partial}{\partial z}(\rho v_z) = 0 \quad \text{(B.4-2)}$$

Spherical coordinates (r, θ, φ):

$$\frac{\partial\rho}{\partial t} + \frac{1}{r^2}\frac{\partial}{\partial r}(\rho r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\rho v_\theta\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\phi}(\rho v_\phi) = 0 \quad \text{(B.4-3)}$$

[a] When the fluid is assumed to have constant mass density ρ, the equation simplifies to $(\nabla\cdot\mathbf{v}) = 0$.

§B.5 THE EQUATION OF MOTION IN TERMS OF $\boldsymbol{\tau}$

$$[\rho D\mathbf{v}/Dt = -\nabla p - [\nabla \cdot \boldsymbol{\tau}] + \rho \mathbf{g}]$$

Cartesian coordinates (x, y, z):[a]

$$\rho\left(\frac{\partial v_x}{\partial t} + v_x \frac{\partial v_x}{\partial x} + v_y \frac{\partial v_x}{\partial y} + v_z \frac{\partial v_x}{\partial z}\right) = -\frac{\partial p}{\partial x} - \left[\frac{\partial}{\partial x}\tau_{xx} + \frac{\partial}{\partial y}\tau_{yx} + \frac{\partial}{\partial z}\tau_{zx}\right] + \rho g_x \quad \text{(B.5-1)}$$

$$\rho\left(\frac{\partial v_y}{\partial t} + v_x \frac{\partial v_y}{\partial x} + v_y \frac{\partial v_y}{\partial y} + v_z \frac{\partial v_y}{\partial z}\right) = -\frac{\partial p}{\partial y} - \left[\frac{\partial}{\partial x}\tau_{xy} + \frac{\partial}{\partial y}\tau_{yy} + \frac{\partial}{\partial z}\tau_{zy}\right] + \rho g_y \quad \text{(B.5-2)}$$

$$\rho\left(\frac{\partial v_z}{\partial t} + v_x \frac{\partial v_z}{\partial x} + v_y \frac{\partial v_z}{\partial y} + v_z \frac{\partial v_z}{\partial z}\right) = -\frac{\partial p}{\partial z} - \left[\frac{\partial}{\partial x}\tau_{xz} + \frac{\partial}{\partial y}\tau_{yz} + \frac{\partial}{\partial z}\tau_{zz}\right] + \rho g_z \quad \text{(B.5-3)}$$

[a] These equations have been written without making the assumption that $\boldsymbol{\tau}$ is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric, τ_{xy} and τ_{yx} may be interchanged.

Cylindrical coordinates (r, θ, z):[b]

$$\rho\left(\frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} + v_z \frac{\partial v_r}{\partial z} - \frac{v_\theta^2}{r}\right) = -\frac{\partial p}{\partial r} - \left[\frac{1}{r}\frac{\partial}{\partial r}(r\tau_{rr}) + \frac{1}{r}\frac{\partial}{\partial \theta}\tau_{\theta r} + \frac{\partial}{\partial z}\tau_{zr} - \frac{\tau_{\theta\theta}}{r}\right] + \rho g_r \quad \text{(B.5-4)}$$

$$\rho\left(\frac{\partial v_\theta}{\partial t} + v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + v_z \frac{\partial v_\theta}{\partial z} + \frac{v_r v_\theta}{r}\right) = -\frac{1}{r}\frac{\partial p}{\partial \theta} - \left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2\tau_{r\theta}) + \frac{1}{r}\frac{\partial}{\partial \theta}\tau_{\theta\theta} + \frac{\partial}{\partial z}\tau_{z\theta} + \frac{\tau_{\theta r} - \tau_{r\theta}}{r}\right] + \rho g_\theta \quad \text{(B.5-5)}$$

$$\rho\left(\frac{\partial v_z}{\partial t} + v_r \frac{\partial v_z}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_z}{\partial \theta} + v_z \frac{\partial v_z}{\partial z}\right) = -\frac{\partial p}{\partial z} - \left[\frac{1}{r}\frac{\partial}{\partial r}(r\tau_{rz}) + \frac{1}{r}\frac{\partial}{\partial \theta}\tau_{\theta z} + \frac{\partial}{\partial z}\tau_{zz}\right] + \rho g_z \quad \text{(B.5-6)}$$

[b] These equations have been written without making the assumption that $\boldsymbol{\tau}$ is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric, $\tau_{r\theta} - \tau_{\theta r} = 0$.

Spherical coordinates (r, θ, ϕ):[c]

$$\rho\left(\frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_r}{\partial \phi} - \frac{v_\theta^2 + v_\phi^2}{r}\right) = -\frac{\partial p}{\partial r}$$
$$- \left[\frac{1}{r^2}\frac{\partial}{\partial r}(r^2\tau_{rr}) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\tau_{\theta r}\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}\tau_{\phi r} - \frac{\tau_{\theta\theta} + \tau_{\phi\phi}}{r}\right] + \rho g_r \quad \text{(B.5-7)}$$

$$\rho\left(\frac{\partial v_\theta}{\partial t} + v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_\theta}{\partial \phi} + \frac{v_r v_\theta - v_\phi^2 \cot\theta}{r}\right) = -\frac{1}{r}\frac{\partial p}{\partial \theta}$$
$$- \left[\frac{1}{r^3}\frac{\partial}{\partial r}(r^3\tau_{r\theta}) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\tau_{\theta\theta}\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}\tau_{\phi\theta} + \frac{(\tau_{\theta r} - \tau_{r\theta}) - \tau_{\phi\phi}\cot\theta}{r}\right] + \rho g_\theta \quad \text{(B.5-8)}$$

$$\rho\left(\frac{\partial v_\phi}{\partial t} + v_r \frac{\partial v_\phi}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\phi}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi} + \frac{v_\phi v_r + v_\theta v_\phi \cot\theta}{r}\right) = -\frac{1}{r\sin\theta}\frac{\partial p}{\partial \phi}$$
$$- \left[\frac{1}{r^3}\frac{\partial}{\partial r}(r^3\tau_{r\phi}) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}(\tau_{\theta\phi}\sin\theta) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \phi}\tau_{\phi\phi} + \frac{(\tau_{\phi r} - \tau_{r\phi}) + \tau_{\phi\theta}\cot\theta}{r}\right] + \rho g_\phi \quad \text{(B.5-9)}$$

[c] These equations have been written without making the assumption that $\boldsymbol{\tau}$ is symmetric. This means, for example, that when the usual assumption is made that the stress tensor is symmetric, $\tau_{r\theta} - \tau_{\theta r} = 0$.

§B.6 EQUATION OF MOTION FOR A NEWTONIAN FLUID WITH CONSTANT ρ AND μ

$$[\rho D\mathbf{v}/Dt = -\nabla p + \mu\nabla^2\mathbf{v} + \rho\mathbf{g}]$$

Cartesian coordinates (x, y, z):

$$\rho\left(\frac{\partial v_x}{\partial t} + v_x\frac{\partial v_x}{\partial x} + v_y\frac{\partial v_x}{\partial y} + v_z\frac{\partial v_x}{\partial z}\right) = -\frac{\partial p}{\partial x} + \mu\left[\frac{\partial^2 v_x}{\partial x^2} + \frac{\partial^2 v_x}{\partial y^2} + \frac{\partial^2 v_x}{\partial z^2}\right] + \rho g_x \quad \text{(B.6-1)}$$

$$\rho\left(\frac{\partial v_y}{\partial t} + v_x\frac{\partial v_y}{\partial x} + v_y\frac{\partial v_y}{\partial y} + v_z\frac{\partial v_y}{\partial z}\right) = -\frac{\partial p}{\partial y} + \mu\left[\frac{\partial^2 v_y}{\partial x^2} + \frac{\partial^2 v_y}{\partial y^2} + \frac{\partial^2 v_y}{\partial z^2}\right] + \rho g_y \quad \text{(B.6-2)}$$

$$\rho\left(\frac{\partial v_z}{\partial t} + v_x\frac{\partial v_z}{\partial x} + v_y\frac{\partial v_z}{\partial y} + v_z\frac{\partial v_z}{\partial z}\right) = -\frac{\partial p}{\partial z} + \mu\left[\frac{\partial^2 v_z}{\partial x^2} + \frac{\partial^2 v_z}{\partial y^2} + \frac{\partial^2 v_z}{\partial z^2}\right] + \rho g_z \quad \text{(B.6-3)}$$

