L-2/T-2/CHE **Date: 17/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2016-2017

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.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) For the loading shown in figure for Q. No. 1(a), find the maximum force P that can be applied neglecting the weight of all members. Consider maximum vertical movement of P is 5 mm. **(20)**

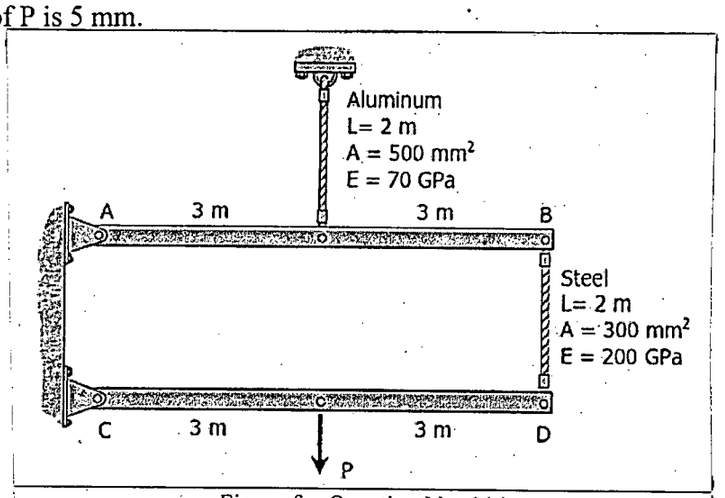


Figure for Question No. 1(a)

(b) Show that for a thin walled cylinder, tangential stress is twice the value of longitudinal stress. **(15)**

2. (a) A crane hook of trapezoidal cross-section supports load P as shown in figure for Q. No. 2(a). If the allowable stress in either tension or compression is 120 MPa, determine the maximum load P that can be supported. **(20)**

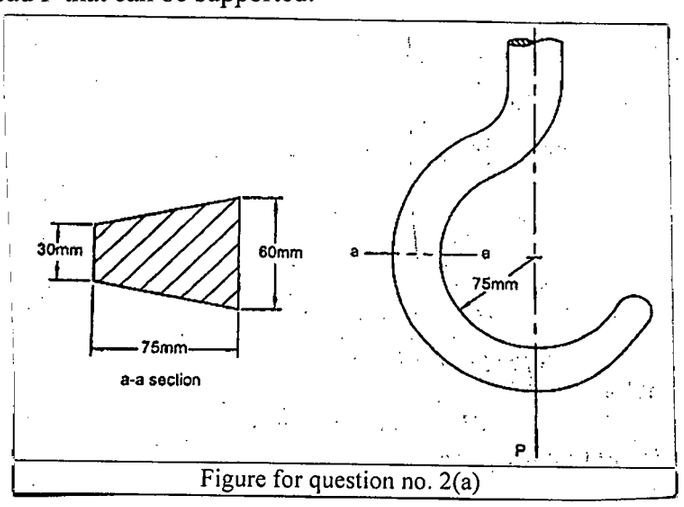


Figure for question no. 2(a)

(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)**

Contd P/2

ME 243/CHE

3. The state of plane stress at a point with respect to the xy-axes is shown in figure for Q. No. 3. Using Mohr's Circle, **(35)**

   (i) Determine the principal stresses and principal planes.

   (ii) Determine the maximum in-plane shear stress and the plane where it occurs.

   (iii) Show the principal stresses, principal planes and maximum in-plane shear stress on sketches of properly oriented elements.

   (iv) Find the equivalent state of stress with respect to the $x'y'$ axes.

   (v) Show the equivalent state of stress calculated in Q. No. 3 (iv) on sketches of properly oriented elements.

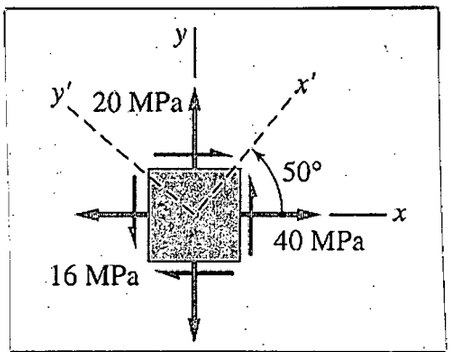


Figure for question no. 3

4. (a) A 6 m long column is hinged at both ends. Find the value of maximum axial load it can support if the yield strength and modulus of rigidity of the column material is 350 MPa and 200 GPa respectively. The cross-section of the column is shown in figure for Q. No. 4 (a). **(17)**

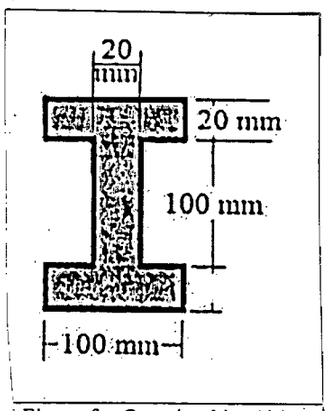


Figure for Question No. 4(a)

