L-2/T-1/MME **Date : 27/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **MATH 271** (Numerical Analysis, Statistics and Partial Differential Equations)

Full Marks: 280 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Derive Lagrange interpolation formula. **(23)**

   (b) Find the form of the function $f(x)$ which satisfies the following table. **(23⅔)**

x	–4	–1	0	2
$f(x)$	1245	33	5	9

2. (a) Find the first and second derivatives of the function tabulated below, at the point $x = 3$. **(20⅔)**

x	3.0	3.2	3.4	3.6	3.8	4.0
y	–14.000	–10.032	–5.296	0.256	6.672	14.000

   (b) Evaluate $\int_0^{1.2} \frac{xe^{-x^2}}{\sqrt{1+x^2}}\,dx$ by **(13+13)**

   (i) Simpson's $\frac{3}{8}$ rule

   (ii) Weddle's rule

   dividing the range of integration into 12 equal parts.

3. (a) By using Newton-Raphson method find the root of the equation $e^{-x} = \sin x$ which lies between 0 and 1, correct to four decimal places. **(23)**

   (b) Fit an exponential curve of the form $y = ab^x$ to the following data. **(23⅔)**

x	1	2	3	4	5	6	7	8
y	1.0	1.2	1.8	2.5	3.6	4.7	6.6	9.1

4. (a) Solve $\frac{dy}{dx} = x - y$, $y(0) = 1$ by Picard's method to find $y(0.2)$ taking $h = 0.1$. **(24)**

   (b) Apply Runge-Kutla method to find $y(0.2)$ from $\frac{dy}{dx} = x - y^2$, $y(0.1) = 0.9138$. **(22⅔)**

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Contd P/2

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SECTION – B

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

5. (a) For the following incomplete frequency distribution, it is know that the total frequency is 1000 and the median is 415. Estimate the missing frequencies and hence find the modal value of the completed table. **(25)**

Variable	Frequency
300 – 325	5
325 – 350	17
350 – 375	80
375 – 400	?
400 – 425	326
425 – 450	?
450 – 475	88
475 – 500	9

Comment also on the shape of the frequency distribution.

(b) The weight of BUET students is assumed to be normal random variable. It is known that 10% of the students have weights under 125 pounds and 15% exceed 165 pounds. What percentage of students have weights' between 135 and 155? (Necessary chart 1 is attached) **(21⅔)**

6. (a) Find the mean and the variance of the binomial distribution. **(10)**

(b) Calculate the two regression equations and the coefficients of correlation from the data given below: **(16⅔)**

Age of husband	22	25	28	31	35	32	37
Age of wife	19	18	22	29	31	23	30

Also estimate the most likely age of wife when husband's age is 33 and the age of husband when wife's age is 25.

(c) Define Type-I error, Type-II error, Null hypothesis and Degrees of Freedom. **(5+15=20)**

The average score of a sixth-grander in a certain school district on a math aptitude exam is 85 with a standard deviation of $\sigma = 9.6$. A random sample of 75 students in one school was taken. The mean score of these students was 74. Does this indicate that the students of this school are significantly slower in their mathematical ability? Use 5% Level of Significance (Necessary chart 1 is attached).

Contd P/3

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7. (a) Apply charpits method to solve $p^2 + q^2 - 3px - 2qy + 2xy = 0$. **(20)**

   (b) Find the complete integral and the singular integral (if exists) of $z = px + qy + p^2 - q^2$. **(15)**

   (c) Applying Lagrange's method, solve: **(11⅔)**

$$x^2(y-z)p + y^2(z-x)q = z^2(x-y).$$

8. Solve the following partial differential equations:

   (a) $\left(D_X^2 - 5D_X D_Y + 4D_Y^2\right)z = \sin(4x+y)$ **(13)**

   (b) $\left(D_X^2 + 2D_X D_Y + D_Y^2\right)z = 2\cos y - x\sin y$ **(18⅔)**

   (c) $\left(x^2 D_X^2 - y^2 D_Y^2\right)z = x^3 y$. **(15)**

Areas under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
−3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
−3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
−3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

(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

Chart 1 for question no. 5(b) and 6(c) (Math 271)

Mejor

L-2/T-1/MME **Date : 01/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **ME 243** (~~Strength of Materials~~) Mechanics of Solid.

