Extra

L-2/T-1/MME Date : 12/05/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

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

Full Marks: 140 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The questions are of equal value.

1. (a) Define symmetry. Show that it is not possible to have a S-fold rotational symmetry.
   (b) Distinguish between
      (i) a mirror plane and a glide plane of symmetry
      (ii) congruent and enantio morphous objects.
   (c) Determine the point group symmetry of a chess board (i) without the chessmen and (ii) with the chessmen in the opening position [Ignore the colour of the chessmen].

2. (a) Use a suitable example and show that the choice of unit cell is arbitrary.
   (b) Identify the symmetry contents of a crystal with rectangular sides and square ends.
   (c) Identify the symmetry contents of a rectangle.

3. (a) What is stereographic projection? Explain, with neat sketches, how it is obtained. Explain the measurement of angle between two planes of a crystal by using stereographic projection.
   (b) Differentiate between a great circle and a small circle.

4. (a) What is a standard projection? How could you identify the Miller indices of a plane when a standard projection is NOT available?
   (b) What is a Wulff net? Explain, with a neat sketch, the measurement of angles between two planes of a crystal by using Wulff net.

SECTION – B

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

The figures in the margin indicate full marks.

5. (a) Distinguish between an amorphous and a crystalline substance. **(3⅓)**
   (b) Discuss the characteristics of metallic bond. **(6)**
   (c) Show that for BCC and FCC crystal structures the lattice parameters are given by **(6)**

$$a_{BCC} = \frac{4R}{\sqrt{3}} \text{ and } a_{FCC} = \frac{4R}{\sqrt{2}}$$

   Where R = atomic radius.
   (d) Calculate the densities of packing for BCC and FCC crystal structures. **(8)**

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MME 211

6. (a) Copper has an atomic radius of 0.128 nm, an FCC crystal structure, and an atomic weight of 63.5 g/mol. Compute its density. **(7)**

   (b) Calculate the linear density of the [100] direction for BCC crystal. **(4⅓)**

   (c) Calculate the planar density of the (110) plane for FCC crystal. **(5)**

   (d) On heating, α-iron (BCC) transforms into γ-iron (FCC) at 910°C. If the atomic radius of iron is 0.124 nm, determine the percentage of volume change that would occur during this heating. **(7)**

7. (a) For BCC iron, compute (i) the interplanar spacing, and (ii) the diffraction angle for the (220) set of planes. The lattice parameter for iron is 0.2866 nm. Assume that monochromatic radiation having a wavelength of 0.179 nm is used, and the order of reflection is 1. **(8)**

   (b) Draw neat sketches and explain the analysis of crystal structures by the Debye-Scherrer method. **(15⅓)**

8. Figure 1 shows the first four peaks of the x-ray diffraction pattern for polycrystalline copper, which has an FCC crystal structure. Monochromatic x-radiation having a wavelength of 0.1542 nm was used.

   (a) Index (i.e., give *h*, *k*, and *l* indices for) each of these peaks. **(3⅓)**

   (b) Determine the interplanar spacing for each of the peaks. **(8)**

   (c) Determine the lattice parameter and the atomic radius for copper. **(12)**

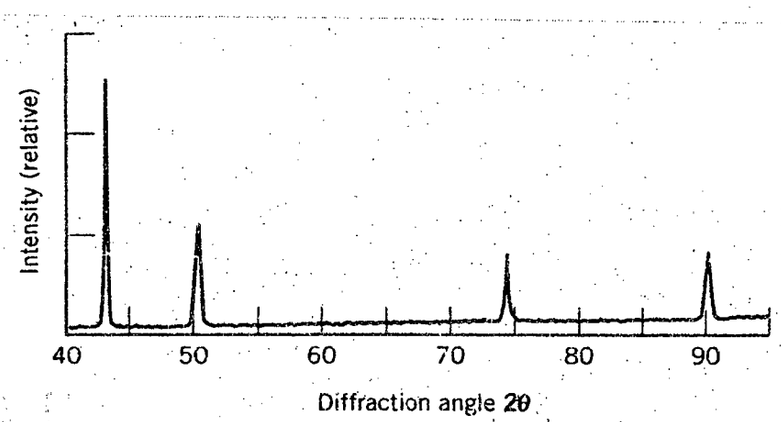

Figure 1 for Q. No. 8

L-2/T-1/MME **Date : 09/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

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

Full Marks: 280 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**.