(b) A timber beam is reinforced at the bottom only by a steel plate as shown in figure for Q. No. 4(b). Determine the moment that can be resisted by the beam if the allowable stress in timber σ_t = 8 MPa and that in steel σ_s = 125 MPa. Consider n = 15. **(18)**

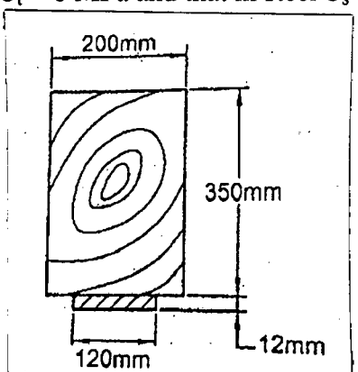


Figure for Question No. 4(b)

Contd P/3

ME 243/CHE

SECTION – B

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

5. (a) Draw the shear force and bending moment diagrams for the loaded beam as shown in Figure 5(a). Specify values at all change of loading positions. Also specify the value of maximum bending moment and the location where it occurs. **(17)**

(b) A beam of T-section supports concentrated loads as shown in Figure 5(b). Find the maximum value of P if the limiting stresses in tension and compression are 35 MPa and 75 MPa respectively. **(18)**

6. (a) A simply supported beam carries uniformly distributed loads of **w** symmetrically placed from its ends as shown in Figure 6(a). Using double integration method, find an expression of maximum deflection. **(17)**

(b) Using area-moment method, find the deflection of point B, for the loaded cantilever beam, as shown in Figure 6(b). The cross-section of the beam is 40 mm wide and 130 mm high. Consider E = 79 GPa. **(18)**

7. (a) Determine the maximum torque that can be transmitted by a hollow circular shaft of outer diameter of 130 mm and inner diameter of 90 mm, if the maximum shearing stress is limited to 65 MPa and the angle of twist limited to 1.5°/m. Consider modulus of rigidity G = 80 GPa. **(17)**

(b) An aluminum shaft of diameter 35 mm is connected with four gears, which are subjected to torques, as shown in Figure 7(b). Determine the relative angle of twist of gear A with respect to gear D, if the modulus of rigidity G = 30 GPa. **(18)**

8. (a) One steel bar A and one bronze bar B are supported by rigid walls at 20°C such that there is a gap of 0.4 mm between them, as shown in Figure 8(a). Determine the stresses in each bar at 140°C. **(17)**

(b) An equiangular strain rosette placed on the surface of a stressed machine part reveals strains along the ε_0, ε_{60} and ε_{120} directions equal to 0.000400, -0.000300 and 0.000600 respectively. If E = 200 GPa and μ = 0.30, determine the principal stresses and their directions relative to the assumed 0° direction. **(18)**

ME-243 (CHE)

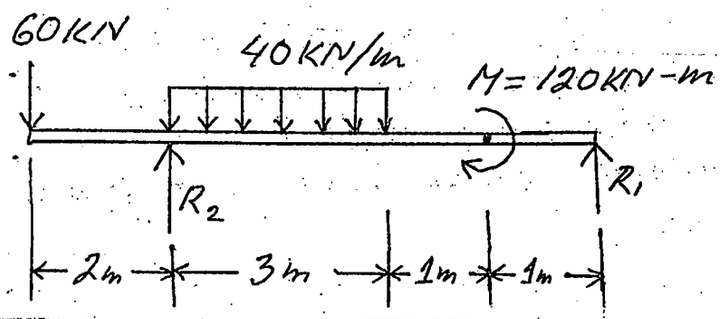
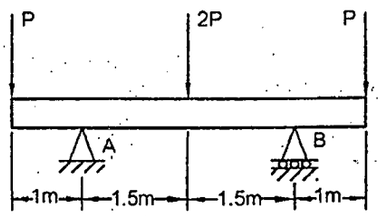


Figure 5(a)



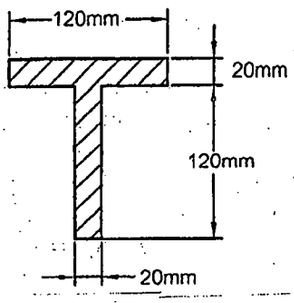


Figure 5(b)

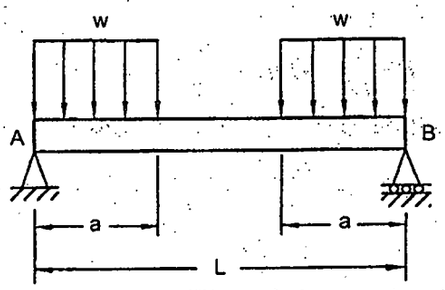


Figure 6(a)

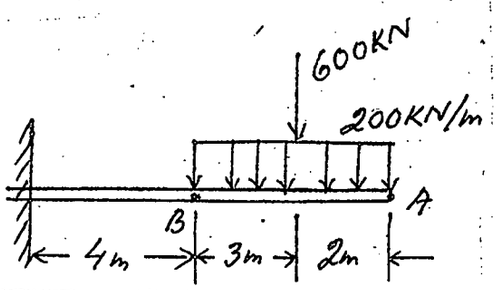


Figure 6(b)

