

92 學年度碩士班考試電機所電子學試題

1. Basic concepts: 25%

- (1). Please compare the characteristics of BJT and MOSFET. (5%)
- (2). What is the Barkhausen criterion? (5%)
- (3). A P-channel JFET: $V_p = 5\text{ V}$, $V_{SG} = -3\text{ V}$. If the JFET is operating at pinch-off region, determine V_{SD} ? (10%)
- (4). Please describe the CMOS inverter. (5%)

2. In the Fig. (2), the MOSFET circuit: Q_1 is operating at saturation region. Q_1 :

$W_1, L_1, Q_2: W_2, L_2$, determine $\frac{V_o}{V_i} = ?$ (10%)

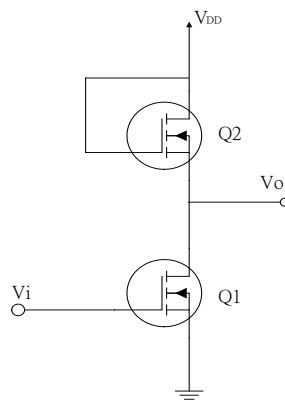


Fig. (2)

3. A negative feedback amplifier is shown in Fig. (3)

- (a) What is the type of negative feedback? (5%)
- (b) If the two BJTs have the same characteristics and $r_\pi = 1\text{ k}\Omega$, $\beta = 60$, $r_o = \infty$, then determine V_o/V_s ? (10%)

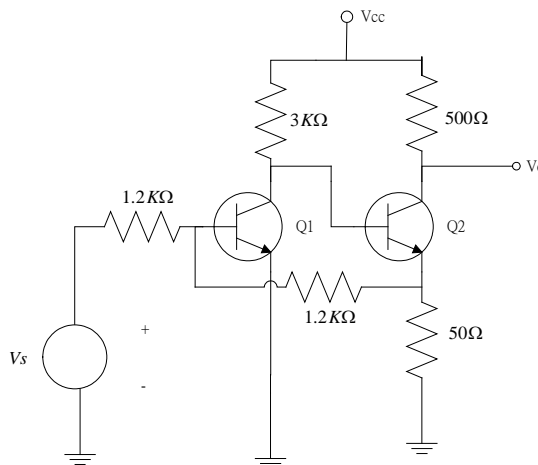


Fig. (3)

- (c). A feedback amplifier has open-loop transfer function: $A(s) = (12/(1 + s/100))^3$. Determine the amplifier to be unstable, what is the critical \square value? (5%)

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4. 在圖(4)中的運算放大器電路，電阻的單位為歐姆，試推導出輸出電壓與輸入電壓的關係。(10%)

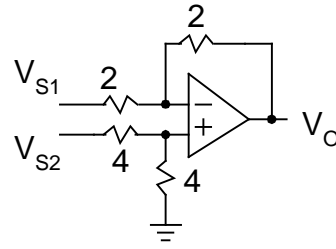


Fig. (4)

5. 圖(5)為 BJT 高頻放大器的簡化等效電路，試推導出 $v_o(s)/v_s(s)$ 的一階近似轉移函數關係。其中， $r_\pi = 1\text{k}\Omega$ 、 $R_L = 3\text{k}\Omega$ ， $C_\pi = 10\text{pF}$ 、 $C_\mu = 2\text{pF}$ ， $r_o \rightarrow \infty$ ， $g_m = 0.1\text{A/V}$ 。(25%)

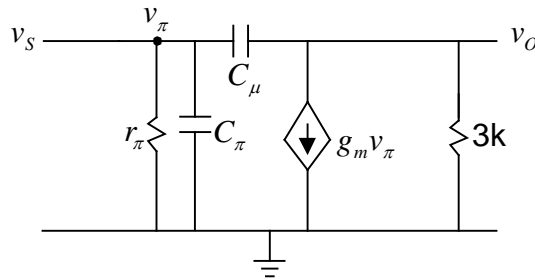


Fig. (5)

6. 在圖(6)中，如果 MOSFET 的參數如下： $V_t = 1\text{V}$ ， $k = 0.5\text{mA/V}^2$ ， $V_A = 50\text{V}$ ，且 $R_D = R_L = 10\text{k}\Omega$ ，則在忽略大電阻 R_G 的影響下，詳細算出其電壓增益 v_o/v_s 。(10%)

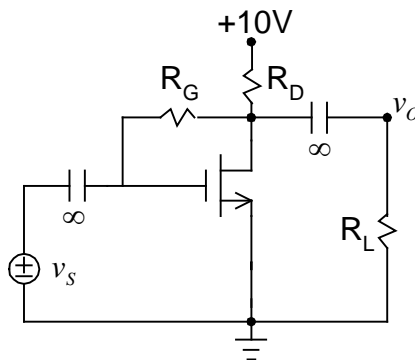


Fig. (6)

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1. (10%) Find the general solution of $y^{(4)}(t) - y(t) = 0$
2. (10%) Solve the logistic equation $y'(t) = (r - a y(t))y(t)$, where $r, a \in R$
3. (10%) Solve the solution of $y''(t) + y(t) = \cos t$ with initial value $y(0) = 0$ and $y'(0) = 1$
4. (10%) Find the general solution of $X'(t) = \begin{bmatrix} 5 & -1 \\ 0 & 3 \end{bmatrix} X(t)$
5. (10%) Solve the initial-value problem $\frac{dy}{dx} + 5x^4 y = x^4, y(0) = \frac{1}{5}$

If the system has no solutions.

6. $A = \begin{bmatrix} 1 & 1 & 1 & 0 \\ 2 & 1 & 0 & 1 \end{bmatrix}$,

(1) determine $N(A)$ (6%)

(2) determine $\text{rank}(A)$ (4%)

7. $A \in R^{n \times n}, \alpha \in R$, prove

(1) $\det(\alpha A) = \alpha^n \det(A)$ (5%)

(2) $\det(A^{-1}) = \frac{1}{\det(A)}$, if A is nonsingular. (5%)

8. $A = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 1 & 0 \\ -3 & 3 & 5 \end{bmatrix}$, determine

(1) the eigenvalues of A (3%)

(2) the eigenvectors (including generalized eigenvectors) of A (7%)

9. $A = \begin{bmatrix} -3 & 1 \\ 0 & -2 \end{bmatrix}$, find

(1) e^{At} (5%)

(2) $\sin(A)$ (5%)

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10. $A = \begin{bmatrix} 1 & 4 & 3 \\ -1 & -2 & 0 \\ 2 & 2 & 3 \end{bmatrix}$, compute A^{-1} by a series of elementary row operations
(Gauss-Jordan reduction). (10%)