EE240 – Circuits I

Final Examination (Fall 2019)

December 18, 2019 11:30 am–02:30 pm

Student ID _____ Name _____

Signature _____

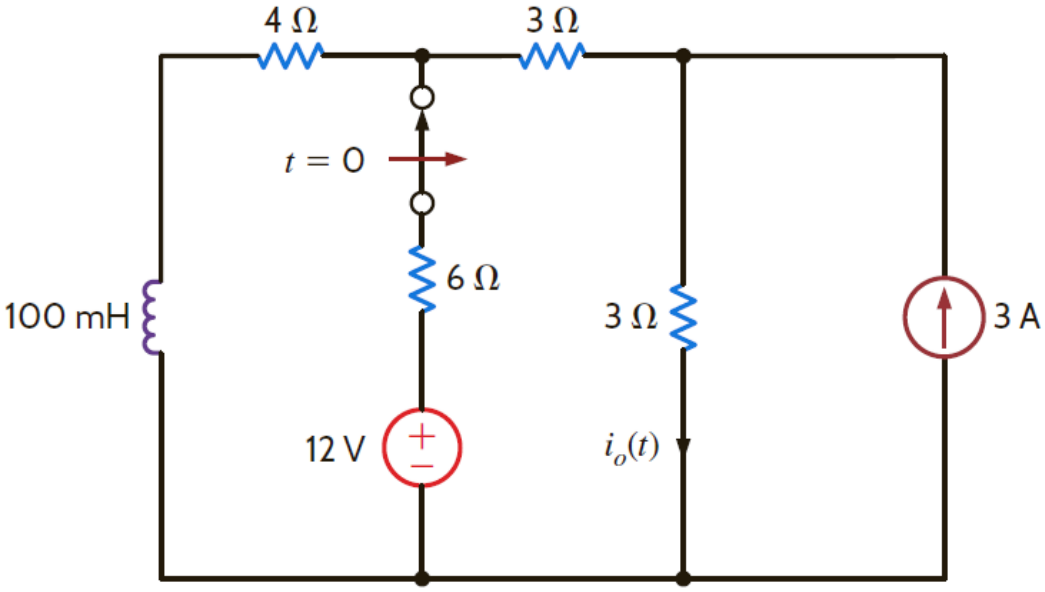
INSTRUCTIONS:

- Do not flip this page over until told to do so.
- Reading time: 10 minutes
- Writing time: 2 hours and 50 minutes
- The exam consists of 8 problems worth a total of 90 points.
- **The exam needs to be solved on this book and not on blue book.**
- If you need the blue book for rough work, please ask the exam staff.
- The exam is closed book and notes. You are allowed to bring calculator and two A4 sheets with *hand-written* notes on both sides.

Problem	**Total Points**	**Obtained Points**
Problem 1	15	
Problem 2	10	
Problem 3	10	
Problem 4	10	
Problem 5	05	
Problem 6	10	
Problem 7	10	
Problem 8	20	
Total	90	

Part 1: First Order Circuits

Problem 1. (**15 pts**) The circuit given below is in steady state with switch closed. The switch is opened at $t = 0$.



(a) (**4 pts**) Determine the current $i_o(t)$ at $t = 0^-$, that is, just before the switch is operated. Also determine the current through the inductor.

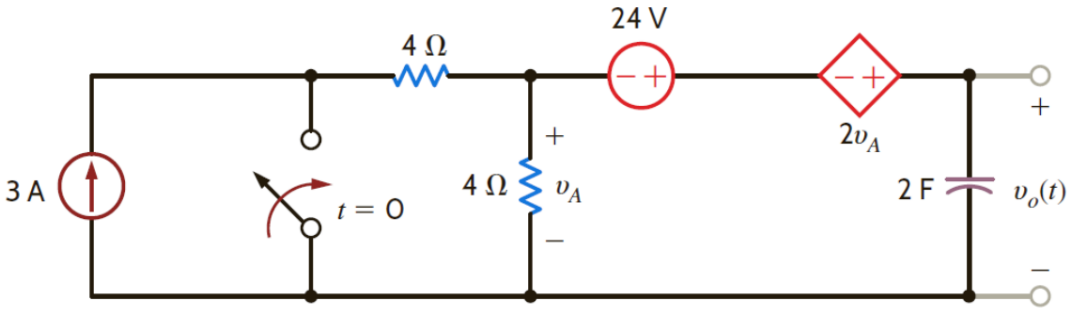
(b) (**3 pts**) Determine the current $i_o(t)$ at $t = 0^+$, that is, just after the switch is operated.

