*請依題號順序作答

一、多選擇題(25%，每題 5%，不倒扣，請於試卷內之「選擇題作答區」依序作答。)

1. To analyze the circuit, there are several important theorems, such as source transformation, Thevenin's theorem, and Norton theorem. Which of the following is TRUE for these circuit theorems?
(A) Basic to these theorems is the concept of balance that a balance circuit is one whose I-V characteristics shared with the original circuit. (B) Thevenin's theorem states that a linear two-terminal circuit can be replaced by an equivalent circuit consisting of a voltage source in parallel with a resistor. (C) Norton's theorem states that a linear two-terminal circuit can be replaced by an equivalent circuit consisting of a current source in parallel with a resistor. (D) The maximum power is transferred to the load when the load resistance equals the Thevenin resistance as seen from the load. (E) The superposition principle states that the voltage across an element in a linear circuit is the algebraic sum of the voltage across that element due to each independent source.
2. The operational amplifier (Op Amp) is one of the most important circuit building blocks. Which of the following is TRUE for Op Amp?
(A) The Op Amp behaves like a voltage-controlled current source. (B) The ideal Op Amp has infinite open-loop gain and infinite input resistance. (C) The ideal Op Amp has infinite frequency bandwidth and finite output resistance. (D) The real Op Amp has finite open-loop gain and the gain increases with frequency. (E) The real Op Amp has the leakage input current that results in the finite open-circuit gain.
3. The time response of a circuit demonstrates its capability to handle the signal in different frequency spectrum. Which of the following statement is TURE?
(A) The capacitance is the ratio of the charge on one plate of a capacitor to the voltage difference between the two plates. (B) The inductance is the property whereby an inductor exhibits opposition to the charge of current flowing through it. (C) At DC, the inductor acts like an open circuit and capacitor acts like a short circuit. (D) The time constant of a circuit is the time required for the response to decay to a factor of $1/e$ of its initial value. (E) The natural response of a circuit refers to its I-V behavior without any external excitation source.
4. The silicon has become the most important material in the circuits and electronics. Which of the following statement is NOT TURE?
(A) The intrinsic silicon has regular lattice structure and high resistivity at room temperature. (B) To enhance the conductivity, germanium can be used to dope the silicon substrate. (C) There are two kinds of carriers, electrons and holes, in silicon substrates. Both of these carriers are real particles existing within the silicon substrates. (D) The carrier concentration increases with temperature. Therefore, the conductivity of silicon substrate also increases with temperature. (E) The major carrier-moving mechanism within the diode is diffusion. Therefore, the diode current suffers from the temperature effect.
5. Both biopolar junction transistor, BJT, and metal-oxide-semiconductor field effect transistor, MOSFET, are used widely in both discrete and integrated circuit design. Which of the following statement is TURE?
(A) Both of these transistors can be modeled as the voltage-controlled current sources. (B) To simplify the current equation, we only consider diffusion current in both BJT and MOSFET. (C) BJT has the base-current because of the recombination effect within the base region. (D) The early effect of MOSFET results from the depletion region changes driven by reversed source-drain voltage. (E) BJT can have better frequency response than MOSFET.

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二、非選擇題 (75%)

1. (15%) Find V_{out} in the circuit of Fig. 1.

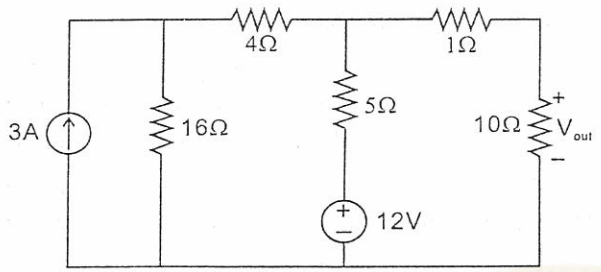

Figure 1

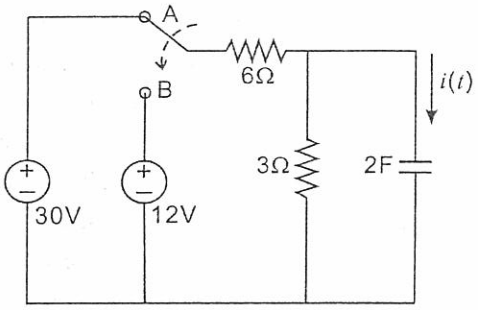

Figure 2

2. (15%) The switch in Fig. 2 has been in position A for a long time. At $t = 0$, it moves to position B. Calculate $i(t)$ for all $t > 0$.

3. (15%) Derive the transfer function of the active filter in Fig. 3. In addition, what kind of filter is it?

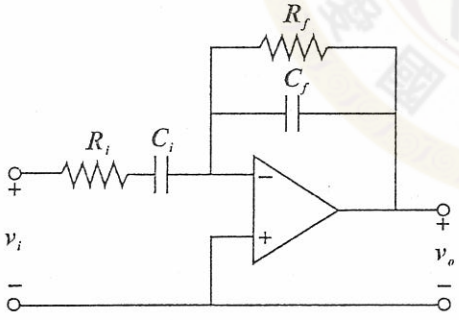

Figure 3

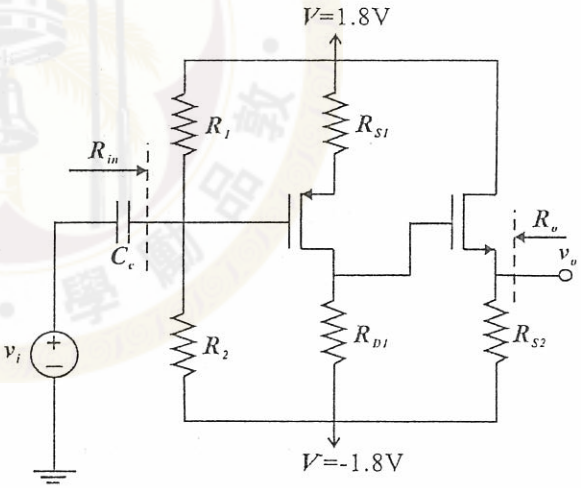

Figure 4

4. (30%) Consider the circuit shown in Fig. 4. The transistor parameters are $V_{th\text{-}PMOS} = -0.4$V, $V_{th\text{-}NMOS} = 0.4$V, $(W/L)_{PMOS} = 20$, $(W/L)_{NMOS} = 80$, $k'_{PMOS} = 40\text{uA/V}^2$, $k'_{NMOS} = 100\text{uA/V}^2$, and $\lambda_1 = \lambda_2 = 0$. Let $R_{in} = 200\text{k}\Omega$. (a) Design the circuit such that $I_{D\text{-}PMOS} = 0.1$mA, $I_{D\text{-}NMOS} = 0.3$mA, $V_{SD\text{-}PMOS} = 1.0$V, and $V_{DS\text{-}NMOS} = 2.0$V. The voltage across R_{S1} is to be 0.6V. (b) Determine the small-signal voltage gain $A_v = v_o/v_i$. (c) Find the small-signal output resistance R_o.

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