

1. An infinite long cylinder carries a charge density that is proportional to the distance from the axis:  $\rho = ks$ , for some constant  $k$ .  $s$  is the distance from the axis,  $s \leq R$ , where  $R$  is the radius of the cylinder. Find the electric field at a point inside this cylinder. (12%)
2. Find the electrostatic energy of a uniformly charged spherical shell of total charge  $Q$  and radius  $R$ . (12%)

3. A slab of linear dielectric material of permittivity  $\epsilon$  is partially inserted between the plates of a parallel-plate capacitor of width  $a$ , length  $w$ , and separation  $d$  (Figure I). The capacitor is charged to a voltage  $V_0$  by a battery. Determine the electric force on the slab after the battery is disconnected. (12%)

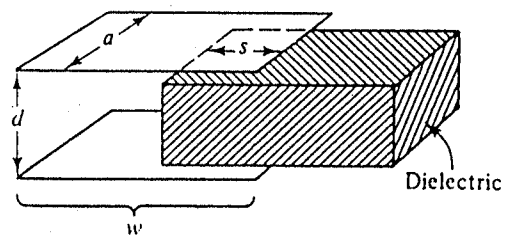


Figure I

4. Two concentric metal spherical shells, of radius  $a$  and  $b$ , respectively, are separated by weakly conducting material of conductivity  $\sigma$  (Figure II). What is the resistance between the shells? (12%)

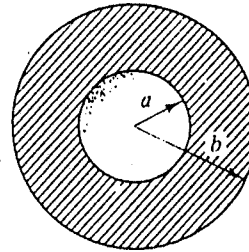


Figure II

5. Find the magnetic energy stored in a section of length  $l$  of a very long solenoid (radius  $R$ , current  $I$ ,  $n$  turns per unit length). (12%)
6. Please explain the classical Hall effect. (12%)
7. Show that a hollow wave guide cannot support TEM waves. (12%)
8. State and prove the Poynting's theorem. (16%)