Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2023
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)	Give the posterior relation of right kidney. Write down the mode of blood supply of kidney.	(15)
	b)	Mention different abdominal regions for descriptive purposes with their main contents.	(12)
	c)	Write down the contents and function of greater omentum.	(08)
2.	a)	Discuss about the lymphatic drainage and histological structure of stomach.	(10)
	b)	Mention the differences between jejunum and ileum. Discuss about the structure of testis.	(15)
	c)	Write down the components of extrahepatic biliary apparatus. Describe the relation of inferior surface of liver.	(10)
3.	a)	Write down the origin, insertion, nerve supply, and action of diaphragm. Mention the structures passing through different openings of diaphragm.	(15)
	b)	Discuss in details about the interior of anal canal.	(10)
	c)	What are the histological layers of retina? What is meant by pupillary light reflex?	(10)
4.	a)	Describe the cervix and primary supports of uterus.	(12)
	b)	What is tract? Name the ascending and descending tracts of spinal cord.	(10)
	c)	Describe the blood supply of brain with schematic diagram.	(08)
	d)	Write short note on 'Cerebrospinal fluid'.	(05)

Section B

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

5.	a)	Describe the anatomical structure of the following bones: i) Hip bone and ii) Scapula.	(10)
	b)	Give the origin, insertion, nerve supply, and action of the following muscles: i) Brachialis, ii) Gluteus maximus, and iii) Sartorius.	(15)
	c)	Describe the boundary and contents of cubital fossa.	(10)
6.	a)	Discuss about the boundary and contents of axilla.	(10)
	b)	Write down the structures related to the mediastinal surfaces of both the right and left lung.	(15)
	c)	Describe the conductive system of heart.	(10)
7.	a)	Give the boundary and contents of femoral triangle with schematic diagram.	(10)
	b)	Mention the differences between right and left ventricle. Mention the changes after the birth of foetal circulation.	(12)
	c)	How hip joint is formed? Enumerate the muscles causing its various movements.	(13)
8.	a)	What is mediastinum? Write down the boundary and contents of middle mediastinum.	(10)
	b)	Describe the shoulder joint. What is rotator cuff?	(10)
	c)	Describe trachea. Give its nerve supply.	(07)
	d)	Describe the structures exposed after the reflection of gluteus maximus.	(08)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2023
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 the following terms (i) Duality principle, (ii) Standard form, and (iii) Canonical form. (12)

b) Explain the distinction between number system and code with example. Convert the decimal number $(605)_{10}$ into following forms: (i) BCD code, (ii) Excess-3 code, and (iii) Gray code. (12)

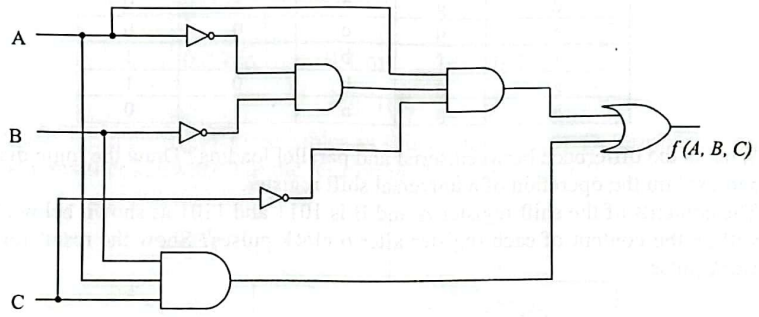
c) Find the complement of the Boolean function and reduce this complement function to a minimum number of literals: (11)

$$F = [(AB)'A][(AB)'B]$$

2. a) Obtain the simplified expression in (i) Sum of products and (ii) Product of sums. (10)

$$(A'+B'+D')(A+B'+C')(A'+B+D')(B+C'+D')$$

b) Simplify the following logic circuit: (11)



c) Reduce the following Boolean expressions to the minimum number of literals: (14)