Cylindrical coordinates (r, θ, z):

$$\rho\left(\frac{\partial v_r}{\partial t} + v_r\frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} + v_z\frac{\partial v_r}{\partial z} - \frac{v_\theta^2}{r}\right) = -\frac{\partial p}{\partial r} + \mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r}(rv_r)\right) + \frac{1}{r^2}\frac{\partial^2 v_r}{\partial \theta^2} + \frac{\partial^2 v_r}{\partial z^2} - \frac{2}{r^2}\frac{\partial v_\theta}{\partial \theta}\right] + \rho g_r \quad \text{(B.6-4)}$$

$$\rho\left(\frac{\partial v_\theta}{\partial t} + v_r\frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + v_z\frac{\partial v_\theta}{\partial z} + \frac{v_r v_\theta}{r}\right) = -\frac{1}{r}\frac{\partial p}{\partial \theta} + \mu\left[\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial}{\partial r}(rv_\theta)\right) + \frac{1}{r^2}\frac{\partial^2 v_\theta}{\partial \theta^2} + \frac{\partial^2 v_\theta}{\partial z^2} + \frac{2}{r^2}\frac{\partial v_r}{\partial \theta}\right] + \rho g_\theta \quad \text{(B.6-5)}$$

$$\rho\left(\frac{\partial v_z}{\partial t} + v_r\frac{\partial v_z}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_z}{\partial \theta} + v_z\frac{\partial v_z}{\partial z}\right) = -\frac{\partial p}{\partial z} + \mu\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial v_z}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 v_z}{\partial \theta^2} + \frac{\partial^2 v_z}{\partial z^2}\right] + \rho g_z \quad \text{(B.6-6)}$$

Spherical coordinates (r, θ, ϕ):

$$\rho\left(\frac{\partial v_r}{\partial t} + v_r\frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_r}{\partial \phi} - \frac{v_\theta^2 + v_\phi^2}{r}\right) = -\frac{\partial p}{\partial r}$$
$$+ \mu\left[\frac{1}{r^2}\frac{\partial^2}{\partial r^2}(r^2 v_r) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial v_r}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_r}{\partial \phi^2}\right] + \rho g_r \quad \text{(B.6-7)}^a$$

$$\rho\left(\frac{\partial v_\theta}{\partial t} + v_r\frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_\theta}{\partial \phi} + \frac{v_r v_\theta - v_\phi^2\cot\theta}{r}\right) = -\frac{1}{r}\frac{\partial p}{\partial \theta}$$
$$+ \mu\left[\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial v_\theta}{\partial r}\right) + \frac{1}{r^2}\frac{\partial}{\partial \theta}\left(\frac{1}{\sin\theta}\frac{\partial}{\partial \theta}(v_\theta\sin\theta)\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_\theta}{\partial \phi^2} + \frac{2}{r^2}\frac{\partial v_r}{\partial \theta} - \frac{2\cot\theta}{r^2\sin\theta}\frac{\partial v_\phi}{\partial \phi}\right] + \rho g_\theta \quad \text{(B.6-8)}$$

$$\rho\left(\frac{\partial v_\phi}{\partial t} + v_r\frac{\partial v_\phi}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\phi}{\partial \theta} + \frac{v_\phi}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi} + \frac{v_\phi v_r + v_\theta v_\phi\cot\theta}{r}\right) = -\frac{1}{r\sin\theta}\frac{\partial p}{\partial \phi}$$
$$+ \mu\left[\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial v_\phi}{\partial r}\right) + \frac{1}{r^2}\frac{\partial}{\partial \theta}\left(\frac{1}{\sin\theta}\frac{\partial}{\partial \theta}(v_\phi\sin\theta)\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_\phi}{\partial \phi^2} + \frac{2}{r^2\sin\theta}\frac{\partial v_r}{\partial \phi} + \frac{2\cot\theta}{r^2\sin\theta}\frac{\partial v_\theta}{\partial \phi}\right] + \rho g_\phi \quad \text{(B.6-9)}$$

[a] The quantity in the brackets in Eq. B.6-7 is *not* what one would expect from Eq. (M) for $[\nabla \cdot \nabla\mathbf{v}]$ in Table A.7-3, because we have added to Eq. (M) the expression for $(2/r)(\nabla \cdot \mathbf{v})$, which is zero for fluids with constant ρ. This gives a much simpler equation.

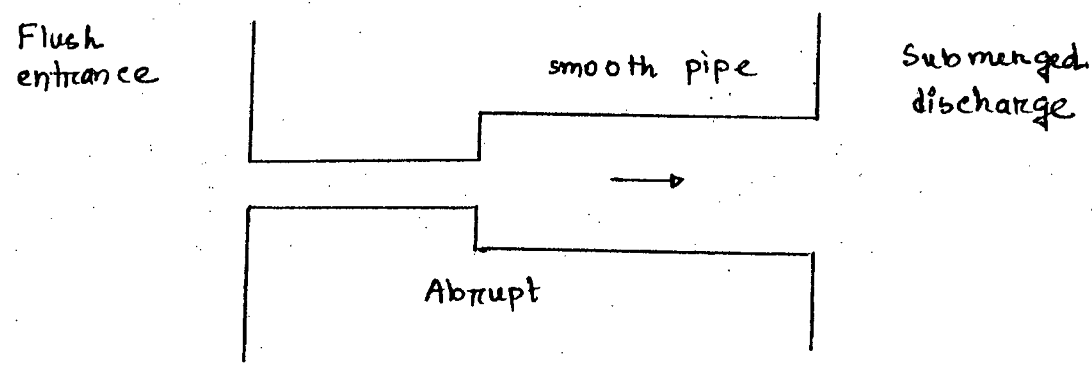


Figure for Q 1 (d)

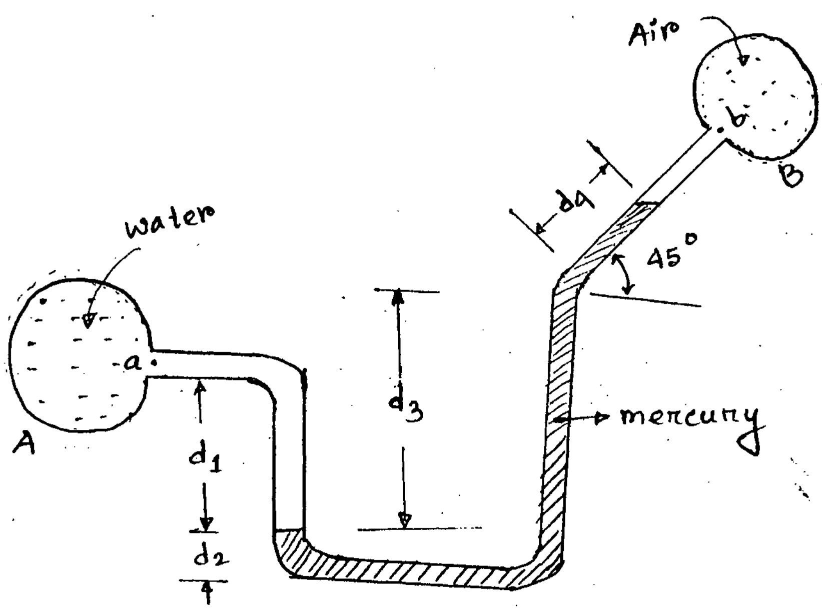


Figure for Q 6 (c)

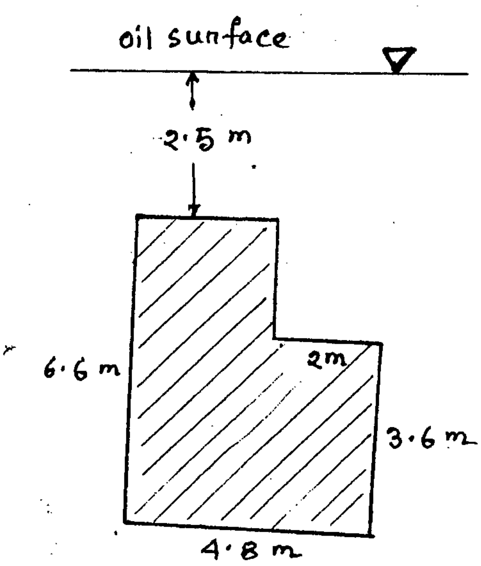


Figure for Q 6 (d)

