BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1   B. Sc. Engineering Examinations 2020-2021

Sub: **ME 203** (Engineering 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.

Symbols used have their usual meanings and interpretation. *Thermodynamic property tables will be supplied to the exam halls separately.*

1.   (a) A piston-cylinder device initially contains 0.4 m^3 of air at 100 kPa and 80°C. The air is now compressed to 0.1 m^3 in such a way that the temperature inside the cylinder remains constant. Determine the work done during this process.   **(10)**

(b) What are the conditions under which the ideal-gas assumption is appropriate for steam?   **(7)**

(c) Steam is to be condensed in the condenser of a steam power plant at a temperature of 50°C with cooling water from a nearby lake, which enters the tubes of the condenser at 18°C at a rate of 101 kg/s and leaves at 27°C. Determine the rate of condensation of the steam in the condenser.   **(18)**


Fig. for Q No. 1(c)
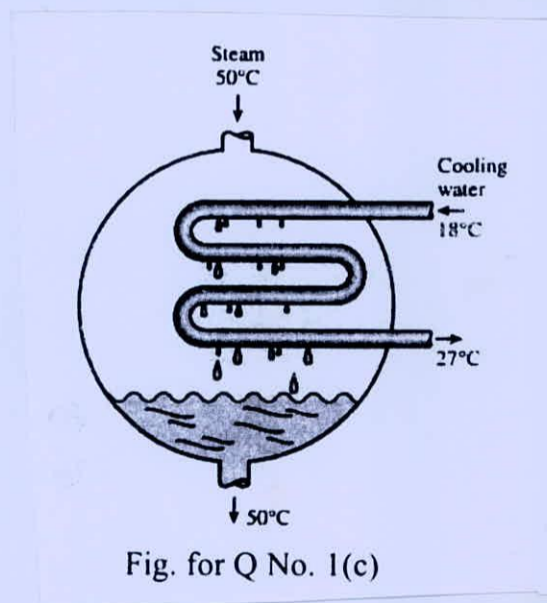
2.   (a) Show that the Kelvin-Planck and the Clausius expression of the second law are equivalent.   **(8)**

(b) If two objects with temperatures of T_1 and T_2 are connected, which direction will the heat flow? Mathematically explain using the concept of entropy.   **(10)**

(c) Steam at 4 MPa and 350°C is expanded in an adiabatic turbine to 120 kPa. What is the isentropic efficiency of this turbine if the steam is exhausted as a saturated vapor?   **(17)**
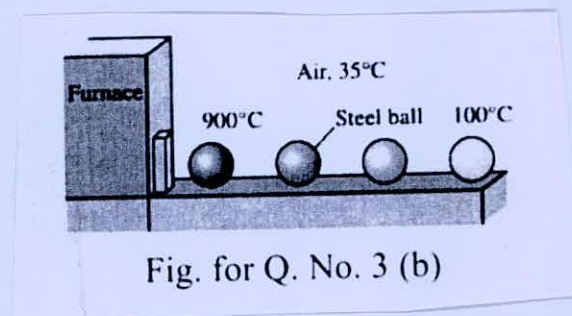
ME 203

Contd... Q. No.2(c)

4 MPa
350°C

Steam
turbine

120 kPa
sat. vapor

Fig. for Q. No. 2(c)
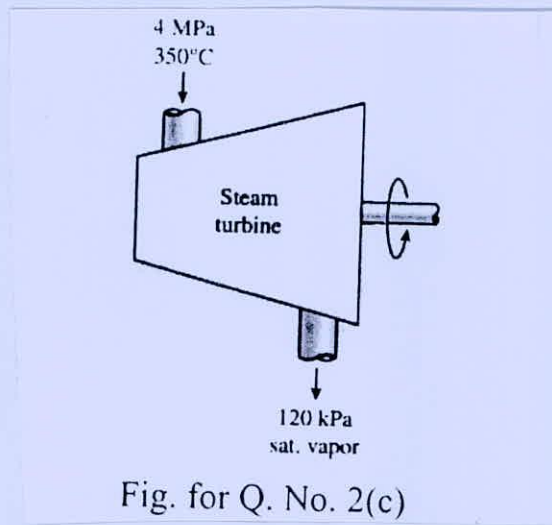
3.   (a) A cylinder of an internal combustion engine contains 2450 cm³ of gaseous combustion products at a pressure of 7 bar and a temperature of 867°C just before the exhaust valve opens. Determine the specific exergy of the gas in kJ/kg. Ignore the effects of motion and gravity, and model the combustion products as air and as an ideal gas. Take $T_0 = 300$ K and $p_0 = 1.013$ bar. **(17)**

2450 cm³ of air
at 7 bar, 867°C

Fig. for Q. No. 3(a)
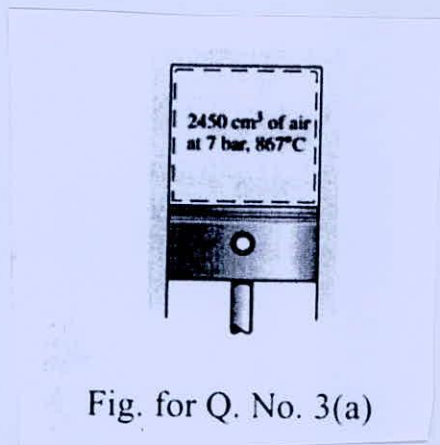
(b) Carbon steel balls ($\rho = 7833$ kg/m³ and $c_p = 0.465$ kJ/kg°C) 8 mm in diameter are annealed by heating them first to 900°C in a surface and then allowing them to cool slowly to 100°C in ambient air at 35°C. If 1200 balls are to be annealed per hour, determine (i) the rate of heat transfer from the balls to the air and (ii) the rate of exergy destruction due to heat loss from the balls to the air. **(18)**

Air, 35°C

900°C   Steel ball   100°C

Fig. for Q. No. 3 (b)

4.   (a) Does the reference point selected for the properties of a substance have any effect on thermodynamic analysis? Why? **(5)**

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Contd... Q. No.4

(b) Atmosphere air at pressure of 1 atm and dry-bulb temperature of 28°C has a dew-point temperature of 20°C. Using the psychrometric chart, determine (i) the relative humidity, (ii) the humidity ratio, (iii) the enthalpy, (iv) the wet bulb temperature, and (v) the water vapor pressure. **(5)**

(c) Water at 30°C and at a rate of 5 kg/s is to be cooled to 22°C in a cooling tower. Humid air enters this tower at 1 atm and 15°C with a relative humidity of 25 percent and leaves at 18°C with a relative humidity of 95 percent. Determine the mass flow rate of dry air through this tower. **(25)**

SECTION – B

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

5. (a) What are the ideal characteristics of a working fluid for the vapor power cycle for both the low and high temperature sides? Evaluate water as a working fluid in this regard. **(10)**

(b) The steam leaves the boiler and enters the turbine of a stem turbine power plant working on Rankine cycle at 400°C and a pressure of 4 MPa. The capacity of the power plant is 25 MW and the condenser pressure is 10 kPa. The isentropic efficiency of the steam turbine is 85%. Considering pump work, determine **(25)**

    (i) the thermal efficiency of the cycle,

    (ii) the quality of steam leaving the turbine, and

    (iii) the steam flow rate in kg per hour.

