

Name:_____

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City University of Hong Kong
Department of Electrical Engineering

EE 3121 Differential Equations for Electrical Engineering

Midterm Test 1

NOTE:

1. This is a 1.5-hour, open book, open notes midterm test.
2. There are 4 problems altogether, which amount to 100 points.
3. In addition to final answers, you need to include necessary steps to show your derivations. An answer without any supporting development will unlikely be awarded with a point. You do receive partial credits if you write down the steps despite that you may not complete your solution.
4. Please sign the following statement of pledge of honor. Enjoy the test, and good luck!

I pledge that the answers in this exam/quiz are my own and that I will not seek or obtain an unfair advantage in producing these answers. Specifically,

- *I will not plagiarize (copy without citation) from any source;*
- *I will not communicate or attempt to communicate with any other person during the exam/quiz; neither will I give or attempt to give assistance to another student taking the exam/quiz; and*
- *I will use only approved devices (e.g., calculators) and/or approved device models.*

I understand that any act of academic dishonesty can lead to disciplinary action.

Signature: _____

Question 1 (30 marks)

(1) Solve the nonlinear differential equation

$$\frac{dy}{dt} - 3y - y^2 = 2, \quad y(0) = 0.$$

(2) Determine the maximum time t_M such that a solution may exist.

(3) Without solving the equation, determine the highest lower bound t_E on the time such that a solution may exist.

Question 2 (15 marks)

Find the second in the sequence of successive approximations to the solution of

$$\frac{dy}{dt} + \frac{2t}{1+t^2}y + \varepsilon y^2 = 0, \quad y(0) = 1.$$

Question 3 (15 marks)

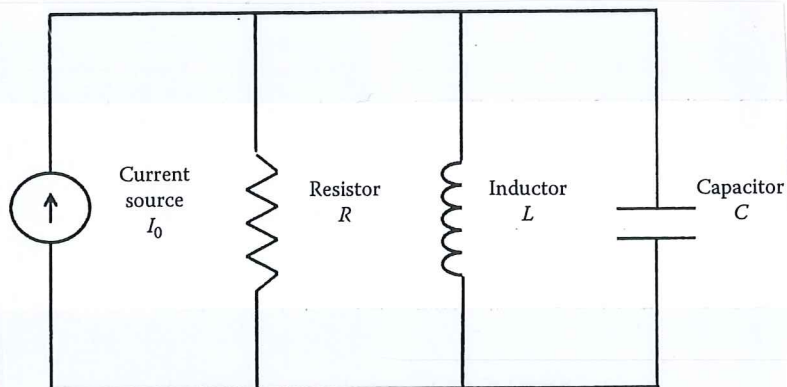
Determine the equilibrium points for the differential equation

$$\frac{dy}{dt} = y^4 - 20y^2 + 64.$$

Draw a direct-line vector field. Determine which equilibrium points are stable and which are not.

Question 4 (40 marks)

In the following circuit, the current source is a constant DC current I_0 . The voltage V_C on the capacitor and the current through the inductor I_L are all initially equal to zero, i.e., $V_C(0) = I_L(0) = 0$.



(1) Derive a differential equation for $V_C(t)$.

(2) Let $R = 2$, $L = 5/3$, and $C = 1/10$. Solve for $V_C(t)$.

(3) If we replace the constant I_0 by $I_0(t) = e^{-t}$ but keep the same initial conditions, what will be $V_C(t)$?