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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2021/2022

COURSE NAME	:	NUMERICAL METHODS / ENGINEERING MATHEMATICS IV
COURSE CODE	:	BEE 32402/ BEE 31602
PROGRAMME CODE	:	BEE / BEV
EXAMINATION DATE	:	JULY 2022
DURATION	:	3 HOURS
INSTRUCTION		1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS AN **ONLINE** ASSESSMENT AND CONDUCTED VIA **OPEN BOOK**

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

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Q1 (a) Find value I_d, that **you will use in Question 1(b) until Question 2.**

$$I_d = \frac{y}{n}$$

Note:

(a) $\boldsymbol{y}$ is your ***year of registration*** and $\boldsymbol{n}$ is your ***last 2 digit of your matrix number***.

(b) The lecturer will cross check your y and n with the student's database.
Example: AE**190011** ($y = 19,\ n = 11$)

(1 mark)

(b) Given the following set of discrete data:

x	0.3	0.4	0.5	0.6	0.7	0.8
$f(x)$	$1.1972I_d$	$1.3771I_d$	$1.6487I_d$	$2.0544I_d$	$2.6644I_d$	$3.5966I_d$

Compare **FOUR (4)** suitable methods to approximate $f'(0.5)$ in 4 decimal places in which the exact solution with $f(x) = I_d e^{2x^2}$. Determine the best approximation method.

(15 marks)

(c) Calculate the second derivatives of function $f(x) = \sin(x) + I_d e^{2x}$ at point $x = 0.625$ using 3-points central and 5-point central differential with $h = 0.125$.

(9 marks)

Q2 (a) If the current flowing in a circuit is related to time by the formula $i(t) = I_d e^{-5t} cos5t$ and is applied to a capacitor with capacitance $\mathrm{C} = 0.2F$. The voltage drops across the capacitor is given by $V_C = \frac{1}{C}\int i(t)\, dt$,

(i) Approximate V_C, $0 \le t \le 0.8$ with $h = 0.1$ by using trapezoidal rule and suitable Simpson's rule.

(13 marks)

(ii) Find the absolute error for each method from Q2(a)(i) if the actual value of V_C is 0.498V.

(2 marks)

(iii) Determine the best approximation method.

(1 mark)

(b) An electrical device was measured for its current fluctuates at a number of different values of time. Calculate the current by referring the following experimental data using suitable Simpson's rules.

Time (s)	0.3	0.5	0.7	0.9	1.1	1.3	1.5	1.7	1.9	2.1
Current (A)	0.4	0.5	$0.6I_d$	0.8	$0.7I_d$	1.5	$1.9I_d$	$2.2I_d$	5.3	6.2

(9 marks)

Q3 (a) A cougar was found dead in the woods by a ranger, which he assumed was shot by a poacher. The recorded body temperature of the dead body was 27 °C (degree Celcius) while the temperature of the woods was assumed to be uniform at 24 °C. The rate of cooling of the body can be expressed as:

$$\frac{dT}{dt} = -k(T - T_a),$$

where T is the temperature of the body in °C, T_a is temperature of the surrounding medium (in °C) and k is proportionally constant. Let initial temperature of the cougar be 37 °C while $k = 0.152$.

i Estimate the temperature of the dead body at time, $0 \leq t \leq 9$ hours by using Euler's method with $\Delta t = 1\ hour$.

(10 marks)

ii. Approximate how long the cougar had been killed at $T = 27$ °C by using linear interpolation techniques.

(3 marks)

(b) Solve $y" + y = 0, y(0) = 3, y(1) = -3$ by using finite-difference method with $h = 0.2$.

(12 marks)

Q4 (a) Analyse the temperature distribution of all interior nodes in the copper cable wire by using an explicit finite-difference method of the heat equation, $\frac{\partial u}{\partial t} = 1.1819\frac{\partial^2 u}{\partial x^2}$. The cable has a length (x) of 18 cm, and the length interval $(h = \Delta x)$ is given by 6 cm, which consists of four (4) nodes starting from 0 cm to 18 cm. The boundary condition for the left end of the cable, $u(0,t)$ is 400 $°C$; meanwhile, the right end of the cable, $u(18,t)$ is 20 $°C$. The initial temperature of the cable is $u(x,0) = 20\,°C$ for $6 \leq x \leq 18$. The time interval $(k = \Delta t)$ is 10 s, and the temperature distribution in the cable is examined from $t = 0$ s to $t = 30$ s.

(12 marks)

(b) Given a wave equation:
$\frac{\partial^2 u}{\partial t^2} = 7.5\frac{\partial^2 u}{\partial x^2}, 0 < x < 2, \ t > 0$

Subject to boundary conditions:
$u(0,t) = 0, \ u(2,t) = 1$ for $0 \leq t \leq 0.4$

An initial conditions:
$u(x,0) = \frac{2x}{4}, \ \frac{\partial u(x,0)}{\partial t} = 1$ for $0 \leq x \leq 2$

By using the explicit finite-difference method, analyse the wave equation by taking:
$h = \Delta x = 0.5, k = \Delta t = 0.2$

(13 marks)

-END OF QUESTIONS –