

## 18.03 Exam 1 Topics List

1. Model a simple system with a first order O.D.E. What happens if inputs, initial conditions, or parameters increase/decrease?
2. a) Draw solutions using the direction field and isoclines (Lec 1)
  - b) Use the phase line diagram to determine long term behavior of solutions (Lec 8)
  - c) If there is harder, more conceptual or theoretical question, then it might be about super or subsolutions. These can be used to determine long term behavior in the general case, not just the autonomous case of part (b).
3. Carry out Euler's approximation method
4. a) Solve first-order linear differential equations using an integrating factor
  - b) Solve first-order linear differential equations using a suggested substitution or change of variables.
5. a) Calculate using complex numbers and exponentials
  - b) Use complex exponentials to solve differential equations, find amplitude, phase lag.

### Common mistakes

1. Linear ODE:
  - a) using an integrating factor  $e^{\int p dx}$  with wrong function  $p(x)$  (because equation is not in standard form)
  - b) forgetting to multiply right hand side  $q$  by integrating factor.
  - c) failure to handle logs correctly,  $e^{\int \frac{5}{x} dx} = e^{5 \ln x} = (e^{\ln x})^5 = x^5$ .
2. Orthogonal trajectories (not on Exam 1, but may be on other tests):
  - a) forgetting to eliminate  $c$  in family
  - b) forgetting to change from  $y'$  to  $-1/y'$ .
3. Direction fields: confusing isoclines with solution curves = integral curves or with sub and supersolutions. (Occasionally an isocline will also be a solution. Often an isocline will also happen to be a sub or supersolution.)
4. Autonomous equations: memorizing a formula for maximum harvesting rate that only applies to a specific population model, the logistic equation  $y' = ay - by^2$
5. Complex numbers:
  - a) reluctance to go polar
  - b) memorizing formulas rather than procedures