1. Magnetic field flux density in air is 
\[ \vec{B} = 15z\hat{a}_x + 3\cos(2t)\hat{a}_z \text{ Wb/m}^2. \]
   a. Calculate the induced electro-motive-force (emf) around the closed path placed on \( z = 0 \) shown in the figure below.
   b. Find the magnitude of the induced current if the resistor \( R = 10 \Omega \) in the figure below.

2. A current density of 
\[ \vec{J} = xe^{-0.1t}\hat{a}_x \text{ A/m}^2 \] is given. Find the charge density after 10 seconds if it has an initial value of \( \rho_0 = 0 \text{ C/m}^3. \)
3. A uniform plane wave oscillating with a frequency of 100 MHz in a lossless dielectric medium has the total phasor electric field component of
\[ \vec{E} = 10\left(e^{-j2\pi z} + 0.7e^{j(2\pi z + \pi/6)}\right) \text{V/m}. \]
   a. Write the electric field expression in time domain.
   b. Find the period T of the wave.
   c. Find the wavelength \( \lambda \) of the wave.
   d. Find the relative permittivity \( \varepsilon_r \) of the medium.
   e. Find the phase velocity \( v_p \) of the wave.

4. The electric field component of a uniform plane wave (in time domain) in a lossy dielectric is
\[ \vec{E} = 30e^{-z/3} \cos(4\pi \times 10^8 t - \beta z) \hat{a}_y \text{V/m}, \]
and the intrinsic impedance of this medium is \( \eta = 150\angle60^\circ \Omega \).
   a. Calculate the frequency \( f \).
   b. Determine the attenuation constant \( \alpha \).
   c. Find the corresponding magnetic field vector in time domain.
   d. Are the electric field and magnetic field in phase? Explain why.

5. A magnetic field \( \vec{H} = H_0 (e^{j(3t-2z)} \hat{a}_y + 3\hat{a}_z) \text{A/m} \) in free space is given, and the conduction current \( \vec{J} = 0 \) in this region. Calculate the electric field \( \vec{E} \) using Maxwell’s equations explicitly.

6. In air the magnetic field component of a plane wave is
\[ \vec{H}(z, t) = 12\cos(\pi \times 10^6 t + \beta z + \pi / 6)\hat{a}_x \text{A/m}. \]
   a. Calculate the time-average power density.
   b. Calculate the total power across a 2 m\(^2\) surface area located at \( z = 3 \text{ m} \) plane.
   c. Total power across a 3 m\(^2\) surface area located at \( x = 1 \text{ m} \) plane.

7. Determine the electric potential difference between the points A(0, 2, 0) and B(0, 0, 4) if the electric field in this region is \( \vec{E} = (6x + 3y)\hat{a}_x + 5x\hat{a}_y - 3\hat{a}_z \text{ V/m}. \)
8. Several types of charges placed in free space has following coordinates:

A point charge $Q_1$ is located at $(1, 1, 1)$, another point charge $Q_2$ is located at $(-2, -2, 3)$. A uniform line charge, $\rho_L$ is located parallel to z-axis and passing through at the point $x = 1$, and $y = -1$, and an infinitely large uniform surface charge $\rho_S$ is located on $z = -1$ plane.

Calculate the total electric flux emanating from the closed surface shown below.

![Diagram of electric flux](image)

9. Calculate the magnetic flux density $\vec{B}$ at $(0, 1, 5)$ due to a surface current density $\vec{K} = 5\hat{x}$ A/m flowing on infinitely large surface located at $z = -2$ plane in air, and an infinitely long line current $I = 3$A flowing in positive $y$ direction on the $y$-axis.

(Note: Draw the coordinate system and show all the vectors necessary to work the problem first)

10. Suppose you have a surface current density $\vec{K} = 25\hat{x}$ A/m along the $z = 0$ plane. A 5nC point charge is moving along with velocity $\vec{v} = -10\hat{x}$ m/s at 1 m above this plane.

Calculate the magnetic force experienced by this point charge due to the magnetic filed generated by the surface current density.