L-2/T-2/CE **Date: 8/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2021-2022

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** Questions.

1. (a) Solve the following system of linear equations using LU decomposition: **(11)**

$$-8x + y - 2z = -20$$
$$2x - 6y - z = -38$$
$$-3x - y + 7z = -34$$

(b) Determine the solution of the simultaneous non-linear equations **($12\frac{1}{3}$)**

$$3x + y^2 + \cos(x) = 3$$
$$e^{-x} + 4y - \sin(x+y) = 1$$

Use Newton-Raphson method and employ the initial guesses of x = y = 0. Perform 2 iterations

2. (a) The pressure of the gas (P) corresponding to various volumes (V) is measured and given as below: **(13)**

$V(cm^3)$	50	60	70	90	100
$P(kg/cm^3)$	64.7	51.3	40.5	25.9	78

Fit the data to the model $PV^n = C$ to determine the constants n and C. Estimate the R-square value of the fit.

(b) Write down the system of linear equations (in matrix form) of the boundary value problem: **($10\frac{1}{3}$)**

$$\frac{d^2y}{dx^2} = -4y + 4x \qquad y(0) = 0,\ \left.\frac{dy}{dx}\right|_{x=\pi/2} = 0$$

Use a step size of $\pi/20$. No need to solve the problem.

3. (a) Use 4^{th} order Runge-Kutta method do solve **(14)**

$$\frac{dy}{dx} = -2y + 4e^{-x}$$

$$\frac{dz}{dx} = -\frac{yz^2}{3}$$

over the range x = 0 to 1 using a step size of 0.5 with y(0) = 2 and z(0) = 4.

Contd …… P/2

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Contd... Q. No. 3

(b) What do you mean by numerical stability? What kind of stability problems arise in applying 'explicit method' and why? Write down the steps of solving differential equation using 'Shooting Method'. **($9\frac{1}{3}$)**

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

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

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

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

initial condition: the temperature of the rod is 10°C at t = 0

boundary condition: $\left.\frac{dT}{dx}\right|_{x=0} = 5 \, and \left.\frac{dT}{dx}\right|_{x=10} = 0$ at all times.

(b) Solve the problem in 4(a) using explicit method for t = 0.1 sec. **($6\frac{1}{3}$)**

(c) Write short notes on (i) Cholesky Factorization (ii) Partial Pivoting (iii) Overdetermined system **(9)**

SECTION – B

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

5. (a) Derive the general expression for area calculation in Simpson's rule. **(6)**

(b) Figure 1 shows a simply supported beam and its deflected shape. Find slope, bending moment and shear forces at points -2, 0 and +2. Given: $E = 29 \times 10^6$ psi and $I = 1400$ in^4 **($17\frac{1}{3}$)**

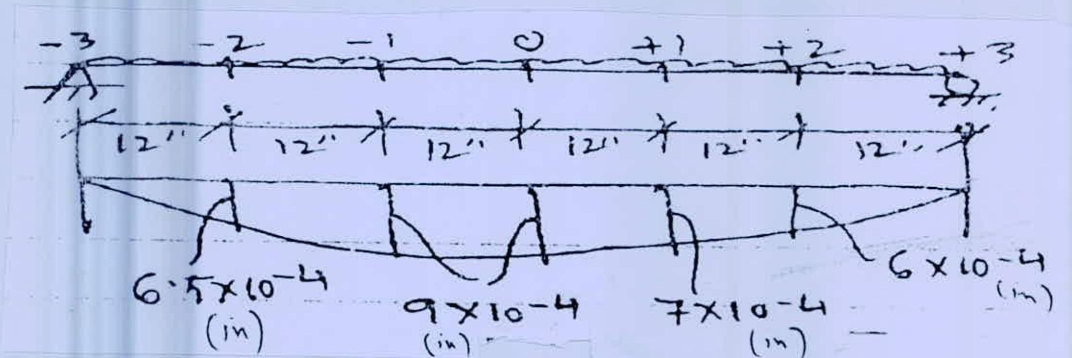

Figure 1

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6. (a) Explain the iteration method with neat sketches: **(8)**

(b) For the following data find (i) General Polynomial equation and (ii) Function value for X = 0.31 **($7+8\frac{1}{3}=15\frac{1}{3}$)**

X	0.11	0.19	0.28	0.36	0.49
F(X)	1.31	1.42	1.67	1.88	2.13

7. (a) For Newton-Raphson method prove that at each iteration the absolute error is proportional to the square of the previous error and the convergence is quadratic. **(8)**

(b) In the SM laboratory, the result of a rebar test shows the following stress-strain data. Set a polynomial equation passing through all the points and find the stress corresponding to the strain 0.0007 without using the difference table. **($7+8\frac{1}{3}=15\frac{1}{3}$)**

Strain (inch/inch)	0.0	0.0002	0.0004	0.0006	0.0008	0.0010	0.0012
Stress in psi	0.0	5590	11190	16800	22390	27980	33580

8. (a) Explain Lagrange's Method of Interpolation **(8)**

(b) Estimate the value of the following integral using Romberg's Quadrature **($15\frac{1}{3}$)**

$$I = \int_1^3 \frac{1}{1+2x}\,dx$$

L-2/T-2/CE **Date: 14/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **CE 207** (Applied Mathematics for Engineers)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

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

1. (a) The time to failure in hours of an important piece of electronic equipment used in a manufactured DVD player has the following density function: **(15)**

$$f(x)=\begin{cases}\frac{1}{c}e^{-\frac{x}{2000}}, & x\geq 0\\ 0, & x<0\end{cases}$$

(i) Find the value of c if the above function is a valid density function.

(ii) Find the cumulative distribution function (CDF)

(iii) Determine the probability that the component lasts more than 1000 hours before it needs to be replaced.

(b) Find the maximum likelihood estimate (MLE) of the Pareto distribution with parameter α. The pdf of the distribution is given below. α has range $(1, \infty)$. **(10)**

$$f(x)=\frac{\alpha}{x^{\alpha}}$$

(c) A new analytical method can detect three different contaminants -- organic pollutants, volatile solvents, and chlorinated compounds -- in water. The makers of the test claim that it can detect high levels of organic pollutants with 99.7% accuracy, volatile solvents with 99.95% accuracy, and chlorinated compounds with 89.7% accuracy. If a pollutant is not present, the test does not provide any signal. Samples are prepared for the calibration of the test and 60% of them are contaminated with organic pollutants, 27% with volatile solvents, and 13% with traces of chlorinated compounds. A test sample is selected randomly. **(10)**

i) What is the probability that the test will generate a signal?

ii) If the test signals, what could be the potential contaminant that is present in the test sample?

iii) If the test signals, what is the probability that either volatile solvents or chlorinated compounds are present?