Symbols used have their usual meaning.

1. (a) Define Interpolation. Derive Newton's general interpolation formula. **(23)**

   (b) Find the equation of the curve passing through the points (1, 3), (2, 9), (4, 45) and (5, 81) using Lagrange interpolation formula. **(23⅔)**

2. (a) From the following table find the value of x for $y = 90$ **(23)**

x	2	5	8	11
y	94.12	87.54	81.43	75.9

   (b) Find the formula for the first and second derivative from Newton's forward interpolation formula. The values of x and y are tabulated below: **(23⅔)**

x	1	2	3	4
y	3	9	22	45

   Evaluate $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ at $x = 2.5$.

3. Discuss general quadrature method for equidistant ordinates to evaluate the integral $\int_a^b f(x)dx$ and hence derive Weddle's formula. **(46⅔)**

4. Solve $\frac{dy}{dx} = \sqrt{3x+1} + \sqrt{2y+1}, x = 0, y = 1$ to find the value of y at $x = 0.6$ by

   (i) Euler's method taking $h = 0.1$ and **(20)**

   (ii) Runge-Kutta method taking $h = 0.3$ **(26⅔)**

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MATH 271/MME

SECTION – B

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

5. (a) The following are the scores of two batsman A and B in a series of 8 innings. **(18)**

A	16	112	15	70	19	27	84	78
B	41	110	75	13	25	50	19	65

Who is better run getter? Who is more consistent?

(b) Calculate the two regression lines and the coefficient of correlation from the following table **(28⅔)**

X	67	68	67	72	73	67	60	71
Y	69	68	68	71	72	66	59	70

6. (a) It is known that 4% of the bulbs produced by MAS Co. are defective. Find the probability that a box of 400 of these bulbs contains at least 5 defective bulbs. **(15)**

(b) The probability that A can solve a problem is $\frac{5}{8}$, that B can solve it is $\frac{3}{7}$, that C can solve it is $\frac{4}{5}$. If all of them try independently, find the probability that the problem will be solved. **(12)**

(c) The heights of 10 students of BUET are found to be 72, 65, 61, 69, 60, 67, 70, 64, 63 and 65 inches. Is it reasonable to believe that the average height is greater than 64 inches? Test at 5% level of significance. Given t = 1.83. **(19⅔)**

7. (a) Apply Lagrange's auxiliary equation technique to solve **(14)**

$$(y+z)p+(z+x)q=x+y$$

(b) Solve: $px+qy=pq$ **(15)**

(c) Solve: $2(z+px+qy)=p^2y$ **(17⅔)**

8. Solve the following higher order PDEs

(a) $\left(D_x^2+D_xD_y-12D_y^2\right)z=x^2y^2$ **(16)**

(b) $\left(5D_x+3D_y-3\right)\left(2D_x-7D_y+1\right)z=e^{3x-2y}\sin(5x-2y)$ **(18)**

(c) $\left(x^2D_x^2-y^2D_y^2\right)z=x^2y$ **(12⅔)**

MME-231

19.05.2014

L-2/T-1/MME **Date : 19/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

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) Classify the following thermodynamic systems: **(8)**

   (i) A dry cell battery

   (ii) A flower vase

   (iii) An electric magnet inside a toy

   (iv) You

   (b) List the kind of energy conversion involved in using arm and hand to turn the pages of this question paper. **(4)**

   (c) Examine the characteristics and significance of a reversible process used in thermodynamics. **(4+3=7)**

