1. Given a magnetic field $\mathbf{A} = 3\mathbf{a}_x - 2\mathbf{a}_y + \mathbf{a}_z$, find a unit magnetic field **B** such that a) **B** will be parallel to **A**, and b) **B** will be perpendicular to **A**.(10%)
2. Two dielectric media with permittivities ε_1 and ε_2 are separated by a charge-free boundary. The electric field intensity in medium 1 at the boundary P_1 has a magnitude E_1 and makes an angle α_1 with the normal. Determine the magnitude and direction of the electric field intensity at point in medium 2 as close as possible to P_1.(10%)
3. Assume that the space between the inner and outer conductors of a long coaxial cylindrical structure is filled with an electron cloud having a volume density of charge $\rho = 1/r$ for $a < r < b$. where a and b are the radii of the inner and outer conductors, respectively. The inner conductor is maintained at a potential 5 V, and the outer conductor is grounded. Determine the potential distribution in the region $a < r < b$.(20%)
4. Two conducting spheres of equal radius a are maintained at potentials V_0 and 0, respectively. Their centers are separated by a distance D. Find the capacitance between the two spheres.(20%)
5. Determine the resistance between two concentric spherical surfaces of radii r_1 and r_2 ($r_1 < r_2$), assuming that a material of conductivity $\sigma = 1 + A/r$ fills the space between them.(10%)
6. Hyperthermia is an experimental therapy currently being tested at several hospitals for the treatment of certain kinds of cancer. It generally involves reaching and maintaining a temperature between 42° and 45°C for several minutes in the tumor and surrounding tissues. Describe this heating mechanism based on the principles of electromagnetism.(10%).
7. Explain the following terminology: 1) Poynting's theorem, 2) Stokes' theorem, 3) Helmholtz's theorem, 4) Gauss's theorem.(20%)