L-2/T-2/CHE Date : 16/07/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Describe the benefits, limitation and prerequisite for successful completion of dimensional-analysis. **(8)**

(b) Write down the significance and application of the following dimensionless numbers. **(3×3=9)**

(i) Reynolds Number

(ii) Froude Number

(iii) Euler Number

(c) Derive an expression for the velocity of rise of an air bubble in a stationary liquid using dimensional analysis. Consider the effect of surface tension as well as other important variables. **(18)**

2. (a) Two rectangular plates of equal length (L) and width (W) are positioned vertically with a fixed separation distance of 2β. The downward flow of fluid under the action of both pressure and gravity in the channel formed by the plates is laminar. Derive expression for shear-stress (τ) and velocity (V) distributions across the separation distance from the appropriate shell-momentum balance. You are allowed to make all required assumptions. **(23)**

(b) Discuss briefly the working principle and application of Hot-Film Anemometer and Laser-Doppler Anemometer. **(6+6=12)**

3. (a) With the help of Power vs. Discharge diagram, show and explain briefly the relative proportion/amount of energy losses encountered in the operation of a centrifugal pump. **(10)**

(b) Write a technical note on cavitation and NPSH of a pump-operation. **(7)**

(c) Two reservoirs A and B are connected with a long pipe which has characteristics such that the head loss through the pipe is expressible as $h_L = 15 \times 10^4 Q^2$, where h_L is in meters and Q is the flow rate in L/s. The water surface elevation in reservoir B is 10.5 m above that in reservoir A. Two identical pumps are available for use to pump the water from A to B. The characteristic curve of the pump when operating at 1800 rpm is given in the following table. **(18)**

Contd P/2

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Contd ... Q. No. 3(c)

Operation at 1800 rpm	
Head (m)	Flow rate (L/s)
30	0
27	6.9
24	11.4
18	15.8
12	18.9
6	21.5

At the optimum point of operation the pump delivers 12.6 L/s at a head of 22.5 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 1800 rpm; (ii) Two pumps in series, each operating at 1800 rpm; (iii) Two pumps in parallel, each operating at 1800 rpm.

4. (a) Write down the physical significance and use of 'Equation of continuity' and 'Equation of Motion'. **(4+4)**

(b) Viscosity is always considered as an important fluid properly. Demonstrate the determination of fluid-viscosity experimentally employing a tube-type viscometer. **(9)**

(c) Consider the system shown in figure below, in which the central cylindrical rod is being moved with a velocity V. The rod and the outside cylinder are coaxial. Find the steady-state velocity distribution of flow in the annulus region using right-forms of Equation of continuity and Equation of Motion. **(18)**

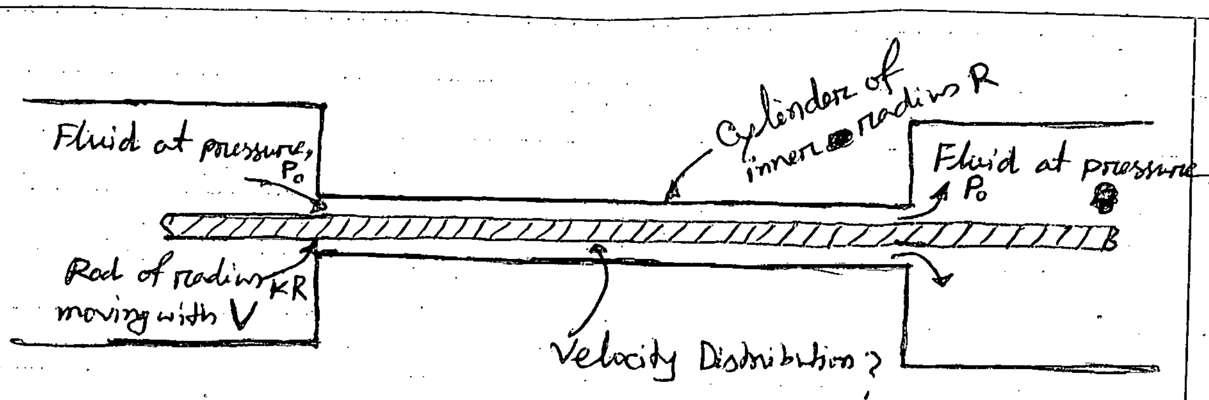

Fig: for question 4(c)

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SECTION – B

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

5. (a) Classify fluids based on their shear stress-strain rate behavior. **(10)**

(b) A 2-mm-diameter clean glass tube is inserted, as shown in Figure for Q. 5(b), in water (surface tension 72 mN/m). Determine the height that the water will climb up the tube. The water makes a contact angle of 0°with the clean glass. **(10)**

(c) Determine the pressure difference between the water pipe and the oil pipe shown in Figure for Q. 5(c). **(15)**

6. (a) Show that the center of pressure of a submerged plane is always below the centroid. **(18)**

(b) Figure for Q. 6(b) shows the side view of a submerged 7 m × 3 m rectangular gate hinged at the bottom. Find the force, P needed to hold the gate as shown. **(12)**

(c) With a neat sketch show the relations among absolute pressure, gage pressure and vacuum. **(5)**

7. (a) Deduce the Bernoulli's equation. List all assumptions made for the derivation of the equation. **(18)**

(b) In the pipe contraction shown in Figure for Q. 7(b), water flows steadily with a velocity of V_1 = 0.5 m/s and V_2 = 1.125 m/s. Two piezometer tubes are attached to the pipe at sections 1 and 2. Determine the height H. Neglect any losses through the contraction. **(12)**

(c) Draw velocity profiles for fully developed laminar flow and turbulent flow inside a pipeline. **(5)**

8. (a) What is minor loss? Explain with examples. **(5)**

(b) Water of 1.0×10^{-6} m^2/s kinematic viscosity is to be pumped at 0.02 m^3/s flow rate through a 300 m of Galvanized Iron pipe of 8 cm diameter. Calculate the head loss and pressure drop. Attach the Moody diagram with your answer script marking the friction factor appropriate for this flow. **(20)**

(c) Water is to be transported through 500 m of a smooth, horizontal, 30 cm × 20 cm rectangular duct at a flow rate of 0.24 m^3/s. What will be the Reynolds number for this flow? Take kinematic viscosity of water to be 1.0×10^{-6} m^2/s. **(10)**

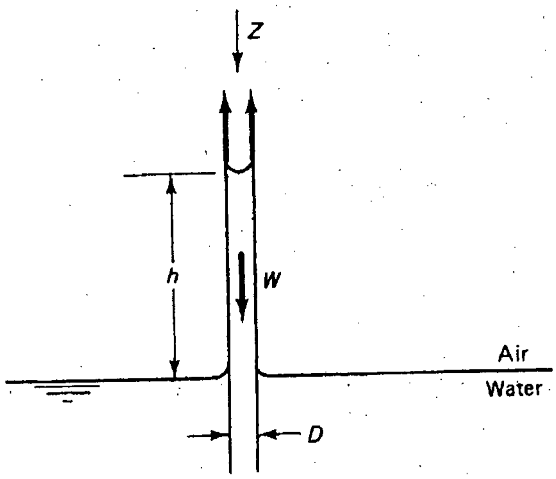

Figure for Q5(b)

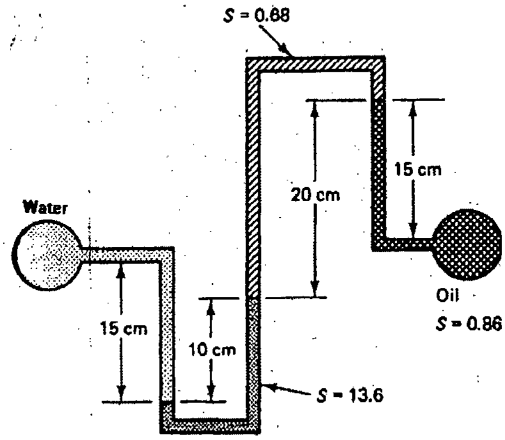

Figure for Q5(c)

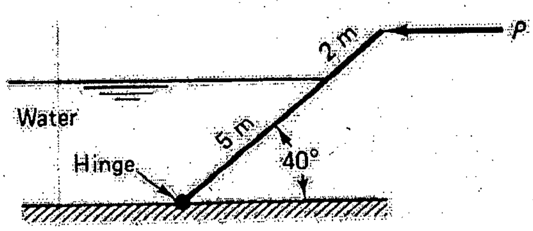

Figure for Q6(b)