   (d) Establish the criterion of spontaneity of a process based on entropy. **(6)**

   (e) Five moles of an ideal gas of volume 2.5 m^3 and temperature 25°C are expanded isothermally to 3.4 m^3. The change in entropy during the process is calculated as 5.0 J mol^{-1} K^{-1}. Calculate the change in internal energy of the system. **(10)**

2. (a) The temperature and pressure dependence of volume of an ideal gas, V = V (T, P), can be expressed by the ideal gas law, PV = nRT. Determine the coefficient relations for the function V = V (T, P) and, using Maxwell relation, prove that all of these functions are state variables. **(4+6=10)**

   (b) Deduce a relationship between the Gibbs free energy of a system to its entropy and temperature. **(15)**

   (c) Five moles of ideal diatomic gas is heated adiabatically from 298 K to 1000 K. Estimate the change in Gibbs free energy for this process. Use S_{298} = 105.8 J K^{-1}. **(10)**

3. (a) Explain the concept of metastable equilibrium and indicate, using suitable example, the importance of metastability in materials science and engineering. **(5+5=10)**

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Contd... Q. No. 3

(b) If the temperature, volume and total number of moles of a system are constrained to be constant, then the criterion for equilibrium is that the Helmholtz free energy of the system is the minimum. Paraphrase the strategy to deduce the conditions for equilibrium for a two-phase unary system. **(20)**

(c) Using the First Law, derive the expression **(5)**

$$\left(\frac{\partial U}{\partial T}\right)_P = C_P - P\left(\frac{\partial V}{\partial T}\right)_P$$

4. (a) Derive expressions for the macroscopic properties of entropy, Helmholtz free energy and internal energy in terms of the partition function. **(15)**

(b) A system permits continuous programmed control of the pressure and volume of the gas that it contains. The system is filled with one mole of an ideal monoatomic gas and brought to an initial conditions of 1 atm pressure and 273 K temperature. It is then reversibly compressed to 2 atm along a programmed path given by the expression $V = 2P^2 + 20$, where P is in atm and V is in litres. Compute:

(i) The initial volume and final temperature of the system **(2+3=5)**

(ii) The heat absorbed by the system. **(15)**

SECTION – B

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

5. (a) Deduce an expression indicating the temperature dependence of equilibrium constant. **(10)**

(b) Explain how the concept of equilibrium constant can be used in controlling the furnace atmosphere during heat treatment. **(10)**

(c) Calculate the equilibrium extent of decomposition of nitrogen tetraoxide according to the chemical reaction $N_2O_4 = 2NO_2$ at 25°C and 5 atm. What will be the equilibrium composition of the gas mixture? Use $\Delta G^0_{298} = 4644$ J/mol. **(15)**

6. (a) Explain the concept of wetting. **(15)**

(b) Differentiate between chemical adsorption and physical adsorption. **(5)**

(c) What is the difference between a surface and interface? Describe the concept of surface tension. **(15)**

Contd P/3

MME 231

7. (a) X_A moles of A and X_B moles of B are mixed to form a regular binary AB solution. Deduce an expression for the Gibbs free energy change of mixing of this solution. What would be the expression if the solution formed were an ideal solution? **(20)**

(b) The activity coefficient of zinc in liquid brass has been expressed for the temperature range of 1000 - 1500 K by the equation: **(15)**

$$RT \ln \gamma_{Zn} = -4600 X_{Cu}^2$$

Calculate (i) the partial pressure of Zinc over a solution of 60 percent of copper and (ii) the activity coefficient of copper at 1500 K.

8. (a) Construct the phase diagram of pure silicon using the following data: **(20)**

$T_m = 1683$ K, $T_b = 2750$ K, $\Delta H^F = 46.4$ KJ/mol, $\Delta H^G = 46.4$ KJ/mol 297 KJ/mol

(b) The vapor pressure of liquid zinc as a function of temperature is given as: **(15)**

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

Calculate the heat of vaporization of zinc at its boiling point 907°C. If the heat of sublimation of zinc at the boiling temperature is 30 Kcal/mol, what will be the heat of fusion of zinc at its boiling temperature?

