

Electromagnetic Theory I

Problem Set 5

Due: 7 October 2020

17. Following the method discussed in class for the Dirichlet Green function, obtain the mixed Dirichlet/Neumann Green function for the region between two concentric spheres of radii $a < b$ with Neumann conditions ($\partial G / \partial r = 0$) on the inner shell and Dirichlet conditions $G = 0$ on the outer shell.

18. Use the Green function found in the previous problem to calculate

- a) the potential and
- b) The electric field components

in the region $a < r < b$ for the situation in which the normal component of the electric field, E_r , vanishes on the inner sphere, and the potential on the outer sphere has the behavior $\phi(b, \theta) = V_0 \cos \theta$.

- c) Sketch the electric field lines in the case where $a/b = 0.5$. The electric field lines are those curves that are everywhere tangent to the electric field.

19. The general electrostatic problem to find the potential in the interior of a hollow right circular cylinder of radius a and length L , given its value on the boundary, was partially solved in class by finding the solution with an arbitrary potential on the face of one end, but vanishing potential at the other end and on the cylindrical surface.

- a) Complete the solution, using cylindrical coordinates, by finding the potential inside the cylinder which vanishes on the two end faces, but is an arbitrary function $V(\phi, z)$ on the cylindrical boundary surface. Note that for these boundary conditions, the separation of variables constants should be chosen so Z involves trigonometric functions. The solution will then involve a double Fourier series.
- b) Evaluate the expansion coefficients for the case where $V(\phi, z) = +V$ for $0 \leq \phi \leq \pi$ and $V(\phi, z) = 0$ for $\pi < \phi < 2\pi$.

20. J, Problem 3.12, parts a),b),c). Note that the answer to part a) can be expressed as an integral in one variable only. You may consult tables of integrals involving Bessel functions, for example Gradshteyn and Ryzhik.