(i) $xyz + x'y + xyz'$

(ii) $AB + A\bar{B}C(\overline{BC} + C) + \overline{AC}$

3. a) Design combinational circuit that controls a common bulb of a room to satisfy the following conditions. If two or more members of the room want to study then the bulb is ON. Otherwise the bulb will remain OFF. Assume that no. of students in the room is 4. (10)

b) Implement the function using only NOR gate: (11)

$$F = AB' + B'CD + C'D$$

c) Show that $A \odot B \odot C \odot D = \sum(0, 3, 5, 6, 9, 10, 12, 15)$ (08)

d) What is decoder? Implement the following function using decoder: (06)

$$F(A, B, C, D) = \sum(0, 1, 3, 4, 8, 9, 10, 11).$$

4. a) Implement the following function with a multiplexer: (11)

$$F(A, B, C, D) = \sum(0, 1, 3, 4, 8, 9, 15).$$

b) Implement a Full Adder circuit using Decoder. (11)

c) A combinational circuit is designed by the following functions: (13)

$$F_1(A, B, C) = \sum(3, 5, 6, 7)$$

$$F_2(A, B, C) = \sum(0, 2, 4, 7)$$

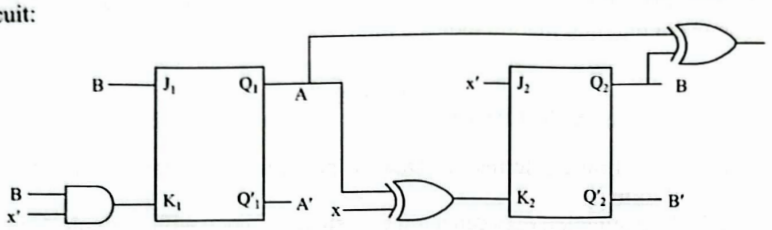
Implement the circuit with a PLA having three inputs, four product terms and two outputs.

Section B

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

5. a) What is sequential circuit? Draw the block diagram of a sequential circuit. (05)
   b) Draw the diagram of RS, JK, D and T flip-flop. Also, write their characteristic table and excitation table. (12)
   c) Show the operation of D-type edge-triggered flip-flop with necessary diagrams. (10)
   d) Draw the diagram of clocked master-slave JK flip-flop using NAND gates. (08)

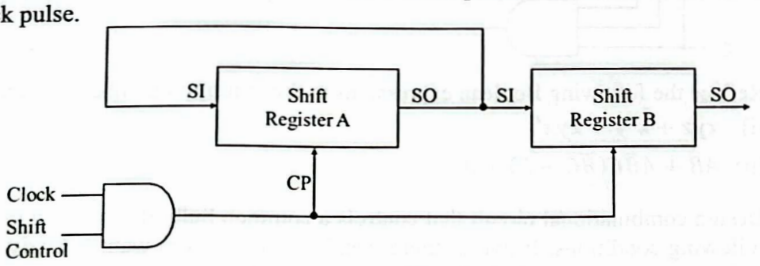
6. a) Write down the state table and draw the state diagram of the following sequential circuit: (12)



   b) Design a counter that counts 2, 3, 5, 7, 8, 9 using T flip-flop. (12)
   c) Reduce the number of states shown in the state table below and tabulate the reduced state table. Starting from state 'a' of the reduced state table, find the output sequence generated with input sequence 01110010011. (11)

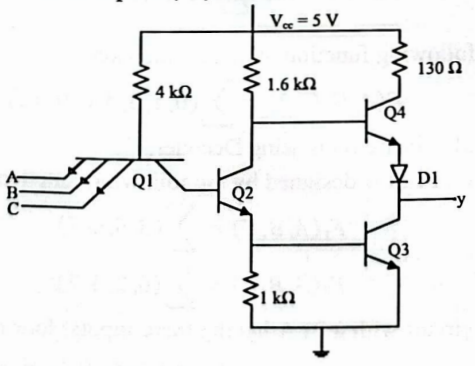
Present State	Next State		Output	
	$x = 0$	$x = 1$	$x = 0$	$x = 1$
a	f	a	0	0
b	d	c	0	0
c	f	e	0	0
d	g	a	1	0
e	d	c	0	0
f	f	b	1	1
g	g	h	0	1
h	g	a	1	0