Extra

L-2/T-1/MME **Date : 26/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

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

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) Describe the reaction zones in a producer gas furnace with the help of necessary reactions and diagrams. **(20)**

   (b) What are the impurities in raw producer gas? Explain their effects. **(15)**

2. (a) What is draught? Explain the different types of draught with relative merits and demerits. **(20)**

   (b) Explain how flame stability is affected by V_n and V_{av}. **(15)**

3. (a) Explain with the help of a labelled diagram, the operation of the travelling grate stoker. Mention why it cannot burn low ash coal. **(20)**

   (b) What are the advantages and disadvantages of pulverised coal? **(15)**

4. (a) Reducing exit flue gas temperature is a means to reduce heat loss during combustion of fuels. Presence of sulphur in fuel limits this reduction of exit five gas temperature with the help of figures; explain how. **(20)**

   (b) Explain the factors upon which the selection of a burner depends. **(15)**

SECTION – B

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

5. (a) Mention the differences between coal and coke. Describe what happens when a coking grade of coal is subjected to a uniformly increasing temperature in absence of air. **(15)**

   (b) List the salient features and points of differences between the high temperature and low temperature carbonization processes. **(15)**

   (c) List the by-products obtained during carbonization of coal using the by-product process. **(5)**

Contd P/2

MME 241

6. (a) Give a comparative study of solid, liquid and gaseous fuels mentioning their advantages and disadvantages. **(18)**

(b) Describe briefly why the washing of coal is necessary? What are the advantages and disadvantages of dry and wet processes of coal washing? With the help of a neat sketch explain the working principle of 'Baum Jig' coal washing process. **(17)**

7. (a) What are the products of primary distillation of crude oil? Mention their approximate percentages and boiling points. **(15)**

(b) What is reforming of heavy oil and why is it necessary in oil industry? Give the advantages and limitations of thermal and catalytic reforming. **(15)**

(c) What is knocking? **(5)**

8. (a) Classify petroleum depending on the nature of hydrocarbons present. Define each class with examples. Mention some uses of various petroleum products. **(14)**

(b) Write notes on: **(21)**

(i) hydrogenation of coal

(ii) shale oil

(iii) higher and lower heating value of coal.

L-2/T-1/MME **Date : 02/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2012-2013

Sub : **ME 243** (Mechanics of Solids)

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) A cylindrical steel pressure vessel 400 mm in diameter with a wall thickness of 20 mm is subjected to an internal pressure of 4.5 MN/m^2. (i) Calculate the tangential and longitudinal stresses in the steel. (ii) To what value may the internal pressure be increased if the stress in the steel is limited to 120 MN/m^2. (iii) If the internal pressure were increased until the vessel burst, sketch the type of fracture that would occur. **(15)**

   (b) For the hook of circular section as shown in Fig. for question No. 1(b). (i) determine the maximum load 'P' that may be supported without exceeding a stress of 120 MPa. (ii) what stress then exists at B? **(20)**

2. (a) For the state of plane stress as shown in Fig. for question No. 2(a), determine (i) the principal planes and the principal stresses, (ii) the maximum shearing stress and the corresponding normal stress, (iii) the stress components developed on the 30° plane counterclockwise from the x-axis. Use Mohr's Circle. **(18)**

   (b) The stresses are to be computed at two points A and B on the cantilever shown in Fig. for question No. 2(b). The forces are F = 0.55 kN, P = 8 kN, and T = 30 N.m. Draw both stress elements, label the axes and stress components using proper magnitudes and directions. **(17)**

