L-2/T-2/CE **Date : 15/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **CE 213** (Mechanics of Solids II)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Assume reasonable value for any missing data.

SECTION – A

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

1. An overhanging beam of constant flexural rigidity EI is loaded as shown in Fig. 1. Find the elastic curve equation for the portion of the beam AB between supports. Determine the maximum deflection between supports and compare it with the deflection midway between supports. **($26\frac{1}{4}$)**

2. For the cantilever beam shown in Fig. 2, determine the principal stresses at point 'A' that is just below the flange. Show your result on a complete sketch of a differential element including the angle of the planes on which they act. **($26\frac{1}{4}$)**

3. A 100 × 100 × 10 mm angle is welded to a gusset plate and carries a load of 350 kN (see Fig. 3). Determine the lengths of side fillet welds required at the heel and toe of the angle for a non-eccentric connection. Maximum permissible weld is 8 mm considering thickness of the toe. Allowable shearing stress at the throat of the weld is 145 MPa. **($26\frac{1}{4}$)**

   Recalculate the lengths of these two welds assuming that a fillet weld is added along the entire length of the end of the angle.

4. For the beam shown in Fig. 4, determine the maximum deflection and rotation at the support using moment-area method. **($26\frac{1}{4}$)**

   Determine the numerical values for rotation and maximum deflection if P = 4 kN, 4a = 8 metre, $EI = 4.8\times10^6$ N-m^2.

5. If a point is subjected to the state of stress shown in Fig. 5, determine (a) the principal stresses and the corresponding planes on which they act and (b) maximum in-plane shearing stress along with associated normal stress. Construct Mohr's circle of stress and show the results on complete sketches of differential elements. **($26\frac{1}{4}$)**

Contd P/2

CE 213

SECTION – B

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

6. (a) Derive equation of shape of cable subjected to uniformly distributed load with respect to horizontal axis with origin at left end of cable. **(16⅓)**

   (b) For the side span of a suspension bridge, given that cross-section of cable = 60 in^2, Modulus of Elasticity of cable material = 27 × 10^6 psi, Sag ratio = 1/50, uniform horizontal load on cable = 1.1 Kips/ft, tan γ = 0.7, Span = 500 ft. Calculate: (i) Maximum slope of the cable, (ii) Maximum cable tension, (iii) Length of cable and (iv) Unstressed length of cable. **(10)**

7. (a) Describe the necessity of theories of failure? Name at least six yielding theories of failure. **(8⅓)**

   (b) Starting from components of total strain energy, derive the equation of ellipse for maximum energy of distortion failure criteria. **(18)**

8. (a) A plate is attached to the frame of a machine by two side fillet welds as shown in Fig. 6. Determine the size of the welds to resist a vertical load of 12 kips. Assume that the allowable shearing stress through the throat of the weld is 21 ksi. **(13⅓)**

   (b) If the shearing stress in the rivets governs the allowable load P which may be applied to the connection shown in Fig. 7, what is the allowable load P? The rivets are 19 mm and the allowable shearing stress is 100 MPa. All dimensions shown in figure are in mm. **(13)**

9. (a) Using AISC ASD column formulas, select the lightest W shape for a 15 ft long, pin-ended column to carry a concentric concentrated load of 850 kips. Given $\sigma_{yp} = 36\,\text{ksi}$. **(18⅓)**

   (b) Using AISC LRFD column formulas, determine the design compressive strength P_u for the steel column as designed in question 9(a). **(8)**

10. (a) Using elastic strain energy method for the axially loaded bar shown in Fig. 8, prove that, it's elongation due to applied load is: $\Delta = \dfrac{PL}{AE}$. **(6⅓)**

    (b) Using elastic strain energy method for the axially loaded bar shown in Fig. 9, prove that, it's angle of twist due to applied load is: $\Phi = \dfrac{TL}{GJ}$. **(6)**

    (c) Using elastic strain energy method for the beam shown in Fig. 10, prove that, it's deflection at loading point: $\Delta = \dfrac{Pa^2b^2}{3EIL}$. **(14)**

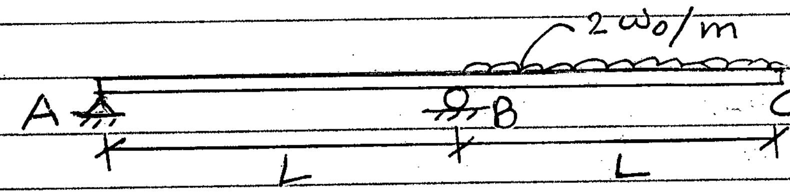


FIG. 1

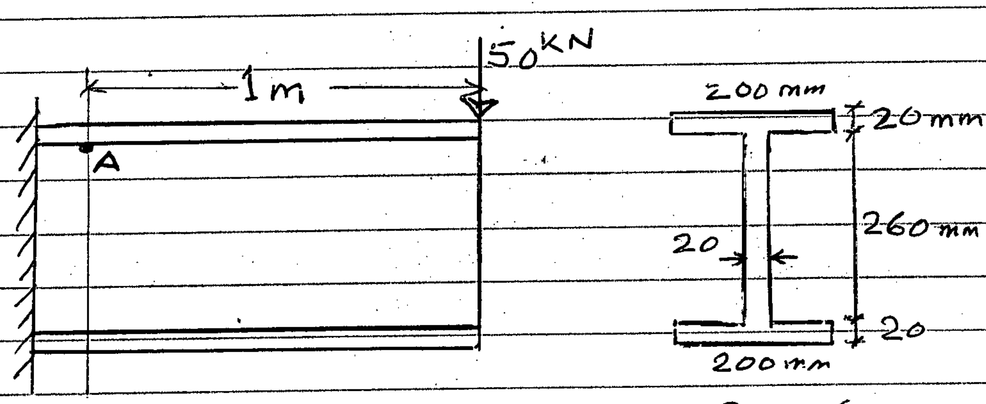


FIG. 2

Beam Sec.

