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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2012/2013

COURSE NAME	:	MATHEMATICS IV
COURSE CODE	:	BWM 21403
PROGRAMME	:	1 BBV 2 BBV 3 BBV
EXAMINATION DATE	:	DECEMBER 2012/JANUARY 2013
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE (5)** QUESTIONS ONLY

THIS EXAMINATION PAPER CONSISTS OF **SIX (6)** PAGES

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Q1 (a) Show that $y(x) = 3\sin x + 8\cos x$ is a general solution of the differential equation, $3\frac{d^2y}{dx^2} + 3y = 0$, where A and B are constants.

(4 marks)

(b) Solve the following equation using the separable method and give your answer in the exponent form,

$$x^2y^2\frac{dy}{dx} - x = x^2$$

(6 marks)

(c) Determine if the following linear equations are homogeneous:

(i) $2y'' + 4y - 6 = 30$

(ii) $3\frac{d^2y}{dx^2} + 6 = 3\frac{dy}{dx}$

(2 marks)

(d) Find the general solution for the following homogeneous equation,

(i) $y'' - 2y' - 3y = 0$

(ii) $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = 0$

(8 marks)

Q2 A nonlinear equation below

$$f(x) = x^3 - 0.39x + 0.07$$

has three different roots where two roots lie on positive x-axis and another root on the negative x-axis. Based on the following intervals, find all three roots for the function, $f(x)$ by using Bisection method:

(a) $[a_0, b_0] = [0, 0.3]$

(6 marks)

(b) $[a_0, b_0] = [0.3, 0.8]$

(6 marks)

(c) $[a_0, b_0] = [-1, 0]$

(8 marks)

For part (a), (b) and (c) above, iterate until $|f(c_i)| < \varepsilon = 0.005$.

Q3 Three masses, $m_1 = 3$ kg, $m_2 = 4.5$ kg and $m_3 = 2$ kg, are attached to springs, $k_1 = 40$ N/m, $k_2 = 20$ N/m, $k_3 = 25$ N/m and $k_4 = 18$ N/m. Initially the masses are positioned such that the springs are in their natural length (not stretched or compressed), then the masses are slowly released and move downward to an equilibrium position. The equilibrium equations of the three masses are given as follows

$$(k_1 + k_2 + k_3)x_1 - k_3x_2 = m_1g$$
$$-k_3x_1 + (k_3 + k_4)x_2 - k_4x_3 = m_2g$$
$$-k_4x_2 + k_4x_3 = m_3g,$$

where x_1, x_2 and x_3 are the relative displacement of each mass, with g = gravitational acceleration ($g = 9.81$ m/s^2).

(a) Represent the above problem in the form of $Ax = b$ by substituting the given parameter values.

(6 marks)

(b) Hence, find the resulting displacements by using Crout method.

(14 marks)

Q4 The arc length of the curve $y = f(x)$ over the interval $a \le x \le b$ is given by

$$\text{Arc length} = \int_a^b \frac{x}{x^2+4}\,dx$$

(a) Approximate the arc length of curve $f(x)$, in the interval [0, 1.4] by using the trapezoidal rule, with a step size of $h = 0.1$.

(10 marks)

(b) Approximate the arc length of curve $f(x)$, in the interval [0, 1.4] by using the trapezoidal rule, with a step size of $h = 0.28$.

(5 marks)