L-2/T-1/MME **Date: 30/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks: 140 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** questions.

1. (a) Derive the Bragg's law for diffraction? **(10)**

   (b) A powder pattern obtained for lead (FCC) with X-ray radiation of wavelength 1.54 Å. The (222) reflection is observed at Bragg angle $2\theta = 32$ degree. **(10)**

   What is the lattice parameter of lead?

   What is the lowest index reflection observed in the powder pattern?

   (c) List the first five planes of allowed reflection for FCC. **($3\frac{1}{3}$)**

2. (a) Describe all the Bravais lattices in 2D. Lattice parameters a = b, θ = any angle between 0-90 degree and not equal to 60 degree do create a new Bravais lattice – explain why? **($12\frac{1}{3}$)**

   (b) Centered oblique and centered hexagonal structures are not included in the list of 2-D Bravais lattice– justify this with necessary sketches. **(6)**

   (c) Show that face centered tetragonaland body centered tetragonal structures are equivalent. **(5)**

3. (a) With neat sketches, explain 4-fold rotorefection and 4-fold rotoinversion symmetry elements step by step showing their equivalence. **($10\frac{1}{3}$)**

   (b) Describe the screw symmetry element $^4C_1$. **(7)**

   (c) Differentiate between proper and improper rotation with necessary sketches. **(6)**

4. (a) Stereographic projection of a great circle can be either straight line or a circle – show with a neat sketch of the projection. **($10\frac{1}{3}$)**

   (b) Draw a standard (001) projection of a cubic crystal, showing all poles for the planes {100}, {110} and {111}. **(7)**

   (c) Show that, inter-planar spacing of (110) plane in reciprocal lattice is reciprocal to the corresponding inter-planar spacing in normal lattice. **(6)**

Contd P/2

MME 211

SECTION – B

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

5. (a) Distinguish between an amorphous and a crystalline substance. Why do atoms of metal tend to assemble into ordered or crystalline structures? **(3+3=6)**

   (b) Show that, atomic packing factor does not vary for FCC and HCP structures. **($11\frac{1}{3}$)**

   (c) Calculate the planar density of atoms in the (110) and (111) planes of Aluminum (face centered cubic). The atomic radius of Aluminum is 0.1431 nm. **(6)**

6. (a) Is thee any difference in packing sequence of FCC and HCP structures? What contributes to a marked difference between the physical and mechanical properties of FCC and HCP structures?– explain. **(7)**

   (b) For FCC structures, show that the maximum radius of the sphere that fits into an octahedral void is 0.414R, 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. **(8)**

   (c) When BCC iron (a = 2.90Å) is heated to 910°C and changes to FCC iron (a = 3.64Å) at the transition temperature (910°C), why carbon atoms prefer to accommodate into the octahedral sites? Explain, why is carbon atom solubility much higher in FCC iron compared to BCC iron? **($8\frac{1}{3}$)**

7. (a) Within a cubic unit cell, sketch the following directions: **(6)**

   (i) [101], (ii) $[\bar{1}1\bar{1})$, (iii) [120]

   (b) In case of hexagonal crystal system, why is four-axis (Miller-Bravais) coordinate system preferable rather than three axes? Convert [100] and [210] directions to a four-axis (Miller-Bravais) coordinate system for a hexagonal crystal structure. **($10\frac{1}{3}$)**

   (c) Calculate the percentage change in volume that occurs when BCC iron is heated and changes to FCC iron. At the transformation temperature the lattice parameter of BCC iron is 2.863 Å and the lattice parameter of FCC iron is 3.591 Å. Does a given mass of iron contract or expand in volume as the transformation takes place? **(5+2=7)**

8. (a) What are forbidden reflections? Explain why (100) reflection from a body centered cubic metal is not observed although the crystal orientation satisfies Bragg's law. **(2+7=9)**

   (b) For BCC iron, compute (i) the interplanar spacing, and (ii) the diffraction angle for the (220) set of planes. The lattice parameter for BCC 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. **($7\frac{1}{3}$)**

   (c) What do you understand by zone axis? Find out the zone axis of the planes (211) and (110). **(3+4=7)**

L-2/T-1/MME **Date: 26/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

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

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** questions.

