**Field and Waves (ECPC-204)** **Test-II (MM: 20)** **Dated 23.10.2024**

**Note: Attempt all questions.**

1. A current $I$ flows in the inner conductor of an infinitely long coaxial line and returns via the outer conductor. The radius of the inner conductor is $a$, and the inner and outer radii of the outer conductor are $b$ and $c$, respectively. Find the magnetic flux density B for all regions and plot $|\mathbf{B}|$ versus $r$.

**OR**

A thin conducting wire is bent into the shape of a regular polygon of $N$ sides. A current $I$ flows in the wire. Show that the magnetic flux density at the center is $B = a_n \frac{\mu_0 NI}{2\pi b}\tan\frac{\pi}{N}$ where $b$ is the radius of the circle circumscribing the polygon and $a_n$ is a unit vector normal to the plane of the polygon. Show also that, as $N$ becomes very large, this result reduces to that given by $B = a_z \frac{\mu_0 I b^2}{2(z^2+b^2)^{3/2}}$ with $z = 0$.

2. Calculations concerning the electromagnetic effect of currents in a good conductor usually neglect the displacement current even at microwave frequencies.
   a. Assuming $\epsilon_r = 1$ and $\sigma = 5.70 \times 10^7$ (S/m) for copper, compare the magnitude of the displacement current density with that of the conduction current density at 100 GHz. $J_d$
   b. Write the governing differential equation for magnetic field intensity $H$ in a source free good conductor.

3. Find the resistance between two concentric spherical surfaces of radii $R_1$ and $R_2$ ($R_1 < R_2$) if the space between the surfaces is filled with a homogeneous and isotropic material having a conductivity $\sigma$.

4. It is known that the electric field intensity of a spherical wave in free space is $\mathbf{E} = \mathbf{a}_\theta \frac{E_0}{R}\sin\theta\cos(\omega t - kR)$. Determine the magnetic field intensity $\mathbf{H}$ and the value of $k$

$J = \sigma E$