

**EE3109 Applied Electromagnetics**  
**2024/25 Semester B**  
**Assignment 1A**

1. Write Maxwell's Equations in differential form. Write within brackets the unit for each variable (eg.  $\mathbf{E}$  [V/m]).
2. A plane wave has magnetic flux density  $\mathbf{B}^-(z, t) = B_0 \cos(\omega t + kz + \phi) \hat{\mathbf{x}}$  [C/m<sup>2</sup>]
  - (a) In what direction does it travel, and what is the speed of this plane wave?
  - (b) What is the corresponding electric field?
  - (c) What is the electric field at the origin?
  - (d) What is the electric field at the point  $(x, y, z) = (10\text{m}, -10\text{m}, 0\text{m})$ ?
3. The electric field of a plane wave is  $\mathbf{E}(\mathbf{r}, t) = 15 \cos(5 \times 10^9 \pi t + mx + ny - 70^\circ) (2\hat{\mathbf{x}} - \hat{\mathbf{y}})$  [mV/m]. The wave travels in a lossless, material with  $\epsilon_r = 1$  and  $\mu_r = 9$ . Find:
  - (a) Its frequency
  - (b) Its wavelength
  - (c) Its propagation direction
  - (d) The constants  $m$  and  $n$
  - (e) The corresponding  $\mathbf{H}(\mathbf{r}, t)$ .
  - (f) The amplitude of the  $\mathbf{H}$  field at the origin, at time  $t = 0$ .
4. Consider an electric field phasor in the form of a Gaussian beam:
$$\mathbf{E}(x, y, z, t) = E_0 \exp\left(-\frac{(x^2 + y^2)}{w_0^2}\right) \exp(-jkz) \hat{\mathbf{x}}.$$
  - (a) Find the corresponding magnetic field phasor using Maxwell's equations.
  - (b) Show that, close to the center of the beam (i.e. for  $x^2 + y^2 \ll w_0^2$ ), the Gaussian beam can be approximated by a plane wave.