1. (a) Establish the conditions that a solution must fulfill of becoming an ideal solution. How does non-ideal solutions deviate from ideality? List the characteristics of a regular solution. **(6+4+4=14)**

(b) Copper and gold form complete ranges of solid solution at temperatures between 410 and 889 °C. The excess molar Gibbs free energy of formation of solutions at 600 °C is given as $G^{ex} = -28280\, X_{Au}\, X_{Cu}$. Calculate the activities of Au and Cu exerted by the solid solution containing $X_{Cu} = 0.6$ at 600 °C. **(15)**

(c) Draw free energy - composition diagrams of the phase diagram given in Figure 1 at T_1 and T_2 temperatures. **(6)**

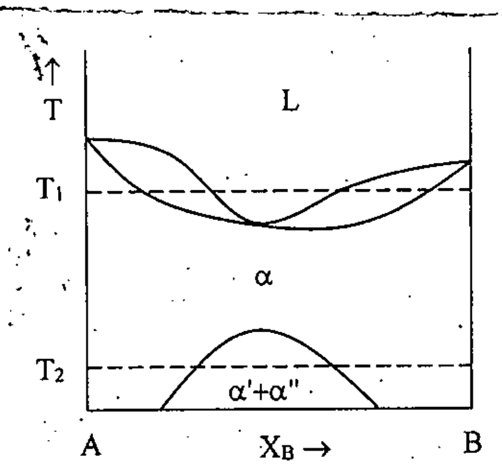


Figure 1 for Q. 1(c)

2. (a) Deduce an expression between the pressure and temperature at which a liquid phase and a gaseous phase of a unary system can exist in equilibrium. List all assumptions you made while deducing this equation. Indicate three probable applications of this expression. **(15+2+3=20)**

(b) Calculate the phase diagram for water using the following information: **(15)**

$$T_m = 273 \text{ K},\ T_b = 373 \text{ K},\ \Delta H^F = 1436 \text{ cal/mol},\ \Delta H^G = 9717 \text{ cal/mol}$$

Indicate clearly all assumptions you made to solve this problem.

Contd P/2

3. (a) Using suitable examples, analyse the use of the equilibrium constant in controlling the furnace atmosphere to prevent rusting during heat treatment of steel. **(10)**

(b) Mercuric oxide (HgO) solid is placed in a vessel which is then evacuated, filled with nitrogen, and heated to 600 K. At this temperature the total pressure in the vessel is 2 atm. Calculate the mole fractions of O_2 and Hg vapour in the gas phase. Given data: (Hg) + 1/2 (O_2) = <HgO>; $\Delta G° = -152200 + 207.2\ T$ Joules. **(15)**

(c) Using thermodynamic principles, explain the functions of detergent in a cutting fluid and potassium ethyl xanthate in the froth flotation concentration process of galena. **(10)**

4. (a) Analyse the concept of macrostate and microstate in statistical thermodynamics. **(6)**

(b) Derive the conditions for equilibrium in statistical thermodynamics. **(15)**

(c) Deduce expressions for the internal energy, entropy and volumetric heat capacity in terms of the partition function. **(6)**

(d) Explain the concept of wetting and its application in metallurgical process. **(8)**

SECTION – B

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

5. (a) Define state functions. The relationship between three variables x, y, and z can be represented as $z = x^4 y + 2xy^2$. Obtain the coefficient relations of this function and determine whether or not these functions are state functions. **(13)**

(b) Classify the following thermodynamic systems: **(10)**

(i) A dry cell battery, (ii) A flower vase, (iii) An electric magnet inside a toy, (iv) human body, (v) A steam boiler heated by gas.

(c) State and prove the third law of thermodynamics. Mention one important use of this law. **(12)**

6. (a) What are the characteristics and significance of reversible process? **(7)**

(b) One mole of an ideal gas is compressed isothermally but irreversibly at 130°C from 2.5 bar to 6.5 bar in a piston-cylinder drive. The work required is 25% greater than the work of reversible, isothermal compression. The heat transferred from the gas during compression flows to a heat reservoir at 25°C. Calculate the entropy change of the gas, the heat reservoir, and ΔS_{total}. **(15)**

Contd P/3

MME 231

Contd... Q. No. 6

(c) Indicate the relative magnitudes of the entropy transfer versus entropy production in the following processes: **(8)**

(i) A thermally insulated container has two compartments of equal size. Initially one side is filled with a gas and the other is evacuated. A valve is opened and the gas expands to fill both compartments.

(ii) A gas contained in a steel cylinder is slowly expanded to twice its volume.

(d) Establish the criterion of spontaneity of a process based on entropy. **(5)**

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

(b) Show that heat is not a state variable. **(5)**

(c) One mole of an ideal monatomic gas initially at temperature 298 K and occupying 5 litres is compressed reversibly and adiabatically to a final volume of 1 litre. Compute the final temperature of the system. **(15)**

8. (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)**

(b) Explain metastable equilibrium. **(8)**

(c) Find the constrained maximum of the function: $z = (x-4)^2 + (y-2)^2 + 3$ corresponding to the condition $x + y = 1$. **(7)**

L-2/T-1/MME Date: 09/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

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 **THREE** questions.

