Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
Department of Biomedical Engineering

BME 2151
Numerical Methods and Statistics

Time: 3 Hours **Full Marks: 210**

N.B. i) Answer **any THREE** questions from each section in separate scripts
ii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) What is error propagation? Draw a block diagram for evaluation of $x^2 + y^2 + z^2$. (08)

b) Find the absolute and relative errors in evaluating the expression xe^y, when $x = 1.25$ and $y = 2.16$. (10)

c) Calculate a root of the following function using false position method in the range $1 < x < 3$ (upto 3rd iteration): (10)

$$f(x) = x^2 - x - 2 = 0.$$

d) Show that bisection method is linearly convergent. (07)

2. a) Find a root of the following equation using Secant method with the initial estimates of $x_1 = 4$ and $x_2 = 2$: (15)

$$x^2 - 4x - 10 = 0.$$

b) Evaluate a root of the following equation using fixed point iteration algorithm: (10)

$$x^2 - 5 = 0$$

c) Find a root of the equation $x^2 - 3x + 2 = 0$ in the vicinity of $x = 0$ using Newton-Raphson method. (10)

3. a) Using Gauss Elimination method, solve the following set of equations: (13)

$$w + 2x - y + z = 6$$
$$-w + x + 2y - z = 3$$
$$2w - x + 2y + 2z = 14$$
$$w + x - y + 2z = 8.$$

b) Find the Lagrange interpolation polynomial to fit the following data (13)

i	0	1	2	3
x_i	0	1	2	3
e^{x_i}	1	2.7183	7.3891	20.0855

c) Find the divided differences $f[x_0, x_1]$, $f[x_1, x_2]$, $f[x_0, x_1, x_2]$ for the data given below: (09)

i	0	1	2
x_i	1.0	1.5	2.5
$f(x_i)$	3.2	3.5	4.5

4. a) Compute the integral $\int_{-1}^{1} e^x dx$ using composite trapezoidal rule for $n = 3$. (05)

b) Given the equation $y'(x) = \frac{2y}{x}$ with $y(1) = 2$. Estimate $y(2)$ using Euler's method when $h = 0.5$. (05)

c) Use the classical RK method to estimate $y(0.5)$ when $y'(x) = x/y$ with $y(0) = 1$ and $h = 0.25$. (15)

d) Define wave function with an example. Solve the Poisson's equation $\nabla^2 f = 2x^2y^2$ over the square domain $0 \le x \le 3$ and $0 \le y \le 3$ with $f = 0$ on the boundary and $h = 1$. (10)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is meant by probability? Find the probability of not getting a 7 or 11 total on either of two tosses of a pair of fair dice. (11)

b) Define random variables. Classify it with examples. (08)

c) Find the distribution function and its graph for the random variable X, where X represents the number of girls in families with three children, assuming equal probabilities of boys and girls. (16)

6. a) A continuous random variable X having values only between 0 and 4 has a density function given by $P(X) = \frac{1}{2} - aX$, where a is a constant, calculate a and find $P(1 < X < 2)$. (12)

b) Ten percent of the tools produced in a certain manufacturing process turn out to be defective. Find the probability that in a sample of 10 tools chosen at random exactly two will be defective by using (i) the binomial distribution and (ii) the Poisson approximation to the binomial distribution. (07)

c) Define class limits. Prove that the total area of the rectangles in a histogram is equal to the total area bounded by the corresponding frequency polygon and x-axis. (09)

d) Show that the algebraic sum of the deviations of a set of numbers from their arithmetic mean is zero. (07)

7. a) Compute the mean weekly wage of the 65 employees at the P&R company from the frequency distribution shown in Table 7(a) using long and coding methods. (12)

Table 7(a)

Wage ($)	No. of employees
250.00 – 259.99	8
260.00 – 269.99	10
270.00 – 279.99	16
280.00 – 289.99	14
290.00 – 299.99	10
300.00 – 309.99	5
310.00 – 319.99	2
Total = 65	

b) If $d = X - A$ are the deviations of X from an arbitrary constant A, prove that (07)

$$s = \sqrt{\frac{\sum fd^2}{N} - \left(\frac{\sum fd}{N}\right)^2}$$

c) Fit a least squares line to the data given in Table 7(c) by using (i) X as the independent variable and (ii) X as the dependent variable. (16)

