



### Continuous Assessment Test (CAT)- I- September 2022

|              |   |           |   |
|--------------|---|-----------|---|
| Programme    | : B.Tech.   | Semester  | : Fall 2022-2023  |
| Course Title | : Complex Variables and Linear Algebra  | Code      | : BMAT2011  |
| Faculty      | : Dr. M. Dhivya, Dr. N. Durga, Dr. M. Prasannalakshmi,<br>Dr. C. Rajivganthi, Dr. Ashish Kuniar, Dr. Prosenjit,<br>Dr. Ankit Kumar, Dr. Surath Ghosh, Dr. Sandip Saha,<br>Dr. Kamalesh, Dr. P. Sushmitha, Dr. Amitkumar Rahul | Slot      | : A1+TA1+TAA1   |
| Duration     | : 1 ½ Hours   | Class Nbr | : CH2022231001157,<br>60, 62, 64, 67, 70,<br>72, 74, 76, 80, 82 |

**Answer all the Questions (50 marks)**

- | Q.No. | Question Description  | Marks |
|-------|---|-------|
| 1.    | Prove that the function $u = e^x(x \cos y - y \sin y)$ is harmonic. Also find a function $v$ such that $f(z) = u + iv$ is analytic and express $f(z)$ in terms of $z$ .   | [10]  |
| 2.    | Show that the function $f(z) = \begin{cases} \frac{\bar{z}^2}{z}, & z \neq 0 \\ 0, & z = 0 \end{cases}$ satisfies the Cauchy Riemann equations at origin but not analytic at $z = 0$ .  | [10]  |
| 3.    | In a two-dimensional fluid flow, if $\psi(x, y) = x^2 - y^2 - 3x - 2y + 2xy$ can represent the stream function, find the velocity potential and complex potential.  | [15]  |
| 4.    | a) Find the points for which the following function is not conformal $f(z) = z^2 + \frac{1}{z^2}$<br>b) Find the image of the circle $ z  = 2$ under the transformation $w = (\sqrt{2} e^{i\frac{\pi}{4}})z$ .  | [5]   |
| 5.    | Find the image of the wedge $ z  \leq \frac{1}{2}, -\frac{\pi}{8} < \arg(z) < \frac{\pi}{8}$ under the mappings (i) $w = z^2$ and (ii) $w = iz$ . Sketch the region of images.  | [10]  |
| 6.    | Determine the bilinear transformation which maps the points $z = 0, -i, 2i$ into the points $w = 5i, \infty, \frac{-i}{3}$ respectively. List the invariant points of this transformation. Sketch the image of $ z - i  < 1$ under the obtained transformation. | [10]  |



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**Continuous Assessment Test (CAT) - I – June 2023**

$$n^r = n^{r(n-1)}$$

Programme : B.Tech.

Semester : Fall Inter Semester  
2022-23

Course Title : Complex Variables and Linear Algebra

Code : BMAT201L  
Slot : X11+X12+X21+Z2

Faculty : Dr. Kriti Arya

Class Nbr : 1  
Max. Marks : CH2022232501343  
50

Duration : 1 ½ Hours

**Answer all the Questions (5×10=50)**

| Q.No. | Sub. Sec. | Question Description  | Marks |
|-------|-----------|---|-------|
| 1.    | (a)       | Determine whether $\frac{1}{z}$ is analytic or not?   | [5]   |
|       | (b)       | Show that the function defined by $f(z) = \sqrt{ xy }$ satisfies Cauchy-Riemann equation at the origin but is not analytic at that point.                             | [5]   |
| 2.    |           | Prove that $u = x^2 - y^2 - 2xy - 2x + 3y$ is harmonic. Find a function $v$ such that $f(z) = u + iv$ is analytic. Also, express $f(z)$ in terms of $z$ .             | [10]  |
| 3.    | (a)       | If $w = \theta + i\varphi$ represents the complex potential for an electric field and $\varphi = x^2 - y^2 + \frac{x}{x^2 + y^2}$ , determine the function $\theta$ . | [5]   |
|       | (b)       | Transform the rectangular region ABCD in the $z$ -plane bounded by $x = 1, x = 3; y = 0$ , and $y = 3$ , under the transformation $w = z + (2 + i)$ .                 | [5]   |
| 4.    | (a)       | Show that under the transformation $w = \frac{1}{z}$ , the image of the hyperbola $x^2 - y^2 = 1$ is the lemniscate $R^2 = \cos 2\varphi$ .                           | [5]   |
|       | (b)       | Find a bilinear transformation which maps the points $i, -i, 1$ of the $z$ -plane into $0, 1, \infty$ of the $w$ -plane, respectively.                                | [5]   |
| 5.    | (a)       | Find the radius of convergence of the power series:   | [5]   |
|       |           | $f(z) = \sum_{n=0}^{\infty} \frac{n!}{n^n} z^n.$  |       |
|       | (b)       | Find the terms in the Laurent expansion of $\frac{1}{z(e^z - 1)}$ for the region $0 <  z  < 2\pi$ .   | [5]   |
|       |           | Or  |       |
|       |           | Expand the function $f(z) = \tan^{-1} z$ in powers of $z$ .   | [5]   |