6. (a) How does intercooling between the compressor stages reduce the work of compression? Why is isothermal compression more advantageous than adiabatic compression? **(10)**

(b) In an ideal regenerative cycle working on Rankine cycle, the boiler and condenser pressures are 3 MPa and 4 kPa, respectively. Steam enters the turbine in dry saturated condition. Steam is bled from the turbine at a pressure of 0.25 MPa and is supplied to an open feed water heater. Determine: **(25)**

    (i) the mass flow rate of the bled steam (in kg/kg of steam)

    (ii) the thermal efficiency of the cycle

7. (a) Why is the ideal vapor compression refrigeration cycle not an internally reversible cycle? **(5)**

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Contd... Q. No.7

(b) Why is there a limit on the pressure ratio that can be used in a Brayton cycle? For a fixed maximum temperature of the Brayton cycle, how does the pressure ratio affect the cycle efficiency? **(10)**

(c) The pressure and temperature of air entering the compressor of a gas turbine power plant, working on the Brayton cycle, is 100 kPa and 300 K. The pressure ratio in the compressor is 10 and the turbine inlet temperature is 1400K. The volumetric flow rate of air to the compressor is 5 m^3/s. **(20)**

After clearly stating the assumptions you have made to solve this problem, determine:

      (i) Thermal efficiency of the cycle

      (ii) back work ratio

Now, if the isentropic efficiency of the turbine and compressor is 0.85 and 0.75, respectively, determine the back work ratio for the above problem.

8.   (a) Describe the inversion line and the maximum inversion temperature. **(7)**

    (b) Using the Clapeyron equation, estimate the enthalpy of vaporization of refrigerant-134a at 40°C, and compare it to the tabulated value. **(8)**

    (c) A rigid tank contains 2 kmol of N_2 and 6 kmol of CO_2 gases at 300 K and 15 MPa. Estimate the volume of the tank based on (i) the ideal-gas equation of state, (ii) Kay's rule, (iii) compressibility factors and Amagat's law, and (iv) compressibility factors and Dalton's law. **(20)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1   B. Sc. Engineering Examinations 2020-2021

Sub: **ME 247**   (Engineering Mechanics-I)

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** questions.

1. (a) On what conditions the center of gravity and centroid of a plate element becomes the same?   **(5)**

(b) Differentiate between truss, frame, and machines. Show sketches follower each type structure.   **(12)**

(c) Member ABCDE is a component of mobile as shown in figure 1(b) and is formed from a single piece of aluminum tubing. Knowing that the member is Pin supported at C and that $L = 2$ m, determine the distance d so that portion BCD of the member is horizontal.   **(18)**
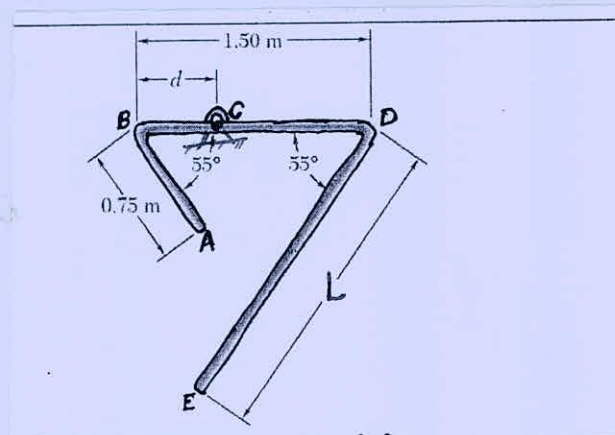

Fig. 1(c)

2. (a) A truss is loaded with four concentrated loads as shown in figure 2(a). Determine the force in members ED, EH, and GH of the truss, and state whether the members are in tension or in compression.   **(18)**
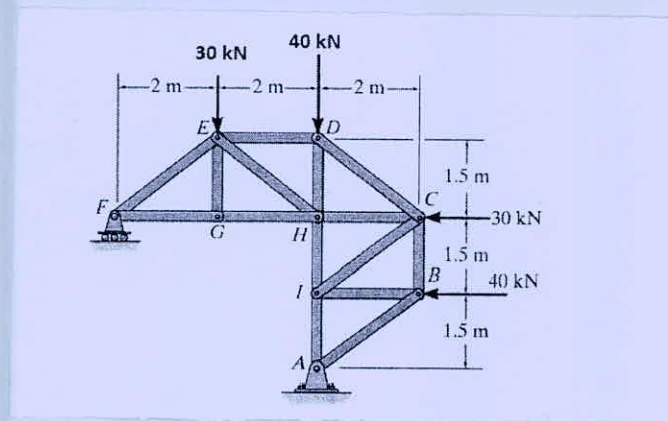

Fig. 2(a)

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Contd... Q. No. 2

(b) A semicircular rod is loaded as shown in figure 2(b). Determine the internal forces at point J knowing that $\theta = 30°$. **(17)**
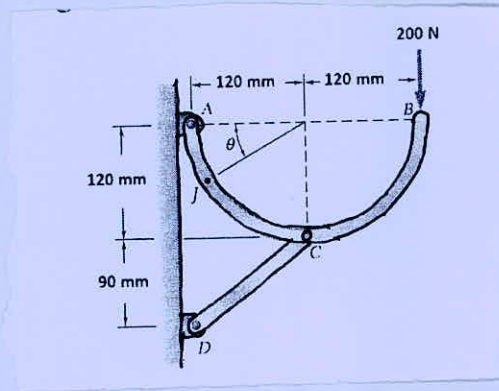
Fig. 2(b)

3. (a) Two channels are welded to a rolled W section as shown in figure 3(a). Determine the moments of inertia and radius of gyration of the combined section with respect to the x-axis (see attachment). **(18)**
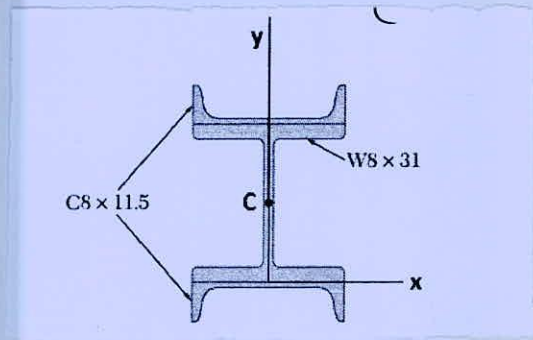
Fig. 3(a)

(b) Determine by direct integration the moment of inertia of the shaded area shown in figure 3(b) with respect to the x-axis. **(17)**
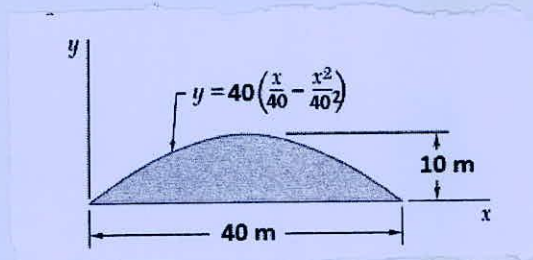
Fig. 3(b)

4. (a) Cable AB supports a load uniformly distributed along the horizontal as shown in figure 4(a). Knowing that the cable forms an angle of 35° with the horizontal at B, determine (i) the maximum tension in the cable, (ii) the vertical distance, a of the lowest point of the cable from A. **(20)**
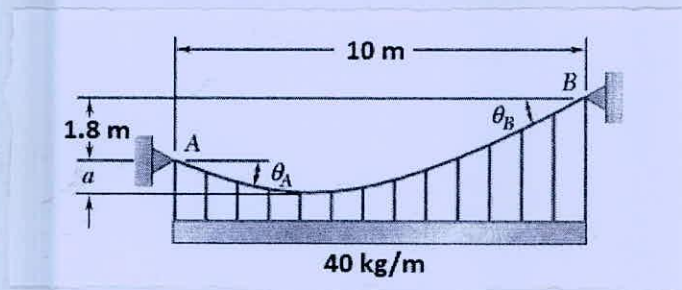

