L-2/T-1/ME **Date : 03/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2017-2018

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 have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) If A and B symmetric matrices, prove that AB is symmetric if and only if A and B commute. **(15)**

(b) For the matrix $A=\begin{bmatrix}1 & 0 & 2\\ 1 & 1 & 0\\ 1 & 2 & 3\end{bmatrix}$ verify that $A(adjA)=|A|I_3$. Find the inverse of A as well. **(15)**

(c) Reduce the real quadratic form $q = x_1^2+2x_2^2-2x_3^2+4x_1x_2+6x_1x_3+4x_3x_2$ to the canonical form and hence find the rank, signature and index of the form. Write down the corresponding equations of transformation as well. **(16⅔)**

2. (a) Reduce $A=\begin{bmatrix}1 & 2 & -1 & 2\\ 3 & 1 & -2 & -1\\ 4 & -3 & 1 & 1\end{bmatrix}$ to the normal form B and obtain non-singular matrices P and Q such that PAQ = B **(20⅔)**

(b) State and verify Cayley-Hamilton theorem for $A=\begin{bmatrix}5 & 4 & -1\\ 4 & 5 & -1\\ -4 & -4 & 3\end{bmatrix}$. Hence find A^4. **(16)**

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

3. (a) If $\boldsymbol{P}$ = **A**coskt + **B**sinkt, where **A** and **B** are constant vectors and k, a constant scalar, then find $\frac{d^2\boldsymbol{P}}{dt^2}+k^2\mathbf{P}$. **(16⅔)**

(b) Find $\nabla\cdot(\mathbf{F}\times\mathbf{r})$ if $\nabla\times\mathbf{F}=0$ where **F** is an arbitrary vector and **r**, a position vector. **(15)**

(c) Show that the gradient of a scalar function f is a vector along the normal to the level surface whose magnitude is the greatest rate of change of f. **(15)**

Contd P/2

MATH 261(ME)

4. (a) State and verify Gauss's divergence theorem for $\mathbf{F} = 2xy\mathbf{i} + yz\mathbf{j} + zx^2\mathbf{k}$ taken over region bounded by the cylinder $y^2 + z^2 = 9$ and the planes x = 0, x = 3. **(26⅔)**

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

SECTION – B

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

5. (a) Solve in series by the method of Fröbeneous of the following differential equation:
$x^2y''(x)+xy'(x)+(x^2-4)y(x)=0.$ **(36⅔)**

(b) Prove that $J_2(x)=J_0''(x)-x^{-1}J_0'(x)$. **(10)**

6. (a) Prove that $J_{n-1}(x)=\frac{2}{x}[nJ_n(x)-(n+2)J_{n+2}(x)+(n+4)J_{n+4}(x)-...]$ and deduce that

$\frac{x}{2}J_n(x)=(n+1)J_{n+1}(x)-(n+3)J_{n+3}(x)+(n+5)J_{n+5}(x)-...$ **(16⅔)**

(b) Show that $\int_{-1}^{1}xP_n(x)P_{n-1}(x)dx=\frac{2n}{4n^2-1}$. **(16)**

(c) Show that $xP_n'(x)-P_{n-1}'(x)=nP_n(x)$ **(14)**

7. (a) Using Laplace Transform, evaluate $\int_0^\infty \frac{\cos 6t-\cos 4t}{t}dt$. **(15)**

(b) If $f(t)=t^2$, $0<t<2$ and $f(t+2)=f(t)$ then find $L\{f(t)\}$. **(16⅔)**

(c) State Convolution theorem and using this theorem, find

$$L^{-1}\left\{\frac{1}{(s+1)(s^2+1)}\right\}$$ **(15)**

8. (a) Evaluate the integral $\int_0^\infty \frac{\sin tx}{x(1+x^2)}dx$, by using Laplace Transform. **(15)**

(b) Find the inverse Laplace Transform of $\frac{s^2-3}{(s+2)(s-3)(s^2+2s+5)}$. **(15)**

(c) Use Laplace Transform to solve $y''(t)+2y'(t)+5y(t)=e^{-t}\sin t$, where y(0) = 0. y'(0)=1. **(16⅔)**

L-2/T-1/ME **Date : 12/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2017-2018

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

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

The symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) The zener shunt regulator shown in Fig. for Q. 1(a) employs a 9.1 V zener diode for which V_z = 9.1 V at I_z = 9 mA, with r_z = 30 Ω and I_{ZK} = 0.3 mA. The available supply voltage of 15 V can vary as much as ±15%. Here $V_Z = V_L = V_0$ = output voltage. **(26⅔)**

(i) Find the value of supply resistor R that will supply a nominal zener current of 10 mA for a nominal load resistance, R_L = 1 K Ω.

(ii) For a ±10 % change in supply voltage, what variation in output voltage results?

(iii) If the load current is reduced by 50%, what increase in output voltage results?

(iv) What is the smallest value of load resistance that can be tolerated while maintaining regulation when the supply voltage is low?

(v) What is the lowest possible output voltage of the circuit?

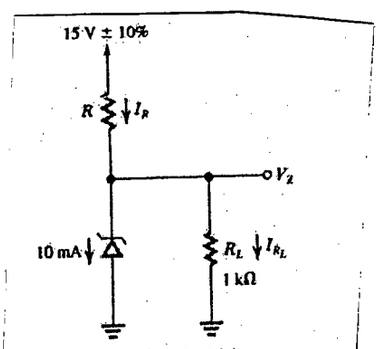

Fig. for Q. 1(a)

(b) Design a parallel-based clipper circuit that will yield the voltage transfer function shown in Fig. for Q. 1(b). Draw the output wave shape for v_i = 10sinout. (Show proper calculations for your design assuming ideal diode) **(20)**

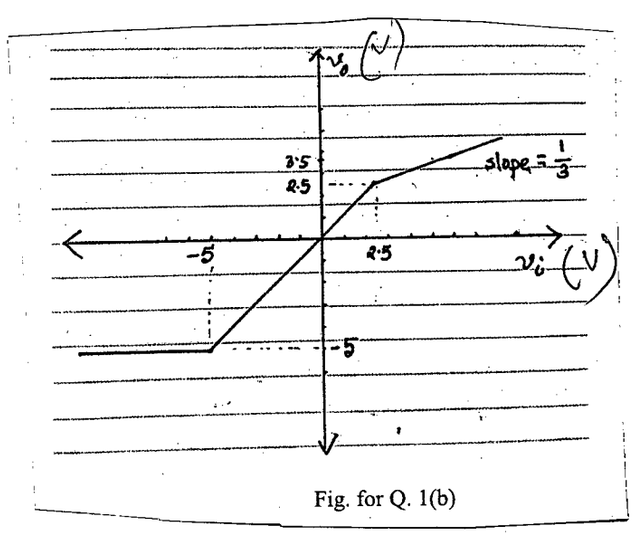

Fig. for Q. 1(b)

EEE 259(ME)

2. (a) The NMOS and PMOS transistors in the circuit shown in Fig. for Q. 2(a) are matched with $k_n'\left(\frac{W_n}{L_n}\right) = k_p'\left(\frac{W_p}{L_p}\right) = 1mA/V^2$ and $V_{tn} = -V_{tp} = 1V$. Assuming $\lambda = 0$ for both devices, find the drain current i_{DN} and i_{DP} and the voltage v_0 for $v_I = 0V, +2.5\ V, -2.5\ V$. **(26⅔)**