7. a) What is the difference between serial and parallel loading? Draw the logic diagram and explain the operation of a universal shift register. (12)
   b) The contents of the shift register A and B is 1011 and 1101 as shown below. What will be the content of each register after 6 clock pulses? Show the result for each clock pulse. (11)



   c) Construct a cascaded BCD counter that can count up to 999. Explain its working principle. (12)

8. a) Construct a Johnson counter with ten timing signals. (10)
   b) What is Ripple counter? Draw the diagram and explain the operation of 4-bit binary ripple counter. (11)
   c) Describe the operation of the following circuit and find out the output value of y for all possible combination of input A, B, and C. (10)



   d) Define the terms: (i) Propagation delay, and (ii) Fan out. (04)

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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) Explain the following terms: (i) Newton's law of gravitation and (ii) Equilibrium of a particle. (05)

b) The bracket BCD is hinged at C and attached to a control cable at B as shown in Fig. 1(b). For the loading shown, determine (i) the tension in the cable, and (ii) the reaction at C. (15)

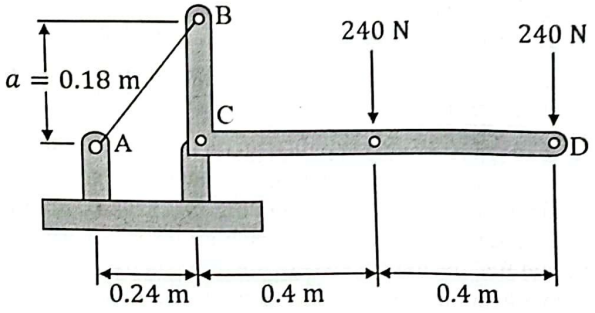

Fig. 1(b)

c) A container is supported by three cables as shown in Fig. 1(c). Determine the weight w of the container knowing that the tension in cable AB is 500 N. (15)

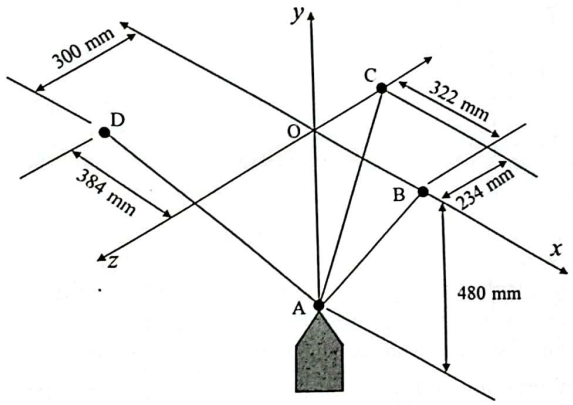

Fig. 1(c)

2. a) State the principle of transmissibility interms' of rigid body. (05)

b) The smooth disks D and E have a mass of 100 kg and 50 kg, respectively shown in Fig. 2(b). Determine the largest horizontal force that can be applied to the center of disk E without causing disk D to move up the incline. (15)

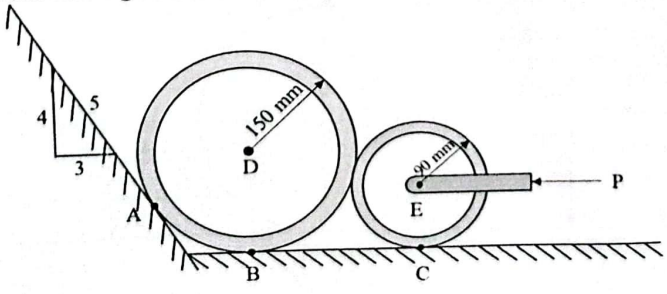

Fig. 2(b)

c) Determine the location of the centroid for the plane area shown in Fig. 2(c). (15)

