L-2/T-2/WRE **Date : 16/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **WRE 201** (Fluid Mechanics)

Full Marks : 280 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**.

Assume reasonable data, where missing.

1. (a) Distinguish between the following terms: **(10)**

   (i) Laminar flow and Turbulent flow

   (ii) Steady flow and Unsteady flow

   (iii) Kinematic viscosity and Dynamic viscosity

   (iv) Newtonian fluid and non-Newtonian fluid

   (b) In a flow the velocity vector is given by $V = 5xi + 3yj - 8zk$. Determine the equation of the streamline passing through a point M (1, 4, 5). **(10)**

   (c) An idealized velocity field is given by the formula $V = 3txi - t^2yj + 2xzk$. Compute the acceleration vector. **(8 2/3)**

   (d) Given the velocity field $V = 10x^2yi + 20\ (yz + x)j + 13k$, what is the total angular velocity of a fluid particle at (1, 4, 3)m? **(8)**

   (e) Assume the conduit shown in Figure 1 has inside diameters of 30 cm and 45 cm at sections 1 and 2 respectively. If water is flowing in the conduit at a velocity of 5.0 m/s at section 2. Find the (i) velocity at section 1, (ii) volume flow rate, (iii) weight flow rate, and (iv) mass flow rate. **(10)**

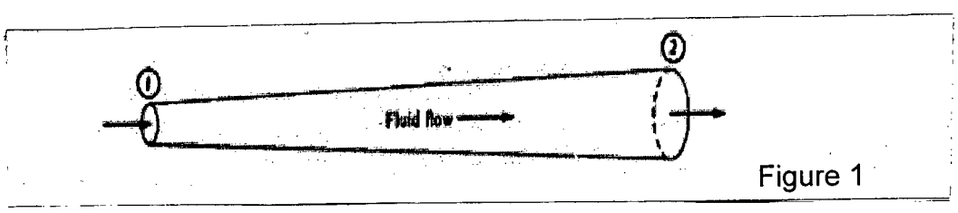


Figure 1

2. (a) Derive the general energy equation for steady flow and for any fluid. **(10)**

   (b) Water is to be delivered from a reservoir through a pipe to a lower level and discharge into the air, as shown in Figure 2. If head loss in the entire system is 11.58 m, determine the vertical distance between the point of water discharge and the water surface in the reservoir. ($Q = 0.00631 m^3/s$). **(8 2/3)**

Contd P/2

WRE 201

Contd ... Q. No. 2

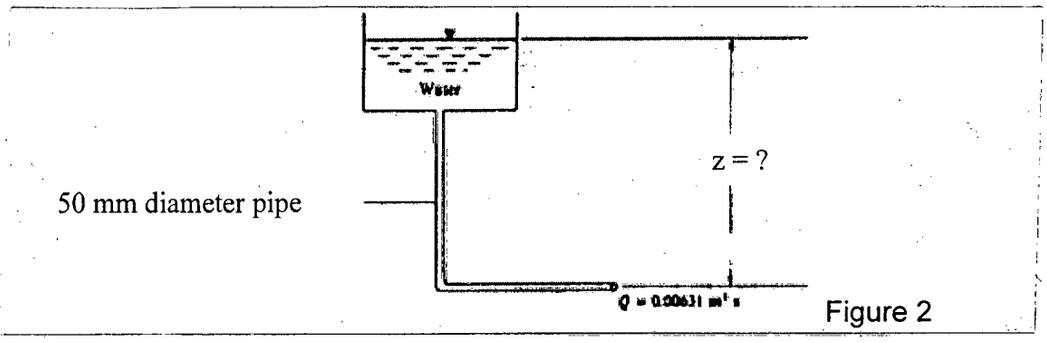


Figure 2

(c) For the water shooting out of the pipe and nozzle under the condition shown in Figure 3, find the height above the nozzle to which the water jet will shoot (i.e. distance h in Figure 3). Assume negligible head loss. **(12)**

(d) Sketch the hydraulic grade line (HGL) and the energy line (EL) for the pipe shown in Figure 4. Evaluate key points for the hydraulic grade line (HGL). The turbine is developing a head equivalent to 5.42 m. The diameter of the nozzle is 0.05 cm. The discharge in the pipe is 0.94 m^3/s. Given, the entrance loss coefficient is K = 0.5. **(16)**

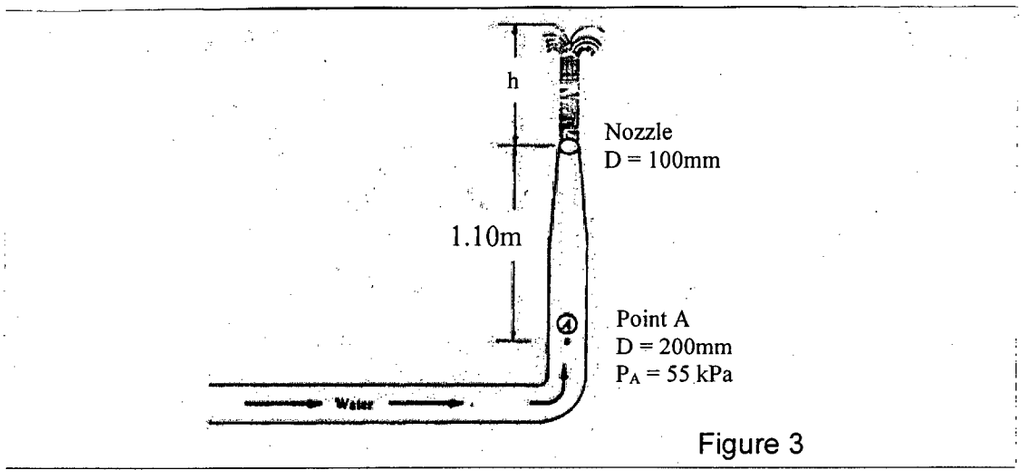


Figure 3

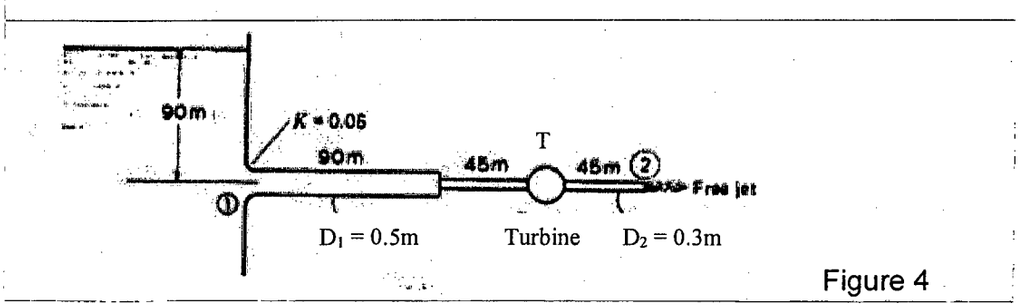


Figure 4

3. (a) Derive the equation of force exerted by fluid on a reducing pipe bend. **(8)**

