

Math2130 Higher Mathematical Methods for Differential Equations: Some Remarks for 2007 exam

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1. Note that Cauchy problem questions like Question 3(ii) in 2006 are not applicable (as we did not cover it in lectures).
2. Note from looking at the solutions of the previous exams 2004-6, you will notice a series of formulae/things you are expected to know by heart and to be able to use. These include (not an exhaustive list: if you see it in a previous solution, you are expected to know it for this exam)

- i) The parametrised Bessel equation

$$x^2 u'' + xu' + [\omega^2 x^2 - \nu^2]u = 0,$$

which has the general solution

$$u = AJ_\nu(\omega x) + BY_\nu(\omega x).$$

- ii) The definition and use of the Wronskian.
- iii) The fact that the Frobenius form at $z = 0$ is

$$z^2 u'' + zP(z)u' + Q(z)u = 0,$$

where P and Q are analytic at $z = 0$. It may help to know that the indicial equation is

$$r(r - 1) + rP(0) + Q(0) = 0.$$

- iv) The theory behind finding the second solution of the Frobenius normal form in the case of double roots as in 2006 Question 2 i)d) [see P36 of printed lecture notes].
- v) The form of a self-adjoint operator and the derivation using integration by parts of the Lagrange identity as in 2005 Question 3 b)c) and 2006 Question 3 i)b) [see P59 of printed lecture notes].
- vi) The way to derive a condition for the existence of solutions for a two-point boundary value problem as in 2006 Question 3 c) [see P62 of printed lecture notes].
- vii) The general form of a Sturm-Liouville equation as in 2005 Question 2 ii) b)[see P76 of printed lecture notes], the relevance of $r(x)$ as the weight function in the orthogonality of the eigenfunctions of a regular S-L equation as in 2005 Question 4 iv) [see P80-81 of printed lecture notes].