



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2021/2022**

COURSE NAME : NUMERICAL METHODS/ENGINEERING  
MATHEMATICS IV

COURSE CODE : BEE 32402/BEE 31602

PROGRAMME CODE : BEJ

EXAMINATION DATE : JANUARY / FEBRUARY 2022

DURATION : 3 HOURS

INSTRUCTION : 1. ANSWERS ALL QUESTIONS.

2. THIS FINAL EXAMINATION IS A  
**ONLINE ASSESSMENT AND  
CONDUCTED VIA OPEN BOOK**



THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

- Q1** (a) Find value  $I_d$ , that you will use it in **Question 1(b)** and **1(c)**

$$I_d = \frac{m}{d}$$

Note:  $m$  is your month of birth and  $d$  is your day of birth

(1 mark)

- (b) The following data given are collected from the experimental measurement on the electrical circuit with the current as input variable and voltage as output variable:

$i$	0	1.2	2.4	3.6	4.8	6	7.2
$v(i)$	$2I_d$	$9I_d$	$18I_d$	$27I_d$	$38I_d$	$45I_d$	$57I_d$

Compare **FOUR(4)** suitable methods to approximate  $v'(6)$  in 4 decimal places in which the exact solution of  $v'(6)$  is 8.3878.

(15 marks)

- (c) A point  $P$  is moving along the curve whose equation is  $f(x) = I_d e^{2x+3}$ . By using second derivative for 3-point central and 5-point difference formula with  $h = 0.05$ , calculate how far  $P$  is moving when  $x = 1.25$ .

(9 marks)

- Q2** (a) A miniature quadcopter flies in a curve line from one point to another. Suppose that the path of the quadcopter from its initial hovering point to the final resting point is described by:

$$y = 2.15 + 2.09x - 0.41x^2, 0 \leq x \leq 3.6$$

where  $x$  is the horizontal distance (in meters) from the point of release, and  $y$  is the total distance (in meters) from the initial point.

- (i) Estimate the travels distance of the quadcopter from the moment of its hovering point to the moment it rests, by using trapezoidal rule and appropriate Simpson's rule with  $h = 0.4$  given that the arc length of the curve line is:

$$L = \int_a^b \sqrt{1 + \left(\frac{dy}{dx}\right)^2} dx$$

(11 marks)

- (ii) Estimate (C2), change to TOS  
Calculate the exact solution of the traveled distance by using a scientific calculator.

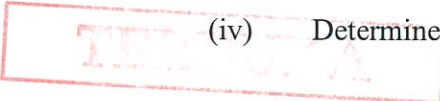
(1 mark)

- (iii) Find the absolute error for each methods (from **Q2(a)(i)**).

(2 mark)

- (iv) Determine which method approximates better.

(1 mark)



- (b) Evaluate the following equation by using Simpson's 3/8 rule with 12 equal parts of interval subdivision. The value of  $I_d$  is same as in equation **Q1(a)**. Find the value of  $x$  and its absolute errors.

$$\int_{0.2}^{1.4} I_d e^{\sin x} dx$$

(10 marks)

- Q3** (a) A polluted pool has an initial concentration of bacteria of  $10^4$  part/m<sup>3</sup>, while the acceptable level is only  $5 \times 10^3$  part/m<sup>3</sup>. The concentration of the bacteria will reduce as fresh water enter the pool. The differential equation that governs the concentration  $C$  of the pollutant as a function of time (in weeks) is given by:

$$\frac{dC}{dt} + 0.05C = 0, \quad C(0) = 10^4$$

- (i) Estimate the concentration of the pollutant after 15 weeks by taking a step size of 1 week.

(11 marks)

- (ii) Find the absolute error if the exact solution of **Q3(a)(i)** is

$$C(t) = 10^4 e^{-0.05t}$$

(2 marks)

- (b) Find the solution for  $\cos(x) \frac{d^2y}{dx^2} - (1 + x^2) \frac{dy}{dx} - 2xy = \frac{1}{1+x^2}$  with the conditions  $y(1) = -1$ ,  $y(2) = 2$  and  $h = 0.25$  by using finite-difference method.

(12 marks)

- Q4** (a) The temperature distribution  $u(x, t)$  of the one-dimensional gold rod is governed by the heat equation as follows.

$$\frac{\partial u}{\partial t} = 0.25 \frac{\partial^2 u}{\partial x^2}$$

Given the boundary conditions  $u(0, t) = 2t^2$ ,  $u(1, t) = 5t$ , for  $0 \leq t \leq 0.04$  s and the initial condition  $u(x, 0) = x(1 - x)$  for  $0 \leq x \leq 1.0$  mm, analyze the temperature distribution of the rod with  $\Delta x = 0.25$  mm and  $\Delta t = 0.02$  s in 4 decimal places.

(10 marks)

- (b) An elastic string which is fixed at both ends is governed by the wave equation

$$\frac{\partial^2 u}{\partial t^2} = \frac{\partial^2 u}{\partial x^2}, \quad 0 \leq x \leq 1, \quad t \geq 0,$$

Where,  $u(x, t)$  is the displacement of the string. The initial conditions are given by

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$$u(x, 0) = \begin{cases} x, & 0 \leq x \leq 0.5 \\ -(x - 1) & 0.5 < x \leq 1 \end{cases} \quad \frac{\partial u}{\partial t}(x, 0) = 0, \quad 0 \leq x \leq 1$$

Determine the variation of the displacement of the string by using the finite-difference method for  $0 \leq t \leq 0.3$  s using  $\Delta x = 0.25$  mm and  $\Delta t = 0.1$  s.

(15 marks)

- END OF QUESTIONS -

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