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### Continuous Assessment Test I (CAT-1) – May 2023

Programme : B.tech

Semester : Fall Inter Semster2022-  
23

|   |   |              |                                   |
|---|---|--------------|-----------------------------------|
| Course Code   | : BMAT 201L   | Class Nbr(s) | : CH2022232500603,60<br>1,602,567 |
| Course Title : Complex Variables and Linear Algebra |   |              |                                   |
| Faculty(s)  | : Dr. Pankaj Shukla,Dr Prabhakar V, Dr. Rajiv Gandhi, Dr Dhivya P | Slot         | : D1+TD1+TDD1                     |
| Time  | : One and half Hours  | Max. Marks   | : 50                              |

Answer all the Questions

|    |   |    |
|----|---|----|
| 1. | Show that the function $f(z)$ defined by $f(z) = \frac{xy(y-ix)}{x^2+y^2}$ , $z \neq 0$ and $f(0) = 0$ is not analytic at the origin, though it satisfies Cauchy – Reimann equations at the origin.   | 10 |
| 2. | If $\varphi = (x-y)(x^2 + 4xy + y^2)$ can represent the equipotential for an electric field, find the corresponding complex potential $w = \varphi + i\psi$ and also $\psi$ , if possible.  | 10 |
| 3. | Find the image of the following regions under the transformation $w = \frac{1}{z}$ :<br><br>(i) The half plane $x > c$ , when $c < 0$<br>(ii) The half plane $y > c$ , when $c < 0$<br>(iii) The infinite strip $\frac{1}{4} \leq y \leq \frac{1}{2}$ . | 10 |
| 4. | Show that the transformation $w = \frac{z-1}{z+1}$ maps the unit circle in the $w$ – plane onto the imaginary axis in the $z$ – plane. Find also the images of the interior and exterior of the unit circle in the $z$ -plane.                          | 10 |
| 5. | Find the Laurent's series of $f(z) = \frac{1}{z(1-z)}$ valid in the regions: (i) $ z + 1  < 1$ ,<br>(ii) $1 <  z + 1  < 2$ (iii) $ z + 1  > 2$ .  | 10 |



**Continuous Assessment Test (CAT)- I- May 2023**

|              |   |            |                                      |
|--------------|---|------------|--------------------------------------|
| Programme    | : B.Tech.   | Semester   | : Fall Inter2022-23                  |
| Course Title | : Complex Variables and Linear Algebra  | Code       | : BMAT201L                           |
| Faculty      | : Dr. P. Durgaprasad, Dr. Tharasi Dilleswar Rao,<br>Dr. C. Rajivganthi, Dr. Pankaj Shukla,<br>Dr. B. Jaganathan | Slot       | : D2+TD2+TDD2                        |
| Duration     | : 1 ½ Hours   | Class Nbr  | : CH2022232500604,<br>05, 06, 07, 09 |
|              |   | Max. Marks | : 50                                 |

**Answer all the Questions (50 marks)**

- | Q.No. | Question Description  | Marks |
|-------|---|-------|
| 1.    | a) Determine all the points where the given function $\frac{\bar{z}+1}{ z+1 ^2}$ is differentiable<br><br>b) For what values of $a$ and $b$ the given $v = (x-1)^3 - axy^2 + by^2$ is harmonic and find its harmonic conjugate. [4+6] | [4+6] |
| 2.    | Find the potential and stream functions of a complex potential function, when $\phi - \psi = (x-y)(x^2 + y^2 + 3xy)$ . [10]   | [10]  |
| 3.    | Show that the transformation $w = \frac{z-i}{1-iz}$ maps (i) the interior of the circle $ z  = 1$ onto the lower half of the $w$ -plane and (ii) the upper half of the $z$ -plane onto the interior of the circle $ w  = 1$ . [10]    | [10]  |
| 4.    | a) Find the bilinear transformation whose fixed points are $\frac{1}{2}$ and 2.<br>b) Find the bilinear transformation that maps the points $i, -i, 1$ into the points $0, 1, \infty$ , respectively. [5+5]                           | [5+5] |
| 5.    | Find the Laurent series expansion for the function $f(z) = \frac{7z-2}{(z+1)z(z-2)}$ in the region i) $1 <  z  < 2$ , ii) $1 <  z+1  < 3$ . [10]  | [10]  |