Fig. 4(a)

(b) The two bars as shown in figure 4(b), each have a weight of 6 lb. Determine the required stiffness k of the spring software that the two bars are in equilibrium when θ = 30°. The spring has an unstretched length of 1 ft. Solve the problem by principle of virtual work. **(15)**
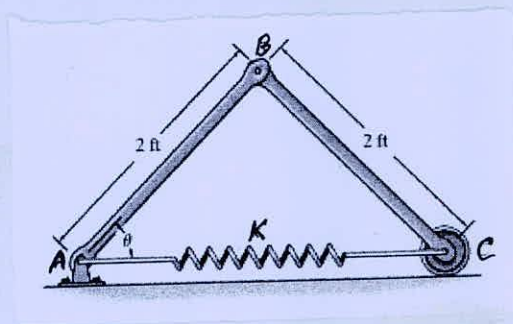

Fig. 4(b)

SECTION – B

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

5. (a) Define Statics and mention about its basic concepts. Also illustrate the Principle of Transmissibility. **(10)**

(b) Rod AB is fined at point B as shown in the figure attached herewith. Knowing that c = 840 mm and that the moment about B of the force exerted by the cord at point A is 756 N.m, and neglecting the weight of rod AB, determine the tension in the cord. **(10)**

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Contd... Q. No. 5

(c) Before the trunk of a large tree is felled, cables AB and BC are attached as shown. Knowing that the tensions in cables AB and BC are 555 N and 660 N, respectively, determine the moment about O of the resultant force exerted on the tree by the cables at B. **(15)**

6. (a) A rod AB, hinged at A and attached at B to cable BD, supports the loads shown. Knowing that d is equal to 150 mm, determine (a) the tension in cable BD, (b) the reaction at A. **(17)**

    (b) Neglecting friction, determine the tension in cable ABD and the reaction at C when $\theta = 60°$ as shown in the figure attached herewith. **(18)**

7. (a) The 6-m pole ABC is acted upon by a 455-N force as shown. The pole is held by a ball-and-socket joint at A and by two cables BD and BE. For a = 3 m, determine the tension in each cable and the reaction at A. **(25)**

    (b) A 100-kg uniform rectangular plate is supported in the position shown by hinges A and B and by cable DCE that passes over a frictionless hook at C. Assuming that the hinge at B does not exert any axial thrust, draw the free body diagram (Equilibrium Diagram) of the plate. **(10)**

8. (a) If the angle $\theta = 45°$, determine the range of values of P for which equilibrium of the block shown is maintained. **(17)**

    (b) The 10-lb uniform rod *AB* is held in the position shown by the force P in the attached figure. Knowing that the coefficient of static friction is 0.20 at *A* and *B*, determine both the largest and smallest values of P follower which equilibrium is maintained. **(18)**

Attachment for question 3(a).
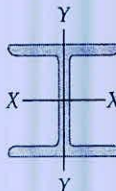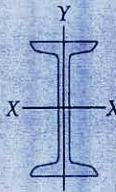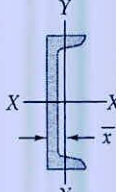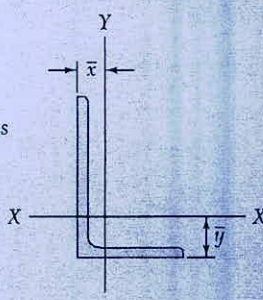
		Designation	Area in²	Depth in.	Width in.	Axis X-X			Axis Y-Y		
						$\overline{I}_x$, in⁴	$\overline{k}_x$, in.	$\overline{y}$, in.	$\overline{I}_y$, in⁴	$\overline{k}_y$, in.	$\overline{x}$, in.
W Shapes (Wide-Flange Shapes)		W18 × 76†	22.3	18.2	11.0	1330	7.73		152	2.61	
		W16 × 57	16.8	16.4	7.12	758	6.72		43.1	1.60	
		W14 × 38	11.2	14.1	6.77	385	5.87		26.7	1.55	
		W8 × 31	9.12	8.00	8.00	110	3.47		37.1	2.02	
S Shapes (American Standard Shapes)		S18 × 54.7†	16.0	18.0	6.00	801	7.07		20.7	1.14	
		S12 × 31.8	9.31	12.0	5.00	217	4.83		9.33	1.00	
		S10 × 25.4	7.45	10.0	4.66	123	4.07		6.73	0.950	
		S6 × 12.5	3.66	6.00	3.33	22.0	2.45		1.80	0.702	
C Shapes (American Standard Channels)		C12 × 20.7†	6.08	12.0	2.94	129	4.61		3.86	0.797	0.698
		C10 × 15.3	4.48	10.0	2.60	67.3	3.87		2.27	0.711	0.634
		C8 × 11.5	3.37	8.00	2.26	32.5	3.11		1.31	0.623	0.572
		C6 × 8.2	2.39	6.00	1.92	13.1	2.34		0.687	0.536	0.512
Angles		L6 × 6 × 1‡	11.0			35.4	1.79	1.86	35.4	1.79	1.86
		L4 × 4 × ½	3.75			5.52	1.21	1.18	5.52	1.21	1.18
		L3 × 3 × ¼	1.44			1.23	0.926	0.836	1.23	0.926	0.836
		L6 × 4 × ½	4.75			17.3	1.91	1.98	6.22	1.14	0.981
		L5 × 3 × ½	3.75			9.43	1.58	1.74	2.55	0.824	0.746
		L3 × 2 × ¼	1.19			1.09	0.953	0.980	0.390	0.569	0.487

Properties of rolled-steel shapes (U.S. customary units).*

*Courtesy of the American Institute of Steel Construction, Chicago, Illinois
†Nominal depth in inches and weight in pounds per foot
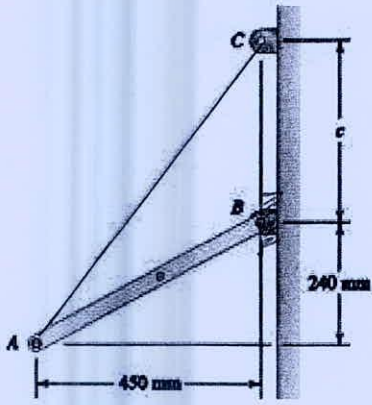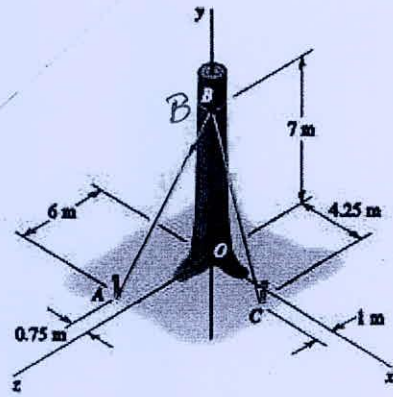‡Depth, width, and thickness in inches