(b) A jet of water flowing freely in the atmosphere is deflected by a curved vane as shown in Figure 5. If the water jet has a diameter of 4 cm and a velocity of 8 m/s, what is the force required to hold the vane in place? **(8 2/3)**

Contd P/3

WRE 201

Contd ... Q. No. 3

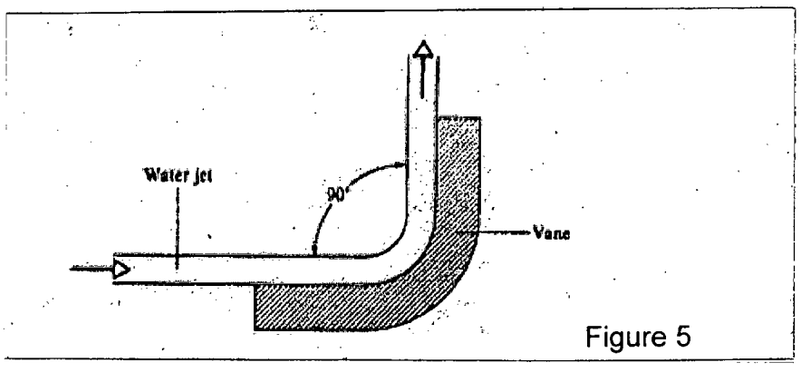


Figure 5

(c) Determine the power that can be obtained from a series of moving vanes curved through 160° moving 21.5 m/s from 0.09 m^3/s water jet having a cross-section of 25.0 cm^2. Draw the velocity vector diagram at entrance and exit and calculate the force of water on the vane. **(12)**

(d) A reaction turbine has $r_1 = 1.6$ m, $r_2 = 1.0$ m, $\beta_1 = 70°$, $\beta_2 = 140°$, and a thickness of 0.3 m parallel to the axis of rotation. With a guide vane angle of 12° and flow rate of 8 m^3/s, calculate the required speed of the runner for smooth flow at inlet. For this condition also calculate: **(18)**

(i) Torque exerted on the runner

(ii) Power developed of the machine

(iii) Energy extracted from each Newton of fluid.

4. (a) Derive Darcey-Weisbach equation for pipe friction. **(8)**

(b) A badly corroded concrete pipe of diameter 1.75 m has an equivalent sand roughness of 12 mm. A 8 mm thick lining is proposed to reduce the roughness value to 0.3 mm. For a discharge of 5.0 m^3/s in the pipe calculate the reduction in head loss per kilometer of the pipe. (Given $\nu = 1 \times 10^{-6}$ m^2/s). **(8)**

(c) The pipe system shown in Figure 6 are all new cast iron (e = 0.25 mm). The discharge at point A is 0.6 m^3/s. Find the head loss from A to E. Provide your answer with two (2) trials (Given $\nu = 1.14 \times 10^{-6}$ m^2/s). **(14 2/3)**

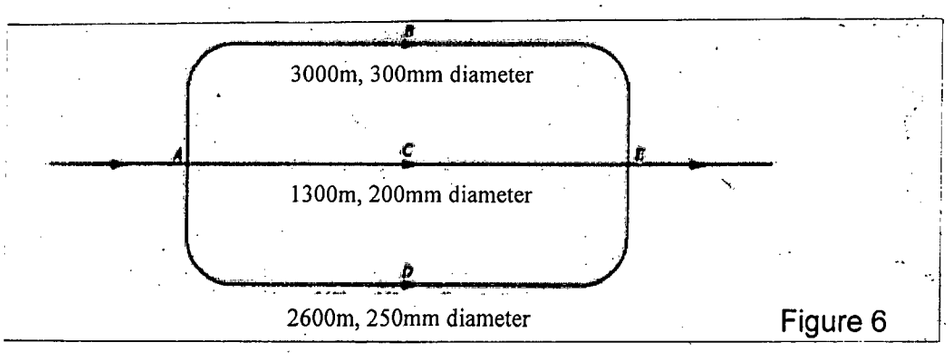


Figure 6

Contd P/4

WRE 201

Contd ... Q. No. 4

(d) The flows into and out of a two-loop pipe system are shown in Figure 7, determine the flow in each pipe by Hardy-Cross method. The K values for each pipe were calculated from the pipe and minor loss characteristics are from an assumed value of f. The discharges are in liter/sec. Show only one (1) trial. **(16)**

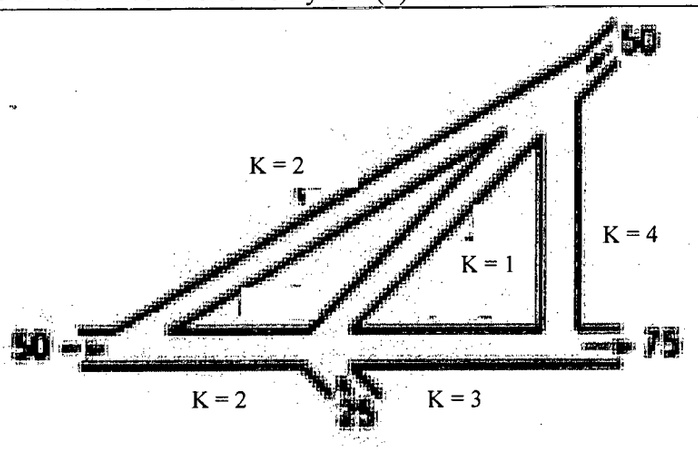


Figure 7

SECTION – B

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

5. (a) Distinguish between classical hydrodynamics and hydraulics. **(7⅔)**

(b) Describe the effect of viscosity due to change of temperature on liquid and gas. **(7)**

(c) A hydraulic lift used for lifting automobiles has 160 mm diameter ram which slides in a 163 mm diameter cylinder. The annular space between the cylinder and ram is filled with an oil of kinematic viscosity 8.5 stokes and relative density 0.72. If the travel of 6.5 m long ram has a uniform rate of 15 cm/s, estimate the frictional resistance experienced by the ram. **(14)**