**Answer all the Questions**  
**(5x10 = 50 marks)**

| Q.No. | Sub.<br>Sec. | Question Description   | Marks       |
|-------|--------------|--|-------------|
| 1     |              | Find the constant 'a' so that $u(x, y) = ax^2 - y^2 + xy$ is harmonic. Find an analytic function $f(z)$ for which $u$ is the real part. Also find its harmonic conjugate.  | 10          |
| 2     |              | (a) In a two-dimensional fluid flow, the velocity potential $\phi(x, y)$ is given as $4x(3y - 4)$ . Find the complex potential $w = \phi(x, y) + i\psi(x, y)$ where $\psi$ is the stream function.<br>(b) Verify whether $f(z) = \frac{1}{z-1}$ is analytic at $z = 1 + i$ . | 10<br>[5+5] |
| 3     |              | Determine the bilinear transformation which maps the points $z = 1, -1, \infty$ into the points $w = 1 + i, 1 - i, 1$ respectively. Find the image of the unit circle $ z  = 1$ under this transformation and sketch the image.  | 10          |
| 4     |              | (a) Find the points where $w = e^{\cosh hz}$ is not conformal.<br>(b) Find the image of the circle $ z - 1  = 1$ under the transformation $w = (\frac{1}{2}e^{i\frac{\pi}{2}})z$ .   | 10<br>[5+5] |
| 5     |              | (a) Find the Taylor series expansion of the given function $f(z) = \frac{z^3+1}{(z-3)(z-5)}$ about $z = 2$ . Also, discuss the radius of convergence.<br>(b) Find the poles and residues of the given function $f(z) = \frac{1}{z^4+5z^2+6}$ .                               | 10<br>[5+5] |



**Continuous Assessment Test (CAT) – 1 – September 2023**

|              |   |              |   |
|--------------|---|--------------|---|
| Programme    | : B.Tech  | Semester     | : Fall 2023-24  |
| Course Title | : Complex Variables and Linear Algebra  | Code         | : BMAT201L  |
| Faculty      | : Dr. S. Balaji, Dr. Ashish Kumar Nandi, Dr. N. Mohana, Dr. G. Hannah Grace, Dr. Abhishek Kumar Singh, Dr. Prosenjit paul, Dr. P. Vijay Kumar, Dr. M Dhivya | Slot(s)      | : A2+TA2+TAA2   |
| Duration     | : 1 ½ Hours   | Class Nbr(s) | : CH2023240101009, 1010, 1011, 1012, 1013, 1014, 1015, 1017 |

**Answer all the Questions ( $5 \times 10 = 50$ )**

| Q.No. | Sub. Sec. | Question Description   | Marks |
|-------|-----------|--|-------|
| 1     | 2         | Check whether $u = x^2 - y^2$ and $v = \frac{-y}{x^2+y^2}$ are harmonic. Also verify if $u + iv$ is analytic. Justify?   | 10    |
| 2     |           | Find the analytic function $f(z)$ given that $2u + 3v = e^x (\cos y - \sin y)$ .   | 10    |
| 3     |           | (a) Find all the points where the mapping $f(z) = \sin z$ is conformal. [3 Marks]<br>(b) Find the image of the triangle with vertices $0, 1+i$ and $1-i$ under the mapping $w = z^2$ . [7 Marks]   | 10    |
| 4     | 2         | Find the bilinear transformation $w = f(z)$ which maps the points $z = 1, i, -1$ onto the points $w = i, 0, -i$ . Also, find the fixed point and image of $ z  \leq 1$ under the mapping $w = f(z)$ .  | 10    |
|       |           | (a) Using Laurent's series, expand the function $f(z) = \frac{2z+1}{z^3+z^2-2z}$ valid in the region $0 <  z-1  < 1$ . [5 Marks]<br>(b) Find the poles and residues of the given function $f(z) = \frac{\sin z}{z \cos z}$ inside the circle $ z  = 5$ . [5 Marks] | 10    |

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