(6)

B.Sc.Engg. CSE 2nd Semester — 15 February 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION — **SUMMER SEMESTER, 2021-2022**

DURATION: 1 HOUR 30 MINUTES — **FULL MARKS: 100**

Math 4241: Integral Calculus and Differential Equations

Programmable calculators are not allowed. Do not write anything on the question paper.

Answer all **3 (three)** questions. Figures in the right margin indicate full marks of questions whereas corresponding CO and PO are written within parentheses.

---

1. a) What is the difference between Riemann Sum and Definite Integral? — 4 (CO2) (PO1)

   b) Consider the function, $f(x) = x^2 + 1$ and answer the following questions: — 6+4 (CO2) (PO1)
      i. Find a formula for the Riemann Sum obtained by dividing the interval [0, 3] into n equal subintervals and use the right-hand endpoint for each. Then take a limit of these sums to calculate the area under the curve over interval [0, 3].
      ii. Use definite integral to find the area under the curve of the given function and compare with the result of 1. a) i.

   c) Briefly explain the fundamental theorem of calculus (part 1) and use it to find- — 9 (CO2) (PO1)

$$\frac{d}{d\theta}\int_{\theta}^{\tan\theta} sec^2 y\, dy$$

   d) A power plant generates electricity by burning oil. Pollutants produced as a result of the burning process are removed by scrubbers in the smokestacks. Over time, the scrubbers become less efficient and eventually they must be replaced when the amount of pollution released exceeds government standards. Measurements are taken at the end of each month determining the rate at which pollutants are released into the atmosphere, recorded as follows: — 6+4 (CO2) (PO1)

Table 1: Record of pollutants release rate for question 1.d)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pollutant release rate (tons/day)	0.20	0.25	0.27	0.34	0.45	0.52	0.63	0.70	0.81	0.85	0.89	0.95

      i. Assuming a 30-day month and that new scrubbers allow only 0.05 ton/day to be released, provide an upper estimate of the total tonnage of pollutants released by the end of June. What is the lower estimate?
      ii. In the best case, approximately when will a total of 125 tons of pollutants be released into the atmosphere?

2. a) Explain the concept of weighted average with necessary examples. — 5 (CO1) (PO1)

   b) Find the area between the curve $x = y^2$ and the line $y = x - 2$ using both vertical strips having width dx and horizontal strips having width dy. — 15 (CO2) (PO1)

c) If $\frac{d}{dx}(F(x)) = \frac{1}{1+x}$ and $F(0) = 1$, the mean value theorem implies that $A < F(4) < B$. Find out the boundary values of A and B. 13 (CO2) (PO1)

3. a) Differentiate between volume by shell method and disk method. 5 (CO1) (PO1)

b) Compute the volume of the solid generated by revolving the triangular region bounded by the lines $2y = x + 4$, $y = x$ and $x = 0$ about: 6×2 (CO2) (PO1)

i. The x-axis using the washer method.

ii. The y-axis using the shell method.

c) A spring has a natural length of $1m$. A force of $24N$ holds the spring stretched to a total length of $1.8\ m$. 9 (CO2) (PO1)

i. Find the force constant k.

ii. How much work will it take to stretch the spring $2m$ beyond its natural length?

iii. How far will a $45N$ force stretch the spring?

d) Find the length of the curve $x = \frac{y^4}{4} + \frac{1}{8y^2}$ from $y = 1$ to $y = 2$. 8 (CO2) (PO1)