L-2/T-1/MME **Date : 17/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2014-2015

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) Derive Newton's general interpolation formula. **(23)**

   (b) From the following, find the value of y for x=1.1673 **(23⅔)**

x:	1.15	1.16	1.17	1.18	1.19
y:	0.93304	0.92980	0.92670	0.92373	0.92088

2. (a) Find first and second derivatives of the function tabulated below at x=3. **(23)**

x:	3.0	3.2	3.4	3.6	3.8	4.0
y:	–14.0	–10.032	–5.296	0.256	6.672	14.0

   (b) Derive general quadrature formula for equidistant ordinates. **(23⅔)**

3. (a) Evaluate $\int_0^1 \frac{\ln(1+x^2)}{1+x^2}dx$ by (i) Simpson's $\frac{1}{3}$ formula and (ii) Weddle's formula taking 12 subintervals. **(23)**

   (b) Solve $\frac{dy}{dx} = y - x^2,\ y(0)=1$ by Picard's method to find the value of y(0.2) taking stepvalue 0.1. **(23⅔)**

4. (a) Compute y(0.2) by Runge-Kutta method of fourth order from the differential equation $\frac{dy}{dx} = xy + y^2,\ y(0)=1$ taking stepvalue h=0.1. **(23)**

   (b) Use Newton-Raphson method to find the roots of the simultaneous equations **(23⅔)**

$$x^2 - y^2 = 4$$
$$x^2 + y^2 = 16$$

Assume $x_0 = 2\sqrt{2}, y_0 = 2\sqrt{2}$.

Contd P/2

MATH 271

SECTION – B

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

5. (a) Use Lagrange's method to solve the equation: **(14)**

$$\left(x^3+3xy^2\right)p+\left(y^3+3x^2y\right)q=2\left(x^2+y^2\right)z.$$

(b) Find the complete integral of **(14)**

$$p^2q^2+x^2y^2=x^2q^2\left(x^2+y^2\right).$$

(c) Use Charpit's method to solve the PDE **(18⅔)**

$$xp+3yq=2\left(z-x^2q^2\right).$$

6. Solve the following higher order partial differential equations:

(i) $t-2xq+x^2z=(x-2)e^{3x+2y}$ **(15)**

(ii) $\left(D_x+D_y-1\right)\left(D_x+D_y-3\right)\left(D_x+D_y\right)z=e^{x+y}\sin(2x+y)$ **(15)**

(iii) $\left(x^2D_x^2-y^2D_y^2+xD_x-yD_y\right)z=(\log x)^2+(\log y)^2.$ **(16⅔)**

7. (a) Calculate the first four moments and using moments find the coefficients of skewness and kurtosis from the following distribution which shows the marks obtained by 100 students in an examination: **(22)**

Marks	1–10	11–20	21–30	31–40	41–50	51–60
No. of Students	3	16	26	31	16	8

(b) In a study between the amount of rainfall (X) and the quantity of air pollution removed (Y) the following data were collected. **(24⅔)**

Find the regression line of Y on X.

Daily Rainfall in 0.01 cm	4.3	4.5	5.9	5.6	6.1	5.2	3.8	2.1
Pollution Removed (mg/m^3)	12.6	12.1	11.6	11.8	11.4	11.8	13.2	14.1

8. (a) The probability that an entering college student will graduate is 0.4. Determine the probability that out of 5 students (i) none (ii) one (iii) at least one will graduate. **(15)**

(b) If the probability that an individual suffers a bad reaction from injection of a given serum is 0.001, determine the probability that out of 2000 individuals (i) exactly 3, (ii) more than 2 individuals will suffer a bad reaction. **(15)**

Contd P/3

MATH 271

Contd... Q. No. 8

(c) The mean lifetime of a sample of 100 fluorescent light bulbs produced by a company is computed to be 1570 hours with a standard deviation of 120 hours. If μ is the mean lifetime of all the bulbs produced by the company, test the hypothesis $\mu = 1600$ hours against the alternative hypothesis $\mu \neq 1600$ hours, using a level of significance of (i) 0.05 (ii) 0.01. **(16⅔)**

(Necessary chart is attached)

Level of significance, α	0.10	0.05	0.01	0.005	0.002
Critical values of z for one-tailed tests	-1.28 *or* 1.28	-1.645 *or* 1.645	-2.33 *or* 2.33	-2.58 *or* 2.58	-2.88 *or* 2.88
Critical values of z for two-tailed tests	-1.645 *and* 1.645	-1.96 *and* 1.96	-2.58 *and* 2.58	-2.81 *and* 2.81	-3.08 *and* 3.08

Chart for Q no 8(c)

L-2/T-1/MME **Date : 23/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2014-2015

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 Q. No. 1 and any **TWO** from the rest.

