國 立 宜 蘭 大 學

１０３ 學年度研究所碩士班考試入學

准考證號碼：

《作答注意事項》

## Part I. **Choose** the correct answer for the following questions. (40%)

1. Si sample S_B is doped with boron of $8 \times 10^{16}\ cm^{-3}$. Si sample S_P is doped with phosphorus of $8 \times 10^{16}\ cm^{-3}$. Si sample $S_{B\&P}$ is doped with boron of $8 \times 10^{16}\ cm^{-3}$ and with phosphorus of $8 \times 10^{16}\ cm^{-3}$. With respect to the **conductivity** of each sample at room temperature, which of the following is **correct**?　(A) $S_B > S_P > S_{B\&P}$　(B) $S_{B\&P} > S_B = S_P$　(C) $S_B < S_P < S_{B\&P}$　(D) $S_P > S_B > S_{B\&P}$

2. In the following circuit, the voltage transfer function $\dfrac{V_o}{V_i}(s)$ is　(A) $\dfrac{-\left(R_2 + \dfrac{1}{SC_2}\right)}{R_1 /\!/ \dfrac{1}{SC_1}}$　(B) $\dfrac{-\left(R_1 + \dfrac{1}{SC_1}\right)}{R_2 /\!/ \dfrac{1}{SC_2}}$　(C) $\dfrac{-\left(R_2 /\!/ \dfrac{1}{SC_2}\right)}{R_1 + \dfrac{1}{SC_1}}$　(D) $\dfrac{-\left(R_1 /\!/ \dfrac{1}{SC_1}\right)}{R_2 + \dfrac{1}{SC_2}}$
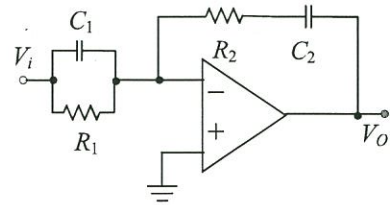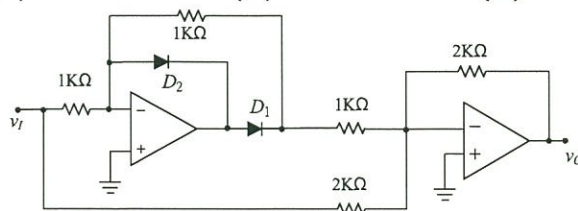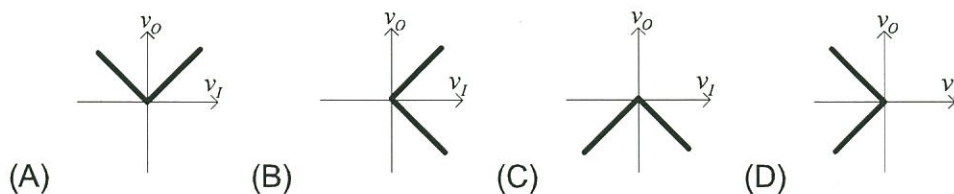
3. In the following circuit, the voltage transfer curve $\dfrac{v_O}{v_I}$ is

(A)　　　(B)　　　(C)　　　(D)
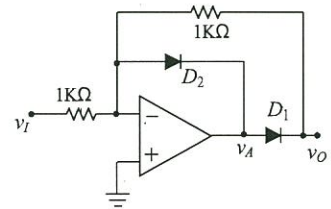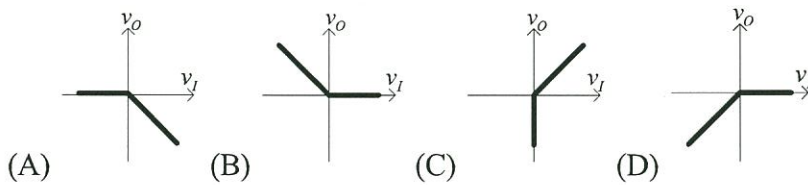
4. For a NPN BJT operated at room temperature, the collector current is 1mA. Its g_m is
(A) 25mV (B) 40m/Ω (C) 40Ω (D) 25m/Ω

5. Which of the following devices has 4 terminals? (A) Diode (B) JFET (C) BJT (D) MOSFET

6. In the following circuit, the voltage transfer curve $\dfrac{v_O}{v_I}$ is

(A)　　　(B)　　　(C)　　　(D)

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7. Which of the following statements is **false**?

   (A) As the biasing current increases, the BJT transconductance increases linearly with respect to biasing current

   (B) As the biasing current increases, the MOS transconductance increases linearly with respect to biasing current

   (C) The BJT transconductance increases exponentially with respect to V_{BE}

   (D) The MOS transconductance increases linearly with respect to V_{GS}.