1. (a) 'Can hydrogen fuel replace fossil fuel in near future?' — Justify your answer. **(10)**

   (b) Explain the process of hydrogen gas generation in solid oxide fuel cell (SOFC). **(12)**

   (c) Briefly discuss the thermochemical pathway of solar fuel generation. **(13)**

2. (a) What are the advantages of using microalgae as a source of biofuel? With the help of a flow chart, explain microalgae production in mass level. **(8+9)**

   (b) Briefly explain the mostly used enrichment process of fissile isotope. How can we reprocess spent nuclear fuel? **(9+9)**

3. (a) Explain the reason behind choosing CO measurement as a prime tool for optimising air-fuel ratio with the help of total stack loss curve at different loading conditions. **(17)**

   (b) What should be done to maximise heat recovery from exit flue gas containing sulphur? **(10)**

   (c) How does balance drought remove the problems associated with forced and induced drought? **(8)**

4. (a) With the help of a flow chart, explain Lurgi gasification process. Mention the process variables and the final products. **(17)**

   (b) Differentiate between premixed and diffusion flames. **(6)**

   (c) Discuss the requirements for establishing successful combustion process. **(12)**

Contd P/2

MME 241

SECTION – B

There are **EIGHT** questions in this section. Answer any **SIX** questions.

5. (a) What are the ultimate and proximate analyses of coal and what are their significances to the coal users? **(11)**

   (b) Differentiate between fixed carbon and total carbon of coal. **(6½)**

6. (a) Why is washing of coal necessary? Mention advantages and disadvantages of dry and wet processes of coal washing. **(8)**

   (b) Describe the stages in the formation of coal from vegetable matter. **(9½)**

7. A sample of coal is given for washing. If you want to wash the sample according to wettability of dirts, which process will you follow? -explain the process with neat sketch. Also mention the advantages and disadvantages of the process. **(17½)**

8. (a) What are the problems that arise due to low temperature oxidation during storage of coal? **(6½)**

   (b) Mention the guidelines followed to ensure safe storage of coal. **(11)**

9. (a) What are the limitations of Carbide and Engler theory regarding origin of petroleum? How the limitations are resolved by modern theory? **(6½)**

   (b) What are the advantages of catalytic cracking over thermal cracking? Describe the fluidized bed catalytic cracking (F.C.C) process. **(11)**

10. (a) Briefly discuss the differences between hydrocracking and hydrotreating. **(8)**

    (b) Classify catalysts used in catalytic reforming process. Also exhibit the influence of catalyst particle size and trace materials in feed on the outcome of refined product. **(9½)**

11. (a) Compare the gas cleaning process of coarse and submicronic dust particle in the blast furnace gas. **(12½)**

    (b) Coke oven gas has a more extended use than blast furnace gas. — Why? **(5)**

12. (a) What are characteristics of blast furnace gas? Is there any poisonous effect of B.F. gases? — Explain. **(11)**

    (b) What are the factors affecting the quantity of converter gas recovered? **(6½)**

L-2/T-1/MME **Date: 03/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

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

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** questions.

Symbols have their usual meaning. Assume reasonable value for any missing data.

1. (a) A cylindrical assembly consisting of a brass core and an aluminum collar is compressed by a load P as shown in Figure for Q. No. 1(a). The length of the aluminum collar and brass core is 350 mm, the diameter of the core is 25 mm, and the outside diameter of the collar is 40 mm. Also, the moduli of elasticity of the aluminum and brass are 72 GPa and 100 GPa, respectively. **(20)**

   (i) If the length of the assembly decreases by 0.1% when the load P is applied, what is the magnitude of the load?

   (ii) What is the maximum permissible load P_{max} if the allowable stresses in the aluminum and brass are 80 MPa and 120 MPa, respectively?

   (b) The rigid bar ABC as shown in Figure for Q. No. 1(b) is pinned at B and attached to the two vertical rods. Initially, the bar is horizontal and the vertical rods are stress-free. Determine the stress in the aluminum rod if the temperature of the steel rod is decreased by 40°C. Neglect the weight of bar ABC. **(15)**

2. (a) The cantilever beam as shown in the Figure for Q. No. 2(a) carries a trapezoidal load, the intensity of which varies from 50 kN/m at the fixed end to 25 kN/m at the free end. **(20)**

   (i) Derive the shear force and bending moment equations, and

   (ii) Draw the shear force and bending moment diagrams and mention value at all changes of load position.

   (b) A 60° strain rosette attached to the aluminum skin of an airplane fuselage measures the following strains: $\varepsilon_a = 100\times10^{-6}$, $\varepsilon_b = 100\times10^{-6}$ and $\varepsilon_c = 100\times10^{-6}$. If the material properties are E = 180 GPa and ν = 0.3, determine the principal stresses and the maximum shearing stress. **(15)**

3. (a) A beam of T-section is supported and loaded as shown in the Figure for Q. No. 3(a). The cross section has width b = 65 mm, height h = 75 mm, and thickness t = 13 mm. **(20)**

   (i) Determine the maximum tensile and compressive stresses in the beam.