(d) An open rectangular tank contains mercury upto 0.5 m depth and above it water of depth 2.5 m and certain oil of specific gravity 0.86 for e depth of 2.0 m. Find the pressure **(18)**

(i) At the interface of mercury and water

(ii) At the bottom of the tank

6. (a) What is center of pressure? Prove that for an inclined plane surface submerged in a static fluid, center of pressure is always below center of gravity. **(14⅔)**

(b) Find the difference of pressure between pressure at A and pressure at B as shown in Figure 8. Given specific gravity of mercury 13.6. **(14)**

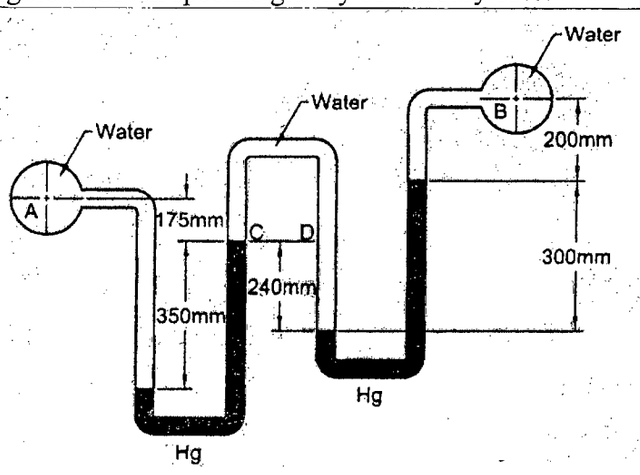


Figure 8

Contd P/5

WRE 201

Contd ... Q. No. 6

(c) This common type of irrigation head gate is a plate which slides over the opening to a culvert. The coefficient of friction between the gate and its sliding ways is 0.6. Find the force required to slide open this 4 kN gate if it is set (i) Vertically; (ii) on 2H : 1V slope [See Figure 9]. **(18)**

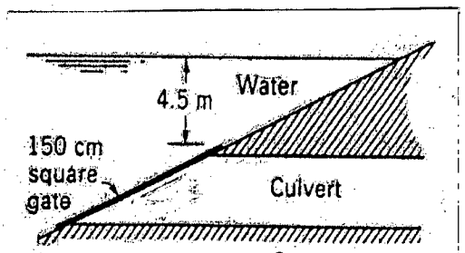


Figure 9

7. (a) What is Buckingham π theorem? Give its merits and demerits over Rayleigh's method. **(8⅔)**

(b) What do you mean by true model and distorted model? **(6)**

(c) A 1 : 25 model of aeroplane is tested in water, which is 55 times more viscous and 850 times denser than air. Find the pressure drop in the prototype, if the pressure drop in the model is 250 kPa. **(14)**

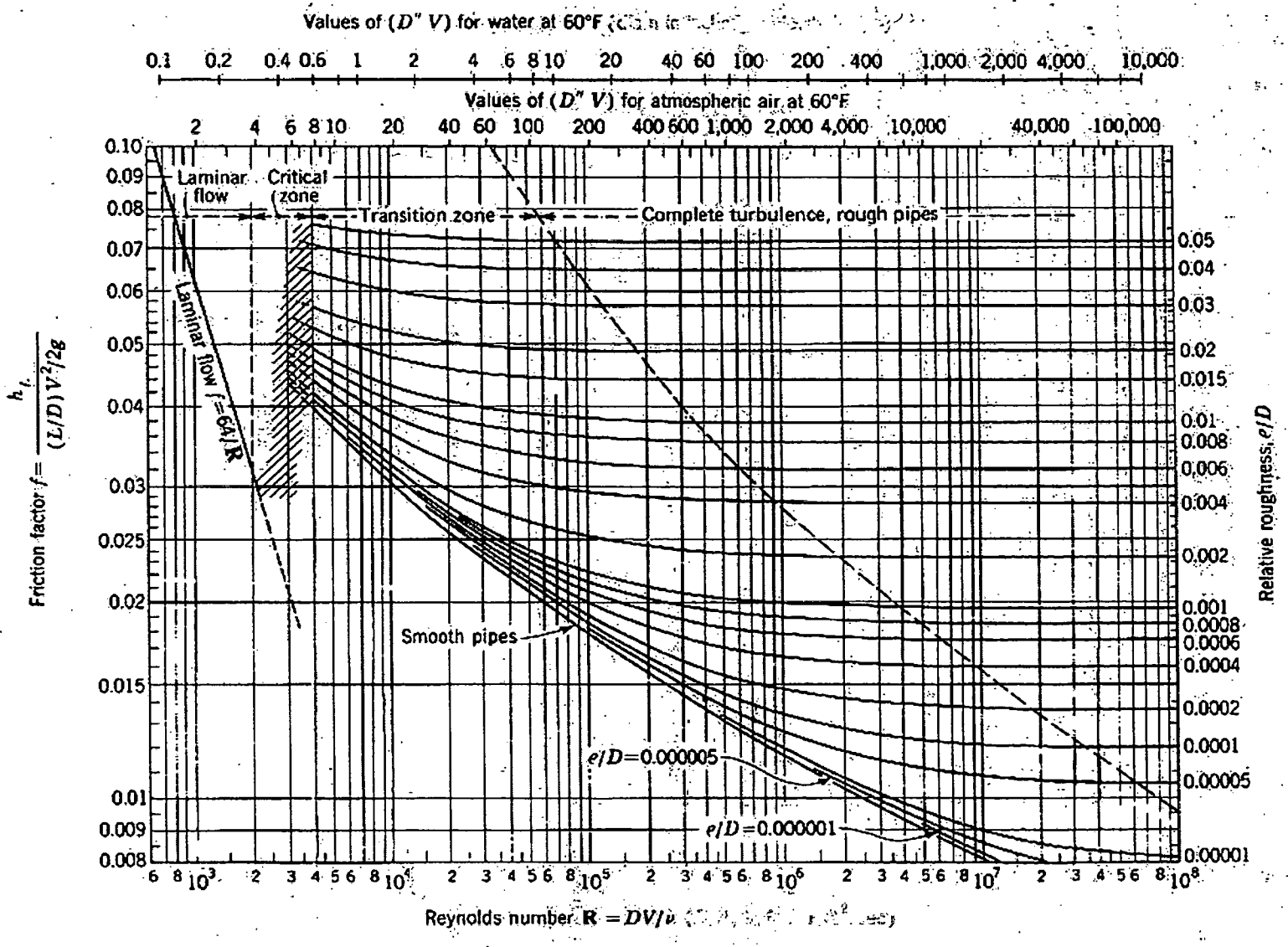
(d) Derive an expression for the drag on a surface vessel. The parameters involved are the size of the vessel, the velocity of the vessel V, the viscosity of the water μ and the density of the water ρ and the acceleration due to gravity g, to account for the effect of wave action. The size of the vessel may be represented by its diameter or its length. **(18)**

