SECTION A

1. (a) What do you understand by atomic packing factor? Show that, atoms are more closely packed in FCC lattice than in BCC lattice by calculating atomic packing factor of each one.

(b) A cylindrical specimen of steel having an original diameter of 12.8 mm is tensile tested to fracture and found to have an engineering fracture strength of 460 MPa. If, its cross-sectional diameter at fracture is 10.7 mm, determine:
   (i) The ductility in terms of percent reduction in area
   (ii) The true stress at fracture

(c) Compare between ductility and toughness.

2. (a) Draw a typical engineering stress-strain diagram and describe the plastic deformation phenomenon along with the underlying mechanism when tensile loading continues beyond yield point.

(b) A tensile stress is to be applied along axis of a cylindrical brass rod that has a diameter of 10 mm. Determine the magnitude of the load required to produce a $2.5 \times 10^{-3}$ mm change in diameter if the deformation is entirely elastic.

(c) Explain the mechanism of strain hardening. How cold working can affect stress-strain behavior of a low carbon steel?

3. (a) What do you understand by ductile to brittle transition? Explain the factors that affect the ductile to brittle transition curve.

(b) Discuss various S-N curves showing fatigue life, fatigue strength and fatigue limit in the curve.

(c) Draw a typical creep curve showing the various stages of creep and explain the stages.

4. (a) What are the principal reactions in iron making? Describe the outline of operations and the overall process of iron making.

(b) Give a simplified flowchart of steel production from raw materials of continuous casting and finishing treatments.

(c) Compare between ductile cast iron and malleable cast iron.

Contd.......... P/2
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SECTION - B

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

5. (a) Compare interstitial solid solution with substitutional solid solution.
(b) Using the equilibrium diagram shown in Fig. 1 for Question 5(b), answer the following questions for an alloy of 70% Pb-30% Sn:
   (i) Calculate the fractions of pro-eutectic α and eutectic α at just above and below the eutectic temperature respectively.
   (ii) Draw microstructures of the alloy at 300°C, 225°C and room temperature.
(c) Non-equilibrium cooling generally results in a cored structure – explain.

6. (a) Describe briefly how pearlite is formed from austenite.
(b) Differentiate between hypo-eutectoid steel and hyper-eutectoid steel in terms of structure and properties.
(c) Identify the steel having 50% pearlite at room temperature. For the identified steel, calculate (i) the fraction of pro-eutectoid ferrite and pearlite and (ii) the fraction of ferrite and cementite.

7. (a) Select and describe an annealing heat treatment process suitable for toughening hyper-eutectoid steel.
(b) Mention the effect of tempering temperature on mechanical properties of a quenched carbon steel part.
(c) How hardenability of steel can be increased?

8. (a) Sketch and level the microstructural changes that occur in 0.35% carbon steel during equilibrium cooling from 900°C to room temperature.
(b) Normalized hypo-eutectoid steel has higher hardness as compared to annealed hypo-eutectoid steel of same composition – explain.

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Fig. 1 for Question 5(b)

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SECTION - A
There are FOUR questions in this section. Answer any THREE.

1. (a) Explain the term "Identical but indistinguishable" in statistical mechanics. (5)
   (b) Derive the Maxwell-Boltzmann Distribution equation in the following form:
   \[ n(E)dE = \frac{2nN}{(nkT)^{3/2}}\sqrt{Ee^{-\frac{E}{kT}}}dE \]
   where, the symbols indicate their usual meaning.
   (c) Using the equation of 1(b), calculate the total energy of a system of particles and
   hence find out the expression for average energy. (8)

2. (a) Distinguish between Fermi-Dirac and Bose-Einstein statistics. (5)
   (b) Derive the Fermi-Dirac distribution law for a system of particles. (22)
   (c) Discuss the behavior of the Fermi function. Show that the derivative of the Fermi
   function is symmetrical about the \( E = E_F \), where, \( E_F \) is the Fermi energy. (8)

3. (a) What are eigenfunction and eigenvalue? Why expected value is considered instead
   of average value in Quantum mechanics? (10)
   (b) Derive the one dimensional time dependent Schrödinger equation and hence find
   the time independent Schrödinger equation for a particle. Show that the normalization
   of wave function is independent of time. (17)
   (c) A particle is moving in a one-dimensional box (of infinite height) of width 12 Å.
   Calculate the probability of finding the particle within an interval of 0.5 Å at the
   centre of the box, when it is in its state of least energy. (8)

4. (a) What are grating and grating element? Derive an expression for intensity
   distribution due to a plane transmission grating. (25)
   (b) What is the highest order spectrum, which may be seen with monochromatic light
   of wavelength 6000 Å by means of a diffraction grating with 5000 lines/cm? (10)
There are FOUR questions in this section. Answer any THREE.