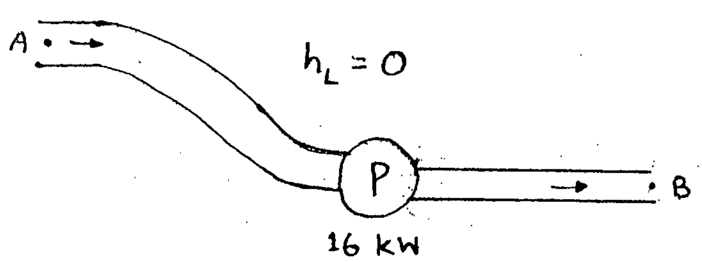


Figure for Q 7 (c)

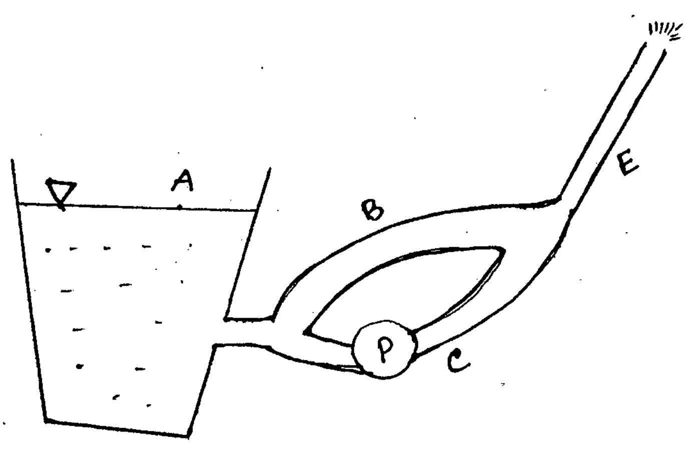


Figure for Q 8 (d)

TABLE A.1 **Physical properties of water at standard sea-level atmospheric pressure**[a]

Temperature, T	Specific weight, γ	Density, ρ	Absolute viscosity,[b] μ	Kinematic viscosity,[b] ν	Surface tension, σ	Saturation vapor pressure, p_v	Satur'n vapor pressure head, p_v/γ	Bulk modulus of elasticity, E_v
°F	lb/ft³	slugs/ft³	10^{-6} lb·sec/ft²	10^{-6} ft²/sec	lb/ft	psia	ft abs	psi
32°F	62.42	1.940	37.46	19.31	0.00518	0.0885	0.204	293,000
40°F	62.43	1.940	32.29	16.64	0.00514	0.122	0.281	294,000
50°F	62.41	1.940	27.35	14.10	0.00509	0.178	0.411	305,000
60°F	62.37	1.938	23.59	12.17	0.00504	0.256	0.592	311,000
70°F	62.30	1.936	20.50	10.59	0.00498	0.363	0.839	320,000
80°F	62.22	1.934	17.99	9.30	0.00492	0.507	1.173	322,000
90°F	62.11	1.931	15.95	8.26	0.00486	0.698	1.618	323,000
100°F	62.00	1.927	14.24	7.39	0.00480	0.949	2.20	327,000
110°F	61.86	1.923	12.84	6.67	0.00473	1.275	2.97	331,000
120°F	61.71	1.918	11.68	6.09	0.00467	1.692	3.95	333,000
130°F	61.55	1.913	10.69	5.58	0.00460	2.22	5.19	334,000
140°F	61.38	1.908	9.81	5.14	0.00454	2.89	6.78	330,000
150°F	61.20	1.902	9.05	4.76	0.00447	3.72	8.75	328,000
160°F	61.00	1.896	8.38	4.42	0.00441	4.74	11.18	326,000
170°F	60.80	1.890	7.80	4.13	0.00434	5.99	14.19	322,000
180°F	60.58	1.883	7.26	3.85	0.00427	7.51	17.84	318,000
190°F	60.36	1.876	6.78	3.62	0.00420	9.34	22.28	313,000
200°F	60.12	1.868	6.37	3.41	0.00413	11.52	27.59	308,000
212°F	59.83	1.860	5.93	3.19	0.00404	14.69	35.36	300,000
°C	kN/m³	kg/m³	N·s/m²	10^{-6} m²/s	N/m	kN/m² abs	m abs	10^6 kN/m²
0°C	9.805	999.8	0.001781	1.785	0.0756	0.611	0.0623	2.02
5°C	9.807	1000.0	0.001518	1.519	0.0749	0.872	0.0889	2.06
10°C	9.804	999.7	0.001307	1.306	0.0742	1.230	0.1255	2.10
15°C	9.798	999.1	0.001139	1.139	0.0735	1.710	0.1745	2.14
20°C	9.789	998.2	0.001002	1.003	0.0728	2.34	0.239	2.18
25°C	9.777	997.0	0.000890	0.893	0.0720	3.17	0.324	2.22
30°C	9.765	995.7	0.000798	0.800	0.0712	4.24	0.434	2.25
40°C	9.731	992.2	0.000653	0.658	0.0696	7.38	0.758	2.28
50°C	9.690	988.0	0.000547	0.553	0.0679	12.33	1.272	2.29
60°C	9.642	983.2	0.000466	0.474	0.0662	19.92	2.07	2.28
70°C	9.589	977.8	0.000404	0.413	0.0644	31.16	3.25	2.25
80°C	9.530	971.8	0.000354	0.364	0.0626	47.34	4.97	2.20
90°C	9.467	965.3	0.000315	0.326	0.0608	70.10	7.40	2.14
100°C	9.399	958.4	0.000282	0.294	0.0589	101.33	10.78	2.07

[a] In these tables, if (for example, at 32°F) μ is given as 37.46 and the units are 10^{-6} lb·sec/ft² then $\mu = 37.46 \times 10^{-6}$ lb·sec/ft².
[b] For viscosity, see also Figs. A.1 and A.2.

TABLE A.4 **Physical properties of common liquids at standard sea-level atmospheric pressure[a]**

Liquid	Temperature, T	Density, ρ	Specific gravity,[b] s	Absolute viscosity,[c] μ	Surface tension, σ	Vapor pressure, p_v	Bulk modulus of elasticity, E_v	Specific heat, c
	°F	slug/ft³	—	10^{-6} lb·sec/ft²	lb/ft	psia	psi	ft·lb/(slug·°R) = ft²/(sec²·°R)
Benzene	68°F	1.70	0.88	14.37	0.0020	1.45	150,000	10,290
Carbon tetrachloride	68°F	3.08	1.594	20.35	0.0018	1.90	160,000	5,035
Crude oil	68°F	1.66	0.86	150	0.002	—	—	—
Gasoline	68°F	1.32	0.68	6.1	—	8.0	—	12,500
Glycerin	68°F	2.44	1.26	31,200	0.0043	0.000002	630,000	14,270
Hydrogen	−430°F	0.143	0.074	0.435	0.0002	3.1	—	—
Kerosene	68°F	1.57	0.81	40	0.0017	0.46	—	12,000
Mercury	68°F	26.3	13.56	33	0.032	0.000025	3,800,000	834
Oxygen	−320°F	2.34	1.21	5.8	0.001	3.1	—	~5,760
SAE 10 oil	68°F	1.78	0.92	1,700	0.0025	—	—	—
SAE 30 oil	68°F	1.78	0.92	9,200	0.0024	—	—	—
Fresh water	68°F	1.936	0.999	21.0	0.0050	0.34	318,000	25,000
Seawater	68°F	1.985	1.024	22.5	0.0050	0.34	336,000	23,500
	°C	kg/m³	—	10^{-3} N·s/m²	N/m	kN/m² abs	10^6 N/m²	N·m/(kg·K) = m²/(s²·K)
Benzene	20°C	876	0.88	0.65	0.029	10.0	1030	1720
Carbon tetrachloride	20°C	1588	1.594	0.97	0.026	13.1	1100	842
Crude oil	20°C	856	0.86	7.2	0.03	—	—	—
Gasoline	20°C	680	0.68	0.29	—	55.2	—	2100
Glycerin	20°C	1258	1.26	1494	0.063	0.000014	4344	2386
Hydrogen	−257°C	73.7	0.074	0.021	0.0029	21.4	—	—
Kerosene	20°C	808	0.81	1.92	0.025	3.20	—	2000
Mercury	20°C	13550	13.56	1.56	0.51	0.00017	26200	139.4
Oxygen	−195°C	1206	1.21	0.278	0.015	21.4	—	~964
SAE 10 oil	20°C	918	0.92	82	0.037	—	—	—
SAE 30 oil	20°C	918	0.92	440	0.036	—	—	—
Fresh water	20°C	998	0.999	1.00	0.073	2.34	2171	4187
Seawater	20°C	1023	1.024	1.07	0.073	2.34	2300	3933

[a] In these tables, if (for example, for benzene at 68°F) μ is given as 1.437 and the units are 10^{-6} lb·sec/ft² then $\mu = 1.437 \times 10^{-6}$ lb·sec/ft².
[b] Relative to pure water at 60°F.
[c] For viscosity, see also Figs. A.1 and A.2.