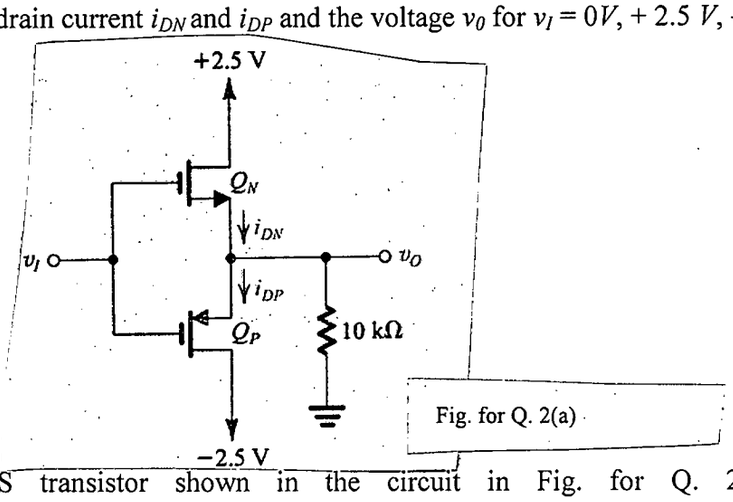

Fig. for Q. 2(a)

(b) The NMOS transistor shown in the circuit in Fig. for Q. 2(b) has $V_{tn} = 1V, k_n'\left(\frac{W}{L}\right) = 1mA/V^2$ and $\lambda = 0$. if $R_D = R_S = 6K\Omega$ and $1\mu A$ current flows through the voltage divider, then find the values of R_{G1} and R_{G2} for which the transistor operates at the edge of saturation. **(20)**

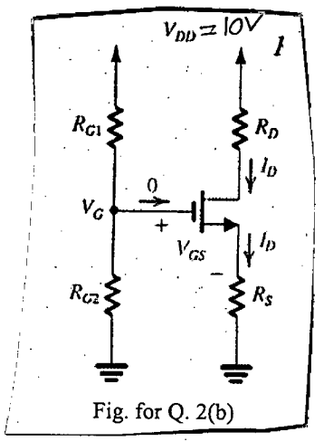

Fig. for Q. 2(b)

3. (a) For the Si transistor in the circuit shown in Fig. for Q. 3(a), β is specified to be 100. **(26⅔)**

(i) Determine the voltages at all nodes and current through all branches.

(ii) Find the highest voltage at which the base can be raised while the transistor remains in the active mode.

(iii) Find the value to which the base voltage should be changed so that the transistor operates in saturation with a forced β of 5.

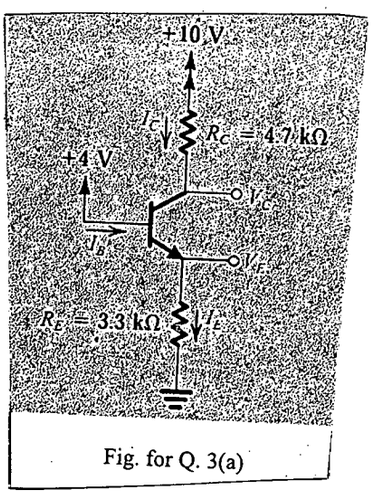

Fig. for Q. 3(a)

EEE 259(ME)

Contd ... Q. No. 3

(b) Analyze the circuit shown in Fig. for Q. 3(b) and determine the voltages at all nodes and currents through all branches. Assume $\beta = 100$ and *Si* transistor. **(20)**

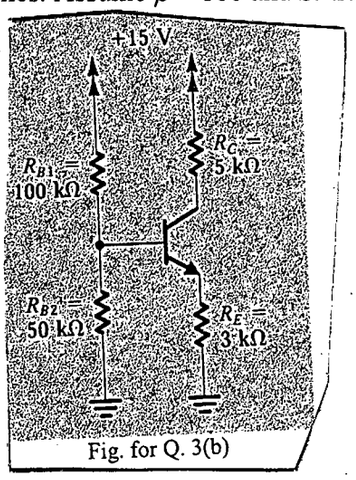

Fig. for Q. 3(b)

4. (a) Design a circuit using ideal operational amplifiers and other necessary elements to solve the following differential equation. (Assume $C = 1uF$ and show proper calculations for other parameters)

$$\frac{d^2v}{dt^2} + 20\frac{dv}{dt} + 100v = 25$$ **(26⅔)**

(b) For the circuit shown in Fig. for Q. 4(b), show that $v_0 = m(v_1 - v_2)$ where, $m = \frac{R_4}{R_3} = \frac{R_2}{R_1}$, v_1 and v_2 are inputs and v_0 is the output. **(20)**

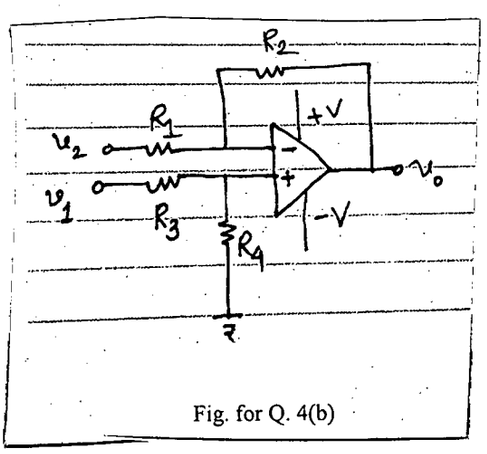

Fig. for Q. 4(b)

SECTION – B

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

5. (a) Consider, a Δ connected balanced three phase load with abc sequence is supplied by a Δ connected three phase source with abc sequence. Each phase has a load of 2+3j Ω. The current flowing in one line is $3\angle 30^0$ A. The line impedance is 0.1+0.5j Ω. Determine: **(30⅔)**

(i) phase voltages at the source side. (ii) total power consumed by the load.

(b) Make a free hand plot for the following expressions **(16)**

(i) V = A sin (ωt+ 30°) (ii) I = B cos (ωt–70°)

where, A = 2B. What is the p. f.? Is the p. f. leading or lagging? Why?

EEE 259(ME)

6. (a) Show that, without any commutator, a dc motor can still operate. **(12)**

   (b) With proper diagrams show the function of commutators in a dc generator. **(23⅔)**

   (c) Explain with proper diagrams, how does the increase of field resistance for speed control in small shunt dc motor affect its operation? **(11)**

7. (a) A 460 V, 25 hp, 60 Hz, four pole, Y connected induction motor has the following impedances in ohms per phase referred to the stator circuit:
   R_1 = 0.641 Ω, R_2 = 0.332 Ω, X_1 = 1.106 Ω. X_2 = 0.464 Ω. X_m = 26.3 Ω. The total rotational losses are 1100 W and are assumed to be constant. The core loss is lumped in with the rotational losses. For a rotor slip of 2.2% at the rated voltage and frequency, find the motor's: **(30⅔)**

   (i) speed (ii) stator current (iii) p. f. (iv) P_{conv} (v) induced torque (vi) efficiency.

   (b) Differentiate between the operations of a synchronous motor and an induction motor with diagrams. **(16)**

8. (a) The equivalent circuit impedances of a 20 kVA, 8000 V/240V, 60 Hz transformer are to be determined. The following data were taken: **(30⅔)**

Open circuit test	Short circuit test
V_{oc} = 240 V	V_{sc} = 489 V
I_{oc} = 7.133 A	I_{sc} = 2.5A
P_{oc} = 400 W	P_{sc} = 240 W

   Find the impedances of the approximate equivalent circuit referred to the primary side and draw the circuit.