5. (a) What are coherent sources? Show with a suitable diagram how coherent sources are produced in Fresnel bi-prism experiment.
(b) In Newton’s rings experiment for reflected light show that, (i) diameters of dark rings are proportional to the square roots of natural numbers, and (ii) diameters of bright rings are proportional to the square roots of odd numbers.
(c) Newton’s rings are observed in reflected light of wavelength 5900 Å. The diameter of the 10th dark ring 0.5 cm. Find the radius of curvature of the lens and the thickness of air film.

6. (a) Distinguish between unpolarized and polarized light.
(b) Describe the phenomenon of double refraction in uniaxial crystal. What is the Huygens’ theory of double refraction?
(c) The values of \( \mu_r \) and \( \mu_c \) for quartz are 1.5508 and 1.5418, respectively. Determine the phase retardation for light of wavelength 5000 Å and the thickness of the plate is 0.032 mm.

7. (a) What are damped vibrations? Establish the differential equation of damped harmonic oscillator and solve it to obtain an expression for the displacement of the oscillator. Discuss the condition under which the oscillations become oscillatory.
(b) A particle of mass 3 gm is subjected to an elastic force of 48 dyne-cm\(^{-1}\) and a damping force of 12 dyne-cm\(^{-1}\)sec. If its motion is oscillatory, find its period.

8. (a) Define reverberation. Give the theory of growth and decay of sound inside a room. Hence obtain an expression for reverberation time.
(b) What are the acoustic requirements of a good auditorium?
SECTION - A

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

1. (a) What is glass? Write down the physical and chemical properties of Glass. (6)
   (b) Discuss the Manufacturing process of glass with important unit operations and chemical conversions. (10)
   (c) What are the commonly used glass colouring agents for different shades in glass? (4)
   (d) Show the bonding in the \([\text{SiO}_4]\) complex. (3)

2. (a) What is corrosion? Discuss the economic aspects of corrosion. (6)
   (b) Distinguish between dry-corrosion and wet-corrosion. (5)
   (c) Write down the high temperature corrosion reactions between the oxidizing agents present in the environmental and metals Copper, Iron and Zinc. (9)
   (d) What is patina? How it forms? (3 1/2)

3. (a) What is lubricant? Give the characteristics of a good lubricant. (6)
   (b) Discuss the classification of lubricant. Illustrate your answer with examples. (8)
   (c) What are the advantages and disadvantages of air lubricant? (3 1/2)
   (d) Why paraffin waxes are objectionable impurities in lubricating oils and how you will remove it? (6)

4. (a) What is paint? Draw the flowsheet for mixing of paint. (5)
   (b) Distinguish between paint and varnish. (6)
   (c) Discuss the characteristics of a good paint. (5)
   (d) Write a short note on the prospect of glass industry in Bangladesh. (7 1/2)
There are FOUR questions in this section. Answer any THREE.

5. (a) What are the differences between macromolecule and polymer? Classify polymers based on their structure. (5)
(b) Write down the mechanism of free-radical polymerization. (5)
(c) Why is compounding of plastic performed? Discuss the functions of fillers, plasticizers and antioxidants as additives in plastics. (5 1/3)
(d) Write down the synthesis and important applications of following polymers-
   (i) Polyester
   (ii) Urea-formaldehyde resin (8)

(b) Describe the industrial manufacturing process of PVC. (6 2/3)
(c) Discuss the compression moulding and calendaring processes used for plastic product manufacturing. (6)

7. (a) What is denier count? State the basic requirements of fiber forming polymers. (6)
(b) How are fibers prepared by wet spinning process? (6 1/3)
(c) Write down the chemical reactions involved in the synthesis of viscose rayon. (5)
(d) Describe the acetylation process involved in the synthesis of acetate rayon. (6)

8. (a) Explain the chemical composition of natural and synthetic rubbers. (6)
(b) Why does rubber need vulcanization? Show the mechanism of peroxide vulcanization. (10)
(c) How does latex turn into rubber? Mention some advantages of using reclaimed rubbers. (7 1/3)
SECTION – A

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

Symbols have their usual meaning

1. (a) Assume that a current \( i(t) = I_m \sin \omega t \) flows through a series RLC circuit. Given that inductive reactance is larger than capacitive reactance, derive the expressions for applied voltage, impedance, instantaneous power, real power and reactive power. Also draw the wave shape of power.

(b) Find the equivalent impedance, \( Z_{eq} \) of the circuit shown in Fig. for Q. No. 1(b).

2. (a) Assume that a voltage \( v(t) = 100 \sin (100\pi t + 45') \) V is applied to the circuit shown in Fig. for Q. No. 2(a). Find the expression of \( i(t) \), \( h(t) \) and \( v(t) \).

