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Applied Differential Equations 2250
Sample Midterm Exam 1
Tuesday, 9 February 2006
Wednesday, 10 February 2006 arranged

Instructions: This in-class exam is 50 minutes. No calculators, notes, tables or books. No answer check is expected. Details count 75%. The answer counts 25%.

1. (Quadrature Equation)

Solve for the general solution $y(x)$ in the equation $y' = xe^{-x} + \csc^2 x + 2\sec^2 x + \frac{16x^4}{1+4x^2}$.

[Integral tables will be supplied for anything other than basic formulae. This sample problem would require no integral table. The exam problem will be shorter.]

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2. (Separable Equation Test)

The problem

$$y' = x \left(e^{2x} x^{2/3} y e^y + \sin(x) y e^y \right) - x \sin(x) \sin(y) - e^{2x} x^{5/3} \sin(y)$$

may or may not be separable. If it is, then write formulae for F , G which decompose the problem as $y' = F(x)G(y)$. Otherwise, explain in detail why it fails to be separable. Do not solve for y !

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3. (Solve a Separable Equation)

Given $yy' = \frac{6x^3 + 12x}{1+x}(1 - 4y^2)$,

- (a) Find all equilibrium solutions,
- (b) Find the non-equilibrium solution in implicit form.

Do not solve for y explicitly.

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4. (Linear Equations)

(a) Solve $2v'(t) = -64 + \frac{4}{t+1}v(t)$, $v(0) = 3$. Show all integrating factor steps.

(b) Using the answer $v(t)$ from (a), solve $y'(t) = v(t)$, $y(0) = 2$. Show all quadrature steps.

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5. (Stability)

(a) Draw a phase line diagram for the differential equation

$$dx/dt = (2 - 5x)^3(1 - 2x)(1 - 4x^2).$$

Expected in the diagram are equilibrium points and signs of x' (or flow direction markers $<$ and $>$).

(b) Draw a phase diagram using the phase line diagram of (a). Add these labels as appropriate: funnel, spout, node, stable, unstable. Show at least 10 threaded curves. A direction field is not required.

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