Q. No. 1 is compulsory.

1. Give the required definitions, principles, or mathematical expressions for any 15 (fifteen) of the following. Carefully define any symbol. **(45)**

   (i) A state function
   (ii) The work function
   (iii) The mathematical expression of the second law of thermodynamics
   (iv) Nernst heat theorem
   (v) The metastable equilibrium
   (vi) The conditions for three-phase equilibrium of solid, liquid and gaseous phases in the binary A-B system.
   (vii) The partial molar Gibbs free energy of carbon in Fe-C-Si alloy
   (viii) The Gibbs-Duhem equation
   (ix) The activity of a component in solution
   (x) The infinitely dilute solution
   (xi) The change in entropy of mixing for a regular solution
   (xii) Gibbs phase rule
   (xiii) Equation for ice-steam phase equilibrium
   (xiv) Richard's rule
   (xv) The chemical affinity of a reaction
   (xvi) Temperature dependence of the equilibrium constant of a chemical reaction
   (xvii) Langmuir adsorption isotherm
   (xviii) Boltzmann hypothesis
   (xix) Conditions for equilibrium in statistical thermodynamics
   (xx) Definiting entropy of a system in terms of partition function

2. (a) Derive an expression for the increase in temperature for process in which the volume of the system is changed at constant entropy. **(15)**

   (b) Derive the expression $\left(\partial U / \partial T\right)_p = C_p - P\left(\partial V / \partial T\right)_p$. **(5)**

   (c) The temperature of one mole of diatomic ideal gas is raised from 300 K to 1000 K inside a rigid container. Calculate the change of entropy of the gas. **(10)**

3. (a) Use the equilibrium principle (i.e. criterion for equilibrium) governing equilibrium under constant entropy, pressure and number of moles to determine the conditions for equilibrium for unary two-phase system. **(20)**

Contd P/2

MME 231

Contd... Q. No. 3

(b) Al-Zn alloys exhibit the following relation at 750 K **(10)**

$$TR\ln\gamma_{Zn} = 1750(1 - X_{Zn})^2$$

where R and T are expressed in cal/mol-K and K, respectively. Calculate the activity of aluminium at 750 K in an Al-Zn alloy containing 40 atom% zinc.

4. (a) Explain the principle characters of a dilute solution. **(10)**

(b) Explain the differences between ideal, real and regular solutions. **(10)**

(c) Show that the enthalpy and volume change of mixing for an ideal solution are zero. **(10)**

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 deoxidation in Steelmaking process. **(10)**

(c) Calculate the equilibrium composition of the gas mixture for the reaction at 10 atm and 1000 K: $SO_2 + \frac{1}{2}O_2 = SO_3$ at 25°C, $\Delta G^\circ = -94600 + 89.37\ T$ Joules. **(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)**

7. (a) Explain in your own words the difference between phenomenological thermodynamics and statistical thermodynamics. **(15)**

(b) Discuss the statistical nature of the concept of entropy. **(15)**

(c) What is meant by the term "microstate"? **(5)**

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

$T_m = 273$ K, $T_b = 373$ K, $\Delta H^F = 1436$ KCal/mol , $\Delta H^V = 9717$ Cal/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?

L-2/T-1/MME **Date : 27/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2014-2015

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

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**.

Use tracing paper, Wulff net and Thumb Tracks as and when required.