Contd ............ P/2
(b) Find the Thevenin equivalent circuit between terminals 'a' and 'b' in the circuit shown in Fig. for Q. No. 2(b). Draw the power diagram of $V_1$, $V_2$, $I_1$, and $I_2$ assuming $V_s$ as reference.

3. (a) Find the phase currents at the source and at the load for the circuit shown in Fig. for Q. No. 3(a). Also determine $V_{AB}$, $V_{BC}$, $V_{CA}$ total average power delivered by the source and total reactive power at the load.

(b) For the circuit shown in Fig. for Q. No. 3(b), find I and V. Assume that diodes are ideal.
4. (a) Determine the current $I_D$ and voltage across resistance $V_R$ for the circuit shown in Fig. for Q. No. 4(a). Assume that the diode has a current of 2 mA at a voltage of 0.7 V. Given, $n = 1$ and $V_T = 25$ mV.

(b) For the circuit shown in Fig. for Q. No. 4(b), calculate the dc voltage of the diode and the amplitude of the sine wave signal appearing across it. Assume that the diode has a 0.7 V drop at 1 mA current. Given, $n = 1$ and $V_T = 25$ mV.

(c) For the circuit shown in Fig. for Q. No. 4(c), draw the transfer characteristics of the circuit.

Assume that diodes have a constant voltage drop of 0.7 V.
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SECTION - B

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

5. (a) Determine the voltages at all nodes and the currents through all branches for the circuit shown in Fig. for Q. No. 5(a). Assume that the transistor $\beta$ is specified to be at least 50.

(b) Find the equivalent resistance $R_{eq}$ for the network shown in Fig. for Q. No. 5(b).

6. (a) Determine the node voltages in the circuit of Fig. for Q. 6(a) using nodal analysis. Also find the power dissipated in each resistor of the circuit.

(b) Apply mesh analysis to find $i$ in Fig. for Q. 6(b).
7. (a) Use the superposition principle to find $v_o$ and $i_o$ in circuit of Fig. for Q. 7(a).

(b) Find $i_o$ in circuit of Fig. for Q. 7(b) using source transformation.

8. (a) Find the Thevenin and Norton equivalents at terminals a-b of the circuit shown in Fig. for Q. No. 8(a).
(b) Find the value of $R_L$ for maximum power transfer in the circuit shown in Fig. for Q. No. 8(b). Find the maximum power. (20)
1. (a) Prove by vector method that the diagonals of a parallelogram bisect each other. (16\frac{2}{3}) 
(b) Find the unit vector perpendicular to both \( \vec{a} = 2\hat{i} + 3\hat{j} - \hat{k} \) and \( \vec{b} = 3\hat{i} - 2\hat{j} + \hat{k} \) using dot product. (15) 
(c) Forces of magnitudes 5 and 3 units acting in the directions \( 6\hat{i} + 2\hat{j} + 3\hat{k} \) and \( 3\hat{i} - 2\hat{j} + 6\hat{k} \) respectively on a particle which is displaced from the point (2, 2, -1) to (4, 3, 1). Find the work done by the forces. (15) 

2. (a) Define scalar and vector product of two vectors and give their geometrical interpretation. (15) 
(b) A force of 10 units acts through the point (4, 2, -5) in the direction of the vector (1, -3, 5). Find its moment about the point (3, 4, -1) and the moment about axes through that point parallel to the coordinate axes. (15) 
(c) In each case determine whether the vectors are linearly dependent or independent. If dependent find a relation between them (16\frac{2}{3}) 
(i) \( \vec{u} = 2\hat{i} + \hat{j} - 3\hat{k} \), \( \vec{v} = \hat{i} - 4\hat{k} \), \( \vec{w} = 4\hat{i} + 3\hat{j} - \hat{k} \) 
(ii) \( \vec{u} = -3\hat{j} + 2\hat{k} \), \( \vec{v} = 2\hat{i} - 4\hat{j} - \hat{k} \), \( \vec{w} = 3\hat{i} + 2\hat{j} - \hat{k} \) 

3. (a) Write down algorithm to find inverse of a non-singular matrix using elementary row operations. (6\frac{2}{3}) 
(b) Compute the inverse of the matrix 
\[
A = \begin{bmatrix} 2 & 1 & 3 \\ 1 & 0 & 1 \\ 2 & 1 & 1 \end{bmatrix}
\]
by applying elementary row operations and verify the result. (20) 
(c) Find the rank of the matrix A by its reduced normal form, where 
\[
A = \begin{bmatrix} 2 & -4 & 3 & 1 & 0 \\ 1 & -2 & 1 & -4 & 2 \\ 0 & 1 & -1 & 3 & 1 \\ 4 & -7 & 4 & -4 & 5 \end{bmatrix}
\]
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4. (a) Reduce the ‘quadratic’ form \( q = 6x_1^2 + 3x_2^2 + 3x_3^2 - 4x_1x_2 - 2x_2x_3 + 4x_3x_1 \) to canonical form and find the rank, index and signature of the form. (23)

(b) Consider a matrix

\[
M = \begin{pmatrix}
2 & 1 & 0 \\
0 & 2 & 1 \\
0 & 1 & 2 \\
\end{pmatrix}
\]

(i) Compute the eigenvalues and eigenvectors for the matrix \( M \).