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) A homogeneous rod of constant cross section is attached to unyielding supports. It carries an axial load P applied as shown in Figure for Q. 1(a). Prove that the reactions are given by $R_1 = Pb/L$ and $R_2 = Pa/L$. **(20)**

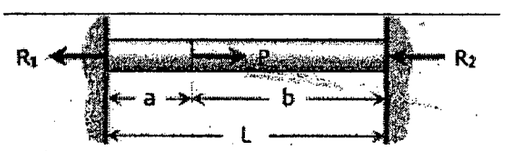

Figure for Q. 1(a)

(b) The strength of the longitudinal joint in cylindrical pressure vessel is 2.26 KN/m, whereas in the girth joint it is 1.1 KN/m. Calculate the maximum diameter of the cylindrical tank if the internal pressure is 1.03 MPa. **(15)**

2. (a) As shown in Figure for Q. 2(a) a rigid bar with negligible mass is pinned at O and attached to two vertical rods. Assuming that the rods were initially stress-free, what maximum load P can be applied without exceeding stresses of 150 MPa in the steel rod and 70 MPa in the bronze rod. **(23)**

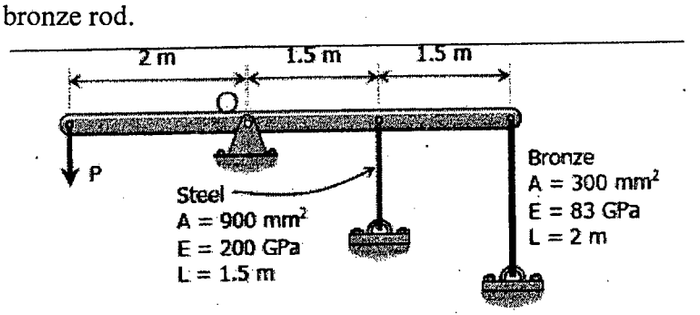

Figure for Q. 2(a)

(b) A solid steel shaft is loaded as shown in Figure for Q. 2(b). Using G = 83 GPa, determine the required diameter of the shaft if the shearing stress is limited to 60 MPa and the angle of rotation at the free end is not to exceed 4 deg. **(12)**

Contd P/2

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Contd ... Q. No. 2(b)

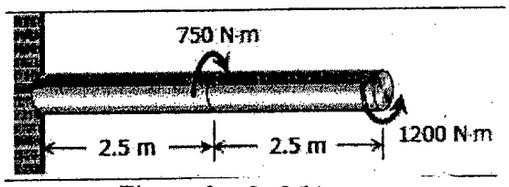

Figure for Q. 2(b)

3. (a) Draw the shear and moment diagrams for the beam shown in Figure for Q. 3(a). Calculate the numerical values at the change of loading positions and at the points of zero shear. **(15)**

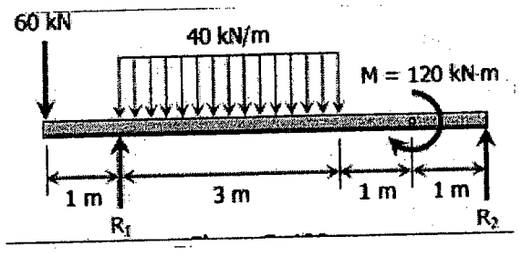

Figure for Q. 3(a)

(b) A beam carries a concentrated load W and a total uniformly distributed load of 4W as shown in Figure for Q. 3(b). What safe value of W can be applied if $f_{bc} \leq 100$ MPa and $f_{bt} \leq 60$ MPa? Can a greater load be applied if the section is inverted? Explain. **(20)**

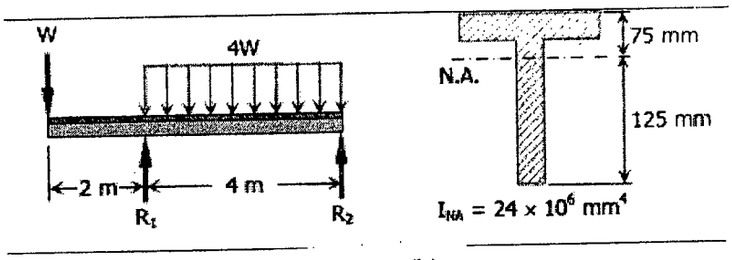

Figure for Q. 3(b)

4. (a) A timber beam 150 mm by 250 mm is reinforced only at the bottom by a steel plate, as shown in Figure for Q. 4(a). Determine the concentrated load that can be applied at the center of a simply supported beam of span 5.5 m long if n = 20, $\sigma_s \leq 124$ MPa and $\sigma_w \leq 8.3$ MPa. **(15)**

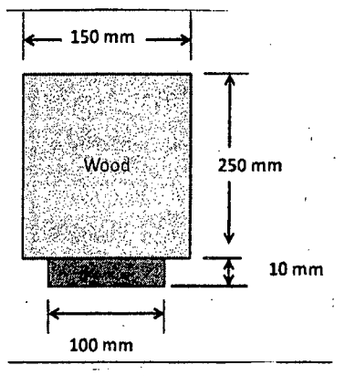

Figure for Q. 4(a)