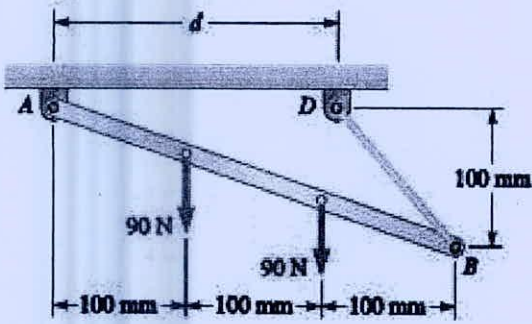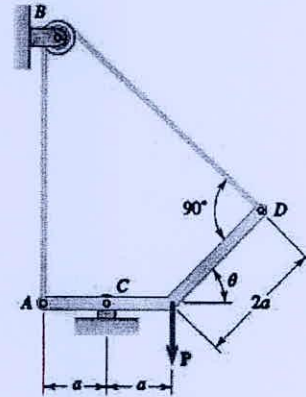Fig. for Qu. No. 5(b)

Fig. for Qu. No. 5(b)

Fig. for Qu. No. 6(a)

Fig. for Qu. No. 6(b)

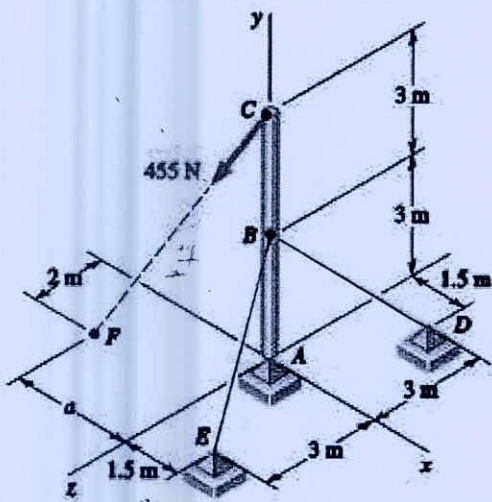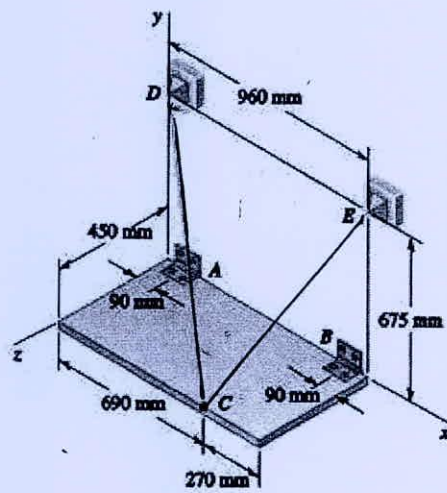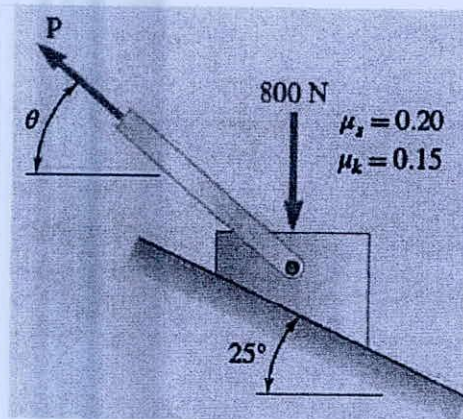
Fig. for Qu. No. 7(a)

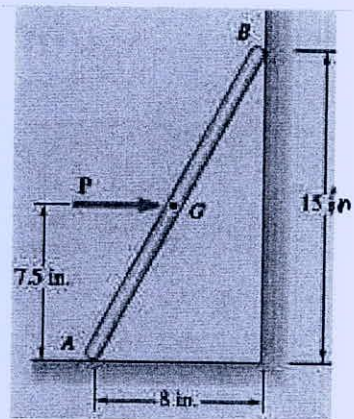Fig. for Qu. No. 7(b)

Fig. for Qu. No. 8(a)

Fig. for Qu. No. 8(b)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1   B. Sc. Engineering Examinations 2020-2021

Sub: **EEE 259** (Electrical and Electronic Technology)

Full Marks: 280   Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1.   (a) A 460-V, 25-hp, 50-Hz, four-pole, Y-connected wound-rotor induction motor has the following impedances in ohms per phase referred to the stator circuit: $(26\frac{2}{3})$

   $R_1 = 0.641\ \Omega$

   $X_1 = 1.106\ \Omega$

   $R_2 = 0.332\ \Omega$

   $X_2 = 0464\ \Omega$

   $X_M = 26.3\ \Omega$

   (i)   What is the maximum torque of this motor? At what speed and slip does it occur?

   (ii)   What is the starting torque of this motor?

   (iii) When the rotor resistance is doubled, what is the speed at which the maximum torque now occurs? What is the new starting torque of the motor?

   (iv)   Sketch the torque-speed characteristics of this motor both with the original rotor resistance and with the rotor resistance doubled.

   (b) Describe how the equivalent circuit parameters of a three-phase induction motor are determined.   **(20)**

2.   (a) A 13.8-kV, 50-MVA, 0.9 power-factor lagging, 50-Hz, four-pole Y-connected synchronous generator has an armature resistance of $0.2\ \Omega$ and synchronous reactance of $2.5\ \Omega$. At 50 Hz, its friction and windage losses are 1 MW, and its core losses are 1.5 MW. The field circuit has a dc voltage of 120 V, and the maximum field current is 10 A. The current of the field circuit is adjustable over the range from 0 to 10 A. The OCC of this generator is shown in Fig. for Q. No. 2(a). $(26\frac{2}{3})$
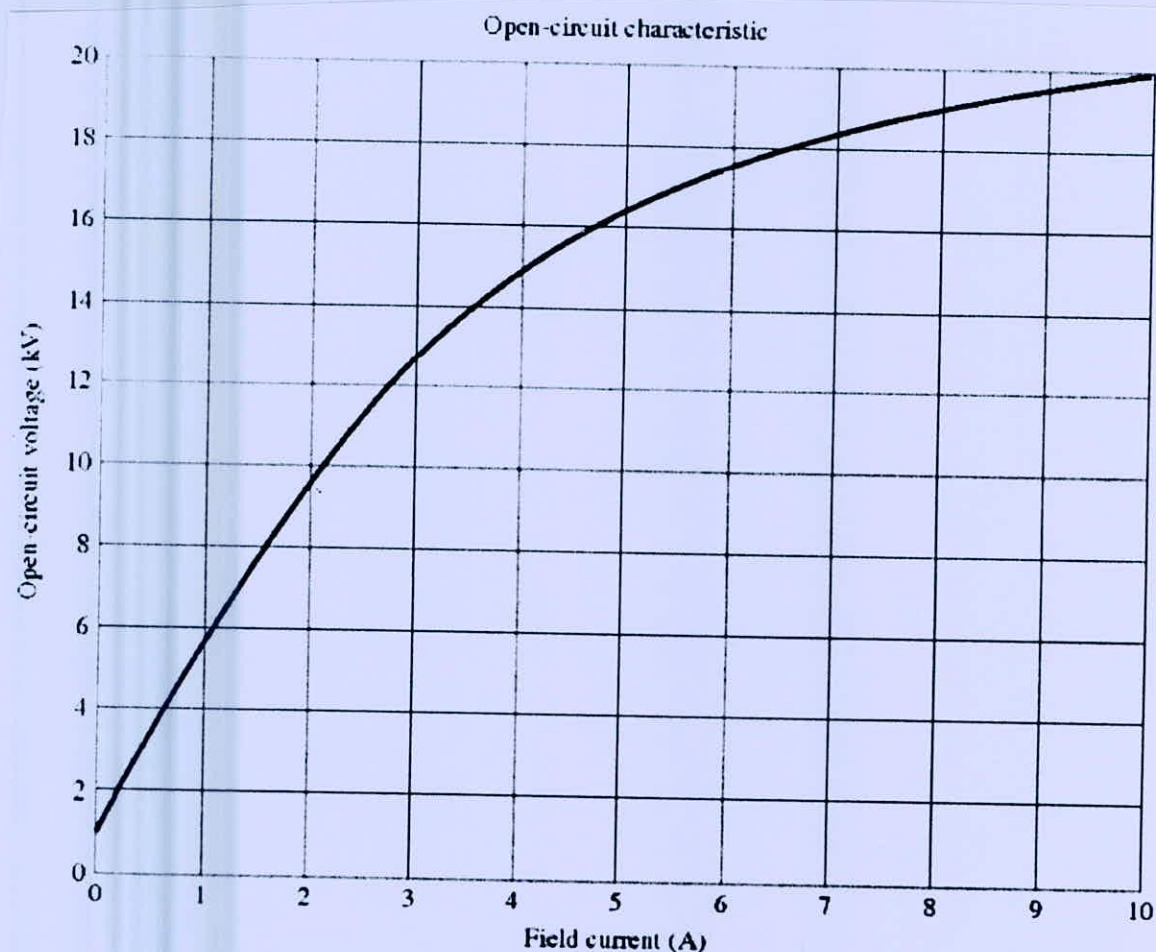
Fig. for Q. No. 2(a).