(ii) Verify Cayley-Hamilton theorem for \( M \) and hence find \( M^{-1} \). (23 8/3)

SECTION - B

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

5. (a) Transform the equation \( 9x^2 + 24xy + 2y^2 - 6x + 20y + 41 = 0 \) in rectangular coordinates using suitable translation and rotation of axes so as to remove the terms in \( x, y \) and \( xy \). (26 8/3)

(b) What do you mean by direction cosines of a line? Find the angle between the two lines whose direction cosines are \((l_1, m_1, n_1)\) and \((l_2, m_2, n_2)\). Hence find the conditions of perpendicularity and parallelism of two lines. (20)

6. (a) Find the equation of the plane through \( x + 2 = \frac{y - 3}{2} = \frac{z + 2}{1} \) and the point \((0, 7, -7)\). (23 8/3)

(b) Find the equation of the plane through \((1, 1, 2)\) and perpendicular to each of the planes \(2x - 2y - 4z = 6\) and \(3x + y + 6z = 4\). (23)

7. (a) Find the shortest distance between the lines \( \frac{x + 3}{3} = \frac{y - 8}{-1} = \frac{z - 3}{1} \);

\[
\frac{x + 3}{3} = \frac{y + 7}{2} = \frac{z - 6}{4}.
\]

Find also the equation and the points in which it meets the given line. (26 8/3)

(b) Find the equation of the line drawn parallel to \( \frac{x}{2} = \frac{y}{3} = \frac{z}{4} \) so as to intersects the lines

\[
9x + y + z + 4 = 0 = 5x + y + 3z \quad \text{and} \quad x + 2y - 3z - 3 = 0 = 2x - 5y + 3z + 3.
\]

(20)

8. (a) Find the equation of two spheres which pass through the circle \( x^2 + y^2 - 4x - y + 3z + 12 = 0 \) and touch the plane \( x - 2y + 2z - 1 = 0 \). (24 8/3)

(b) Obtain the equations of the tangent planes to the sphere \( x^2 + y^2 + z^2 + 6x - 2z + 1 = 0 \) which pass through the line

\[
\frac{16 - x}{2} = \frac{z}{2} = \frac{y + 15}{3}.
\]

(22)
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-1 B.Sc. Engineering Examinations 2017-2018
Sub: **HUM 211** (Sociology)

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**.

1. (a) Explain the fundamental socio-economic changes happened after industrial revolution in Europe.  
   \[13 \frac{1}{3}\]  
   (b) What are the major advantages and disadvantages of globalization for Bangladesh?  
   \[10\]

2. (a) Compile the crucial elements of demography. How do these elements help to understand population dynamics?  
   \[13 \frac{1}{3}\]  
   (b) What is urban community? Describe the salient features of urban community.  
   \[10\]

3. (a) Critically describe the ‘Lee’s Migration Model’.  
   \[13 \frac{1}{3}\]  
   (b) What do you mean by hazard and disaster? Show some sustainable ways to reduce environmental pollution from your society.  
   \[10\]

4. Write short notes on any **THREE** of the following:  
   \[23 \frac{1}{3}\]  
   (a) Fatalism  
   (b) Bourgeoisie  
   (c) Noise pollution  
   (d) Glocalization.

**SECTION - B**

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

5. (a) ‘Sociological imagination is an unusual type of creative thinking for understanding social relationship’ – justify this statement with suitable examples.  
   \[10\]  
   (b) Write the main properties of conflict view and interactionist view of sociology.  
   \[13 \frac{1}{3}\]
6. (a) Define culture. Explain the relationship between culture and human society. (10)
   (b) Discuss counter culture, ethnocentrism, and dominant ideology with examples. (13 \frac{1}{3})

7. (a) How does socialization shape human behavior? Write your answer highlighting the roles of different agents of socialization. (10)
   (b) Briefly discuss Cooley's looking glass self theory of socialization. (13 \frac{1}{3})

8. (a) Explain deviant behavior highlighting the labeling theory of deviance. (10)
   (b) Distinguish between the nature and objective of white collar crime and victimless crime. (13 \frac{1}{3})