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Contd ... Q. No. 4

(b) A circular bar is bent into the shape of a half-ring and supported in a vertical plane as shown in Figure for Q. 4(b). The load P is applied at C in the plane of the ring. Determine the horizontal movement at point C in the direction of P using strain energy method. **(20)**

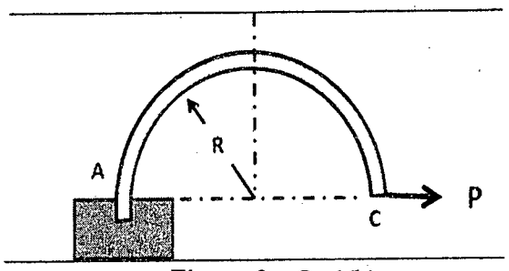

Figure for Q. 4(b)

SECTION – B

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

Symbols have their usual meanings. AISC specification table is attached.

5. (a) Compute the value of ~~EIY~~ EIy at point A of the loaded beam as shown in Fig. 5(a). Solve the problem using double integration method. **(17)**

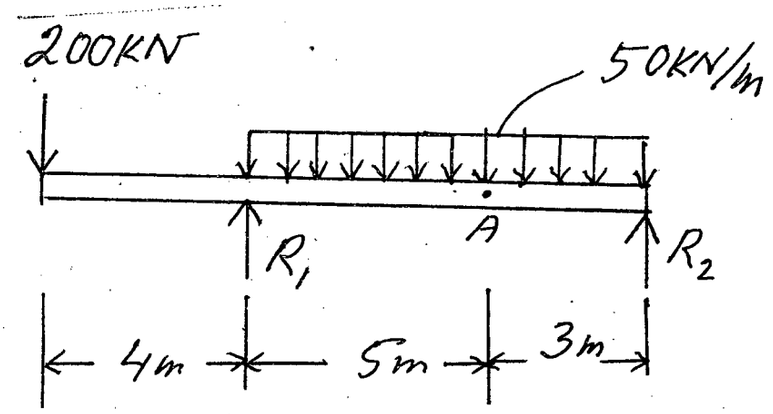

Fig. 5(a).

(b) Find the deflection of point A of the loaded cantilever beam as shown in Fig. 5(b). The cross-section of the beam is 40 mm wide by 130 mm high. Consider E = 70 GPa. Solve the problem by double integration method. **(18)**

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Contd ... Q. No. 5(b)

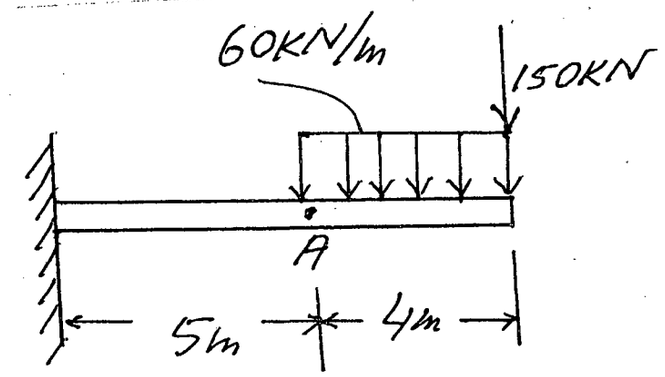

Fig. 5(b).

6. (a) For the state of the stresses, as shown in Fig. 6(a), derive the expressions for the principal stresses and the maximum in plane shearing stresses. Show that the angle between the principal plane and the plane where maximum shear stress occurs is 45°. **(18)**

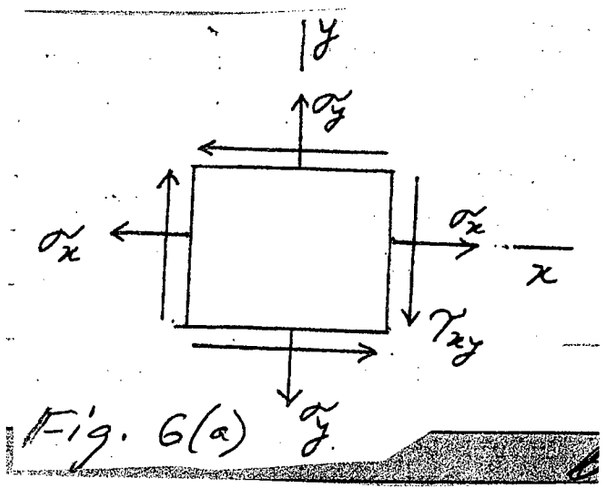

Fig. 6(a)

