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Daffodil International University

Department of Electrical and Electronic Engineering

Faculty of Engineering

Midterm Examination, Fall-2026

Course Code: 0541-111
Section: A, B, C, D, R
Full Marks: 25

Course Title: Differential and Integral Calculus
Level-Term: L1-T1
Exam Date: Oct 31, 2026

Teacher's Initial: SDN
Time: 1.5 Hours

[Answer all the following questions sequentially]
[The second right-most column indicates the COs with the respective Bloom's level]
[The right-most column indicates the assigned marks]

Q1. (a) **Describe** the Mean Value Theorem with its physical meaning. 3

(b) A function is defined as follows

$$f(x) = \begin{cases} x^2 + 1, & when \quad x < 0 \\ x, & when \quad 0 \le x \le 1 \\ \frac{1}{x}, & when \quad x > 1 \end{cases}$$ 5

(i) **Discuss** the continuity and differentiability at $x = 0$. CO-1

(ii) **Describe** your findings graphically. C(2)

(c) **Identify** the horizontal asymptotes of the Sigmoid function $\sigma(x) = \frac{1}{1+e^{-x}}$. 2

Q2. (a) **Determine** y_n for the function $y = \ln(ax + b)$ 2

(b) An equation used in thermodynamics is the Benedict-Webb-Rubine equation of state for the expansion of a gas. The equation is: 3

$$p = \frac{RT}{V} + \frac{\left(B_0RT - A_0 - \frac{C_0}{T^2}\right)}{V^2} + \frac{bRT - a}{V^3} + \frac{A\alpha}{v^6} + \frac{C\left(1 + \frac{\gamma}{V^2}\right)}{T^2}\left(\frac{1}{V^3}\right)e^{\frac{-\gamma}{V^2}}$$ CO-2 C(3)

show that $\frac{\partial^2 p}{\partial T^2} = \frac{6}{V^2T^4}\left\{\frac{C}{V}\left(1 + \frac{\gamma}{V^2}\right)e^{\frac{-\gamma}{V^2}} - c_o\right\}$.

(c) **Determine** the n-th derivative of the function $y = (1 + x^2)e^{2x}$ using Leibnit'z theorem. 2

Q3. (a) A capacitor in an RC circuit discharges according to 5

$$v_C(t) = V_0\, e^{-t/RC}$$

where $V_0 = 12\ V, R = 1\ kohm, C = 1\ muF$.

(i) **Construct** a fourth-order Maclaurin polynomial.

(ii) **Calculate** the percentage error of $v_C(t)$ at $= 0.5\ ms$. CO-3

(iii) **Calculate** the fourth-order Lagrange's form of the remainder. C(3)

(b) The output voltage of a temperature sensor is given by $V(T) = 0.001T^2 + 0.5T + 1$. **Calculate** the temperature T at which the average rate of change of the sensor voltage occurs over the interval $[20, 80]°C$. 3