1. Derive the divergence theorem. Note that the divergence of a vector field must be derived first. (20%)

2. Describe Gauss's Law in the static field (10%). For an electrical dipole (+q and –q with a small separation d), find the potential and electrical field at any point in the space. (10%) Find the formula of electrical field lines (hint: the electric field lines represent the direction of the electrical field in the space, i.e., $d\mathbf{l}=k\mathbf{E}$, k is a constant) (10%)

3. Write down Maxwell's equations and give a short reason for each equation to describe the existing electromagnetic phenomena or characteristics (10%).

4. For a transmission line problem, a 150 MHz generator with $Vg=10\angle 0^{\circ}$ (V) and internal resistance 40Ω is connected to a lossless 40Ω air line that is 4 m long and terminated in a $20+j20\Omega$ load. Find (a) V(z) at a location z from the generator, (b) V_i at the input terminals and V_L the load, (c) the voltage standing-wave ratio on the line, and (d) the average power delivered to the load. (20%).

5. A sinusoidal electrical intensity of amplitude 200 V/m and frequency 3 GHz exists in a lossy dielectric medium that has a relative permittivity of 3 and a loss tangent of 0.002. Find the average power dissipated in the medium per cubic meter. (20%).

$(\tan\delta_c = \frac{\sigma}{\omega\varepsilon}, p = \frac{1}{2}\sigma E^2, \varepsilon_0 = \frac{10^{-9}}{36\pi})$