Assume that the field current of the generator has been adjusted to a value of 5 A.

(i)   What will the terminal voltage of this generator be if it is connected to a Δ-connected load with impedance of $24\angle25°\ \Omega$?

(ii)   Sketch the phasor diagram of this generator.

(iii)   What are the efficiency and voltage regulation of the generator at these conditions?

(iv)   Now assume that another identical Δ-connected load is to be paralleled with the first one. What happens to the phasor diagram for the generator? Sketch the new phasor diagram

(v)   What is the new terminal voltage after the load has been added?

(vi)   What must be done to restore the terminal voltage to its original value?

(b) Using necessary house and phasor diagrams explain   (20)

(i)   The effect of increasing the governor set point of a generator working in parallel with an infinite bus

(ii)   The load sharing of two synchronous generators of similar capacity in parallel.

EEE 259/ME

3. (a) A 1000-VA 230/115-V transformer has been tested to determine its equivalent circuit. The results of the tests are shown below. $(26\frac{2}{3})$

Open-circuit test (on secondary side)	Short-circuit test (on primary side)
VOC = 115 V	VSC = 17.1 V
IOC = 0.11 A	ISC = 8.7 A
POC = 3.9 W	PSC = 38.1 W

(i) Find the equivalent circuit of this transformer referred to the low-voltage side of the transformer.

(ii) Find the transformer's voltage regulation at rated conditions, 0.8 PF lagging and 1.0 PF, respectively.

(iii) Determine the transformer's efficiency at 90% of rated load and 0.8 PF lagging, respectively.

(iv) In which side the open circuit and short circuit tests are carried out? Justify your answer.

(b) What are hysteresis and eddy current loss? How are these losses reduced in a transformer? **(10)**

(c) Prove that while referring to the primary side of the transformer, the impedances of the secondary side are multiplied by a^2. **(10)**

$$Z_L' = a^2.Z_L$$

4. (a) Briefly describe three causes for voltage to fail to buildup in a Shunt DC generator. What are the remedies of this problem? — Give necessary justification. **(18)**

(b) Explain the terminal characteristic of differentially compounded DC motors. What are the advantages and disadvantages of using compounded DC motors? $(10\frac{2}{3})$

(c) Derive the terminal characteristic of a Shunt DC Motor. Explain the effect of change in armature voltage on a shunt motor's torque-speed characteristic. When is armature voltage control method used? **(18)**

SECTION – B

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

5. (a) Explain the operation of the electronic circuit shown in Fig. for Q. No. 5(a) and sketch the output voltage (v_o) as a function of time (t) for the given sinusoid input voltage (v_i). $(26\frac{2}{3})$
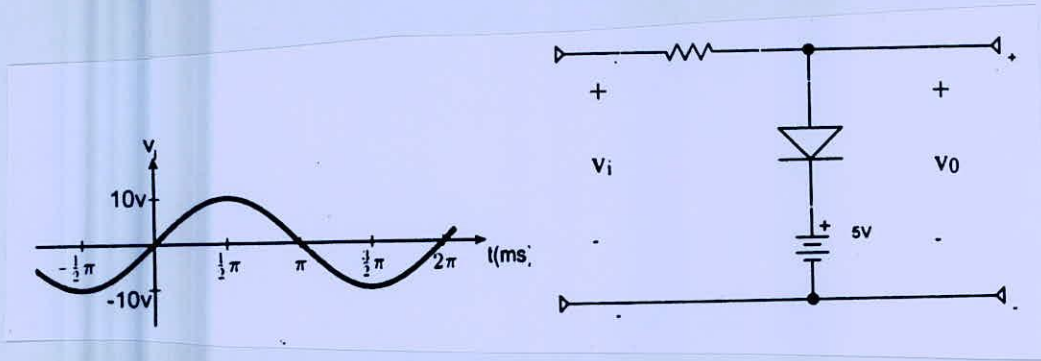
Fig. for Q. No. 5(a)

(b) Assuming ideal diodes in the circuit of Fig. for Q. No. 5(b), find the values of I_{D1}, I_{D2} and v_0. **(20)**
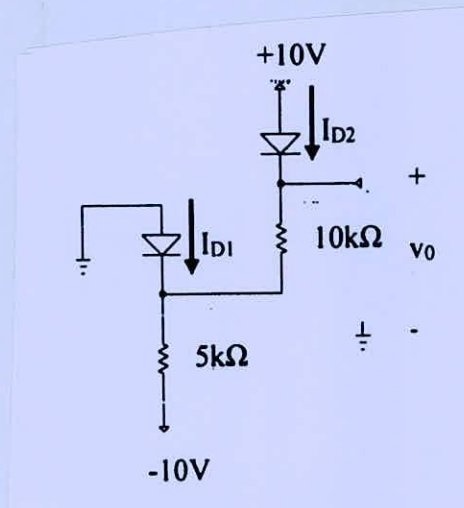
Fig. for Q. No. 5(b)

6. (a) Analyze the circuit shown in Fig. for Q. No. 6(a) to determine the voltages at all nodes and current through all branches. Assume, $\beta = 150$. **(20)**
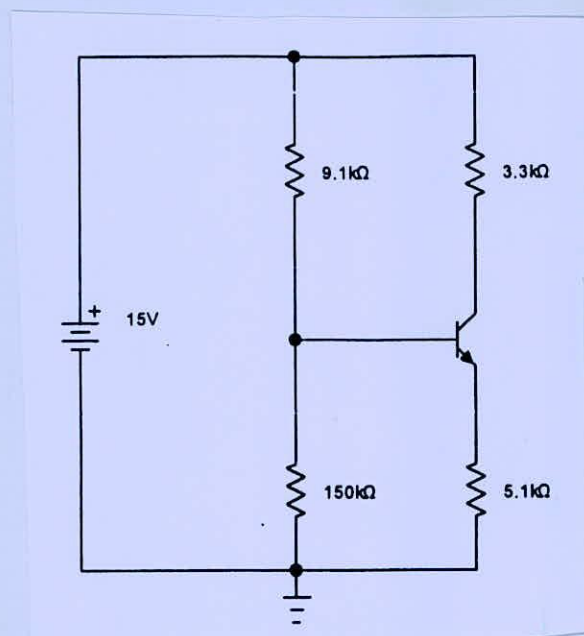
Fig. for Q. No. 6(a)