Table 7(c)

X	1	2	4	6	8	9	11	14
Y	1	2	4	4	5	7	8	9

8. a) Define coefficient of correlation. Prove that for linear regression the coefficient of correlation between the variables X and Y can be written (14)

$$r = \frac{\sum xy}{\sqrt{(\sum x^2)(\sum y^2)}}$$

b) Derive Spearman's rank correlation formula. (11)

c) What is meant by test of hypothesis? What are type I and type II errors? Define level of significance and χ^2. (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
Department of Biomedical Engineering

ME 2115
Basic Mechanics and Thermodynamics

Time: 3 Hours **Full Marks: 210**

N.B. i) Answer **any THREE** questions from each section in separate scripts
ii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) The 100 Kg crate shown in Figure 1(a) is supported by three cords, one of which is connected to a spring. Determine the tension in cords AC and AD and the stretch of the spring. (18)

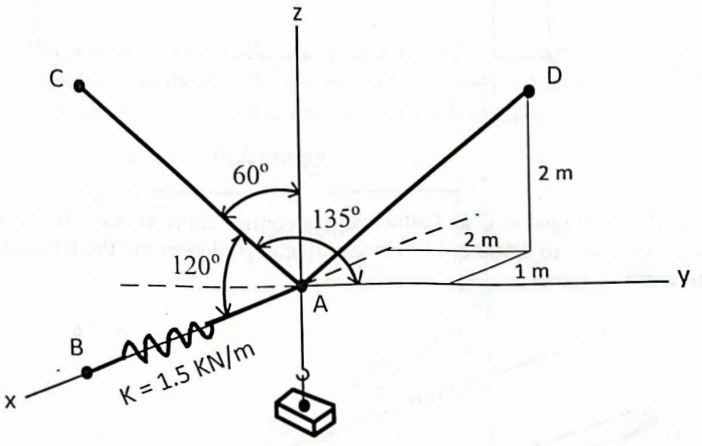

Figure 1(a)

b) Determine the resultant of the three forces as shown in Figure 1(b), knowing that $\alpha = 30^o$. (17)

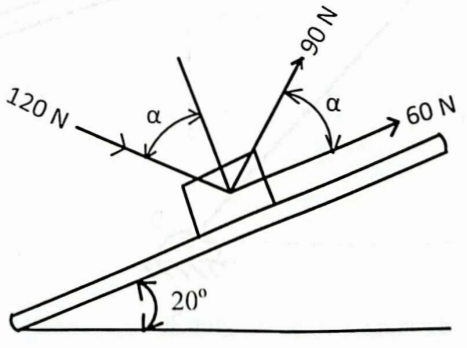

Figure 1(b)

2. a) Determine the centroid of the following area shown in Figure 2(a). (17)

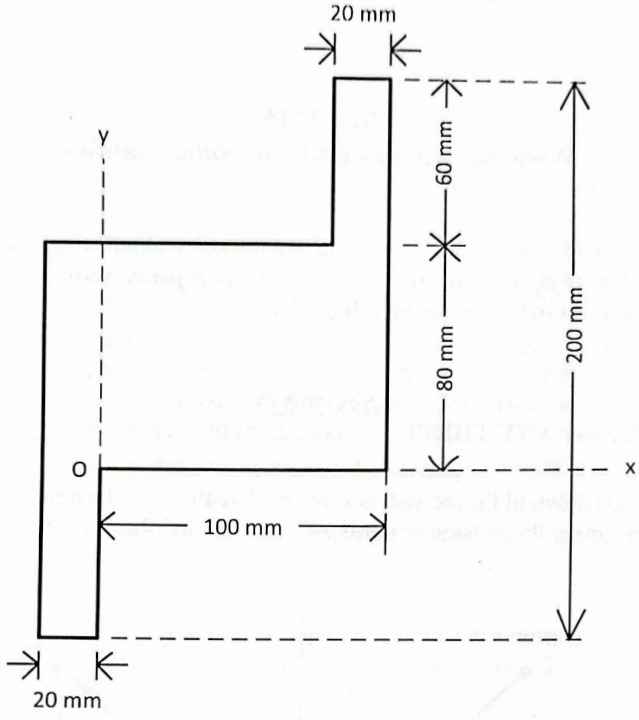

Figure 2(a)

b) A lever AB is hinged at C and attached to a control cable at A as shown in Figure 2(b). If the lever is subjected to a 500 N horizontal force at B, determine the tension in the cable and the reaction at C. (18)