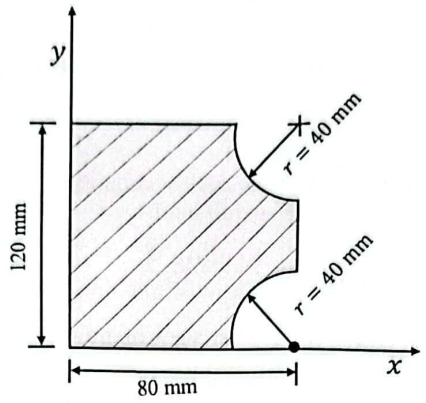

Fig. 2(c)

3. a) Describe why capillary rise and fall occur when a narrow tube is placed in a liquid. Why isn't capillary rise noticeable with a large diameter tube? (10)

b) Demonstrate that when the surface tension and radius are the same, the pressure within a soap bubble is twice that of a droplet. (10)

c) A thin flat plate (30 cm × 30 cm) is pulled at 3.5 m/s horizontally through a 4.0 mm thick oil layer sandwiched between two plates, one stationary and the other moving at a constant velocity of 0.3 m/s, as shown in Fig. 3 (c). The dynamic viscosity of the oil is 0.027 Pa.s. Assuming the velocity in each oil layer to vary linearly, (i) plot the velocity profile and find the location where the oil velocity is zero, and (ii) determine the force that needs to applied on the plate to maintain the motion. (15)

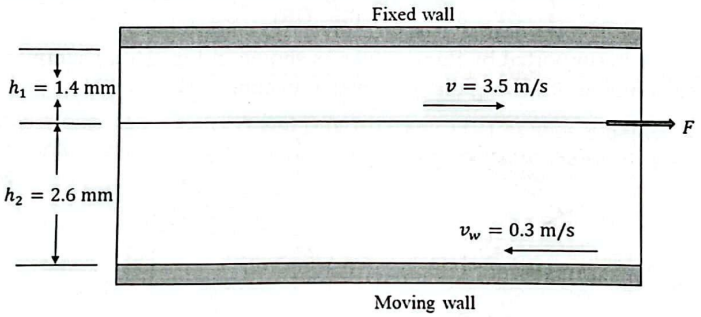

Fig. 3(c)

4. a) Is it possible to calculate the hydrostatic force exerted on a flat surface submerged in water, regardless of its shape or orientation, using only the vertical distance of the surface's centroid from the water surface and its area? If so, prove it. (10)

b) Define the total pressure and center of pressure. Deduce the expression for total pressure on an inclined plane surface. (12)

c) A cylindrical gate of 4 m in diameter and 2 m long has water on both sides as shown in Fig. 4(c). Determine the magnitude and direction of the resultant force exerted by the water on the gate. Find also the least weight of the cylinder so that it may not be lifted away from the floor. (13)

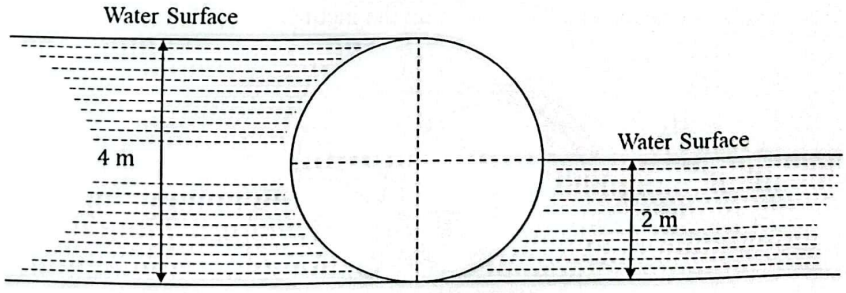

Fig. 4(c)