8. (a) Briefly discuss the measuring mechanism of the following devices: **(9)**
   (i) Falling Sphere type viscometer
   (ii) Pitot Tube
   (iii) Hot-wire Anemometer

(b) Derive the general equation stating the relationship between the head loss and the coefficient of velocity of an orifice. **(10⅔)**

(c) A horizontal venturimeter with a 89 mm diameter throat is installed in a 165 mm diameter pipeline. The absolute pressure at the entrance is 185 kPa and the throat is 62 kPa. Calculate the actual flow rate of water through the venturimeter, when coefficient of discharge is 0.98. **(14)**

(d) A jet of water 7.5 cm in diameter is discharged through a nozzle whose velocity coefficient is 0.96. If the pressure in the pipe is 8 kPa and the pipe diameter is 20 cm and if it is assumed that there is no contraction of the jet, what is the velocity at the tip of the nozzle? What is the rate of discharge? **(13)**


Values of (D" V) for water at 60°F
0.1 0.2 0.4 0.6 1 2 4 6 8 10 20 40 60 100 200 400 1,000 2,000 4,000 10,000
Values of (D" V) for atmospheric air at 60°F
2 4 6 8 10 20 40 60 100 200 400 600 1,000 2,000 4,000 10,000 40,000 100,000
Laminar flow
Critical zone
Transition zone
Complete turbulence, rough pipes
Laminar flow f=64/R
Smooth pipes
e/D=0.000005
e/D=0.000001
Friction factor f= h_f / (L/D) V²/2g
Relative roughness, e/D
0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.025 0.02 0.015 0.01 0.009 0.008
0.05 0.04 0.03 0.02 0.015 0.01 0.008 0.006 0.004 0.002 0.001 0.0008 0.0006 0.0004 0.0002 0.0001 0.00005 0.00001
6 8 10³ 2 3 4 5 6 8 10⁴ 2 3 4 5 6 8 10⁵ 2 3 4 5 6 8 10⁶ 2 3 4 5 6 8 10⁷ 2 3 4 5 6 8 10⁸
Reynolds number R = DV/ν

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **HUM 213** (Government)

Full Marks : 140 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) Define bureaucracy. Describe the functions of a bureaucracy in a democratic state. **(11 1/3)**

   (b) Discuss the merits and demerits of a parliamentary form of government. **(12)**

2. (a) What do you understand by nationalism and internationalism. Explain the various elements of nationalism. **(11 1/3)**

   (b) Define sovereignty. Analyse different forms of sovereignty. **(12)**

3. (a) Review the rights of a citizen in a state. **(11 1/3)**

   (b) Discuss the modern classification of government with a diagram. **(12)**

4. (a) Explain the functions of legislature and executive in a state. **(11 1/3)**

   (b) What is constitution? Briefly discuss the types of constitution and qualities of a good constitution. **(12)**

SECTION – B

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

Symbols indicate their usual meaning.

5. (a) Do you think that disintegration was the main reason behind the emergence of Bangladesh? Give reasons in favour of your answer. **(12)**

   (b) Why is the six-point program called as the charter of freedom to Bengali Nation? **(11 1/3)**

6. (a) Define constitution. Describe the major amendments of Bangladesh constitution. **(12)**

   (b) Critically discuss the impact of geographical position of Bangladesh on its foreign policy formulation. **(11 1/3)**

Contd P/2

HUM 213/WRE

7. (a) Define local government. Critically discuss the constitutional provisions of Bangladesh regarding local government. **(12)**

   (b) Define decentralization. How far is the local government system in Bangladesh decentralized? **(11 1/3)**

8. (a) What is meant by electoral college? Make a brief discussion on the political system of USA. **(12)**

   (b) Discuss the achievements and failures of United Nations Organization. **(11 1/3)**

L-2/T-2/WRE Date : 20/07/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **HUM 211** (Sociology)

Full Marks : 140 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 were the social, economic, and political effects of the industrial revolution? **(13 1/3)**

   (b) Point out the characteristics of globalization. What type of global culture do you get used to? **(10)**

2. (a) Categorize the key sources and consequences of water pollution from your own observation in our society. **(13 1/3)**

   (b) Describe the causes and consequences of rural-urban migration in Bangladesh. **(10)**

3. (a) What are the social and cultural attitudes toward family planning in your community? Do people tend to have large families or small ones? What are the reasons they give for their choices? **(13 1/3)**

   (b) Distinguish the key differences between 'urban ecology' and 'new urban sociology". **(10)**

4. Write short notes on any THREE of the following: **(23 1/3)**

   (a) Social impacts of flood

   (b) Green revolution

   (c) Closed class system

   (d) Permanent settlement

SECTION – B

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

5. (a) 'Sociology is a categorical and not a normative discipline' – Discuss. **(10)**

   (b) Evaluate the formalistic school and synthetic school for developing the distinct characteristics of sociology. **(13 1/3)**

Contd P/2

HUM 211/WRE

6. (a) Make a comparison between patriarchal family and nuclear family. **(10)**

   (b) Critically discuss the recent trends of family relationships. **(13 1/3)**

7. (a) Write down the features of white collar crime. **(10)**

   (b) Discuss the cultural transmission theory for explaining deviant behavior of our society. **(13 1/3)**

8. Write short notes on any three of the following: **(23 1/3)**

   (a) Types of socialization.

   (b) Cooley's looking glass self theory.

   (c) Anomie.

   (d) Functionalism.