3. Determine the safe axial loads on a W360×122 section used as a column under the following conditions: (i) hinged ends and a length of 9 m; (ii) built-in ends and an unsupported length of 10 m; (iii) built-in ends and a length of 10 m braced at the midpoint. Use σ_{yp} = 380 MPa and E = 20 GPa. **(35)**

4. (a) In a reinforced concrete beam, b = 300 mm, d = 500 mm, A_s = 1500 mm^2, n = 8 as shown in Fig. for question No. 4(a). Determine the maximum stresses in the concrete and steel produced by a bending moment of 70 kN.m. **(18)**

   (b) Use Castigliano's theorem to find the downward deflections of points C, and B of the cantilevered crank shown in Fig. for question No. 4(b). **(17)**

Contd P/2

ME 243/MME

SECTION – B

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

5. (a) A rigid bar is pinned at 0 and attached to two vertical rods as shown in Figure 5(a). Determine the stress in each rod if the load P = 100 kN. The bar was initially horizontal and the rods were stress free. Neglect the weight of the rigid bar. **(17)**

(b) A composite bar of steel and copper is subjected to an axial load P = 1500 kN as shown in Figure 5(b). The bar is attached firmly at one end with a rigid wall and at the other end there is a gap of 0.08 mm in between the end of the bar and the plane of the rigid wall. Cross sectional area in the steel and copper portions are respectively 20,000 mm^2 and 10,000 mm^2. If the temperature of the bar increases by 20°C, determine the stresses in the different sections of the copper and steel bars. Consider E_{st} = 200 GPa, α_{st} = 11.7 μm/m°C, E_{cu} = 120 GPa, and α_{cu} = 16.8 μm/m°C. **(18)**

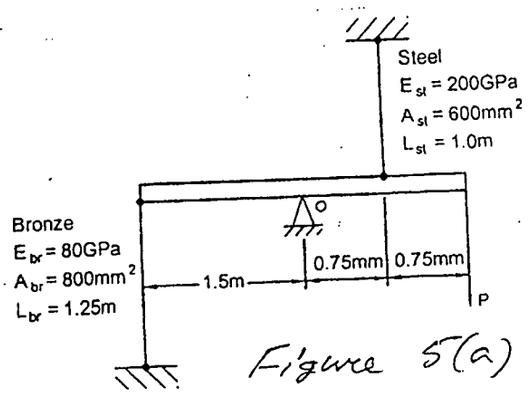

Figure 5(a)

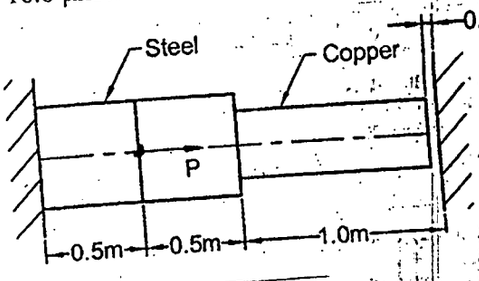

Figure 5(b)

6. (a) Three pulleys are connected by the solid steel shafts of diameters 40 mm and 50 mm as shown in Figure 6(a). Determine the angle through which the pulley A rotates with respect to the (i) pulley B and (ii) pulley C. Consider the shear modulus of rigidity G = 80 GPa. **(17)**

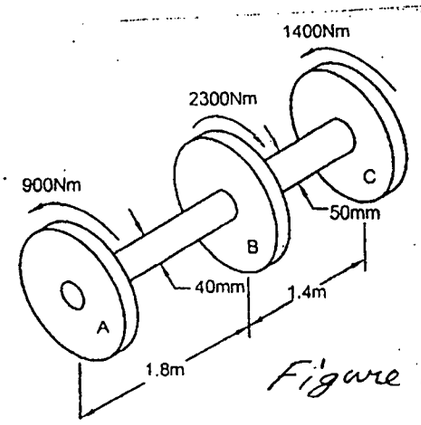

Figure 6(a)