2. (a) The following data presents chloride concentration in surface water body (y) and roadway area in the watershed (x). **(15)**

Contd …… P/2

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Contd... Q. No. 2(a)

chloride concentration, y (mg/L)	9.7	10.6	10.9	12.1	14.3	14.7	15	17.3	19.2	23.1
roadway area, x (percentage)	0.57	0.7	0.63	0.72	0.66	0.78	0.81	0.82	0.92	1.1

The following regression summary was obtained for the dataset.

	Coefficient	**Standard Error**
Intercept	-5.38	1.84
Roadway area, x	25.09	2.22

i) Test the statistical significance of each parameter of the model at 0.05 significance level. State proper null and alternative hypothses.

ii) What will be the chloride concentration if roadway area is 1%?

iii) Find the residual error when roadway area is 0.57%.

(b) The number of cracks in a section of national highway that are significant enough to require repair is assumed to follow a Poisson distribution with a mean of two cracks per mile. **(10)**

i) What is the probability that there are no cracks that require repair in 5 miles of highway?

ii) What is the probability that at least one crack requires repair in 0.5 mile of highway?

(c) A computer scientist is investigating the usefulness of two different design languages in improving programming tasks. Twelve expert programmers, familiar with both languages, are asked to code a standard function in both languages, and the time (in minutes) is recorded, which is shown below. Is there any indication that one design languages is preferable? Condition $\alpha = 0.05$ and show your analysis. **(10)**

Programmer	1	2	3	4	5	6	7	8	9	10	11	12
Design language 1	17	16	21	14	18	24	16	14	21	23	13	18
Design language 2	18	14	19	11	23	21	10	13	19	24	15	20

3. (a) Bangladesh Road Transport Authority (BRTA) did a study, several years back, that showed that the proportion of cars tested which failed to meet the pollution standard was 0.37. BRTA would like to check whether the cars have improved since then. In a sample of 100 cars, tested recently, the proportion of cars not meeting the standards was 0.28. **(15)**

i) Are cars better at meeting the standards than they used to be? Use significance level, $\alpha = 0.01$ and show your analysis.

Contd P/3

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Contd... Q. No. 3(a)

ii) Would you change your conclusion if the same data was obtained from a sample of 300 cars? Justify your answer.

(b) The following data represent the time, in minutes, that a patient has to wait during 12 visits to a doctor's office before being seen by the doctor: **(10)**

17	15	20	20	32	28	12	26	25	25	35	24

i) Use the sign test at the 0.05 level of significance to test the doctor's claim that the median waiting time for her patients is not more than 20 minutes.

ii) Would you change your conclusion, if Wilcoxon signed rank test is used as to test the hypothesis?

(c) The annual rainfall in Sylhet is normally distributed with mean 40 inches and standard deviation 8 inches. **(10)**

i) What is the probability this year's rainfall will exceed 42 inches?

ii) What is the probability that the sum of the next 3 years' rainfall will exceed 126 inches?

iii) What is the probability that next year's precipitation will exceed that of the following year by more than 5 inches?

4. (a) Express the periodic function as in Fig. 1 in a Fourier series. **(15)**

(b) Consider the driven mechanical oscillator shown in Fig. 2, governed by the differential equation of motion, **(10)**

$m\ddot{x} + kx = f(t)$

Where, m = 2 kg and k = 200 N/m. The system is subjected to the force, $f(t)$ as in Fig. 1. Determine the forced response of the system.

(c) The system shown in Fig. 2 is subjected to the force, $f(t)$ as follows: **(10)**

$$f(t) = \begin{Bmatrix} 1 & \text{if } 0 < t < 2s \\ 0 & \text{if } t > 2s \end{Bmatrix} kN$$

Determine the response of the system.

SECTION – B

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

5. (a) What is mathematical modelling? Please outline the steps of modelling. **(6)**

(b) Define a general solution and a particular solution of an ODE. What are the roles of the initial conditions for solving ODEs? **(6)**

Contd …… P/4

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Contd... Q. No. 5

(c) In the atmosphere and in living organisms, the ratio of radioactive carbon ${}^{14}_{6}C$ (made radioactive by cosmic rays) to ordinary carbon ${}^{12}_{6}C$ is constant. When an organism dies, its absorption by breathing and eating terminates. Hence one can estimate the age of a fossil by comparing the radioactive carbon ratio in the fossil with that in the atmosphere. Model this radioactive decay with respect to any time t. [the half-life of ${}^{14}_{6}C$ is 5715 years] **(17)**

How old is a fossil if the ratio of carbon ${}^{14}_{6}C$ to carbon ${}^{12}_{6}C$ in a sample is 52.5% of that of a living organism?

(d) Define power series. What are the assumption of a power series? **(6)**

6. For the following Bessel's equation.

$$x^2y''+xy'+(x^2-v^2)y=0$$

(a) Find the first solution. **(22)**

(b) Find the solution of the first kind for order n. **(5)**

(c) Find the solution of the first kind for order ϑ. Comment on the convergence of this solution. **(8)**

7. (a) What are the four permissible operations in power series. Explain with examples (at least one for each operation). **(12)**

(b) Check the exactness of the following equation and find the generator solution **(13)**

$$(3xy-y^2)dx = x(x-y)dy$$

(c) Determine the radius of convergence of the following series **(10)**

i) $\sin x$

ii) $\sum_{n=0}^{\infty}\Gamma(n+1)(x-4)^n$

8. (a) Evaluate the Fourier Transform of $f(x)=\dfrac{x-5}{x^2+5^2}$ **(8)**

(b) The governing equation of a string of infinite length over an elastic foundation subjected to a force, w(x) is given below. Solve the equation using the Fourier transform. Where, T = tension of the string and k = foundation stiffness. Also evaluate u(x) for the case, where w(x) is a point load at the origin, w(x) = δ(x) **(15)**

$$Tu'' - ku = -w(x)$$

Contd P/5

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Contd... Q. No. 8

(c) Find the solution of the 1-D wave equation of a vibrating string of length, L = 2 m, subjected to the initial displacement, f(x) shown below. **(12)**

$$u(x,t) = \sum_{n=1}^{\infty} B_n \cos \lambda_n t \, \sin\frac{n\pi x}{L}, \qquad \lambda_n = \frac{n\pi x}{L}$$

$$B_n = \frac{2}{L}\int_0^L f(x)\sin\frac{n\pi x}{L} \qquad n = 1, 2, \ldots\ldots$$

$$f(x) = \left\{\begin{matrix} x & if\ 0 < x < 1 \\ (2-x) & if\ 1 < x < 2 \end{matrix}\right\} m$$

