Strathmore
UNIVERSITY

SCHOOL OF COMPUTING AND ENGINEERING SCIENCES

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

END OF SEMESTER EXAMINATION

MAT 1201: MATHEMATICS II

DATE: 16/03/2026 Time: 16:00 – 18:30

Instructions

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

QUESTION ONE [30 MARKS]

(a) In a mass spring-damper system, the acceleration $\frac{d^2x}{dt^2}$ m/s^2, velocity $\frac{dx}{dt}$ m/s and displacement x m are related by the equations:

$$\frac{d^2x}{dt^2}+3\frac{dx}{dt}+4x=35$$
$$2\frac{d^2x}{dt^2}+\frac{dx}{dt}+2x=20$$
$$-3\frac{d^2x}{dt^2}+2\frac{dx}{dt}+5x=24$$

By using Gauss Jordan method, determine the acceleration, velocity and displacement for the system.

[5 Marks]

(b) The impedance, Z, of an electrical circuit is a complex number that satisfies $\left(Z-\frac{1}{j\omega C}\right)\left(\frac{1}{Z}+\frac{1}{j\omega L}\right)=1$, where L, C and ω are positive real numbers. Solve the equation for Z.

[3 Marks]

(c) Using the properties of determinants evaluate

$$\begin{vmatrix} 1 & 3 & -3 & 5 \\ 4 & 2 & 1 & 2 \\ 3 & 2 & -2 & 2 \\ 0 & 1 & 2 & -1 \end{vmatrix}$$

[4 Marks]

(d) Find by Simpson's rule, an approximate value for $\int_1^7 e^x \, dx$. Use six intervals.

[4 Marks]

(e) Given that $I_n = \int_0^1 x^{\frac{n}{2}} e^{\frac{-x}{2}} \, dx, \ n \geq 0.$

(i) Show that $I_n = nI_{n-2} - 2e^{\frac{-1}{2}}, \quad n \geq 2.$ **[4 Marks]**

(ii) Evaluate I_0 in terms of e. **[1 Mark]**

(f) Given that $M = \begin{pmatrix} 2 & -1 \\ 2 & 5 \end{pmatrix}$.Find the eigen values and the corresponding eigen vectors of M .

[5 Marks]

(g) Find the value of the integral $\int_0^{1+j} \left(x - y + jx^2\right) dz$, along the straight line from $z = 0$ to $z = 1 + j$. **[4 Marks]**

QUESTION TWO [15 MARKS]

(a) Given that

$$A = \begin{pmatrix} 1 & 2 & 3 \\ -2 & 1 & 2 \\ 3 & -1 & -1 \end{pmatrix} \quad \text{and} \quad B = \begin{pmatrix} 1 & -1 & 1 \\ 4 & -10 & -8 \\ -1 & 7 & 5 \end{pmatrix}$$

i. Determine AB . Hence A^{-1}. **[4 Marks]**

ii. Hence solve the following system of simultaneous equations:

$$x + 2y + 3z = -6$$
$$-2x + y + 2z = 1$$
$$3x - y - z = 1$$

[4 Marks]

(b) A company makes three types of security locks A, B and C, each of which requires cutting, assembly, and finishing. Each unit of A requires 2 hours for cutting, 1 hour for assembly, and 3 hours for finishing. Each unit of B requires 1 hour for cutting, 2 hours for assembly, and 1 hour for finishing. Each unit of C requires 1 hour for cutting, 2 hours for assembly , and 3 hours for finishing.
Available machine resources provide exactly 10 hours for cutting, 14 hours for assembly, and 18 hours for finishing each week.

i. Use the information provided to form a system of simultaneous equations. **[3 Marks]**

ii. Apply Cramer's rule to calculate the number of locks of each type produced given that there is optimum utilization of machine time at the factory in a week. **[4 Marks]**

QUESTION THREE [15 MARKS]

(a) The eigenvalues of a 2×2 matrix A are $\lambda_1 = 3$ and $\lambda_2 = 2$ with corresponding eigenvectors $x_1 = \begin{bmatrix} -2 & 1 \end{bmatrix}^T$ and $x_2 = \begin{bmatrix} -1 & 1 \end{bmatrix}^T$. Determine the

i. The modal matrix M and spectral matrix Λ of A. **[2 Marks]**

ii. the matrix A. **[3 Marks]**

iii. A^2 **[2 Marks]**

(b) Given that $\begin{bmatrix} 1 & 0 & 1 \end{bmatrix}^T$ is an eigenvector of the matrix $A = \begin{pmatrix} 2 & -1 & 0 \\ -1 & 3 & b \\ 0 & b & c \end{pmatrix}$

Find the:

i. value of b and c. **[3 Marks]**

ii. eigenvalues and corresponding eigenvectors. **[5 Marks]**

QUESTION FOUR [15 MARKS]

(a) Use De Moivres theorem to show that

$$\cos^7\theta = \frac{1}{64}\left(\cos 7\theta + 7\cos 5\theta + 21\cos 3\theta + 35\cos\theta\right)$$ **[5 Marks]**

(b) Using Cauchy Riemann equations, show that $f(z) = z^3$ in the entire $z-plane$. **[5 Marks]**

(c) Evaluate $\int_C \frac{z-1}{(z+1)^2(z-2)}\,dz$ where C is $|z-j|=2$.

[5 Marks]

QUESTION FIVE [15 MARKS]

(a) Find an exact expression for $\int_0^k e^{2x/k}\,dx$. **[3 Marks]**

(b) Use Simpson's rule to show that the approximate value of the integral in (a) is $\frac{k}{6}\left(1+4e+e^2\right)$.

[4 Marks]

(c) By equating your answers to (a) and (b), find an approximate numerical value for e.

[4 Marks]

(d) Show that the corresponding approximation found using the trapezium rule in (a) is $e=3$.

[4 Marks]

END