   (b) Draw the phasor diagrams of a transformer operating at unity p. f. and leading p. f. Also comment on the voltage regulation (VR) for each case. **(16)**

L-2/T-1/ME **Date : 18/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2017-2018

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning. Assume reasonable data, where missing.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) A welded connection is in equilibrium under the action of the four forces as shown in Fig. 1(a). Knowing that F_A= 8 kN and F_B = 16 kN, determine the magnitudes of the other two forces. **(17)**

   (b) A crate is supported by three cables as shown in Fig. 1(b). Determine the weight of the crate knowing that the tension in cable *AB* is 3500 N. **(18)**

2. (a) The frame *ACD* is hinged at *A* and *D* and is supported by a cable that passes through a ring at *B* and is attached to hooks at *G* and *H* as shown in Fig. 2(a). Knowing that the tension in the cable is 450 N, determine the moment of the force exerted on the frame by portion *BH* of the cable about all coordinate axes. **(17)**

   (b) Four forces act on a 700×375-mm plate as shown in Fig. 2(b) . (i) Find the resultant of these forces. (ii) Locate the two points where the line of action of the resultant intersects the edge of the plate. **(18)**

3. (a) Determine the force in members *AC*, *AE*, and *DE* of the truss shown in Fig. 3(a). State whether each member is in tension or compression. Note that at *F* and *G*, there is a pin and roller joint, respectively. **(17)**

   (b) The pin at B is attached to member *ABC* and can slide freely along the slot cut in the fixed plate as shown in Fig. 3(b). Neglecting the effect of friction, determine the couple *M* required to hold the system in equilibrium when $\theta = 30°$. **(18)**

4. (a) If *a* = 4m, determine the magnitudes of P and Q required to maintain the cable in the shape shown in Fig. 4(a). **(17)**

   (b) Derive an expression for the magnitude of the couple *M* required to maintain the equilibrium of the linkage shown in Fig. 4(b). Solve the problem by principle of virtual work. **(18)**

Contd P/2

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SECTION – B

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

5. (a) Determine the total surface area and volume of the solid shown in Fig. for Q. 5(a). **(18)**

   (b) Determine, in terms of 'a', the c.g. of the solid of revolution shown in Fig. for Q. 5(b). The solid consists of a cone, a cylinder and a hemisphere. **(17)**

6. (a) Determine in terms of 'a' the moment of inertia and radius of gyration about x-axis for the area shown in Fig. for Q. 6(a). **(18)**

   (b) For the solid of revolution determine (in terms of 'a' and 'ρ') moment of inertia and radius of gyration about y-axis. The solid consists of a cylinder and a hemisphere as shown in Fig. for Q. 6(b). **(17)**

7. (a) Two wedges of negligible masses are used to move the block A. Mass of block A is 300 kg. Wedge angle is 10° and coefficient of static friction is 0.15 for all surfaces of contact. Determine the force P required to move block A. **(18)**

   (b) Bucket A and block C are connected by a cable that passes over a fixed drum B. The bucket and its content have a combined mass m. Determine the mass m to start the motion of bucket in downward direction. Given, $\mu_s = 0.35$, $\mu_k = 0.25$. **(17)**

8. (a) A 4-kN cylindrical tank, 2 m in diameter, is to be raised over a 0.5 m obstruction. A cable is wrapped around the tank and pulled horizontally as shown in Fig. for Q. 8(a). Knowing that the corner of the obstruction at point A is rough, find the required tension in the cable and reactions at A. **(15)**

   (b) A 200 mm lever and a 240 mm diameter pulley are welded to the axle BE that is supported by short bearings at C and D, as shown in Fig. for Q. 8(b). If a 720 N vertical force is applied at A when AB is horizontal, determine (i) the tension T in the cord, (ii) the reactions at C and D. Assume axial thrust is zero for short bearings. **(20)**

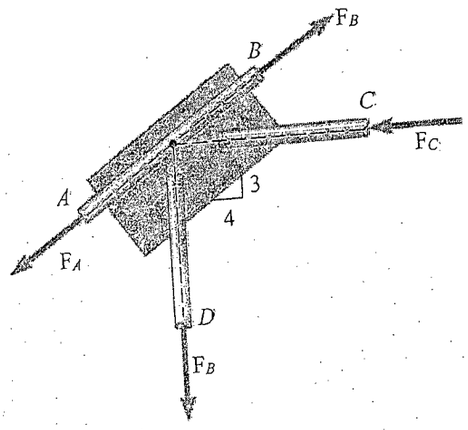


Fig. 1(a)

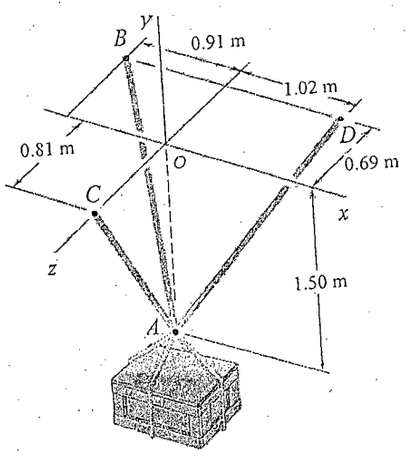


Fig. 1(b)

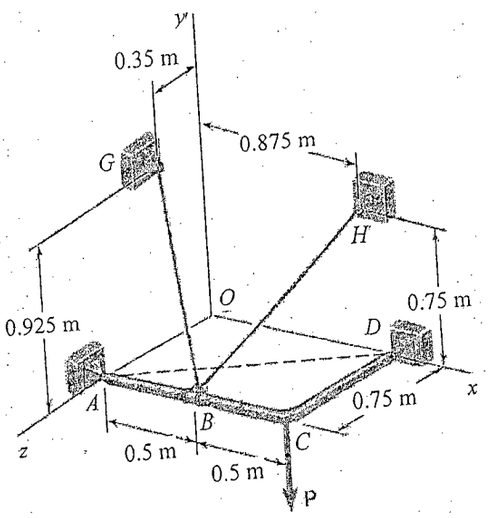


Fig. 2(a)

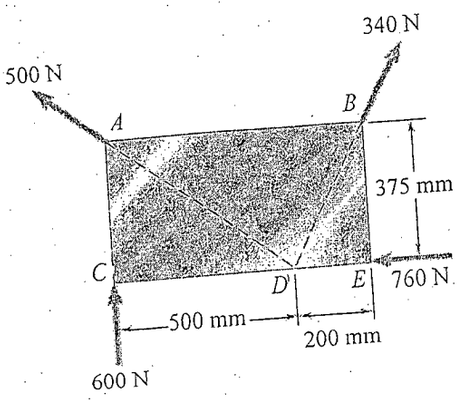


Fig. 2(b)

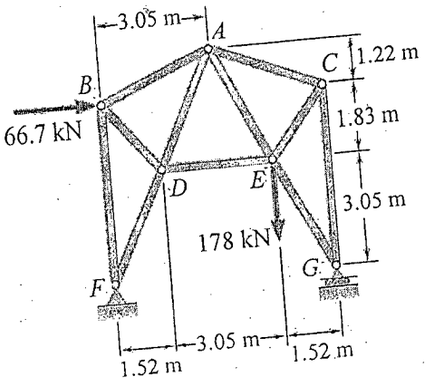


Fig. 3(a)

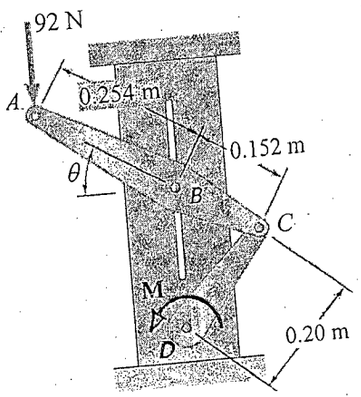


Fig. 3(b)

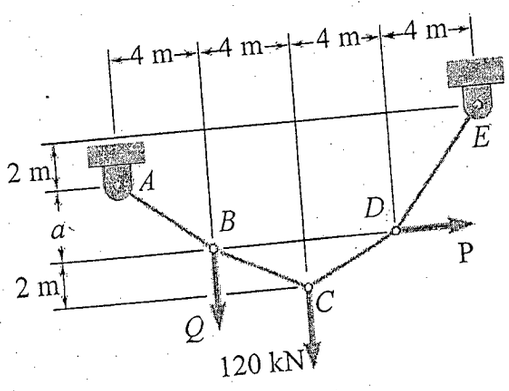


Fig. 4(a)

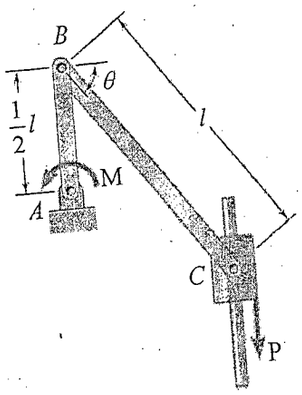


Fig. 4(b)