   (ii) If the allowable stresses in tension and compression are 124 MPa and 82 MPa, respectively, what is the required depth h of the beam? Assume that thickness t remains at 13 mm and that flange width b = 65 mm.

Contd P/2

ME 243/MME

Contd... Q. No. 3

(b) A wood beam, as shown in Figure for Q. No. 3(b), carrying a uniform load of 22.5 kN/m (which includes the weight of the beam). Calculate the maximum shear stress τ_{max} in the beam if the length is 1.95 m and the cross section is rectangular with width 150 mm and height 300 mm, and the beam is **(15)**

(i) simply supported as in the Figure for Q. No. 3(b)A

(ii) has a sliding support at right as in the Figure for Q. No. 3(b)B.

4. (a) A cantilever beam AB supporting a distributed load of peak intensity q_0 acting over one-half of the length as shown in Figure for Q. No. 4(a). Determine the deflections δ_B and δ_C of the beam at points B and C, respectively. (Use double- integration method) **(20)**

(b) Find the deflection midway between the supports for the overhanging beam shown in Figure for Q. No. 4(b). (Use area-moment method) **(15)**

SECTION – B

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

5. (a) Shaft *BC* is hollow with inner and outer diameters of 90 mm and 120 mm, respectively as shown in Figure for question no 5(a). Shafts *AB* and *CD* are solid and of diameter *d*. For the loading shown, determine (i) the maximum and minimum shearing stress in shaft *BC*, (ii) the required diameter *d* of shafts *AB* and *CD* if the allowable shearing stress in these shafts is 65 MPa. **(20)**

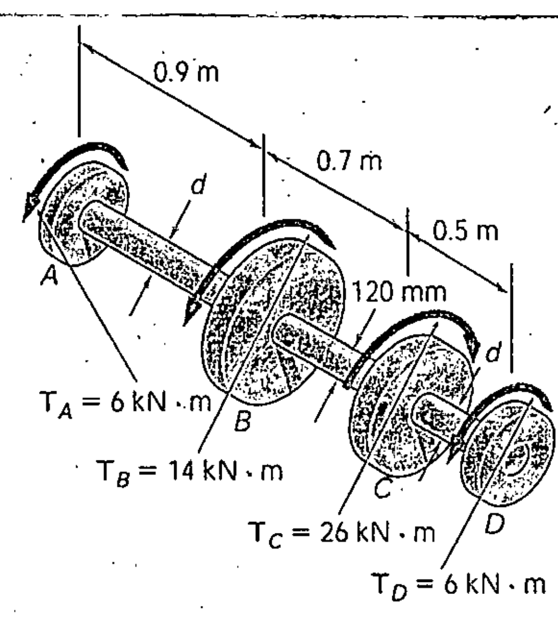


Figure for question no 5(a)

ME 243/MME

Contd... Q. No. 5

(b) A dead weight W is supported at the end of a rigid bar hinged at the point B as shown in Figure for question no 5(b). The rigid bar is supported by two identical steel springs. The mean diameter of each spring is 180 mm, wire diameter is 20 mm and number of turns is 25. Determine the maximum weight that can be supported if the maximum shearing stress in each spring is limited to 150 MPa. **(15)**

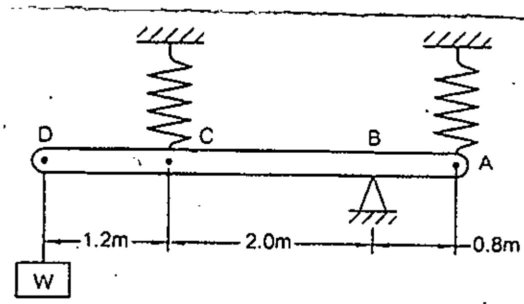


Figure for question no 5(b)

6. (a) Draw stress versus slenderness ratio curve for different values of eccentricity ratio (ec/k^2) for steel column. A steel column of effective length of 1.5 m has a rectangular section of 50 mm × 75 mm. Using Secant formula, determine the safe eccentric load that can be carried by the column with a safety factor of 2.0 and an eccentricity of 12 mm from the weaker axis. Modulus of elasticity and yield strength are respectively 200 GPa and 250 MPa. **(20)**

(b) A column of 1.5 m effective length consists of a solid 30 mm diameter brass rod carries a central load. In order to reduce the weight of the member, the solid rod is replaced by a hollow rod having outer and inner diameters are 30 mm and 15 mm respectively. Determine (i) the percent reduction in the critical load, (ii) the value of the critical load for the hollow rod. Use E = 105 GPa. **(15)**