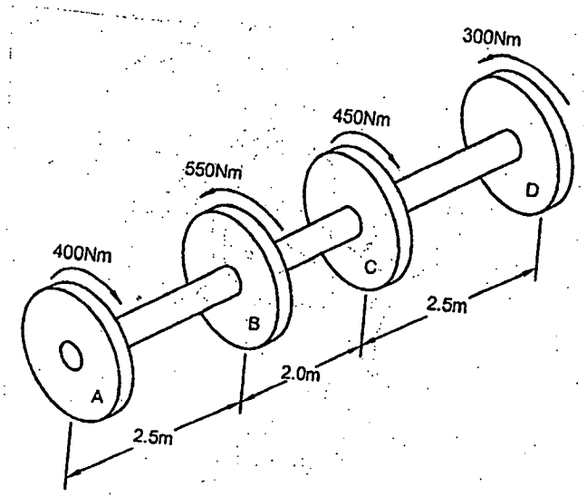


Figure 7(b)

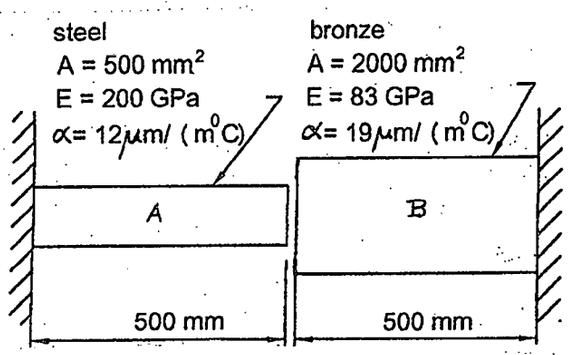


Figure 8(a)

L-2/T-2/ChE **Date : 22/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2016-2017

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) Use the fixed point iteration method to find a real root, correct to four decimal places of the equation. **(17)**

$$\cos x = 3x - 1$$

(b) Derive Newton's general interpolation formula with divided difference method and apply the formula to find a polynomial $f(x)$ which approximates the following data: **(18)**

x	– 1	0	3	6	7
$f(x)$	3	– 6	39	822	1611

2. (a) Determine the constants a and b by the method of least squares such that $y = ae^{bx}$ fits the following data: **(17)**

x	0	0.5	1.0	1.5	2.0	2.5
y	0.10	0.45	2.15	9.15	40.35	180.7

(b) From the following table, find the value of $e^{1.17}$ of using Gauss' forward formula: **(18)**

x	1.00	1.05	1.10	1.15	1.20	1.25	1.30
e^x	2.7183	2.8577	3.0042	3.1582	3.3201	3.49	3.67

3. (a) Use Romberg's method of integration to compute $\int_0^1 \frac{1}{1+x}\,dx$ correct to three decimal places with h = 0.5, 0.25, 0.125. **(17)**

(b) The distances travelled by a rocket at different times are as given below:

t (time)	0	1	2	3	4	5
s (distance)	0	3	7	15	38	50

Estimate the rocket's velocity and acceleration at time t = 1. **(18)**

Contd P/2

MATH 223/ChE

4. (a) Use Newton-Raphson method to find the roots of the simultaneous equations

$$x^2 - y^2 = 3$$
$$x^2 + y^2 = 13$$

with $x_0 = y_0 = \sqrt{6.5}$. **(17)**

(b) Derive Simpson's 3/8 rule and use this rule to find $\int_0^2 \frac{dx}{x^3 + x + 1}$ with 12 strips. **(18)**

SECTION – B

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

5. (a) Solve $\frac{dy}{dx} = y - x^2$, $y(0) = 1$ by Picard's method up to third approximation. Hence find the value of y(0.2). **(17)**

(b) Compute y(0.2) by Runge-Kutta method of 4^{th} order for the following differential equation $\frac{dy}{dx} = xy + y^2$, $y(0) = 1$ **(18)**

6. (a) For the following data compute the values of quartiles, 6^{th} decile and 20^{th} percentile.

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
No. of Students	5	25	40	70	90	40	20	10

Comment on your result. **(17)**

(b) The following table shows the experience (X) and the performance rating (Y) of 5 persons: **(18)**

X	16	12	18	4	3
Y	87	88	89	68	58

(i) Fit a linear regression model Y on X.

(ii) Is the linear model appropriate for given data, Justify your result using coefficient of determination?

Contd P/3

MATH 223/ChE

7. (a) An important factor in solid missile fuel is the particle size distribution. Significant problems occur if the particle sizes are too large. From production data in the past, it has been determined that the particle size (in micrometers) distribution is characterized by **(16)**

$$f(x)=\begin{cases} kx^{-4}, & x>1 \\ 0, & elsewhere \end{cases}$$

(i) For which value of k is a valid density function. Plot the density function.

(ii) Evaluate $F(x)$.

