AIR FORCE INSTITUTE OF TECHNOLOGY KADUNA
FIRST SEMESTER EXAMINATION 2020/2021 SESSION
DEPT: AEN, EEE, CED, ICE, AUT.MET, TEL, MTE and MEC
LEVEL: 200

Course Title: ENGINEERING MATHEMATICS I
Course Code: GET 209
Credit Unit: 3
Instruction: Answer any FOUR (4) Questions
Duration : 3hrs
Date : 30th July 2021

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1. Apply the Runge-Kutta method to solve the differential equation: $\frac{dy}{dx} = 3 - \frac{y}{x}$ for the range 1.0 to 1.6 with $h = 0.2$, given that the initial conditions $x = 1$ when $y = 2$. [17.5 Marks]

2. (a) The tension T_1, T_2 and T_3 in a simple framework are given by the equations

$$5T_1 + 5T_2 + 5T_3 = 7.0$$
$$T_1 + 2T_2 + 4T_3 = 2.4$$
$$4T_1 + 2T_3 = 4.0$$

Determine T_1, T_2 and T_3 using the Matrices method [9 Marks]
(b) A particle moves along the curve $r = (t^3 - 4t)i + (t^2 + 4t)j + (8t^2 - 3t^3)k$.
Find the component of its acceleration. [4 Marks]
(c) Find the coordinates of the inflexion point on the curve
$y = x^3 + 3x^2 - 9x - 10$ [4.5 Marks]

3. (a) Find the general and particular solutions of the equation $(x-2)\frac{dy}{dx} + \frac{3(x-1)}{(x+1)}y = 1$ given the boundary conditions that $y = 5$ when $x = -1$. [8 Marks]
(b) Determine T_1, T_2 and T_3 in Question (2a) using the Determinant method [5.5 Marks]
(c) Find the direction cosines of each of the following vectors
(i) $r = 2i - 5j + k$ (ii) $r = -3i + 2j - 6k$ [4 Marks]

4. (a) If $U = sin^{-1}(\frac{x}{y}) + tan^{-1}(\frac{y}{x})$, prove that $x\frac{\partial U}{\partial x} + y\frac{\partial U}{\partial y} = 0$ [7 Marks]
(b) Determine T_1, T_2 and T_3 in Question (2a) using the Gaussian elimination method [6.5 Marks]
(c) Using vector product, find the sine angle between
$a = i - 2j + k$ and $b = 2i - 3j + 4k$ [4 Marks]

5. (a) Solve the equation: $7x(x - y)dy = 2(x^2 + 6xy - 5y^2)dx$ [8 Marks]
(b) Obtain the first and second order partial derivatives of
$Z = 5y - 2x^3 + 7x^2y^3$ [5.5 Marks]
(c) Find the unit vectors in the direction of the following vectors
(i) $r = 7i + 2j - 3k$ [2 Marks]
(ii) $r = 3i - 5j - 3k$ [2 Marks]

6. (a) Using the scalar product, find the angle between the vectors
$a = i + 2j + 3k$ and $b = 2i + 3j + 4k$ [4.5 Marks]
(b) Given the equation $x\frac{dy}{dx} = \frac{2}{x+2} - y$ show that the particular solution is $y = \frac{2}{x}ln(x+2)$, given the boundary conditions that $x = -1$ when $y = 0$ [7 Marks]

(c) Given that $f(x) = \frac{x}{x+3}$ and $g(x) = \frac{2}{x}$, evaluate
(i). $f(g(x))$ (ii). $g(f(x))$ (iii). $(f \circ g)(-2)$ (iv). $(g \circ f)(3)$ [6 Marks]

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