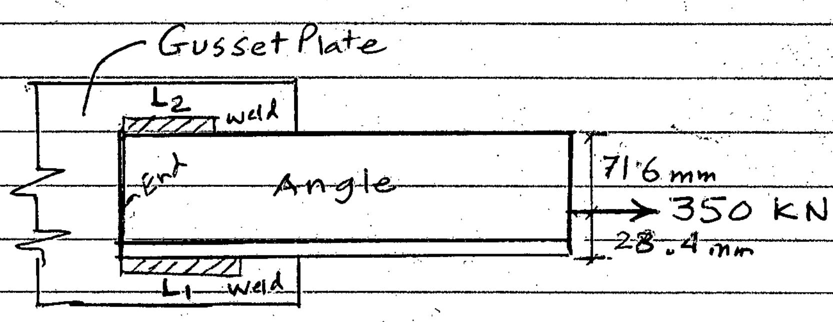


FIG. 3

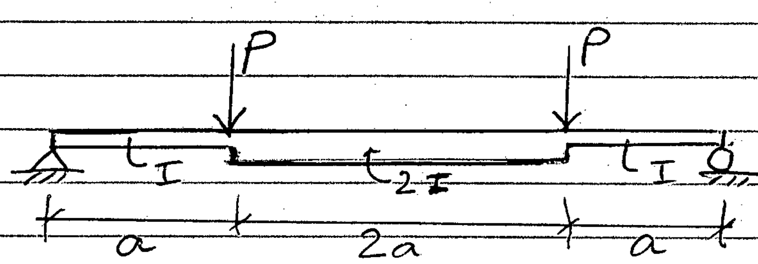


FIG. 4

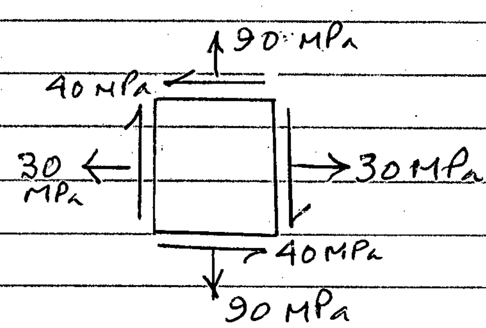


FIG. 5

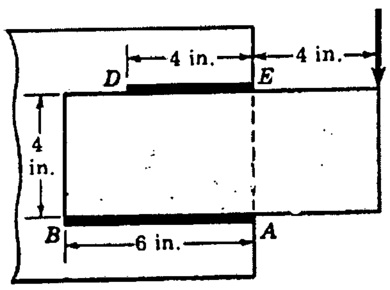


Fig-~~1~~6

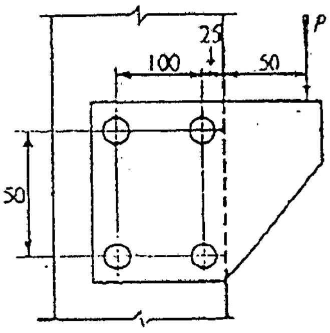


Fig-~~2~~7

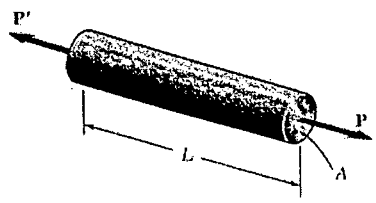


Fig-~~3~~8

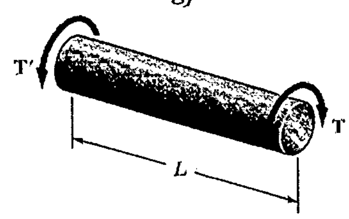


Fig-~~4~~9

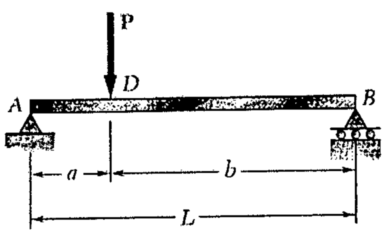


Fig-~~5~~10

Table-1

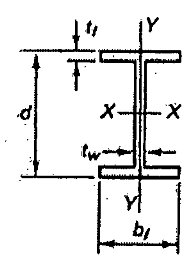


TABLE 4A. AMERICAN STANDARD STEEL W SHAPES DIMENSIONS AND PROPERTIES U.S. CUSTOMARY UNITS (ABRIDGED LIST)

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.

