International Islamic University Chittagong (IIUC)

Department of Computer and Communication Engineering (CCE)

Final Examination

Program: **B.sc (Engg.)**
Course Code: **CCE-2401**
Total Marks: **50**

Semester: **Autumn-2021**
Course Title: **Numerical Methods**
Time: **2 Hours 30 Minutes**

Figures in the right margin indicate full marks.

Answer should be relevant and clearly written. All the parts of a question must be answered serially.

Part A

Answer any Two of the following Questions.

Q1. (b) There is strong evidence that the first level of processing what we see is done in the retina. It involves detecting something called edges or positions of transitions from dark to bright or bright to dark points in images. These points usually coincide with boundaries of objects. To model the edges, derivatives of functions such as **10 CLO2**

$$f(x = \begin{cases} 1 - e^{-ax}, & x \geq 0 \\ e^{ax} - 1, & x \leq 0 \end{cases}$$

need to be found.

a. Use the central divided difference approximation of the first derivative of f(x) to calculate the functions derivative at **x = 0.1** for **a = 0.24**. Use a step size of $\Delta t = 0.05$.
b. Find the absolute relative true error for part (a).

Q2. (a) The velocity of a rocket is given by **10 CLO2**

$$v(t) = 2000\, ln\left[\frac{14 \times 10^4}{14 \times 10^4 - 2100t}\right] - 9.8t, 0 \leq t \leq 30.$$

Where 'v' is given in m/s and 't' is given in seconds.

a. Use the forward difference approximation of the first derivative of v(t) to calculate the acceleration at t = 15s. Use a step size of $\Delta t = 3s$.
b. Find the exact value of the acceleration of the rocket.
c. Find the absolute relative true error for part (b).

Q3. (a) Find Solution of an Equation $2x^3 - 4x + 1$, *if* $x_1 = 2$, $x_2 = 4$ *and* $x = 2.25$. Step value (h) = 0.25 using Newton's Forward Difference formula. **5 CLO2**

(b) Using Stirling's formula to find solution. **5 CLO2**

x	f(x)
0	135
300	149
600	157
900	183
1200	201
1500	205
1800	193

For x = 900.

Part B

Answer any Three of the following Questions.

Q4. (a) The vertical distance covered by a rocket from $t = 8$ to $t = 30$ seconds by **10 CLO2**

$$x = \int_{8}^{30} \left(2000\, ln\left[\frac{140000}{140000 - 2100t}\right] - 9.8t\right) dt$$

a. Use the two-segment trapezoidal rule to find the distance covered from **t = 8** to **t = 30** seconds.
b. Find the true error, E_t for part (a).
c. Find the absolute relative true error for part (a).

Q5. (a) In an attempt to understand the mechanism of the depolarization process in a fuel cell, an electro-kinetic model for mixed oxygen-methanol current on platinum was developed in the laboratory at FAMU. A very simplified model of the reaction developed suggests a functional relation in an integral form. To find the time required for 50% of the oxygen to be consumed, the time, $T(s)$ is given by **10 CLO2**

$$T = -\int_{1.22 \times 10^{-6}}^{0.61 \times 10^{-6}} \left(\frac{6.73x + 4.3025 \times 10^{-7}}{2.316 \times 10^{-11}x}\right) dx$$

a) Use Simpson's 1/3 rule to find the time required for 50% of the oxygen to be consumed.
b) Find the true error, E_t, for part (a).
c) Find the absolute relative true error, $|\epsilon_t|$, for part (a).

Q6. (a) Find **y(0.4)** for **y' = – 2x – y, y(0) = – 1**, with step length 0.1 using Taylor Series Method. **10 CLO2**

Q7. (a) Find $y(0.2)\ for\ y' = \frac{x-y}{2}, x_0 = 0, y_0 = 1$, with step length **0.1** using Runge-Kutta 2 method (1st order derivative). **5 CLO2**

(b) Find an approximate value of **5 CLO2**

$$\int_{5}^{8} 6x^3\, dx$$

Using Euler's method of solving an ordinary differential equation. Use a step size of h = 1.5.