(c) (**2 pts**) Determine the current $i_o(t)$ at $t = \infty$.

(d) (**5 pts**) Using the results of the previous parts, or otherwise, determine the current $i_o(t)$ for all times $t > 0$.

(e) (**1 pts**) Plot the current $i_o(t)$ for $-\tau \leq t \leq 6\tau$ (where τ denotes the time constant of the circuit).

Problem 2. (**10 pts**) The circuit given below is in steady state with switch in open state. The switch is closed at $t = 0$.



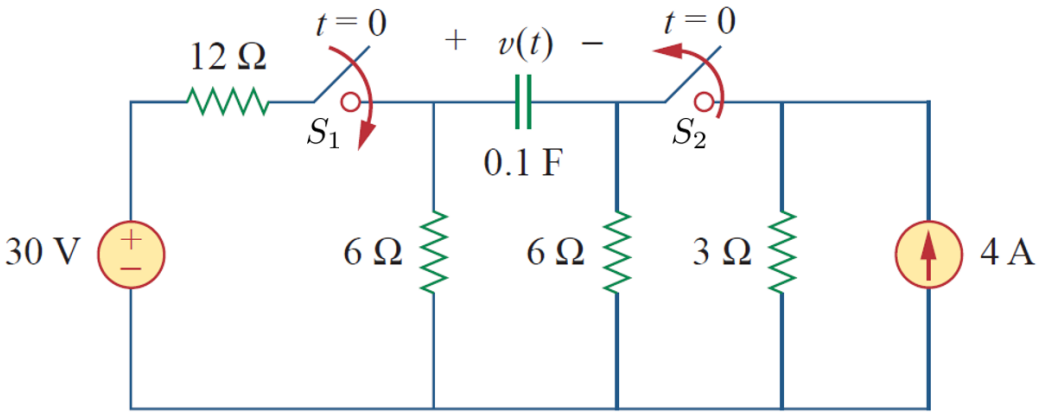
(a) (**2 pts**) Determine the voltage $v_o(t)$ at $t = 0^-$.

(b) (**1 pts**) Determine the the voltage $v_o(t)$ at $t = 0^+$.

(c) (**1 pts**) the voltage $v_o(t)$ at $t = \infty$

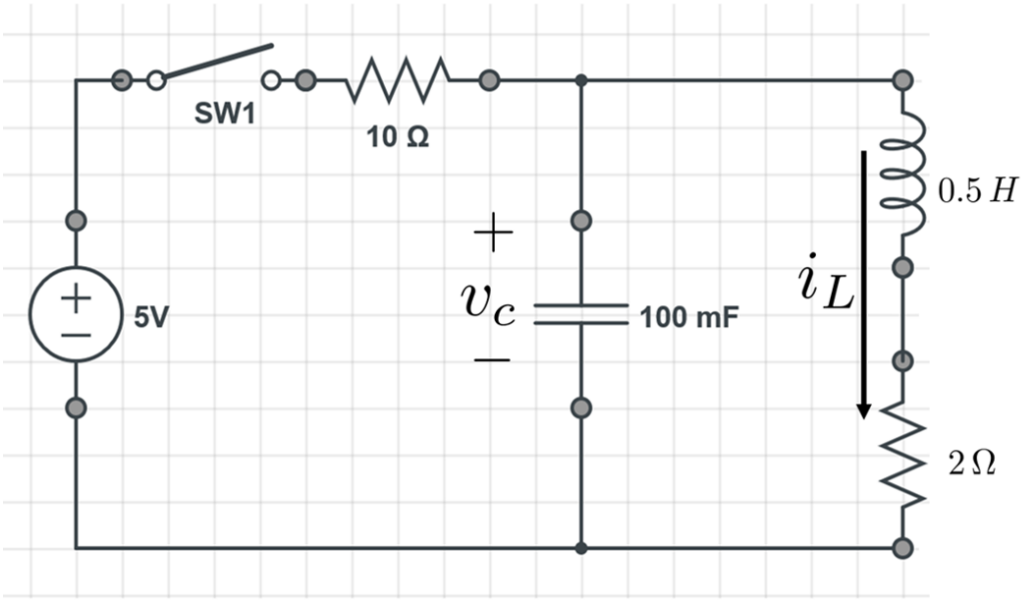
(d) (**6 pts**) Using the results of the previous parts, or otherwise, determine the voltage $v_o(t)$ for all times $t > 0$.