ME 247 (Section B)

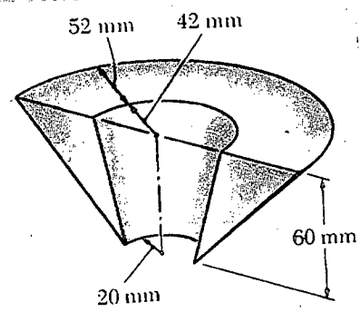


Fig. for Q. 5(a)

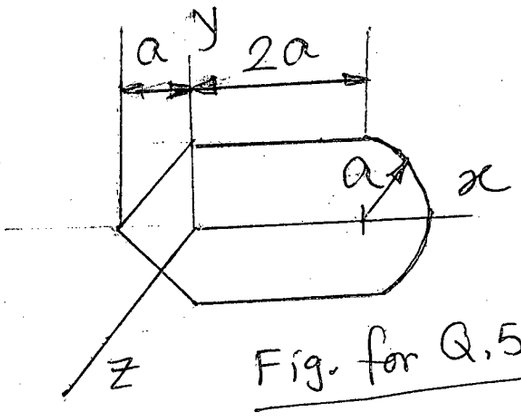


Fig. for Q.5(b)

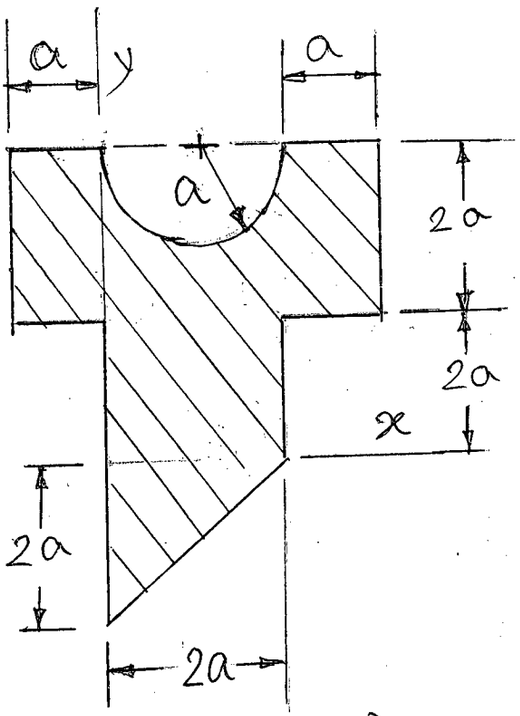


Fig. for Q. 6(a)

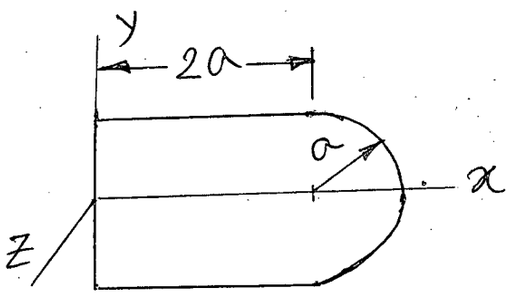


Fig. for Q. 6(b)

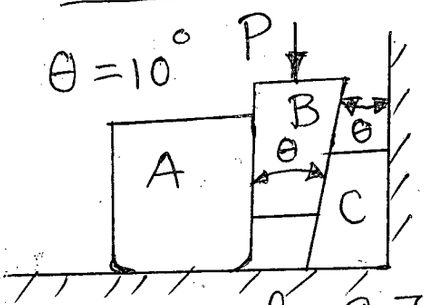


Fig. for Q. 7(a)

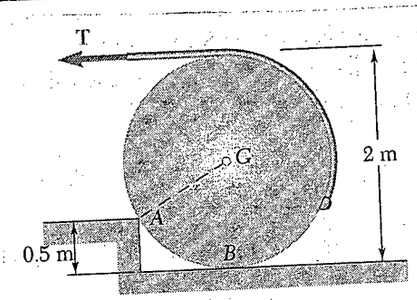


Fig. for Q. 8(a)

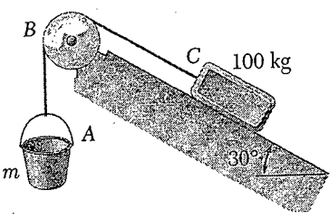


Fig. for Q. 7(b)

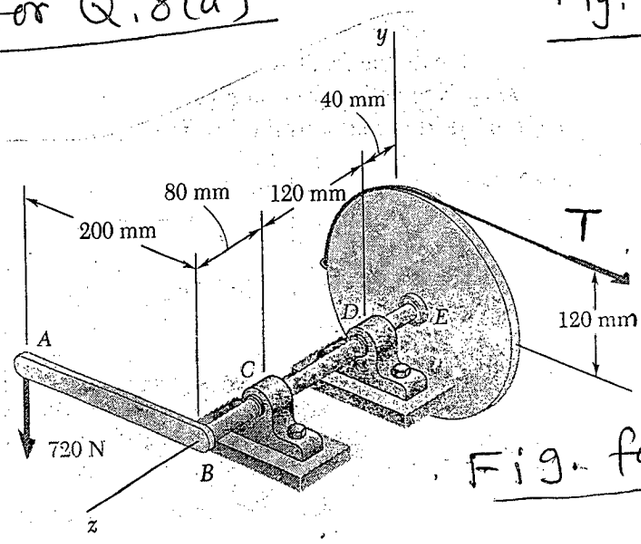


Fig. for Q. 8(

L-2/T-1/ME **Date : 24/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2017-2018

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**.

1. (a) What is the second Law of thermodynamics all about? **(5)**

   (b) What are the factors that cause a process irreversible? **(5)**

   (c) What do you mean by entropy generation? **(5)**

   (d) Steam expands in a turbine steadily at a rate of 11.1 kg/s, entering at 8 MPa & 500°C and leaving at 40 KPa as saturated vapor. If the power generated by the turbine is 8.2 MW, determine the rate of entropy generation for this process. Assume the surrounding medium is at 25°C. **(20)**

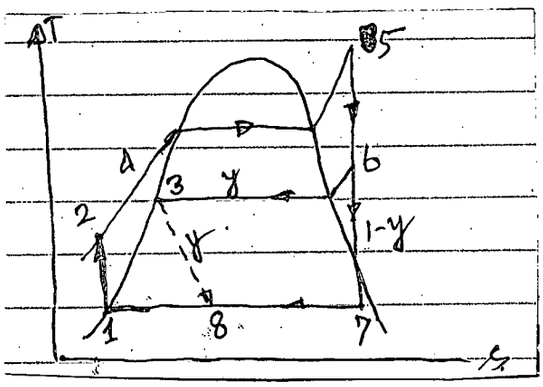
2. (a) Define exergy and briefly explain how exergy and irreversibility are related. **(5)**

   (b) Refrigerant-134a is to be compressed from 0.14 MPa, - 10°C to 0.8 MPa, 50°C steadily by a compressor. Taking the environment conditions to be 20°C and 95 KPa, determine the minimum work input that needs to be supplied to the compressor per unit mass of the refrigerant. Use energy analysis. **(10)**

   (c) Steam enters a turbine steadily at 3 MPa & 450°C at a rate of 8 kg/s and exits at 0.2 MPa & 150°C. The steam is losing heat to the surrounding air at 100 KPa & 25°C at a rate of 300 kW, and the kinetic and potential energy changes are negligible. Conduct the second law analysis of the steam turbine. [Hint: calculate actual power output, the maximum possible power output, the second law efficiency, the energy destroyed, the entropy generation] **(20)**

3. (a) Draw both block-and T-s diagrams of an ideal vapor power system. Also write the expressions of performance parameters in terms of enthalpies. **(10)**

   (b) T-s diagram of a vapor power system is given as follows: **(10)**



Contd P/2

ME 203

Contd ... Q. No. 3(b)

(i) Draw the block diagram of the power system.

