TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR THE BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2414: NUMERICAL METHODS FOR ENGINEERS

SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: MARCH 2014
TIME: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Answer Booklet*

This paper consist of **FIVE** questions in **TWO** sections **A** & **B**
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

SECTION A (COMPULSORY)

Question One

$$A = \begin{pmatrix} 8 & 3 \\ 2 & 7 \end{pmatrix}$$

a) Find the eigen values and eigen vectors of **(5 marks)**

b) Given that $L = (D^2 + 3D + 2)$ and $f(t) = t^3$ $f_2(t) = \cos t$, evaluate $L(3f,(t) + 4f_2(t))$ **(5 marks)**

c) If $A = \begin{pmatrix} 3-2i & 1+i \\ 2-i & -2+3i \end{pmatrix}$ find A* **(3 marks)**

d) Use trapezoidal rule with 8 intervals to evaluate: $\int_1^3 \frac{2}{\sqrt{x}}dx$ correct to 3 decimal places **(5 marks)**

e) Find the approximate values of y at t = 0.1, 0.2, 0.3 and 0.4 using Euler's method with a step size of h = 0.1 given that $y'+2y = 2-e^{-4t}$ and y(0) = 1 **(7 marks)**

f) Apply Taylor series to solve the differential equation $y' = 3x+2y$ at x = 0.2 given that y(0) = 1 **(5 marks)**

SECTION B (Answer any TWO questions from this section)

Question Two

a) Evaluate $\int_0^{\pi/3} \sqrt{1-\tfrac{1}{3}\sin^2\theta}\ d\theta$ correct to 3 d.p using Simpsons rule with 6 intervals. **(7 marks)**

b) Solve the system using the matrix method:

$$\frac{dx}{dt} = 6x+5y$$

$$\frac{dy}{dt} = x+2y$$

(7 marks)

c) Use row reduction to find the inverse of the following matrix:

$$M = \begin{pmatrix} 3 & 0 & 2 \\ 2 & 0 & -2 \\ 0 & 1 & 1 \end{pmatrix}$$

(6 marks)

Question Three

a) The velocity of a car accelerating at uniform acceleration a between two points is given by $r = u+at$ where u is its velocity when passing the first point and t is the time taken to pass between the two points. If v = 21m/s when t = 3.5s and r = 33 m/s when t = 6s use determinants to find the values of u and a correct to 4 significant figures. (5 marks)

b) Use Crammer's Rule to solve the system of linear equations **(7 marks)**

$$3x + y + z = 3$$
$$2x + 2y + 5z = -1$$
$$x - 3y - 4z = 2$$

c) Apply the modified Euler's method to determine the approximate values of y given that $y' = x + y,\ y(0) = 1$ and $0 \le x \le 0.04$ with h = 0.02 **(8 marks)**

Question Four

a) Use the fourth order Runge – Kutta method to solve $y' = y^2 + 1 : y(0) = 0$ on the interval (0, 0.3) wth h = 0.1. **(9 marks)**

b) In two closed loops of an electrical circuits the current flowing are given by the simultaneous equations:

$$I_1 + 2I_2 + 4 = 0$$
$$5I_1 + 3I_2 - 1 = 0$$

Use to solve for I1 and I2 Kirchoffs method **(6 marks)**

c) Convert each of the following into normal system.

(i) $$\frac{d^2x}{dt^2} - \frac{5dx}{dt} + x = e^{4t}$$ **(2 marks)**

(ii) $$\frac{d^3x}{dt^3} + 2\frac{d^2x}{dt^2} - \frac{7dx}{dt} = 2t^2 + 1$$ **(3 marks)**

Question Five

a) Use Romberg method to compute:

$$\int_0^1 \frac{dx}{1+x}$$

correct to 4 d.p

h = 0.5, I (a) = 0.7084, I $\left(h/2\right) = 0.69$ and $I\left(h/4\right) = 0.6941$ **(6 marks)**

b) Applying Gauss and quadrature formula for the interval (-1, 1) to compute the integral:

$$I = \int_5^{12} \frac{dx}{x}$$

choosing n = 3 **(8 marks)**

c) Use the trapezium rule to evaluate $\int_0^{\pi/2} \frac{1}{1+\sin x}\, dx$ using 6 intervals **(6 marks)**