(b) If an element is subjected to the state of stresses, as shown in Fig. 6(b), find the principal stresses and the maximum in plane shearing stress. Also compute the stress components on a plane at 35° CCW from the x-face. Show all results on complete sketches of differential elements. Solve the problem using Mohr's circle. **(17)**

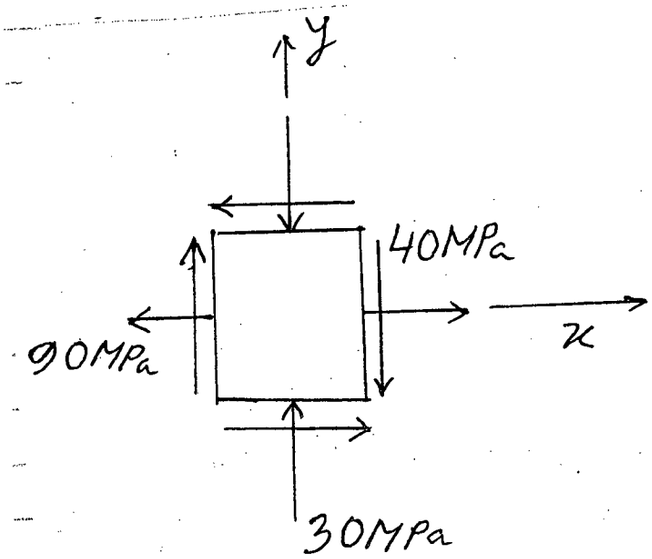

Fig. 6(b).

Contd P/5

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7. (a) Derive an expression for the flexure formula of a curved beam. List the assumptions you made for your derivation. **(17)**

(b) The cross-section of a ring is the T section, as shown in Fig. 7(b). For P = 25 KN, compute the stresses at point A and B. **(18)**

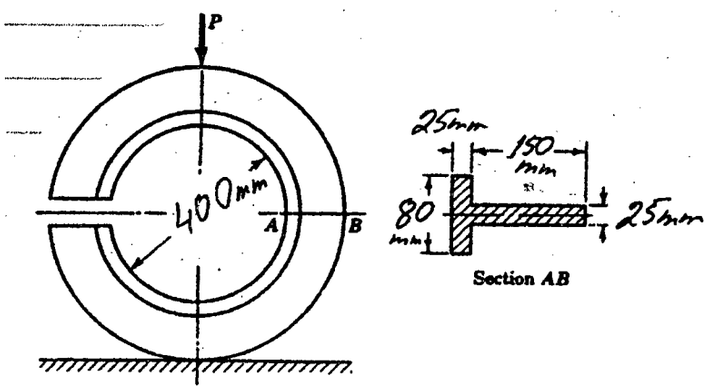

Fig. 7(b)

8. (a) Select the lightest W shape, according to AISC specification, that can be used as a column to support an axial load of 700 KN on an effective length of 3.5 m. Assume σ_{yp} = 250 MPa and E = 200 GPa. **(18)**

(b) An equiangular strain rosette placed on the surface of a stressed machine part reveals strain along the ε_0, ε_{60} and ε_{120} directions equal to 0.00065, –0.00025 and 0.00043 respectively. If E = 200 GPa and μ = 0.30, determine the principal stresses and the planes on which they act. **(17)**

AISC – Table

PROPERTIES OF WIDE-FLANGE SECTIONS (W SHAPES): SI UNITS (*Continued*)