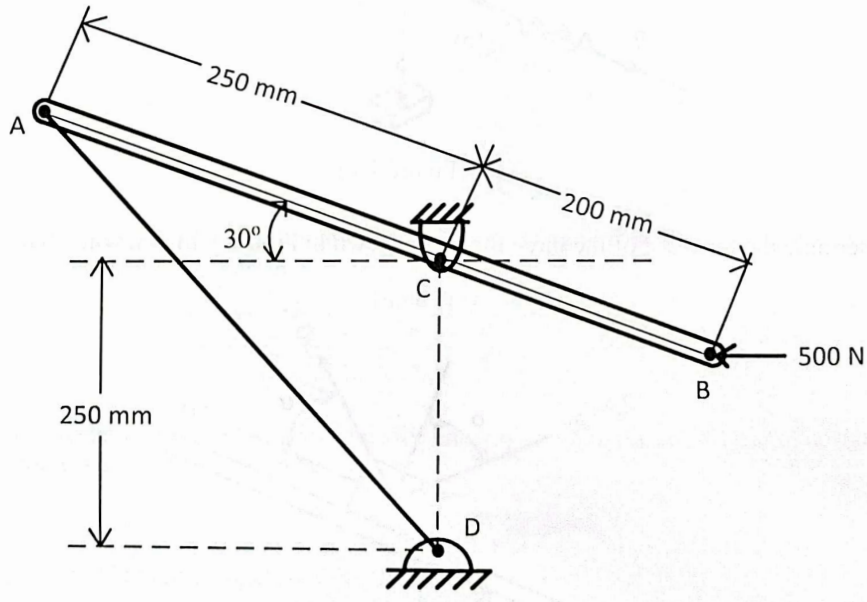

Figure 2(b)

3. a) State and prove Newton's law of viscosity. Why does viscosity of a liquid decrease with increase of temperature? (12)

b) What is surface tension? Why does a liquid droplet take spherical shape? Derive the expression of capillary rise in a tube due to surface tension. (12)

c) The belt in Figure 3(c) moves at steady velocity v and skims the top of a tank of oil of viscosity μ. Assuming a linear velocity profile, develop a simple formula for the belt drive power P required as a function of (h, L, v, b, μ). Neglect air drag. What power P is required if the belt moves at 2.5 m/s over SAE oil at 20°C ($\mu = 0.29$ Kg/m. s)? Assume $L = 2$ m, $b = 60$ cm, and $h = 3$ cm. (11)

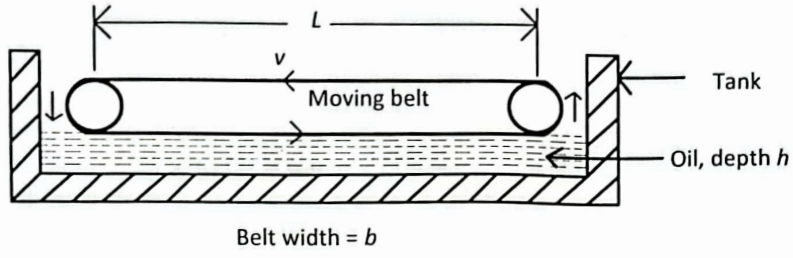

Figure 3(c)

4. a) What is meant by total pressure and center of pressure? Deduce the expression for total pressure on an inclined plane surface. (12)

b) How flow velocity can be calculated from static pressure and stagnation pressure in a pipe using pilot-static tube? (08)

c) The gate in Figure 4(c) is 1.5 m wide, is hinged at point B, and rests against a smooth wall at point A. Compute (i) the force on the gate due to seawater pressure, (ii) the horizontal pressure P exerted by the wall at point A, and (iii) the reactions at the hinge B. (15)