(iii) What is the probability that a random particle from the manufactured fuel exceeds 4 micrometers?

(iv) Give the mean and variance of the particle size.

(b) Find the mean and variance for the Binomial distribution. **(10)**

(c) Service calls come to a maintenance center according to a Poisson process, and on average, 2.7 calls are received per minute. Find the probability that **(9)**

(i) no more than 4 calls come in any minute.

(ii) more than 10 calls come in a 5 minute period.

8. (a) An article in Knee Surgery showed a mean time of 129 minutes and a standard deviation of 14 minutes for ACL reconstruction surgery at high-volume hospitals (with more than 300 such surgeries per year). (i) What is the probability that your ACL surgery at a high volume hospital requires a time more than two standard deviations above the mean? **(20)**

(ii) What is the probability that your ACL surgery at a high volume hospital is completed in less than 100 minutes?

(iii) The probability of a completed ACL surgery at a high volume hospital is equal to 95% at what time?

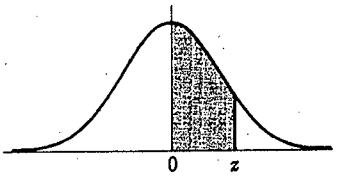
(iv) If your surgery requires 199 minutes, what do you conclude about the volume of such surgeries at your hospital? Explain. (Necessary table attached).

(b) A random sample of 100 recorded deaths in Bangladesh during the past year showed an average life span of 61.8 years. Assume a population standard deviation of 4.9 years, does this seem to indicate that the mean life span today is different than 60 years? Use a 0.05 level of significance. (Necessary table attached) **(15)**

For 9N.8

Appendix II

Areas Under the Standard Normal Curve from 0 to *z*



z	0	1	2	3	4	5	6	7	8	9
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0754
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2258	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
0.7	.2580	.2612	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2996	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	.4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	.4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998	.4998
3.6	.4998	.4998	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.7	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.8	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.9	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000

L-2/T-2/CHE **Date: 27/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2016-2017

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) Discuss the assumptions of perfect competition. **(5)**

   (b) Explain the short run equilibrium of a firm under perfect competition. **(10)**

   (c) Define the concept of long run in the theory of production. How would you derive a long run average cost (LAC) curve of a firm from its short run average cost curves? Why is LAC curve often called the planning curve? **(10)**

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

   $TR = 5900Q - 10Q^2$

   $TC = 2Q^3 - 4Q^2 + 140Q + 845$

   Where Q is quantity of output

   (i) Set up the profit function

   (ii) Find out the quantity which will make the profit maximum

   (iii) Calculate the maximum profit and verify that is maximized.

2. (a) Explain the concept of production function. **(10)**

   (b) Illustrate the various returns to scale of production. **(15)**

   (c) State and prove the application of Euler's theorem in the theory of distribution of production. **(10)**

3. (a) Discuss the circular flow of income and expenditure in a two sector economy. **(7)**

   (b) Discuss the concept of inflation. Explain the various causes of inflation. **(8)**

   (c) Briefly discuss the monetary policy, fiscal policy and trade policy for controlling inflation with reference to the context of Bangladesh. **(10)**

   (d) Calculate national income from the following information: **(10)**

   GNP = Tk. 1,22,000 crore

   Depreciation = Tk. 9,500 crore

   Indirect tax = Tk. 11,000 crore

   Subsidy is 25% of indirect tax.

4. (a) Describe the assumptions of ordinal approach to utility analysis. **(10)**

   (b) What is an indifference curve? Describe the properties of an indifference curve. **(10)**

   (c) Illustrate the optimal consumption point of a consumer given his/her indifference map and budget line. **(15)**

Contd P/2

HUM 103/CHE

SECTION – B

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

Symbols indicate their usual meaning.

5. (a) What is a market supply curve? Describe the common factors that affect supply of a commodity in the market. **(20)**

(b) Following are the demand and supply functions of Maxell super ball pen respectively **(15)**

$Q_{Dm} = 1950 - 48P_m$

$Q_{Sm} = 990 + 63P_m$

Find the equilibrium price and quantity of Maxell super ball pen. If a 18% supplementary tax is imposed on unit price, what would be the new equilibrium price and quantity? What is the proportion of this tax that the suppliers are likely to bear.

6. (a) What do you understand by 'economic growth' and 'economic development'? Describe the three core values of development. **(15)**

(b) Define 'Lorenz curve' and 'Gini coefficient'. How would you measure inequality of income distribution of a country using these concepts? (You may use hypothetical data) **(20)**

7. (a) What is the main purpose of a Cost-Benefit Analysis (CBA)? Explain the present value (PV) approach and internal rate of return (IRR) approach to a Cost-Benefit Analysis (CBA). **(15)**

(b) Evaluate the miraculous economic development of China. What lessons can Bangladesh learn from the experience of Chinese economic development? **(20)**

8. Write short notes on any THREE of the following: **(35)**

(a) Fundamental economic problems

(b) The mechanism of market equilibrium

(c) Substitution effect and income effect of a price change

(d) Elasticity of demand and Engle's law.