Designation	Theoretical mass (kg/m)	Area (mm^2)	Depth (mm)	Flange Width (mm)	Flange Thickness (mm)	Web Thickness (mm)	Axis X–X I (10^6 mm^4)	Axis X–X $S = \frac{I}{c}$ (10^3 mm^3)	Axis X–X $r = \sqrt{I/A}$ (mm)	Axis Y–Y I (10^6 mm^4)	Axis Y–Y $S = \frac{I}{c}$ (10^3 mm^3)	Axis Y–Y $r = \sqrt{I/A}$ (mm)
W250 ×167	167.4	21 300	289	265	31.8	19.2	300	2 080	119	98.8	746	68.1
×149	148.9	19 000	282	263	28.4	17.3	259	1 840	117	86.2	656	67.4
×131	131.1	16 700	275	261	25.1	15.4	221	1 610	115	74.5	571	66.8
×115	114.8	14 600	269	259	22.1	13.5	189	1 410	114	64.1	495	66.3
×101	101.2	12 900	264	257	19.6	11.9	164	1 240	113	55.5	432	65.6
×89	89.6	11 400	260	256	17.3	10.7	143	1 100	112	48.4	378	65.2
×80	80.1	10 200	256	255	15.6	9.4	126	982	111	43.1	338	65.0
×73	72.9	9 280	253	254	14.2	8.6	113	891	110	38.8	306	64.7
×67	67.1	8 550	257	204	15.7	8.9	104	806	110	22.2	218	51.0
×58	58.2	7 420	252	203	13.5	8.0	87.3	693	108	18.8	186	50.3
×49	49.0	6 250	247	202	11.0	7.4	70.6	572	106	15.1	150	49.2
×45	44.9	5 720	266	148	13.0	7.6	71.1	534	111	7.03	95.1	35.1
×39	38.7	4 920	262	147	11.2	6.6	60.1	459	111	5.94	80.8	34.7
×33	32.7	4 170	258	146	9.1	6.1	48.9	379	108	4.73	64.7	33.7
×28	28.5	3 630	260	102	10.0	6.4	40.0	307	105	1.78	34.8	22.1
×25	25.3	3 230	257	102	8.4	6.1	34.2	266	103	1.49	29.2	21.5
×22	22.4	2 850	254	102	6.9	5.8	28.9	227	101	1.23	24.0	20.8
×18	17.9	2 270	251	101	5.3	4.8	22.4	179	99.3	0.913	18.1	20.1
W200 ×100	99.5	12 700	229	210	23.7	14.5	113	989	94.3	36.6	349	53.7
×86	86.7	11 100	222	209	20.6	13.0	94.7	853	92.4	31.4	300	53.2
×71	71.5	9 110	216	206	17.4	10.2	76.6	709	91.7	25.4	246	52.8
×59	59.4	7 560	210	205	14.2	9.1	61.1	582	89.9	20.4	199	51.9
×52	52.3	6 660	206	204	12.6	7.9	52.7	512	89.0	17.8	175	51.7
×46	46.0	5 860	203	203	11.0	7.2	45.5	448	88.1	15.3	151	51.1
×42	41.7	5 310	205	166	11.8	7.2	40.9	399	87.7	9.00	108	41.2
×36	35.9	4 580	201	165	10.2	6.2	34.4	342	86.7	7.64	92.6	40.8
×31	31.4	4 000	210	134	10.2	6.4	31.4	299	88.6	4.10	61.1	32.0
×27	26.6	3 390	207	133	8.4	5.8	25.8	249	87.2	3.30	49.6	31.2
×22	22.4	2 860	206	102	8.0	6.2	20.0	194	83.6	1.42	27.8	22.3
×19	19.4	2 480	203	102	6.5	5.8	16.6	163	81.8	1.15	22.6	21.5
×15	15.0	1 900	200	100	5.2	4.3	12.7	127	81.8	0.869	17.4	21.4
W150 ×37	37.1	4 730	162	154	11.6	8.1	22.2	274	68.5	7.07	91.8	38.7
×30	29.8	3 790	157	153	9.3	6.6	17.2	219	67.4	5.56	72.6	38.3
×22	22.3	2 850	152	152	6.6	5.8	12.1	159	65.2	3.87	50.9	36.8
×24	24.0	3 060	160	102	10.3	6.6	13.4	168	66.2	1.83	35.8	24.5
×18	18.0	2 290	153	102	7.1	5.8	9.16	120	63.2	1.26	24.7	23.5
×14	13.6	1 730	150	100	5.5	4.3	6.87	91.5	63.0	0.918	18.4	23.0
W130 ×28	28.1	3 580	131	128	10.9	6.9	10.9	167	55.2	3.81	59.6	32.6
×24	23.6	3 010	127	127	9.1	6.1	8.80	139	54.1	3.11	49.0	32.1
W100 ×19	19.4	2 470	106	103	8.8	7.1	4.76	89.9	43.9	1.61	31.2	25.5

* Produced exclusively by Algoma Steel (Canada).

L-2/T-1/MME **Date : 06/03/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 20010-2011

Sub : **MME 231** (Materials Thermodynamics)

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**.