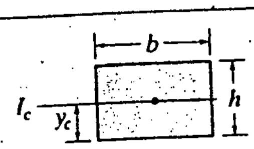
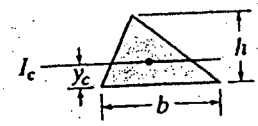
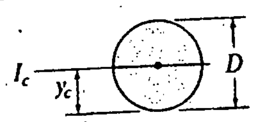
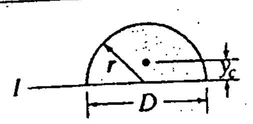
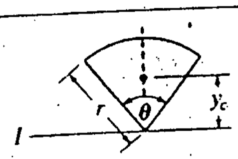
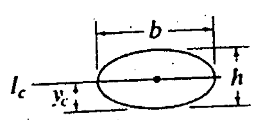
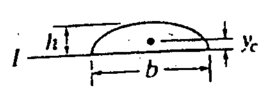
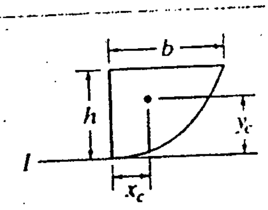
TABLE A.5 **Physical properties of common gases at standard sea-level atmospheric pressure**[a]

Gas	Chemical formula	Molar mass, M	Density, ρ	Absolute viscosity,[b] μ	Gas constant, R	Specific heat, c_p	Specific heat, c_v	Specific heat ratio, $k = c_p/c_v$
at 68°F	—	slug/slug-mol	slug/ft³	10^{-6} lb·sec/ft²	ft·lb/(slug·°R) = ft²/(sec²·°R)	ft·lb/(slug·°R) = ft²/(sec²·°R)		—
Air		28.96	0.002 31	0.376	1,715	6,000	4,285	1.40
Carbon dioxide	CO_2	44.01	0.003 54	0.310	1,123	5,132	4,009	1.28
Carbon monoxide	CO	28.01	0.002 26	0.380	1,778	6,218	4,440	1.40
Helium	He	4.003	0.000 323	0.411	12,420	31,230	18,810	1.66
Hydrogen	H_2	2.016	0.000 162	0.189	24,680	86,390	61,710	1.40
Methane	CH_4	16.04	0.001 29	0.280	3,100	13,400	10,300	1.30
Nitrogen	N_2	28.02	0.002 26	0.368	1,773	6,210	4,437	1.40
Oxygen	O_2	32.00	0.002 58	0.418	1,554	5,437	3,883	1.40
Water vapor	H_2O	18.02	0.001 45	0.212	2,760	11,110	8,350	1.33
at 20°C	—	kg/kg-mol	kg/m³	10^{-6} N·s/m²	N·m/(kg·K) = m²/(s²·K)	N·m/(kg·K) = m²/(s²·K)		—
Air		28.96	1.205	18.0	287	1003	716	1.40
Carbon dioxide	CO_2	44.01	1.84	14.8	188	858	670	1.28
Carbon monoxide	CO	28.01	1.16	18.2	297	1040	743	1.40
Helium	He	4.003	0.166	19.7	2077	5220	3143	1.66
Hydrogen	H_2	2.016	0.0839	9.0	4120	14 450	10 330	1.40
Methane	CH_4	16.04	0.668	13.4	520	2250	1730	1.30
Nitrogen	N_2	28.02	1.16	17.6	297	1040	743	1.40
Oxygen	O_2	32.00	1.33	20.0	260	909	649	1.40
Water vapor	H_2O	18.02	0.747	10.1	462	1862	1400	1.33

[a] In these tables, if (for example, for air at 68°F) μ is given as 0.376 and the units are 10^{-6} lb·sec/ft² then $\mu = 0.376 \times 10^{-6}$ lb·sec/ft².

[b] For viscosity, see also Figs. A.1 and A.2. Absolute viscosity μ is virtually independent of pressure, whereas kinematic viscosity ν varies with pressure (density) (Sec. 2.11).

TABLE A.7 Properties of areas

Shape	Sketch	Area	Location of centroid	I_c or $I = I_c + Ay_c^2$
Rectangle		bh	$y_c = \frac{h}{2}$	$I_c = \frac{bh^3}{12}$
Triangle		$\frac{bh}{2}$	$y_c = \frac{h}{3}$	$I_c = \frac{bh^3}{36}$
Circle		$\frac{\pi D^2}{4}$	$y_c = \frac{D}{2}$	$I_c = \frac{\pi D^4}{64}$
Semicircle		$\frac{\pi D^2}{8}$	$y_c = \frac{4r}{3\pi}$	$I = \frac{\pi D^4}{128}$
Circular sector		$\frac{\theta r^2}{2}$	$y_c = \frac{4r}{3\theta}\sin\frac{\theta}{2}$	$I = \frac{r^4}{8}(\theta + \sin\theta)$
Ellipse		$\frac{\pi bh}{4}$	$y_c = \frac{h}{2}$	$I_c = \frac{\pi bh^3}{64}$
Semiellipse		$\frac{\pi bh}{4}$	$y_c = \frac{4h}{3\pi}$	$I = \frac{\pi bh^3}{16}$
Parabola		$\frac{2bh}{3}$	$x_c = \frac{3b}{8}$ $y_c = \frac{3h}{5}$	$I = \frac{2bh^3}{7}$

