	where X = sum of end ordinates O = sum of odd ordinates E = sum of even ordinates	
14.	$I=\int_{x_0}^{x_{3n}} y\,dx=\frac{h}{8}[y_0+3(y_1+y_2+y_4+y_5+y_7+y_8+\cdots+y_{3n-2}+y_{3n-1})$ $+2(y_3+y_6+y_9+\cdots+y_{3n-3})+y_{3n}]$	
15.	$\int_{x_0}^{x_n} y\,dx=\frac{3h}{10}[y_0+5(y_1+y_5+y_7+y_{11}+\cdots)+(y_2+y_4+y_8+y_{10}+\cdots)$ $+6(y_3+y_9+y_{15}+\cdots)+2(y_6+y_{12}+y_{18}+\cdots)+y_n]$	
16.	$y_n=y_0+\int_{x_0}^{x} f(x,y_{n-1})\,dx$	
17.	$y_{n+1}=y_n+\frac{h}{1!}y_n'+\frac{h^2}{2!}y_n''+O(h^3)$	
18.	$y_{n+1}=y_n+h\,f(x_n,y_n)$	
19.	$y_{n+1}=y_n+K_2$	$K_2=hg\left[x_n+\frac{h}{2},y_n+\frac{K_1}{2}\right]$ $K_1=hg(x_n,y_n)$
20.	$y=a+bx$ $b=\frac{SS_{xy}}{SS_{xx}}$ $a=\frac{1}{n}(\Sigma y_i-b\Sigma x_i)=\overline{y}-b\overline{x}$	$SS_{xx}=\Sigma(x_i-\overline{x})^2=\Sigma x_i^2-(\Sigma x_i)^2/n$ $SS_{xy}=\Sigma(x_i-\overline{x})(y_i-\overline{y})=\Sigma x_iy_i-(\Sigma x_i)(\Sigma y_i)/n$
21.	$na+\left(\sum_{i=1}^{n}x_i\right)b+\left(\sum_{i=1}^{n}x_i^2\right)c=\sum_{i=1}^{n}y_i$ $\left(\sum_{i=1}^{n}x_i\right)a+\left(\sum_{i=1}^{n}x_i^2\right)b+\left(\sum_{i=1}^{n}x_i^3\right)c=\sum_{i=1}^{n}x_iy_i$ $\left(\sum_{i=1}^{n}x_i^2\right)a+\left(\sum_{i=1}^{n}x_i^3\right)b+\left(\sum_{i=1}^{n}x_i^4\right)c=\sum_{i=1}^{n}x_i^2y_i$	$y=a+bx+cx^2+dx^3+\cdots+zx^m+e$ $S_{y/x}=\sqrt{\frac{S_r}{n-(m+1)}}$
22.	$y=ab^x$ $\log y=\log a+x\log b$ $Y=A+Bx$	$\Sigma Y=nA+B\Sigma x$ $\Sigma xY=A\Sigma x+B\Sigma x^2$
23.	$E_a=\lvert X_E-X_A\rvert$ $E_r=\left\lvert\frac{X_E-X_A}{X_E}\right\rvert$	$E_p=100E_r=100\left\lvert\frac{X_E-X_A}{X_E}\right\rvert$

gree'

Helpful Equations:

1.	$\phi(x) = y_0 + u\Delta y_0 + \frac{u(u-1)}{2!}\Delta^2 y_0 + \frac{u(u-1)(u-2)}{3!}\Delta^3 y_0 + \cdots + \frac{u(u-1)\cdots(u-(n-1))}{n!}\Delta^n y_0$
2.	$y(x) = y_n + p\nabla y_n + \frac{p(p+1)}{2!} \times \nabla^2 y_n + \frac{p(p+1)(p+2)}{3!} \times \nabla^3 y_n + \frac{p(p+1)(p+2)(p+3)}{4!} \times \nabla^4 y_n + \cdots$
3.	$f'(x) = \frac{1}{h}\left[\Delta y_0 + \frac{2u-1}{2!}\Delta^2 y_0 + \frac{3u^2-6u+2}{3!}\Delta^3 y_0 + \frac{4u^3-18u^2+22u-6}{4!}\Delta^4 y_0 + \frac{5u^4-40u^3+105u^2-100u+24}{5!}\Delta^5 y_0\right.$
4.	$f''(x) = \frac{1}{h^2}\left[\Delta^2 y_0 + \frac{6u-6}{3!}\Delta^3 y_0 + \frac{12u^2-36u+22}{4!}\Delta^4 y_0 + \frac{20u^3-120u^2+210u-100}{5!}\Delta^5 y_0 + \cdots\right]$
5.	$f'(x_0) = \frac{1}{h}\left[\Delta y_0 - \frac{1}{2}\Delta^2 y_0 + \frac{1}{3}\Delta^3 y_0 - \frac{1}{4}\Delta^4 y_0 + \frac{1}{5}\Delta^5 y_0 - \cdots\right]$
6.	$f''(x_0) = \frac{1}{h^2}\left[\Delta^2 y_0 - \Delta^3 y_0 + \frac{11}{12}\Delta^4 y_0 - \frac{5}{6}\Delta^5 y_0 + \cdots\right]$
7.	$f'(x) = \frac{1}{h}\left[\nabla y_n + \frac{2v+1}{2!}\nabla^2 y_n + \frac{3v^2+6v+2}{3!}\nabla^3 y_n + \frac{4v^3+18v^2+22v+6}{4!}\nabla^4 y_n + \frac{5v^4+40v^3+105v^2+100v+24}{5!}\nabla^5 y_n + \cdots\right]$
8.	$f''(x) = \frac{1}{h^2}\left[\nabla^2 y_n + \frac{6v+6}{3!}\nabla^3 y_n + \frac{12v^2+36v+22}{4!}\nabla^4 y_n + \frac{20v^3+120v^2+210v+100}{5!}\nabla^5 y_n + \cdots\right]$
9.	$f'(x_n) = \frac{1}{h}\left[\nabla y_n + \frac{1}{2}\nabla^2 y_n + \frac{1}{3}\nabla^3 y_n + \frac{1}{4}\nabla^4 y_n + \frac{1}{5}\nabla^5 y_n + \cdots\right]$
10.	$f''(x_n) = \frac{1}{h^2}\left[\nabla^2 y_n + \nabla^3 y_n + \frac{11}{12}\nabla^4 y_n + \frac{5}{6}\nabla^5 y_n + \cdots\right]$
11.	$I = \int_{x_0}^{x_n} y\,dn = nh\left[y_0 + \frac{n}{2}\Delta y_0 + \frac{n(2n-3)}{12}\Delta^2 y_0 + \frac{n(n-2)^2}{24}\Delta^3 y_0 + \cdots\right]$
12.	$I = \sum_{i=1}^{n} I_i = \int_{x_0}^{x_n} y\,dx = \frac{h}{2}[y_0 + 2(y_1 + y_2 + y_3 + \cdots + y_{n-1}) + y_n] = \frac{h}{2}[X + 2I]$ where X = sum of the end points I = sum of the intermediate ordinates.
13.	$I = \int_{x_0}^{x_n} y\,dx = \frac{h}{3}[y_0 + 4(y_1 + y_3 + y_5 + \cdots + y_{2n-1}) + 2(y_2 + y_4 + y_6 + \cdots + y_{2n-2}) + y_{2n}]$ $= \frac{h}{3}[X + 4O + 2E]$

Q4. 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) $\kappa(7)$

Q5. 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

Q6. 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

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.

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.