L-2/T-2/WRE **Date : 26/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **CE 223** (Mechanics of Solids II)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. For the suspension bridge shown (Fig. 1), draw bending moment and shear force diagram of the stiffened girder. State all necessary assumptions. **(26 ¼)**

2. The shaded area shown in Fig. 2 represents the Kern of the footing ABCD. For the given loads, calculate normal stresses at A, B, C, D and locate the neutral axis. **(26 ¼)**

3. (a) The coordinate of the center of a Mohr's circle is (30, 0) and its radius is 12 (all units are in MPa). If the principal plane is located at an angle of $\theta = 30°$ from the plane X-X. Calculate normal stress (σ_x, σ_y) and shear stress (τ_{xy}) on that plane. Show stresses graphically on Mohr's circle. **(13)**

   (b) Calculate the principal stress and the principal planes for point A of the beam shown in Fig. 3. **(13 ¼)**

4. (a) Find the energy absorbed by an elastic rectangular beam in pure bending in terms of the maximum stress and the volume of the material. **(10)**

   (b) Find the maximum deflection due to a force P applied at the end of an elastic cantilever beam having length L and rectangular cross section (b × h) for flexure only (neglect shear). **(16 ¼)**

5. (a) Name the various failure theories. State the maximum shear stress theory with relevant mathematical expressions and show graphically the yield criteria based on maximum shear stress theory. **(14)**

   (b) Calculate the shear stress necessary to cause yielding of a material in a pure shear condition. Use maximum shear stress theory, if the yield strength of the material is 36 ksi. **(12 ¼)**

Contd P/2

CE 223/WRE

SECTION – B

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

6. (a) Determine the bending stresses at the corners in the cantilever loaded, as shown in the Fig. 4, at a section 600 mm from the free end. Also locate the line of zero stress. **(14 ¼)**

   (b) A frame for a punch press has the proportions shown in the Fig. 5. What force P can be applied to this frame controlled by the stresses in the sections such as a-a, if the allowable stresses are 4500 psi in tension and 12,500 psi in compression? **(12)**

7. (a) Using direct integration method, determine the equation of the elastic curve for the beam shown in the Fig. 6 due to the applied loading. EI for the beam is constant. **(13 ¼)**

   (b) Find the moments at the supports for a fixed-end beam loaded with a uniformly distributed load shown in Fig. 7. **(13)**

8. A plate is attached to the frame of a machine by two side fillet welds as shown in Fig, 8. Determine the size of the welds to resist a vertical load of 10 kips. Assume that the allowable shearing stress through the throat of the weld is 21 ksi. **(26 ¼)**

9. Find the allowable tensile force that the multiple-riveted structural joint shown in Fig. 9 can transmit. Also find the efficiency of this joint. All rivets are nominally 19 mm in 22 mm holes and connected plates are of 16 mm thickness. The allowable stresses are 140 MPa in tension, 95 MPa in shear, and 220 MPa in bearing. **(26 ¼)**

10. Using the AISC ASD column formulas, select a 15-ft-long pin-ended column to carry a concentric load of 230 kips. The structural steel is to be A572, having $\sigma_{yp} = 50$ ksi. **(26 ¼)**

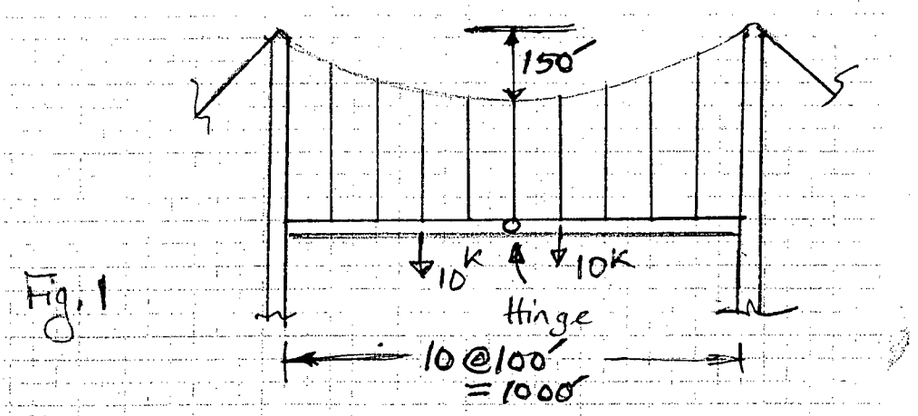
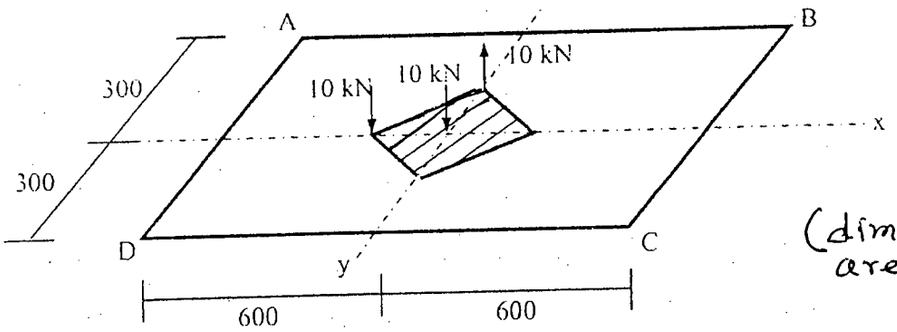


Fig. 1



(dimensions are in mm)