Problem 3. (**10 pts**) The circuit given below is operating in the steady state with the switch S_1 in open state and switch S_2 in closed state for $t < 0$. At $t = 0$, the switch S_1 is *closed* and S_2 is *opened*. Determine the voltage $v(t)$ for all times.

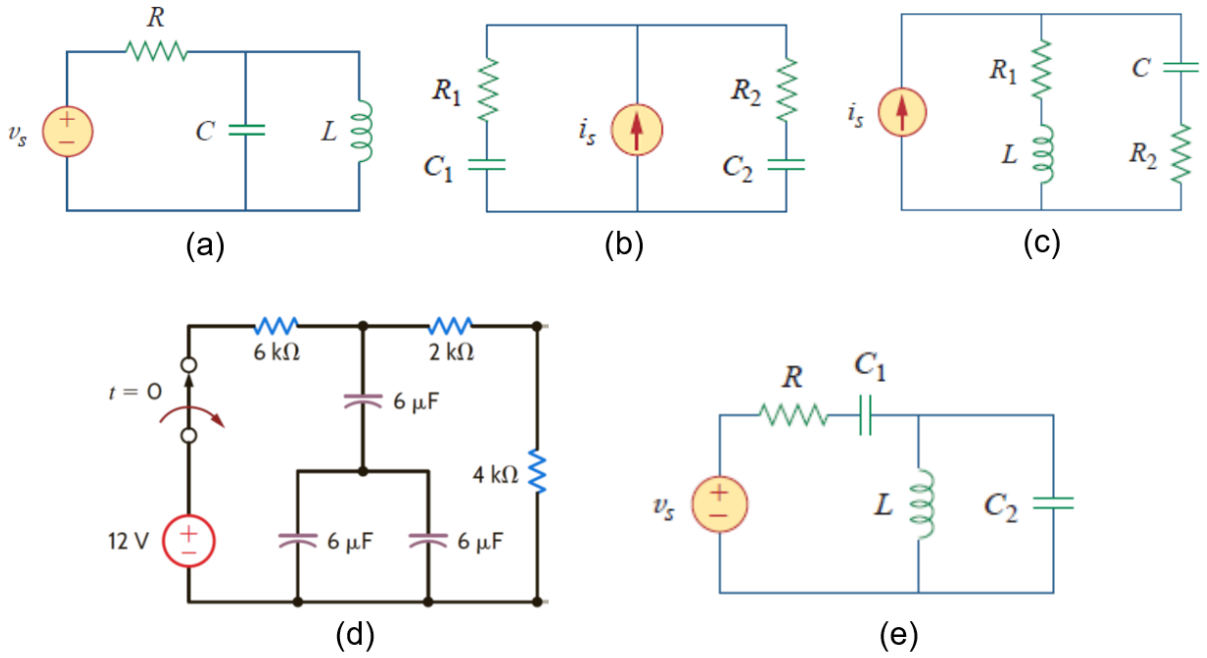


Part 2: Evaluation of Initial Conditions

Problem 4. (**10 pts**) In the circuit given below, assume that the switch SW1 is initially open and is closed at $t = 0$. Determine $v_c(t)$, $i_L(t)$, $dv_c(t)/dt$, $di_L(t)/dt$ and $dv_C^2(t)/dt^2$ at $t = 0^+$.



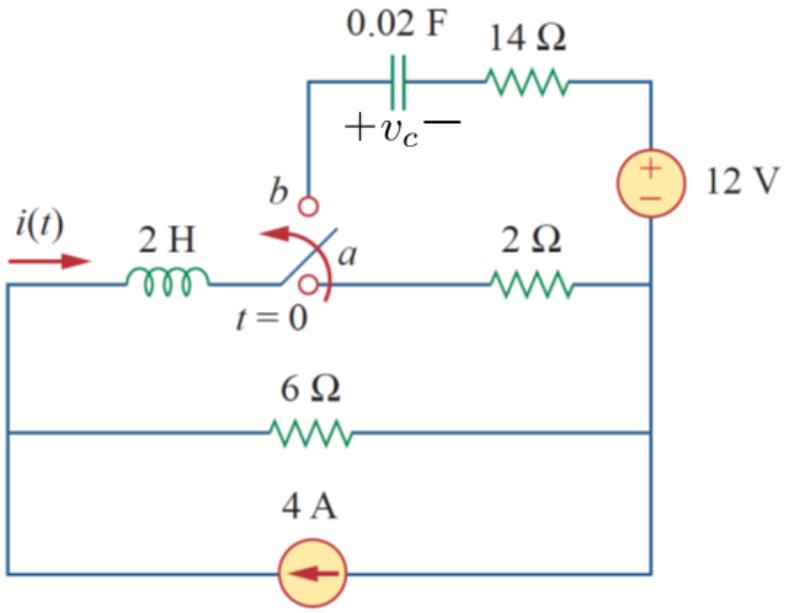
Problem 5. (**5 pts**) Determine the circuit-order for each of the following circuits.