Section B

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

5. a) Interpret the necessities of Reynolds Transport theorem for the analysis of fluid problems. Derive the mass conservation continuity equation using the theorem. (12)

b) Derive Bernoulli's equation, providing a brief explanation of its constituent terms. (10)

c) A venturimeter (30 cm × 15 cm) is provided in a vertical pipeline carrying oil of specific gravity 0.85, the flow being upwards. The difference in elevation of the throat section and entrance section of the venturimeter is 30 cm. The differential U-tube mercury nanometer shows a gauge deflection of 20 cm. Calculate the (i) discharge of oil and (ii) the pressure difference between the entrance section and the throat section. Take the co-efficient of the discharge as 0.98 and specific gravity of mercury as 13.6. (13)

6. a) Define system, surroundings, and boundary with neat sketches. (07)
How does a system is said to be in thermodynamic equilibrium?

b) State and explain the "zeroth law of thermodynamics". Also, explain how this law can be used for temperature measurement. (08)

c) Describe how the second law of thermodynamics overcomes the limitations of the first law of thermodynamics. (08)

d) A system composed of 3 kg of thin substance expands from an initial pressure of 500 KPa and a volume of 0.22 m^3 to a final pressure 100 KPa in a process in which pressure and volume are related by $PV^{1.2} = \text{constant}$. The initial energy of a certain substance is given by the following equation, $u = 3.60PV + 85$. If the expansion is quasi-static, find Q, ΔU and W for the processes. (12)

7. a) Show that the COP of a heat pump is always greater than 1. (08)

b) State the Kelvin-Planck and Clausius statements of 2nd law of thermodynamics. Also, prove that the two statements are equivalent. (10)

c) Interpret the terms of reversible and irreversible processes. Explain the phenomena about the cause of irreversibility and condition for reversibility. (07)

d) Briefly derive the expression for steady flow energy equation (SFEE). Also, show the application of SFEE for the nuzzle and throttling devices. (10)

8. a) Imagine a scenario where a person is standing outside on a sunny day. The person is wearing a black shirt and feels noticeably warmer than when he wear a white shirt on another sunny day. Explain the different modes of heat transfer involved in this situation and discuss how the color of the shirt affects heat absorption and transfer. (07)

b) Describe an expression for the temperature distribution of a composite wall consisting of two different materials having thermal conductivity of K1 and K2, respectively. (10)

c) Explain the following; "A living human body may be likened to a heat engine". Also, write the expression of thermal energy (heat) balance equation for the human body considering as the control volume. (08)

d) "A black body is a perfect emitter"- Explain with the justification. (10)
The emission of radiation from a surface can be approximated as a black body radiation at $T = 1050$ K. Calculate (i) the total energy emitted bellow the wavelength, $\lambda = 5.5$ μm from it and (ii) the wavelength at which the maximum spectral emission occurs at $T = 1450$ K.

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 1st Term Examination, 2023
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) Define casual and non-causal system. Determine whether the following systems are causal or non-causal system: (12)
(i) $y(t) = x^2(t) + x(t-3)$
(ii) $y(t) = x(3-t) + x(t-2)$
(iii) $y(n) = \sin[x(n)]$

b) Write two difference between Laplace transform and z-transform. Also write important properties of ROC of z-transform. (11)

c) Determine the z-transform of the signal $x(n) = a^n u(n) - b^n u(-n-1)$, ($a$ and b) < 1, $b < a$, and plot the *ROC*. (12)

2. a) By applying the time shifting property determine the signal of (10)

$$X(z) = \frac{z^{-2} + \frac{1}{2}z^{-1}}{1 - \frac{1}{2}z^{-1}}$$

b) Find the inverse z-transform of (12)

$$X(z) = \frac{z + 0.5}{(z + 0.6)(z + 0.8)}, |z| > 0.8$$

using residue method.

c) Solve the difference equation $y(k+2) - 18y(k+1) + 32y(k) = 0$ subject to $y(0) = 0, y(1) = 2$ using z transform method. (13)

