	國	立	清	華	大	學	命	題	紙	
九十五學年度微機電系統工程研究所系(所)組碩士班入學考試										
科目	電子學	科目代	碼2406	共	_3頁第	頁	*請在試	卷【答案	卷】內作答	

1. (15%) The circuit as shown contains passive elements and ideal operation amplifiers. The sub-circuit inside the dash-line box on the right is equivalent to an inductor.

(a) (10%) Please express the inductance value in terms of  $R_1$ ,  $C_2$ ,  $R_3$ ,  $R_4$ , and  $R_5$ .

(b) (5%) Write down the transfer function  $V_0(s)/V_i(s)$ .



2. (20%) The schematic of a state-variable filter as shown contains passive elements and ideal operational amplifiers. Please derive the transfer functions of  $v_1(s)/v_i(s)$  and  $v_3(s)/v_i(s)$ .



3. (15%) The circuit shown is a Wilson current mirror made by bipolar-junction transistors. Assume the collector current is related to the base current by  $I_c = \beta I_b$ , please derive its current gain  $I_o/I_{REF}$ .



## 4. (10%)

- (a) (5%) Design V<sub>G</sub> to let the drain current to be 1 mA, where  $\mu_n C_{ox}$ = 100  $\mu$ A/V<sup>2</sup>, L= 0.25  $\mu$ m, W= 5  $\mu$ m, and V<sub>f</sub>= 0.7 V. (5)
- (b) (5%) If connect a source resistance between the source terminal of the MOSFET to ground, what is the value of R<sub>s</sub> to reduce the gain by 20%?



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5. (15%) Analyze the active-loaded common-source amplifier shown below, where  $I_{bias} = 50 \ \mu A$ :

(a) (5%) Calculate the low-frequency small-signal gain  $(v_o/v_i)$ .

(b) (10%) Determine the 3-dB frequency  $f_{H}$ .



6. (25%) For the circuit shown below:

- (a) (10%) Determine  $A_d$  (dB) and  $A_{cm}$  (dB).
- (b) (5%) Determine the small-signal input resistance.
- (c) (10%) Assuming a load of 1pF is connected, plot CMRR (dB). Mark the important frequencies and slopes.



## Circuit parameters:

 $(W/L)_3 = (W/L)_4 = (W/L)_5 = 20$   $R_c = 50 \text{ K}, (V_A)_{BJT} = 50 \text{ V}, \beta = 100,$   $(V_A)_{MOS} = 20 \text{ V}, (C_{gd})_{MOS} = 50 \text{ fF},$ neglect all other capacitances.