Part 3: Second-Order Circuits

Problem 6. (**10 pts**)

Consider the circuit shown below. The circuit is in steady state with switch at position a. At $t = 0$, the switch is moved from position a to position b.



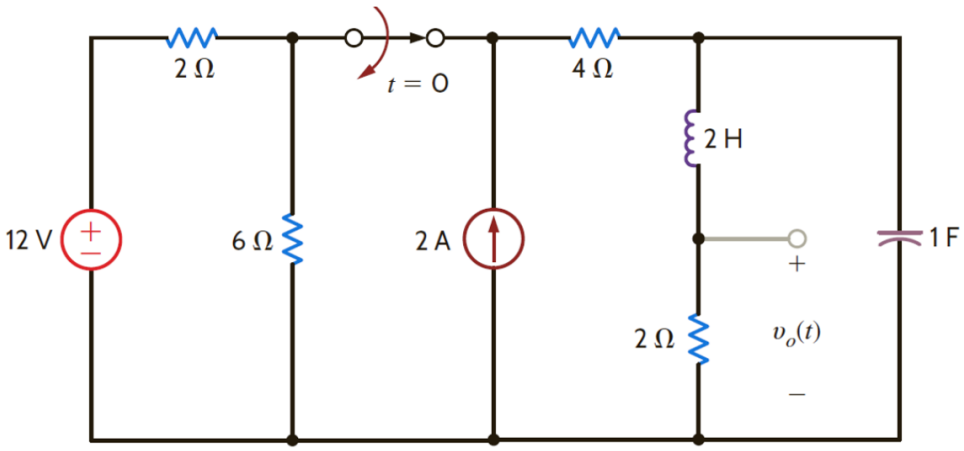
(a) (**1 pts**) Determine $i(t)$ at $t = 0^-$.

(b) (**1 pts**) Determine $v_c(t)$ at $t = 0^-$.

(c) (**8 pts**) Determine $i(t)$ for all times $t \geq 0$.

Problem 7. (**10 pts**)

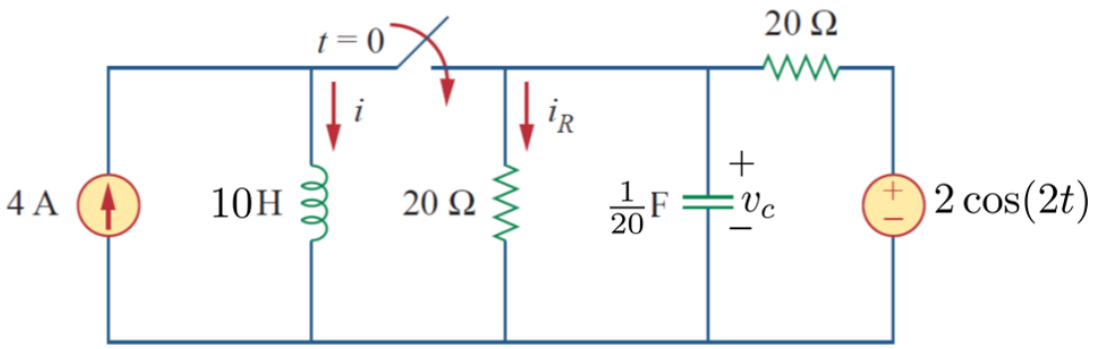
The switch in the following circuit is opened at $t = 0$.



(a) (**8 pts**) Determine $v_o(t)$ for all times.

(b) (**2 pts**) Determine the damping ratio ζ and undamped natural frequency ω_n for the circuit after the switch is operated.

Problem 8. (**20 pts**) In the circuit given below, assume that the switch is initially open and is closed at $t = 0$.



(a) (**5 pts**) For $\mathbf{t < 0}$, determine the voltage across capacitor, $v_c(t)$ and the current through inductor, $i(t)$.

(b) (**4 pts**) Formulate a second-order differential equation in $i(t)$.

(c) (**8 pts**) Determine $i(t)$ for all times $t \geq 0$.

(d) (**3 pts**) Determine $i_R(t)$ for all times $t \geq 0$.