1. (a) Draw unit cells of the fiver plane lattices. Show the symmetry elements present in the above lattices and their plane group symbols. **(15)**

   (b) Identify the differences in the distribution of triad axes and mirror lines in the plane groups of p31m and p3m1. **(8⅓)**

2. (a) Make and examine the crystal models of NaCl, diamond and $BaTiO_3$. Identify the Bravais lattice and describe the motif of each structure. Mention the changes of Bravais lattice of $BaTiO_3$ which occur at the curie temperature and below. **(11⅓)**

   (b) What crystal system and point group the following stereographs belong to? **(12)**

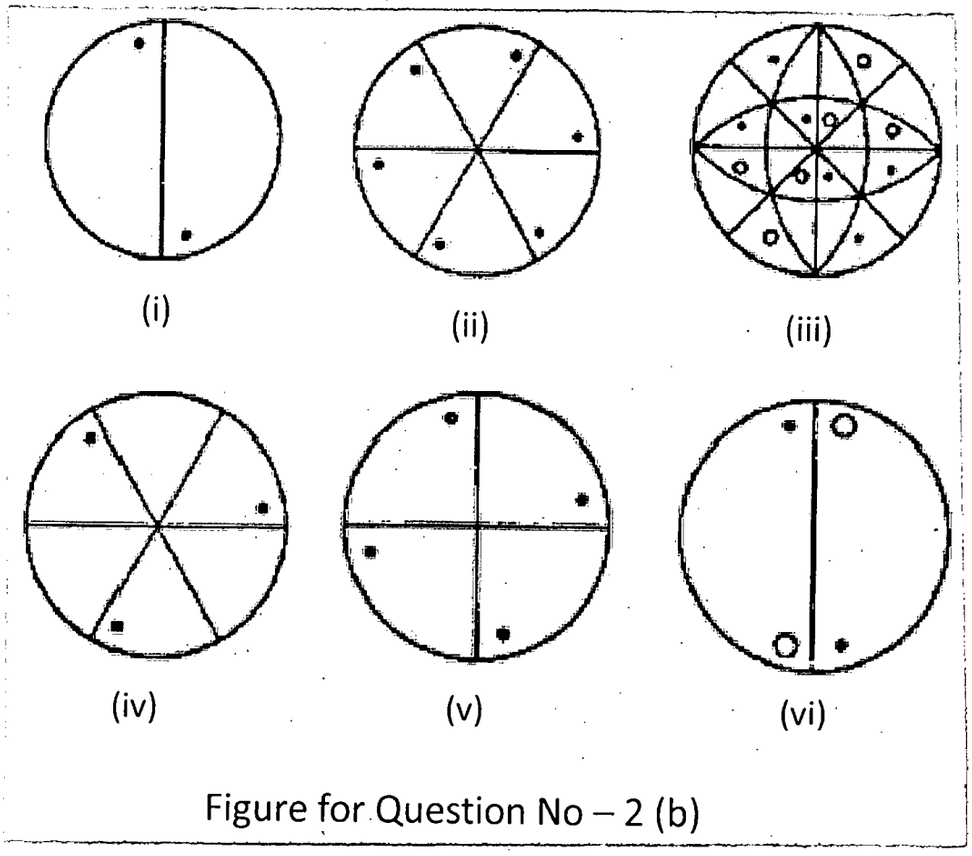


Figure for Question No – 2 (b)

Contd P/2

MME 211

3. (a) Draw a standard (001) projection of cubic crystal. **(8⅓)**

   (b) Find the angle between poles of **(15)**

   (i) intersection between the $(1\bar{1}1)$ and $(0\bar{1}1)$ traces

   (ii) intersection between the (111) and $(\bar{1}01)$ traces

   and also determine the poles of above intersections.

4. (a) Sketch and briefly describe how a pole projection is constructed. **(8⅓)**

   (b) Place the [011] normal of a cube at the centre of stereogram and draw all poles and traces of low indices planes: (100), (110) and (111) showing appropriate symmetry elements at all poles. **(15)**

SECTION – B

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

5. (a) Show that in cubic crystals, directions are perpendicular to the planes with the same numerical indices. **(5⅓)**

   (b) Determine whether the [101] direction in a tetragonal unit cell with a *c/a* ratio of 1.5 is perpendicular to the (101) plane. If it is not perpendicular, calculate the angle between the direction and the plane. **(18)**

6. (a) Distinguish between a space lattice and a crystal. **(3⅓)**

   (b) Show that the lattice parameters for a body centered cubic cell (a_{bcc}) and a face centered cubic cell (a_{fcc}) are given by: **(8)**

$$a_{bcc} = \frac{4r}{\sqrt{3}} \text{ and } a_{fcc} = \frac{4r}{\sqrt{2}}$$

   where r = atomic radius.