Fig. 2

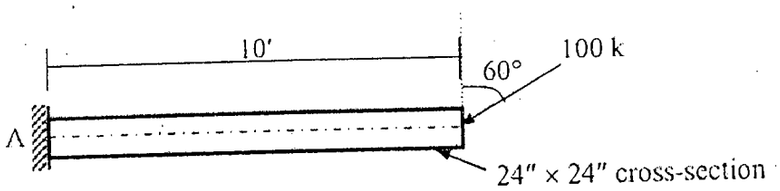


Fig. 3

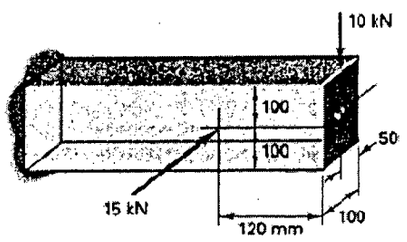


Fig. 4

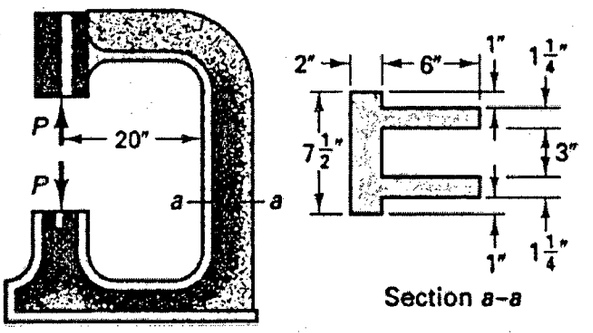


Fig. 5

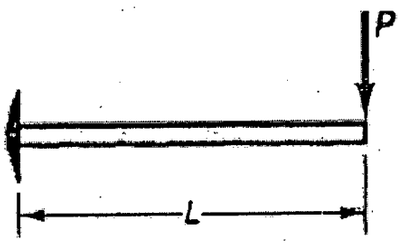


Fig-6

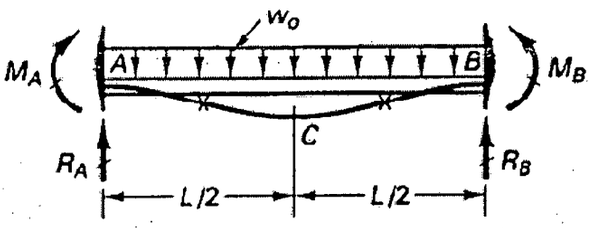


Fig- 7

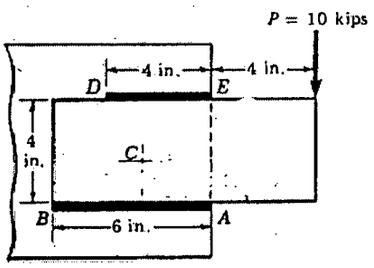


Fig- 8

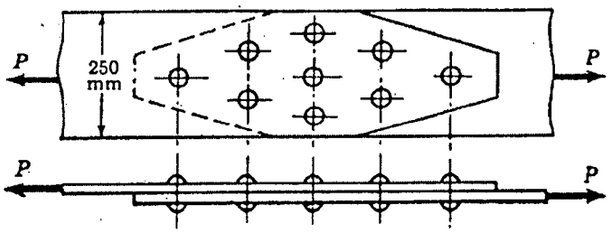


Fig- 9

AISC ASD Formulas for Columns

$$C_c = \sqrt{2\pi^2 E/\sigma_{yp}}$$

The formula for long columns when $(L_e/r) > C_c$ is

$$\sigma_{allow} = \frac{12\pi^2 E}{23(L_e/r)^2}$$

For an L_e/r ratio less than C_c, AISC specifies a parabolic formula:

$$\sigma_{allow} = \frac{[1 - (L_e/r)^2/2C_c^2]\sigma_{yp}}{\text{F.S.}}$$

where F.S., the factor of safety, is defined as

$$\text{F.S.} = \frac{5}{3} + \frac{3(L_e/r)}{8C_c} - \frac{(L_e/r)^3}{8C_c^3}$$

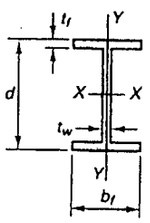


TABLE 4A. AMERICAN STANDARD STEEL W SHAPES DIMENSIONS AND PROPERTIES U.S. CUSTOMARY UNITS (ABRIDGED LIST)

Designation*	Area A	Depth d	Web Thickness t_w	Flange Width b_f	Flange Thickness t_f	Axis X–X I_x	Axis X–X r_x	Axis Y–Y I_y	Axis Y–Y r_y
in × lb/ft	in^2	in	in	in	in	in^4	in	in^4	in
W36 × 245	72.1	36.08	0.800	16.510	1.350	16100	15.0	1010	3.75
230	67.6	35.90	0.760	16.470	1.260	15000	14.9	940	3.73
150	44.2	35.85	0.625	11.975	0.940	9040	14.3	270	2.47
135	39.7	35.55	0.600	11.950	0.790	7800	14.0	225	2.38
W33 × 201	59.1	33.68	0.715	15.745	1.150	11500	14.0	749	3.56
130	38.3	33.09	0.580	11.510	0.855	6710	13.2	218	2.39
118	34.7	32.86	0.550	11.480	0.740	5900	13.0	187	2.32
W30 × 191	56.1	30.68	0.710	15.040	1.185	9170	12.8	673	3.46
173	50.8	30.44	0.655	14.985	1.065	8200	12.7	598	3.43
W27 × 161	47.4	27.59	0.660	14.020	1.080	6280	11.5	497	3.24
146	42.9	27.38	0.605	13.965	0.975	5630	11.4	443	3.21
94	27.7	26.92	0.490	9.990	0.745	3270	10.9	124	2.12
84	24.8	26.71	0.460	9.960	0.640	2850	10.7	106	2.07
W18 × 60	17.6	18.24	0.415	7.555	0.695	984	7.47	50.1	1.69
50	14.7	17.99	0.355	7.495	0.570	800	7.38	40.1	1.65
46	13.5	18.06	0.360	6.060	0.605	712	7.25	22.5	1.29
35	10.3	17.70	0.300	6.000	0.425	510	7.04	15.3	1.22
W16 × 26	7.68	15.69	0.250	5.500	0.345	301	6.26	9.59	1.12
W14 × 193	56.8	15.48	0.890	15.710	1.440	2400	6.50	931	4.05
159	46.7	14.98	0.745	15.565	1.190	1900	6.38	748	4.00
99	29.1	14.16	0.485	14.565	0.780	1110	6.17	402	3.71
90	26.5	14.02	0.440	14.520	0.710	999	6.14	362	3.70
W12 × 72	21.1	12.25	0.430	12.040	0.670	597	5.31	195	3.04
65	19.1	12.12	0.390	12.000	0.605	533	5.28	174	3.02
50	14.7	12.19	0.370	8.080	0.640	394	5.18	56.3	1.96
45	13.2	12.06	0.335	8.045	0.575	350	5.15	50.0	1.94
40	11.8	11.94	0.295	8.005	0.515	310	5.13	44.1	1.93
W10 × 112	32.9	11.36	0.755	10.415	1.250	716	4.66	236	2.68
60	17.6	10.22	0.420	10.080	0.680	341	4.39	116	2.57
49	14.4	9.98	0.340	10.000	0.560	272	4.35	93.4	2.54
45	13.3	10.10	0.350	8.020	0.620	248	4.33	53.4	2.01
39	11.5	9.92	0.315	7.985	0.530	209	4.27	45.0	1.98
33	9.71	9.73	0.290	7.960	0.435	170	4.19	36.6	1.94
W8 × 67	19.7	9.00	0.570	8.280	0.935	272	3.72	88.6	2.12
58	17.1	8.75	0.510	8.220	0.810	228	3.65	75.1	2.10
40	11.7	8.25	0.360	8.070	0.560	146	3.53	49.1	2.04
31	9.13	8.00	0.285	7.995	0.435	110	3.47	37.1	2.02
28	8.25	8.06	0.285	6.535	0.465	98.0	3.45	21.7	1.62
24	7.08	7.93	0.245	6.495	0.400	82.8	3.42	18.3	1.61
21	6.16	8.28	0.250	5.270	0.400	75.3	3.49	9.77	1.26
18	5.26	8.14	0.230	5.250	0.330	61.9	3.43	7.97	1.23

American standard wide-flange shapes are designated by the letter W followed by the nominal depth in inches with the weight in pounds per linear foot given last.