3. a) Define integral transform. Find the kernel of the transform also find the kernel of Fourier sine transform. (08)

b) Define discrete time Fourier transform (DTFT). Find the DTFT of the following finite duration sequence of length L, (14)

$$x(n) = \begin{cases} A & \text{for } 0 < n < L-1 \\ 0 & \text{for otherwise} \end{cases}$$

c) Determine the IDTFT of $X(e^{j\omega}) = 2cos2\omega, -\pi < \omega < \pi$. (13)

4. a) Define discrete Fourier transform (DFT). Determine 4-point DFT of the signal (13)

$$x(n) = \begin{cases} 1, & 0 \le n \le 3 \\ 0, & \text{otherwise} \end{cases}$$

b) Find the inverse DFT of $X(k) = \{1, 2, 3, 4\}$. (12)

c) Find the Fourier sine and cosine transforms of (10)

$$h(t) = \begin{cases} e^{at}, & |t| < 1 \\ 0, & \text{otherwise} \end{cases}$$

Section B

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

5. a) Discuss the concept of piecewise continuity and function of exponential order with suitable examples. (10)

b) Find the Laplace transform of $e^{-2t-5}tsintcost$ and $erf\sqrt{2t}$. (12)

c) Solve $y'' + y = f(t),\ y(0) = 1, y'(0) = 0$ using Laplace transforms where (13)

$$f(t) = \begin{cases} 1, & 0 \le t < \frac{\pi}{2} \\ sint, & t \ge \frac{\pi}{2} \end{cases}$$

6. a) Prove that $L\{U(t-a)\} = \frac{e^{-as}}{s}$ where $U(t-a)$ is Heaviside's unit step function. (10)

b) Find the inverse Laplace transform of $\frac{s^2}{(s^2+4)^2}$ using convolution method. (12)

c) Expand $f(x) = \begin{cases} 2+x, & -2 < x < 0 \\ 2, & 0 < x < 2 \end{cases}$ in Fourier series. Also sketch the graph of $f(x)$. (13)

7. a) Define inner product of functions and norm of functions. Find the inner product of $f_1(x) = x,\ f_2(x) = cos2x$ over $[0, \pi]$ and norm of each of them. Are they orthogonal? Why or why not? (11)

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

c) Find the Fourier integral of the function $f(x) = e^{-kx}$, when $x > 0$ and $f(-x) = -f(x)$ for $k > 0$ and hence prove that (12)

$$\int_0^\infty \frac{u\ sin\ ux}{k^2+u^2} du = \frac{\pi}{2} e^{-k}\ , k > 0.$$

8. a) State the Parseval's theorem for Fourier series. Using this theorem find the root-mean-square (RMS) value of $f_6(x) = e^x; -\pi < x < \pi$. (12)

b) Find the Fourier series representation of (18)

$$f_7(x) = \begin{cases} sin2x, & -\pi < x < -\frac{\pi}{2} \\ 0, & -\frac{\pi}{2} \le x \le 0 \\ sin2x, & 0 < x < \pi \end{cases}$$

upto fifth harmonics.

c) Write the Dirichlet's condition for Fourier series expansion. (05)

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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)

a) What is numerical error? Discuss different kinds of numerical errors that affect the numerical computations. (10)

b) What is machine epsilon? Estimate the relative error in $z = x - y$ when $x = 0.5432 \times 10^4$ and $y = 0.5401 \times 10^4$ as stored in a system with four-digit mantissa. (10)

c) Show how error propagates in arithmetic division operations. (07)

d) Formulate a mathematical model for predicting the growth of nails of a human. (08)

a) Calculate the value of $\sqrt{2}$ using bisection method (up to 4^{th} iteration). (12)

b) Use the false position method to find a root of the function $f(x) = x^2 - x - 2 = 0$ in the range $1 < x < 3$. (11)

c) Apply secant method to estimate a root of the equation $x^2 - 4x - 10 = 0$ with the initial estimates of $x_1 = 4$ and $x_2 = 2$ (up to 6^{th} iteration). (12)