AISC ASD column formulas:

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

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

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

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

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

AISC LRFD column formulas:

the *column slenderness parameter* λ_c is defined as

$$\lambda_c = \frac{L_e}{r\pi}\sqrt{\frac{\sigma_{yp}}{E}}$$

For $\lambda_c > 1.5$, the *critical* buckling stress σ_{cr} is

$$\sigma_{cr} = \left[\frac{0.877}{\lambda_c^2}\right]\sigma_{yp}$$

For values of λ_c less or equal to 1.5:

$$\sigma_{cr} = (0.658^{\lambda_c^2})\sigma_{yp}$$

$$\sigma_{cr} = \left(0.658^{\lambda_c^2}\right) \cdot \sigma_{yp}$$

L-2/T-2/CE **Date : 21/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks: 140 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Derive the general expression of $I = \int_a^b f(x)dx$ using Simpson's rule. **(10)**

(b) The following data have been obtained by throwing a projectile on the sky. Derive the highest possible order of polynomial equation. Also estimate speed corresponding to 165 s [Don't use difference table]. **($13\frac{1}{3}$)**

Time(s)	0	70	140	210	280	350
Speed (m/s)	0.0000	0.0853	0.2759	0.6561	1.3512	3.4560

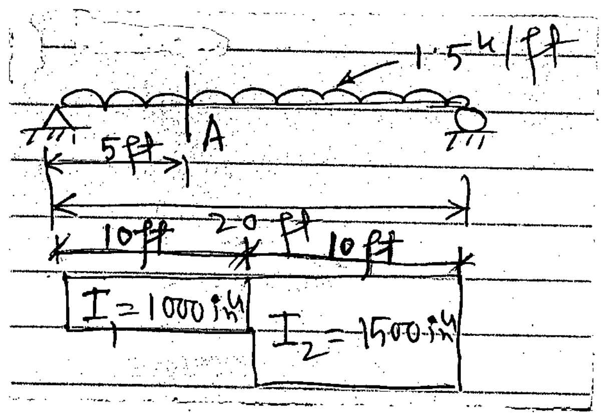
2. (a) Explain the Romberg's Quadrature method analytically. **(10)**

(b) Solve the following system of linear equations by Inverse matrix and Gauss-Jordan method. **($13\frac{1}{3}$)**

$$x + 5y + 6z = 29$$
$$3x + 4y + z = 14$$
$$2x + y + 5z = 19$$

3. (a) Derive the weighing coefficients and associated points for n = 3 in Gauss Quadrature method. **(10)**

(b) Estimate deflection at point 'A' of the following beam. **($13\frac{1}{3}$)**



Given: E = 30 × 10^6 psi.

Contd P/2

CE 205

4. (a) Explain Crout's method analytically. **(8)**

(b) The deflection at various points on a normally loaded plate are shown in the following table. Calculate the bending moments in the plate at points 1, 4, 7 and 16 as shown in fig. 1. **(15⅓)**

Given: Plate thickness = 7 inch

Poisson's Ratio = 0.15

$E = 30 \times 10^6$ psi

Point	Deflection (inch) $\times 10^{-4}$	Point	Deflection (inch) $\times 10^{-4}$
1	2.5	9	4.8
2	3.5	10	3.5
3	4.5	11	4.7
4	3.6	12	4.6
5	3.9	13	4.0
6	3.1	14	3.9
7	4.0	15	3.8
8	4.2	16	3.2

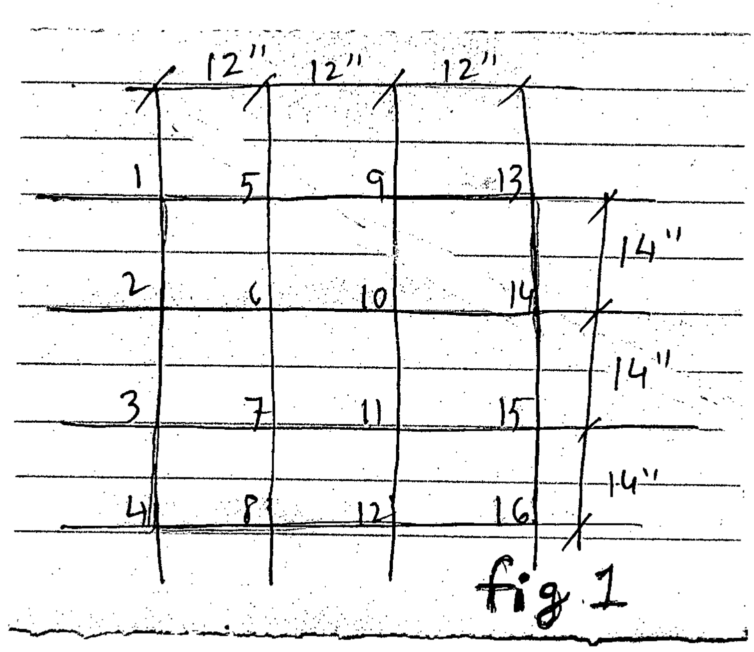


fig. 1

SECTION – B

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

5. (a) Find the root of the following function: **(11)**

$$f(x) = x^3 - \cos x - 2.5$$

applying Newton-Raphson Method. Use an initial guess of $x_0 = 1$. Perform 5 (five) iterations and calculate the approximate error (ε_a) for each iteration performed.

