

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF NATURAL SCIENCES

Mid-Semester Examination

Course No: Math 4161

Course Title: Mathematics I

Winter Semester, A. Y. 2024-2025

Time : 2 Hours

Full Marks : 120

There are 4 (four) questions. Answer all questions. Marks of each question and corresponding CO and PO are written in the brackets. Programmable calculators are not allowed. Do not write on this question paper. The Symbols have their usual meaning.

1. a) Solve each of the following inequalities and illustrate them on a number line: [10]
 (i) $3(2 - 3x) > 4(1 - 4x)$; (ii) $\frac{5(3t+1)}{3} > \frac{2t-4}{6} + \frac{t}{2}$. [CO1]
 (PO1)
- b) One leg of a right triangle is 5 cm longer than the other. How long should the shorter leg be to ensure that the area of the triangle is greater than or equal to 12? Also, convert your result to inches. [10]
 (CO2)
 (PO1)
- c) The highway department is planning to build a picnic area for motorists along a major highway. It is to be rectangular with an area of 10,000 square yards and is to be fenced off on the three sides not adjacent to the highway. Express the number of yards of fencing required as a function of the length of the unfenced side. [10]
 (CO3)
 (PO1)
2. a) Find the angle through which the axes are to be turned so that the equation may be reduced to the form $x = k$, also determine the value of k . [8]
 (CO2)
 (PO1)
- b) Show that the equation [12]

$$12x^2 - 10xy + 2y^2 + 11x + 5y + 2 = 0$$
 (CO3)
 (PO1)
 can be made a homogeneous equation of second degree by transferring the origin to a properly chosen point.
- c) Remove the product term from the equation $19x^2 + 5xy + 7y^2 = 13$, by suitable rotation of axes. [10]
 (CO1)
 (PO1)
3. a) An open box is to be made from a rectangular piece of cardboard 16 inches long and 10 inches wide by cutting away identical squares (x by x inches) from each corner and folding up the resulting flaps. Find an expression giving the volume V of the box as a function of x . Find the domain of the function. [6]
 (CO1)
 (PO1)

- b) Based on data compiled by WHO, the number of people living with HIV worldwide from 1985 through 2006 is estimated to be [12]
(CO2)
(PO1)

$$N(t) = \frac{39.88}{1 + 18.94e^{-0.2997t}} \quad (0 \leq t \leq 21)$$

Where $N(t)$ is measured in millions and t in years with $t = 0$ corresponding to the beginning of 2005.

(i) How many people were living with HIV world-wide at the beginning of 2005? at the beginning of 2015? at the beginning of 2020?

(ii) Assuming that the trend continued, how many people were living with HIV world-wide at the beginning of 2026?

- c) The solid waste generated each year in the cities of the Bangladesh is increasing. [12]
The solid waste generated, in millions of tons, was 238.3 in 2015 and 251.3 in (CO3)
2021. Assuming that the amount of solid waste generated by Bangladesh cities is (PO1)
a linear function of time, find a formula for this function by finding the equation of the line through these two points. Use this formula to predict the amount of solid waste generated in the year 2030.

4. a) Define elementary transformations. Write down an algorithm to find inversion of [6]
a matrix using elementary row operations. (CO1)
(PO1)

- b) A trucking company New Royal Transport Service owns three types of trucks A, [12]
B and C which are equipped to carry three different types of machines per load (CO2)
as shown below: (PO1)

Trucks			
	Type-A	Type-B	Type-C
Machine I	6	4	8
Machine II	4	2	2
Machine III	2	6	4

How many trucks of each type should be used to carry exactly 58 of type I machines, 26 of type II machines and 32 of type III machines? Assume that each truck is fully loaded and use matrix method.

- c) Using elementary row operations, find the inverse of the following matrix A [12]
(CO3)
(PO1)

$$A = \begin{bmatrix} 1 & 0 & 1 & 2 \\ -1 & 1 & 2 & 1 \\ 1 & 0 & 1 & 1 \\ 3 & 1 & 0 & 2 \end{bmatrix}$$