長庚大學107學年度研究所碩士班招生考試試題

系所：電子工程學系碩士班　　考試科目：電子學

注意：請詳細閱讀下列試題，並請標明題號依試題順序將答案書寫於答案卷上。　本試題共2頁：第1頁

1. For the circuit in Fig. 1, use superposition to find Vo in terms of the input voltages V_1 and V_2. Assume an ideal OP Amp. (12%)
   For $V_1=10\sin(2\pi \times 60t)-0.1\sin(2\pi \times 1000t)$, volts
   $V_2=10\sin(2\pi \times 60t)+0.1\sin(2\pi \times 1000t)$, volts
2. The differential amplifier in Fig. 2 uses transistor with $\beta=100$. Evaluate the following: (12%)
   (a) The input differential resistance R_{id}.
   (b) The overall differential voltage gain V_{od}/V_{sig} (neglect the effect of r_o)

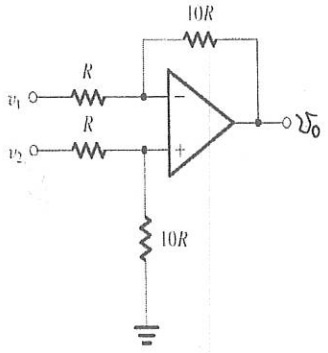

Fig.1

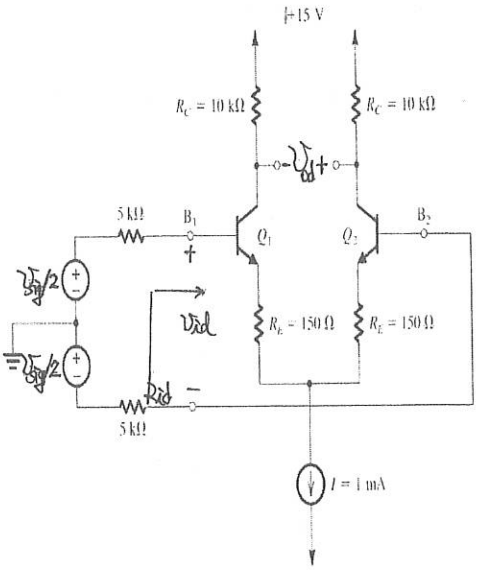

Fig. 2

3. The NMOS and PMOS transistors in the circuit of Fig. 3 are matched with $k_n'(W_n/L_n)=k_p'(W_p/L_p)=1\text{mA/V}^2$ and $V_{tn}=-V_{tp}=1\text{V}$. Assume $\lambda=0$ for both devices, find the drain currents i_{DN} and i_{DP}, and the voltage V_O for $V_I=+2.5\text{V}$, and -2.5V. (15%)
4. We want to analyze the circuit of Fig. 4 to determine the small-signal voltage gain Vo/Vs, the input resistance Rin, and the output resistance Rout. The transistor has $\beta=100$. (12%)

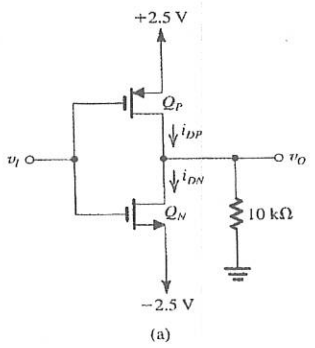

Fig. 3

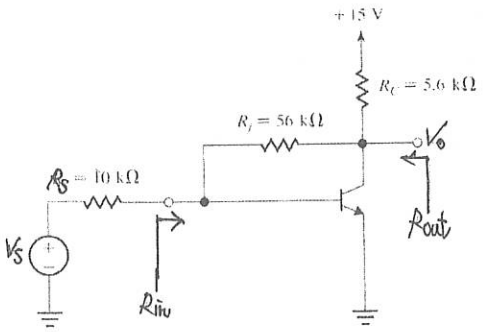

Fig. 4

5. Please explain the following:
   (a) Short Channel Effect. (5%)
   (b) Avalanche breakdown. (5%)

6. Assuming the diodes to be ideal, describe the transfer characteristic of the circuit shown in Fig. 5. (12%)

7. For the circuit in Fig. 6, it is required to determine the value of the voltage V_{BB} that results in the transistor operating (a) in the active mode with V_{CE}=5V; (b) at the edge of saturation; (c) deep in saturation with β_{forced}=10. For simplicity, assume that V_{BE} remains constant at 0.7V. The transistor β is specified to be 50. (15%)

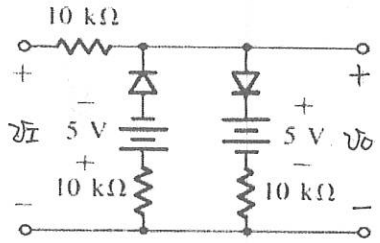

Fig. 5

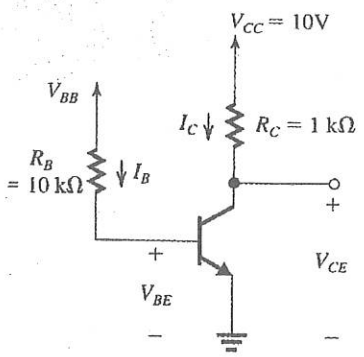

Fig. 6

8. Find Id(drain current), gm(transconductance), ro(output resistance), Ao(open circuit voltage gain) , Cgs(gate-to-source capacitance), Cgd(gate-to-drain capacitance) for an NMOS transistor fabricated in the 0.18-um CMOS technology specified in the following Table.1. Let L=0.18um, W=1.8um, and Vov=0.2V. (12%)

Table.1

	0.8 μm		0.5 μm		0.25 μm		0.18 μm	
Parameter	NMOS	PMOS	NMOS	PMOS	NMOS	PMOS	NMOS	PMOS
t_{ox} (nm)	15	15	9	9	6	6	4	4
C_{ox} (fF/μm²)	2.3	2.3	3.8	3.8	5.8	5.8	8.6	8.6
μ (cm²/V·s)	550	250	500	180	460	160	450	100
μC_{ox} (μA/V²)	127	58	190	68	267	93	387	86
V_{t0} (V)	0.7	−0.7	0.7	−0.8	0.43	−0.62	0.48	−0.45
V_{DD} (V)	5	5	3.3	3.3	2.5	2.5	1.8	1.8
$\lvert V'_A \rvert$ (V/μm)	25	20	20	10	5	6	5	6
C_{ov} (fF/μm)	0.2	0.2	0.4	0.4	0.3	0.3	0.37	0.33