   (c) Calculate the densities of packing for bcc and fcc crystal structures. **(5)**

   (d) Show that the ideal *c/a* ratio for the close packed hexagonal crystal is 1.633. **(7)**

7. (a) Within a cubic unit cell, sketch the following directions: **(8)**

   (i) $[\bar{1}10]$, (ii) $[0\bar{1}2]$, (iii) $[\bar{1}\bar{2}1]$ and (iv) [021]

   (b) Sketch within a cubic unit cell the following planes: **(8)**

   (i) $(11\bar{2})$, (ii) $[10\bar{2}]$, (iii) $[1\bar{3}1]$ and (iv) $[\bar{1}1\bar{1}]$

   (c) Compute the linear densities of the [110] and [111] directions for BCC. **(3⅓)**

   (d) Calculate the planar densities of the (100) and (111) planes for FCC. **(4)**

8. (a) Consider any crystal lattice and explain how a reciprocal lattice is constructed. **(6)**

   (b) "The reciprocal lattice of an FCC crystal lattice is a BCC lattice." Explain. **(6)**

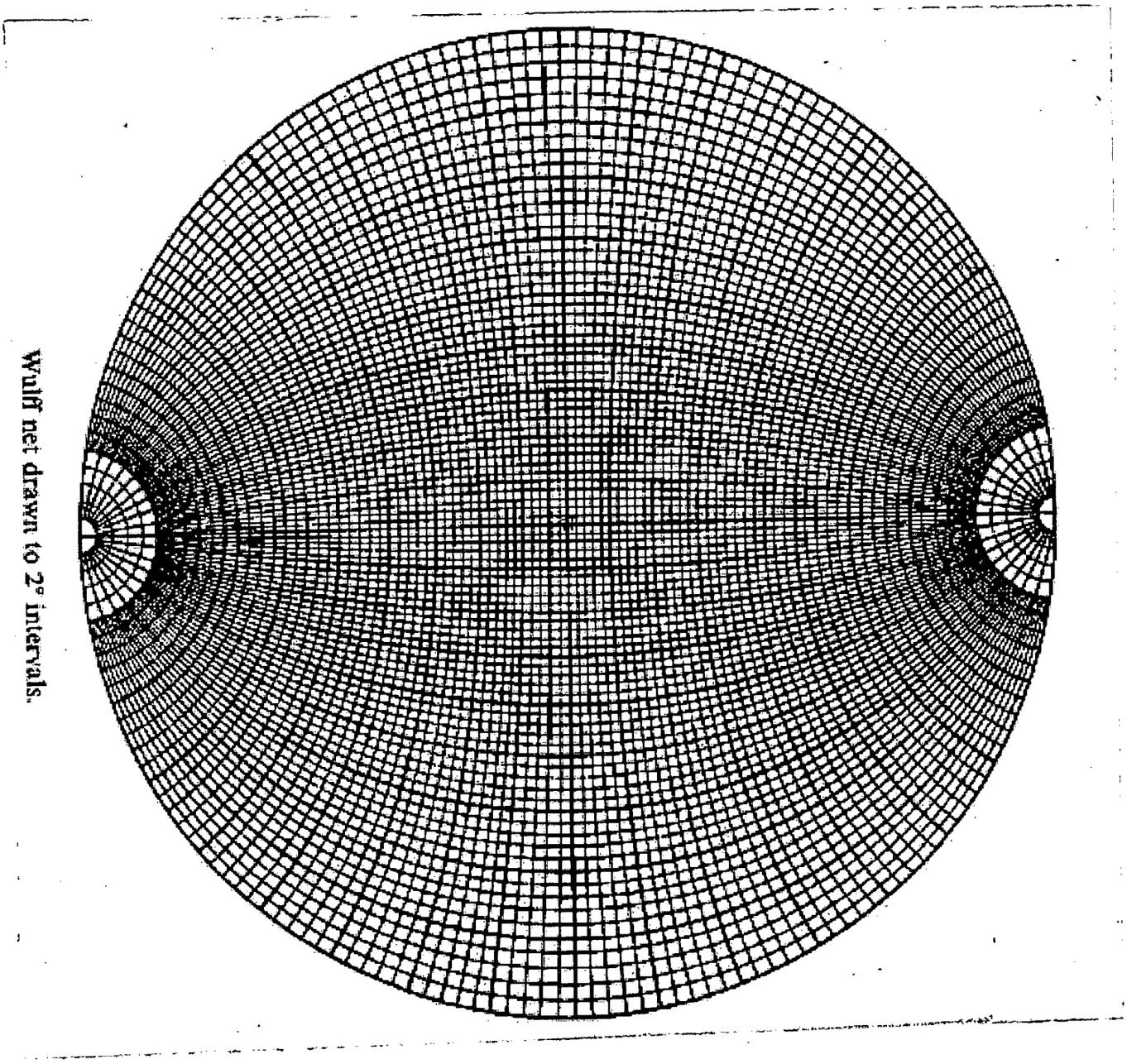
   (c) Show that the reciprocal lattice vector H_{hkl} is normal to the plane (hkl). **(5⅓)**