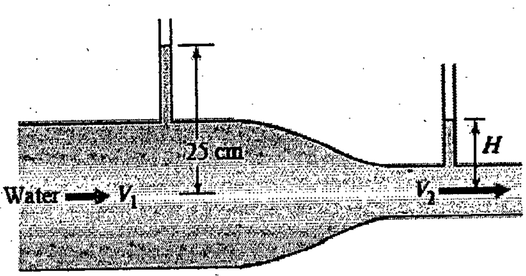

Figure for Q7(b)

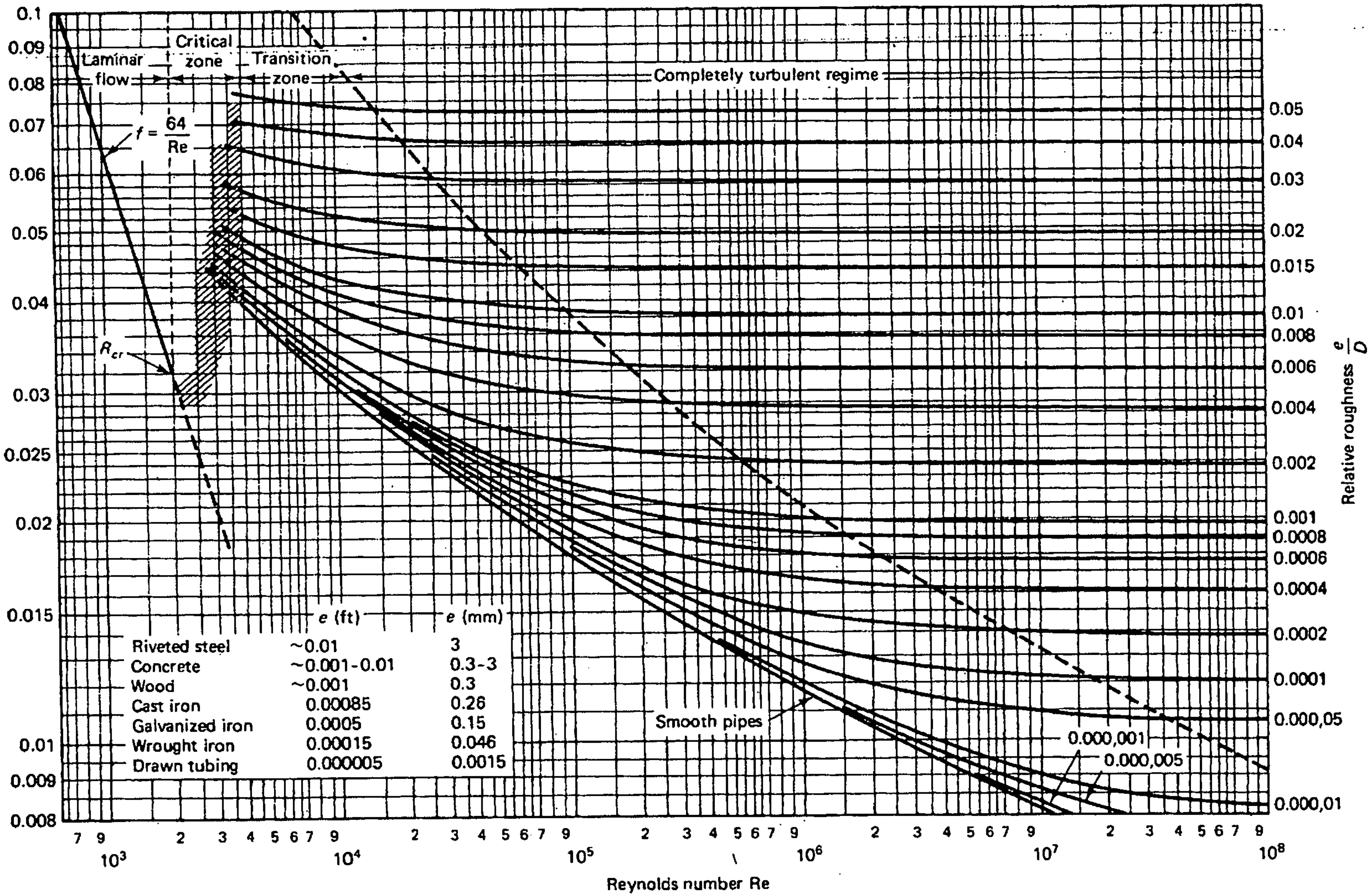

Figure 7.13 Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)

The Equation of Continuity and the Equation of Motion in Cartesian, cylindrical, and spherical coordinates

Continuity Equation, Cartesian coordinates

$$\frac{\partial \rho}{\partial t} + \left(v_x \frac{\partial \rho}{\partial x} + v_y \frac{\partial \rho}{\partial y} + v_z \frac{\partial \rho}{\partial z} \right) + \rho \left(\frac{\partial v_x}{\partial x} + \frac{\partial v_y}{\partial y} + \frac{\partial v_z}{\partial z} \right) = 0$$

Continuity Equation, cylindrical coordinates

$$\frac{\partial \rho}{\partial t} + \frac{1}{r}\frac{\partial (\rho r v_r)}{\partial r} + \frac{1}{r}\frac{\partial (\rho v_\theta)}{\partial \theta} + \frac{\partial (\rho v_z)}{\partial z} = 0$$

Continuity Equation, spherical coordinates

$$\frac{\partial \rho}{\partial t} + \frac{1}{r^2}\frac{\partial (\rho r^2 v_r)}{\partial r} + \frac{1}{r \sin\theta}\frac{\partial (\rho v_\theta \sin\theta)}{\partial \theta} + \frac{1}{r \sin\theta}\frac{\partial (\rho v_\phi)}{\partial \phi} = 0$$

Equation of Motion for an incompressible fluid, 3 components in Cartesian coordinates

$$\rho \left(\frac{\partial v_x}{\partial t} + v_x \frac{\partial v_x}{\partial x} + v_y \frac{\partial v_x}{\partial y} + v_z \frac{\partial v_x}{\partial z} \right) = -\frac{\partial P}{\partial x} + \left(\frac{\partial \tilde{\tau}_{xx}}{\partial x} + \frac{\partial \tilde{\tau}_{yx}}{\partial y} + \frac{\partial \tilde{\tau}_{zx}}{\partial z} \right) + \rho g_x$$

$$\rho \left(\frac{\partial v_y}{\partial t} + v_x \frac{\partial v_y}{\partial x} + v_y \frac{\partial v_y}{\partial y} + v_z \frac{\partial v_y}{\partial z} \right) = -\frac{\partial P}{\partial y} + \left(\frac{\partial \tilde{\tau}_{xy}}{\partial x} + \frac{\partial \tilde{\tau}_{yy}}{\partial y} + \frac{\partial \tilde{\tau}_{zy}}{\partial z} \right) + \rho g_y$$

$$\rho \left(\frac{\partial v_z}{\partial t} + v_x \frac{\partial v_z}{\partial x} + v_y \frac{\partial v_z}{\partial y} + v_z \frac{\partial v_z}{\partial z} \right) = -\frac{\partial P}{\partial z} + \left(\frac{\partial \tilde{\tau}_{xz}}{\partial x} + \frac{\partial \tilde{\tau}_{yz}}{\partial y} + \frac{\partial \tilde{\tau}_{zz}}{\partial z} \right) + \rho g_z$$

Equation of Motion for an incompressible fluid, 3 components in cylindrical coordinates

$$\rho \left(\frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} - \frac{v_\theta^2}{r} + v_z \frac{\partial v_r}{\partial z} \right) = -\frac{\partial P}{\partial r} + \left(\frac{1}{r}\frac{\partial (r \tilde{\tau}_{rr})}{\partial r} + \frac{1}{r}\frac{\partial \tilde{\tau}_{\theta r}}{\partial \theta} - \frac{\tilde{\tau}_{\theta\theta}}{r} + \frac{\partial \tilde{\tau}_{zr}}{\partial z} \right) + \rho g_r$$

$$\rho \left(\frac{\partial v_\theta}{\partial t} + v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_\theta v_r}{r} + v_z \frac{\partial v_\theta}{\partial z} \right) = -\frac{1}{r}\frac{\partial P}{\partial \theta} + \left(\frac{1}{r^2}\frac{\partial (r^2 \tilde{\tau}_{r\theta})}{\partial r} + \frac{1}{r}\frac{\partial \tilde{\tau}_{\theta\theta}}{\partial \theta} + \frac{\partial \tilde{\tau}_{z\theta}}{\partial z} + \frac{\tilde{\tau}_{\theta r} - \tilde{\tau}_{r\theta}}{r} \right) + \rho g_\theta$$

$$\rho \left(\frac{\partial v_z}{\partial t} + v_r \frac{\partial v_z}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_z}{\partial \theta} + v_z \frac{\partial v_z}{\partial z} \right) = -\frac{\partial P}{\partial z} + \left(\frac{1}{r}\frac{\partial (r \tilde{\tau}_{rz})}{\partial r} + \frac{1}{r}\frac{\partial \tilde{\tau}_{\theta z}}{\partial \theta} + \frac{\partial \tilde{\tau}_{zz}}{\partial z} \right) + \rho g_z$$