-14-

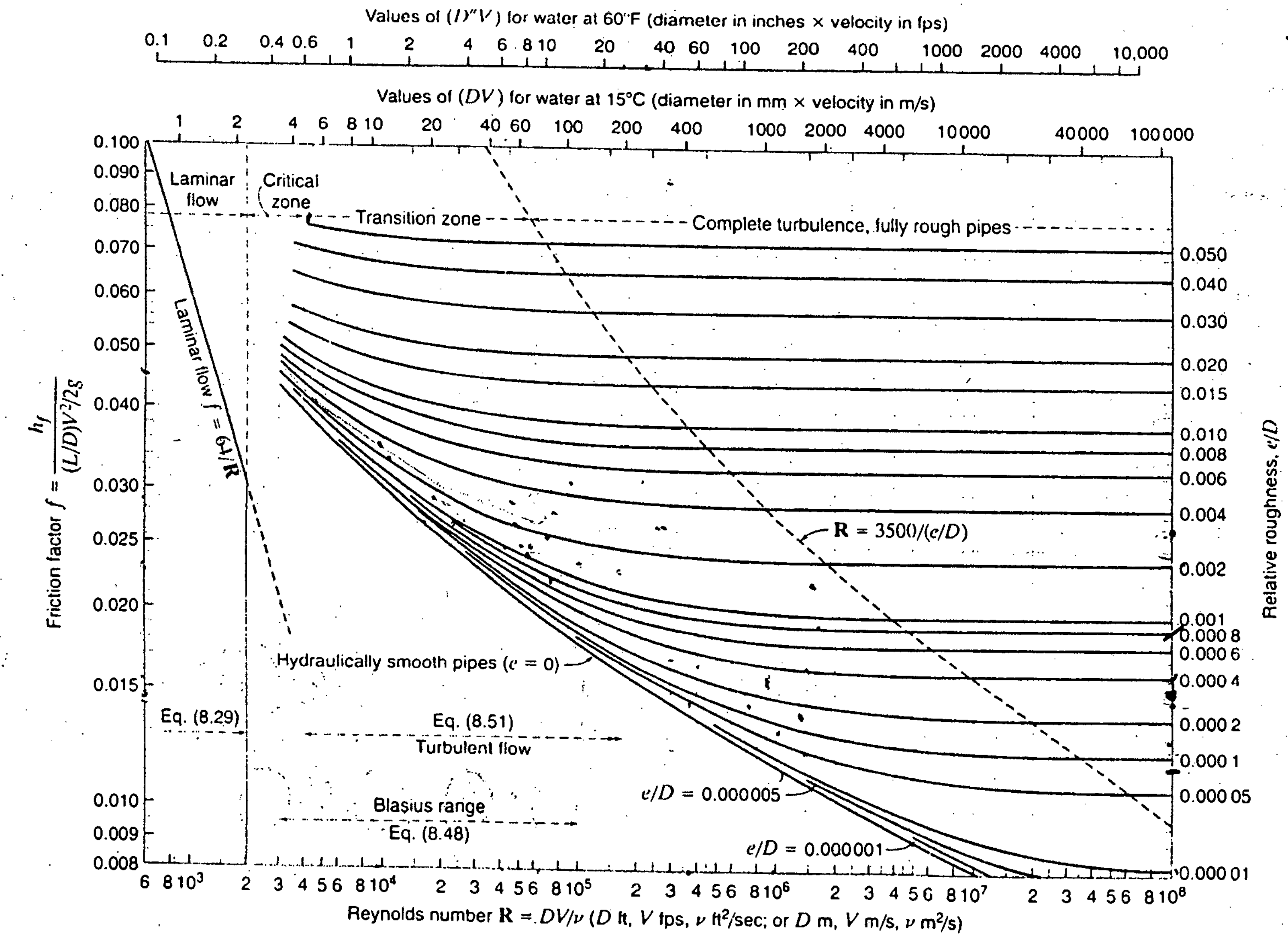


Figure 8.11
Moody chart for pipe friction factor (Stanton diagram).

kaniz fatema
25.9.13

L-2/T-2/CHE Date : 22/07/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **HUM 103** (Economics)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What is meant by production possibility frontier (PPF)? Explain how resources can be allocated in a society with the help of PPF. **(20)**

   (b) Describe three applications of production possibility frontier. **(15)**

2. (a) Critically analyse the concept of optimization. **(5)**

   (b) Given the following total revenue (TR) and total cost (TC) functions for a firm **(10)**

$$TR = 1000Q - 2Q^2$$
$$TC = Q^3 - 59Q^2 + 1315Q + 2000$$

   (i) Set up the profit function,
   (ii) Find the critical value(s) and
   (iii) Calculate the maximum profit.

   (c) Discuss the various difficulties of measuring national income. **(10)**

   (d) Show that an economy's growth rate is directly related to its savings ratio and inversely related to its capital-output ratio. **(10)**

3. (a) Define aggregate demand and aggregate supply. Point out the factors that can change the aggregate demand and aggregate supply. **(8)**

   (b) How will you determine macroeconomic equilibrium with the help of aggregate demand and aggregate supply? **(8)**

   (c) Distinguish between demand pull and cost push inflation. Make a comparison between the effects of demand pull and cost push inflation. **(9)**

   (d) Given that **(10)**

   GNP = Tk. 1,03,000 crore
   Depreciation = Tk. 8,500 crore
   Indirect tax = Tk. 12,000 crore
   Subsidy is 20% of indirect tax.
   Calculate national income.

4. (a) Explain any two characteristics of a least developed country like Bangladesh. **(5)**

   (b) Briefly discuss the theories of economic development. **(15)**

   (c) What is meant by investment? Briefly narrate the criteria for making an investment decision. **(15)**

Contd P/2

HUM 103

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define demand function. From the following demand function, make a hypothetical demand schedule and plot the curve. **(10)**

$$Q = 60 - 15P + P^2$$

(b) What are the main determinants of demand? Explain them. **(10)**

(c) What are the exceptions to the law of demand? Explain them. **(10)**

(d) Why do demand curves slope downward? **(5)**

6. (a) How is price determined in an economy under competition? Explain graphically. **(10)**

(b) What will happen to the equilibrium price and quantity due to change in supply? **(10)**

(c) From the following demand and supply functions, calculate equilibrium price and equilibrium quantity and show the result in a graph. **(15)**

SS: $P = 0.1Q + 10$

DD: $P = -0.5Q + 50$

If the demand function changes to

DD: $P = -0.6Q + 36$

then what will be the new equilibrium price and quantity? Plot the coordinates on the graph and describe the change in equilibrium points on the graph.

7. (a) What are the properties of an indifference curve? Explain them. **(10)**

(b) How would you measure price elasticity of demand at any point on a straight line demand curve? Explain graphically. **(15)**

(c) From the following table, calculate elasticity of demand if you move from point A to C and explain what you understand from the result. **(10)**

Point	Y	Q
A	5000	950
B	7000	900
C	9000	800

8. (a) What is meant by development? Explain. **(5)**

(b) Explain the concept of vicious circle of poverty. Discuss the demand side and supply side of vicious circle of poverty. **(15)**

(b) Briefly discuss the strategy of Balanced growth with reference to a least developed country like Bangladesh. **(15)**

L-2/T-2/CHE

Date : 28/09/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **ME 243** (Mechanics of Solids)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Notations have their usual meanings.

1. (a) The rigid platform in Fig. for Q. 1(a) has negligible mass and rests on two steel bars, each 250.0 mm long. The center bar is of aluminium and 249.9 mm long. Calculate the stress in the aluminium bar after the center load P = 400 kN has been applied. Cross-sectional area and modulus of elasticity of each steel bar are 1200 mm^2 and 200 GPa, respectively, and that of aluminium bar are 2400 mm^2 and 70 GPa. **(15)**

   (b) Sketch the Mohr's circle for a state of plane stress $\sigma_x = 9$ Pa, $\sigma_y = 3$ Pa and $\tau_{xy} = 4$ Pa. Hence find the principal stresses and show them on properly oriented elements. **(20)**

2. (a) Calculate the thickness of metal plate necessary to form a cylindrical shell of internal diameter 30 cm to withstand an internal pressure of 20 MPa. The permissible tensile stress in the material is 60 MPa. Assume the shell as thick walled and check whether the assumption is valid. **(12)**

   (b) Derive the Euler's column formula and lists the necessary assumptions for the derivation. **(15)**

   (c) A column with both ends fixed has a cross-section of 5 cm × 10 cm and a length of 4 m. Is it a Euler's column? Give reason for your answer. **(8)**

3. (a) A solid shaft is subjected to torques as shown in Fig. for Q. 3(a). Determine the required diameter of the shaft if the limiting shear stress is 60 MPa and limiting angular deformation at the free end is 4^0. Use G = 82 GN/m^2. **(17)**

   (b) Derive the expression for deflection of a close coiled helical spring and lists the necessary assumptions. Hence show that torsional deflection is much larger than shear deflection. **(18)**

4. (a) Show that hoop stress is twice the longitudinal stress in a thin walled cylindrical pressure vessel. **(10)**

   (b) Using Hooke's law for triaxial stress, prove that $\sigma_r+\sigma_t$ = constant for a thick walled cylindrical pressure vessel. **(15)**

   (c) Describe the nature of induced stresses by cooling or heating a metallic bar whose ends are attached to rigid supports. **(10)**

Contd P/2

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Write shear force and bending moment equations for the beam shown in Fig. 5(a). Also, draw the shear force and bending moment diagrams for the same beam and specify the values at all change of loading positions and at all points of zero shear. Neglect the mass of the beam. **(15)**

   (b) The T-section shown in Fig. 5(b) is the cross-section of a beam formed by joining two rectangular pieces of wood. The beam is subjected to a maximum shearing force of 60 kN. Determine the shearing stress at (i) the neutral axis and (ii) the junction between the two pieces of wood. **(20)**

6. (a) Using the method of integration, determine the maximum deflection in a simply supported beam of length L carrying a uniformly distributed load of intensity w_0 applied over its entire length. What is the slope at the midpoint of the beam? **(15)**

   (b) The cantilever beam shown in Fig. 6(b) has a rectangular cross-section of width 50 mm ~~m~~ and height h mm. Find the height h if the maximum deflection is not to exceed 10 mm. Assume E = 10 GPa. Solve the problem by area moment method. **(20)**