L-2/T-2/CHE **Date: 05/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2016-2017

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) State the condition for aromaticity. Draw the structures of the following and show whether they are aromatic or not. **(3+6=9)**

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

   (ii) Cycloheptatriene

   (iii) Isoquinoline

   (b) Explain the difference between hybridization of nitrogen in pyrrole and pyridine. **(5)**

   (c) Give the general method for the synthesis of the three five-membered heterocycles starting from the same compound. **(6)**

   (d) How would you carry out the following conversions? **(5×3=15)**

   (i) 2-Phenylazopyrrole from pyrrole

   (ii) 2-Chlorothiophene from thiophene

   (iii) Tetrahydrothiophene from thiophene

   (iv) 2-Lithiumfuran from furan

   (v) Pyrrole-2-aldehyde from pyrrole

2. (a) Give a view of the molecular orbital picture of pyridine. Apply Huckel rule to prove the aromaticity of pyridine. Show the resonance structure of pyridine. **(3+2+2=7)**

   (b) Deduce a tentative structure for pyridine by degradative methods and confirm it by a synthesis. **(8)**

   (c) Justify with example that pyridine undergoes nucleophilic substitution reaction at C-2 position. **(8)**

   (d) How can pyridine be converted into the following? **(4×3=12)**

   (i) Piperidine

   (ii) Pyridine-3-sulphonic acid

   (iii) N-Methylpyridinium bromide

   (iv) 2-Hydroxypyridine.

Contd P/2

CHEM 221/CHE

3. (a) Give the Fischer-Indole synthesis of indole and skraups synthesis for quinoline with mechanism. **(10)**

(b) Unlike pyrrole, indole undergoes electrophilic substitution at C-3 position. Justify the statement with examples. **(9)**

(c) Write the structure of thioindigo. How will you obtain thioindigo from anthranilic acid? **(2+5=7)**

(d) What happens when indole is treated with **(3×3=9)**

(i) methyliodide in DMSO at 80°C

(ii) Benzene diazonium chloride in acidic solution

(iii) Chloroform in presence of alkali.

4. (a) What are alkaloids? Discuss their isolation from plant materials with a flow-diagram. **(10)**

(b) Write down the structures of the following alkaloids and classify them on the basis of heterocyclic rings present in their structure. **(5×2=10)**

(i) Quinine

(ii) Papavarine

(iii) Gramine

(iv) Cuscohygriene

(v) Nicotine

(c) Describe how the nature of nitrogen groups can be identified in the structure of alkaloids. **(8)**

(d) Explain the Zeisel's method for the determination and estimation of methoxyl groups in an alkaloid. **(7)**

SECTION – B

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

5. (a) What is conformation? Show the energy diagram of different conformers of cyclohexane. **(8)**

(b) How can you prepare isohexane from isopropyl bromide? **(5)**

(c) Give the mechanism for chlorination of ethane under diffuse sunlight. **(8)**

(d) Explain the catalytic hydrogenation due to preparation of alkanes with examples. **(6)**

(e) If the relative reactivity of hydrogen for bromination of isobutene is H:3°:2°:1°=1600:82:1.0, calculate the percentage yield of the products. **(8)**

Contd P/3

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6. (a) Compare the relative reactivity of alkane and alkene. Explain in terms of hybridization. **(6)**

(b) Draw the structure of the following alkenes: **(2×4=8)**

(i) 2-Methyl-bicyclo[3.2.2]non-6-ene

(ii) Bicyclo[3.2.1] oct-2-ene

(iii) 3-methylcycloheptene

(iv) 1,6-dimethylcyclohexene.

(c) Compare the polarity of cis-alkene and trans-alkene? Give examples. **(5)**

(d) How can you prepare trans-2-methyl-cyclopentanol from 1-methyl-cyclopentene? **(6)**

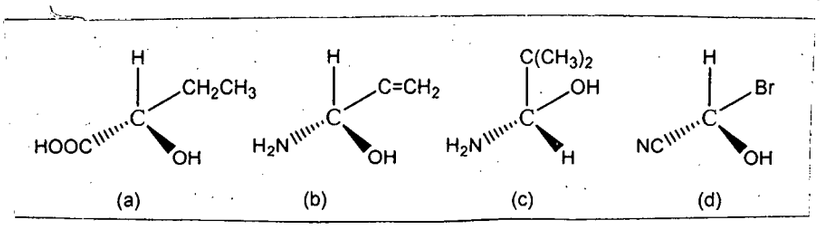
(e) Explain the formation of dichlorocarbene compound from cyclopentene. **(10)**

7. (a) Give the mechanism of bromination of 2-butyne. **(6)**

(b) Discuss the acidity of alkyne. How can you prepare alkyne from germinal dichloride? **(5)**

(c) What is stereogeneic center? Level stereogeneic centers and draw all possible stereoisomers of $CH_3CH(OH)CH(OH)COOH$. **(8)**

(d) Identify and R-and-S-configuration for following compounds: **(2×4=8)**



(e) How a compound can be achiral although it contain chiral centre? Discuss the stereochemistry of disubstituted cycloalkanes. **(8)**

8. (a) Discuss the reactivity of vinyl halide and allylic halide in terms of hybridization. **(6)**

(b) Explain the nucleophilicity and basicity of NH_3 and H_2O. **(6)**

(c) Discuss the effect of protic and aprotic solvents for substitution reaction. **(5)**

(d) How an optical active alkyl halide can become optical iactive after nucleophilic substitution reaction? **(6)**

(e) Explain the possible spectroscopic analysis of $CH_3CH_2CH_2NH_2$. **(12)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2016-2017

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**.