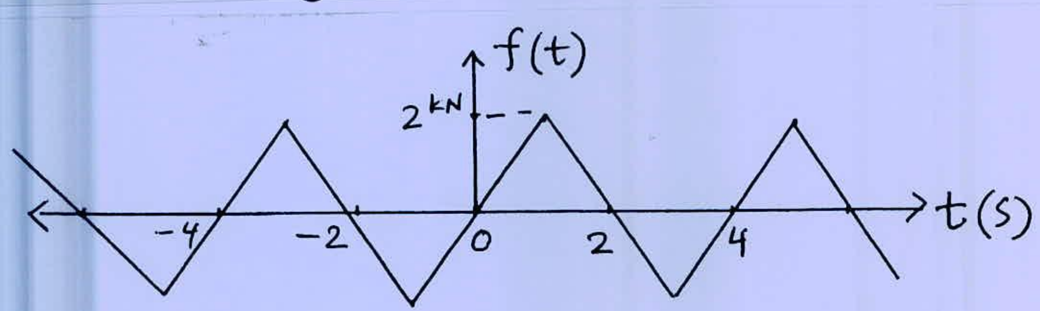

Fig. 1

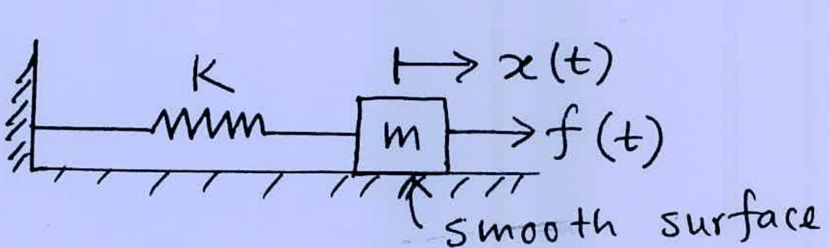

Fig. 2

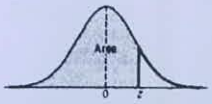

Table A.3 (continued) Areas under the Normal Curve

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

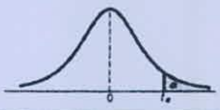

Table A.4 Critical Values of the t-Distribution

v	α 0.40	0.30	0.20	0.15	0.10	0.05	0.025
1	0.325	0.727	1.376	1.963	3.078	6.314	12.706
2	0.289	0.617	1.061	1.386	1.886	2.920	4.303
3	0.277	0.584	0.978	1.250	1.638	2.353	3.182
4	0.271	0.569	0.941	1.190	1.533	2.132	2.776
5	0.267	0.559	0.920	1.156	1.476	2.015	2.571
6	0.265	0.553	0.906	1.134	1.440	1.943	2.447
7	0.263	0.549	0.896	1.119	1.415	1.895	2.365
8	0.262	0.546	0.889	1.108	1.397	1.860	2.306
9	0.261	0.543	0.883	1.100	1.383	1.833	2.262
10	0.260	0.542	0.879	1.093	1.372	1.812	2.228
11	0.260	0.540	0.876	1.088	1.363	1.796	2.201
12	0.259	0.539	0.873	1.083	1.356	1.782	2.179
13	0.259	0.538	0.870	1.079	1.350	1.771	2.160
14	0.258	0.537	0.868	1.076	1.345	1.761	2.145
15	0.258	0.536	0.866	1.074	1.341	1.753	2.131
16	0.258	0.535	0.865	1.071	1.337	1.746	2.120
17	0.257	0.534	0.863	1.069	1.333	1.740	2.110
18	0.257	0.534	0.862	1.067	1.330	1.734	2.101
19	0.257	0.533	0.861	1.066	1.328	1.729	2.093
20	0.257	0.533	0.860	1.064	1.325	1.725	2.086
21	0.257	0.532	0.859	1.063	1.323	1.721	2.080
22	0.256	0.532	0.858	1.061	1.321	1.717	2.074
23	0.256	0.532	0.858	1.060	1.319	1.714	2.069
24	0.256	0.531	0.857	1.059	1.318	1.711	2.064
25	0.256	0.531	0.856	1.058	1.316	1.708	2.060
26	0.256	0.531	0.856	1.058	1.315	1.706	2.056
27	0.256	0.531	0.855	1.057	1.314	1.703	2.052
28	0.256	0.530	0.855	1.056	1.313	1.701	2.048
29	0.256	0.530	0.854	1.055	1.311	1.699	2.045
30	0.256	0.530	0.854	1.055	1.310	1.697	2.042
40	0.255	0.529	0.851	1.050	1.303	1.684	2.021
60	0.254	0.527	0.848	1.045	1.296	1.671	2.000
120	0.254	0.526	0.845	1.041	1.289	1.658	1.980
∞	0.253	0.524	0.842	1.036	1.282	1.645	1.960

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TABLE VIII Critical Values for the Sign Test

r_α^*

n \ α	0.10	0.05	0.01	Two-sided tests	n \ α	0.10	0.05	0.01	Two-sided tests
	0.05	0.025	0.005	One-sided tests		0.05	0.025	0.005	One-sided tests
5	0				23	7	6	4	
6	0	0			24	7	6	5	
7	0	0			25	7	7	5	
8	1	0	0		26	8	7	6	
9	1	1	0		27	8	7	6	
10	1	1	0		28	9	8	6	
11	2	1	0		29	9	8	7	
12	2	2	1		30	10	9	7	
13	3	2	1		31	10	9	7	
14	3	2	1		32	10	9	8	
15	3	3	2		33	11	10	8	
16	4	3	2		34	11	10	9	
17	4	4	2		35	12	11	9	
18	5	4	3		36	12	11	9	
19	5	4	3		37	13	12	10	
20	5	5	3		38	13	12	10	
21	6	5	4		39	13	12	11	
22	6	5	4		40	14	13	11	

TABLE IX Critical Values for the Wilcoxon Signed-Rank Test

w_α^*

n^* \ α	0.10	0.05	0.02	0.01	Two-sided tests
	0.05	0.025	0.01	0.005	One-sided tests
4					
5	0				
6	2	0			
7	3	2	0		
8	5	3	1	0	
9	8	5	3	1	
10	10	8	5	3	
11	13	10	7	5	
12	17	13	9	7	
13	21	17	12	9	
14	25	21	15	12	
15	30	25	19	15	
16	35	29	23	19	
17	41	34	27	23	
18	47	40	32	27	
19	53	46	37	32	
20	60	52	43	37	
21	67	58	49	42	
22	75	65	55	48	
23	83	73	62	54	
24	91	81	69	61	
25	100	89	76	68	

*If $n > 25$, W^+ (or W^-) is approximately normally distributed with mean $n(n+1)/4$ and variance $n(n+1)(2n+1)/24$