(ii) Write energy balance equations of all the components.

(c) Steam is generated in the boiler of a cogeneration plant at 10 MPa and 450°C at a steady rate of 5 kg/s. In normal operation, steam expands in a turbine to a pressure of 0.5 MPa and 60% of the steam is routed to the process heater, where it supplies the process heat, and the reminder is expanded to the condenser pressure of 20 kPa. Assuming steam leaves the process heater as a saturated liquid and is pumped to the boiler pressure,

(i) draw both block and T-s diagrams

(ii) determine the power produced and the rate of process heat supplied.

4. (c) A room contains air at 25°C and 98 kPa at a relative humidity of 75%. Calculate **(10)**

(i) partial pressure of dry air

(ii) Specific humidity

(iii) enthalpy per unit mass of dry air

(b) Cooling water leaves the condenser of a power plant and enters a wet cooling tower at 35°C at a rate of 100 kg/s as shown in the figure for Q. No. 4(b). Water is cooled to 22°C in the cooling tower by air that enters the tower at 1 atm, 20°C, and 60% relative humidity and leaves saturated at 30°C. Show the process in the psychrometric chart and neglecting the power to the fan, determine - **(25)**

(i) the volume flow rate of air into the cooling tower, and

(ii) mass flow rate of the makeup water.

Also explain the cooling process.

SECTION – B

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

Assume standard data if necessary. Abbreviations/Symbols have their standard meaning.

HFC-134a chart (P.G) attached

5. (a) Define "Air-Standard" cycle. State the assumptions associated with it. **(9)**

(b) Deduce on expression of thermal efficiency of an air-standard Otto cycle. **(12)**

(c) What limits the use of high compression ratio in Otto cycle engines? Is this a limitation of the thermodynamic cycle? Briefly explain. **(14)**

6. (a) Define "Pressure Ratio" for a gas turbine. Deduce and expression of pressure ratio for which the net work of a Brayton cycle gas turbine is maximized. What limits the maximum temperature for such a case? **(15)**

Contd P/3

ME 203

Contd ... Q. No. 6

(b) What do you understand by "Bypass Ratio" for a jet engine? What is the "Bypass Ratio" typically used by jet engines most commonly used in modern passenger air crafts? **(10)**

(c) State the advantages and limitations associated with a "Stirling" Cycle engine. **(10)**

7. (a) Define "Cut-off Ratio" for Diesel engine cycle. Why is the heat addition part of Diesel cycle characterized as a constant pressure process? Briefly explain. **(14)**

(b) Define MEP for reciprocating engine. A 1.8 liter Diesel engine has a compression. ratio of 18 and a cut off ratio of 2.2. The working fluid is at 1 bar and 32°C at the beginning of the compression process. Considering ideal air-standard Diesel cycle calculate - **(21)**

(i) Maximum cycle pressure and temperature

(ii) Net work output and thermal efficiency

(iii) MEP of cycle.

8. (a) Distinguish between isentropic and adiabatic processes. How can a process be adiabatic in practice? Explain with examples. **(6)**

(b) Define Flow and Non-flow processes with example. Deduce an expression of Non-flow energy equation for a polytropic process. **(7)**

(c) What is the reason of keeping the pressure of the low pressure side above atmospheric in a vapor compression refrigeration cycle? Briefly explain. **(6)**

(d) Refrigerant R-134a enters the compressor of a refrigerator at 1.5 bar pressure and -10°C and leaves at 10 bar and 60°C. In the condenser the refrigerant is cooled to 25°C. For a required 5 TR cooling capacity calculate - **(16)**

(i) Refrigerant circulation rate in kg/s

(ii) Power requirement of compressor

(iii) COP and EER

[attach the P-h diagram with your answer script]

Table-1:

Saturated water—Pressure table

Press., P kPa	Sat. temp., T_{sat} °C	Specific volume, m³/kg: Sat. liquid, v_f	Specific volume, m³/kg: Sat. vapor, v_g	Internal energy, kJ/kg: Sat. liquid, u_f	Internal energy, kJ/kg: Evap., u_{fg}	Internal energy, kJ/kg: Sat. vapor, u_g	Enthalpy, kJ/kg: Sat. liquid, h_f	Enthalpy, kJ/kg: Evap., h_{fg}	Enthalpy, kJ/kg: Sat. vapor, h_g	Entropy, kJ/kg·K: Sat. liquid, s_f	Entropy, kJ/kg·K: Evap., s_{fg}	Entropy, kJ/kg·K: Sat. vapor, s_g
20	60.06	0.001017	7.6481	251.40	2204.6	2456.0	251.42	2357.5	2608.9	0.8320	7.0752	7.9073
25	64.96	0.001020	6.2034	271.93	2190.4	2462.4	271.96	2345.5	2617.5	0.8932	6.9370	7.8302
30	69.09	0.001022	5.2287	289.24	2178.5	2467.7	289.27	2335.3	2624.6	0.9441	6.8234	7.7675
40	75.86	0.001026	3.9933	317.58	2158.8	2476.3	317.62	2318.4	2636.1	1.0261	6.6430	7.6691
50	81.32	0.001030	3.2403	340.49	2142.7	2483.2	340.54	2304.7	2645.2	1.0912	6.5019	7.5931
450	147.90	0.001088	0.41392	622.65	1934.5	2557.1	623.14	2120.3	2743.4	1.8205	5.0356	6.8561
500	151.83	0.001093	0.37483	639.54	1921.2	2560.7	640.09	2108.0	2748.1	1.8604	4.9603	6.8207
550	155.46	0.001097	0.34261	655.16	1908.8	2563.9	655.77	2096.6	2752.4	1.8970	4.8916	6.7886

$h_f@22°C = 92.28$ kJ/kg and $h_f@35°C = 146.64$ kJ/kg

Table-2

Superheated water

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K
	P = 0.20 MPa (120.21°C)			
Sat.	0.88578	2529.1	2706.3	7.1270
150	0.95986	2577.1	2769.1	7.2810
200	1.08049	2654.6	2870.7	7.5081
250	1.19890	2731.4	2971.2	7.7100
300	1.31623	2808.8	3072.1	7.8941
	P = 0.50 MPa (151.83°C)			
Sat.	0.37483	2560.7	2748.1	6.8207
200	0.42503	2643.3	2855.8	7.0610
250	0.47443	2723.8	2961.0	7.2725
300	0.52261	2803.3	3064.6	7.4614
	P = 3.00 MPa (233.85°C)			
400	0.09938	2933.6	3231.7	6.9235
450	0.10789	3021.2	3344.9	7.0856
500	0.11620	3108.6	3457.2	7.2359
	P = 8.0 MPa (295.01°C)			
400	0.034344	2864.6	3139.4	6.3658
450	0.038194	2967.8	3273.3	6.5579
500	0.041767	3065.4	3399.5	6.7266
	P = 10.0 MPa (311.00°C)			
400	0.026436	2833.1	3097.5	6.2141
450	0.029782	2944.5	3242.4	6.4219
500	0.032811	3047.0	3375.1	6.5995

Table-3

Superheated refrigerant-134a

T °C	v m³/kg	u kJ/kg	h kJ/kg	s kJ/kg·K
	P = 0.14 MPa (T_{sat} = −18.77°C)			
Sat.	0.14014	219.54	239.16	0.9446
−20				
−10	0.14605	225.91	246.36	0.9724
0	0.15263	233.23	254.60	1.0031
	P = 0.80 MPa (T_{sat} = 31.31°C)			
Sat.	0.025621	246.79	267.29	0.9183
40	0.027035	254.82	276.45	0.9480
50	0.028547	263.86	286.69	0.9802
60	0.029973	272.83	296.81	1.0110