Assume reasonably if any additional data/information is required.

1. (a) Explain briefly the characteristics of a centrifugal pump operating at constant speed with the help of an appropriate graphical demonstration. **(7)**

(b) List and describe all the energy losses which are required to be considered for the design of a centrifugal pump. Show graphically the typical relationship among those losses. **(10)**

(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 in metres 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 1,800 rpm is given in the following table. **(18)**

Operation at1,800 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 rate of flow under the following conditions: (i) Two pumps in series, each operating at 1,800 rpm; (ii) Two pumps in parallel, each operating at 1,800 rpm.

2. (a) Discuss the importance and applications of geometric, kinematic and dynamic similarities in the context of similitude and dimensional analysis. **(10)**

(b) Write down the prerequisite, benefits and limitation of dimensional analysis. **(7)**

(c) By dimensional analysis through the use of Buckingham π theorem, determine the expression for the shear stress at the wall when an incompressible fluid flows in a pipe under pressure. The significant parameters are velocity of flow V, diameter of pipe D, and viscosity μ and density ρ of the fluid. **(18)**

Contd P/2

CHE 205

3. (a) Consider the system pictured in the figure given below, in which the cylindrical rod is being moved with a velocity V. The rod and cylinder are coaxial. Applying shell-momentum balance, determine the steady-state velocity distribution and the volume rate of flow. **(18)**

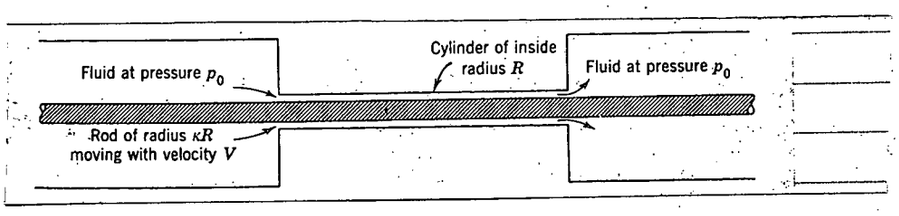


Fig. 3(a): Annular flow with inner cylinder moving axially.

(b) Momentum balance is completely equivalent to Newton's law of motion — elaborate. **(8)**

(c) With an appropriate example, show the application of 'Equation of Continuity' in solving fluid flow problem. **(9)**

4. (a) Describe the working principle and application of the following fluid measurement device: **(5×5=25)**

   (i) Saybolt viscometer
   (ii) Borda tube
   (iii) Piezometer ring
   (iv) Particle image velocimetry
   (v) Hydrometer

(b) A pump is to discharge 10.0 m^3/s at a head of 5.0 m when running at 300 rpm. What type of pump will be required? Suppose the required speed is 450 rpm. What could then be done? **(10)**

SECTION – B

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

5. (a) The bulk modulus for water at standard conditions is approximately 2100 MPa. What will be the volume change of 2 m^3 water at standard conditions if 10 MPa is applied? **(12)**

(b) Derive and explain Newton equation of viscosity, $\tau = \mu \frac{du}{dy}$. **(10)**

(c) Calculate the vacuum necessary to cause cavitations in a water flow at a temperature 25°C under atmospheric pressure. Use the properties of water given below. **(13)**

Given: 1 torr = 0.1333 kPa

Contd P/3

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Contd... Q. No. 5(c)

Selected physical properties of water	
molar mass	18.0151 grams per mole
melting point	0.00 °C
boiling point	100.00 °C
maximum density (at 3.98°C)	1.0000 grams per cubic centimetre
density (25°C)	0.99701 grams per cubic centimetre
vapor pressure (25°C)	23.75 torr
heat of fusion (0°C)	6.010 kilo joules per mole
heat of vaporization (100°C)	40.65 kilojoules per mole
heat of formation (25°C)	–285.85 joules per mole
entropy of vaporization (25°C)	118.8 joules per °C mole
viscosity	0.8903 centipoise
surface tension (25°C)	71.97 dynes per centimeter

6. (a) A tank 20 ft deep and 7 ft wide is layered with 8 ft of oil, 6 ft of water, and 4 ft of mercury (Fig. for Question No. 6(a)). Compute (i) the total hydrostatic force and (ii) the resultant center of pressure of the fluid. **(18)**

(b) In Fig. for Question No. 6(b) the pressure at point A is 25 lb_f/in^2. All fluids are at 25°C. What is the air pressure in the closed chamber B? (SG is specific gravity) **(17)**

7. (a) What do you understand by the minor losses in pipe flow? Explain with examples. **(10)**

(b) Water (ρ = 64.4 lb/ft^3 and $v = 0.000011\ ft^2/s$) is pumped between two reservoirs at 0.2 ft^3/s through 400 ft of 2-in-diameter pipe and several minor losses, as shown in Fig. for Q. No. 7(b). The roughness ratio $\varepsilon/d = 0.001$. **(25)**

(i) Write down the energy equation between point 1 and 2

(ii) Compute the required power for the pump.