Table of Fourier Transforms

	$f(x)$	$\hat{f}(\omega) = \int_{-\infty}^{\infty} f(x) e^{-i\omega x}\, dx$
1.	$\dfrac{1}{x^2 + a^2} \quad (a > 0)$	$\dfrac{\pi}{a} e^{-a\lvert\omega\rvert}$
2.	$H(x) e^{-ax} \quad (\operatorname{Re} a > 0)$	$\dfrac{1}{a + i\omega}$
3.	$H(-x) e^{ax} \quad (\operatorname{Re} a > 0)$	$\dfrac{1}{a - i\omega}$
4.	$e^{-a\lvert x\rvert} \quad (a > 0)$	$\dfrac{2a}{\omega^2 + a^2}$
5.	e^{-x^2}	$\sqrt{\pi} e^{-\omega^2/4}$
6.	$\dfrac{1}{2a\sqrt{\pi}} e^{-x^2/(2a)^2} \quad (a > 0)$	$e^{-a^2\omega^2}$
7.	$\dfrac{1}{\sqrt{\lvert x\rvert}}$	$\sqrt{\dfrac{2\pi}{\lvert\omega\rvert}}$
8.	$e^{-a\lvert x\rvert/\sqrt{2}} \sin\left(\dfrac{a}{\sqrt{2}}\lvert x\rvert + \dfrac{\pi}{4}\right) \quad (a > 0)$	$\dfrac{2a^3}{\omega^4 + a^4}$
9.	$H(x + a) - H(x - a)$	$\dfrac{2 \sin \omega a}{\omega}$
10.	$\delta(x - a)$	$e^{-i\omega a}$
11.	$f(ax + b) \quad (a > 0)$	$\dfrac{1}{a} e^{ib\omega/a} \hat{f}\left(\dfrac{\omega}{a}\right)$
12.	$\dfrac{1}{a} e^{-ibx/a} f\left(\dfrac{x}{a}\right) \quad (a > 0,\ b \text{ real})$	$\hat{f}(a\omega + b)$
13.	$f(ax) \cos cx \quad (a > 0,\ c \text{ real})$	$\dfrac{1}{2a}\left[\hat{f}\left(\dfrac{\omega - c}{a}\right) + \hat{f}\left(\dfrac{\omega + c}{a}\right)\right]$
14.	$f(ax) \sin cx \quad (a > 0,\ c \text{ real})$	$\dfrac{1}{2ai}\left[\hat{f}\left(\dfrac{\omega - c}{a}\right) - \hat{f}\left(\dfrac{\omega + c}{a}\right)\right]$
15.	$f(x + c) + f(x - c) \quad (c \text{ real})$	$2\hat{f}(\omega) \cos \omega c$
16.	$f(x + c) - f(x - c) \quad (c \text{ real})$	$2i\hat{f}(\omega) \sin \omega c$
17.	$x^n f(x) \quad (n = 1, 2, \ldots)$	$i^n \dfrac{d^n}{d\omega^n} \hat{f}(\omega)$
Linearity of transform and inverse:		
18.	$\alpha f(x) + \beta g(x)$	$\alpha \hat{f}(\omega) + \beta \hat{g}(\omega)$
Transform of derivative:		
19.	$f^{(n)}(x)$	$(i\omega)^n \hat{f}(\omega)$
Transform of integral:		
20.	$f(x) = \int_{-\infty}^{x} g(\xi)\, d\xi$, where $f(x) \to 0$ as $x \to \infty$	$\hat{f}(\omega) = \dfrac{1}{i\omega} \hat{g}(\omega)$
Fourier convolution theorem:		
21.	$(f * g)(x) = \int_{-\infty}^{\infty} f(x - \xi) g(\xi)\, d\xi$	$\hat{f}(\omega)\hat{g}(\omega)$

L-2/T-2/CE **Date: 3/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2021-2022

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

SECTION – A

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

1. (a) The state of stress at a point is represented by the element shown in Fig. 1. Using stress transformation equations, determine the state of stress at same the point on another element oriented 30° clockwise from the position shown. **(15)**

   (b) Draw Mohr's circle for the state of stress at a point as represented by the element shown in Fig. 2. From the Mohr's circle, determine the principal stresses and show their sense on a properly oriented element. **(20)**

2. (a) Find the **Kern** of a rectangular section (having dimensions **b** x **h**) and show the results on the section. **(15)**

   (b) Determine the normal stress developed at corners acting on a section through ABCD that is 500 mm below the top surface, of the column shown in Fig. 3. **(20)**

3. (a) Given that the shape of cable with respect to horizontal axis (x) is defined as: $y = \frac{4hx}{L^2}(x-L) + x\tan\gamma$, when origin at left support of cable and the right support is above or at the same level of left support. Starting from this equation, show that length of cable with horizontal chord is $s = \frac{L}{2}\left(1+16\theta^2\right)^{\frac{1}{2}} + \frac{L}{8\theta}\ln\left[4\theta + \left(1+16\theta^2\right)^{1/2}\right]$ **(20)**

   (b) For the cable shown in the Fig. 4, calculate final length of the cable subjected to the applied loading. **(15)**

4. (a) Determine the bending stresses at the corners in the cantilever loaded, as shown in the Fig. 5, at a section ABCD, 500 mm from the free end. Also locate the neutral axis. **(20)**

   (b) For the cable loaded as shown in Fig. 6, calculate magnitude of P so that sag at points B and C are same. Horizontal distances between points are shown in figure. Also calculate the sag at B. **(15)**

Contd P/2

CE 213

SECTION – B

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

5. (a) The beam is subjected to the load shown figure 7. Derive the elastic curve. Find the displacement at 'C' and slope at 'A' EI is constant. **(20)**

   (b) Derive the Euler buckling formula for the column whose both ends are fixed. **(15)**

6. (a) The beam is subjected to the load shown in Figure 8. Determine the slope at 'A' and maximum deflection of the beam. EI in constant. **(19)**

   (b) Derive the axial and hoop stress and strain formula for cylindrical and spherical thin -walled pressure vessels. **(16)**

7. (a) Using moment-area method determine the value of 'a' so that the displacement at 'c' is equal to zero for the beam shown in Figure 9. **(20)**

   (b) The thin-walled cylinder can be supported one of two ways as showing in Figure 10. Determine the state of stresses in the wall for both cases. Where internal pressure is 70 psi and wall thickness is 0.25 inch and inner diameter is 8 inch. **(15)**

8. (a) For the truss shown in the Figure 11 find out the deflection (vertical) at 'E' using Energy principle. E = 73 GPa. **(20)**

   (b) Determine the largest allowable length for the column shown in Figure 12.