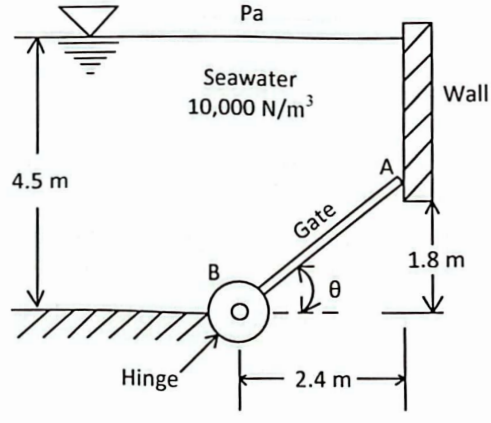

Figure 4(c)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Derive the integral form of energy equation from the first law of thermodynamics using the Reynolds transport theorem. Now deduce the extended Bernoulli equation from the integral form. (12)

b) How pilot-static tube can be used to measure the flow velocity? (08)

c) Water flows steadily through a 90^o reducing elbow as shown in Figure 5(c). At the inlet, the absolute pressure is 220 KPa and the cross-sectional area is 0.01 m^2. At the outlet, the cross-sectional area is 0.0025 m^2 and the velocity is 15 m/s. The elbow discharges to atmosphere. Determine the force required to hold the elbow in place. Assume the weight of elbow with water is 4 Kg. (15)

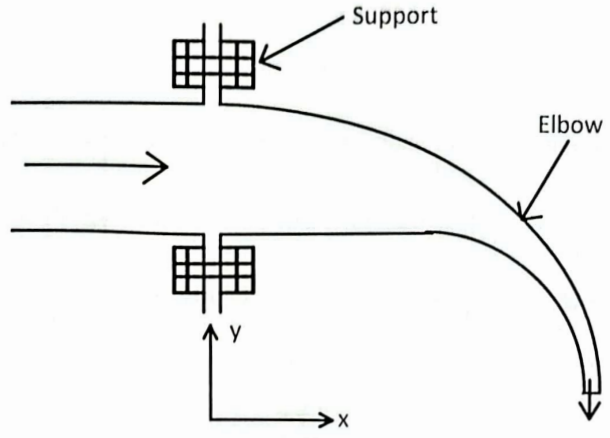

Figure 5(c)

6. a) What is meant by point function and path function? "Work and heat transfer are energy in transition"- justify the statement. (13)

b) What is meant by steady process and uniform process? Discuss the limitations of 1^{st} law of thermodynamics with examples. (12)

c) What are the examples of moving boundary work? Derive the expression of workdone for polytropic process. (10)

7. a) Discuss the differences between microscopic and macroscopic forms of energy with examples. (09)

b) What are the observations that can be made from the Kelvin-Planck and Clausius statements of 2^{nd} law of thermodynamics? Also, prove that the two statements are equivalent. (14)

c) Why a heat engine without a condenser is a perpetual motion machine of 2^{nd} kind (PMM2)? Why this PMM2 won't work? (12)

8. a) What is metabolism and basal metabolic rate? Explain how biological system of human body can be compared with thermodynamic heat engine. (10)

b) What is meant by COP? Compare the performance of a heat pump with a refrigerator. (07)

c) Prove that entropy of isolated system like universe is increasing. (08)

d) Discuss the mechanism of the three modes of heat transfer. (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
Department of Biomedical Engineering

BME 2101
Human Anatomy

Time: 3 Hours **Full Marks: 210**

N.B. i) Answer **any THREE** questions from each section in separate scripts
ii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) What are the parts of stomach? Name the structures forming the stomach bed. (12)
b) Give the mode of blood supply of kidney. (08)
c) Discuss the histological structure of the following organs: (15)
(i) Liver, (ii) Pancreas, and (iii) Spleen.

2. a) What is nephron? Draw and label the different parts of the nephron. (10)
b) How is nasal septum formed? Give the blood and nerve supply of nasal septum. (10)
c) Write short note on Uterine tube. (05)
d) Describe the gross anatomy of thyroid gland with its histological structure. (10)

3. a) What are the subdivisions of anterior triangle of neck? Describe carotid triangle. (15)
b) Draw and label the different refractive media of eyeball. (10)
c) Name the extraocular muscle. Give their nerve supply and action. (10)