Equation of Motion for an incompressible fluid, 3 components in spherical coordinates

$$\rho \left(\frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta} + \frac{v_\phi}{r \sin\theta}\frac{\partial v_r}{\partial \phi} - \frac{v_\theta^2 + v_\phi^2}{r} \right)$$

$$= -\frac{\partial P}{\partial r} + \left(\frac{1}{r^2}\frac{\partial (r^2 \tilde{\tau}_{rr})}{\partial r} + \frac{1}{r \sin\theta}\frac{\partial (\tilde{\tau}_{\theta r} \sin\theta)}{\partial \theta} + \frac{1}{r \sin\theta}\frac{\partial \tilde{\tau}_{\phi r}}{\partial \phi} - \frac{\tilde{\tau}_{\theta\theta} + \tilde{\tau}_{\phi\phi}}{r} \right) + \rho g_r$$

$$\rho \left(\frac{\partial v_\theta}{\partial t} + v_r \frac{\partial v_\theta}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta} + \frac{v_\phi}{r \sin\theta}\frac{\partial v_\theta}{\partial \phi} + \frac{v_r v_\theta}{r} - \frac{v_\phi^2 \cot\theta}{r} \right)$$

$$= -\frac{1}{r}\frac{\partial P}{\partial \theta} + \left(\frac{1}{r^3}\frac{\partial (r^3 \tilde{\tau}_{r\theta})}{\partial r} + \frac{1}{r \sin\theta}\frac{\partial (\tilde{\tau}_{\theta\theta} \sin\theta)}{\partial \theta} + \frac{1}{r \sin\theta}\frac{\partial \tilde{\tau}_{\phi\theta}}{\partial \phi} + \frac{\tilde{\tau}_{\theta r} - \tilde{\tau}_{r\theta}}{r} - \frac{\tilde{\tau}_{\phi\phi} \cot\theta}{r} \right) + \rho g_\theta$$

$$\rho \left(\frac{\partial v_\phi}{\partial t} + v_r \frac{\partial v_\phi}{\partial r} + \frac{v_\theta}{r}\frac{\partial v_\phi}{\partial \theta} + \frac{v_\phi}{r \sin\theta}\frac{\partial v_\phi}{\partial \phi} + \frac{v_r v_\phi}{r} + \frac{v_\phi v_\theta \cot\theta}{r} \right)$$

$$= -\frac{1}{r \sin\theta}\frac{\partial P}{\partial \phi} + \left(\frac{1}{r^3}\frac{\partial (r^3 \tilde{\tau}_{r\phi})}{\partial r} + \frac{1}{r \sin\theta}\frac{\partial (\tilde{\tau}_{\theta\phi} \sin\theta)}{\partial \theta} + \frac{1}{r \sin\theta}\frac{\partial \tilde{\tau}_{\phi\phi}}{\partial \phi} + \frac{\tilde{\tau}_{\phi r} - \tilde{\tau}_{r\phi}}{r} + \frac{\tilde{\tau}_{\phi\theta} \cot\theta}{r} \right) + \rho g_\phi$$

Equation of Motion for incompressible, Newtonian fluid (Navier-Stokes equation) 3 components in Cartesian coordinates

$$\rho\left(\frac{\partial v_x}{\partial t}+v_x\frac{\partial v_x}{\partial x}+v_y\frac{\partial v_x}{\partial y}+v_z\frac{\partial v_x}{\partial z}\right) = -\frac{\partial P}{\partial x}+\mu\left(\frac{\partial^2 v_x}{\partial x^2}+\frac{\partial^2 v_x}{\partial y^2}+\frac{\partial^2 v_x}{\partial z^2}\right)+\rho g_x$$

$$\rho\left(\frac{\partial v_y}{\partial t}+v_x\frac{\partial v_y}{\partial x}+v_y\frac{\partial v_y}{\partial y}+v_z\frac{\partial v_y}{\partial z}\right) = -\frac{\partial P}{\partial y}+\mu\left(\frac{\partial^2 v_y}{\partial x^2}+\frac{\partial^2 v_y}{\partial y^2}+\frac{\partial^2 v_y}{\partial z^2}\right)+\rho g_y$$

$$\rho\left(\frac{\partial v_z}{\partial t}+v_x\frac{\partial v_z}{\partial x}+v_y\frac{\partial v_z}{\partial y}+v_z\frac{\partial v_z}{\partial z}\right) = -\frac{\partial P}{\partial z}+\mu\left(\frac{\partial^2 v_z}{\partial x^2}+\frac{\partial^2 v_z}{\partial y^2}+\frac{\partial^2 v_z}{\partial z^2}\right)+\rho g_z$$

Equation of Motion for incompressible, Newtonian fluid (Navier-Stokes equation), 3 components in cylindrical coordinates

$$\rho\left(\frac{\partial v_r}{\partial t}+v_r\frac{\partial v_r}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta}-\frac{v_\theta^2}{r}+v_z\frac{\partial v_r}{\partial z}\right) = -\frac{\partial P}{\partial r}+\mu\left(\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial (r v_r)}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 v_r}{\partial \theta^2}-\frac{2}{r^2}\frac{\partial v_\theta}{\partial \theta}+\frac{\partial^2 v_r}{\partial z^2}\right)+\rho g_r$$

$$\rho\left(\frac{\partial v_\theta}{\partial t}+v_r\frac{\partial v_\theta}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta}+\frac{v_r v_\theta}{r}+v_z\frac{\partial v_\theta}{\partial z}\right) = -\frac{1}{r}\frac{\partial P}{\partial \theta}+\mu\left(\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial (r v_\theta)}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 v_\theta}{\partial \theta^2}+\frac{2}{r^2}\frac{\partial v_r}{\partial \theta}+\frac{\partial^2 v_\theta}{\partial z^2}\right)+\rho g_\theta$$

$$\rho\left(\frac{\partial v_z}{\partial t}+v_r\frac{\partial v_z}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_z}{\partial \theta}+v_z\frac{\partial v_z}{\partial z}\right) = -\frac{\partial P}{\partial z}+\mu\left(\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial v_z}{\partial r}\right)+\frac{1}{r^2}\frac{\partial^2 v_z}{\partial \theta^2}+\frac{\partial^2 v_z}{\partial z^2}\right)+\rho g_z$$

Equation of Motion for incompressible, Newtonian fluid (Navier-Stokes equation), 3 components in spherical coordinates

$$\rho\left(\frac{\partial v_r}{\partial t}+v_r\frac{\partial v_r}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_r}{\partial \theta}+\frac{v_\phi}{r\sin\theta}\frac{\partial v_r}{\partial \phi}-\frac{v_\theta^2+v_\phi^2}{r}\right)$$
$$=-\frac{\partial P}{\partial r}+\mu\left(\frac{\partial}{\partial r}\left(\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 v_r\right)\right)+\frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial v_r}{\partial \theta}\right)+\frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_r}{\partial \phi^2}\right.$$
$$\left.-\frac{2}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(v_\theta\sin\theta\right)-\frac{2}{r^2\sin\theta}\frac{\partial v_\phi}{\partial \phi}\right)+\rho g_r$$

$$\rho\left(\frac{\partial v_\theta}{\partial t}+v_r\frac{\partial v_\theta}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_\theta}{\partial \theta}+\frac{v_\phi}{r\sin\theta}\frac{\partial v_\theta}{\partial \phi}+\frac{v_r v_\theta}{r}-\frac{v_\phi^2\cot\theta}{r}\right)$$
$$=-\frac{1}{r}\frac{\partial P}{\partial \theta}+\mu\left(\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial v_\theta}{\partial r}\right)+\frac{1}{r^2}\frac{\partial}{\partial \theta}\left(\frac{1}{\sin\theta}\frac{\partial}{\partial \theta}\left(v_\theta\sin\theta\right)\right)+\frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_\theta}{\partial \phi^2}\right.$$
$$\left.+\frac{2}{r^2}\frac{\partial v_r}{\partial \theta}-\frac{2\cot\theta}{r^2\sin\theta}\frac{\partial v_\phi}{\partial \phi}\right)+\rho g_\theta$$

$$\rho\left(\frac{\partial v_\phi}{\partial t}+v_r\frac{\partial v_\phi}{\partial r}+\frac{v_\theta}{r}\frac{\partial v_\phi}{\partial \theta}+\frac{v_\phi}{r\sin\theta}\frac{\partial v_\phi}{\partial \phi}+\frac{v_r v_\phi}{r}+\frac{v_\phi v_\theta\cot\theta}{r}\right)$$
$$=-\frac{1}{r\sin\theta}\frac{\partial P}{\partial \phi}+\mu\left(\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial v_\phi}{\partial r}\right)+\frac{1}{r^2}\frac{\partial}{\partial \theta}\left(\frac{1}{\sin\theta}\frac{\partial}{\partial \theta}\left(v_\phi\sin\theta\right)\right)+\frac{1}{r^2\sin^2\theta}\frac{\partial^2 v_\phi}{\partial \phi^2}\right.$$
$$\left.+\frac{2}{r^2\sin\theta}\frac{\partial v_r}{\partial \phi}+\frac{2\cot\theta}{r^2\sin\theta}\frac{\partial v_\theta}{\partial \phi}\right)+\rho g_\phi$$

Note: the r-component of the Navier-Stokes equation in spherical coordinates may be simplified by adding $0 = \frac{2}{r}\nabla\cdot\underline{v}$ to the component shown above. This term is zero due to the continuity equation (mass conservation). See Bird et. al.

