MAKERERE UNIVERSITY

COLLEGE OF ENGINEERING, DESIGN, ART AND TECHNOLOGY

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

EMT 1201: ENGINEERING MATHEMATICS II EXAMINATION 2014/2015

Date: 11th May 2015 **Time: 09:00-12:00 Noon**

Instructions: Attempt any five (5) questions for full marks

Question 1 [20 Marks]

1.1: Briefly explain the following terms as applied to Engineering Mathematics

i) Unit vector (2 marks)
ii) Argand diagram (2 marks)
iii) Matrix (2 marks)
iv) Diagonal matrix (2 marks)
v) Conservative vector field (2 marks)

1.2: With the aid of an argand diagram, find the cube roots of the complex number $z = 5(\cos 225^o + j\sin 225^o)$ (6marks)

1.3: If $\frac{R_1 + j\omega L}{R_3} = \frac{R_2}{R_4 - j\frac{1}{\omega C}}$, where R_1, R_2, R_3, R_4, ω, L and C are real, show that $L = \frac{CR_2R_3}{\omega^2 C^2 R_4^2 + 1}$ (4 marks)

Question 2 [20 Marks]

2.1: If x and y are real, solve the equation; $\frac{jx}{1+jy} = \frac{3x + j4}{x + 3y}$ (4 marks)

2.2: In a star connected circuit, currents i_1, i_2 and i_3 flowing through impedances Z_1, Z_2 and Z_3 are given by:

$$i_1 + i_2 + i_3 = 0$$
$$Z_1 i_1 - Z_2 i_2 = e_1 - e_2$$
$$Z_2 i_1 - Z_3 i_3 = e_2 - e_3$$

If Z_1=10; Z_2=8; Z_3=3; e_1-e_2=65; e_2-e_3=160; use Cramer's rule to determine the values of i_1, i_2 and i_3 (8 marks)

2.3: Determine the eigen values and eigen vectors of **Ax**=λ**x** where **A**=$\begin{pmatrix} 1 & 0 & 4 \\ 0 & 2 & 0 \\ 3 & 1 & -3 \end{pmatrix}$ (8 marks)

Question 3 [20 Marks]

3.1: If **a** and **b** are vectors defined by **a**=8**i**+2**j**-3**k** and **b**=3**i**-6**j**+4**k**, where **i**, **j** and **k** are mutually perpendicular unit vectors.

i) Calculate **a**.**b** and hence show that **a** and **b** are perpendicular vectors (4 marks)

ii) Find the magnitude and direction cosines of the vector **a**x**b** (5marks)

3.2: If position vectors $\overline{OA}$, $\overline{OB}$ and $\overline{OC}$ are defined by $\overline{OA} = 2i - j + 3k$, $\overline{OB} = 3i + 2j - 4k$ and $\overline{OC} = -i + 3j - 2k$, determine;

i) the vector $\overline{AB}$ (2 marks)

ii) the vector $\overline{BC}$ (2 marks)

iii) the scalar product $\overline{AB}.\overline{BC}$ (3 marks)

iv) the vector product $\overline{AB} X \overline{BC}$ (4 marks)

Question 4 [20 Marks]

4.1: A particle moves in space so that at time t, its position is given by $x = 2t + 3, y = t^2 + 3t, z = t^3 + 2t^2$. Find the components of its velocity and acceleration in the direction of the vector 2**i**+3**j**+4**k** when t= 2seconds (10 marks)

4.2: If **F**=2**i**+4u**j**+u^2**k** and **G**=u^2**i**-2u**j**+4**k**, determine $\int_0^2 (\boldsymbol{F} x \boldsymbol{G}) du$ (5 marks)

4.3: Find the directional derivative of the function $\phi = x^2 y - 2xz^2 + y^2 z$ at the point (1, 3, 2) in the direction of the vector **a**=3**i**+2**j**-**k**. (5 marks)

Question 5 [20 Marks]

5.1: Briefly describe the following theorems as applied to vector calculus and state their significance in Engineering;

i) Gauss' theorem (3 marks)

ii) Green's theorem (3 marks)

iii) Stokes' theorem (3 marks)

5.2:If **F**=(2xyz)**i**+(x^{2}z)**j**+(x^{2}y)**k**, evaluate the line integral $\int \boldsymbol{F}.\boldsymbol{dr}$ between A(0,0,0) and B(2,4,6)

i) Along the curve c whose parametric equations are $x = u, y = u^2, z = 3u$ (4 marks)

ii) Along the 3 straight lines C_1: (0,0,0) to (2,0,0); C_2: (2,0,0) to (2,4,0); C_3: (2,4,0) to (2,4,6) (4 marks)

iii) Determine whether **F** is a conservative field (3 marks)

Question 6 [20 Marks]

6.1: The equation $2x^3 - 7x^2 - x + 12 = 0$ has a root near x=1.5. Use Newton-Raphson method to find the root to six decimal places (6 marks)

6.2: A pin moves along a straight guide so that its velocity, v (mm/s) when its distance, x (mm) from the beginning of the guide at time t(s) is summarized in the table below. Apply Simpson's rule using 8 intervals to find the approximate total distance travelled by the pin between t=0 and t=4. (8 marks)

t(s)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
v(mm/s)	0	40	79.4	116.8	149.7	173.9	182.5	160.8	0

6.3: Given a certain unknown function, f(x), has the following values at the corresponding x – values:

x	**f(x)**
1.5	0.405
2.1	0.742
3	1.099

Use Lagrange interpolation to find f(1.8). (6 marks)