Mathematical Physics, Autumn 2008
Assignment 5 (due Friday 29/11/2008)

You will find four pdf files on the course webpage (also attached with this email) which are scanned copies of problems from Joglekar's book on Mathematical Methods (Advanced). Some of the problem numbers here refer to the problems in these pages.

All Arfken problem numbers are from Edition 3.

1. Let a conducting circular disk of unit radius be kept in the $x - y$ plane, with its center at the origin. Let (ρ, θ, z) be the usual cylindrical coordinates. We shall use the coordinates (u, θ, v) defined through $\rho = \cos u \cosh v, \theta = \theta, z = \sin u \sinh v$.

   (a) Is the (u, θ, v) coordinate system orthogonal ? If yes, determine the metric (h_i values).

   (b) Draw the surfaces of constant u and constant v (approximately). What does the surface of the disk correspond to ?

   (c) Write down Laplace's equation for the potential $\Phi(u, \theta, v)$.

   (d) What are the boundary conditions ? Do they allow us to use symmetries in u, v or θ to simplify the equation ?

   (e) If you have identified all the symmetries, you should be able to plot the equipotentials (and hence the electric field lines) in the $u - v$ plane *without solving Laplace's equation.* Draw them.

2. Joglekar 1.21

3. Joglekar 1.25

4. Arfken 9.1.5

5. Arfken 9.2.9

Not to be submitted:

1. Joglekar 1.8

2. Joglekar 1.16

3. Joglekar 1.24

4. Joglekar 1.27

5. Arfken 8.5.17

6. Arfken 8.6.7

7. Arfken 8.7.16

8. Arfken 9.1.3

9. Arfken 9.3.5

10. The relevant questions in the Drop Test