References:

1. R. B. Bird, W. E. Stewart, and E. N. Lightfoot, *Transport Phenomena*, 2nd edition, Wiley: NY, 2002.
2. R. B. Bird, R. C. Armstrong, and O. Hassager, *Dynamics of Polymeric Fluids: Volume 1 Fluid Mechanics*, Wiley: NY, 1987.

L-2/T-2/CHE **Date : 20/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

Sub : **HUM 103** (Economics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What is meant by the concepts of "change in quantity demanded" and "change in demand"? Explain graphically the above changes with reference to the change in prices of substitute and complementary commodities. **(13)**

   (b) Explain the process of resource allocation in a society with the help of production possibility frontier. **(12)**

   (c) Calculate the equilibrium price and quantity from the following demand and supply functions. **(10)**

   $$QD_x = 1200 - 5P_x$$

   $$QS_x = -500 + 12P_x$$

   What will happen to the equilibrium price and quantity if Government provides a subsidy of Tk. 10 per unit? Graphically show the results.

2. (a) Assume a hypothetical utility function and mathematically derive the cardinal theory of consumer equilibrium. **(15)**

   (b) Explain the concept of supply function. **(5)**

   (c) Discuss the factors that affect the supply of a commodity. **(15)**

3. (a) What is meant by price elasticity of demand? Write down the formula for price elasticity of demand and explain with suitable example. **(12)**

   (b) Derive a demand curve with the help of indifference curve and price-consumption line and show that price effect is equal to substitution effect and income effect. Present and explain all necessary diagrams. **(13)**

   (c) Mathematically derive the Harrod-Domar growth model of economic development. **(10)**

4. (a) "If the doctrine of balanced growth is to be fully implemented, then investment will have to be made in consumer goods industries, agriculture, capital goods industries and social overhead capital" – Explain. **(12)**

   (b) Discuss the following criterion for investment decision: **(10)**

   (i) Capital output ratio criterion.

   (ii) Marginal social productivity criterion.

   (c) Briefly discuss the various theories of economic development. **(13)**

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HUM 103/CHE

SECTION – B

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

Symbols indicate their usual meaning.

5. (a) Why does monopoly arise? Explain. **(10)**

   (b) What are the differences between monopoly and perfectly competitive market? **(15)**

   (c) From the following revenue and cost functions, calculate the profit maximizing level output and maximum profit. **(10)**

   $$R = 4000Q - 30Q^2$$

   $$C = 2Q^3 - 3Q^2 + 400Q + 5000$$

6. (a) Define monopolistic competition with example. **(5)**

   (b) Explain a monopolistically competitive firm's equilibrium in both short run and long run. **(20)**

   (c) Why is monopolistic competition less efficient than perfect competition? Explain. **(10)**

7. (a) Explain the concept of development. **(10)**

   (b) Discuss Professor Rostow's various stages of economic growth. **(12)**

   (c) Explain the operation of four wheels of growth in developing countries. **(13)**

8. (a) What are the flows in the market economy that go from firms to households and the flows from households to firms? Explain with circular flow diagram. **(15)**

   (b) Define nominal GDP and real GDP. **(5)**

   (c) The people on Coral Island buy only juice and cloth. The CPI basket contains the quantities bought in 2009. The average household spent \$60 on juice and \$30 on cloth in 2009 when the price of juice was \$2 a bottle and the price of cloth was \$5 a yard. In the current year, 2010, juice is \$4 a bottle and cloth is \$6 a yard. **(15)**

   Calculate the CPI basket and the percentage of the household's budget spent on juice in 2009. Calculate the CPI and the inflation rate in 2010.

L-2/T-2/CHE Date : 26/07/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Assume reasonable value for any missing data if necessary.

Symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) A composite stepped bar made of copper and steel is firmly attached to a rigid wall at one end and there is a gap of 0.03 mm between the other end and the rigid wall plane as shown in the Figure 1(a). Cross sectional areas in the copper and steel portions are respectively 20000 mm^2 and 10000 mm^2. Effect of bending action is neglected. Determine the stresses in the steel and copper portions for a temperature rise of 30°C. E_{st} = 200 GPa, $\alpha_{st} = 11.7 \times 10^{-7}$ m/m°C, E_{cu} = 120 GPa and $\alpha_{cu} = 16.8 \times 10^{-6}$ m/m°C. **(20)**

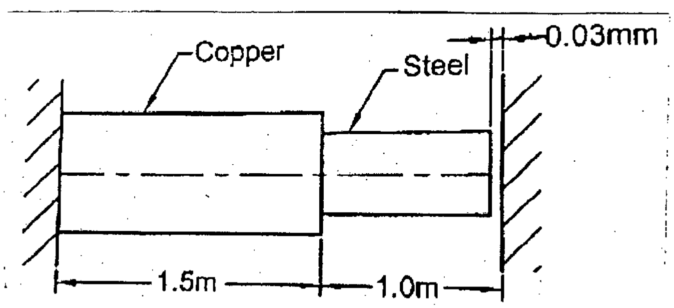

Figure for Question No. 1(a)

(b) A long concrete pipe of internal diameter d_i = 1 m is submerged in water at a depth of 40 m below the water surface. If the allowable stress in compression for concrete is 1.5 MPa, determine the wall thickness of the cylinder assuming uniform distribution of pressure outside the cylinder. **(15)**

2. (a) The simply supported beam in Figure 2(a) has the T-shaped cross section as shown. Determine the values and locations of the maximum tensile and compressive bending stresses. **(20)**

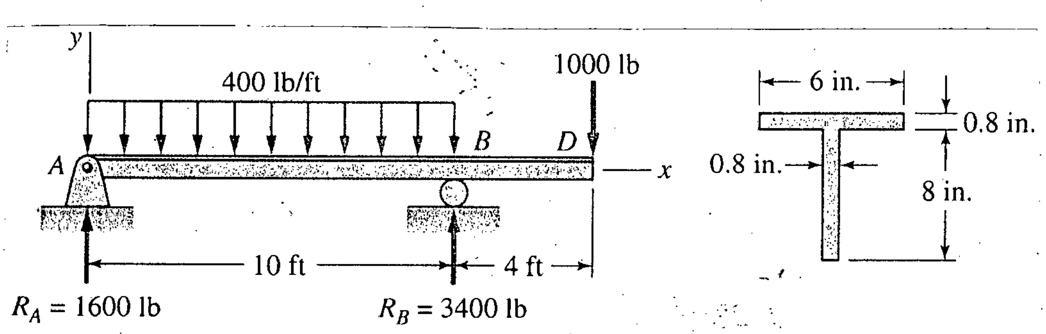

Figure for Question No. 2(a)

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(b) A timber beam is reinforced at the bottom only by a steel plate as shown in Figure 2(b). Determine the moment that can be resisted by the beam if the allowable stress in timber $\sigma_t = 8$ MPa and that in steel $\sigma_s = 125$ MPa. Consider n = 15. **(15)**

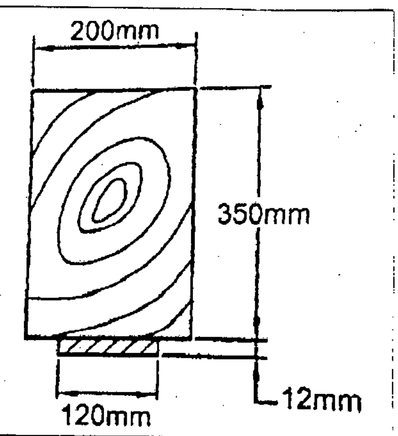

Figure for Question No. 2(b)