(b) Design the circuit shown in Fig. for Q. No. 6(b) so that a current of 2 mA flows through the collector and a voltage of +5 V appears at the collector. Assume, $\beta = 100$, $v_{BE} = 0.7$ V at $i_C = 1$ mA. Here, ± 15 V dc power supplies are used. $(26\frac{2}{3})$
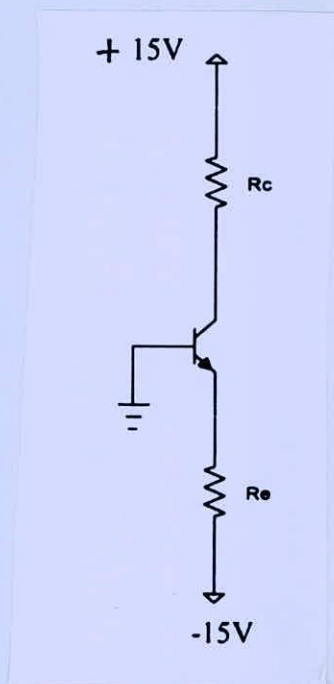
Fig. for Q. No. 6(b)

7.   (a) Determine the values of R_D and R_S in the circuit shown in Fig. for Q. No. 7(a), so that the transistor operates at $I_D = 0.4$ mA and $V_D = +0.5$ V. The NMOS transistor has $V_t = 0.7$ V, $\mu_n C_{ox} = 100$ $\mu A/V^2$, $L = 1$ μm, and $W = 32$ μm. Neglect the channel-length modulation effect.   (20)
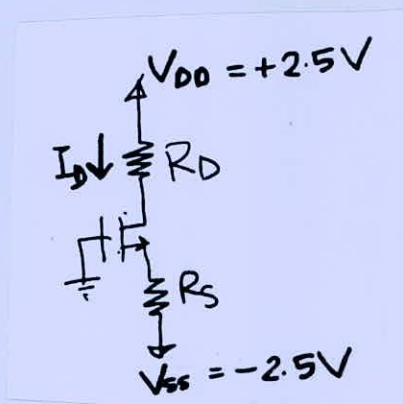
Fig. for Q. No. 7(a)

(b) Design the circuit of Fig. for Q. No. 7(b) so that the MOSFET operates in the saturation region with $I_D = 0.5$ mA and $V_D = +3$ V. Let the enhancement-type PMOSFET have $V_{tp} = -1$ V and $k_p(W/L) = 1$ mA/V^2. Assume $\lambda = 0$. What is the largest value that R_D can have while maintaining the operation in the saturation-region? $(26\frac{2}{3})$
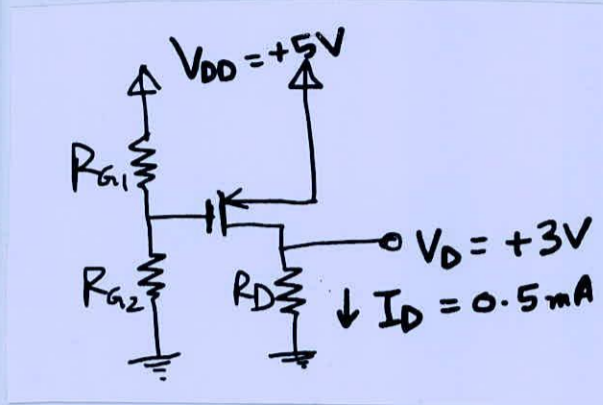
Fig. for Q. No. 7(b)

8.　(a) Design a circuit using operational amplifiers with inputs v_1 and v_2 such that the output voltage $v_{out} = 2v_2 - 3v_1$.　**(20)**

(b) The NMOS and PMOS transistors in the circuit of Fig. for Q. No. 8(b) are matched, with $k_n'(W_n / L_n) = k_p'(W_p / L_p) = 1$ mA/V^2 and $V_{tn} = -V_{tp} = 1$ V. Find the drain currents i_{DN} and i_{DP} and the voltage v_o for $v_1 = 0$ V and +2.5 V.　**(26⅔)**

Fig. for Q. No. 8(b)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1   B. Sc. Engineering Examinations 2020-2021

Sub: **MATH 261** (Vector Calculus, Matrices, Laplace Transform and Series Solution)

Full Marks: 280   Time: 3 Hours

The figures in the margin indicate full marks

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Prove that the transpose of a product of two matrices is equal to the product of their
transposes in reverse order.   **(10)**

(b) Find the inverse of the matrix $A = \begin{bmatrix} 3 & 4 & -1 \\ 1 & 0 & 3 \\ 2 & 5 & -4 \end{bmatrix}$ only using row transformations.

Hence show that $A(adjA) = |A| I_3$.   **(20)**

(c) Reduce the quadratic form $q = x_1^2 - x_3^2 - 4x_1x_2 + 4x_2x_3$ to a sum of squares and
hence express the quadratic form in terms of the new variables.   **(16⅔)**

2. (a) If $A = \begin{bmatrix} 3 & -3 & 4 \\ 2 & -3 & 4 \\ 0 & -1 & 1 \end{bmatrix}$, then find two non-singular matrices P and Q such that

$PAQ = I$. Hence find A^{-1}.   **(20⅔)**

(b) State and verify Cayley-Hamilton theorem for $A = \begin{bmatrix} 2 & -1 & 3 \\ 1 & 0 & 2 \\ 4 & -2 & 1 \end{bmatrix}$. Hence find A^3.   **(16)**

(c) Show that $\nabla \times (\mathbf{A} \times \mathbf{B}) = \mathbf{A}(\nabla \cdot \mathbf{B}) - \mathbf{B}(\nabla \cdot \mathbf{A}) - (\mathbf{A} \cdot \nabla)\mathbf{B} + (\mathbf{B} \cdot \nabla)\mathbf{A}$.   **(10)**

3. (a) Show that acceleration of a particle along a curve is a vector in the plane of the
tangent and the normal with $\dfrac{dv}{dt}$ and $v^2\kappa$ as its tangential and normal components
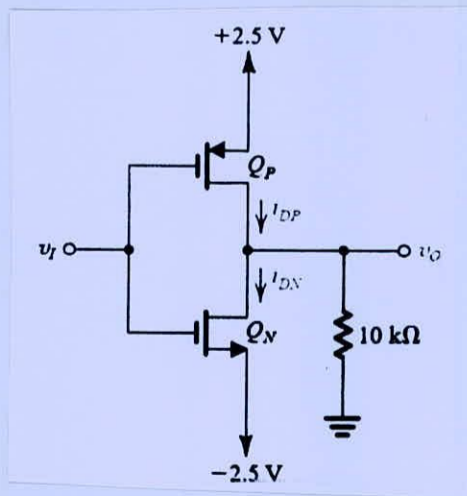respectively.   **(16⅔)**

(b) Find the direction along which the directional derivative of $Q = 2x^2y^3z$ at $(2,1,-1)$
is the greatest. Determine the greatest value as well.   **(15)**