   [Given F.S = 2.5 and E = 10.6×10^6 psi} **(15)**

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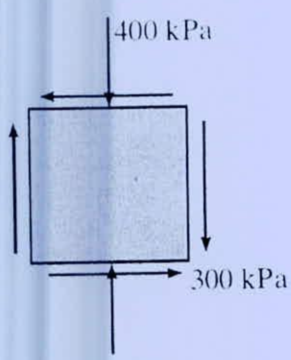

Fig-1

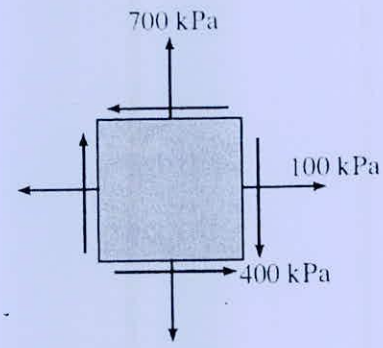

Fig-2

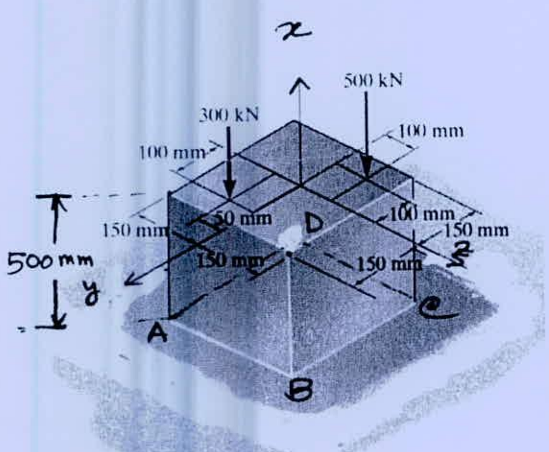

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Fig-3

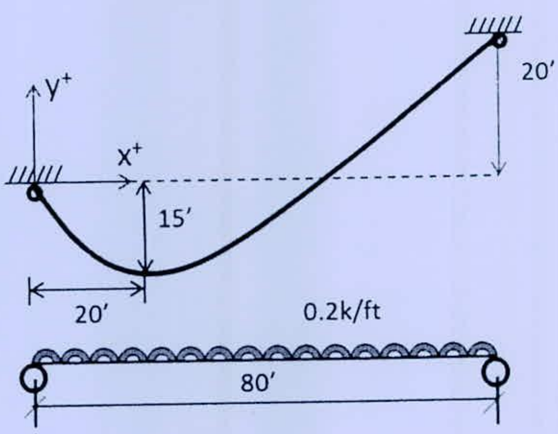

Fig-4

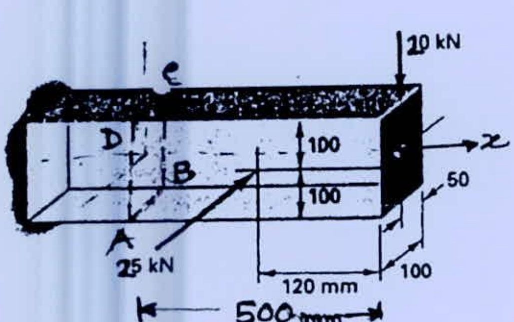

Fig-5

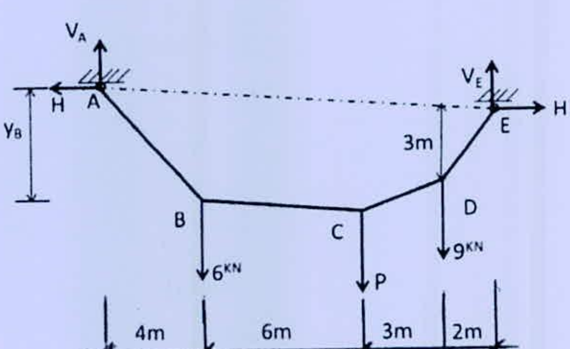

Fig-6

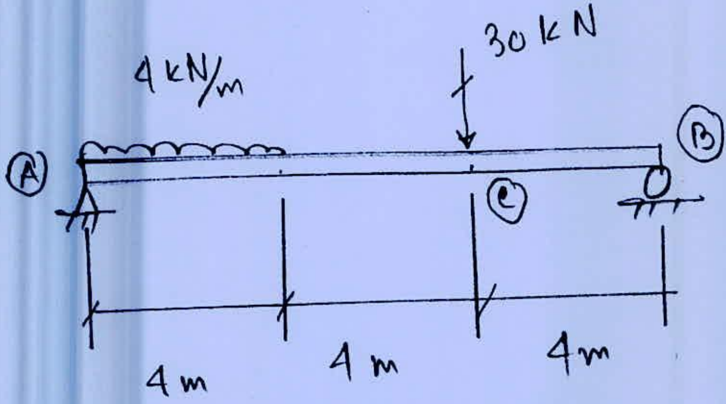

Figure 7 ~~(a)~~

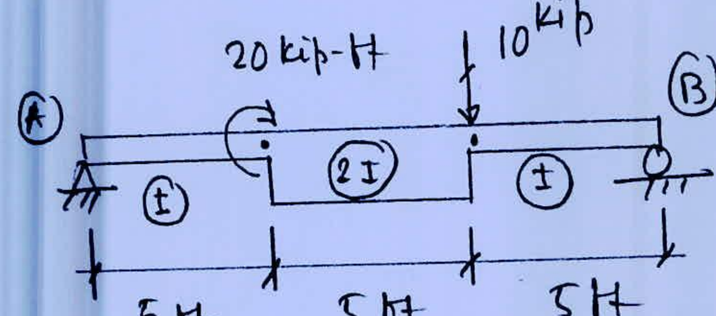

Figure 8 ~~(a)~~

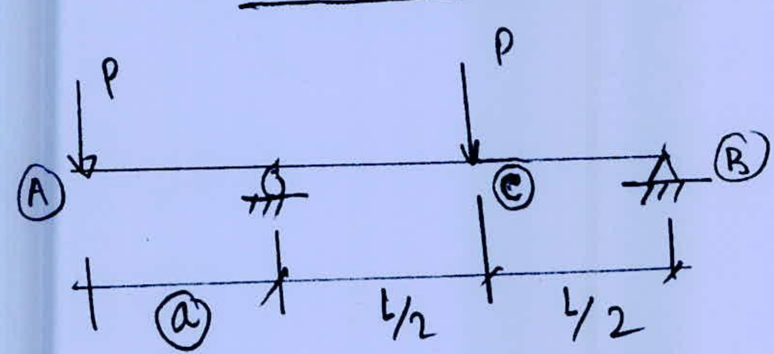

Figure 9 ~~(a)~~

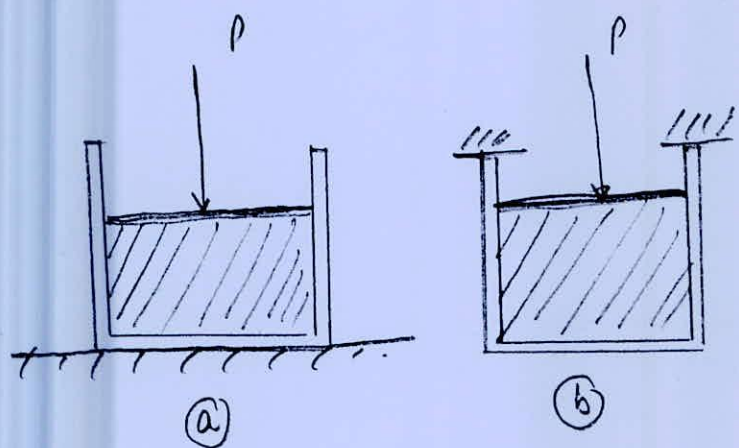

Figure ~~7(a)~~ 10

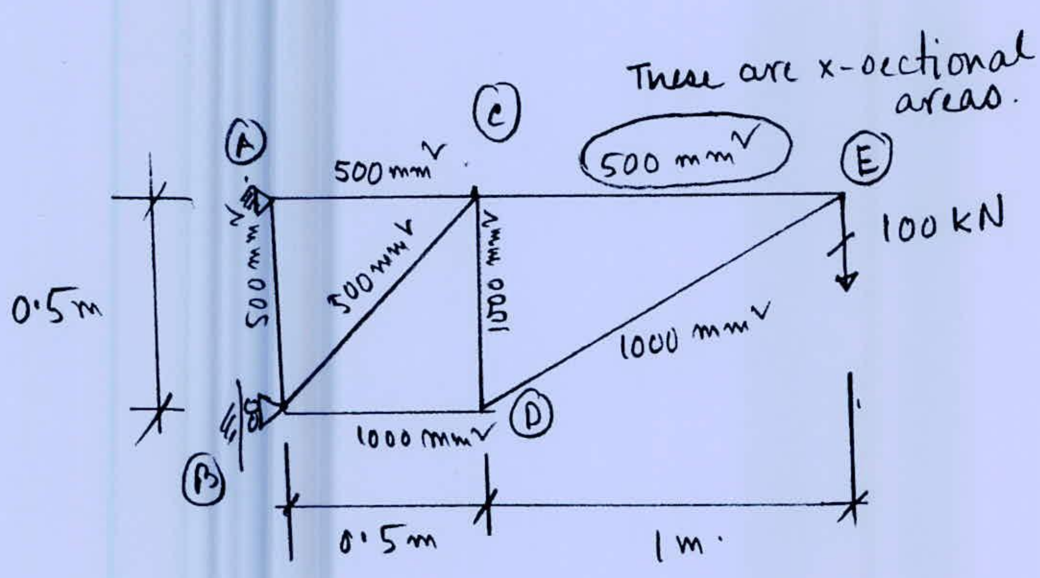

Figure ~~8(a)~~ 11

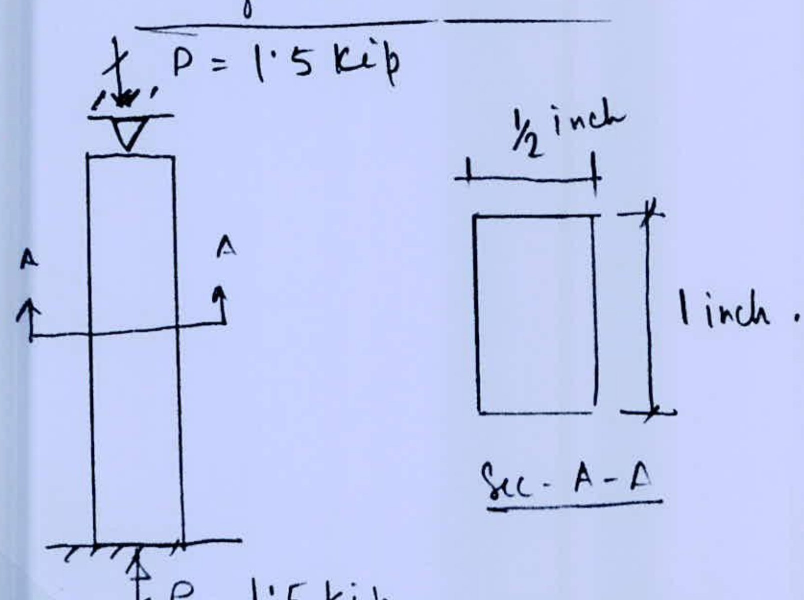

Figure ~~8(b)~~ 12

L-2/T-2/CE Date: 30/10/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2021-2022

Sub: **WRE 211** (Fluid Mechanics)

Full Marks: 210 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** Questions.
Assume reasonable values (in case of missing data)

1. (a) Derive Newton's law of viscosity and differentiate between Newtonian fluid and non-Newtonian fluid with proper examples. **(14)**

