Daffodil International University

Department of Electrical and Electronic Engineering

Faculty of Engineering

Final Examination, Spring-2026

Course Code: 0541-213
Section: A, B, C, D
Full Marks: 40

Course Title: Numerical Methods
Level-Term: L2-T1
Exam Date: April 27, 2026

Teacher's Initial: AKB, SP
Time: 2 Hours

[Questions 1 and 2 are Mandatory. Answer any 3 of the remaining Questions. The second rightmost column indicates the COs (course learning outcomes of the course) with respective Bloom's level, and the rightmost column indicates the assigned marks.]

Q1. A circuit is designed such that the total inductance L_{eq} is depended upon two of the inductances L_1 and L_2. The relation is $L_{eq} = \frac{L_1+2L_2+5}{2+L_2}$. The current through the equivalent circuit is calculated by $I = \alpha(L_1 + L_2)^2$; where $\alpha = 0.003\ AH^{-2}$ and the stored energy in the circuit is $W = \frac{1}{2}L_{eq}I^2$. L_1 and L_2 are related with each other and the following data table has been found: CO-2 C(3) 8

$L_1(Henry)$	2	4	6	8	10	12
$L_2(Henry)$	3.6	6.6	12.1	22.1	40.2	73.2

i) Using exponential curve fitting, **determine** the energy stored in the circuit for $L_1 = 3\ Henry$.

ii) If the actual value of the energy is 0.065 J, then **determine** the relative error and percentage error.

$y = ab^x$

Q2. Given that $\frac{dy}{dt} = 4e^{0.8t} - 0.5y$ CO-2 C(3) 8

The initial condition at t = 0 is y = 2.

i) **Determine** y from t = 0 to 4 with a step size of 1 using Euler's method

ii) If the actual solution is: $y = \frac{4}{1.3}(e^{0.8t} - e^{-0.5t}) + 2e^{-0.5t}$, then **determine** the relative error and percentage error.

Q3. The total mass of a variable density rod is given by, CO-1 C(3) 8

$$m = \int_0^L d(x)A_c(x)dx$$

where m = mass, d(x) = density, $A_c(x)$ = cross-sectional area, x = distance along the rod and L = the total length of the rod. The following data have been measured for a 24 m length rod.

$x\ (m)$	0	4	8	12	16	20	24
$d(x)\ (Kgm^{-3})$	4	3.95	3.80	3.60	3.41	3.30	3.10
$A_c(x)\ (m^2)$	100	105	107	112	117	120	130

Determine the mass in Kilograms.

4. In a Signal Processing Unit, a parameter named kappa is dependent on two hyper-parameters u and v. u and v both are dependent on time. u is defined by the equation: $u(t) = C_0 e^{-\alpha t}$ In a particular experiment, C_0 and α was 2 and 0.3 respectively. And the below chart was found: CO-1 C(3) 8

Time (t)	0	3	6	9	12
v	2	5	7	9	18

If κ is a parameter and is defined by $\kappa(t) = \frac{d}{dt}(uv)$, then **determine**

i) $\kappa(1)$

ii) $\kappa(7)$

5. A differential equation is defined by $\frac{dy}{dx} = -xy^2$, y(2) = 1
Using the Runge-Kutta method of order two with h = 0.1 for the initial problem, **determine** the value of y(2.3) CO-1 C(3) 8

6. A lossy communication channel is modeled by a second degree polynomial. The experimental data are given in the following table: CO-1 C(3) 8

X(m)	0	1	2	3	4	5
Y (dB loss)	2	8	14	27	41	61

i) **Fit** a second degree polynomial with the experimental data above.

ii) **Determine** the Y (dB loss) for X = 1.5m with the polynomial

$u^3 - 2u^2 - u^2 + 2u$

$u^3 - 3u^2 + 2u$

$3 \underline{| 27, 3, 3}$

9, 1, 1