(c) Find curl of $\mathbf{F}$ where $\mathbf{F} = (x^2 - y^2 + 2xz)\mathbf{i} + (xz - xy + yz)\mathbf{j} + (z^2 + x^2)\mathbf{k}$. Also show
that the vectors given by curl $\mathbf{F}$ at the points $P(1, 2, -3)$ and $Q(2, 3, 12)$ are
orthogonal.   **(15)**

4. (a) State and verify Gauss's divergence theorem for $\mathbf{F} = 2xy\,\mathbf{i} - 3yz\,\mathbf{j} - zx^2\,\mathbf{k}$ taken over
region bounded by the cylinder $y^2 + z^2 = 4$ and the planes $x = 0$, $x = 2$.   **(26⅔)**

(b) Find the work done by the force field $\mathbf{F} = (3x^2 - y)\mathbf{i} + (y^2 - x^2)\mathbf{j} + (zy^2 + 3x)\mathbf{k}$ on a
particle that moves it along the line segments from $(0, 0, 0)$ to $(1, -2, -1)$ to $(2, -3, 2)$.   **(20)**

MATH 261

SECTION – B

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

5. (a) Find the solution of the following differential equation by Fröbenius method: **(26⅔)**

$$2x^2 y'' - xy' + (1 - x^2)y = 0$$

(b) Show that: $[J_{1/2}(x)]^2 + [J_{-1/2}(x)]^2 = \dfrac{2}{\pi x}$. **(10)**

(c) Show that: $\dfrac{d}{dx}[x^{-n}J_n(x)] = -x^{-n}J_{n+1}(x)$. **(10)**

6. (a) Show that: $[x^2 J_n''(x)] + [(x^2 + n - n^2)J_n(x)] = x J_{n+1}(x)$. **(17⅔)**

(b) Express: $x^4 + 2x^3 + 2x^2 - x - 3$ in terms of Legendre's polynomial. **(11)**

(c) Show that: $\displaystyle\int_{-1}^{1} P_m(x)P_n(x)\,dx = \begin{cases} 0 & \text{,if } m \neq n \\ \frac{2}{(2n+1)} & \text{,if } m = n \end{cases}$. **(18)**

7. (a) Evaluate the following Laplace transform: **(11)**

$$L\{t^2(\sin at + e^{at})\}.$$

(b) Show that $L\{erf(\sqrt{t})\} = \dfrac{1}{s\sqrt{s+1}}$. **(17)**

(c) Evaluate the following inverse Laplace transform: **(18⅔)**

$L^{-1}\left\{\dfrac{2s^2 - 4}{(s+1)(s-2)(s-3)}\right\}$ using Heaviside expansion formula.

8. (a) Evaluate the following inverse Laplace transform: **(10)**

$L^{-1}\left\{\dfrac{1}{(s+1)(s^2+1)}\right\}$ using convolution theorem.

(b) Solve the following differential equation using Laplace transform: **(16⅔)**

$$\dfrac{d^2 y}{dt^2} + \dfrac{dy}{dt} - 2y = \sin t; \quad y(0) = 0, \ y'(0) = 0.$$

(c) Solve the following boundary value problem using Laplace transform: **(20)**

$\dfrac{\partial U}{\partial t} = \dfrac{\partial^2 U}{\partial x^2} - 4U; U_x(0,t) = 0, U(\pi,t) = 0, U(x,0) = 6\sin x - 4\sin 2x$.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1   B. Sc. Engineering Examinations 2020-2021

Sub : **HUM 303** (Principles of Accounting)

Full Marks : 210   Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Can a business enter into a transaction in which only the left side of the basic accounting equation is affected? If so, give an example.   (5)

    (b) Mr. Robert opened a computer service business. The transactions of January 2021 are as follows –   (30)

    January - 1:   Invested Tk. 500,000 cash in the business.

    January - 2:   Paid insurance premium for the month in cash Tk. 50,000.

    January - 4:   Purchase office machinery on account for Tk. 15,000.

    January - 5:   Provide service on account Tk. 40,000.

    January - 7:   Paid Tk. 10,000 in cash for advertising expense.

    January - 10:   Received Tk. 15,000 in cash from dues on January 5.

    January - 12:   Paid dues on machinery purchase.

    January - 20:   Received Tk. 25,000 for future services.

    Required:

    (i) Prepare necessary journal entries for January 31, 2021.

    (ii) Prepare ledger for Asset Accounts.

2. (a) Following information is available for "Walton Company" –   (15)

Walton Company

Income Statement

For the year ended December 31, 2020

		Amount (Tk.)
Net Sales		**600,000**
Expenses:		
Cost of goods sold	415,000	
Selling and administrative expense	120,800	
Interest expense	7,800	
Income tax expense	18,000	
Total expense		**561,600**
Net income		**38,400**

HUM 303

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

Walton Company
Balance Sheet
December 31, 2020

Asset	Amount(Tk.)	Liabilities and Equity	Amount(Tk.)
Cash	21,000	Accounts payable	122,000
Investment (Short term)	18,000	Income tax payable	23,000
Accounts receivable	86,000	Bond payable	120,000
Prepaid expense	62,000	Wage payable	62,000
Inventory	90,000	Common stock or equity (Tk. 5 par)	150,000
Plant asset	423,000	Retained earnings	223,000
Total asset	**700,000**	**Total Liabilities and Equity**	**700,000**

Other information: Common stock or equity recently sold at Tk. 20.00 per share in the market.

Required:

(i) Quick or acid test ratio.

(ii) Current ratio.

(iii) Debt to total asset.

(iv) Earnings per share (EPS).

(v) Gross margin ratio.

(b) Consider the projects below with respective cash flows –   (20)

Project	Year					
	0	1	2	3	4	5
A	(200,000)	35,000	80,000	90,000	75,000	20,000
B	(200,000)	28,000	40,000	50,000	90,000	10,000

Required: Calculate –

(i) Payback Period for both projects.

(ii) Internal rate of return (IRR) for only project B.

(iii) Net present value (NPV) at 10% cost of capital only for project A.

3. The Trail Balance of "Walmart Enterprise" at May 31, 2021 is given below –   (35)

"Walmart Enterprise"
Trial Balance
May 31, 2021

Accounts Title	Debit (Tk.)	Credit (Tk.)
Cash	15,000	
Accounts Receivable	19,000	
Prepaid insurance	2,400	
Supplies	1,500	
Office furniture	15,000	
Machinery	14,000	

HUM 303

Contd ... Q. No. 3

Accounts Title	Debit (Tk.)	Credit (Tk.)
Accounts payable		4,500
Notes payable		24,000
Unearned service revenue		6,000
Capital		25,500
Service revenue		12,000
Salary expense	2,000	
Rent expense	1,000	
Travel expense	2,100	
Total	**72,000**	**72,000**

Additional information:

- Supplies on hand Tk. 1000.
- Accrued rent is Tk. 500.
- Insurance policy is for two years.
- Machinery is being depreciated Tk. 300 per month.
- Accrued interest amount is Tk. 800.

Required:

(i) Prepare necessary adjusting entries.

(ii) Prepare an adjusted trial balance as at May 31, 2021.

