Exercise 4

Table 4.1

		Typical Parameter Value		
Parameter Symbol	Parameter Description	n-Channel	p-Channel	Units
V_{T0}	Threshold voltage(V_{BS}=0)	0.7	-0.8	V
K	Transconductance parameter(in saturation)	134	50	$\mu A/V^2$
γ	Bulk threshold parameter	0.45	0.4	$V^{1/2}$
λ	Channel length modulation parameter	0.1	0.2	V^{-1}
$2\|\phi_F\|$	Surface potential at strong inversion	0.9	0.8	V

$* K = \mu C_{OX}$

4-1 For the circuit in Fig.4.1(a) assume that there are no capacitance parasitics associated with M1. The voltage source v_{in} is a small-signal value, whereas voltage source V_{DC} has a dc value of 3 V. Design M1 to achieve the asymptotic frequency response shown in Fig.4.1(b).

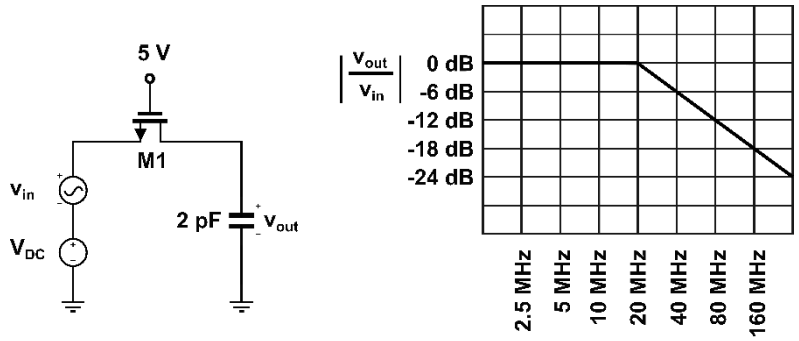


Fig.4.1

4-2 Fig.4.2 illustrates a source-degenerated current source. M1 with W/L=2u/1u, I_D =10 μ A,.

(a) Using Table 4.1 model parameters, calculate the output resistance at the given current bias.

(b) Calculate the minimum output voltage required to keep the device in saturation.

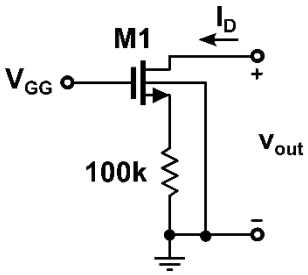


Fig.4.2

4-3 Calculate the output resistance and the minimum output voltage, while maintaining all devices in saturation, for the circuits shown in Fig.4.3. Assume that i_{OUT} is actually 10μA，γ=0. Use Table 4.1 for device model information.

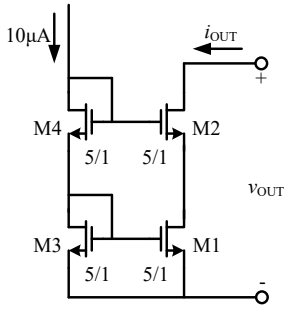


Fig .4.3

4-4 A reference circuit is shown in Fig.4.4, assume that $(W/L)_1=(W/L)_2=(W/L)_3=4$, $(W/L)_4=1$, please derive a symbolic expression of V_{REF}.（已知各管处于饱和区且各管阈值电压为V_{Ti}）

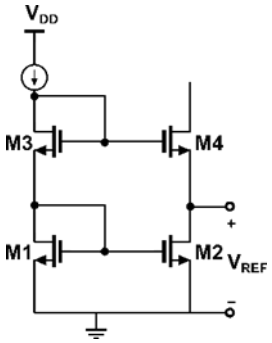


Fig.4.4

4-5 As the circuits shown in Fig.4.5, I_{REF}=0.3mA and γ=0. Using the model parameters in Table 4.1,

(a)Calculate the voltage V_b when $V_X=V_Y$;

(b) If V_b is 100mV smaller than the value in (a), calculate the deviation of I_{out} from 300 μ A.

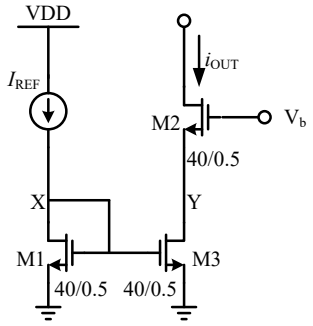
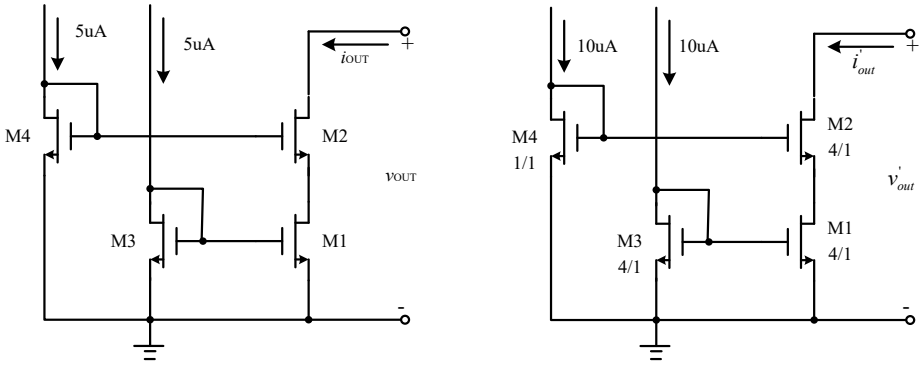


Fig.4.5

4-6 Design M3 and M4 of Fig.4.6(a) so that the output characteristics are identical to the circuit shown in Fig.4.6(b). It is desired that i_{OUT} is ideally 10uA.



(a) (b)

Fig.4.6