1. For the circuit shown in Fig. 1, calculate the average incident power, the average reflected power, and the average power transmitted into the infinite $100-\Omega$ line. The $\lambda/2$ line is lossless and the infinite long line is slightly lossy. (20%)

2. The circuit shown in Fig. 2 uses two identical springs to support a 10-cm-long horizontal wire with a mass of 20 g. In the absence of a magnetic field, the weight of the wire causes the springs to stretch a distance of 0.2 cm each. When a uniform magnetic field is turned on in the region containing the horizontal wire, the springs are observed to stretch an additional 0.5 cm each. What is the intensity of the magnetic flux density **B**? (30%)

3. In wet soil, characterized by $\sigma = 10^{-2}$ (S/m), $\mu_r = 1$, and $\varepsilon_r = 36$, at what frequency is the conduction current density equal in magnitude to the displacement current density? (10%)

4. At microwave frequencies, the power density considered safe for human exposure is 1 (mW/cm^2). A radar radiates a wave with an electric field amplitude E that decays with distance as $E(R) = (3,000/R)$ (V/m), where R is the distance in meters. What is the radius of the unsafe region? (15%)

5. A light ray is incident on a prism in air at an angle θ as shown in Fig. 3. The ray is refracted at the first surface and again at the second surface. In terms of the apex angle ϕ of the prism and its index of refraction n, determine the smallest value of θ for which the ray will emerge from the other side. Find this minimum θ for $n = 1.4$ and $\phi = 60°$. (25%)

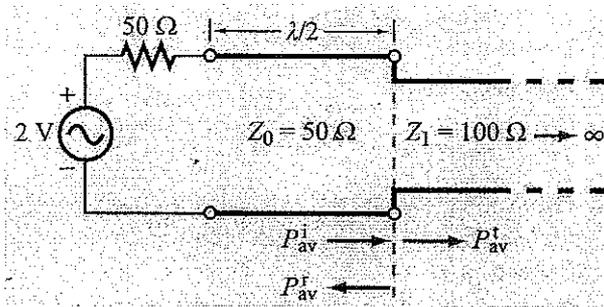(Some constants: $\varepsilon_0 = \dfrac{1}{36\pi} \times 10^{-9}$ F/m; $\mu_0 = 4\pi \times 10^{-7}$ H/m.)
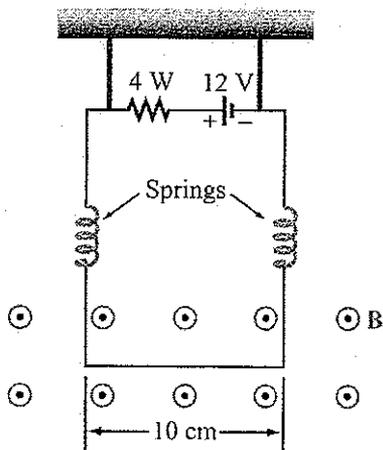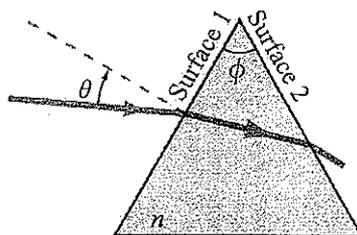
Fig. 1

Fig. 2

Fig. 3