4. a) Discuss about different functional areas of different lobes of cerebral cortex. (10)
b) What is tract? Name the ascending and descending tracts of spinal cord. (10)
c) Describe the blood supply of heart with schematic diagram. (15)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Give the origin, insertion, nerve supply, and action of the following muscles: (15)
i) Triceps brachii
ii) Deltoid
iii) Gluteus medius
b) Describe the boundaries and contents of thoracic inlet. (10)
c) What is mediastinum? Mention the boundary and contents of superior mediastinum. (10)

6. a) Describe the anatomy of the breast. Mention its lymphatic drainage. (15)
b) Mention the name of arteries supplying the heart. Discuss about foetal circulation. (15)
c) Write short note on Pleura. (05)

7. a) Describe about the boundary and contents of the popliteal fossa. (10)
b) Describe the intraarticular structure of the knee joint. Mention the name of the bursa around the knee joint. (15)
c) Mention the differences between the left and right lung. Mention the name of the structure that passes through the roots of the lung. (10)

8. a) What do you mean by peripheral heart? Give the origin, insertion, nerve supply, and action of the muscles constituting peripheral heart. (10)
b) Describe the anatomical features of the following bones: (10)
(i) Femur and (ii) Tibia
c) What is bronchopulmonary segment? Write down the name of the bronchopulmonary segment of both lungs. (15)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
Department of Biomedical Engineering

Math 2115
Transforms Analysis

Time: 3 Hours **Full Marks: 210**

N.B. i) Answer **any THREE** questions from each section in separate scripts
ii) Figures in the right margin indicate full marks.

Section A

(Answer **ANY THREE** questions from this section in Script A)

1. a) We know that $sinx = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots\cdots$. What is the first degree approximation of $sinx$ and when we get better approximation? (05)

b) Find the inner product between e^x and $sinx$ where $x\epsilon[\pi/4, 5\pi/4]$. Are these two functions orthogonal? (10)

c) Determine whether $f_1(t) = sin5\pi t + cos20\pi t$ is periodic or not. If it is periodic, then find its fundamental period. (10)

d) Expand $f_2(x) = x^2 + 1; 0 < x < 3$ in a Fourier cosine series. (10)

2. a) Obtain the trigonometric Fourier series for the function shown in Figure 2(a). (13)

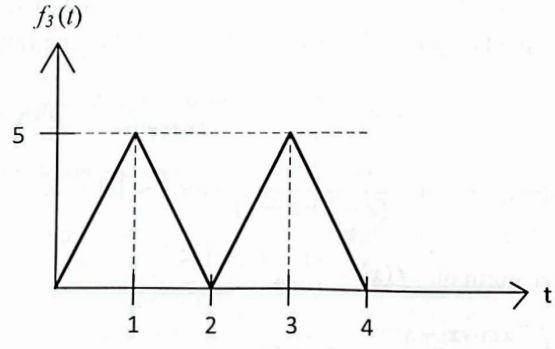

Figure 2(a)

b) Define half range Fourier sine series of a function $f(x)$. If $f(t) = t^2, 0 \le t \le 1$, find half range Fourier sine series. (12)

c) Find the Fourier integral representation of $g(t) = \begin{cases} 0; & t < 0 \\ 0.5; & t = 0. \\ e^{-t}; & t > 0 \end{cases}$ (10)

3. a) Sketch the function $h(t) = \begin{cases} t+1; & -1 < t < 0 \\ -t; & 0 < t < 1 \end{cases}$. Give the numbers to which the Fourier series of $h(t)$ will converge at $x = -1$, $x = 0$, and $x = 1/2$. (12)

b) Define Laplace transform. Find the Laplace transform of $t^2e^{2t}sin3t$. (11)

c) Define convolution theorem. Use this theorem to find the inverse Laplace transform of $\frac{1}{(s-1)(s-2)}$. (12)

4. a) Find $\mathcal{L}^{-1}\left\{\frac{e^{-s}}{s+1} + \frac{s}{s^2+s+1}\right\}$. (10)

b) Find the Laplace transform of full-wave rectification of $Asin\omega_0 t$. Also sketch the function. (10)

c) Using Laplace transform solve the BVP: $y'' + 9y = 18t;\ y(0) = 0, y(\pi/2) = 0$. (15)

Section B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Define integral transform and hence find the kernel of the transform. Also find the kernel of Fourier cosine transform. (08)

b) Define causal and noncausal signal with example. Test whether the following signals are causal or not. (12)