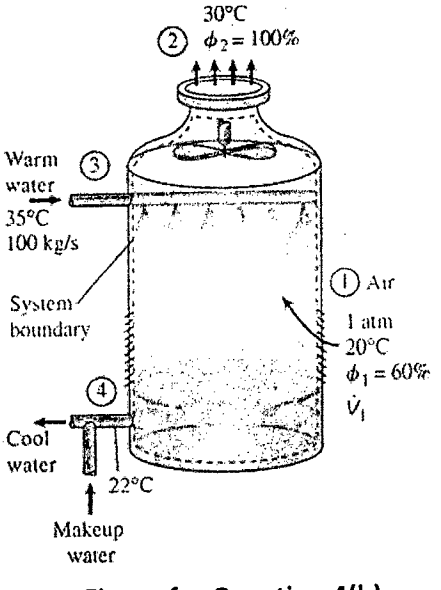
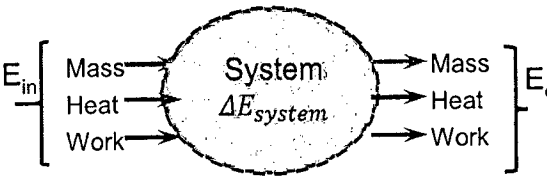


Figure for Question 4(b)

Formula for ME203

Energy



$$E_{in} - E_{out} = \Delta E_{system}$$
$$\dot{E}_{in} - \dot{E}_{out} = dE_{system}/dt$$

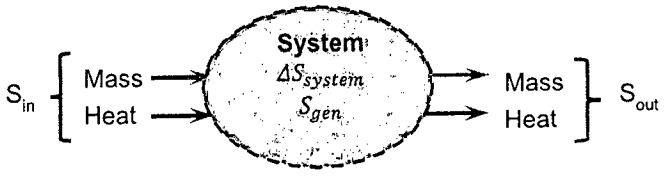
For closed system: $Q - W = \Delta U + \Delta KE + \Delta PE$

For control volume at steady flow condition:

$$\dot{Q} - \dot{W} = \dot{m}(h_2 - h_1) + \dot{m}\left(\frac{V_2^2 - V_1^2}{2}\right) + \dot{m}g\,(z_2 - z_1)$$

NB: Heat supplied to the system and work done by the system are considered positive

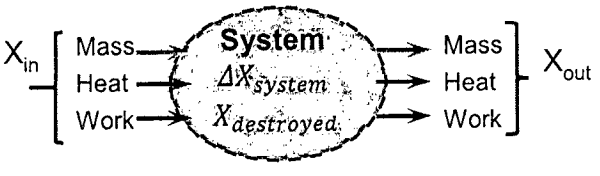
Entropy



$$S_{in} - S_{out} + S_{gen} = \Delta S_{system}$$
$$\dot{S}_{in} - \dot{S}_{out} + \dot{S}_{gen} = dS_{system}/dt$$

$$S_{heat} = \int \frac{\delta Q}{T}$$
$$S_{heat} = \frac{Q}{T}$$
$$S_{mass} = ms$$
$$\dot{S}_{mass} = \dot{m}s$$

Exergy



$$X_{in} - X_{out} - X_{destroyed} = \Delta X_{system}$$
$$\dot{X}_{in} - \dot{X}_{out} - \dot{X}_{destroyed} = dX_{system}/dt$$

$$\phi = (u - u_0) + P_0(v - v_0) - T_0(s - s_0) + \frac{V^2}{2} + gz$$
$$\psi = (h - h_0) - T_0(s - s_0) + \frac{V^2}{2} + gz$$

$$X_{heat} = \int \left(1 - \frac{T_0}{T}\right)\delta Q$$
$$X_{heat} = \left(1 - \frac{T_0}{T}\right)Q$$
$$X_{work} = W - W_{surr}$$

W_{surr}=0 for no boundary work

$$X_{mass,system} = m\phi$$
$$X_{mass,CV} = m\psi$$
$$\dot{X}_{dest} = T_0\dot{S}_{gen}$$

Efficiency

$$\eta_{th} = \frac{W_{net}}{Q_{in}} = \frac{w_{net}}{q_{in}} = 1 - \frac{q_{out}}{q_{in}};$$
$$\eta_{th,Carnot} = 1 - \frac{T_L}{T_H}$$
$$\eta_{II} = \frac{\eta_{th}}{\eta_{th,rev}} = \frac{w_u}{w_{rev}} = 1 - \frac{X_{dest}}{X_{Expended}}$$

Thermodynamic relations

$$Tds = du + Pdv$$
$$Tds = dh - vdp$$
$$c_v = \frac{\partial u}{\partial T};\qquad c_p = \frac{\partial h}{\partial T};\qquad ds = \frac{\delta q}{T}$$

Psychrometric relations

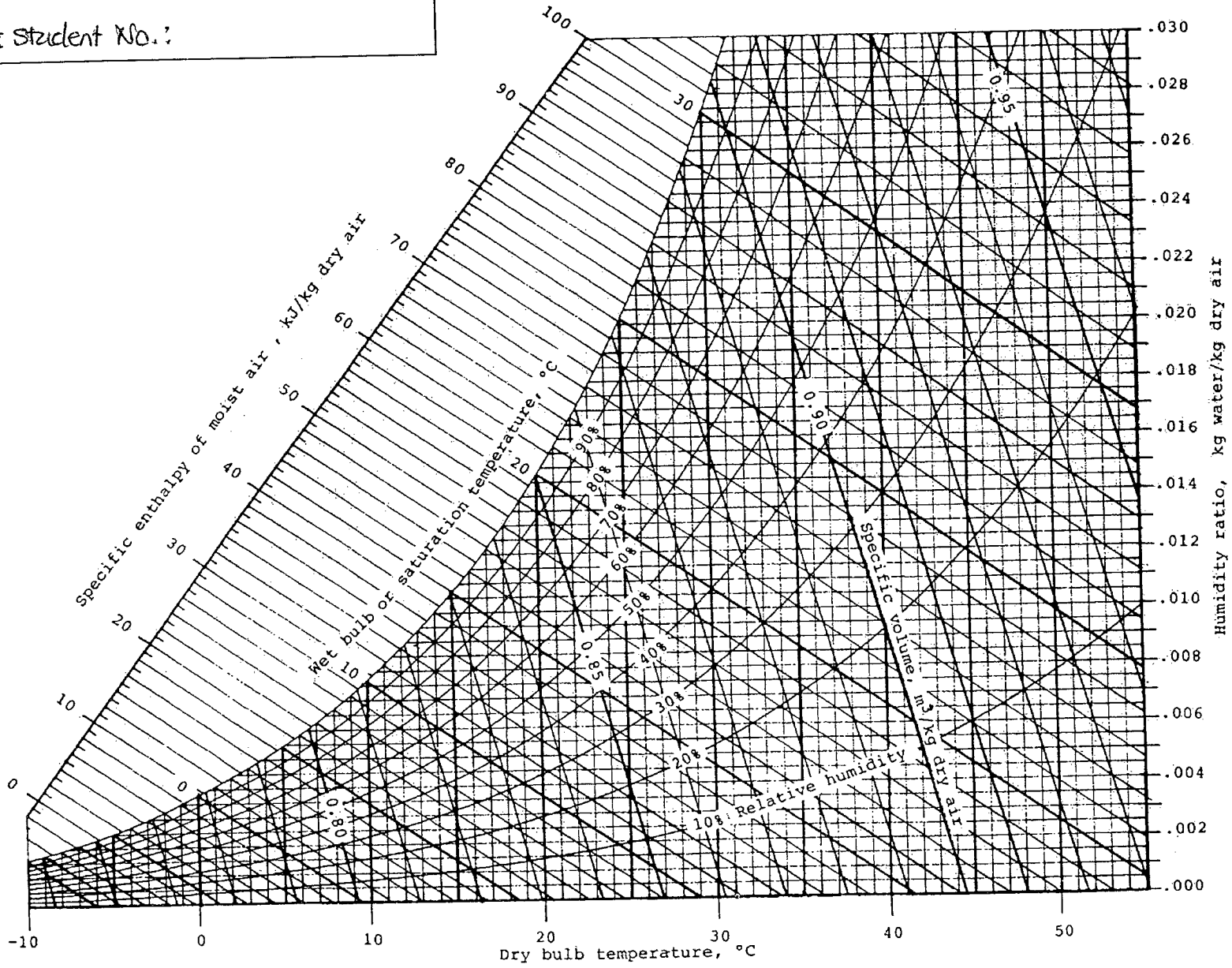
$$\omega = \frac{0.622\,\emptyset\,P_g}{P - \emptyset\,P_g};\qquad \emptyset = \frac{\omega\,P}{(0.622 + \omega)\,P_g}$$
$$h = h_a + \omega\,h_v \cong c_pT + \omega\,h_g$$