4. The following accounts are taken from the ledger balances of "B" Company Ltd. at 31st December, 2020.   (35)

"B Company Ltd"

Trial Balance

31st December, 2020

Accounts Title	Debit (Tk.)	Credit (Tk.)
Cash	50,000	
Accounts receivable	32,000	
Accounts payable		36,000
Capital		51,000
Land	25,000	
Sales revenue		30,200
Salaries	12,000	
Prepaid rent	4,000	
Utility expense	1,000	
Interest expense	15,000	
Commission expense	3,000	
Supplies	1,000	

HUM 303

Contd ... Q. No. 4

Accounts Title	Debit (Tk.)	Credit (Tk.)
Notes payable		15,000
Drawings	2,000	
Goodwill	20,000	
Machinery	85,000	
Long term investment	50,000	
Bond payable		155,000
Salary payable		12,800
Total	**300,000**	**300,000**

Additional information :

Charge 10% depreciation on machinery.

Required:

(i) Prepare a single step income statement for the year ended December, 2020.

(ii) Prepare an owners equity statement.

(iii) Prepare a classified balance sheet at 31st December, 2020.

SECTION – B

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

5. Hudson Company uses a job-order costing system. The following transactions took place last year. (35)

   a. Raw materials were requisitioned for use in production, $38,000 (85% direct and 15% indirect).
   b. Factory utility costs incurred, $19,000.
   c. Depreciation was recorded on plant and equipment, $36,000. Three-fourths of the depreciation related to factory equipment, and the remainder related to selling and administrative equipment.
   d. Advertising expense incurred, $48,000.
   e. Costs for salaries and wages were incurred as follows:
      Direct labor $45,000
      Indirect labor ... $10,000
      Administrative salaries ... $30,000
   f. Insurance costs, $3,000 (80% related to factory operations, and 20% related to selling and administrative activities).
   g. Miscellaneous selling and administrative expenses incurred, $9,500.
   h. Manufacturing overhead was applied to production. The company applies overhead based on $8 per machine-hour; 7,500 machine-hours were recorded for the year.
   i. Goods that cost $140,000 to manufacture according to their job cost sheets were transferred to the finished goods warehouse.
   j. Sales for the year totaled $250,000. The total cost to manufacture these goods according to their job cost sheets was $130,000.

Required:

(i) Prepare appropriate journal entry for each transaction.

(ii) Determine the underapplied or overapplied overhead for the year.

(iii) Prepare an income statement for the year.

HUM 303

6. (a) The number of X-rays taken and X-ray costs over the last six months in Beverly
Hospital are given below: (10)

Month	X-Rays Taken	X-Ray Costs (Tk.)
January	6,250	28,000
February	7,000	29,000
March	5,000	23,000
April	4,250	20,000
May	4,500	22,000
June	3,000	17,000

Required:

(i) Using high and low point method, determine the variable and fixed cost elements
for conducting X-ray.

(ii) Express the variable and fixed costs in the form $Y = a + bX$.

(iii) Using the cost formula, you derived above, what X-Ray costs would you expect
to be incurred during a month in which 4,600 X-rays are taken.

(b) The Regal Cycle Company manufactures three types of bicycles – a dirt bike, a
mountain bike, and a racing bike. Data on sales and expenses for the past quarter follow: (25)

	Total	Dirt Bikes	Mountain Bikes	Racing Bikes
Sales	$300,000	$90,000	$150,000	$60,000
Variable manufacturing and Selling expenses	120,000	27,000	60,000	33,000
Contribution margin	180,000	63,000	90,000	27,000
Fixed expenses:				
Advertisement traceable	30,000	10,000	14,000	6,000
Depreciation of special equipment	23,000	6,000	9,000	8,000
Salaries of product-line mangers	23,000	12,000	13,000	10,000
Allocated common fixed expenses*	60,000	18,000	30,000	12,000
Total fixed expenses	136,000	46,000	66,000	36,000
Net Operating Income (loss)	$44,000	$17,000	$24,000	($9,000)

* Allocated based on sales dollars.

Management is concerned about the continued losses shown by the racing bikes and
wants a recommendation as to whether the line should be discontinued. The special
equipment used to produce racing bikes has no resale value and does not wear out.

Required:

Should production and sale of the racing bikes be discontinued? Explain. Show
computations to support your answer.

HUM 303

7. (a) What are the differences between financial and managerial accounting? (5)

(b) Simpson company has two support departments and two operating departments. For the year 2019 the following information were available: (30)

	Support departments		Operating departments		Total
Budgeted overhead cost before allocation	Financial (FIN)	Information Technology (IT)	Government Consulting	Corporation Consulting	
	60,000	24,000	80,000	1,20,000	2,84,000
Support work by FIN (Allocation base and percentage)	--	2000(25%)	3200(40%)	2800(35%)	8000 (100%)
Support work by IT (Allocation base and percentage)	200 (10%)	---	600(30%)	1200(60%)	2000(100%)

Required:

Allocate two support departments cost to the two operating departments by using

    (i) Direct method

    (ii) Step-down method

    (iii) Reciprocal method

Show all calculation and make the table of allocated cost.

8. (a) Swift Company was organized on March 1 of the current year. After five months of start-up losses, management had expected to earn a profit during August. Management was disappointed, however, when the income statement for August also showed a loss. August's income statement follows: (20)

<center>Swift Company</center>
<center>Income Statement</center>
<center>For the month ended August 31</center>

Particulars	Amount	Amount
Sales		$450,000
Less: Operating expenses		
Direct labor cost	70,000	
Raw material purchased	165,000	
Manufacturing overhead	85,000	
Selling and administrative expense	142,000	
Total operating expenses		462,000
Net operating loss		($12,000)

HUM 303

Contd ... Q. No. 8(a)

After seeing the $ 12,000 loss for August, Swift's president stated, "I was sure we'd be profitable within six months, but our six months are up and this loss for August is even worse than July's. I think it's time to start looking for someone to buy out the company's assets – if we don't, within a few months there won't be any assts to sell. By the way, I don't see any reason to look for a new controller. We'll just limp along with Sam for the time being"

The company's controller resigned a month ago. Sam, a new assistant in the controller's office, prepared the income statement above. Sam has had little experience in manufacturing operations.

Inventory balances at the beginning and end of August were:

	August 1	August 31
Raw material	$8,000	$13,000
Work in process	$16,000	$21,000
Finished goods	$40,000	$60,000

The president has asked you to check over the income statement and make a recommendation as to whether the company should look for a buyer for its assets.

Required:

(i) As one step in gathering data for a recommendation to the president, prepare a schedule of cost of goods manufactured for August.

(ii) As a second step, prepare a new income statement for August.

(iii) Based on your statement prepared in (1) and (2) above, would you recommend that the company look for a buyer?

(b) Outback Outfitters sells recreational equipment. One of the company's products, a small camp stove, sells for $50 per unit. Variable expenses are $32 per stove, and fixed expenses associated with the stove total $108,000 per month.   (15)

Required:

(i) Compute the break-even point in number of stoves and in total sales dollars.

(ii) If the variable expenses per stove increase as a percentage of the selling price, will it result in a higher or a lower break-even point? Why? (Assume that the fixed expenses remain unchanged).

(iii) At present, the company is selling 8,000 stoves per month. The sales manager is convinced that a 10% reduction in the selling price would result in a 25% increase in monthly sales of stoves. Prepare two contribution format income statements, one under present operating conditions, and one as operations would appear after the proposed changes. Show both total and per unit data on your statements.

(iv) Refer to the data in (iii) above. How many stoves would have to be sold at the new selling price to yield a minimum net operating income of $35,000 per month?