THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of JKUAT)

(A Centre of Excellence)

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE IN BACHELOR OF SC. IN MECHANICAL & AUTOMOTIVE ENGINEERING

EMG 2414: NUMERICAL METHODS FOR ENGINEERS

END OF SEMESTER EXAMINATION
SERIES: AUGUST 2012
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 (30 marks)

a) Given that $L = 2D^2 + 3D + 2$ and $f_1(t) = t^3,\ f_2(t) = \sin t;$ evaluate $L[3f_1(t) + 4f_2(t)]$

(5 marks)

b) The velocity of a car accelerating at uniform acceleration α between two points is given by $V = u + at$

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 $V = 33m/s$ when $t = 6.1s$. Use determinants to find the value of U and α. Correct to 4 significant figures. **(5 marks)**

c) Solve the following simultaneous equations using Cramer's Rule.

$$x + y + z = 4$$
$$2x - 3y + 4z = 33$$
$$3x - 2y - 2z = 2$$

(5 marks)

d) Solve by Taylor's series the differential equation $xy' = x - y \quad y(2) = 2$ if at $x = 2.1$, correct to 4 d.p. **(7 marks)**

e) Solve simultaneously the system:

$$\frac{dx}{dt} = 4x - y$$
$$\frac{dy}{dt} = x + 2y$$

using the method of undetermined coefficients. **(7 marks)**

f) Find the approximate value of $I = \int_0^1 \frac{dx}{1+x}$ with step size $h = 0.25$ using the trapezoidal rule. **(6 marks)**

SECTION B (Answer any TWO questions from this section)

Question Two (20 marks)

a) Applying Kirchhoff's Laws to an electric circuit, results in the following equations, $(9+12j)I_1 - (6+8j)I_2 = 5$ and $-(6+8j)I_1 + (8+3j)I_2 = (2+4j)$ solve by matrix method the equations for I_1 and I_2. **(4 marks)**

b) Estimate $\int_0^1 e^{-x^2} dx$ correct to two decimal places using Trapezoidal rule. **(8 marks)**

c) Apply the classical fourth order Runge-Kutta method to approximate the solution to the initial value problem $\frac{dy}{dt} = \left(\frac{y}{t}\right)^2 + \left(\frac{y}{t}\right) \quad 1 \le t \le 1.2 \quad h = 0.1$, and **(8 marks)**

Question Three (20 marks)

$$\begin{bmatrix} 1+i & i^2 \\ -i^3 & 1-4i \end{bmatrix}$$

a) Evaluate the determinant of **(5 marks)**

$$\int_{4.0}^{5.0} Log_e x dx$$

b) Use the trapezium rule hence the Rombers method to solve **(9 marks)**

c) Use the augmented matrix method to obtain the inverse matrix of A. **(6 marks)**

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

(6 marks)

Question Four (20 marks)

$$\begin{bmatrix} 5 < 30^o & 2 < -60^o \\ 3 < 60^o & 4 < -90^o \end{bmatrix}$$

a) Evaluate the determinant of **(5 marks)**

b) By Euler's method solve the differential equation $\frac{dy}{dx} = -y$ with condition $y(0) = 1$ and $h = 0.01$ the up to $n = 3$.

(4 marks)

c) Using row reduction find values of the 3 forces in a system related by the simultaneous equations.

$$F_1 - 2F_2 + 3F_3 = 7$$
$$-F_1 + F_2 - 2F_3 = -5$$
$$2F_1 - F_2 - F_3 = 4$$

(7 marks)

d) A body starts from rest and its velocity is measured every second for 8 seconds as follows:

Time (s)	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
Velocity (m/s)	0	0.4	1.0	1.7	2.9	4.1	6.2	8.0	9.4

If the distance moved is given by $\int_0^{8.0} v dt$ estimate the integral using Simpson's rule **(4 marks)**

Question Five (20 marks)

a) Use the Euler's modified method to determine the value of y given that y(0) = 1. If $\frac{dy}{dx} = y + x^2$ and $h = 0.05$

(5 marks)

$$\int_{2}^{4} \sqrt{(1+x)}\, dx$$

b) Use Simpson's rule to approximate with step size h = 0.5; correct to 4 significant figures.

(4 marks)

$$\frac{dx}{dt} = 3x + 2y$$

c) Solve simultaneously the system

$$\frac{dy}{dt} = -5x + y$$

(11 marks)