(i) $y(t) = x(t^2)$,
(ii) $y(n) = x(n) - x(n-1)$
(iii) $y(t) = x^2(t)$.

c) Find the inverse z-transform of given function using power series expansion method for region of convergence (ROC), $|z| < 1$, where $X(z) = \dfrac{1}{1 - 1.5z^{-1} + 0.5z^{-2}}$. (15)

6. a) Write down the important property of ROC for the z-transform. (10)

b) Define z-transform. Determine the z-transform of the signal $x(n) = sin\omega_0 n\, u(n)$ and hence using scaling property find the z-transform of $x(n) = 2^n sin\omega_0 n\, u(n)$. (12)

c) Find the signal $x(n)$ by using convolution for $X(z) = \dfrac{1}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 + \frac{1}{4}z^{-1}\right)}$. (13)

7. a) Solve the difference equation $u_{n+2} - 5u_{n+1} + 6u_n = 1;\ u_0 = 0, u_1 = 1$ using z-transform. (15)

b) Define Discrete Fourier Transform (DFT). Derive the DFT of the simple data sequence $x(n) = \{1, 1, 2, 2, 3, 3\}$ and compute the corresponding amplitude and phase spectrum. (20)

8. a) Find the Discrete Time Fourier Transform (DTFT) of the following finite duration sequence of length L. (08)

$$x(n) = \begin{cases} A, & \text{for } 0 \le x \le L \\ 0, & otherwise \end{cases}$$

b) Find the inverse z-transform of $\dfrac{1}{(z-2)(z-3)}$ for $2 < |z| < 3$. (12)

c) Find the Fourier transform of $f(x) = \begin{cases} 1 - x^2, & |x| < 1 \\ 0, & |x| > 1 \end{cases}$. (15)

Hence evaluate $\int_0^\infty \dfrac{xcosx - sinx}{x^3} cos\dfrac{x}{2}\, dx.$

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2022
Department of Biomedical Engineering

ECE 2115
Digital Electronics and Logic Design

Time: 3 Hours **Full Marks: 210**

N.B. i) Answer **any THREE** questions from each section in separate scripts
ii) Figures in the right margin indicate full marks.

Section A
(Answer **ANY THREE** questions from this section in Script A)

1. a) Define reflected code. What are the advantages of reflected codes over pure binary numbers? (06)
   b) Convert the following numbers from the given base to the bases indicated: (12)
   (i) Hexadecimal D2763 to decimal, octal, and binary
   (ii) Decimal 25.6875 to octal and binary.
   c) Find the complements of the following functions: (10)
   $$F_1 = x'yz' + x'yz$$
   $$F_2 = x(y'z' + yz).$$
   d) Define universal gate. Why some gates are called universal and some are not? (07)

2. a) Encode the following decimal numbers in BCD and Excess-3 codes: (12)
   (i) 46
   (ii) 321.32
   (iii) -20.32.
   b) Minimize the following function in both SOP and POS form using K-map: (13)
   $$f(A, B, C, D) = \sum m\,(1, 3, 4, 7, 11) + d\,(5, 12, 13, 14, 15).$$
   c) Reduce the following Boolean expressions to the minimum number of literals: (10)
   (i) $xy + x'z + yz$
   (ii) $B'D + A'BC' + ABC + A'BC.$

3. a) Implement the following function using only NAND gate: (10)
   $$F_1 = AB' + B'CD + C'D$$
   b) Define combinational logic. Design the combinational circuit that detects error during transmission of binary information. (13)
   c) Implement the following function with a multiplexer: (12)
   $$F(A, B, C, D) = \sum(0, 1, 3, 4, 8, 9, 15)$$

4. a) What is decoder? Design 4 × 16 decoder using 3 × 8 decoder. (10)
   b) Design a combinational circuit using ROM. The circuit accepts 3-bit number and generates an output binary number equal to the square of the input number. (12)
   c) A combinational circuit is design by the following functions (13)
   $$F_1(A, B, C) = \sum(3, 5, 6, 7)$$
   $$F_2(A, B, C) = \sum(0, 2, 4, 7).$$
   Implement the circuit with a PLA having three inputs, four product terms, and two outputs.