Contd P/3

CE 205

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(b) Solve the same problem using bisection method assuming that the root lies between 0 and $\pi/2$. How many bi-section iterations would it require to determine the root to an absolute error of 0.001 with your initial guess range? **(12⅓)**

6. (a) Use 4th order Runge-Kutta method to solve **(15)**

$$\frac{dx}{dt} = x + 2y$$

$$\frac{dy}{dt} = 3x + 2y$$

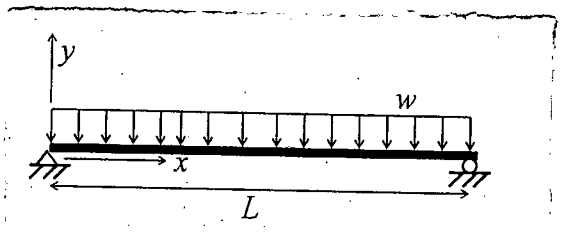
over the range $x = 0$ to 0.04 using a step size of 0.02 with $x(0) = 6$ and $y(0) = 4$.

(b) What is the convergence criteria in fixed point iteration method? Give examples (with diagrams) where the solution using fixed point iteration diverges and converges. **(6)**

(c) How can you improve the estimation of Euler's method for solving differential equations? **(2⅓)**

7. (a) The basic differential equation of the elastic curve for a simply supported, uniformly loaded beam (shown in figure below) is given as **(13)**

$$EI\frac{d^2y}{dx^2} = \frac{wLx}{2} - \frac{wx^2}{2}.$$



Where, E = 30,000 ksi, I = 800 in^4, L = 10 ft, w = 1 kip/ft.

Solve for the deflection of the beam using finite difference approach. Use $\Delta x = 2.5$ ft.

(b) Use nonlinear regression to fit the equation $y = ax^b$ to the data shown in the following table: **(10⅓)**

x	10	20	30	40	50	60	70	80
y	20	50	350	500	630	1150	900	1500

(Determine the coefficients, a, b only, no need to perform goodness-of-fit test)

Contd P/4

CE 205

8. (a) The temperature distribution of a long, thin rod of length 10 cm is described by the equation: **(13)**

$$k\frac{\partial^2 T}{\partial x^2} = \frac{\partial T}{\partial t}$$

where, $k = 0.835$ cm^2/sec. Write down the simultaneous equations (in matrix form) to solve the temperature distribution of the rod at $t = 0.1$ sec given the following:

$\Delta x = 2$ cm, $\Delta t = 0.1$ sec,

initial condition: the temperature of the rod is zero at $t = 0$

boundary condition $T(0) = 100^\circ$ C and $\left.\frac{dT}{dx}\right|_{x=10} = 0$ at all times.

(b) Solve the following equation for $y(1.0)$: $\frac{dy}{dt} = 4e^{0.8t} - 0.5y$ **($10\frac{1}{3}$)**

using a step size of 0.5 with $y(0) = 2$. Use Heun's Method.

L-2/T-2/CE **Date : 25/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **HUM 217** (Engineering Economics)

Full Marks: 140 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols indicate their usual meaning.

SECTION – A

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

1. (a) Clarify the concept of utility in Economics. Narrate the assumptions of the cardinal approach to utility analysis. **($5\frac{1}{3}$)**

(b) Explain the law of diminishing marginal utility with numerical as well as graphical presentations. **(8)**

(c) Briefly describe the basic economic problems that every economy has to face. How are these problems solved with reference to the mixed economic system? **(10)**

2. (a) Distinguish between 'change in quantity supplied" and 'change in supply"? **($5\frac{1}{3}$)**

(b) Graphically explain the interactions between demand and supply of a commodity in the determination of its equilibrium price and quantity in the free market economy. **(8)**

(c) From the following demand and supply functions **(10)**

$$Q_D = 1450 - 75P_Z$$
$$Q_S = 780 + 25P_Z$$

Find the equilibrium price and quantity of the commodity Z. If the Government provides a subsidy of Tk. 3.50 per unit. What will be the new equilibrium price and quantity?

3. (a) What do you know about Ernst Engel's Law and its implications? **($5\frac{1}{3}$)**

(b) Define price elasticity and cross-price elasticity of demand. How would you derive the formulae for measuring these two types of elasticity of demand. **(8)**

(c) Given the demand function of a commodity M **(10)**

$$Q_{dm} = 2250 - 25P_m + 0.005\,M + 3.8\,P_n - 7P_r$$

Where price of M (P_m) is Tk. 80, price of N (P_n) is Tk. 100, price of R (P_r) is Tk. 120 and the level of income (Y) is Tk. 80000. Find the income elasticity and cross-price elasticities of demand for commodity M. What kind of commodity M is? Define the relationship between M and each of the other two commodities based on the results.