7. (a) The dimensions of a reinforced concrete beam are b = 300 mm, d = 450 mm, A_s = 1400 mm^2, and n = 8. If the allowable stresses are $f_c \leq 12$ MPa and $f_s \leq 140$ MPa, determine the maximum bending moment that may be applied. In what state of reinforcement is the beam? **(15)**

   (b) The cross-sections of a ring is the T section as shown in Fig. 7(b). The inside diameter of the ring is 396.24 mm. Determine the value of P that will cause a maximum stress of 124.15 MPa. **(20)**

8. (a) Briefly discuss one of the failure theories you think suitable for each of the following materials (i) ductile, (ii) brittle. **(10)**

   (b) What is Castigliano's theorem? **(5)**

   (c) A cantilever beam of uniform cross-section A and length L is subjected to the loading as shown in Fig. 8(c). The Young's modulus, shear modulus, area moment of inertia, and polar moment of inertia of the beam are E, G, I, and J, respectively. (i) What is the total strain energy stored in the beam? (ii) What is the vertical deflection at the tip of the beam? **(15+5)**

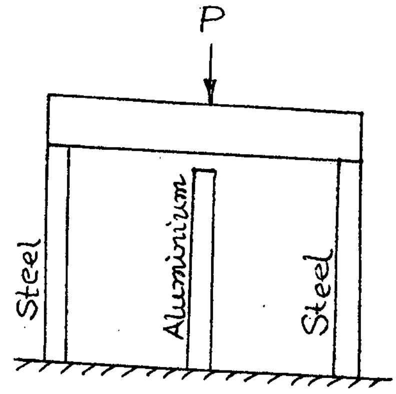


Fig. for Q.1(a)

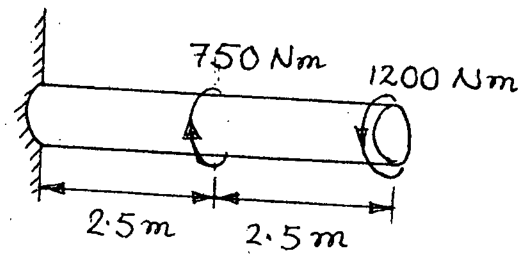


Fig. for Q.3(a)

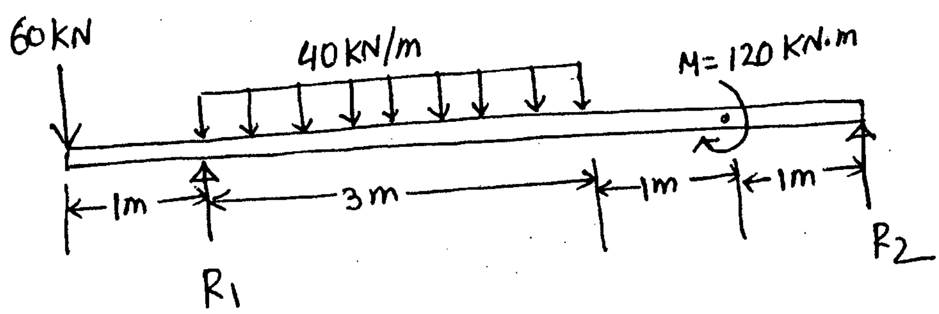


Fig. 5(a)

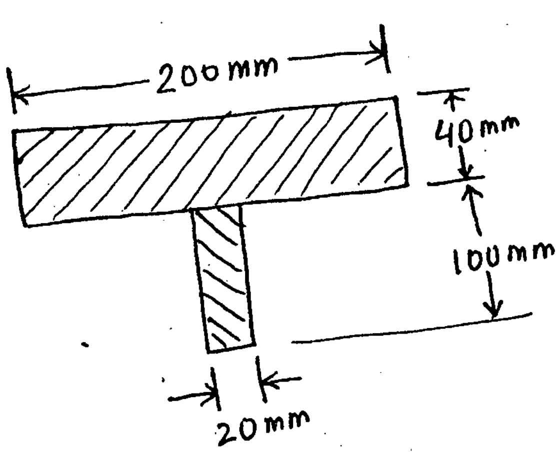


Fig. 5(b)

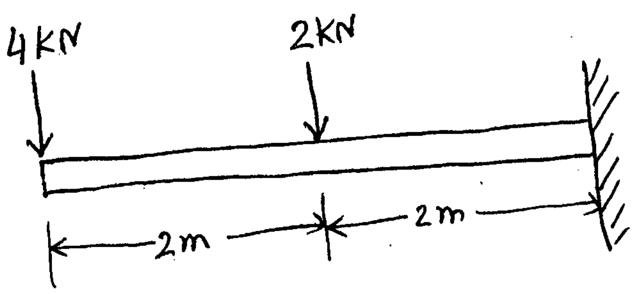


Fig. 6(b)

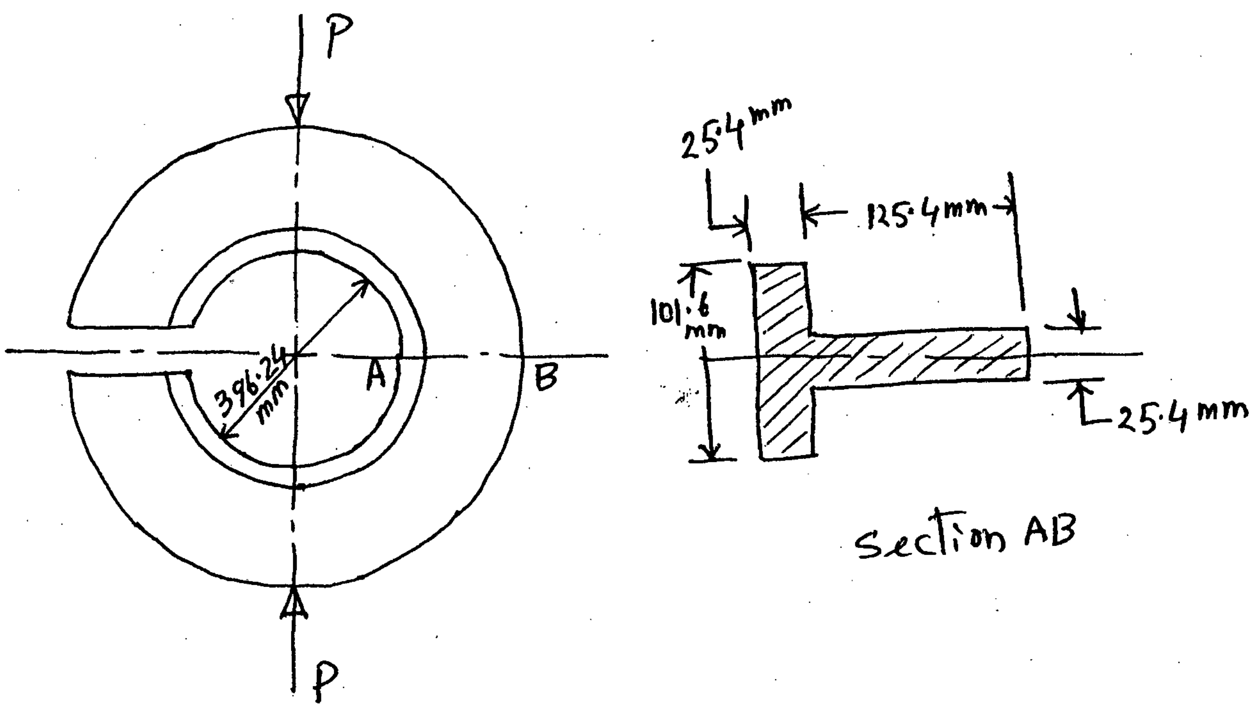


Fig. 7(b)