   (d) Using reciprocal lattice show that **(6)**

$$hu + kv + lw = 0$$

   where the plane (*hkl*) belongs to the zone whose axis is [*uvw*].

Contd. P/3



Wulff net drawn to 2° intervals.

L-2/T-1/MME **Date : 31/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2014-2015

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

   (b) What is flash-back? **(5)**

   (c) Write short note on: **(10)**

   (i) Carburetted water gas.

   (ii) Liquified petroleum gas.

2. (a) During combustion efficiency loss can be reduced by reducing the exit gas temperature. Can you reduce the exit gas temperature to room temperature? Why? **(15)**

   (b) Calculate the Wobbe index of natural gas comprising of 89% CH_4, 8% C_2H_6, 2% C_3H_8 and 1% C_4H_{10} by volume. The calculate values (kcal/Nm^3) of the constituents are as given below: **(12)**

   $CH_4 = 9500$, $C_2H_6 = 16644$, $C_3H_8 = 23688$, $C_4H_{10} = 30714$

   (c) What is "Limit of inflammability"? **(8)**

3. (a) Mention the reasons of knocking in petrol engine. **(10)**

   (b) Describe the manufacturing process of water gas briefly. **(15)**

   (c) Briefly explain ultimate and proximate analysis of coal. **(10)**

4. (a) With the help of a neat flowsheet describe the working principle of thermofer catalytic reforming (TCR) moving bed process. **(20)**

   (b) Write short note on: **(15)**

   (i) Cetane number.

   (ii) Ignition point.

Contd P/2

MME 241

SECTION – B

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

5. (a) What are the objectives and advantages of coal washing? **(8)**

   (b) Explain froth flotation process for coal washing with its advantages and disadvantages. **(10)**

   (c) Briefly discuss the significance of volatile matter, ash, fixed carbon, total carbon, sulphur and hydrogen in coal. **(17)**

6. (a) What is the working pressure in various units of a two stage and a three stage distillation unit? Explain the working principles of a single stage crude oil distillation unit with a schematic diagram. **(15)**

   (b) What is cracking? Discuss the necessity of cracking crude oil. **(8)**

   (c) What are the advantages of catalytic cracking over thermal cracking? Describe the fluidized bed catalytic cracking (F.C.C) process. **(12)**

7. (a) Describe the three stages of carbonization. **(10)**

   (b) Briefly describe coke making in a beehive coke oven. State its merits and demerits. **(8+10=18)**

   (c) Write a short note on reactivity of coke. **(7)**

8. (a) Discuss the modern theory of petroleum formation. **(10)**

   (b) Give a brief outline of a typical direct process for by-product in carbonization. **(20)**

   (c) Low temperature oxidation of coal causes what five things? **(5)**

L-2/T-1/MME **Date : 06/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2014-2015

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 machine element is subjected to a tensile load of 10 kN as shown in figure 1(a). If the thickness of the machine element is 15 mm, determine the total elongation of the element. E = 200 GPa. **(15)**

