

Among the following problems choose as many as you would like. You may use any resources you wish to use, but you must **show all work!** You can't get more than 100%, so I would suggest doing only the problems that will bring your quiz grade up to 100%. I have set it up so that everyone will be able to find some combination of problems to bring their quiz scores up to 100%. Of course how many and which you choose to do is up to you even if that problem/problems rack up more points than you need.

- (1) **(1 pt.)** Solve  $\dot{x} = ax$  where  $a$  is a constant.
- (2) **(2 pts.)** Solve  $\ddot{x} + 2\dot{x} + x = 0$ .
- (3) **(4 pts.)** Sketch the direction field for  $\dot{x} = x^2 - x - 2$ .
- (4) **(6 pts.)** Sketch the vector field for  $\dot{x} = x^3 - x$  and find the stability (graphically and analytically) of the fixed points.
- (5) **(14 pts.)** Sketch the phase plane for  $\ddot{x} + x^3 - x = 0$  and find all the relevant values (i.e. fixed points, eigenvectors, etc.). Also, prove that this system is Hamiltonian.  
You are welcome to email me if you're unsure about something.