Section B
(Answer **ANY THREE** questions from this section in Script B)

5. a) What is flip flop? Why flip flop is called one-bit memory cell? (10)
   b) Write down the characteristics table and excitation table of RS, JK, D, and T flip flops. (10)
   c) Show the operation of D type edge triggered flip flop with necessary diagram. (10)
   d) Write down the difference between analog and digital signals. (05)

6. a) Define state table. Write down the state table and draw the state diagram of the sequential circuit shown in Figure 6(a). (12

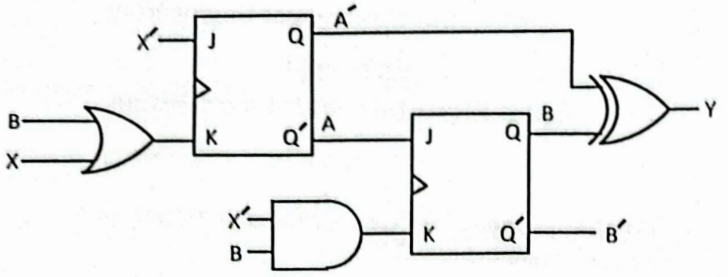

Figure 6(a)

b) Design a counter that counts the decimal digits according to excess-3 code using T flip flop. (12)

c) Reduce the number of states shown in the state Table 6(c) and tabulate the reduced state table. (11) Starting from state '*a*' of the reduced table, find the output sequence generated with an input sequence of 10110101001.

Table 6(c)

Present State	Next State		Output	
	$x=0$	$x=1$	$x=0$	$x=1$
a	*f*	*b*	0	0
b	*d*	*c*	0	0
c	*f*	*c*	0	0
d	*g*	*a*	1	0
e	*d*	*c*	0	0
f	*f*	*b*	1	1
g	*g*	*h*	0	1
h	*g*	*a*	1	0

7. a) Explain the operation of a "binary up counter with parallel loading" with appropriate circuit diagram and control signal table. (15)

b) Construct a cascaded BCD counter that can count upto 999. Explain its working principle. (10)

c) Define the following terms that relate with the characteristics of digital logic families: (10)
(i) Fan out
(ii) Figure of merit
(iii) Power dissipation
(iv) Noise margin
(v) Propagation delay.

8. a) The content of a 4-bit register is initially 1011. The register is shifted six times to right with a serial input 101101. What will be the content of the register after each shift? (13)

b) Define random access memory. Describe the read and write operation of RAM with appropriate timing waveform. (10)

c) Construct the truth table of the following resistor-transistor logic gates shown in Figure 8(c). (12) The inputs of this truth table are A, B, C. Show the binary state X, Y, Z and each transistor on/off state for all possible inputs.

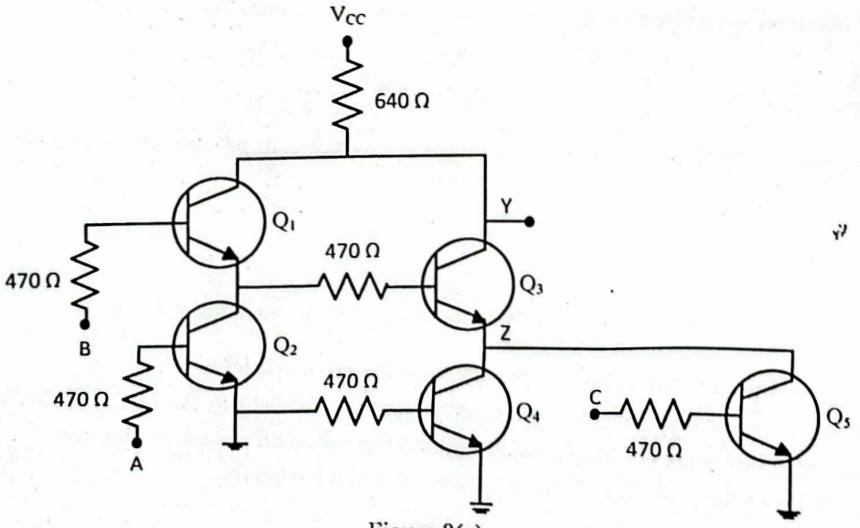

Figure 8(c)