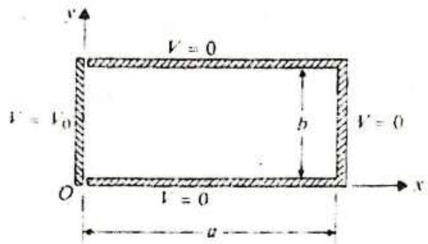
Field and Waves (ECPC-31) **Test-II** **Dated:17.11.2022**

Note: Attempt three questions in all attempting at-least one question from each part. All questions carry equal marks i.e. 10 **M.M. 30**

Part – I

1. Consider a rectangular box shown in Fig below (with the changed boundary conditions in this question) as the cross-section of an enclosure formed by four conducting planes. The left and right plates are grounded, and the top and bottom plates are maintained at constant potentials V_1 and V_2, respectively. Determine the potential distribution inside the enclosure in generalized terms. Also explain why Fourier series expansion is required to satisfy certain boundary conditions.



2. Determine the resistance between two concentric spherical surfaces of radii R_1 and $R_2 (R_1 < R_2)$, assuming that a material of conductivity $\sigma = \sigma_0\left(1 + \frac{k}{R}\right)$ fills the space between them.
3. 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 in $B = a_z \frac{\mu_0 I b^2}{2\left(z^2 + b^2\right)^{3/2}}$ with $z = 0$.

Part – II

4. Given that $\mathbf{E} = \mathbf{a}_y 0.1\sin(10\pi x)\cos\left(6\pi 10^9 t - \beta z\right)$ V/m in air. Find $\mathbf{H}$ and β.
5.
   a. Derive the following general expression of the attenuation and phase constants for conducting media: $\alpha = \omega\sqrt{\frac{\mu\varepsilon}{2}}\left[\sqrt{1 + \left(\frac{\sigma}{\omega\varepsilon}\right)^2} - 1\right]^{1/2}$ Np/m and $\beta = \omega\sqrt{\frac{\mu\varepsilon}{2}}\left[\sqrt{1 + \left(\frac{\sigma}{\omega\varepsilon}\right)^2} + 1\right]^{1/2}$ rad/m
   b. **Prove that i) an elliptically polarized plane wave can be resolved into right hand and left hand circularly polarized waves ii) a circularly polarized plane wave can be obtained from a superposition of two oppositely directed elliptically polarized waves.**