Contd P/2

HUM 217/CE

4. (a) What is the basic difference between the cardinal utility approach and the indifference curve approach to consumer demand theory? **(5⅓)**

(b) Clarify the concept of marginal rate of substitution (MRS) and state the properties of an indifference curve. **(8)**

(c) What do you know about the optimum consumption point of a consumer? Illustrate the conditions for achieving the optimum consumption point under the ordinal approach to utility analysis. **(10)**

SECTION-B

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

5. (a) What do you understand by MRTS? Explain any three characteristics of an isoquant. **(10)**

(b) Complete the following table and plot the total product (TP), average product (AP) and marginal product (MP) of labour. **(13⅓)**

Number of workers	Total product (TP)	Average Product (AP)	Marginal Product (MP)
1	8		
2	24		
3	54		
4	82		
5	95		
6	100		
7	100		
8	96		

6. (a) How would you derive the short run supply curve of a firm under perfect competition? **(10)**

(b) Graphically explain the long run equilibrium of a firm under perfect competition. **(13⅓)**

7. (a) Define fixed cost and variable cost. From the following cost function, find the AC, AVC, AFC and MC function. Calculate the amount of output when MC and AVC will be minimum, **(10)**

$$C = \frac{1}{3}Q^3 - 8Q^2 + 122Q + 50$$

(b) How would you derive the long run average cost (LAC) curve of a firm from its short run average cost curves? Explain graphically. **(13⅓)**

8. (a) What do you understand by division of labour? Explain different types of division of labour. **(10)**

(b) Explain the advantages and disadvantages of division of labour. **(13⅓)**

L-2/T-2/CE **Date : 30/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **WRE 211** (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) Write short notes on **(10)**
   - (i) Saturation vapour pressure
   - (ii) Minor losses in pipe flow
   - (iii) Hydrostatic law of pressure
   - (iv) Viscous sublayer.

   (b) A space of 25 mm width between two large plane surfaces is filled with SAE 30 Western lubricating oil at 25°C ($\mu = 2.1\times10^{-1}$ N-s/m^2). What force is required to drag a very thin plate of 0.35 m^2 area between the surfaces at a speed of 0.1 m/s. **(10)**
   - (i) If this plate is equally spaced between the two surfaces?
   - (ii) If it is at a distance of 8.5 mm from one surface?

   (c) Derive Newton's equation of viscosity. Explain why the viscosity of all liquids decrease and that of all gases increase with temperature. **(10)**

   (d) Define and proof Pascal's Law. **(5)**

2. (a) Derive the expression for friction loss with laminar flow. **(10)**

   (b) A cubical block weighing 200 gm and having a 20 cm edge is allowed to slide down on an inclined plane surface making an angle of 20° with the horizontal on which there is a thin film having a viscosity of 2.2×10^{-3} N/s/m^2. What terminal velocity will be attained if the film thickness is 0.025 mm. **(10)**

   (c) For the system shown in Figure 1, pipe dimension are as follows **(10)**

$L_1 = 300$ m	$L_2 = 350$ m	$L_3 = 320$ m
$D_1 = 0.6$ m	$D_2 = 0.4$ m	$D_3 = 0.8$ m
$f_1 = 0.021$	$f_2 = 0.018$	$f_3 = 0.019$

   Find discharge Q considering minor losses.

   (d) Why water rises in capillary glass tube and mercury depress below the glass tube. **(5)**

3. (a) Show the relationship between absolute and gage pressure with a diagram. Explain relative advantages and disadvantages of piezometer and double column manometers. **(10)**

Contd P/2

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(b) Calculate the rate of flow of water from the reservoir A to B for the system shown in Figure 2. Pipe dimensions are as follows: **(10)**

$L_1 = 400$ m	$D_1 = 600$ mm	$e_1 = 2$ mm
$L_2 = 300$ m	$D_2 = 1000$ mm	$e_2 = 0.6$ mm

Considering minor losses, and $\nu = 2\times10^{-6}$ m²/s. Use Moody diagram.

(c) Water at 20°C flows in a 50 cm dia welded steel pipe (e = 0.046 mm). If $h_L/L = 0.006$, determine Q and δ_1. Is the pipe behaving as a wholly rough pipe? **(10)**

(d) Prove that for a constant rate of discharge and a constant value of f, the frictional head loss in a pipe varies inversely as the fifth power of the diameter. **(5)**

4. (a) Differentiate between **(10)**
   - (i) Adhesion and cohesion
   - (ii) Solid and fluid
   - (iii) Newtonian and Non-Newtonian fluid
   - (iv) Compressible and incompressible fluid.

(b) For the pipes connected in parallel as shown in Figure 3, the pipe dimensions and friction factors are as follows: **(10)**

$L_1 = 900$ m	$D_1 = 0.3$ m	$f_1 = 0.021$ m
$L_2 = 600$ m	$D_2 = 0.2$ m	$f_2 = 0.018$ m
$L_3 = 1200$ m	$D_3 = 0.4$ m	$f_3 = 0.019$ m

For a total discharge of 0.6 m³/s, determine the flow through each pipe and head loss from A to B.

(c) Initial distribution of flows through a pipe network is shown in Figure 4. Taking n = 2 for all pipes, obtain flows in each pipe after applying correction twice. Discharge in l/s. **(15)**

SECTION-B

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

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

Use proper notations where needed.