8. The output v_O of the following circuit is
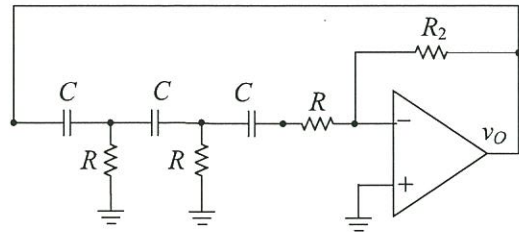
   (A) square wave

   (B) triangular wave
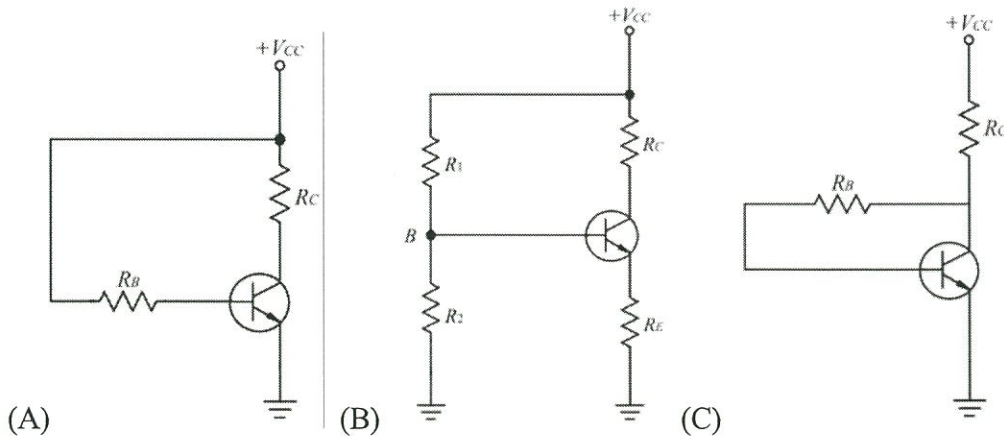
   (C) sinusoidal wave

   (D) impulse wave.
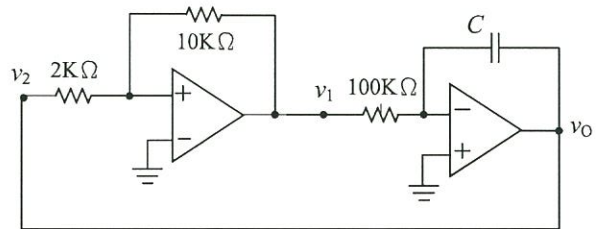
9. The following figure shows a phase-shift oscillator circuit. The OP amplifier is assumed to be ideal. The oscillation frequency is

   (A) $\dfrac{\sqrt{6}}{2\pi RC}$ (B) $\dfrac{\sqrt{3}}{2\pi RC}$ (C) $\dfrac{1}{2\pi\sqrt{3}RC}$

   (D) $\dfrac{1}{2\pi\sqrt{6}RC}$
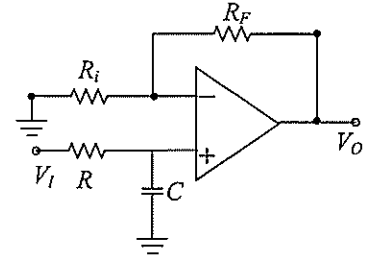

10. Which of the following circuits has a temperature-invariant operating point (I_C, V_{CE})?

   (D) all of three circuits shown above.

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Part II. Calculate and Answer the following questions. (60%)

1. **Derive** (5%) the transfer function $\dfrac{V_o}{V_i}(s)$ of the following circuit to **verify** (5%) what kind of a filter is.

2. (10%) Assume that the breakdown voltage of the zener diode shown in the circuit is **5V**. Suppose the required minimum current I_Z is **1mA** and the maximum power dissipation of the zener diode is **50mW**.
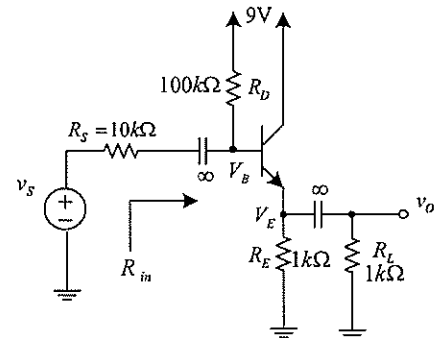
   Please **derive** the DC range of V_S such that the circuit can provide $V_O = 5V$ normally.
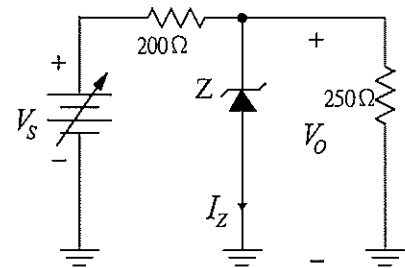
3. For the BJT circuit shown below, β = **200**.

   Please **find**
   (1) I_E (4%)
   (2) V_E (4%)
   (3) V_B (4%)
   (4) the input resistance R_{in} (4%)
   (5) the voltage gain v_o / v_s (4%)

4. Due to the bias devices in the amplifier circuit shown below, $I_D = 1mA$ and $g_m = 1mA/V$. Assume the r_0 effect is neglected.
   (1) **Find** C_S if the pole frequency associated with the capacitor C_S is 10Hz. (5%)
   (2) **Find** the zero frequency associated with the capacitor C_S. (5%)
   (3) **Calculate** the DC voltage gain of this amplifier. (5%)
   (4) **Find zero** frequency and **pole** frequency if the resistor R_S is replaced by an ideal current source. (5%)