615–Maths Methods in Theoretical Physics

Key Topics and Hints for Preparing for Final Exam

- Separation of variables for Helmholtz and Laplace equations in two and three dimensions; Legendre polynomials, Rodrigues' formula and generating function; Spherical harmonics; Analysis of singular points of 2nd-order ODEs; Series solutions around ordinary points and regular singular points; Wronskian, construction of second solution; General Sturm-Liouville self-adjoint operators, orthogonality of eigenfunctions.

- Complex numbers; Analytic functions; Cauchy-Riemann relations; Contour integration; Types of singularities (poles, branch points, essential singularities); Calculus of residues; Evaluation of real integrals and summation of infinite series using contour integral methods; Analytic continuation; Gamma function.

Hints

- Write legibly!!!

- Problems will involve a combination of proving results (typically, that were proved in class), and solving problems.

- No memorisation of complicated formulae is expected. If such expressions are required in order to answer the question, then they will be provided. If you find yourself needing a complicated result that you have memorised, you may not be solving the problem the way that has been asked for in the question, and it may cost you points.

- Remember that the idea is to convince the grader (i.e. me) that you understand the principles, and are able to apply them logically. So if a derivation of a particular result is requested, based on stated initial assumptions, then do not skip important steps, and do not quote memorised intermediate steps without proof.

- The calculations required will all be fairly simple. If things are looking complicated, make sure that you have read the question carefully! A common reason for running out of time in an exam is because of misreading a question, thereby making it far more complicated and time-consuming than it actually is.

- I have never set an exam that required more than a total of three single-sided sheets of paper for all the solutions. There is commonly an *inverse* relation between the number of sheets handed in and the number of points scored!

- Common reasons for losing points are: (1) Not solving the problem that was asked; (2) Quoting intermediate formulae or results without proof when asked to prove a particular result from a given starting point; (3) Presenting sketchy calculations that lack a logical flow in which the key deductive steps are spelt out.