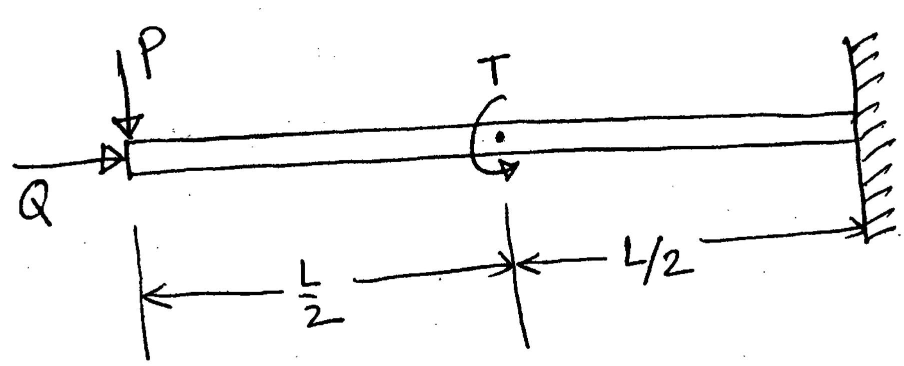


Fig. 8(C)

L-2/T-2/CHE Date : 05/10/2013

Hahm 05-10-13

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **MATH 223** (Numerical Analysis and Statistics)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Derive Newton's forward interpolation formula. Hence obtain the inverse interpolation formula by successive approximation. **(18)**

(b) Find the equation of the curve passing through the points (1,3), (2,7), (4, 21), (5, 31), (7, 57) and (8, 73) using Newton's general interpolation formula. **(17)**

2. (a) Derive inverse interpolation formula from Lagrange formula and hence obtain the value of x for y = 70 from the following table. **(18)**

x	2	5	8	14
y	94.8	87.9	81.3	68.7

(b) The values of x and y are tabulated below. **(17)**

x	0	1	3	6
y	18	10	−18	90

Evaluate $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at $x = 5$.

3. (a) Discuss Gauss quadrature method to evaluate the integral $\int_a^b f(x)dx$. **(17)**

(b) Evaluate $\int_0^2 \frac{e^{\sqrt{x}}}{\sqrt{1+x^3}}dx$ by Simpson's $\frac{3}{8}$ rule taking 12 subintervals. **(18)**

4. Discuss Newton-Raphson method to solve the simultaneous equations $\phi(x, y) = 0$, $\psi(x, y) = 0$. Use this method to find the roots of the equations **(35)**

$$x^2 + xy = 6$$

$$x^2 - y^2 = 3$$

Assume the initial guesses as $x_0 = 1$ and $y_0 = 1$.

Contd P/2

MATH 223

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Solve $\frac{dy}{dx} = x^2 + y^2$, $y(0) = 0$ by Picard's method to find $y(0.4)$ taking step 0.2. **(20)**

(b) Using Runge-Kutta method of fourth order, solve the differential equation $\frac{dy}{dx} = \frac{y^2 - x^2}{x^2 + y^2}$, $y(0.2) = 1.1959$, to find $y(0.4)$ taking $h = 0.2$. **(15)**

6. (a) An incomplete distribution is given below: **(18)**

Marks	10–20	20–30	30–40	40–50	50–60	60–70	70–80
No. of students	11	31	?	67	?	24	21

Given that the median value is 45 and the total frequency is 230.

(i) Using the median formula fill up the missing frequencies.

(ii) Calculate the modal value of completed table. Hence comment on the shape of the frequency distribution.

(b) The heights of university students are assumed to be normal random variable. It is known that 10% of the students have heights under 65 inches and 25% exceed 75 inches. What percentage of students has heights between 60 and 74 inches? (Necessary chart 1 is attached). **(17)**

7. (a) Fifteen students were asked to indicate how many hours they had studied before taking their statistics examination. Their responses were then matched with their grades on the exam, which had a maximum score of 100. **(18)**

Hours, X	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25	3.50	3.75	4.00
Scores, Y	57	64	59	68	74	76	79	83	85	86	88	89	90	94	96

(i) Find the regression equation that will predict a student's score if we know how many hours the students has studied.

(ii) Also comment on the correlation of the above mentioned data. If a student has studied 0.25 hours, what is his predicted score?

(b) One prominent physician claims that 25% of those with lung cancer are chain smokers. If his assertion is correct, find the probability that of (i) 6 and (ii) 14 such patients recently admitted to a hospital, fewer than half are chain smokers, using binomial distribution and Poisson approximation to the binomial distribution. **(17)**

Contd P/3

MATH 223

8. (a) Suppose that the measured voltage in a certain electric circuit has a normal distribution with mean 120 and standard deviation 2. If 3 independent measurements of the voltage are made, what is the possibility that all three measurements will lie between 116 and 118? **(10)**

(b) The probability that a married man watches a certain TV show is 0.25 and the married woman watches the show is 0.35. A study revealed that for couples where the husband watches the program regularly, 80% of the wives also watch regularly. Find

(i) the probability that a married couple watches the show.

(ii) the probability that a husband watches the show given that his wife does not.

(c) The mean weekly sale of the BD chocolate bar in candy stores was 153.7 bars per store. After an advertising campaign, the mean weekly sale in 29 stores for a typical week increased to 169.4 and showed a standard deviation of 19.7. Was the advertising successful? Use a 5% level of significance. (Necessary chart 2 is attached). **(10)**

Chart-2 for Q. No. 8(c)

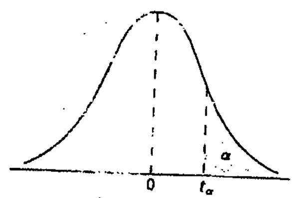


TABLE A.4 Critical Values of the t-Distribution

v	0.40	0.30	0.20	0.15	0.10	0.05	0.025
				α			
1	0.325	0.727	1.376	1.963	3.078	6.314	12.706
2	0.289	0.617	1.061	1.386	1.886	2.920	4.303
3	0.277	0.584	0.978	1.250	1.638	2.353	3.182
4	0.271	0.569	0.941	1.190	1.533	2.132	2.776
5	0.267	0.559	0.920	1.156	1.476	2.015	2.571
6	0.265	0.553	0.906	1.134	1.440	1.943	2.447
7	0.263	0.549	0.896	1.119	1.415	1.895	2.365
8	0.262	0.546	0.889	1.108	1.397	1.860	2.306
9	0.261	0.543	0.883	1.100	1.383	1.833	2.262
10	0.260	0.542	0.879	1.093	1.372	1.812	2.228
11	0.260	0.540	0.876	1.088	1.363	1.796	2.201
12	0.259	0.539	0.873	1.083	1.356	1.782	2.179
13	0.259	0.537	0.870	1.079	1.350	1.771	2.160
14	0.258	0.537	0.868	1.076	1.345	1.761	2.145
15	0.258	0.536	0.866	1.074	1.341	1.753	2.131
16	0.258	0.535	0.865	1.071	1.337	1.746	2.120
17	0.257	0.534	0.863	1.069	1.333	1.740	2.110
18	0.257	0.534	0.862	1.067	1.330	1.734	2.101
19	0.257	0.533	0.861	1.066	1.328	1.729	2.093
20	0.257	0.533	0.860	1.064	1.325	1.725	2.086
21	0.257	0.532	0.859	1.063	1.323	1.721	2.080
22	0.256	0.532	0.858	1.061	1.321	1.717	2.074
23	0.256	0.532	0.858	1.060	1.319	1.714	2.069
24	0.256	0.531	0.857	1.059	1.318	1.711	2.064
25	0.256	0.531	0.856	1.058	1.316	1.708	2.060
26	0.256	0.531	0.856	1.058	1.315	1.706	2.056
27	0.256	0.531	0.855	1.057	1.314	1.703	2.052
28	0.256	0.530	0.855	1.056	1.313	1.701	2.048
29	0.256	0.530	0.854	1.055	1.311	1.699	2.045
30	0.256	0.530	0.854	1.055	1.310	1.697	2.042
40	0.255	0.529	0.851	1.050	1.303	1.684	2.021
60	0.254	0.527	0.848	1.045	1.296	1.671	2.000
120	0.254	0.526	0.845	1.041	1.289	1.658	1.980
∞	0.253	0.524	0.842	1.036	1.282	1.645	1.960

