**Department of Mathematics**
**Indian Institute of Technology Patna**
**B.Tech. II year (Autumn Semester: 2020-21)**

**Tutorial-3: MA201 (Complex Analysis)**

1. Prove that if $f'(z) = 0$ everywhere in a domain $D$, then $f(z)$ must be constant throughout $D$.
2. Use Cauchy-Riemann equations to check whether or not the function $f(z) = e^{\bar{z}}$ is analytic anywhere.

3. Verify the following inequalities.
   (i) $|e^{2z+i} + e^{iz^2}| \leq e^{2x} + e^{-2xy}$ (ii) $|e^{z^2}| \leq e^{|z|^2}$ (iii) $|e^{-2z}| < 1$ iff $Re(z) > 0$

4. Find all values of $z$ such that:
   (i) $e^z = 2$ (ii) $e^z = 1 + \sqrt{3}\, i$ (iii) $e^{2z-1} = 1$ (iv) $e^z = -4$ (v) $e^z = \sqrt{3} - i$
5. 
   (i) Show that $\overline{\exp(iz)} = exp(i\bar{z})$ if and only if $z = n\pi,\ (n = 0, \pm 1, \pm 2, \ldots)$
   (ii) $e^z$ is real then what restriction is placed on $z$.
   (iii) $e^z$ is imaginary then what restriction is placed on $z$.

6. Show that:
   (i) $Log(1+i)^2 = 2Log(1+i)$
   (ii) $Log(-1+i)^2 \neq 2Log(-1+i)$
   (iii) $log(i^2) = 2log(i)$ when $log(z) = ln(r) + i\theta(r > 0,\ \frac{\pi}{4} < \theta < \frac{9\pi}{4})$
   (iv) $log(i^2) \neq 2log(i)$ when $log(z) = ln(r) + i\theta(r > 0,\ \frac{3\pi}{4} < \theta < \frac{11\pi}{4})$
   (v) the set of values for $log(i^{1/2})$ and $(1/2)log(i)$ are same also find that common values
   (vi) if $Re(z_1) > 0$ and $Re(z_2) > 0$ then $Log(z_1 z_2) = Log(z_1) + Log(z_2)$

7. Find:
   (i) the values of $(1+i)^i$ (ii) the values of $(-1)^{1/\pi}$
   (iii) principal value of $i^i$ (iv) principal value of $[(e/2)(-1-\sqrt{3}\, i)]^{3\pi i}$
   (v) all $z$ for which $Log(z) = 1 - (\pi/4)i$ (vi) all $z$ for which $e^z = -ie$

8. Show that:

   (i) $\overline{\sin(z)} = \sin \bar{z}$ (ii) $\overline{\cos(z)} = \cos \bar{z}$ (iii) $\overline{\cos(iz)} = \cos i\bar{z}$
   (iv) $\overline{\sin(iz)} = \sin i\bar{z}$ iff $z = n\pi i,\ (n = 0, \pm 1, \pm 2, \ldots)$
   (v) $\sin \bar{z}$ and $\cos \bar{z}$ is nowhere analytic

9. Find the roots of the following equations:
   (i) $\sin z = \cosh 4$ (ii) $\cos z = 2$ (iii) $\sin z = i \sinh 1$ (iv) $\sinh z = -1$ (v) $\sinh z = e^z$
   (vi) $\cosh z = -2$ (vii) $\sinh z = i$

10. Show that:
    (i) $\sin(z_1 + z_2) = \sin z_1 \cos z_2 + \cos z_1 \sin z_2$ (ii) $\cos(z_1 + z_2) = \cos z_1 \cos z_2 - \sin z_1 \sin z_2$
    (iii) $|\sin z| \geq |\sin x|$ and $|\cos z| \geq |\cos x|$ (iv) $|\sinh y| \leq |\sin z| \leq \cosh y$
    (v) $|\sinh y| \leq |\cos z| \leq \cosh y$ (vi) $|\sinh x| \leq |\cosh z| \leq \cosh x$
    (vii) $\cosh^2 z - \sinh^2 z = 1$

11. Derive formula for $\sin^{-1} z,\ \cos^{-1} z,\ \tan^{-1} z,\ \sinh^{-1} z,\ \cosh^{-1} z,\ \tanh^{-1} z$.

12. Find values of $\tan^{-1}(2i),\ \cosh^{-1}(-1),\ \tanh^{-1} 0$.

13. Solve the equations $\sin z = 2$ and $\cos z = \sqrt{2}$.