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(b) A rigid bar hinged at O is supported by two steel springs as shown in Figure 6(b). The spring A has number of turns of 15, wire diameter of 10 mm and mean diameter of 140 mm while the spring B has number of turns of 20, wire diameter of 12 mm and mean diameter of 180 mm. Determine the maximum shearing stresses in both the springs A and B for a dead load P of 200 N. Neglect the self weight of the bar. **(18)**

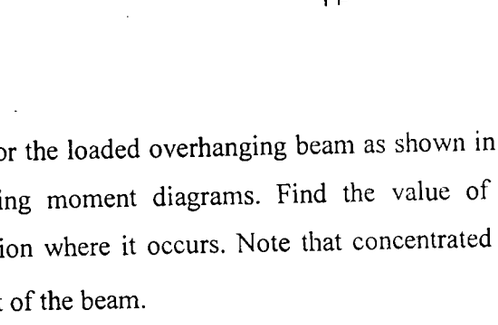


Figure 6(b)

7. (a) For the loaded overhanging beam as shown in Figure 7(a), draw the shear force and bending moment diagrams. Find the value of maximum bending moment and its location where it occurs. Note that concentrated load of 20 kN is applied at the mid-point of the beam. **(17)**

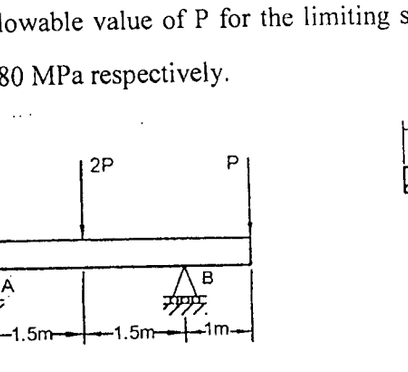


Figure 7(a)

(b) A beam of T-section supports concentrated loads as shown in Figure 7(b). Find the maximum allowable value of P for the limiting stresses in tension and compression of 30 MPa and 80 MPa respectively. **(18)**

Figure 7(b)

Contd P/4

ME 243/MME

8. (a) Using area moment method find an expression of free end deflection for a cantilever beam of length L subjected to a uniformly distributed load of W over half of its length and a couple M_0 at its free end as shown in Figure 8(a). **(17)**

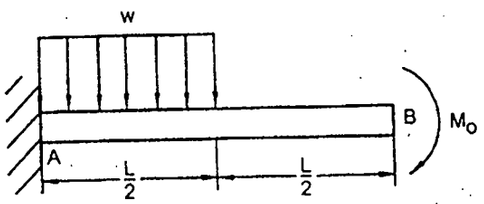
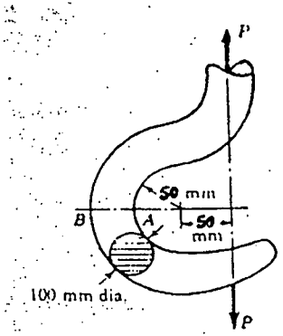


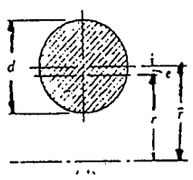
Figure 8(a)

(b) Derive expressions of maximum radial and tangential stresses for a thick-walled cylinder, when the cylinder is subjected to an internal pressure only. **(18)**