Use the k values in the table for Q. No. 7(b) for valves, elbows and tees and assume $k = 0.5$ for the rest.

8. (a) "Bernoulli's equation is essentially the equation of steady motion along a streamline for an ideal fluid" — justify this statement with necessary equations and diagrams. **(12)**

(b) Find a relation between nozzle discharge velocity V_2 and tank free surface height h as shown in figure for Q. No. 8(b). Assume steady frictionless flow. Additionally, determine how long it takes for the water level in the tank to drop to h_2 (i.e. 2 ft from the bottom). Tank data are given below: **(23)**

Cylindrical tank with $h_0 = 4$ ft; $D_{tank} = 3$ ft; $D_{jet} = 0.5$ inch.

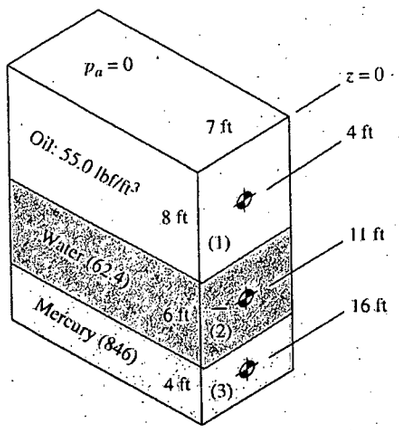

Figure for Q no 6(a)

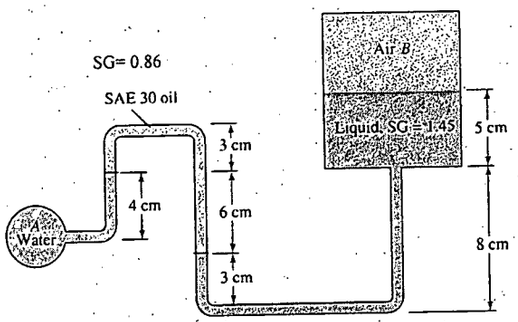

Figure for Q no 6(b)

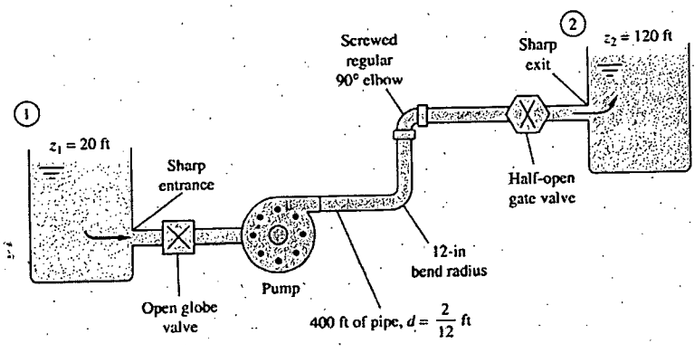

Figure for Q no 7(b)

Table for Q no 7(b): Loss Coefficients (k) for Open valves, Elbow and Tees

	Nominal diameter, in										
	Screwed					Flanged					
	$\frac{1}{4}$	1	2	4	1	2	4	8	20
Valves (fully open):									
Globe	14	8.2	6.9	5.7	13	8.5	6.0	5.8	5.5
Gate	0.30	0.24	0.16	0.11	0.80	0.35	0.16	0.07	0.03
Swing check	5.1	2.9	2.1	2.0	2.0	2.0	2.0	2.0	2.0
Angle	9.0	4.7	2.0	1.0	4.5	2.4	2.0	2.0	2.0
Elbows:									
45° regular	0.39	0.32	0.30	0.29	0.21	0.20	0.19	0.16	0.14
45° long radius					0.50	0.39	0.30	0.26	0.21
90° regular	2.0	1.5	0.95	0.64	0.40	0.30	0.19	0.15	0.10
90° long radius	1.0	0.72	0.41	0.23	0.41	0.35	0.30	0.25	0.20
180° regular	2.0	1.5	0.95	0.64	0.40	0.30	0.21	0.15	0.10
180° long radius									
Tees:									
Line flow	0.90	0.90	0.90	0.90	0.24	0.19	0.14	0.10	0.07
Branch flow	2.4	1.8	1.4	1.1	1.0	0.80	0.64	0.58	0.41