7. (a) Determine the maximum bending moment that can be applied in a reinforced concrete beam with b = 300 mm, d = 450 mm, A_s = 1000 mm^2 and n = 10, if the allowable stress in concrete, $f_c \leq 12$ MPa and that in steel, $f_c \leq 140$ MPa. Is the beam in under-reinforcement, over-reinforcement or balanced reinforcement? **(15)**

(b) An aluminum alloy cylindrical pressure vessel has an outside diameter of 200 mm and a wall thickness of 6 mm. **(20)**

(i) Assuming the vessel as thin walled, what pressure can the cylinder carry if the permissible stress is 82 MPa?

(ii) On the basis of pressure found in part (i), compute the stress components at the inner surface using the theory for thick walled cylinders.

Contd P/4

8. (a) Show that, for a curved beam, the neutral axis and centroidal axis does not coincide. A crane hook of rectangular cross-section supports a load P = 40 kN as shown in Figure for question no 8(a). Determine the flexural stresses at the points A and B. **(20)**

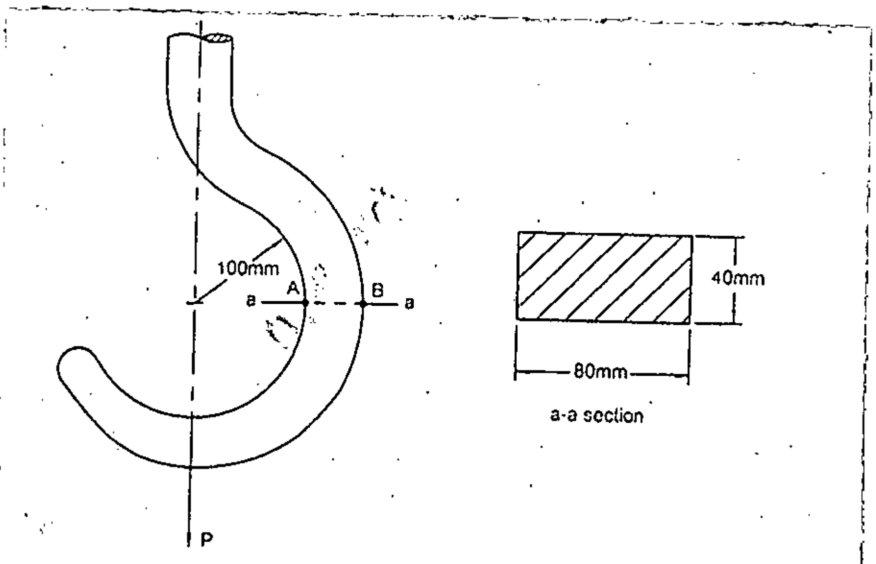


Figure for question no 8(a)

(b) Two wooden members of 80 mm × 120 mm uniform rectangular cross section are joined by the simple glued scarf splice as shown in Figure for question no 8(b). Knowing that β = 22° and that the maximum allowable stresses in the joint are respectively, 400 kPa in tension (perpendicular to the splice) and 600 kPa in shear (parallel to the splice), determine the largest centric load $\boldsymbol{P}$ that can be applied. **(15)**

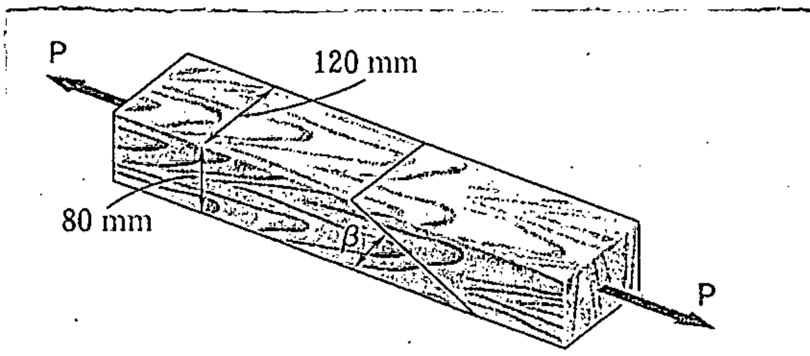


Figure for question no 8(b)