1. (a) Deduce a relationship between the free energy and the equilibrium constant of a chemical reaction and explain how you would measure the spontaneity of the reaction using the derived relation. **(10+5=15)**

   (b) A gaseous mixture of 60% CO, 20% CO_2 and 20% H_2 by volume is fed into a furnace at 1000°C. Determine the equilibrium composition of the gas mixture if the total pressure is 5 atm. Given data. $\Delta G°_{298}(CO) = -32.8$, $\Delta G°_{298}(CO_2) = -94.3$, $\Delta G°_{298}(H_2O) = -54.6$ kcal mol^{-1}. **(15)**

   (c) Using the concept of the equilibrium constant, explain how you could heat treat steel without oxidation by controlling the furnace atmosphere. **(5)**

2. (a) Indicate the conditions for equilibrium in a three-component, three-phase system. **(5)**

   (b) Discuss the information one would gather when a phase diagram is constructed in a space where all the coordinates are thermodynamic potentials. What extra information one would muster if the coordinates are not thermodynamic potentials? **(5+5=10)**

   (c) Platinum (Pt) may exist as a solid, a liquid or a vapour. The vapour pressure for the solid and liquid are given below:

   Solid Pt: $\log p = -28460/T - 1.27 \log T + 14.33$ (mm Hg)

   Liquid Pt: $\log p = -27890/T - 1.77 \log T + 15.71$ (mm Hg)

   Calculate:

   (i) The normal boiling point of Pt **(5)**

   (ii) The triple point temperature and pressure **(5)**

   (iii) The enthalpy of evaporation of Pt at the normal boiling temperature **(3)**

   (iv) the enthalpy of fusion of Pt at the triple point temperature **(5)**

   (v) The difference between the constant-pressure heat capacities of solid and liquid Pt. **(2)**

3. (a) Explain how interfacial tension controls the shapes of a precipitate. How does the addition of manganese in steel eliminate the harmful effect of sulphur? **(10+3=13)**

   (b) A liquid silicate with surface tension of 500 ergs cm^{-2} makes contact with a polycrystalline oxide with an angle $\theta = 45°$ on the surface of the oxide. If mixed with the oxide, it forms liquid globules at three grain intersections. The average dihedral angle ϕ is 90°. If we assume the interfacial tension of the oxide-oxide interface, without the silicate liquid is 1000 dyne cm^{-1}, compute the surface tension of the oxide. **(10)**

   (c) Define and classify adsorption. Explain how the concept of adsorption is used to manufacture cutting fluid solution. **(7+5=12)**

Contd P/2

MME 231

4. (a) Explain the concept of macrostate and microstate in statistical thermodynamics. **(10)**

   (b) What is a partition function? Obtain relations for entropy, internal energy and Helmholtz free energy in terms of partition function. **(3+12=15)**

   (c) The vapour pressure of liquid zinc as a function of temperature is given as:

   $\log p \text{ (mm Hg)} = -6620/T - 1.255 \log T + 12.34$.

   If the heat of sublimation of zinc at its boiling temperature of 907°C is 30 kcal mol^{-1}, how much heat will be required to melt 1 kg zinc at 907°C? **(10)**

SECTION – B

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

5. (a) Classify the following thermodynamic systems: **(10)**

   (i) a balloon floating in air
   (ii) a can of pepsi
   (iii) a dry cell battery
   (iv) a rotating ceiling fan
   (v) A yttria stabilized zirconia furnace tube

   (b) State the second law of thermodynamics. "While entropy of a system may increase or decrease during a process, the entropy of the universe taken as system plus the surroundings involved in producing the changes within the system, can only increase" – Explain. **(10)**

   (c) An ideal gas is held in a piston-cylinder assembly undergoes a reversible adiabatic expansion for which the relationship between pressure and volume is given by PV^{γ} = constant. The initial pressure is 3 bars and the initial and final volumes are 0.1 m^3 and 0.2 m^3 respectively. **(15)**

   Determine (i) the amount of mechanical work done to the system and (2) the change in initial energy of the system for the process if (i) $\gamma = 1.5$ (ii) $\gamma = 0$

6. (a) Relate the internal energy of a system to its pressure and volume. **(20)**

   (b) Compute the change in internal energy when 12 Liters of an ideal gas at 273 K and 1 atm pressure is compressed to 6 Liters with the final pressure equal to 10 atm. Assume, $C_v = 3R/2$ for this monatomic gas, where R = 0.082 Liter-atm/mol-K. **(15)**

7. (a) What are the differences between conditions for equilibrium and criterion for equilibrium? **(10)**

   (b) Deduce the expression for the change in entropy of a unary two phase isolated system. Also derive the conditions of maximum entropy for that system. **(25)**

8. (a) Show that, the heat of formation of an ideal solution is zero. **(8)**

   (b) Calculate the activity of bismuth in a mercury - 3 atom % bismuth alloy at 320°C using the following data: **(15)**

X_{Hg}	0.949	0.893	0.851	0.753	0.653	0.537	0.437	0.330	0.207	0.063
α_{Hg}	0.961	0.929	0.908	0.840	0.765	0.650	0.542	0.432	0.278	0.092

   (c) Explain how a solution may deviate from the idealty. **(12)**

L-2/T-1/MME **Date : 22/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **MME 211** (Crystallography and Structure of Materials)

Full Marks: 140 Time : 3 Hours

The questions are of equal value.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Define symmetry. Explain the basic symmetry operations.
Distinguish between a mirror plane and a glide plane of symmetry.
(b) Draw neat sketches to show the symmetry elements of (i) a crystal with reactangular sides and square ends and (ii) a cubic crystal.