Table for question no. 3

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)
W360 ×262	262.7	33 500	387	398	33.3	21.1	894	4 620	163	350	1 760	102
×237	236.3	30 100	380	395	30.2	18.9	788	4 150	162	310	1 570	101
×216	216.3	27 600	375	394	27.7	17.3	712	3 790	161	283	1 430	101
×196	196.5	25 000	372	374	26.2	16.4	636	3 420	159	229	1 220	95.7
×179	179.2	22 800	368	373	23.9	15.0	575	3 120	159	207	1 110	95.3
×162	162.0	20 600	364	371	21.8	13.3	516	2 830	158	186	1 000	95.0
×147	147.5	18 800	360	370	19.8	12.3	463	2 570	157	167	904	94.2
×134	134.0	17 100	356	369	18.0	11.2	415	2 330	156	151	817	94.0
×122	121.7	15 500	363	257	21.7	13.0	365	2 010	153	61.5	478	63.0
×110	110.2	14 000	360	256	19.9	11.4	331	1 840	154	55.7	435	63.1
×101	101.2	12 900	357	255	18.3	10.5	302	1 690	153	50.6	397	62.6
×91	90.8	11 600	353	254	16.4	9.5	267	1 510	152	44.8	353	62.1
×79	79.3	10 100	354	205	16.8	9.4	227	1 280	150	24.2	236	48.9
×72	71.5	9 110	350	204	15.1	8.6	201	1 150	149	21.4	210	48.5
×64	63.9	8 140	347	203	13.5	7.7	178	1 030	148	18.8	186	48.1
×57	56.7	7 220	358	172	13.1	7.9	161	897	149	11.1	129	39.2
×51	50.6	6 450	355	171	11.6	7.2	141	796	148	9.68	113	38.7
×45	45.0	5 730	352	171	9.8	6.9	122	691	146	8.18	95.7	37.8
×39	39.1	4 980	353	128	10.7	6.5	102	580	143	3.75	58.6	27.4
×33	32.8	4 170	349	127	8.5	5.8	82.7	474	141	2.91	45.8	26.4





$$\bar{r} = r_i + \frac{d}{2}$$

$$r = \frac{d^2}{4(2\bar{r} - \sqrt{4\bar{r}^2 - d^2})}$$

Fig. for question no. 1(b)

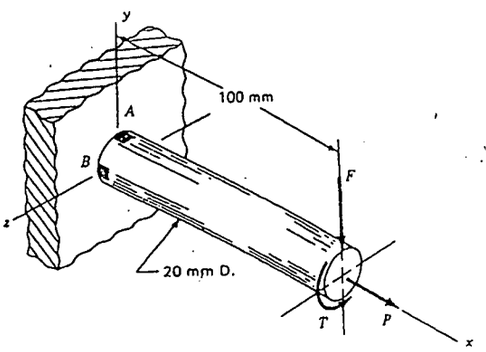


Fig. for question no. 2(b)

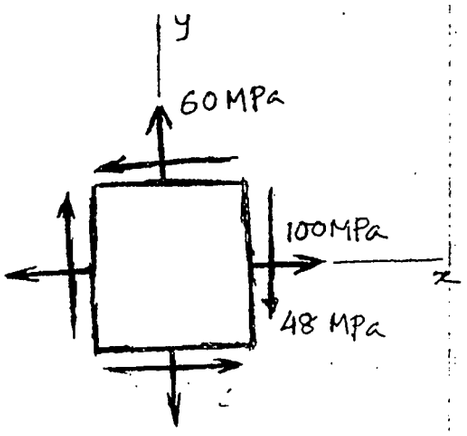


Fig. for question no. 2(a)

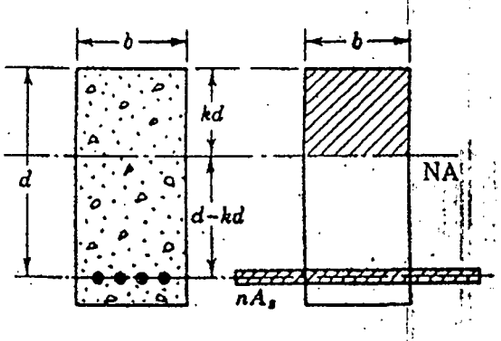


Fig. for question no. 4(a)

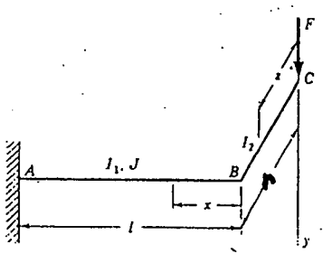


Fig. for question no. 4(b)

(5)