Symbols have their usual meanings

Name:

ID: Student No.:

Source: Zhang and Pate, ASHRAE Transactions, Vol. 94, Pt.1 1988
For total air pressure is 1 atm



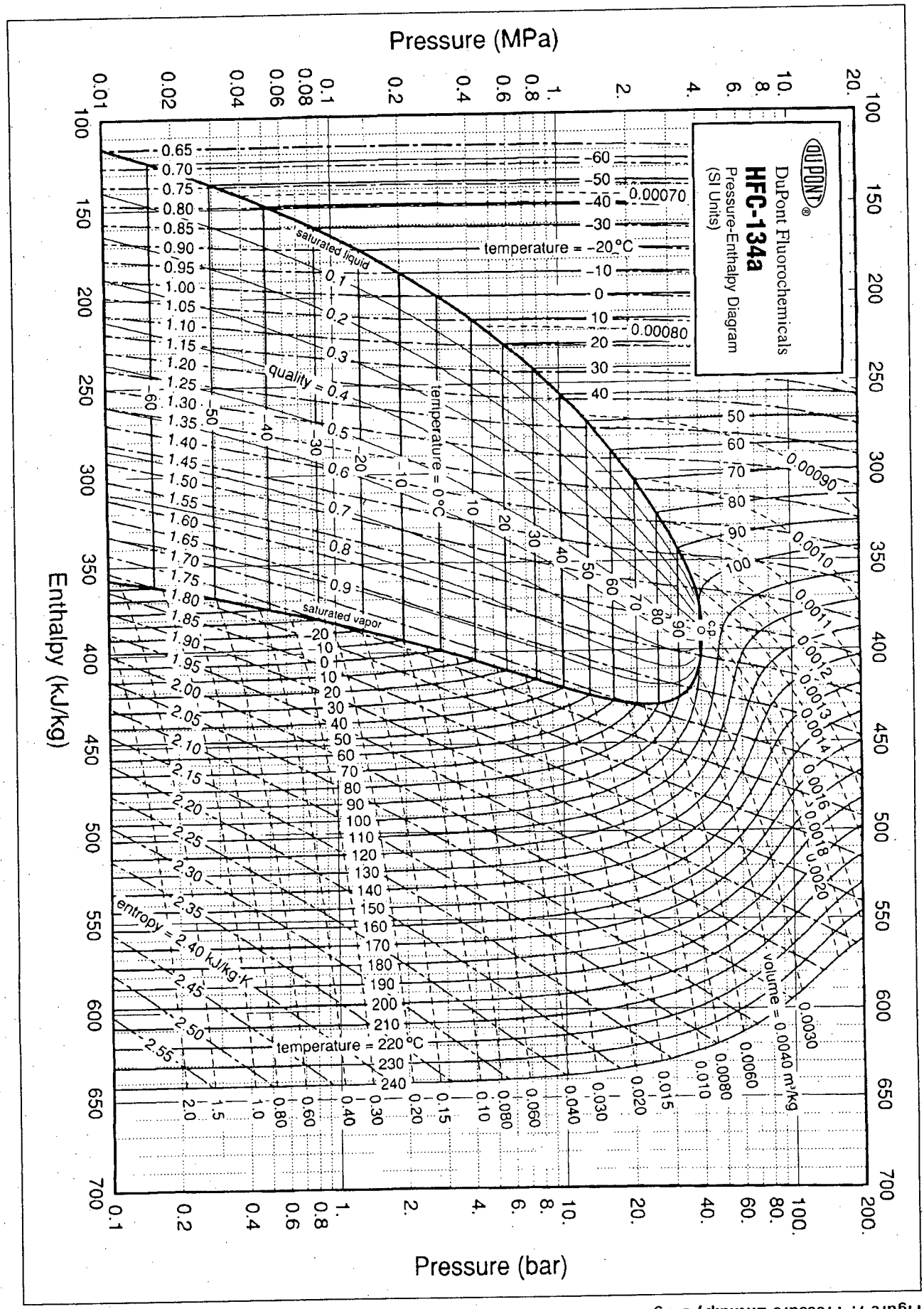


Figure 7. Pressure-Enthalpy Diagram for HFC-134a (SI Units)

L-2/T-1/ME **Date : 30/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-1 B. Sc. Engineering Examinations 2017-2018

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) What are the advantages of a journal book? **(5)**

   (b) Henry Jackson opened a computer service organization. The transaction of January, 2016 are as follows: **(30)**

   January - 2: Invested Tk. 150,000 in the business.

   January - 3: Purchase equipment for Tk. 40,000

   January - 9: Purchase supplies on account for Tk. 5000

   January -11: Provide service on account Tk. 15000

   January - 16: Paid Tk. 5000 for advertising expense.

   January - 21: Received Tk.7000 from dues on January 11.

   January - 25: Paid salary Tk. 20000

   January - 26: Paid dues on suppliers purchase

   January - 27: Received Tk. 5000 for future service.

   January - 30: Paid advance rent Tk. 40000.

   Required: (i) Prepare journal entries for January 31, 2016

   (ii) Prepare ledger for Asset accounts.

2. (a) What are the limitations of trial balance? **(5)**

   (b) Following is the trial balance of Bexton Company: **(30)**

Bexton Company Trial Balance December, 31, 2017		
Particulars	Debit (Tk.)	Credit (Tk.)
Cash	8000	-
Accounts Receivable	4000	-
Prepaid Insurance	2400	-
Supplies	1500	-
Office Equipment	12000	-
Accounts Payable	-	3800
Unearned Service, Revenue	-	3000
Salary expense	3000	-
Rent expense	1900	-
Capital	-	20000
Service Revenue	-	6000
Total	32800	32800

Contd P/2

HUM 303

Contd ... Q. No. 2(b)

Other Information:

- Unused Supplies on hand Tk. 500
- Accrued Travel expense Tk. 350
- Insurance Policy was for 2 years.
- Rent expense incurred but not paid Tk. 900
- Invoice represented that service earned but not recorded Tk. 1000.
- Depreciation of office equipment Tk. 250 per month.

Required : (i) Prepare adjusting journal entries.
(ii) Prepare adjusted trial balance.

3. Following is the trial balance of Joha Company. **(35)**

Joha Company Trial Balance December, 31, 2017		
Account Title	Debit (Tk.)	Credit (Tk.)
Account Receivable	12,000	-
Account Payable	-	6000
Cash	30,500	-
Trademark	20,000	-
Capital	-	50,900
Suppliers	900	-
Salary expense	7,000	-
Administrative expense	3000	-
Maintenance expense	4000	-
Rent expense	13,000	-
Note Payable	-	5,000
Bond Payable (long-term)	-	20,000
Tax Payable	-	20,000
Store equipment	25,000	-
Machinery	2,500	-
Unearned Commission	-	3,000
Sales	-	98,000
Cost of goods sold	30,000	-
Prepaid Insurance	4,000	-
Goodwill	51,000	-
Total	202900	202900

Other Information:

- Two thirds of the supplies were used during the period.
- Charge @ 10% depreciation on store equipment
- 60% rent related to office and remaining to sales.

Required : (i) Prapare a multiple- step Income statement and an owner's equity statement.
(ii) Prepare a classified balance sheet as on 31st December, 2017.