(b) What is moving through a pipe at standard temperature and pressure. At some section, assume a parabolic velocity distribution which has vertex at 1.0 m from the boundary and velocity at the vertex is 4.0 m/s. Calculate the velocity gradient and shear stress at y = 0, 0.25 m, 0.50 m, 0.75 m and 1.0 m, where y is the distance from the boundary. **(15)**

(c) The weight of a certain crown in air was found to be as 14.0 N and its weight in water was 12.7 N. Find out whether the crown is made of pure gold (specific gravity = 19.3). **(6)**

2. (a) Explain why oil, when poured on water, spreads into a very thin film on the water surface. **(7)**

(b) Calculate the pressure at points A, B, C and D of the tank shown in **Figure 1**. **(10)**

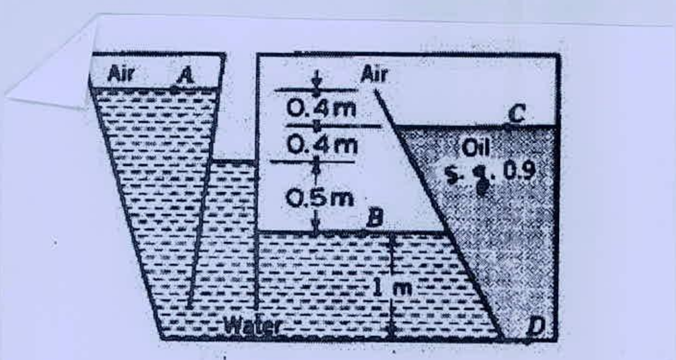

Figure 1 for Q 2(b)

(c) Gate AB in **Figure 2** is a quarter circle with a radius = 8.0 m and width = 10.0 m. The gate is hinged at B. Locate the center of pressure and calculate the resultant hydrostatic force on the gate AB. **(18)**

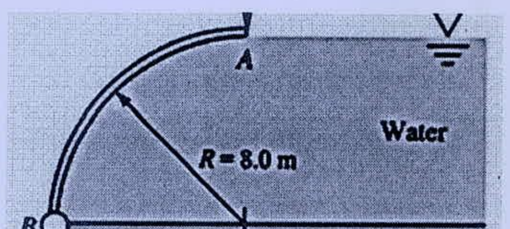

Figure 2 for Q 2(c)

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WRE 211/CE

3. (a) Describe the different types of losses that may occur in pipe flow. **(8)**

(b) Points C and D, at the same elevation are 500 ft apart in an 8-inch pipe and are connected to a differential manometer. When the flow of water is 6.31 cfs, the deflection of mercury in the manometer is 6.43 ft. Determine the Darcy Weisbach friction factor, "f" of the pipe. **(9)**