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

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **WRE 205** (Numerical Methods)

Full Marks : 140 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**.

Use reasonable value of any missing data. Notations have their usual meanings.

1. (a) Write down the assumptions of interpolation. Derive the Newton-Gregory interpolation formula for equal intervals. **(8 1/3)**

   (b) Why is the change of origin and scale for equally spaced data useful in interpolation? **(3)**

   (c) Fit the following data into a straight line **(12)**

x	0	1.0	2.0	3.0	4.0
y	1.1	1.7	3.4	4.4	6.3

   Does your result give a good fit of the data, justify your answer.

2. (a) When do you use a numerical differentiation instead of analytical differentiation? What is effect of error in difference table? **(4)**

   (b) Describe the forward, backward and central difference methods for numerical differentiation with sketch and hence explain why the central difference method is more accurate than the other methods. **(6)**

   (c) For the following data obtain $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ for x = 1. **(13 1/3)**

x	1.0	1.2	1.4	1.6	1.8	2.0	2.2
y	2.72	3.32	4.05	4.95	6.05	7.39	9.02

3. (a) Derive the four point difference formula. **(8)**

   (b) What are the assumptions in trapezoidal rule and Simpson's rule for numerical integration? What is the order of accuracy of each method and what does this order of accuracy mean? **(5)**

   (c) Use Romberg method to compute $\int_0^1 \frac{1}{1+x}\,dx$, correct to three decimal point. **(10 1/3)**

Contd P/2

WRE 205

4. Given the equation $y' = 3x + \frac{y}{2}$ with y(0)= 1, estimate y(0.2) using the Euler method. Modified Euler method and the 4th order Runge-Kutta method when (i) h = 0.2 and (ii) h = 0.1. Comment on the accuracy of each result. **(23 1/3)**

SECTION – B

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

5. (a) Find a root (up to four decimal points) for the following equation using secant method **(10)**

$$x^3 - 8x^2 + 17x - 10 = 0$$

(b) Find the root (up to four decimal points) for the following equation using method of False position. **(10)**

$$e^{-x} - \sin x = 0$$

(c) Differentiate secant method and Newton raphson method with schematic diagram. **(3 1/3)**

6. (a) Solve the following system of equations by Gauss Elimination method **(10)**

$$5x_1 + 7x_2 + 7x_3 - 9x_4 = 46$$
$$-8x_1 + 4x_2 - 6x_3 = -92$$
$$-x_1 - 7x_2 - 9x_4 = 8$$
$$-4x_1 + 7x_2 + 7x_3 + 4x_4 = 23$$

(b) Find the root of the following equation using Newton-Raphson method. (Correct up to four decimal places) **(10)**

$$e^{-x^2} - \frac{x}{\left(1 + x^2\right)} = 0$$

(c) Define accuracy, precision and significant digit. **(3 1/3)**

7. (a) Solve the following system of linear equation using Gauss-Seidal method. (Do minimum four iteration) **(10)**

$$9x_1 + 8x_2 + 3x_3 - 2x_4 = 150$$
$$-7x_1 - 8x_2 + 8x_3 + 3x_4 = -187$$
$$2x_1 + 6x_2 - 6x_3 + 5x_4 = 49$$
$$-3x_1 + 3x_2 - 3x_3 + 4x_4 = -21$$

Contd P/3

WRE 205

Contd ... Q. No. 7

(b) A storage tank contains a liquid where depth is y and the reference level is such that the tank is half full when y = 0. Liquid is withdrawn at a constant flow rate Q to meet demands. The contents are resupplied at a sinusoidal rate $3Q\sin^2(t)$. **(13 1/3)**

$$d(Ay)/dt = 3Q\sin^2(t) - Q$$

(change in volume = (in flow) – (out flow)

Calculate the depth y from t = 0 to 5 day using step size 0.5 day using finite difference method. The parameter value of A = 1250 m^2, Q = 450 m^3/s, consider that the initial condition is y = 0.

8. (a) Solve the following system of linear equation using LU decomposition method **(12)**

$$-7x - 9y - 8z = -36$$
$$8x - 7y - 7z = 93$$
$$6x + 7y - 5z = 33$$

(b) A function is given by $f(x) = 1 + 2x + 3x^2 + 4x^3$

(i) Using the values of the function and its derivatives at x = 1, determine the values of the function at x = 1.01, 1.10 and 1.50 with the help of the Taylor series expansion and compare these values with the actual values of the function. **(5)**

(ii) Taking Δx = 0.01, 0.10 and 0.50, determine the % error of forward, backward and central differences of the first derivative and second derivative with respect to the point where x = 1. **(6 1/3)**

L-2/T-2/WRE **Date : 06/08/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

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

Sub : **MATH 235** (Vector 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) Show that the line joining the middle points of the oblique sides of a trapezium is parallel to the parallel sides and is half of the sum of lengths of parallel sides. **(11)**

(b) Show that the three vectors $\boldsymbol{A} = 2\boldsymbol{i} + \boldsymbol{j} - 3\boldsymbol{k}$, $\boldsymbol{B} = \boldsymbol{i} - 3\boldsymbol{k}$ and $\boldsymbol{C} = 4\boldsymbol{i} + 3\boldsymbol{j} - \boldsymbol{k}$ are linearly dependent. Determine a relation among them and hence show that the terminal points are collinear. **(12)**

(c) A rigid body is rotating with an angular velocity $\frac{\pi}{4}$ radian per second about an axis which passes through a point (–1, 3, 2) having direction cosines proportional to (3, 2, 7). Find the linear velocity of the body at (9, 11, –7) in the direction (1, 4, –2). **(12)**

2. (a) Derive the Frenet-Serret formulae. **(12)**

(b) Find the value of the constants a, b, c so that the directional derivative of $\phi = ax^2 + by^2 + cz^2$ at (1, 1, 2) has a maximum magnitude 4 in the direction parallel to y-axis. **(11)**