5. (a) Define steady flow, uniform flow, compressible flow and gravity flow. **(6)**

(b) Briefly describe laminar and turbulent flows by using the experiment of Osborne Reynolds. **(6)**

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(c) Water flows at 10 m^3/s in a 150 cm diameter pipe. The head loss in a 1000 m length of this pipe is 20 m. Find the increase in temperature, assuming no heat enters or leaves the pipe. Also find the rate of energy loss due to pipe friction. **(10)**

(d) The diameter of a 20 m long circular pipe reduces from 20 cm at one end to 10 cm at the other end. Calculate the convective acceleration at the exit of the pipe. Water is flowing from the larger to the smaller end. Flow rate = 100 l/s. **(13)**

6. (a) Derive the equations of steady motion along a streamline for ideal and real fluids. **(10)**

(b) Referring to the Figure 5, at B the diameter of the tube is 2.5 cm and the diameter of the water jet discharging into the air at C is 4.0 cm. If h = 2 m, what are the values of the velocity and pressure head at B? What it would be if the tube were cut off at B? Neglect head loss and assume that the tube flows full. **(10)**

(c) Water flows in a circular pipe of radius 30 cm. In a section of the pipe, the maximum velocity at the centre is 3 m/s and varies linearly to zero at the wall of the pipe. One pitot tube is inserted at the centre of the pipe and the other pitot tube is inserted at a distance of 5 cm from the wall. Find the readings of the pitot tubes with respect to the centre of the pipe. If the pitot tubes are connected by a manometer containing a liquid (sp. gravity = 0.082), find the manometer reading. The pressure at the section is uniform and equal to 20 kPa. **(15)**

7. (a) Show that for an orifice in a tank, the magnitude of jet reaction is twice the hydrostatic force of the liquid on the orifice area. **(6)**

(b) Why is momentum correction factor used? Derive the expression for momentum correction factor. **(6)**

(c) Water is flowing under a sluice gate of 3 m width. The flow depths are 2 m at far upstream of the gate and 0.3 m downstream of the gate. If the head loss due to the gate is 0.1 m, compute the force on the gate. **(10)**

(d) In Figure 6, $\theta = 30°$, $V_1 = 30$ m/s, and the stream is a jet of water with an initial diameter of 5 cm. Assume friction losses such that $V_2 = 28.5$ m/s. Find the resultant force on the blade. Also find the jet diameter at the exit. Assume flow occurs on a horizontal plane. **(13)**

8. (a) Show the velocity vector diagrams at the inlet and exit of a centrifugal-pump impeller with radial flow with neat sketches. **(10)**

(b) The water jet in the Figure 7, moving at 12 m/s, is divided by the splitter s that one-third of the water is diverted towards A. Calculate the magnitude and direction of the resultant force on this single stationary blade. Assume ideal flow on a horizontal plane. **(15)**

(c) When a turbine is held so that it cannot rotate, the discharge under a head of 15 cm is found to be 0.85 m^3/s. $\alpha_1 = 35°, \beta_2 = 155°, r_1 = 0.2\text{ m}, r_2 = 0.12\text{ m}$. The area of the water jet at the entrance and exit are 0.078 m^2 and 0.082 m^2 respectively. Find the torque at zero speed. Neglect shock loss. **(10)**

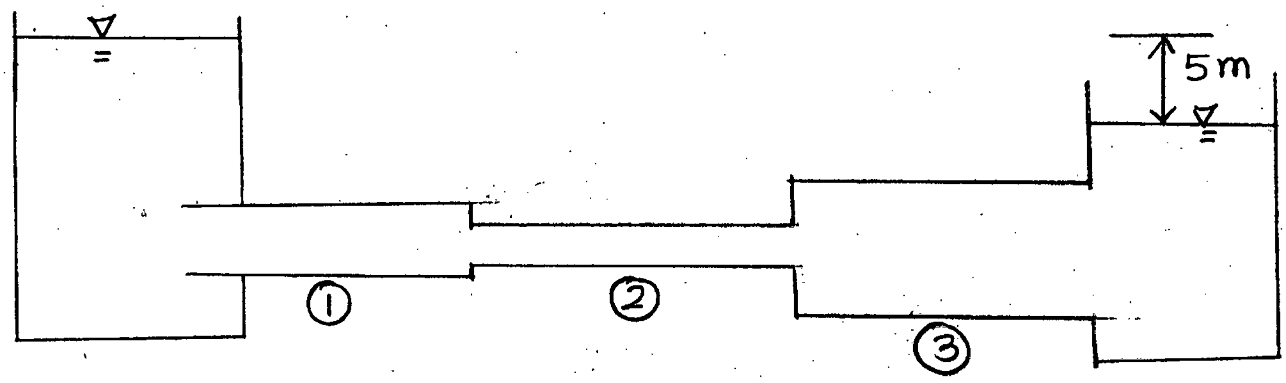

Figure 1 for Question 2(c)