2. (a) Show with suitable examples that the action of a symmetry element can generate another.
(b) Explain the nature of stereographic projection. How could you obtain a stereographic projection?

3. (a) What is a standard projection? How could you identify the Miller indices of a plane with the help of a standard projection?
How would you identify the Miller indices of a plane when a standard projection is not available?
(b) What is a Wulff net? How is it constructed? Explain with neat sketches the measurement of angles between two planes of a crystal by using a Wulff net.

4. (a) Consider a crystal lattice and explain how a reciprocal lattice is drawn.
Show that the reciprocal lattice vector H_{hkl} is normal to the plane (hkl).
(b) Prove the reciprocity of the volumes of the reciprocal and the direct lattices.

SECTION – B

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

The figures in the margin indicate full marks.

5. (a) Explain why covalently bonded materials are generally less dense than ironically or metallically bonded ones. **(5 1/3)**

(b) Illustrate octahedral and tetrahedral interstitial voids in FCC structure. Show that the maximum radius of the sphere that fits into an octahedral void is 0.414 R while the maximum radius that fits into a tetrahedral void is equal to 0.225 R where R represents the radius of the spheres in close packing. **(10+8=18)**

6. (a) Compute and compare the linear densities of [111] and [112] directions for FCC copper where $a_0 = 3.62$ Å. **(8)**

(b) Calculate and compare the planer densities of the (100) and (110) planes for BCC iron (where $a_0 = 2.86$ Å). **(8)**

Contd P/2

MME 211

(c) The atomic radius of iron is 1.24 Å. When heated to 1398 °C, the structure of iron changes from FCC to BCC. Calculate the percentage change in volume that takes place during this transformation and also mention whether the change causes contraction or expansion. **(7 ⅓)**

7. Figure 1 shows three different crystallographic planes for a unit cell of some hypothetical metal; the circle represent atoms:

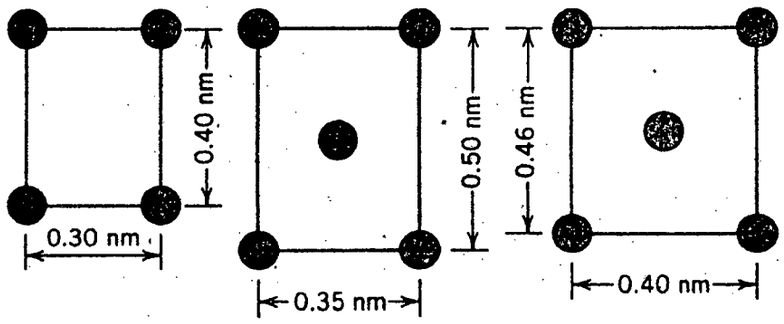

Figure 1

(a) To what crystal system does the unit cell belong? **(8)**

(b) What would this crystal structure (Bravais lattice) be called? **(8)**

(c) If the density of this metal is 8.95 g/cm^3, determine its atomic weight. **(7 ⅓)**

8. (a) Derive the Bragg's law for diffraction? Explain how this is used in the study of metal crystal. **(11 ⅓)**

(b) Figure 2 shown an x-ray diffraction pattern for α-iron taken using a diffractometer and monochromatic x-radiation having a wavelength of 0.1542 nm; each diffraction peak on the pattern has been indexed according to the reflection rules for BCC (i,e, the sum h+k+l must be even). Compute the interplanar spacing for each set of planes indexed; also determine the lattice parameter of Fe for each of the peaks. **(12)**