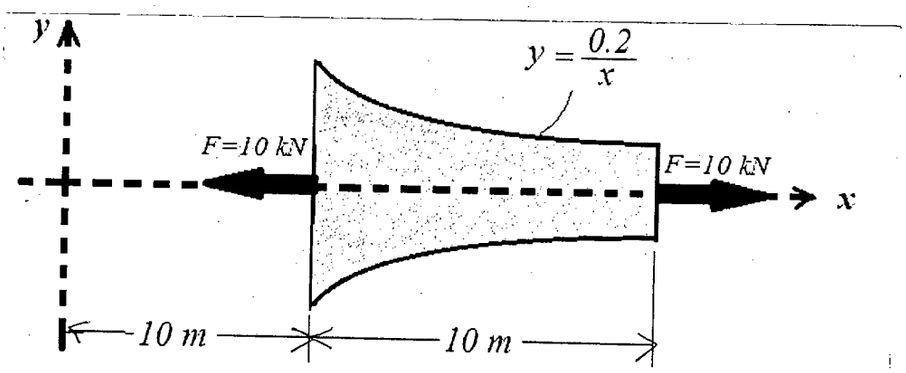


Fig: Question No: 1 (a)

(b) An aluminum shaft is loaded by torques as shown in figure 1(b). The shaft has a diameter of 50 mm and modulus of rigidity of 28 GPa. Find the angular deflection of gear D with respect to gear A. **(20)**

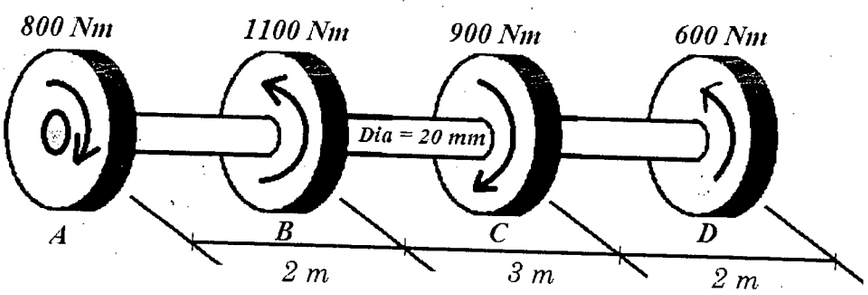


Fig: Question No: 1(b)

2. (a) Draw the 2D mohr's circle for the elementary section shown in figure 2(a). The value of σ_x, σ_y and τ_{xy} are 600 MPa, 400 MPa and 300 MPa respectively. Find the followings: **(18)**

Contd P/2

ME 243

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

(i) Principal stress and principal plane

(ii) Maximum shear stress and plane of maximum shear.

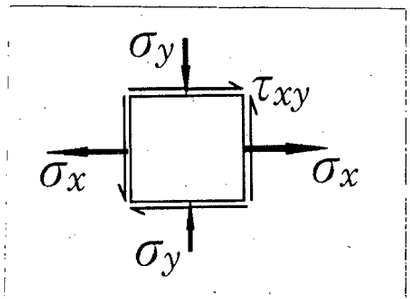


Fig: Question No: 2(a)

(b) Determine the total deflection of the spring when it supports a mass of 150 kg as shown in figure 2(b). The spring diameter is 50 mm. The spring is made of 10 mm diameter wire. The number of active turn is 10 and G = 80 GPa. **(17)**

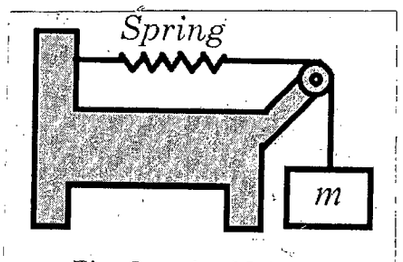


Fig: Question No: 2(b)

3. A 10 m long column is fixed in one end and hinge in other end. Find the maximum load it can support. The yield strength and modulus of rigidity of the column material is 400 MPa and 200 GPa respectively. The cross section of the column is shown in figure 3(a). **(35)** If the length of the column is reduced to 50%, then determine the percentage change in maximum load it can support.