3. (a) For the overhanging beam in Figure 3(a), determine (i) the equation for the elastic curve; and (ii) the values of EIδ midway between the supports and at point E (indicate whether each δ is up or down). **(20)**

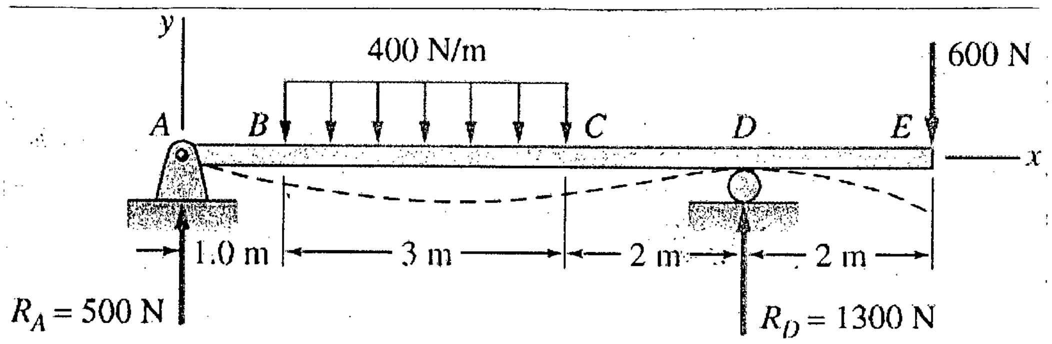

Figure for Question No. 3(a)

(b) Compute the midspan value of EIδ for the beam shown in Figure 3(b).
(Hints: Draw moment diagram by parts, starting from midspan towards the ends. Also take the advantage of symmetry to note that the tangent drawn to the elastic curve at midspan is horizontal). **(15)**

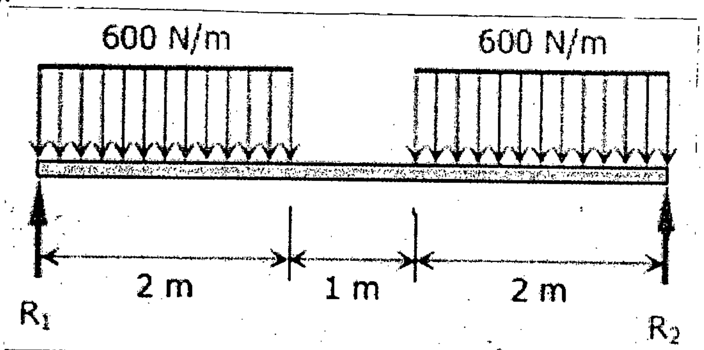

Figure for Question No. 3(b)

ME 243/CHE

4. Select the lightest W shape for a fixed ends column of length 6 m that carries an axial load of 145 kN. Use AISC column specifications. Yield strength σ_y = 360 MPa and modulus of elasticity E = 200 GPa. (Properties of W-shape is attached with the question). **(35)**

SECTION – B

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

5. (a) A plastic rod AB of length L = 0.5 m has a diameter d_1 = 30 mm as shown in Fig. 5(a). A plastic sleeve CD of length *c* = 0.3 m and outer diameter d_2 = 45 mm is securely bonded to the rod so that no slippage can occur between the rod and the sleeve. The rod is made of an acrylic with modulus of elasticity E_1 = 3.1 GPa and the sleeve is made of a polyamide with E_2 = 2.5 GPa. **(18)**

   (i) Calculate the elongation δ of the rod when it is pulled by axial force *P* = 12 kN.

   (ii) If the sleeve is extended for the full length of the rod, what is the elongation?

   (iii) If the sleeve is removed, what is the elongation?

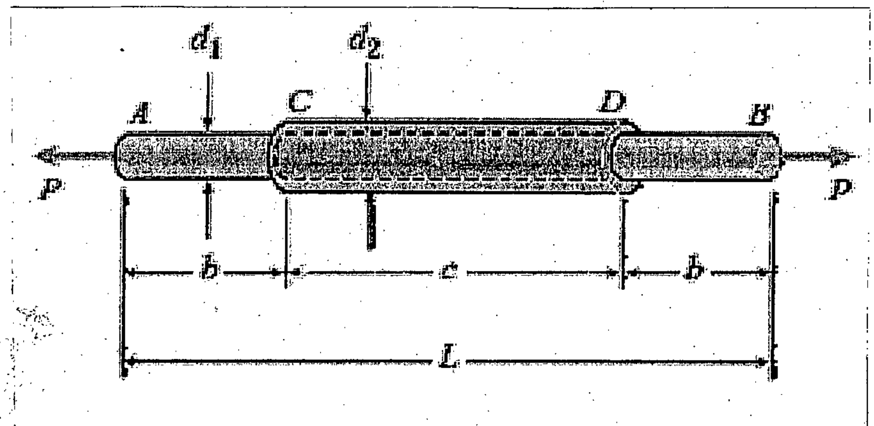

Fig. for Que. No. 5(a)

(b) For the crane hook shown in Fig. 5(b), determine the largest tensile and compressive stress in section *a-a*. **(17)**

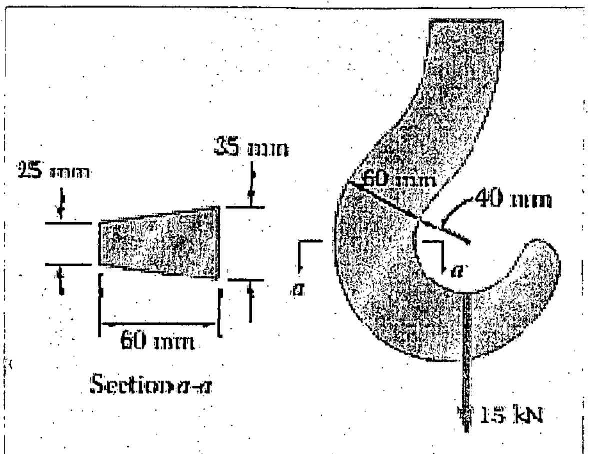

Fig. for Que. No. 5(b)

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6. (a) The aluminum rod AB (G = 27 GPa) is bonded to the brass rod BD (G = 39 GPa) as shown in Fig. 6(a). **(17)**

(i) Knowing that the portion CD of the brass rod is hollow and has an inner diameter of 40 mm, determine the angle of twist at A.

(ii) Assuming that the portion BD is a solid 60 mm rod of length 625 mm, determine the angle of twist at A.

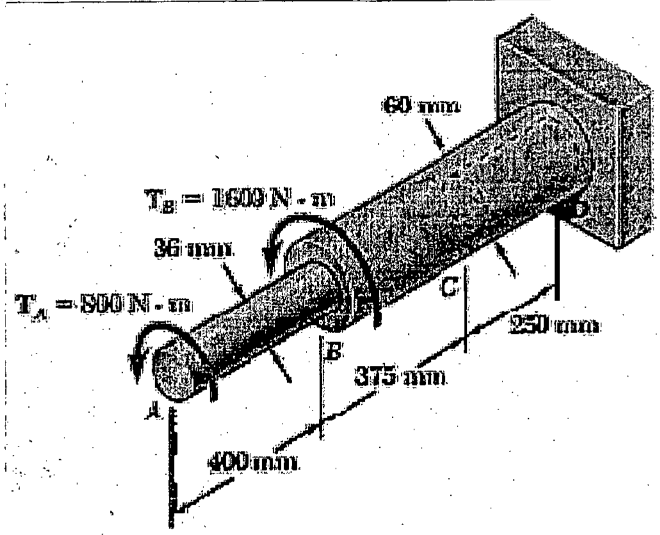

Fig. for Que. No. 6(a)

(b) A homogeneous 50-kg rigid block is suspended by the three springs whose lower ends are originally at the same level as shown in Fig. 6(b). Each steel spring has 24 turns of 10-mm-diameter on a mean diameter of 100 mm, and G = 83 GPa. The bronze spring has 48 turns of 20-mm-diameter wire on a mean diameter of 150 mm, and G = 42 GPa. Compute the maximum shearing stress in each spring. **(18)**

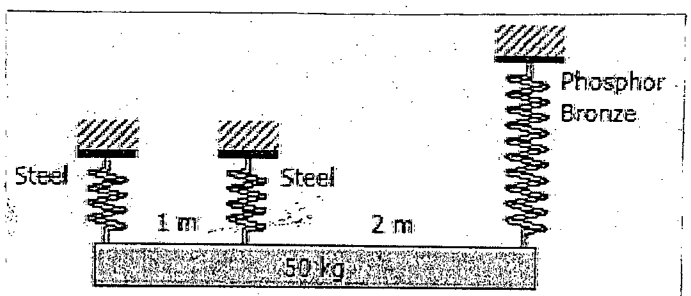

Fig. for Que. No. 6(b)