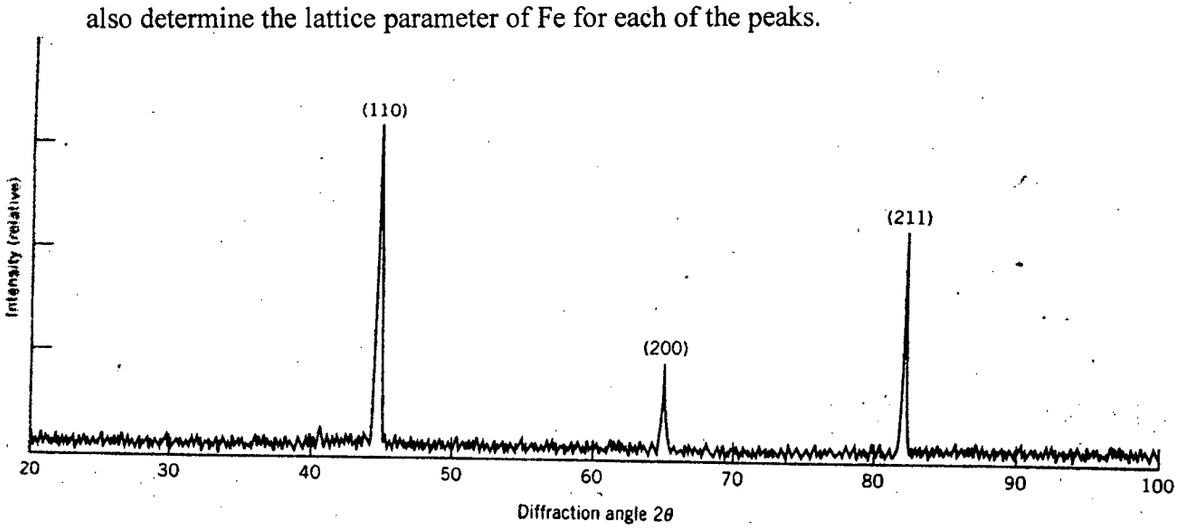

Figure 2: Diffraction pattern for polycrystalline α-iron

L-2/T-1/MME **Date : 15/02/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Examinations 2010-2011

Sub : **MME 241** (Fuels and Combustion)

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 **THEEE**.

1. (a) How many reaction zones would you expect in a Producer Gas furnace? Discuss the zones briefly and mention the reactions involved in each zone. **(15)**

   (b) In Lurgi process, several modifications have been implemented in recent years. Identify the modifications and explain the motivations behind these changes. **(10)**

   (c) Draw a schematic diagram of a Curburetted Water Gas plant and explain how you can improve thermal efficiency of the plant. **(10)**

2 (a) How can you determine carbon monoxide level in atmosphere? Draw a neat sketch and discuss the working principle of the method. **(10)**

   (b) What are the advantages of using wet blast in a Producer Gas plant? **(10)**

   (c) Draw a neat sketch of a Water Gas unit and explain the reasons for which the conventional Water Gas production route is categorised as an intermittent process. **(15)**

3. (a) To install a pulverized coal combustion chamber, choice can be made from several firing systems. Your project manager asks you to find out a better furnace design which would be let most ashes (say 90%) to be removed with flue gases, and three separate streams of blast must be allowed in the design. Which firing system would you finalise? Draw a neat sketch of the corresponding firing furnace and explain the steps of the process. **(15)**

   (b) Do you prefer fluidsed bed combustion over pulverized coal combustion? Justify your answer. **(5)**

   (c) Draw a schematic diagram of a circulating fluidised bed boiler furnace and write down the working principle of this process. **(15)**

4. (a) Write down the reasons for smoke evolution during combustion and their remedies. **(10)**

   (b) Using a schematic chart of gas supply vs primary air supply for an aerated burner, explain that a certain gaseous fuel burner operates within a certain range of gas flow rates. **(15)**

   (c) Briefly discuss the factors governing the limits of inflammability. **(10)**

Contd P/2

MME 241

SECTION – B

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

5. (a) What is coke? Describe what happens when a coking grade of coal is subjected to a uniformly increasing temperature in the absence of air. **(17)**

   (b) List the salient features and points of differences between the high temperature and low temperature carbonization processes. **(18)**

6. (a) What are the products of primary distillation of crude oil? Mention their approximate percentages and boiling points. **(10)**

   (b) Mention the differences between thermal and catalytic cracking. With the help of a flowsheet describe the working principle of the thermofer catalytic cracking (TCC) moving bed process. **(20)**

   (c) How does octane number influence the knocking characteristics of a motor fuel? **(5)**

7. (a) Describe briefly why the washing of coal is necessary. Describe one dry and one wet process of coal washing mentioning the advantages and disadvantages of both the processes. (If necessary give sketches of the processes) **(25)**

   (b) Give the classification of solid, liquid and gasses fuels according to their natural, manufactured and by-product forms. **(10)**

8. Write short notes on the following:

   (a) Polymerization of liquid fuel **(9)**

   (b) Colloidal fuel **(8)**

   (c) Rank of coal **(9)**

   (d) Isomerizaton of liquid fuel. **(9)**
