Topics for the Midterm

APM 384 Partial Differential Equations

Autumn 2014

Here is a list of concepts you should be familiar with for the midterm, which will take place during the lecture slot on **Friday, October 24**.

1. **Definitions and basic classification of differential equations:** You should be familiar with the difference between ordinary and partial differential equations (ODEs and PDEs) and know what the order of a differential equation is. You should also be able to distinguish linear and non-linear PDEs and know when a PDE (or an associated boundary or initial condition) is homogeneous. You should also know what Δ, ∇ and the directional derivatives are.

2. **The method of characteristics:** You should be able to use the method of characteristics in order to solve first order linear PDEs with two arguments. Handout 2 covers this.

3. **Separation of Variables:** We have seen in class how to use separation of variables to solve second order PDEs by reducing then to ODEs via the method (really, the assumption) of separation of variables. You should be familiar with this technique and able to apply it. You should be able to solve the resulting second-order ODEs of the type we discussed in class and use any homogeneous boundary condition. You should also be able to combine this with the method of superposition of solutions and Fourier series (see below) to deal with a non-homogeneous boundary or initial condition. This is covered in Chapter 2 of Haberman

4. **Complex differentiable and harmonic functions:** You should be comfortable with switching viewpoints between a function of one complex and two real variables and know about the connection between complex differentiable and harmonic functions. You should also be aware of the properties of complex differentiable and harmonic functions that we discussed in class. They are summarised in Handout 3. However, since we only mentioned it briefly, Cauchy's theorem is not examinable. A very informal discussion about qualitative properties of harmonic functions can be found in Section 2.5.4 of Haberman.

5. **Fourier Series:** We covered Chapter 3 in Haberman, except for section 3.5 and the subsection of 3.4 titled 'the method of eigenfunction expansion'. You should be comfortable with this material, in particular you should be able to compute Fourier series for a given function.

6. **Uniqueness:** We have seen two methods of proving uniqueness: the maximum principle for harmonic functions and the method of energy functionals. You should understand how these methods work. In particular you may find it useful to revise the relevant exercises on problem sheet 4 and make sure that you understand the solutions.