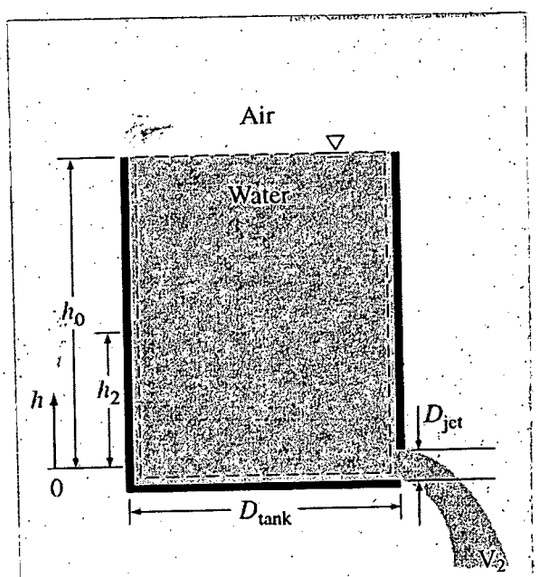

Fig for Q no 8 b)

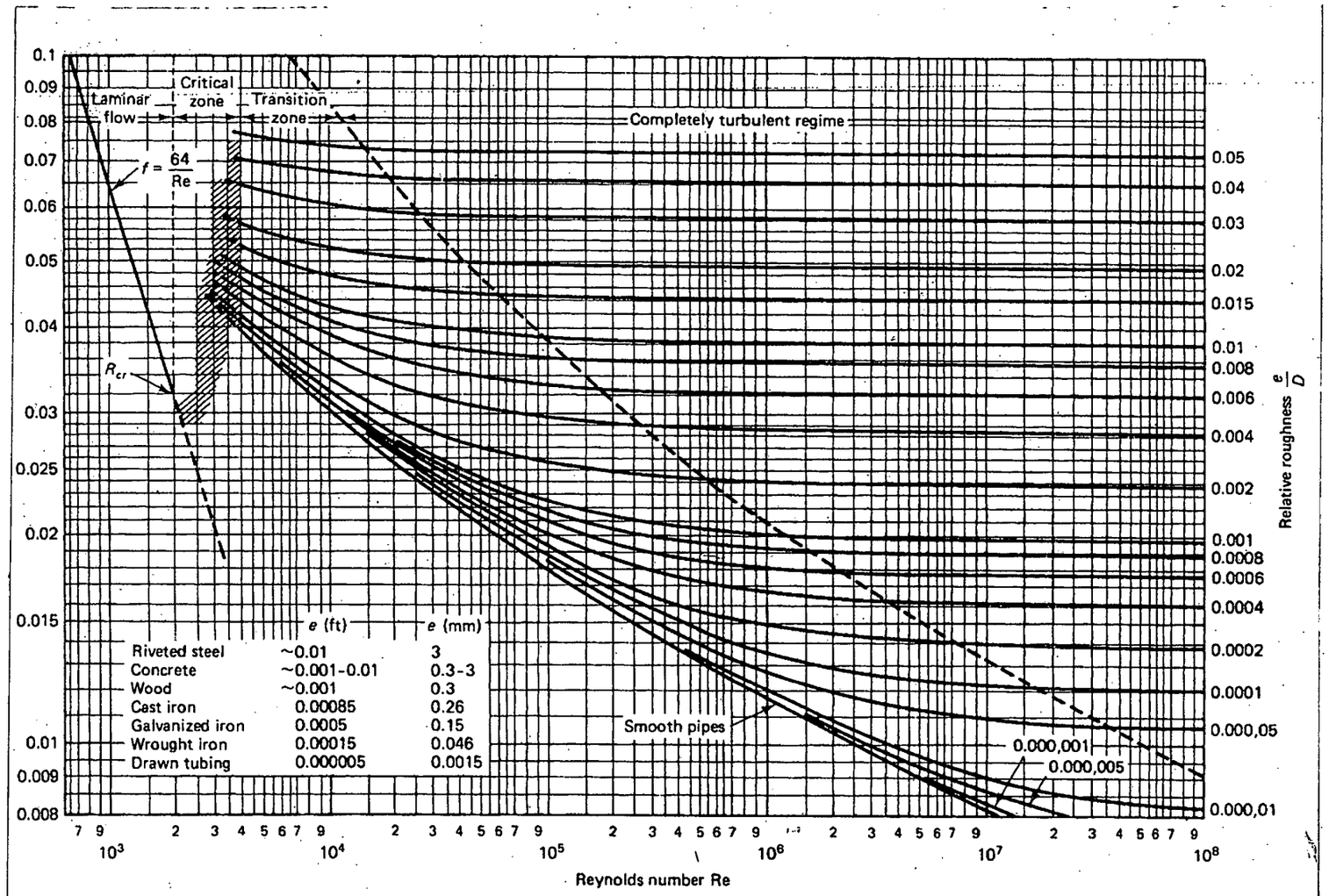

Figure 7.13 Moody diagram. (From L. F. Moody, *Trans. ASME*, Vol. 66, 1944.)