


Final Assessment Test – November 2025

Course: BMAT201L - Complex Variables and Linear Algebra

Class NBR(s): 0675 / 0723 / 0726 / 0739 / 0740

Slot: D2+TD2+TDD2

Time: Three Hours

Max. Marks: 100

- > KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
 > DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Construct analytic functions and find complex potential of fluid flow and electric fields.
CO2	Find the image of straight lines by elementary transformations and express analytic functions in power series.
CO3	Evaluate real integrals using techniques of contour integration.
CO4	Use the power of inner product and norm for analysis.
CO5	Use matrices and transformation for solving engineering problems.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

 Answer ALL Questions

(10 X 10 = 100 Marks)

1. The complex potential of a fluid flow is given by $\Omega(z) = V_0\{z + (a^2/z)\}$ where V_0 and a are positive constants. CO1 BL3
 (a) Obtain equations for the streamlines and equipotential lines, represent them graphically, and interpret physically.
 (b) Show that we can interpret the flow as that around a circular obstacle of radius a .
 (c) Find the velocity at any point and determine its value far from the obstacle.
2. (a) If $f(z) = z^3$, show that u and v satisfy the $C - R$ equations. Also prove that the families of curves $u = C_1$ and $v = C_2$ are orthogonal to each other. [5] CO1 BL2
 (b) Show that the function $u(x, y) = 3x^2y + x^2 - y^3 - y^2$ is a harmonic function. Find the harmonic conjugate $v(x, y)$ such that $u + iv$ is an analytic function. [5]
3. Let the rectangular region \mathcal{R} in the z plane be bounded by $x = 0$, $y = 0$, $x = 2$, $y = 1$. Determine the region \mathcal{R}' of the w plane into which \mathcal{R} is mapped under the transformations: CO2 BL3
 (a) $w = z + (1 - 2i)$
 (b) $w = \sqrt{2}e^{\pi i/4}z + (1 - 2i)$.
4. Find the bilinear transformation which maps $z = 1, i, -1$ respectively onto $w = i, 0, -i$. Hence find the fixed points. CO2 BL2

5.a) Evaluate $\int_0^{\infty} \frac{dx}{x^4 + a^4}, a > 0.$

CO3 BL3

OR

5.b) Expand $f(z) = 1/(z-1)(z-2)$ in a Laurent's series valid in the region
 (i) $|z-1| > 1$, (ii) $0 < |z-2| < 1$, (iii) $|z| > 2$, (iv) $0 < |z-1| < 1$.

CO3 BL3

6. Find a basis and dimension for the row space of $A = \begin{bmatrix} 1 & 4 & 5 & 6 & 9 \\ 3 & -2 & 1 & 4 & -1 \\ -1 & 0 & -1 & -2 & -1 \\ 2 & 3 & 5 & 7 & 8 \end{bmatrix}$

CO4 BL2

consisting entirely the row vectors of A . Also find the nullity of A .

7.a) Let the transformation T be a multiplication by the matrix A where

CO4 BL3

$$A = \begin{bmatrix} 1 & 2 & 5 \\ 3 & 5 & 13 \\ -2 & -1 & -4 \end{bmatrix}$$

- (i) Find a basis for the range of T .
- (ii) Find a basis for the kernel of T .
- (iii) Find the rank and nullity of T .
- (iv) Verify the dimension theorem.

OR

7.b) Let $T: \mathbb{R}^3 \rightarrow \mathbb{R}^3$ be the linear operator defined by the formula
 $T(X_1, X_2, X_3) = (X_1 - X_2 + X_3, 2X_2 - X_3, 2X_1 + 3X_2)$.

CO4 BL3

Determine whether T is one-to-one. If so, find $T^{-1}(X_1, X_2, X_3)$.

8. Use the Gram-Schmidt process to transform the basis $\{1, x, x^2\}$ of P_2 into an orthonormal basis if

CO4 BL3

(i) $\langle p, q \rangle = p(0)q(0) + p(1)q(1) + p(2)q(2)$

(ii) $\langle p, q \rangle = \int_0^2 p(x)q(x) dx$

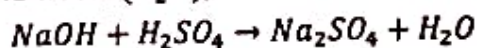
9. Find the Eigenvalues, Eigenvectors and the Eigen spaces of the matrix

CO5 BL2

$$A = \begin{bmatrix} 3 & 2 & 2 \\ 1 & 4 & 1 \\ -2 & -4 & -1 \end{bmatrix}$$

10. Sodium hydroxide ($NaOH$) reacts with sulphuric acid (H_2SO_4) to yield sodium sulphate (Na_2SO_4) and water (H_2O),

CO5 BL3



Balance the equation by using the Gauss-Jordan Method.

⇔⇔⇔ Z/K/TY ⇔⇔⇔