7. (a) For the beam shown in Fig. 7(a), derive the expressions for shear stress, V and bending moment, M as function of *x*, and draw the shear force and bending moment diagrams. Neglect the weight of the beam. **(20)**

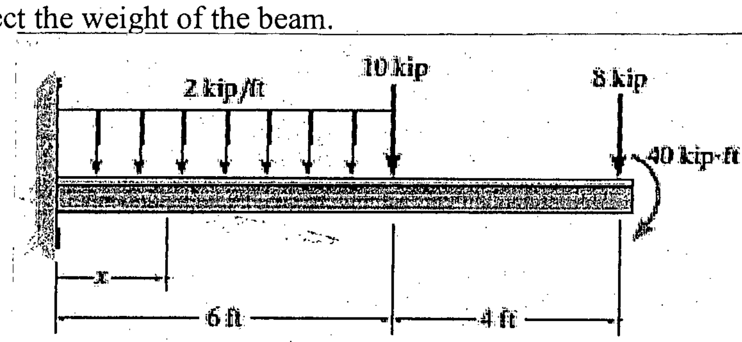

Fig. for Que. No. 7(a)

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Contd … Q. No. 7

(b) Construct the shear force and bending moment diagrams for the beam shown in Fig. 7(b) using the area method. Neglect the weight of the beam. **(15)**

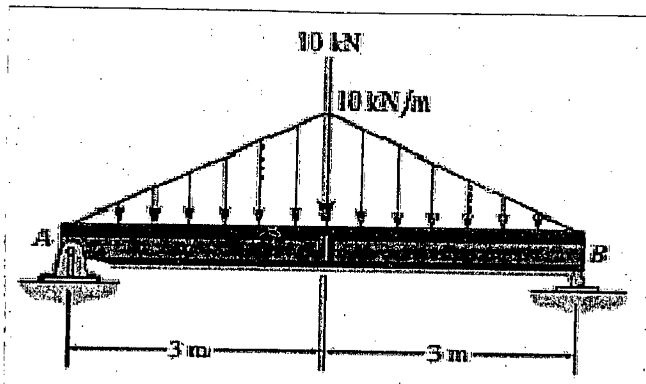


Fig. for Que. No. 7(b)

8. (a) Starting from transformation equations of a plane stress element at a point in stressed body, derive the expressions for principal stresses of the element. Also find the shear stress on the principal plane. **(15)**

(b) An element in biaxial stress is subjected to stresses as shown in the Fig. 8(b). Using Mohr's circle, determine **(20)**

(i) the stresses acting on an element oriented at a slope of 1 on 2.5.

(ii) the principal stresses and principal plane.

(iii) the maximum in-plane shear stresses and associated normal stresses.

Show all results on sketches of properly oriented element.

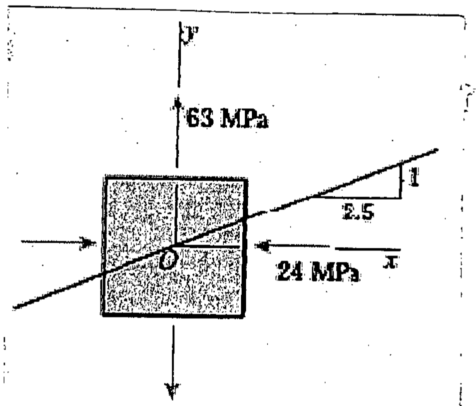
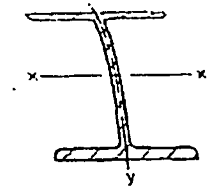


Fig. for Que. No. 8(b)



ME 243/CHE

Properties of *W* Shapes (Wide- Flange Sections)

Designation	Theoretical Mass, m (kg/m)	Area, A (mm^2)	Depth, h (mm)	Flange		Web Thickness t (mm)	Axis x-x			Axis y-y		
				Width, b (mm)	Thickness, t (mm)		I_x ($10^6 mm^4$)	Z_x ($10^3 mm^3$)	$k_x = \sqrt{\frac{I_x}{A}}$ (mm)	I_y ($10^6 mm^4$)	Z_y ($10^3 mm^3$)	$k_y = \sqrt{\frac{I_y}{A}}$ (mm)
W200×100	99.5	12700	229	210	23.7	14.5	113	989	94.3	36.6	349	53.7
×86	86.7	11100	222	209	20.6	13.0	94.7	853	92.4	31.4	300	53.2
×71	71.5	9110	216	206	17.4	10.2	76.6	709	91.7	25.4	246	52.8
×59	59.4	7560	210	205	14.2	9.1	61.1	582	89.9	20.4	199	51.9
×52	52.3	6660	206	204	12.6	7.9	52.7	512	89.0	17.8	175	51.7
×46	46.0	5860	203	203	11.0	7.2	45.5	448	88.1	15.3	151	51.1
×42	41.7	5310	205	166	11.8	7.2	40.9	399	87.7	9.00	108	41.2
×36	35.9	4580	201	165	10.2	6.2	34.4	342	86.7	7.64	92.6	40.8
×31	31.4	4000	210	134	10.2	6.4	31.4	299	88.6	4.10	61.1	32.0
×27	26.6	3390	207	133	8.4	5.8	25.8	249	87.2	3.30	49.4	31.2
×22	22.4	2860	206	102	8.0	6.2	20.0	194	83.6	1.42	22.3	22.3
×19	19.4	2480	203	102	6.5	5.8	16.6	163	81.8	1.15	22.6	21.5
×15	15.0	1900	200	100	5.2	4.3	12.7	127	81.8	0.869	17.4	21.4
W150×37	37.1	4730	162	154	11.6	8.1	22.2	274	68.5	7.07	91.8	38.7
×30	29.8	3790	157	153	9.3	6.6	17.2	219	67.4	5.56	72.6	38.3
×22	22.3	2850	152	152	6.6	5.8	12.1	159	65.2	3.87	50.9	36.8
×24	24.0	3060	160	102	10.30	6.6	13.4	168	66.2	1.83	35.8	24.5
×18	18.0	2290	153	102	7.1	5.8	9.16	120	63.2	1.26	24.7	23.5
×14	13.6	1730	150	100	5.5	4.4	6.87	91.5	63.0	0.918	18.4	23.0
W130×28	28.1	3580	131	128	10.9	6.9	10.9	167	55.2	3.81	59.6	32.6
×24	23.6	3010	127	127	9.1	6.1	8.80	139	54.1	3.11	49.0	32.1
W100×19	19.4	2470	106	103	8.8	7.1	4.76	89.9	43.9	1.61	31.2	25.5

L-2/T-2/CHE **Date : 31/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Derive Newton's backward interpolation formula. **(18)**

(b) Find the equation of the curve which satisfies the following table. **(17)**

x	–1	0	3	6	7
y	3	–6	39	822	1611

2. (a) Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ from the following table. **(18)**

x	1	1.05	1.10	1.15
y	1	1.0247	1.0488	1.0724

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

3. (a) Evaluate $\int_0^1 \frac{e^{\sqrt{1+x^2}}}{\sqrt{1+x^3}}\,dx$ by (i) Trapezoidal formula and (ii) Simpson's $\frac{3}{8}$ formula taking 12 subintervals. **(18)**

(b) Discuss Regula falsi method to solve the equation f(x) = 0. Use this method to find a root of the equation $x^3 - 3x + 1 = 0$ correct to two decimal places. **(17)**

4. (a) Use iteration method to find the real root of the equation $2x^3 - 3x - 6 = 0$ correct to five decimal places. **(18)**

(b) Use Newton-Raphson method to find the roots of the simultaneous equations **(17)**

$$x^3 - y^2 + 1 = 0$$

$$x^2 - 2x + y^3 - 2 = 0$$

Assume $x_0 = 1,\ y_0 = 1$.