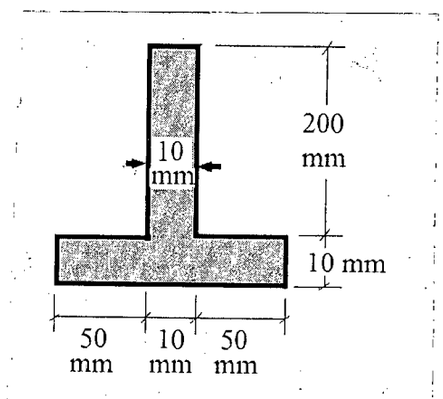


Fig: Question No: 3

Contd P/3

ME 243

4. (a) The yield strength and shear strength of the material is 400 MPa and 180 MPa respectively. The diameter of the rod is 20 mm which supports a force 'F' as shown in figure 4(a). Using maximum shear stress theory, find the maximum value of force F. Consider the elementary area 'A' on the top fiber only. **(17)**

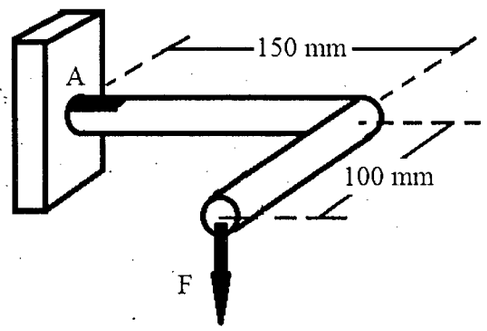


Fig: Question No: 4(a)

(b) A reinforced beam is constructed with wood and steel as shown in figure 4(b). The modulus of elasticity of wood and steel is 20 GPa and 200 GPa respectively. Find the maximum moment it can withstand if the yield strength of wood and steel is 10 MPa and 150 MPa respectively. **(18)**

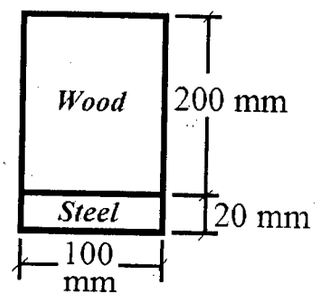


Fig: Question No: 4(b)

SECTION – B

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

5. (a) A solid steel cylinder is placed concentrically within an aluminum hollow cylinder as shown in Fig. 5(a). Both the cylinders are subjected to an axial load P = 250 kN and they have the same length 600 mm. If the cross-sectional areas of the steel and the aluminum cylinders are 2500 mm^2 and 5000 mm^2 respectively, determine the rise of temperature at which the entire load will be carried by the hollow aluminum cylinder only. Consider E_{st} = 200 GPa, $\sigma_{st} = 11.7 \times 10^{-6}$ m/m°C, E_{al} = 70 GPa and $\sigma_{al} = 23.1 \times 10^{-6}$ m/m°C. **(17)**

(b) A beam is loaded and supported as shown in Fig. 5(b). A couple of 4 kN-m is applied at point B. Draw the shear force and bending moment diagrams for the beam. **(18)**

Contd P/4

ME 243

6. (a) An overhanging gray cast iron beam of channel section supports a uniformly distributed load of "W" over its entire length as shown in Fig. 6(a). Determine the maximum value of "W" if the allowable stresses in tension and compression are 35 MPa and 150 MPa respectively. Note that neutral axis of the channel section lies at a distance $\bar{y} = 40.28$ mm from the bottom surface. **(18)**

   (b) For a shear force of 150 kN, determine the maximum and minimum shearing stresses in the web of "I" section of a beam as shown in Fig. 6(b). **(17)**

7. (a) Using double integration method, find the equations of the elastic curve and maximum deflection in between the two supports of an overhanging beam as shown in Fig. 7(a). **(18)**

   (b) For the loaded overhanging beam as shown in Fig. 7(b), determine the free end deflection at point D, using area moment method. Consider $EI = 80 \times 10^4$ N-m^2. **(17)**

8. (a) A 2 m long thin-walled cylinder is fabricated from a steel plant of 6 mm thickness. The cylinder is closed at both the ends by plates using bolts and gaskets to make leak proof. The internal diameter and internal fluid pressure of the cylinder are 300 mm and 3 MPa respectively. Determine the final stress in the bolts if the initial stress in the bolts is 40 MPa. Bolt diameter is 18 mm and number of bolts on each side is 12. **(17)**

