

**NOTE: This is not the official version of the final, it is simply recopied by memory. Therefore, there could be mistakes which make the solutions impossible.**

1. Solve using separation of variables.

a.  $dy(4x + 5)^2 - dx(2y + 3)^2 = 0$

b.  $(x - y)dx + xdy = 0$

hint: use the idea of homogeneous equations where applicable

2. Solve using exact equations

$$(3x^2y + x^2y)dx + (x^3 + xy^2)dy = 0$$

3. Two questions I can't remember about linear equations

4. May have been this, really unsure. Solve using Bernoulli:

$$x \frac{dy}{dx} - y = xy^2$$

5. Atoms, if disturbed, experience a motion governed by:

$$\mu \frac{d^2x}{dt^2} + kx = 0$$

Knowing that for oxygen,  $\mu = 1.33 * 10^{-26}kg$  and  $k = 1195N/m$ , explain why the motion of oxygen is oscillatory and calculate its natural frequency.

6. Solve using the method of choice.

a.  $y'' - y = \cos x$

b.  $y'' + y' - 2y = x^2$

7. Solve using variation of parameters

$$y'' + y = \tan x$$

8. Solve the given boundary-value problem.

$$\frac{d^2V}{dr^2} + \frac{1}{r} \frac{dV}{dr} - \frac{1}{r^2} = 0, V(1) = 0, V(2) = 1$$

9. Solve the system of equation using the method of your choice:

$$\frac{dx}{dt} = x - 2y + 2$$

$$\frac{dy}{dt} = -2x + y$$

10. Solve using series:

$$y'' - y = 0$$