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本科考試禁用計算器

*請在試卷答案卷(卡)內作答

1. 計算題 (15 分)

For the circuit shown in Fig. P1, the input voltage source $v_i = 15 \sin(\omega t)$ volts, $R_1 = 10 \text{ k}\Omega$, $R_S = 1 \text{ k}\Omega$ and $\beta = 29$.

1-1 (5 分) Find the Thevenin equivalent circuit voltage source v_{th} .

1-2 (5 分) Find the Norton equivalent circuit current source i_n .

1-3 (5 分) If an output capacitance load $C_L = 10 \text{ pF}$ is connected between the two output nodes, find the -3 dB frequency ω_o of the output voltage v_o for this case.

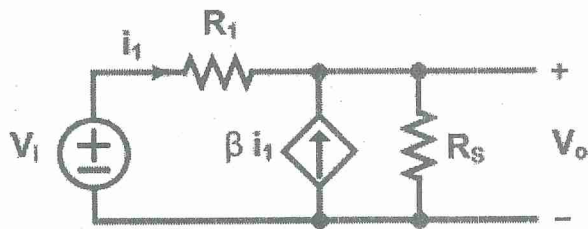


Fig. P1

2. 計算題 (10 分)

Calculate the value $g_m \times r_o$ in an NMOS transistor if $I_D = 1.667 \text{ mA}$, $V_{th} = 0.7 \text{ V}$, $\lambda = 0.02 \text{ V}^{-1}$, $V_{GS} = 1.2 \text{ V}$, and $V_{DS} = 1.0 \text{ V}$.

3. 計算題 (10 分)

As shown in Fig. P3, a transconductance amplifier with limited G_M is used for the operational amplifier design. If $R_1 = 1 \text{ k}\Omega$, $R_2 = 5 \text{ k}\Omega$, and $R_2 \times G_M = 4$, find the output voltage gain V_{OUT} / V_{IN} .

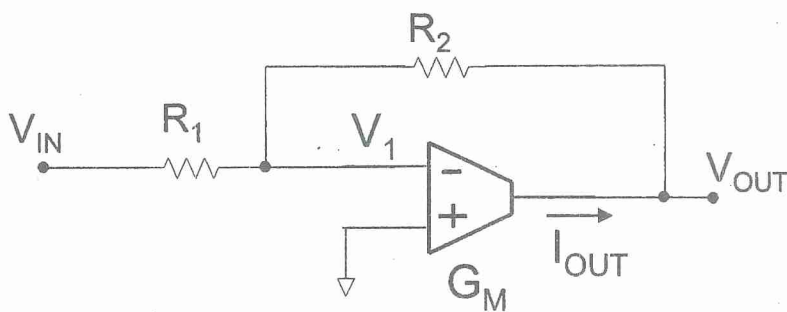


Fig. P3

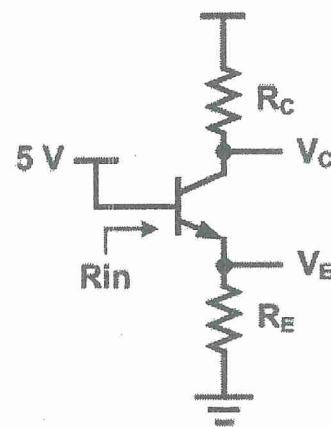


Fig. P4

參考用

4. 計算題 (15 分)

The npn transistor in the circuit of Fig. P4 has $V_{CC} = 10 \text{ V}$, $R_E = 4.3 \text{ k}\Omega$, $\beta = 20$ with $v_{BE} = 0.7 \text{ V}$ at $i_E = 1 \text{ mA}$. Assume thermal voltage $V_T = 25 \text{ mV}$.

4-1 (5 分) If $R_C = 3 \text{ k}\Omega$, find the collector voltage V_C .

4-2 (5 分) What is the largest value that R_C can have while maintaining active mode operation?

4-3 (5 分) Calculate the value of the amplifier input resistance R_{in} .

注意：背面有試題

5. 計算題(20分)

Fig. P5 shows a common-drain/common-gate amplifier which is operated with $g_m = 5 \text{ mA/V}$, $C_{gs} = 2.0 \text{ pF}$, $C_{gd} = 0.1 \text{ pF}$ and C_L (at the output node) = 1.0 pF , and $R_L = R_{sig} = 20 \text{ k}\Omega$. Neglect the r_o and the body effect.

5-1 (10分) Find the midband gain A_M .

5-2 (10分) Find the upper 3-dB frequency f_H .

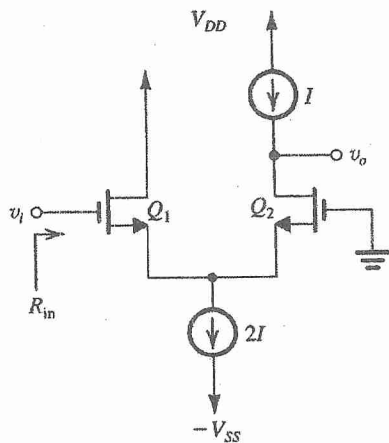


Fig. P5

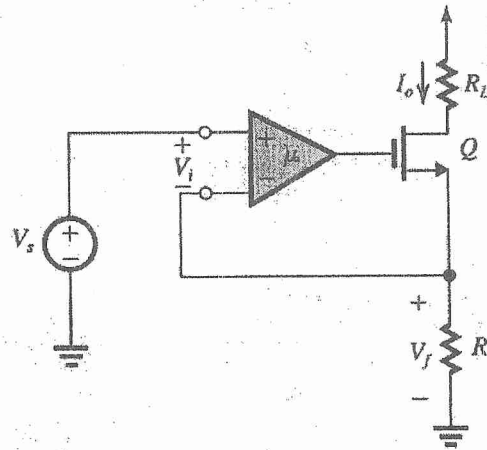


Fig. P7

6. 計算題(10分)

A particular BJT has a short-circuit unity current gain frequency f_T of 5 GHz , $\beta = 150$, and $C_\mu = 0.1 \text{ pF}$ when operated at $I_C = 0.5 \text{ mA}$. Neglect the base contact resistance r_x . Assume thermal voltage $V_T = 25 \text{ mV}$.

6-1 (5分) Find the base-emitter capacitance C_π in this situation.

6-2 (5分) Find the base-emitter resistance r_x .

7. 計算題(20分)

Fig. P7 shows a feedback transconductance amplifier, which consists of an op amp with an open-loop gain μ , very large input resistance, and a very small output impedance, and an NMOS transistor Q with the transconductance of g_m . The amplifier delivers its output current I_o to R_L . The feedback R senses the equal current in the source node of Q and delivers a proportional voltage V_f to the negative input terminal of the op amp. Neglect the r_o and the body effect of the transistor Q .

7-1 (10分) Open the feedback loop by breaking the connection of R to the negative input of the op amp and grounding the negative input terminal, find an expression for the open-loop gain $A = I_o/V_i$.

7-2 (5分) Find an expression for the feedback factor $\beta = V_f/I_o$.

7-3 (5分) Find an expression for the closed-loop gain $A_f = I_o/V_s$.

參考用

注意：背面有試題