Contd P/3

HUM 303

4. The Comparative statements of Villa Tool Company are presented below: **(35)**

Villa Tool Company Balance Sheets December, 31, 2017		
Particulars	2017	2016
Assets		
Cash	$60100	$64200
Short -term investment	69000	50000
Accounts Receivable	117800	102800
Inventory	123000	115500
Plant Assets (net)	600300	520300
Total Assets	9,70,200	8,52,800
Liabilities and Stockholders' Equity		
Account Payable	$160000	$145400
Income Taxes Payable	43,500	42,000
Bonds Payable (10 years)	2,00,000	2,00,000
Total Liabilities	403500	387400
Stock holders' Equity		
Common Stock ($ 5 par)	2,80,000	3,00,000
Retained earnings (ending equity)	2,86,700	1,65,400
Total Stockholders' Equity	566700	465400
Total Liabilities and stockholders' equity	$9,70,200	$8,52,800

Villa Tool Company Income Statement For the year ended December 31, 2017		
Particulars	2017	2016
Net Sales	$1818500	$1750500
Cost of goods sold	1011500	996000
Gross Profit	8,07,000	754500
Selling and administrative expense	516000	479000
Income from operations	291000	275500
Other expenses and losses		
Interest expense	18000	14000
Income before Income tax	273000	261500
Income tax expense	81000	77000
Net Income	$192000	$184500

All sales were on account. The allowance for doubtful accounts was $3200 on December 31, 2017 and $3000 on December 31, 2016.

Contd P/4

HUM 303

Contd ... Q. No. 4

Required: (a) Prepare horizontal and vertical analysis for year 2017 (in amount and percentage),

(b) Prepare the following ratios for 2017 (weighted average common shares in 2017 were 57000).

(i) Earnings per share
(ii) Return on common stock holders' equity
(iii) Return on asset
(iv) Current ratio
(v) Quick ratio
(vi) Receivable turnover
(vii) Inventory turnover
(viii) Times interest earned
(ix) Asset turnover
(x) Debt to asset ratio.

SECTION – B

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

5. (a) Explain the concept of cost with examples. Distinguish between cost, expense, and loss. Discuss the classification of costs into different categories with examples. **(10)**

(b) Following are the particulars taken from the books of Keraniganj Manufacturing Company for the year ended 31 December 2017. **(25)**

Inventories	1 January		31 December
Raw Materials	Tk. 80,000		Tk. 70,000
Work-In-Process	40,000		50,000
Finished Goods	60,000		80,000
Raw Materials Purchased (net)		Tk. 150,000	
Purchase Returns		10,000	
Sales Revenue		500,000	
Sales Returns		20,000	
Labor (80% direct)		150,000	
Depreciation (70% factory)		50,000	
Sales Commission		40,000	
Factory Rent		30,000	
Factory Insurance		20,000	
Marketing Expenses		20,000	
Factory Utilities		10,000	
Supervisor's Salary		30,000	
Office Supplies		10,000	

Required:

Prepare a Cost of Goods Sold Statement and an Income Statement for the year ended 31 December 2017.

Contd P/5

HUM 303

6. (a) Explain the concept of break-even point with a graph (using graph paper is not necessary). **(5)**

(b) Kalatia Company manufactures basketballs. The company has a ball that sells for Tk. 250. At present, the ball is manufactured in a small plant that relies heavily on direct labor workers. thus, variable expenses are high, totaling Tk. 150 per ball, of which 60% is direct labor cost. **(30)**

Last year, the company sold 30,000 of these balls, with the following results:

Sales (30,000 balls)	Tk. 7,500,000
Variable expenses	4,500,000
Contribution margin	3,000,000
Fixed expenses	2,100,000
Net operating income	Tk. 900,000

Required:

1. Compute (i) the CM ratio and the break-even point in balls, and (ii) the degree of operating leverage at last year's sales level
2. Due to an increase in labor rates, the company estimates that variable expenses will increase by Tk. 30 per ball next year. If this change takes place and the selling price per ball remains constant at Tk. 250, what will be the new CM ratio and the break-even point in balls?
3. Refer to the data in (2) above. If the expected change in variable expense takes place, how many balls will have to be sold next year to earn the same net operating income, Tk. 900,000, as last year?
4. Refer again to the data in (2) above. The president feels that the company must raise the selling price of its basketballs. If Kalatia Company wants to maintain the same ratio as last year, what selling price per ball must it charge next year to cover the increased labor cost?
5. Refer to the original data. The company is discussing the construction of a new, automated manufacturing plant. The new plant would slash variable expenses per ball by 40%, but it would cause fixed expenses to double. If the new plant is built, what would be the new CM ratio and the break-even point in balls?
6. Refer to the data in (5) above. If the new plant is built, how many balls will have to be sold next year to earn the same net operating income, Tk. 900,000 as last year? If you were a member of top management, would you have been in favor of constructing the new plant? Explain.

Contd P/6

HUM 303

7. (a) Barilgaon Milk makes the 1-gallon plastic milk jugs used to package its premium goat's milk. The company has been approached by a plastic molding company with an offer to produce the milk jugs at a cost of Tk. 1,400 per thousand jugs. Barilgaon's president believes the company should continue to produce the jugs and the plant manager has recommended accepting the offer because the cost to produce the jugs is greater than the purchase price. The company's cost to produce one thousand jugs is as follows: **(20)**

Direct materials	Tk. 400
Direct labor	275
Variable manufacturing overhead	350
Fixed manufacturing overhead, traceable	300
Fixed manufacturing overhead, common	250
Total production cost	Tk. 1,575

One-half of the traceable fixed manufacturing costs represent supervisory salaries and other costs that can be eliminated if the milk jugs are purchased. The balance of the traceable fixed manufacturing costs is depreciation of manufacturing equipment that has no resale value. Some of the space being used to produce the milk jugs could be used to store empty jugs, eliminating a rented warehouse and reducing common fixed costs by 20%. The rest of the space could be rented to another company for Tk. 3,000,000 per year. Barilgaon Milk produced 10,000,000 milk jugs per year.

Required

Should Barilgaon Milk make or buy the milk jugs? Show computation.

(b) Nehan Company produces a single product. The cost of producing and selling a single unit of this product is: **(15)**

Direct materials	Tk. 25
Direct labor	Tk. 50
Variable manufacturing overhead	Tk. 10
Fixed manufacturing overhead	Tk. 40
Variables selling and administrative expenses	Tk. 15
Fixed selling and administrative expense	Tk. 20

The normal selling price is Tk. 150 per unit. The company's capacity is 12,000 units per month. An order has been received from an overseas source for 2,000 units at the special price of Tk. 120 per unit. This order would not affect the company's regular sales. This order would not also affect its cost behavior pattern. In addition, it would save the company's selling and administrative expense.

Required:

If the order is accepted, how much will monthly profits increase or decrease?

Contd P/7

HUM 303

8. (a) Xinxira Company produces three products: X, Y, and Z. Data concerning three products are as follows: **(15)**

	X	Y	Z
Selling price	Tk. 80	Tk. 56	Tk. 70
Variable expenses:			
Direct Materials	24	15	9
Direct labor	14	13	15
Other variable expenses	10	14	25
Contribution margin	Tk. 32	Tk. 14	Tk. 21

Demand for the company's products is very strong, with far more order each month than the company can produce with the available raw materials. The same material is used in each product. The material cost Tk. 3 per pound, with a maximum of 5,000 pounds available each month.

Required:

In which order should the company produce X, Y and Z? Show computation.

(b) A company wants to purchase a new machine. The related information of the machine is as follows: **(20)**

Cost of the machine Tk. 75,000	
Year	Net Profit After Tax (NPAT)
1	Tk. 35,000
2	12,000
3	18,000
4	10,000
5	8,000

Required:

Determine:

i. Pay Back Period (PBP)

ii. Internal Rate of Return (IRR)

iii. Net Present Value (NPV) at 10% cost of capital

iv. Profitability Index (PI)

Should the company buy the equipment?