(c) If the flow rate of water through the pipe system shown in **Figure 3** is 0.05 cumec under the total head loss of 3.0 m, determine the diameter of pipe C. Assume Chezy's co-efficient, C = 120m$^{1/2}$/s for all pipes. **(18)**

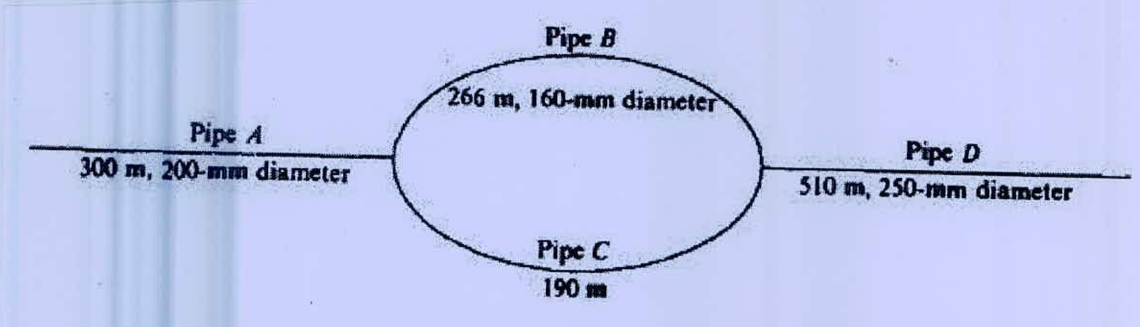

Figure 3 for Q 3(c)

4. (a) Differentiate between the followings: **(15)**

i. Absolute pressure and gauge pressure

ii. Piezometer and manometer

iii. Stable equilibrium and unstable equilibrium of static fluid

(b) Using Hardy Cross method, determine the flows in the network shown in **Figure 4**. Use only two trials. **(20)**

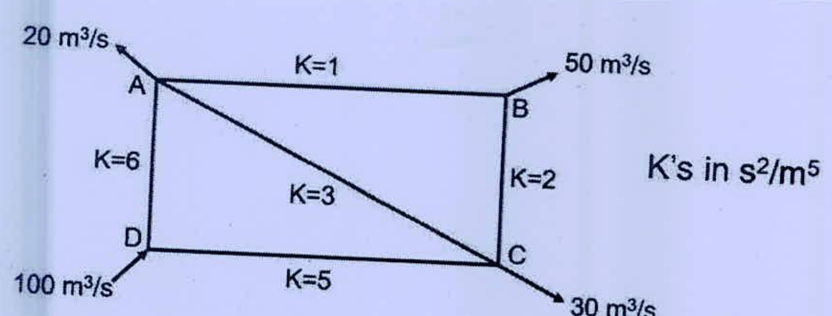

Figure 4 for Q 4(b)

Contd …… P/3

SECTION – B

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

5. (a) What are the uses and limitations of flow net? An incompressible ideal fluid flows at a rate of 15L/s through a circular pipe into a conically converging nozzle. Determine the average velocity and acceleration of flow at sections A an B of **Figure 5**. **(13)**

   (b) A two-dimensional ideal flow occurs in a vertical plane. Data are as follows: r = 7m, b = 3 m, V = 5 m/s. Find the pressure at A, if the pressure at B is 150 kPa in **Figure 6**. **(10)**

   (c) What is the difference between static pressure and stagnation pressure? Derive the equation for steady motion along a streamline for real fluid. **(12)**

6. (a) What is laminar and turbulent flow? A Newtonian fluid with a dynamic viscosity of 0.38 Ns/m^2 and specific gravity of 0.91 flows through a 25 mm diameter pipe with a velocity of 2.6 m/s, find whether the flow is laminar or turbulent? **(10)**

   (b) Neatly sketch the absolute and relative velocity diagram of radial flow hydraulic turbine and centrifugal pump impeller. **(10)**

   (c) A radial flow turbine has the following dimensions: r_1 = 0.5 m, r_2 = 0.3 m and β_1 = 80°. The flow passage width between the two sides of the turbine is 0.25 m. At 300 rpm, the flow rate through the turbine is 4 m^3/s. Find **(15)**

   i) the blade angle β_2 such that the water exits from the turbine in the radial direction.

   ii) the torque exerted by the water on the runner.

   iii) the head utilized by the runner and the resulting power

7. (a) Differentiate between **(15)**

   i. Compressible and incompressible flow,

   ii. Pathline and streak line

   iii. Ideal fluid and real fluid

   iv. Hydraulic grade line and energy grade line

   v. Divergence and curl.

Contd …… P/4

WRE 211/CE

Contd... Q. No. 7

(b) A horizontal reducing bend in an oil pipeline, with a deflection angle of 60°, connects a 300 mm diameter pipe to a 200 mm diameter pipe. When the flow rate is 212.1 L/s, the pressure just upstream of the bend is 125 kPa. If the head loss in the bend is $\mathbf{0.2V^2/2g}$ and the oil has a relative density of 0.85, find the magnitude and the direction of the thrust of the oil on the bend. **(20)**

8. (a) A vertical sluice gate in an open channel (**Figure** 7) forces the water from an upstream depth of y_1 = 3.0 m and a velocity u_1 = 1.07 m/s to a downstream depth of y_2 = 0.45 m and a velocity u_2 = 6.67 m/s. Determine the force per unit width on the sluice. **(10)**

(b) A nozzle that discharges a 60 mm diameter water jet into the air is on the right end of a horizontal 120 mm diameter pipe. In the pipe, the water has a velocity of 4 m/s and a gauge pressure of 400 kPa. Find the magnitude and the resultant axial force the water exerts on the nozzle and the head loss in the nozzle. **(10)**

(c) The jet of water flows from the 100-mm-diameter pipe at 4 m/s. If it strikes the fixed vane and is deflected as shown in **Figure 8**, determine the volume of flow towards *A* and towards *B* if the tangential component of the force that the water exerts of the vane is zero. What would be the normal force. **(15)**

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(5)

