1.

The earth is surrounded by an ionized shell, or ionosphere. Assuming the ionosphere is equivalent to a conducting shell at a height of h km. Let the earth radius be R_E and total charge deposited on the earth be $-Q$. Find (a) the electric filed intensity and flux density at $0<r<R_E$ and $R_E \le r < R_E+h$.. (b) Evaluate capacitance and (c) the energy of the earth-ionosphere combination. (d) Calculate the minimum value of the electric field intensity causing the space-to ground discharge. (20%)

2.

Assume Earth's magnetic dipole to be a cylindrical bar magnet of radius a and length $2R_E$, which has a uniform magnetization $\mathbf{M} = \mathbf{a}_z M_0$ along its axis. Let the center of the magnet be at (0, 0, 0). Find (a) the volume and surface current densities, and (b) the equivalent magnetization surface and volume charge densities. (c) Calculate the magnetic flux density, energy density, and magnetic pressure at the magnetosphere of $(4R_E, \phi, 0)$. (d) Derive the magnetic filed line equation for the magnet. (25%)

3.

An a-c voltage of amplitude V_0 and angular frequency ω, $v_c = V_0 \sin \omega t$, is connected across a parallel-plate capacitor with an area A, plate separation, d, and a dielectric medium of permittivity ε. (a) Calculate the displacement current. (b) Find the magnetic filed intensity at a distance r from the center axis of the capacitor. (15%)

4.

The $\boldsymbol{E}$-filed of a uniform plane wave propagation in a dielectric medium is given by

$$\boldsymbol{E}(t,z) = \boldsymbol{a}_x\, 2\cos(at - bz) - \boldsymbol{a}_y \sin(at - bz) \qquad (V/m)$$

(a) Determine the frequency and wavelength of the wave.
(b) Find the dielectric constant of the medium and the phase velocity of the wave.
(c) Describe the polarization of the wave.
(d) Give the corresponding $\boldsymbol{H}$-Field.
(e) Calculate the average power density over one period. (25%)

5.

A frequency 15 MHz radiowave is vertically transmitted into the ionosphere by an isolated Hertzian dipole. (a) If the dipole is made of a metal wire of radius a, length d and conductivity σ, find its radiation efficiency. (b) Evaluate the forces of a free electron in the ionosphere applied by the $\boldsymbol{E}$ -and $\boldsymbol{B}$ -field of the radiowave. (15%)