   (b) The split ring, as shown in Fig. 8(b), has circular cross-section of 30 mm diameter, knowing that each of 2.5 kN loads is applied at the centroid of the cross-section, determine the stresses at the points A and B. **(18)**

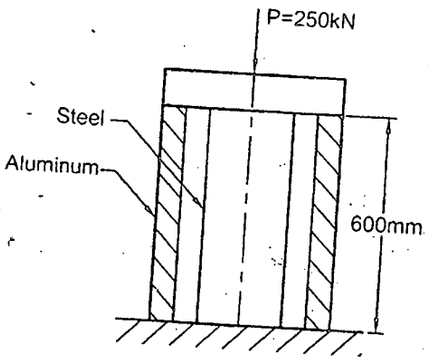


Fig. 5(a)

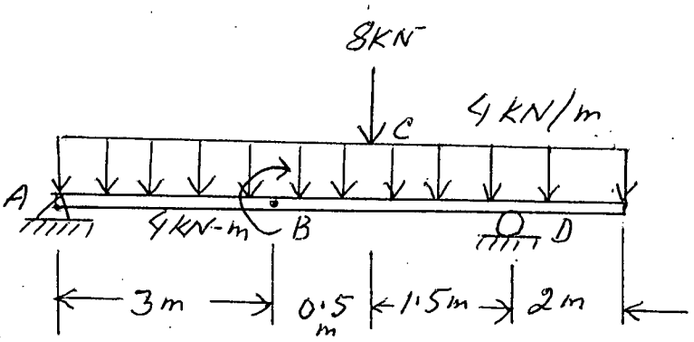
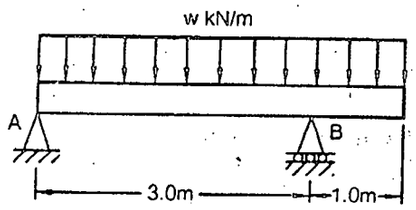


Fig- 5(b)



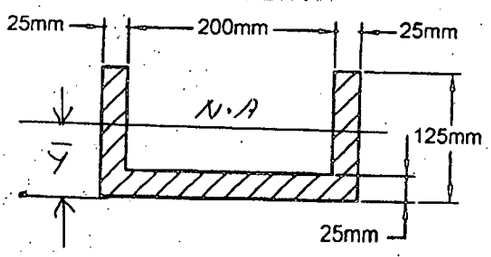


Fig. 6(a)

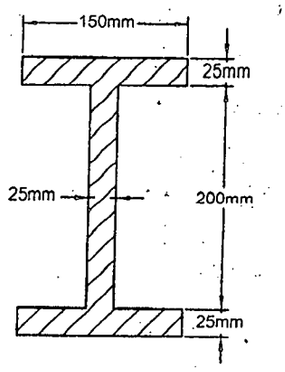


Fig. 6(b)

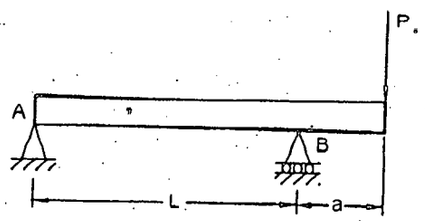


Fig. 7(a)

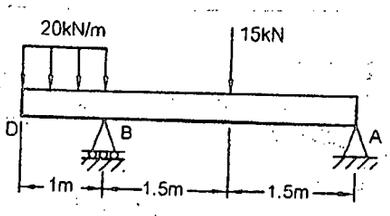


Fig. 7(b)

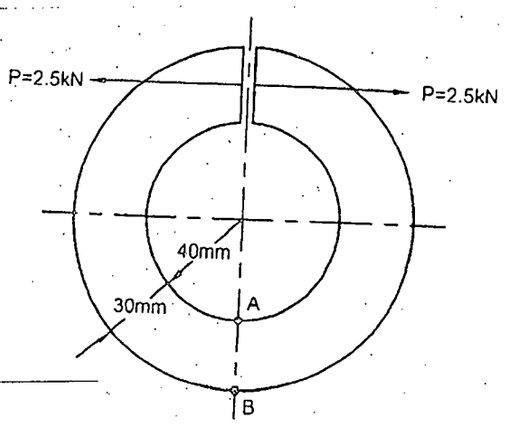


Fig. 8(b)