RULES:

- **Please try to work on your own. Discussion is permissible, but identical submissions are unacceptable! See "上海科技大学学生学术诚信规范与管理办法", http://sist.shanghaitech.edu.cn/cn/NewsDetail.asp?id=782**
- **Please show all intermediate steps: a correct solution without an explanation will get zero credit.**
- **Please submit on time. NO late submission will be accepted.**
- **Please prepare your submission in English only. No Chinese submission will be accepted.**

1. [6%] Three capacitors C_1=5μF, C_2=10μF, and C_3=10μF, are connected in parallel across a 150-V source. Determine:
   (a) the total capacitance,
   (b) the charge on each capacitor,
   (c) the total energy stored in the parallel combination.

2. [8%] Consider the circuit in Fig. 1. Find:
   (a) L_{eq}, $i_1(t)$ if $i_s = 3e^{-t}$ mA,
   (b) $v_0(t)$,
   (c) the energy stored in the 20-mH inductor at $t=1$s.

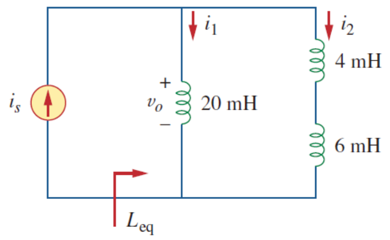

Fig. 1

3. [6%] A 4-mF capacitor has the terminal voltage

$$v = \begin{cases} 50V, & t \le 0 \\ Ae^{-100t} + Be^{-600t}V, & t \ge 0 \end{cases}$$

If the capacitor has an initial current of 2 A, find:
(a) the constants A and B,
(b) the energy stored in the capacitor at $t = 0$,
(c) the capacitor current for $t > 0$.

4. [8%] A 100-mH inductor is connected in parallel with a 2-kΩ resistor. The current through the inductor is $i(t) = 50e^{-400t} mA$.
   (a) Find the voltage v_L across the inductor.
   (b) Find the voltage v_R across the resistor.
   (c) Does $v_L(t) + v_R(t) = 0$?
   (d) Calculate the energy in the inductor at t=0.

5. [8%] A noninverting current amplifier is portrayed in Fig.2. Calculate the gain i_0/i_s. Take $R_1 = 8k\Omega$ and $R_2 = 1k\Omega$.

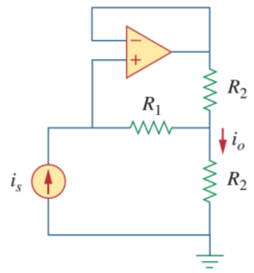

Fig.2

6. [8%] A voltage-to current converter is shown in Fig.3, where $i_L = Av_i$. if $R_1R_2 = R_3R_4$. Find the constant term A.

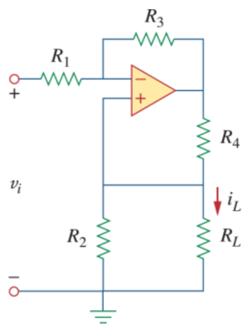

Fig.3

7. [10%] The switch in the circuit has been in position *a* for a long time and $v_2 = 0V$. At $t = 0$, the switch is thrown to position *b*. Calculate

   a) i, v_1, and v_2 for $t \geq 0^+$.

   b) the energy stored in the capacitor at $t = 0$.

   c) the energy trapped in the circuit if the switch remains in position *b* indefinitely.

   d) the total energy dissipated in the $25k\Omega$ resistor if the switch remains in position *b* indefinitely.

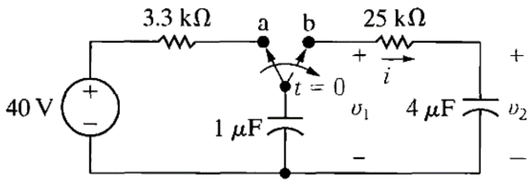

Fig.4

8. [8%] The switch in the circuit has been in position 1 for a long time. At $t = 0$ the switch moves instantaneously to position 2. Find the value of R so that 10% of the initial energy stored in the 10 mH inductor is dissipated in R in $10\mu s$.

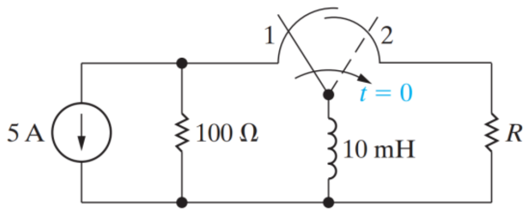

Fig.5

9. [10%] (a) Use component values from Appendix H (in the text book) to create a first-order RL circuit (see Fig. 6) with a time constant of 8μs. Use a single inductor and a network of resistors, if necessary. Draw your circuit.

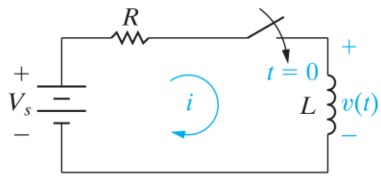

Fig. 6

(b) Suppose the inductor you chose in part (a) has no initial stored energy. At t=0, a switch connects a voltage source with a value of 25V in series with the inductor and equivalent resistance. Write an expression for the current through the inductor for t greater or equal to 0.

(c) Using your result from part (b), calculate the time at which the current through the inductor reaches 75% of its final value.

10. [10%] The switch in the circuit shown in Fig.6. has been in the OFF position for a long time. At t=0, the switch moves instantaneously to the ON position. Find $V_0(t)$ for t greater or equal to 0.

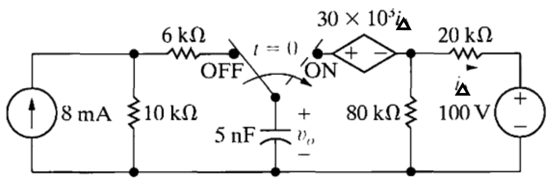

Fig.6

11. [10%] a) Show that the two magnetically coupled coils in the figure below can be replaced by a single coil having an inductance of

$$L_{ab} = \frac{L_1 L_2 - M^2}{L_1 + L_2 - 2M}$$

(Hint: Let i_1 and i_2 be clockwise mesh currents in the left and right windows of the figure below. Sum the voltages around the two meshes. In mesh 1 let V_{ab} be the unspecified applied voltage. Solve for di_1/dt as a function of V_{ab}.)

b) Show that if the magnetic polarity of coil 2 is reversed, then

$$L_{ab} = \frac{L_1 L_2 - M^2}{L_1 + L_2 + 2M}$$

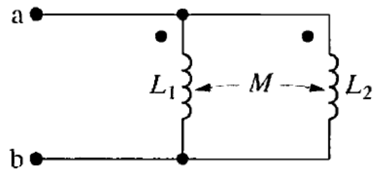

Fig.7

12. [10%] In the circuit below, switch 1 has been in position a and switch 2 has been closed for a long time. At t = 0, switch 1 moves instantaneously to position b. Eight hundred microseconds later, switch 2 opens, remains open for 300 us, and then recloses. Find V_0 1.5 ms after switch 1 makes contact with terminal b.

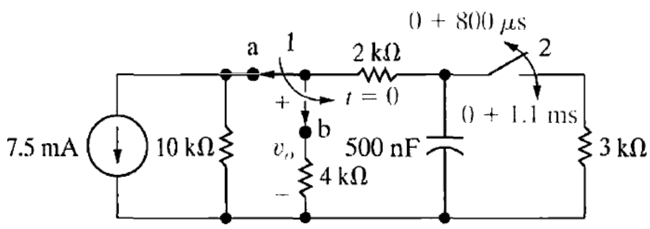

Fig.8