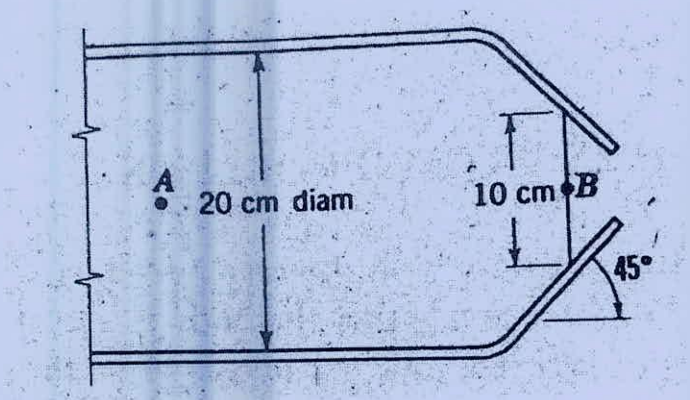

Figure 5 for Question No 5a

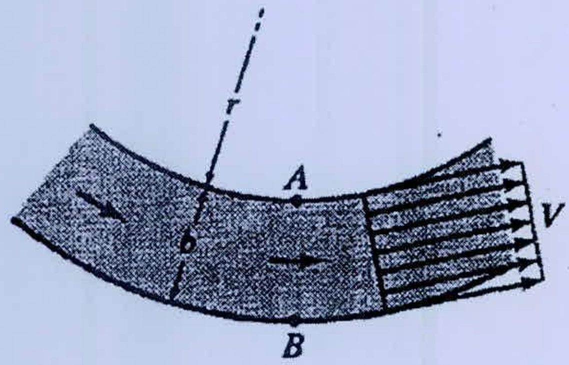

Figure 6 for Question No 5b

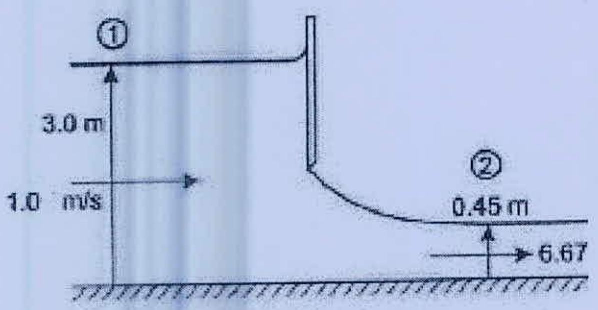

Figure 7 for Question No 8a

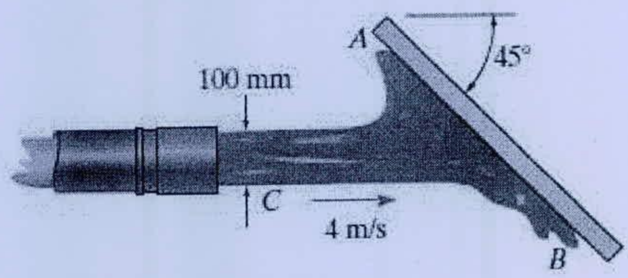

Figure 8 for Question No ~~8b~~ 8(c)

L-2/T-2/CE **Date: 19/10/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2021-2022

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

SECTION – A

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

1. (a) Briefly discuss the determinants of the four components of aggregate expenditure and define marginal propensity to consume (MPC) and marginal propensity to save (MPS). **(10)**

(b) Illustrate macroeconomics equilibrium using the 45° --- line diagram, the Keynesian cross. **($13\frac{1}{3}$)**

2. (a) What do you understand by GDP deflator? Calculate GDP deflator from the following table 1: **(10)**

Table 1:

Commodity	Year 2017		Year 2019	
	Unit produced	Price (Tk)	Unit produced	Price (Tk)
A	250	150	300	160
B	500	750	600	800
C	400	600	500	700
D	300	500	350	550
E	600	200	700	250

(b) What is consumer price index (CPI) and producer price index (PPI)? Table 2 presents hypothetical data on consumer goods and services, and their respective weights and prices. Calculate CPI-based rate of inflation. **($13\frac{1}{3}$)**

Table 2:

Category	Price index for each category		
	Weight	Year 1	Year 2
Food and Beverages	0.250	3000	3340
Housing	0.515	3350	3600
Medical care	0.048	3000	3475
Others	0.187	250	290
	1.00		

Contd …… P/2

HUM 217/CE

3. (a) Define deposit multiplier. Explain the process of creation of money by the commercial banks. **(10)**

(b) Consider the following questions in a closed economy where the price level is constant. **($13\frac{1}{3}$)**

Consumption function	C = 1000 + 0.85 (Y-T)	... (1)
Planned in investment function	I = 2000	... (2)
Government purchase function	G = 1800	... (3)
Tax function	T = 1300	... (4)
Equilibrium condition	Y = C + I + G	... (5)

(i) Find the equilibrium level of GDP.

(ii) Calculate the new equilibrium GDP when 'Government purchase' changes to 2500, and 'Tax' 1500.

(iii) Based on the above equations, and replacing the particular values with letters, derive the 'tax multiplier' 'government purchase multiplier'.

4 Write short notes on any THREE of the following **($23\frac{1}{3}$)**

i) Fundamental economic problems and their solutions

ii) Causes and consequences of inflation

iii) Contractionary and expansionary monetary policy

iv) Circular flow of income and expenditure.

SECTION – B

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

5. (a) "Scarcity implies choice and choice implies opportunity cost." - Explain. **(8)**

(b) Explain the visual model of an economy that shows nominal and real flows through markets among households and firms. **(8)**

(c) State the law of demand. What are the factors that cause demand curve to shift? Explain the influence of any two of them on the demand curve. **($7\frac{1}{3}$)**

6. (a) What do you mean by market equilibrium? Graphically show how market equilibrium is achieved through the forces of demand and supply. **($9\frac{1}{3}$)**

Contd P/3

HUM 217/CE

Contd... Q. No. 6

(b) What would happen to the equilibrium price and quantity if each of the following occurs. **(8)**

i. A decrease in demand that is greater than the increase in supply.

ii. An increase in supply only.

iii. A decrease in supply that is greater than the increase in demand

iv. An increase in demand that is exactly equal to an increase in supply.

(c) Suppose that your demand schedule for burger is as follows: **(6)**

Price of Burger	Quantity demanded	Quantity demanded
(Tk.)	Income = 15,000 taka	Income = 20,000 taka
80	50	60
100	42	55
120	34	40
140	26	32
160	18	22

Calculate the price elasticity of demand as the price of burger increases from Tk. 120 to Tk. 140 if (i) your income is Tk. 15,000 and (ii) your income is Tk. 20,000.

7. (a) Define indifference curve. Briefly explain the properties of an indifference curve. **($8\frac{1}{3}$)**

(b) Given the following utility maximization problem **(15)**

$$U = x^{0.25} y^{0.4}$$

subject to 2*x* + 8*y* = 104

i) Find the optimal value of x and y at which utility is maximized.

ii) Find the value of Lagrange multiplier (λ) and interpret it.

iii) Find the maximum level of utility.

8. (a) Distinguish between **(6)**

i) explicit cost and implicit cost

ii) accounting profits and economic profits.

(b) Given the information below, find the AFC (Average Fixed Cost), AVC (Average Variable Cost), TC (Total Cost), ATC (Average Total Cost), and MC (Marginal Cost). **($7\frac{1}{3}$)**

Contd P/4

Quantity of Output (Q)	Total Fixed Cost (TFC)	Total Variable Cost (TVC)
0	500	0
1	500	50
2	500	80
3	500	100
4	500	110
5	500	130
6	500	160
7	500	200
8	500	250
9	500	310
10	500	380

(c) Define producer's equilibrium. How can we determine the producer's equilibrium? Explain with appropriate graph. **(10)**
