

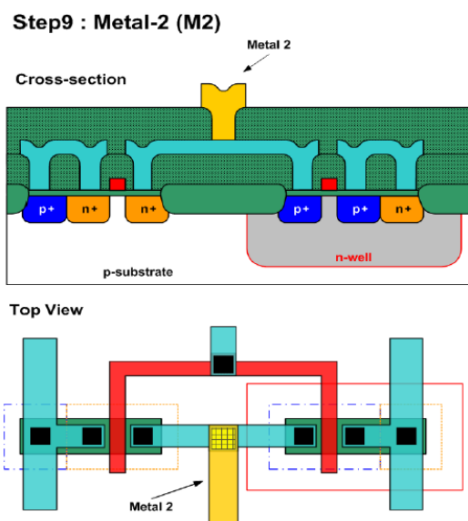
Midterm Solution

1. a. Textbook page 23
b. Textbook page 25
c. Textbook page 585
d. Textbook page 589
e. Textbook page 587
2. Textbook page 36
3. Region 1 channel length modulation
Region 2 DIBL
Region 3 impact ionization

$$4. R_{out} = \frac{1}{g_{mp}} \left| |r_{op}| |r_{on} \right|$$

$$A_v = -g_{mn} * R_{out}$$

5. (a) Cross section



(b) p-sub => NW => OD => PO => PP => NP => CO => M1 => VIA1 => M2

6. (a) $R_{out} = \frac{1}{\frac{1}{R_s} + g_m + g_{mb}} = 415.8 \Omega$
- (b) $A_v = \frac{\frac{1}{g_{mb}} |RL|}{\frac{1}{g_{mb}} |RL + \frac{1}{g_m}} = -0.8316 (V/V)$

7. (a) Max = 2 + 0.5 = 2.5V
Min = 1 - 0.5 = 0.5V
Swing = 2V
- (b) $A_v = -2m * 200k = -400 (V/V)$

8. Textbook page 32

9. Textbook page 167

10. (a) Textbook page 61

$$G_m = \frac{g_m}{1 + g_m R_s} = 9.9 \mu(A/V)$$

$$(b) A_v = -G_m * R_d = -1.98(V/V)$$

11. (a) $R_{out} = 200k \parallel 20k = 18.18k \Omega$

$$A_v = 1m * 18.18k = 18.18(V/V)$$

(b) Textbook page 66

$$A_v = \frac{-g_m r_{o2} R_d}{R_d + 2R_3 + r_o + 2g_m R_s r_o} = -0.049(V/V)$$

$$(c) 0.2 * \sqrt{2} = 0.283V$$

$$(d) MAX = 1.8V \quad MIN = 0.9V$$

12. (a) $V_p = \frac{2g_m V_{incm}}{\frac{1}{r_{o3}} + 2g_m}$

$$V_x = -R_{d1} * g_m * (V_{incm} - V_p)$$

$$V_y = -R_{d2} * g_m * (V_{incm} - V_p)$$

$$A_{cm dm} = 0.0025(V/V)$$

$$(b) CMRR = 18.18 / 0.0025 = 7280$$

13. (a) $A_v = -200(V/V)$

$$C_{in} = C_{gd} * 201 + C_{gs} = 2.02pF$$

$$C_{out} = C_{gd} + C_{db} = 14fF$$

$$(b) W_{in} = \frac{1}{R_s C_{in}} = 24.75Mrad/s$$

$$W_{out} = \frac{1}{R_{out} C_{out}} = 714Mrad/s$$

14. (a) $g_m = 8mA/V$

$$(b) V_b = 0.9V$$

$$V_{out} > 0.4V$$

$$(c) R_{out} = g_m 4r_{o3} r_{o4} = 320M \Omega$$

(d) diode connected NMOS with W/L is ¼ smaller

15. (a) $A_v = 0.002 * 100k = 200(V/V)$

$$(b) W_{p1} = \frac{1}{r_{o1} \parallel r_{o2} * C_L} = 100Mrad/s$$

$$(c) W_{p2} = \frac{1}{g_{m3} * C_L} = 10^{11} rad/s$$

$$(d) W_z = 2W_{p2}$$

16. FTTFT FTTFF