Contd P/2

MATH 223/CHE

SECTION – B

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

5. Solve $\frac{dx}{dy} = x + 3y$ subject to $y(0) = 1$ and hence find an approximate value of y when $x = 1$ using
   (i) Euler's method taking $h = 0.2$ and **(20)**
   (ii) Runge-Kutta method taking $h = 0.5$. **(15)**

6. (a) For a symmetric and Mesokurtic distribution of 200 heights, given that mean and standard deviation are 40 and 15. It was however discovered that 2 items 43 and 35 were wrongly written in place of correct values 34 and 53 respectively. Calculate corrected mean, standard deviation, β_1 and β_2. **(20)**
   (b) A manufacturer of car batteries claims that the life of their batteries is approximately normally distributed with a standard deviation equal to 0.9 year. If a random sample of 10 of these batteries has a standard deviation of 1.2 years, do you think that $\sigma > 0.9$ years? Use a 0.05 level of significance. (Necessary chart is attached). **(15)**

7. (a) A study was made on the amount of converted sugar in a certain process at various temperatures. The data were coded and recorded as follows: **(20)**

Temperature X	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2
Converted Sugar Y	8.1	7.8	8.5	9.8	9.5	8.9	8.6	10.2	9.3	9.2	10.5

   (i) Find the equations of both regression lines.
   (ii) Estimate the amount of converted sugar produced when the coded temperature is 1.75.
   (iii) Find the value of correlation coefficient.

   (b) A real estate agent has 8 master keys to open several new homes. Only 1 key will open any given house. If 40% of these homes are actually left unlocked, what is the probability that the agent can get into a specific home if he selects 3 keys randomly before leaving the office. **(15)**

8. (a) Prove that if X is a binomial random variable with probability distribution b(x; n, p) and $n \to \infty$, $p \to 0$, $np \to \lambda$ remains constant then $b(x; n, p) \to p(x; \lambda)$ that the mean and variance of Poisson distribution. **(10+10)**
   Suppose that airplane engines operate independently and fail with probability equal to 0.4. Assuming that a plane makes a safe flight if at least one-half of its engines run, determine whether a 4-engine plane or a 2-engine plane has the higher probability for a successful flight.
   (b) According to a study published by a group of sociologists at the University of Massachusetts, approximately 49% of the Valium users in the state of Massachusetts are white-collar workers. What is the probability that between 482 and 510, inclusive, of the next 1000 randomly selected Valium users from this state would be white-collar workers? **(15)**

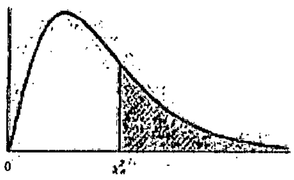


Table A.5 Critical Values of the Chi-Squared Distribution

v	α 0.995	0.99	0.98	0.975	0.95	0.90	0.80	0.75	0.70	0.50
1	0.0^4393	0.0^3157	0.0^3628	0.0^3982	0.00393	0.0158	0.0642	0.102	0.148	0.455
2	0.0100	0.0201	0.0404	0.0506	0.103	0.211	0.446	0.575	0.713	1.386
3	0.0717	0.115	0.185	0.216	0.352	0.584	1.005	1.213	1.424	2.366
4	0.207	0.297	0.429	0.484	0.711	1.064	1.649	1.923	2.195	3.357
5	0.412	0.554	0.752	0.831	1.145	1.610	2.343	2.675	3.000	4.351
6	0.676	0.872	1.134	1.237	1.635	2.204	3.070	3.455	3.828	5.348
7	0.989	1.239	1.564	1.690	2.167	2.833	3.822	4.255	4.671	6.346
8	1.344	1.647	2.032	2.180	2.733	3.490	4.594	5.071	5.527	7.344
9	1.735	2.088	2.532	2.700	3.325	4.168	5.380	5.899	6.393	8.343
10	2.156	2.558	3.059	3.247	3.940	4.865	6.179	6.737	7.267	9.342
11	2.603	3.053	3.609	3.816	4.575	5.578	6.989	7.584	8.148	10.341
12	3.074	3.571	4.178	4.404	5.226	6.304	7.807	8.438	9.034	11.340
13	3.565	4.107	4.765	5.009	5.892	7.041	8.634	9.299	9.926	12.340
14	4.075	4.660	5.368	5.629	6.571	7.790	9.467	10.165	10.821	13.339
15	4.601	5.229	5.985	6.262	7.261	8.547	10.307	11.037	11.721	14.339
16	5.142	5.812	6.614	6.908	7.962	9.312	11.152	11.912	12.624	15.338
17	5.697	6.408	7.255	7.564	8.672	10.085	12.002	12.792	13.531	16.338
18	6.265	7.015	7.906	8.231	9.390	10.865	12.857	13.675	14.440	17.338
19	6.844	7.633	8.567	8.907	10.117	11.651	13.716	14.562	15.352	18.338
20	7.434	8.260	9.237	9.591	10.851	12.443	14.578	15.452	16.266	19.337
21	8.034	8.897	9.915	10.283	11.591	13.240	15.445	16.344	17.182	20.337
22	8.643	9.542	10.600	10.982	12.338	14.041	16.314	17.240	18.101	21.337
23	9.260	10.196	11.293	11.689	13.091	14.848	17.187	18.137	19.021	22.337
24	9.886	10.856	11.992	12.401	13.848	15.659	18.062	19.037	19.943	23.337
25	10.520	11.524	12.697	13.120	14.611	16.473	18.940	19.939	20.867	24.337
20	11.160	12.198	13.409	13.844	15.379	17.292	19.820	20.843	21.792	25.336
27	11.808	12.878	14.125	14.573	16.151	18.114	20.703	21.749	22.719	26.336
28	12.461	13.565	14.847	15.308	16.928	18.939	21.588	22.657	23.647	27.336
29	13.121	14.256	15.574	16.047	17.708	19.768	22.475	23.567	24.577	28.336
30	13.787	14.953	16.306	16.791	18.493	20.599	23.364	24.478	25.508	29.336
40	20.707	22.164	23.838	24.433	26.509	29.051	32.345	33.66	34.872	39.335
50	27.991	29.707	31.664	32.357	34.764	37.689	41.449	42.942	44.313	49.335
60	35.534	37.485	39.699	40.482	43.188	46.459	50.641	52.294	53.809	59.335

Chart for 6(b) question

Table A.5 (continued) Critical Values of the Chi-Squared Distribution

	α									
ν	0.30	0.25	0.20	0.10	0.05	0.025	0.02	0.01	0.005	0.001
1	1.074	1.323	1.642	2.706	3.841	5.024	5.412	6.635	7.879	10.827
2	2.408	2.773	3.219	4.605	5.991	7.378	7.824	9.210	10.597	13.815
3	3.665	4.108	4.642	6.251	7.815	9.348	9.837	11.345	12.838	16.266
4	4.878	5.385	5.989	7.779	9.488	11.143	11.668	13.277	14.860	18.466
5	6.064	6.626	7.289	9.236	11.070	12.832	13.388	15.086	16.750	20.515
6	7.231	7.841	8.558	10.645	12.592	14.449	15.033	16.812	18.548	22.457
7	8.383	9.037	9.803	12.017	14.067	16.013	16.622	18.475	20.278	24.321
8	9.524	10.219	11.030	13.362	15.507	17.535	18.168	20.090	21.955	26.124
9	10.656	11.389	12.242	14.684	16.919	19.023	19.679	21.666	23.589	27.877
10	11.781	12.549	13.442	15.987	18.307	20.483	21.161	23.209	25.188	29.588
11	12.899	13.701	14.631	17.275	19.675	21.920	22.618	24.725	26.757	31.264
12	14.011	14.845	15.812	18.549	21.026	23.337	24.054	26.217	28.300	32.909
13	15.119	15.984	16.985	19.812	22.362	24.736	25.471	27.688	29.819	34.527
14	16.222	17.117	18.151	21.064	23.685	26.119	26.873	29.141	31.319	36.124
15	17.322	18.245	19.311	22.307	24.996	27.488	28.259	30.578	32.801	37.698
16	18.418	19.369	20.465	23.542	26.296	28.845	29.633	32.000	34.267	39.252
17	19.511	20.489	21.615	24.769	27.587	30.191	30.995	33.409	35.718	40.791
18	20.601	21.605	22.760	25.989	28.869	31.526	32.346	34.805	37.156	42.312
19	21.689	22.718	23.900	27.204	30.144	32.852	33.687	36.191	38.582	43.819
20	22.775	23.828	25.038	28.412	31.410	34.170	35.020	37.566	39.997	45.314
21	23.858	24.935	26.171	29.615	32.671	35.479	36.343	38.932	41.401	46.796
22	24.939	26.039	27.301	30.813	33.924	36.781	37.659	40.289	42.796	48.268
23	26.018	27.141	28.429	32.007	35.172	38.076	38.968	41.638	44.181	49.728
24	27.096	28.241	29.553	33.196	36.415	39.364	40.270	42.980	45.558	51.179
25	28.172	29.339	30.675	34.382	37.652	40.646	41.566	44.314	46.928	52.619
26	29.246	30.435	31.795	35.563	38.885	41.923	42.856	45.642	48.290	54.051
27	30.319	31.528	32.912	36.741	40.113	43.195	44.140	46.963	49.645	55.475
28	31.391	32.620	34.027	37.916	41.337	44.461	45.419	48.278	50.994	56.892
29	32.461	33.711	35.139	39.087	42.557	45.722	46.693	49.588	52.335	58.301
30	33.530	34.800	36.250	40.256	43.773	46.979	47.962	50.892	53.672	59.702
40	44.165	45.616	47.269	51.805	55.758	59.342	60.436	63.691	66.766	73.403
50	54.723	56.334	58.164	63.167	67.505	71.420	72.613	76.154	79.490	86.660
60	65.226	66.981	68.972	74.397	79.082	83.298	84.58	88.379	91.952	99.608