(c) Show that the velocity field represented by $\boldsymbol{F} = (z^2 + 2x + 3y)\boldsymbol{i} + (3x + 2y + z)\boldsymbol{j} + (y + 2xz)\boldsymbol{k}$ is irrotational but not solenoidal. Also obtain a scalar Φ such that the grad$\Phi = \boldsymbol{F}$. **(12)**

3. (a) Evaluate $\int_C \boldsymbol{F}.\boldsymbol{dr}$ where $\boldsymbol{F} = \frac{(yi - xj)}{(x^2 + y^2)}$ and C is the square formed by the lines $x = \pm 1$; $y = \pm 1$ in the counter clockwise sense. **(12)**

(b) Evaluate $\iint_s \boldsymbol{F}.\boldsymbol{n}\, \boldsymbol{ds}$, where $\boldsymbol{F} = 2\boldsymbol{i} + \boldsymbol{xj} - 3y^2\boldsymbol{zk}$ and s is the surface of the cylinder $x^2 + y^2 = 16$ included in the first octant between $z = 0$ and $z = 5$. **(12)**

(c) Using Green's theorem evaluate $\oint_c \left[(x^2 y)dx + x^2 dy\right]$ where c is the boundary describe counter clockwise of the triangle with vertices (0, 0), (1, 0), (1, 1). **(11)**

Contd P/2

MATH 235/WRE

4. (a) Verify Stoke's theorem for the function $\boldsymbol{F} = x\boldsymbol{i} + z^2\boldsymbol{j} + y^2\boldsymbol{k}$ over the plane surface $x + y + z = 1$, lying in the first octant. **(18)**

(b) State divergence theorem and evaluate surface integral $\iint_s \boldsymbol{F}.\boldsymbol{n}\, ds$ where $\boldsymbol{F} = (x^2 + y^2 + z^2)(\boldsymbol{i} + \boldsymbol{j} + \boldsymbol{k})$, s is the surface of the tetrahedron $x = 0$, $y = 0$, $z = 0$, $x + y + z = 2$ and $\boldsymbol{n}$ is the unit normal in the outward direction to the closed surface s. **(17)**

SECTION – B

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

5. (a) Following is the distribution of marks obtained by 150 students in Statistics: **(18)**

Marks more than:	0	10	20	30	40	50	60
No. of students:	150	136	120	101	91	35	25

Calculate the mean and the median marks. If 60% of the students pass this test, find the minimum marks obtained by a pass candidate.

(b) Let A, G and H be the Arithmetic mean, Geometric mean and Harmonic mean respectively of n positive numbers, then show that $A \geq G \geq H$. **(17)**

6. (a) 4% of the bulbs produced by MES Co. are known to be defective. Find the probability (using both Binomial and Poisson distributions) that a box of 250 of these bulbs contains at most 5 defective bulbs. **(15)**

(b) The mean weekly sale of the EKK chocolate bar in candy stores was 162.7 bars per store with a standard deviation of 17.9. After an advertising campaign, the mean weekly sale in 25 stores for a typical week increased to 169.4. Was the advertising successful? Use a 5% level of significance. **(10)**

(c) Show that $p(x, \lambda) = \dfrac{e^{-\lambda}\lambda^x}{x!}$, $\lambda > 0$, $x = 0, 1, 2 \ldots$ is a probability distribution function, find its mean as well. **(10)**

7. (a) The personnel manager of a factory wants to find a measure, which he can use to fix the monthly income for persons applying for a job in production department. As an experimental project, he collected the following data of 9 persons form that department referring to years of service and their monthly income. Calculate **(20)**

Contd P/3

MATH 235/WRE

Contd ... Q. No. 7(a)

(i) the two regression equations and the coefficients of correlation.

(ii) what initial start would you recommend for a person applying for a job after having served in a similar capacity in another factory for 12 years?

Year of service	10	8	9	5	7	6	12	11	13
Income in '000	16	13	15	7	10	9	21	20	22

(b) A bag contains 8 green and 10 white balls. Two drawings of 5 balls are made such that (i) the balls are replaced before the second trial (ii) the balls are not replaced before the second trial. Find the probability that the first drawing will give 5 green and the second 5 white balls in each case. **(15)**

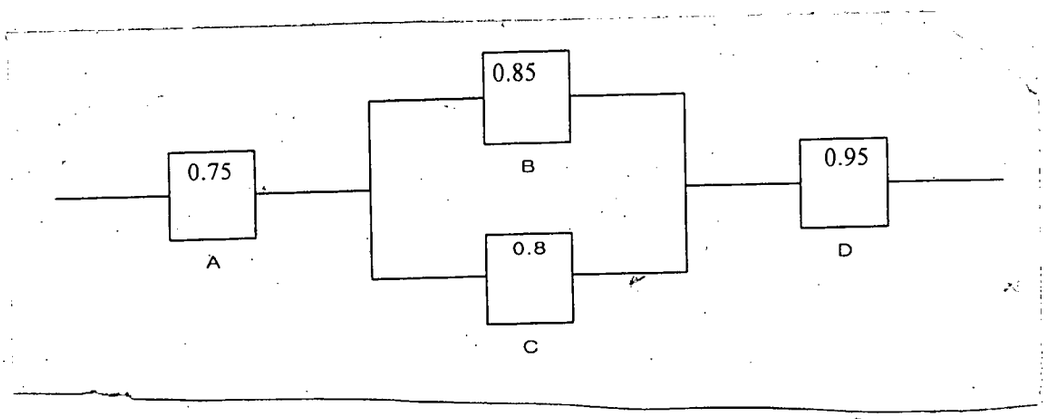
8. (a) The mark in a test is assumed to be normally distributed. It is known that 12% of the students have marks under 40 and 20% exceed 80, what percentage of students have marks between 75 and 95? (Necessary chart 1 is attached). **(18)**

(b) An electrical system consists of 4 components as shown in the following figure. The system works if the components A and D work and either of the components B or C work. The reliability (the probability of working) of each component is also shown in the following figure. Find probability that **(17)**

(i) the entire system works.

(ii) the component B does not work, given that the entire system works.

Assume that the 4 components work independently.



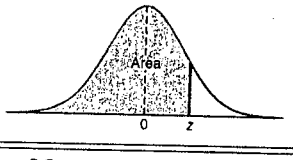


Table A.3 Areas under the Normal Curve

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	0.0351	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	0.0721	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

Chart 1 for Q. 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	0.5438	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	0.9279	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