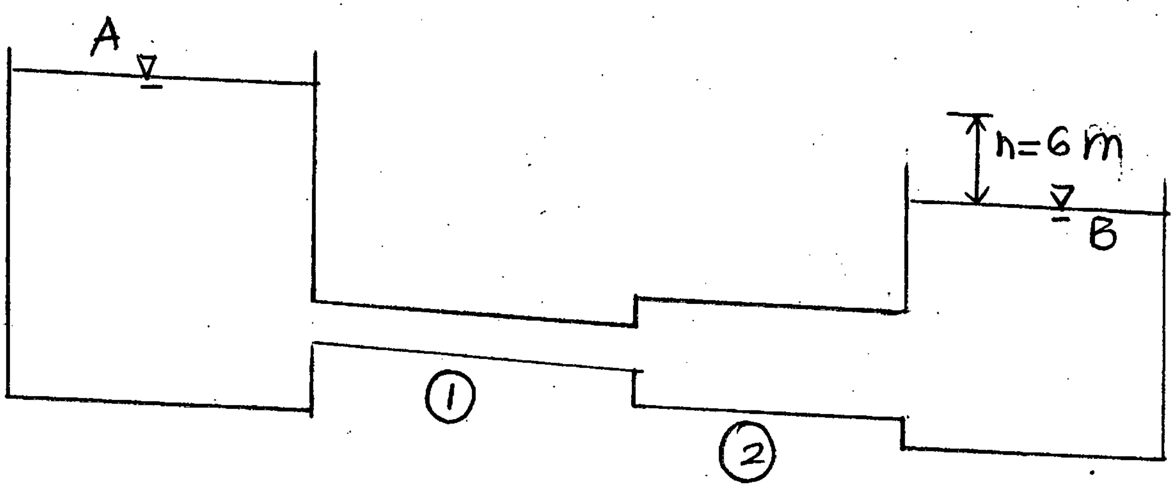

Figure 2 for Question 3(b)

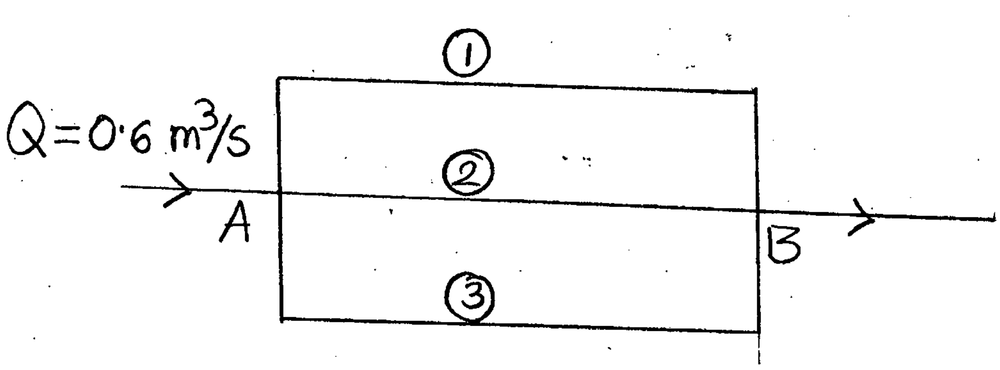

Figure 3 for Question 4(b)

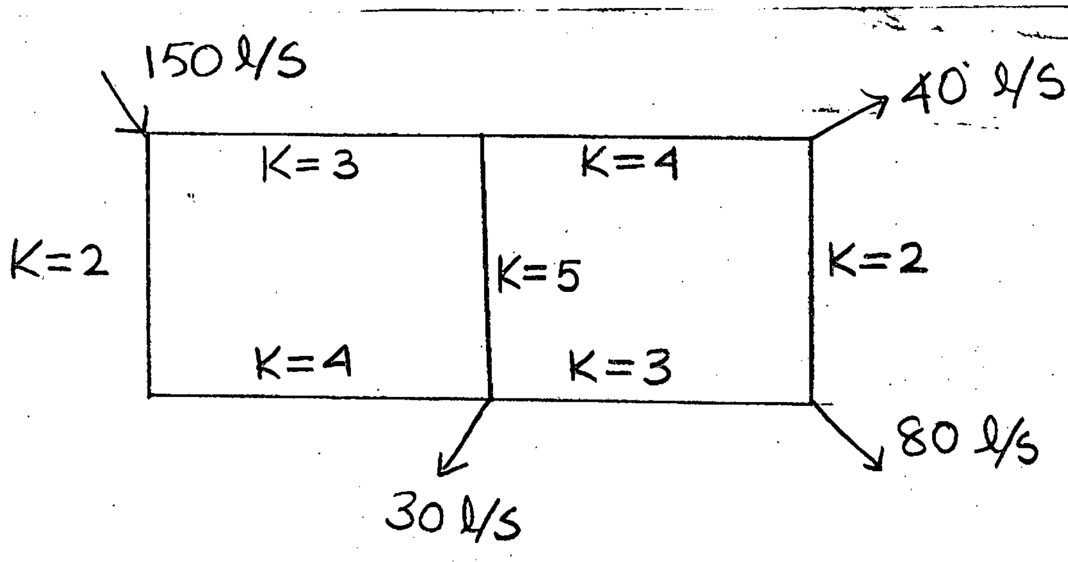

Figure 4 for Question 4(c)

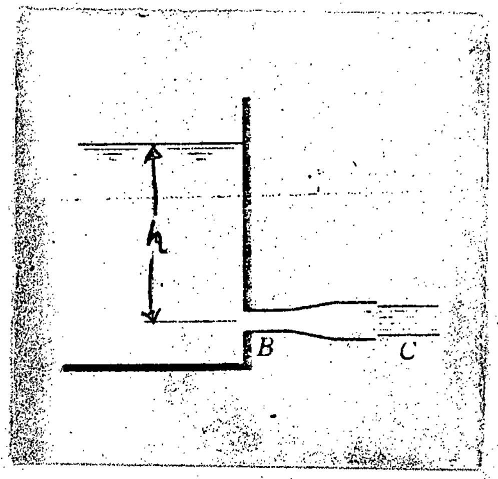

Figure 5 for Q. No 6(b)