TABLE A.4 (continued) Critical Values of the t-Distribution

v	0.02	0.015	0.01	0.0075	0.005	0.0025	0.0005
				α			
1	15.895	21.205	31.821	42.434	63.657	127.322	636.590
2	4.849	5.643	6.965	8.073	9.925	14.089	31.598
3	3.482	3.896	4.541	5.047	5.841	7.453	12.924
4	2.999	3.298	3.747	4.088	4.604	5.598	8.610
5	2.757	3.003	3.365	3.634	4.032	4.773	6.869
6	2.612	2.829	3.143	3.372	3.707	4.317	5.959
7	2.517	2.715	2.998	3.203	3.499	4.029	5.408
8	2.449	2.634	2.896	3.085	3.355	3.833	5.041
9	2.398	2.574	2.821	2.998	3.250	3.690	4.781
10	2.359	2.527	2.764	2.932	3.169	3.581	4.587
11	2.328	2.491	2.718	2.879	3.106	3.497	4.437
12	2.303	2.461	2.681	2.836	3.055	3.428	4.318
13	2.282	2.436	2.650	2.801	3.012	3.372	4.221
14	2.264	2.415	2.624	2.771	2.977	3.326	4.140
15	2.249	2.397	2.602	2.746	2.947	3.286	4.073
16	2.235	2.382	2.583	2.724	2.921	3.252	4.015
17	2.224	2.368	2.567	2.706	2.898	3.222	3.965
18	2.214	2.356	2.552	2.689	2.878	3.197	3.922
19	2.205	2.346	2.539	2.674	2.861	3.174	3.883
20	2.197	2.336	2.528	2.661	2.845	3.153	3.849
21	2.189	2.328	2.518	2.649	2.831	3.135	3.819
22	2.183	2.320	2.508	2.639	2.819	3.119	3.792
23	2.177	2.313	2.500	2.629	2.807	3.104	3.768
24	2.172	2.307	2.492	2.620	2.797	3.091	3.745
25	2.167	2.301	2.485	2.612	2.787	3.078	3.725
26	2.162	2.296	2.479	2.605	2.779	3.067	3.707
27	2.158	2.291	2.473	2.598	2.771	3.057	3.690
28	2.154	2.286	2.467	2.592	2.763	3.047	3.674
29	2.150	2.282	2.462	2.586	2.756	3.038	3.659
30	2.147	2.278	2.457	2.581	2.750	3.030	3.646
40	2.125	2.250	2.423	2.542	2.704	2.971	3.551
60	2.099	2.223	2.390	2.504	2.660	2.915	3.460
120	2.076	2.196	2.358	2.468	2.617	2.860	3.373
∞	2.054	2.170	2.326	2.432	2.576	2.807	3.291

Chart-1 for Q. No. 6(b)

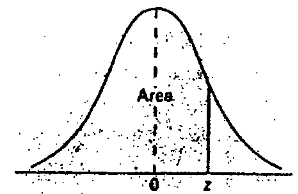


TABLE A.3 Areas Under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
−3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
−3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
−3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0352	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0722	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

TABLE A.3 (continued) Areas Under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9278	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

L-2/T-2/CHE **Date : 21/09/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **CHEM 221** (Organic Chemistry)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

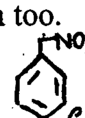
SECTION – A

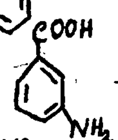
There are **FOUR** questions in this section. Answer any **THREE**.

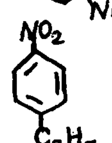
1. (a) What are Fridel Craft's alkylation and acylation reaction? Discuss their mechanism. **(7+7)**

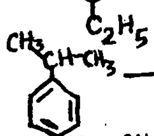
(b) How can you synthesize cumene and propyl benzene from benzene? **(4+5)**

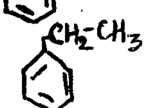
(c) Complete the following reactions showing only the main products. Give reason and name them too. **(2+4+6)**

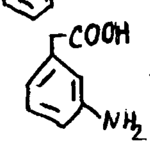
(i)  $+ CH_3CH_2Cl \xrightarrow{AlCl_3}$

(ii)  $\xrightarrow[Br_2]{HCl}$

(iii)  $\xrightarrow[Br_2]{Fe}$

(iv)  $\xrightarrow[\Delta,\ H^+]{Na_2Cr_2O_7}$

(v)  $\xrightarrow[\Delta]{KMnO_4,\ H^+}$

(vi)  $\xrightarrow{I-Cl}$

2. (a) What are heterocyclic compounds? Give the classification of heterocyclic compounds. **(7)**

(b) Describe a general method of synthesis for pyrrole, furan and thiophene and also give a commercial method of synthesis for each one of them. **(4+9)**

(c) How would you bring the following conversions? **(5×3=15)**

(i) 2, 3, 4, 5-Tetrachloropyrrole from pyrrole
(ii) Pyrrolidine from pyrrole
(iii) 2-Lithium thiophene from thiophene
(iv) n-Butane from thiophene
(v) Tetrahydrofuran from furan

Contd P/2

3. (a) What is indigo? Give a commercial method for the synthesis of indigo. **(2+5)**

(b) What happens when indigo is treated with (i) NaOH and (ii) HNO_3 **(4)**

(c) Discuss how the structure of pyridine was confirmed? **(9)**

(d) How are the following conversions carried out? Write with reactions. **(3×5=15)**

(i) 2-Aminopyridine from pyridine

(ii) Quinoliniumchloride from quinoline

(iii) 2-Hydroxyquinoline from quinoline

(iv) Decahydroisoquinoline from isoquinoline

(v) Octahydroindole from indole

4. (a) What are alkaloids? Give classification of alkaloids. **(2+7)**

(b) State Hofmann's rule for exhaustive methylation. Apply the rule to piperidine and predict the products. **(2+8)**

(c) How can you isolate the alkaloid nicotine from the tobacco plant Nicotiana tabaccum? **(7)**

(d) Briefly discuss how the structure of nicotine was established. **(9)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Write a structural formula for each of the following: **(4)**

(i) 3-Hexen-1-yne, (ii) (E)-2-Bromo-1-Chloro-1-fluoroethene, (iii) (Z)-3-Methyl-3-hexene, (iv) Allene.

(b) Show the energy relations of the different conformations of butane and draw Newman projections for the anti and fully eclipsed conformations of butane. **(6)**

(c) Give the synthesis of alkene by using Witting reaction with mechanism. **(8)**

(d) Write the structures and names of the products expected from the reaction of 2-methylpropene with: **(12)**

(i) O_3 followed by H_2O_2 with H^+,

(ii) $KMnO_4$(aq) with OH^-(cold)

(iii) Br_2, H_2O

(e) Starting with ethyne, outline synthesis of 2-Hexyne. **(5)**

Contd P/3

CHEM 221

6. (a) What are the factors that favour SN^1 versus SN^2 reactions? **(5)**

(b) Which product (or products) would you expect to obtain from each of the following reactions? In each part give the mechanism (SN^1, SN^2, E1, or E2) by which each product is formed and predict the relative amount of each product. **(18)**

(i) $CH_3CH(Br)CH_3 + CH_3CH_2ONa \xrightarrow[55^\circ C]{C_2H_5OH}$

(ii) $(CH_3)_3CCl + H_2O \rightarrow$

(c) Give the products that would be formed when each of the following alcohols is subjected to acid-catalyzed dehydration: (i) 3-Methyl-2-butanol (ii) 2-Methyl-2-propanol. **(6)**

(d) Give the major and minor products of the dehydrohalogenatin of alkylhalides: **(6)**

(i) $CH_3CH_2CH(Br)CH_3 \xrightarrow[C_2H_5OH,\ 25^\circ C]{C_2H_5ONa}$

(ii) $CH_3CH_2CH(Br)CH_3 \xrightarrow[(CH_3)_3COH,\ 70^\circ C]{(CH_3)_3COK}$

7. (a) Give the classification of Lipids. **(6)**

(b) What are the importances of Lipids in biological processes? **(6)**

(c) What do you mean by pheromones and steroids? Give their examples with structure. **(8)**

(d) Give the methods of preparation of aniline from benzene and benzoic acid. **(4+4)**

(e) Explain why chlorine acts as ortho and para director, where as- COOH acts as meta director. **(7)**

8. (a) What are organohalo benzene compounds? How can you classify them? Give three methods of preparation of organohalo benzene compounds. **(1+2+6)**

(b) In nucleophilic displacement reaction chlorobenzene is less reactive than benzylchloride— Explain. **(8)**

(c) How can you synthesize TNT and DDT from benzene? **(9)**

(d) How is heterobenzene reduced depending on the pH of the system? Discuss with examples. **(9)**