ME 243

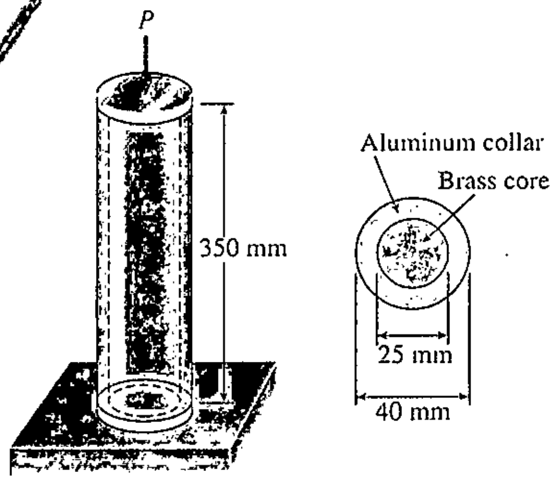


Figure for Q. No. 1(a)

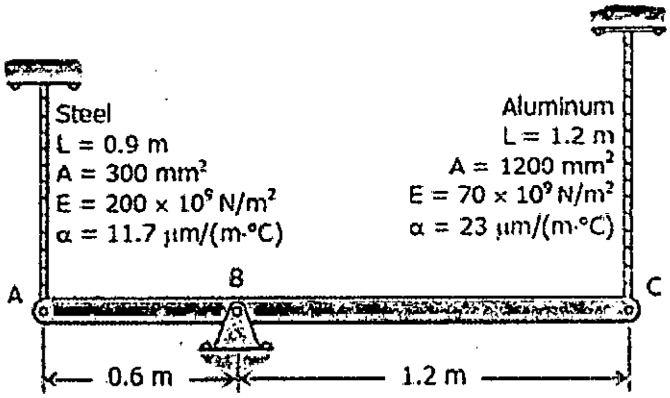


Figure for Q. No. 1(b)

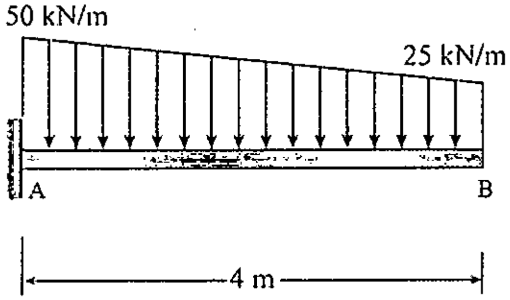


Figure for Q. No. 2(a)

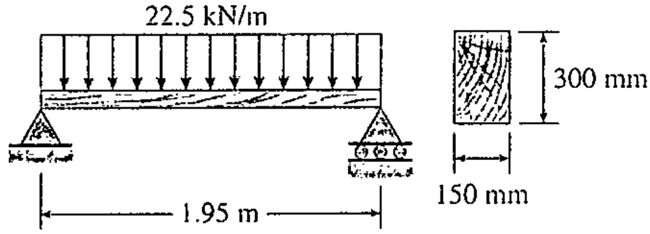


Figure for ~~(a)~~ Q. No. 3(b) A

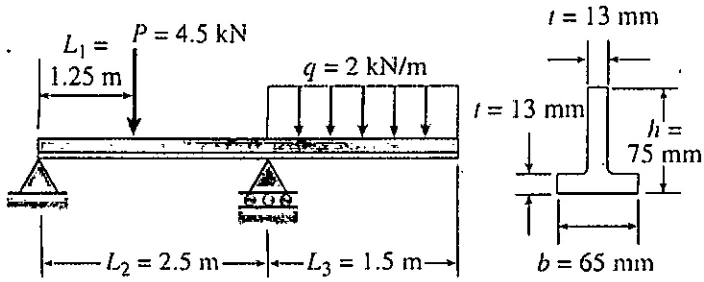
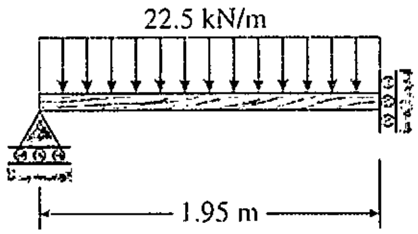


Figure for Q. No. 3(a)



~~(b)~~

Figure for Q. No. 3(b) B

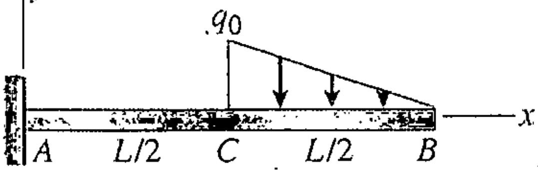


Figure for Q. No. 4(a)

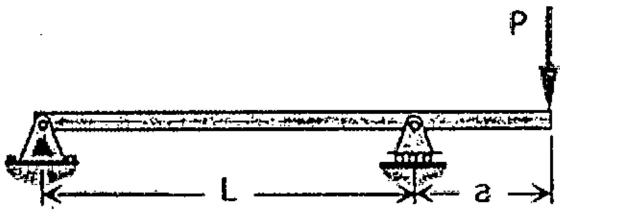


Figure for Q. No. 4(b)