3. a) Solve the following systems of equations by simple Gauss elimination method: (11)

$$2x_1 + 3x_2 + 4x_3 = 5$$
$$3x_1 + 4x_2 + 5x_3 = 6$$
$$4x_1 + 5x_2 + 6x_3 = 7$$

b) Find the Lagrange interpolation polynomial which agrees with the following data: (11)

x	1.0	1.1	1.2
$cosx$	0.5403	0.4536	0.3624

Use the result to estimate $cos1.15$.

c) Compute Romberg estimate R_{22} for $\int_1^2 \frac{1}{x} dx$. (13)

4. a) Given the equation $y'(x) = 2y/x$ with $y(1) = 2$. Estimate $y(3)$ using Heun's method, using $h = 0.75$. (12)

b) Use the classical RK method to estimate $y(0.4)$ when $y'(x) = x^2 + y^2$ with $y(0) = 0$ and assume $h = 0.2$. (15)

c) Solve the Poisson equation $\nabla^2 f = 2x^2y^2$ over the square domain $0 \leq x \leq 3$ and $0 \leq y \leq 3$ with $f = 0$ on the boundary and $h = 1$. (08)

Section B

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

5. a) What is meant by sample space? Give example. Find the probability that a single toss of a die will result in a number less than 4 if i) no other information is given and ii) it is given that the toss resulted in an odd number. (08)

b) Find the distribution function and its graph for the random variable X, where a fair coin is tossed twice and X represents the number of tails that can come up. (12)

c) Find the distribution function for the random variable X of the function (07)

$$f(x) = \begin{cases} cx^2, & 0 < x < 3 \\ 0, & otherwise \end{cases}$$

is a density function.

d) Find the probability that in a family of 4 children there will be i) at least 1 boy and ii) at least 1 boy and 1 girl. (08)

6. a) Define histogram and frequency polygon with figures. (08)

b) Draw and explain different types of frequency curves. (08)

c) A car travels 25 miles at 25 mph, 25 miles at 50 mph, and 25 miles at 75 mph. Find the arithmetic mean and harmonic mean of the three velocities. Which one is correct? (06)

d) Using coding method find the standard deviation and variance of the heights of the 100 male students at XYZ university as given below: (13)

Height (in)	Number of students
60-62	5
63-65	18
66-68	42
69-71	27
72-74	8
Total	100

7. a) Define scatter diagram, approximating curve, and curve fitting with necessary diagrams. (07)

b) What are the limitations of freehand method of curve fitting? How can you overcome these limitations? (05)

c) Fit a least squares parabola having the form $Y = a_0 + a_1X + a_2X^2$ to the given data below: (15)

X	1.2	1.8	3.1	4.9	5.7	7.1	8.6	9.4
Y	4.5	5.9	7.0	7.8	7.2	6.8	4.5	2.7

d) Define correlation and regression. Graphically show different types of correlation. (08)

8. a) Prove that regression lines of Y on X and X on Y have equations given respectively (08)

$$Y - \bar{Y} = \frac{rS_Y}{S_X}(X - \bar{X}) \quad \text{and}$$

$$X - \bar{X} = \frac{rS_X}{S_Y}(Y - \bar{Y}).$$

b) A correlation coefficient based on a sample of size 18 was computed to be 0.32. Can we conclude at significance level of i) 0.05 and ii) 0.01 that the corresponding population correlation coefficient differs from zero? (07)

c) Define population, statistical decision, and statistical hypothesis with examples. (09)

d) What is rank correlation? Use the chi-square test to determine the goodness of fit of the data given below: (11)

Number of Heads (X)	Pr {X Heads}	Expected Frequency	Observed Frequency
0	0.0332	33.2	38
1	0.1619	161.9	144
2	0.3162	316.2	342
3	0.3087	308.7	287
4	0.1507	150.7	164
5	0.0293	29.4	25