Table A.1 Binomial Probability Sums $\sum_{x=0}^{r} b(x; n, p)$

		p									
n	r	0.10	0.20	0.25	0.30	0.40	0.50	0.60	0.70	0.80	0.90
1	0	0.9000	0.8000	0.7500	0.7000	0.6000	0.5000	0.4000	0.3000	0.2000	0.1000
	1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0	0.8100	0.6400	0.5625	0.4900	0.3600	0.2500	0.1600	0.0900	0.0400	0.0100
	1	0.9900	0.9600	0.9375	0.9100	0.8400	0.7500	0.6400	0.5100	0.3600	0.1900
	2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0	0.7290	0.5120	0.4219	0.3430	0.2160	0.1250	0.0640	0.0270	0.0080	0.0010
	1	0.9720	0.8960	0.8438	0.7840	0.6480	0.5000	0.3520	0.2160	0.1040	0.0280
	2	0.9990	0.9920	0.9844	0.9730	0.9360	0.8750	0.7840	0.6570	0.4880	0.2710
	3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0	0.6561	0.4096	0.3164	0.2401	0.1296	0.0625	0.0256	0.0081	0.0016	0.0001
	1	0.9477	0.8192	0.7383	0.6517	0.4752	0.3125	0.1792	0.0837	0.0272	0.0037
	2	0.9963	0.9728	0.9492	0.9163	0.8208	0.6875	0.5248	0.3483	0.1808	0.0523
	3	0.9999	0.9984	0.9961	0.9919	0.9744	0.9375	0.8704	0.7599	0.5904	0.3439
	4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0	0.5905	0.3277	0.2373	0.1681	0.0778	0.0313	0.0102	0.0024	0.0003	0.0000
	1	0.9185	0.7373	0.6328	0.5282	0.3370	0.1875	0.0870	0.0308	0.0067	0.0005
	2	0.9914	0.9421	0.8965	0.8369	0.6826	0.5000	0.3174	0.1631	0.0579	0.0086
	3	0.9995	0.9933	0.9844	0.9692	0.9130	0.8125	0.6630	0.4718	0.2627	0.0815
	4	1.0000	0.9997	0.9990	0.9976	0.9898	0.9688	0.9222	0.8319	0.6723	0.4095
	5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0	0.5314	0.2621	0.1780	0.1176	0.0467	0.0156	0.0041	0.0007	0.0001	0.0000
	1	0.8857	0.6554	0.5339	0.4202	0.2333	0.1094	0.0410	0.0109	0.0016	0.0001
	2	0.9842	0.9011	0.8306	0.7443	0.5443	0.3438	0.1792	0.0705	0.0170	0.0013
	3	0.9987	0.9830	0.9624	0.9295	0.8208	0.6563	0.4557	0.2557	0.0989	0.0159
	4	0.9999	0.9984	0.9954	0.9891	0.9590	0.8906	0.7667	0.5798	0.3446	0.1143
	5	1.0000	0.9999	0.9998	0.9993	0.9959	0.9844	0.9533	0.8824	0.7379	0.4686
	6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	0	0.4783	0.2097	0.1335	0.0824	0.0280	0.0078	0.0016	0.0002	0.0000	
	1	0.8503	0.5767	0.4449	0.3294	0.1586	0.0625	0.0188	0.0038	0.0004	0.0000
	2	0.9743	0.8520	0.7564	0.6471	0.4199	0.2266	0.0963	0.0288	0.0047	0.0002
	3	0.9973	0.9667	0.9294	0.8740	0.7102	0.5000	0.2898	0.1260	0.0333	0.0027
	4	0.9998	0.9953	0.9871	0.9712	0.9037	0.7734	0.5801	0.3529	0.1480	0.0257
	5	1.0000	0.9996	0.9987	0.9962	0.9812	0.9375	0.8414	0.6706	0.4233	0.1497
	6		1.0000	0.9999	0.9998	0.9984	0.9922	0.9720	0.9176	0.7903	0.5217
	7			1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Chart for question no. 8(a)

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	0.5138	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	0.7701	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	0.9279	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

Chart for the question no. 8 (b)

L-2/T-2/CHE Date : 06/08/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Draw Newman projections of the chair and boat forms of cyclohexane. **(6)**

   (b) Draw the structure of the most stable methyl cyclohexane, n-butane and 1, 4-dimethyl chclohexane. **(9)**

   (c) Give the preparation of 2-methyl-1-phenylprop-1-ene using Witting reaction. **(10)**

   (d) Show the preparation of but-2-ene by using Boord et.al. synthesis. **(10)**

2. (a) Discuss the addition polymerization reactions of alkene with example and mechanism. **(7)**

   (b) Give the synthesis of butyne-2, isoprene, butadiene and trans-2-hexene from acetylene. **(16)**

   (c) Write the products of the reactions of 3-methyl butane-1 with following reagents. **(12)**

   (i) 1.O_3, CH_2Cl_2, –78°C, 2-Zn, H+

   (ii) HBr, ROOR (iii) Br_2, H_2O

3. (a) Of the following statements, which are true for nucleophilic substitutions occurring by the S_N2 mechanism? Explain with example: **(15)**

   (i) The absolute configuration of the product is opposite to that of the reactant when an optically active substrate is used.

   (ii) The probable mechanism involves only one step.

   (iii) Carbocations are intermediates.

   (b) Solvolysis of an alkylhalide is S_N1 reaction. Explain with mechanism. **(10)**

   (c) Discuss the solvent and temperature effects on S_N1, S_N2 and E2 reactions. **(10)**

4. (a) Show the synthesis of the following compounds starting with toluene. (i) p-Toluic acid, (ii) m-Bromotoluene. **(12)**

   (b) Give the preparation of the following compounds. **(15)**

   (i) p-Nitroaniline from aniline

   (ii) Acetophenone from benzene

   (iii) m-Bromophenol from nitrobenzene

   (c) Explain, why amino (NH_2) is ortho, para-directing and activating group in electrophilic aromatic substitution reaction. **(8)**

Contd P/2

CHEM 221

SECTION – B

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

5. (a) Describe the Fischer-Indole synthesis of indole and Bischler-Napieralski synthesis of isoquiniline with mechanism. **(10)**

   (b) How furfural undergoes the following: **(10)**

      (i) Claisen-Schmidt condensations

      (ii) Perkin's Reaction

   (c) How would you carry out the following conversions? **(4×3=12)**

      (i) 2-Hydroxyquinoline from quinoline

      (ii) Decahydroisoquinoline from isoquinoline

      (iii) Quinoline-8-sulphoric acid from α-β- Benzopyridine

      (iv) Anthranilic acid from indigo.

   (d) Give a commercial method for the synthesis of pyridine. **(3)**

6. (a) State Huckel rule. Draw the structures of the following and show whether they are aromatic or not. **(2+8=10)**

      (i) 1, 3, 5, 7 – Cyclooctatetraene

      (ii) Cycloheptatriene

      (iii) Pyridine

      (iv) Quinoline

   (b) Discuss the bromination of benzene with mechanism. **(9)**

   (c) Describe the structure of benzene in terms of resonance and orbital concept. **(8)**

   (d) Starting with benzene how can you prepare the following? **(8)**

      (i) Lindane (ii) DDT

7. (a) Define the term dye. Write down the necessary and sufficient conditions for a substance to be a perfect dye. **(9)**

   (b) Write the classification of dyes depending on application. **(10)**

   (c) Provide a suitable synthesis for each of the following dyes and also mention their important uses. **(10)**

      (i) Aniline yellow (ii) Malachite green

   (d) Give the commercial synthesis of the natural dye indigo. **(6)**

8. (a) What are alkaloids? Describe with a flow-diagram their isolation from plant bodies. **(2+7=9)**

   (b) Mention the reactions that have been postulated for the biosynthetic conversion of aminoacids into alkaloids. **(8)**

   (c) Briefly discuss how the structure of nicotine was established. **(10)**

   (d) What are the various degradation methods for the determination of the structure of alkaloids? Describe the Hofmann's degradation method in brief. **(8)**