Self Study/MME **Date: 04/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

B. Sc. Engineering Examinations

Sub : **PHY 157** (Properties of Matter, Electricity and Magnetism and Modern Physics)

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) State Gauss' law and apply this law to obtain an expression for the electric field at point (i) inside, (ii) outside, and (iii) surface of uniformly charged non-conducting solid sphere. All expressions must be calculated in terms of charge density ρ. **(17)**

   (b) Explain how Coulom's law follows from Gauss' law. **(6)**

   (c) Two charges of $+1\mu C$ and $-1\mu C$ are placed at the corners of the base of an equilateral triangle. The length of a side of the triangle is 0.7m. Find the electric field intensity at the apex of the triangle. **(12)**

2. (a) Define capacitance. Calculate the capacitance of a parallel-plate capacitor using Gauss' law. **(12)**

   (b) What is a dielectric material? Derive an expression for Gauss' law after applying a dielectric inside a parallel plate capacitor. **(15)**

   (c) A parallel plate capacitor has a capacitance of 100 pF. **(8)**

      (i) What is the stored energy if the applied potential difference is 50 V?

      (ii) Can you calculate the energy density for the points between the plates?

3. (a) State and explain Faraday's law and Lenz's law for electromagnetic induction. **(8)**

   (b) A circuit contains an inductance L and a resistance R placed in series with a battery of emf ε. Obtain expressions for the growth and decay of current in the circuit. What is the time constant of the circuit? **(19)**

   (c) A wire 40 cm long bent into rectangular loop of 15 cm × 5 cm is placed perpendicular to the magnetic field whose flux density is 0.8 Wb m^{-2}. Within 0.5 sec the loop is changed into 10 cm square and flux density increases to 1.4 Wb m^2. Calculate the value of induced emf in Volt. **(8)**

4. (a) Write down the postulates of specific theory of relativity. Why Galilean transformation fails to follow one of these postulates? **(7)**

   (b) Explain the relativity of mass in special theory of relativity. Derive the relation $E = mc^2$, where the symbols have their usual meanings. **(21)**

   (c) An electron has a kinetic energy of 0.100 MeV. Find its speed according to classical and relativistic mechanics. **(7)**

Contd P/2

PHY 157

SECTION - B

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

5. (a) Explain photoelectric effect. Describe the results of photoelectric effect in the lights of classical and quantum theories. **(18)**

(b) Draw the relative probability curves of occurring photoelectric effect, Compton effect and pair production for Carbon with the change in incident photon energy. **(5)**

(c) In an photoelectric experimental setup when ultraviolet light of wavelength 240 nm incident on one of two metal plates electrons are emitted from one plate and current flows through the wire connecting the two plates. The voltage applied between the plates is gradually increased until the current in the ammeter drops to zero, at which point the battery voltage is 1.40 V. **(12)**

(i) What is the energy of the photons in the beam of light, in eV?
(ii) What is the maximum kinetic energy of the emitted electrons, in eV?
(iii) What is the work function of the metal, in eV?
(iv) What is the longest wavelength that would cause electrons to be emitted for this particular metal?
(v) is this wavelength in the visible spectrum? If not, in what part of the spectrum is this light found?

6. (a) Define average binding energy and explain its change with atomic mass number of elements. **(10)**

(b) Write down the five modes of radioactive decay with suitable examples. **(8)**

(c) Describe the nuclear fission process and the three situation of chain reaction. What is the power output of a reactor fueled by uranium-235 if it takes 30 days to use up to 10 Kg of fuel and if each fission gives 200 MeV of energy? **(17)**

7. (a) Explain viscosity and coefficient of viscosity. **(6)**

(b) Derive Poiseuille's formula for the rate of flow of a liquid through a capillary tube. Explain how this formula is used for finding the viscosity of a liquid by capillary flow method. **(17)**

(c) Calculate the mass of water flowing in 10 minutes through a tube of 0.1 cm in diameter, 40 cm long, if there is a constant pressure head of 20 cm of water. The coefficient of viscosity for water is 8.9×10^{-4} Ns m^{-2}. **(12)**

8. (a) Describe surface tension in terms of molecular structure of matter. Show that the surface energy per unit area is numerically equal to the surface tension per unit length. **(12)**

(b) Find the expression for the excess pressure across the curved surface of a curved membrane and hence obtain expressions of the excess pressure inside (i) a spherical liquid drop, and (ii) a spherical soap bubble. **(16)**

(c) The pressure of air inside a soap bubble of 0.8 cm diameter is 12 mm of water above the atmospheric pressure. Calculate the surface tension of soap solution. **(7)**

L-2/T-1/MME **Date: 20/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks: 280 Time: 3 Hours