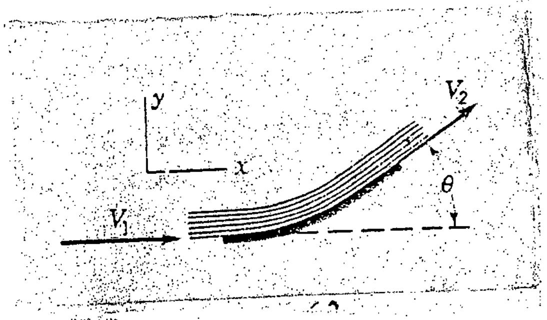

Figure 6 for Q. No 7(d)

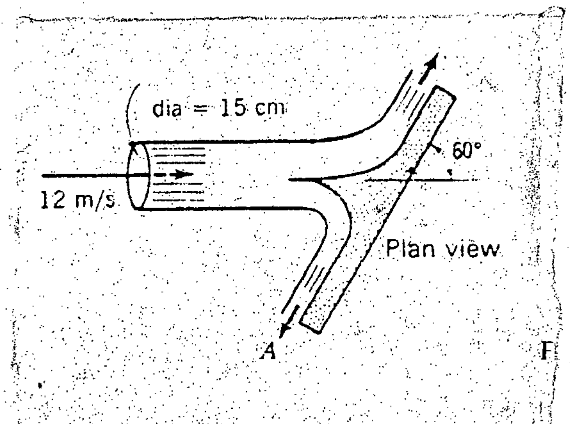

Figure 7 for Q. No 8(b)

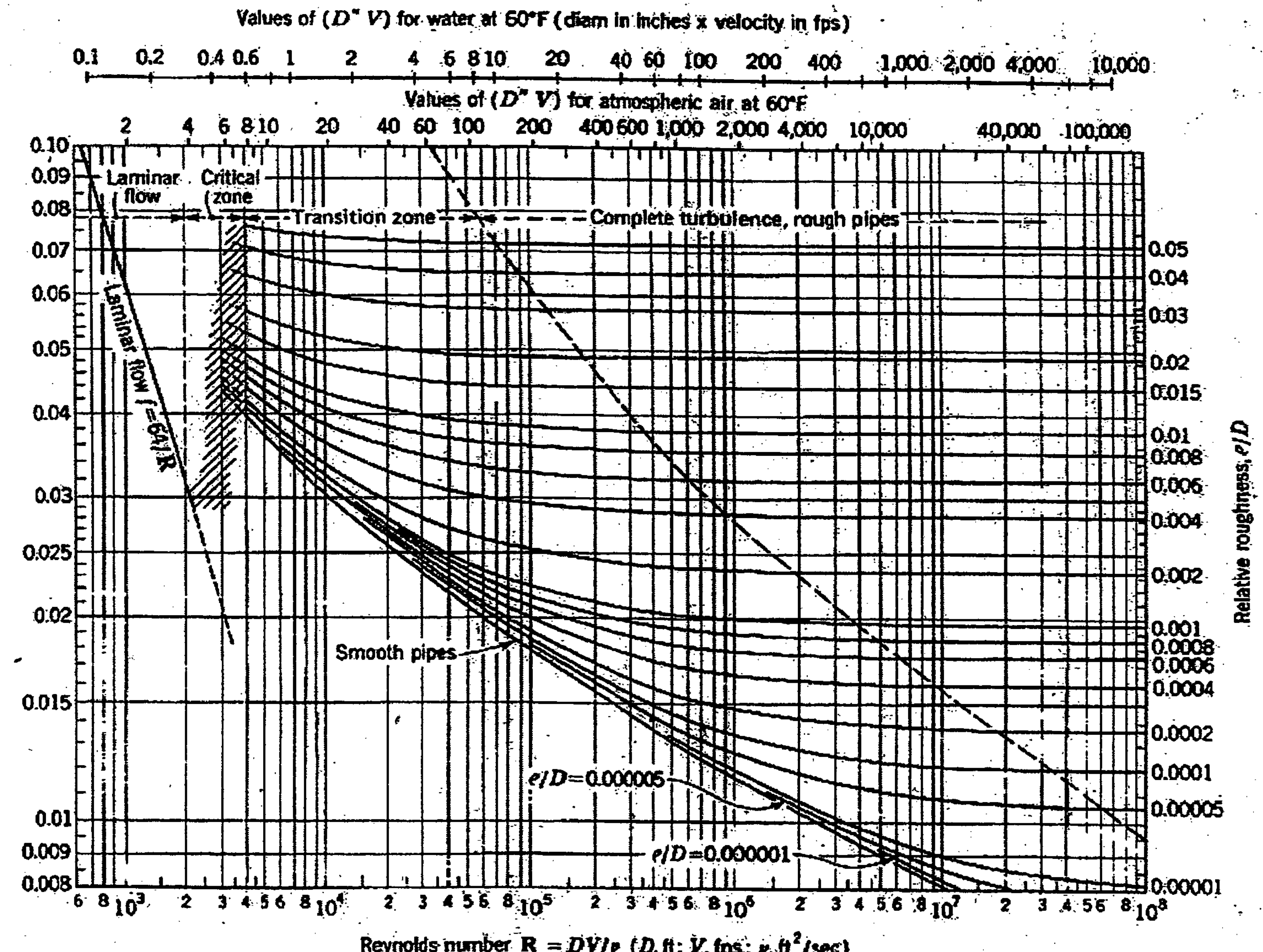

Figure: Moody Diagram for friction factor.