The figures in the margin indicate full marks

Symbols indicate their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Derive Newton's general interpolation formula. Hence, find the polynomial $f(x)$ from following table: **($23\frac{1}{3}$)**

x	0	2	3	4	7	9
$f(x)$	4	26	58	112	466	922

(b) Determine the constants a and b by the method of least squares such that $y = ae^{bx}$ fits the following data: **(23)**

x	2	4	6	8	10
y	4.077	11.084	30.128	81.897	222.62

2. (a) Derive Bisection method to obtain a root of equation $y = f(x)$. Also, by using this method find the root of the equation $x^3 + x^2 + x + 7 = 0$, correct to four decimal places. **($23\frac{1}{3}$)**

(b) Derive the general formula of integration and hence find Simpson's $\frac{3}{8}$ rule. Also, evaluate $\int_0^2 \frac{e^{\sqrt{x}}}{\sqrt{1+x^3}}dx$ by Simpson's $\frac{3}{8}$ rule taking 12 subintervals. **(23)**

3. (a) Use Euler's method with h = 0.1 to find the solution of $\frac{dy}{dx} = x^2 + y^2$, $y(0) = 0$ in the range $0 \le x \le 0.5$. **($23\frac{1}{3}$)**

(b) Use Romberg's method to compute $\int_0^1 \frac{1}{1+x}dx$ correct to three decimal places with h = 0.5, 0.25, 0.125. **(23)**

Contd P/2

MATH 271

4. (a) A rod is rotating in a plane. The following data table gives the angle θ (radians) through which the rod has turned for various values of the time t in seconds. Find the angular velocity of the rod when t = 0.6 **(23⅔)**

t	0	0.2	0.4	0.6	0.8	1.0	1.2
θ	0	0.122	0.493	1.123	2.022	3.200	4.66

(b) Find a real root of the equation $x = 0.2x^2 + 0.8$, $y = 0.3xy^2 + 0.7$ with $x_0 = y_0 = \frac{1}{2}$ by the method of iteration. **(23)**

SECTION – B

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

5. (a) A time study was conducted in a factory with the help of two samples A and B consisting of 7 workers. The time taken by the workers in each case was recorded as follows: **(20⅔)**

	Time taken in minutes						
Sample A	130	124	119	134	142	130	141
Sample B	132	144	136	143	132	133	140

(i) Which sample takes less time on an average?

(ii) Which of the samples is less stable?

(b) From the data given below calculate Karl Pearson's coefficient of skewness and Bowley's coefficient of skewness and make comment on the shape of the distribution: **(26)**

Profit (in lacs)	10-20	20-30	30-40	40-50	50-60
No. of companies	18	20	30	22	10

6. (a) One bag contains 4 white balls and 3 black balls and another bag contains 3 white balls and 5 black balls. One ball is drawn from the first bag and placed unseen in the second bag. What is the probability that a ball now drawn from the second bag is black? **(13)**

(b) Assume that on an average, one telephone number out of 15 is busy. If 6 randomly selected telephone numbers are called, find the probability that (i) no more than 3 will be busy, (ii) at least 3 of them will be busy. **(15)**

(c) If family incomes are normally distributed with mean \$16,000 and standard deviation \$2,000, find the probability that a family picked at random will have an income (i) between \$15,000 and \$18,000, (ii) below \$15,000, (iii) above \$18,000. (Necessary chart is attached) **(18⅔)**

Contd P/3

MATH 271

7. (a) Find the integral surface of the first order linear partial differential equation **(18⅔)**

$$2y(z-3)p+(2x-z)q=y(2x-3)$$

which contains $z=0,\ x^2+y^2=2x$.

(b) Use Charpit's method to find the complete solution of the partial differential equation $z^2=pqxy$. **(15)**

(c) Solve $\left(D_x^2-6D_xD_y+9D_y^2\right)z=12x^2+36xy$ **(13)**

8. Solve the following partial differential equations:

(a) $\left(D_x^2+D_xD_y-6D_y^2\right)z=x^2\sin(x+y)$ **(16⅔)**

(b) $\left(D_x^2-D_xD_y-2D_y^2+2D_x+2D_y\right)z=e^{3x+4y}+24xy$ **(15)**

(c) $\left(x^2D_x^2-y^2D_y^2+xD_x-yD_y\right)z=\ln x^2$. **(15)**

MATH-271 = 4 =

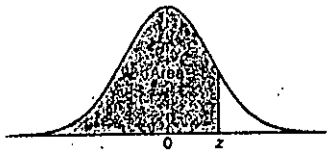


Table A.3 Areas under the Normal Curve

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

Chart 1 for Q. 5(c)

MATH 271

= 5 =

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

Chart for Q. No. 6(c)