Name: **Dr JBO**

Student ID Number: **Model Answer**

Section:

Lecturer: Dr. Jamaludin Bin Omar

EEEB273 - Quiz 2 .

SEMESTER 1, ACADEMIC YEAR 2016/2017

Date: 27 June 2016 Time: 15 minutes

Question:

For a MOSFET current source circuit in **Figure 1** the transistor parameters are V_{TN} **= 0.5 V**, λ **= 0,** and k'_n **= 80 µA/V²**. **Design** the circuit such that V_{DS2}**(sat) = 0.3 V**, I_{REF} **= 50 µA**, and the load current is I_O **= 100 µA.** Show clearly all calculations as marks are given according to this.

[10 marks]

Answer:

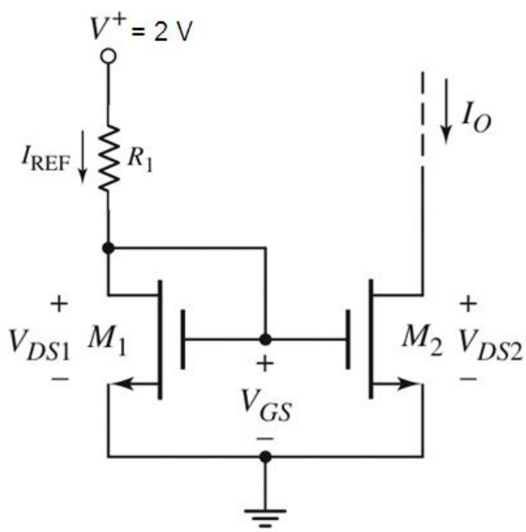

Figure 1

; N – MOSFET

$$v_{DS}(\text{sat}) = v_{GS} - V_{TN}$$

$$i_D = K_n[v_{GS} - V_{TN}]^2$$

$$K_n = \frac{k'_n}{2} \cdot \frac{W}{L}$$

; P – MOSFET

$$v_{SD}(\text{sat}) = v_{SG} + V_{TP}$$

$$i_D = K_p[v_{SG} + V_{TP}]^2$$

$$K_p = \frac{k'_p}{2} \cdot \frac{W}{L}$$

; Small signal

$$g_m = 2\sqrt{K_? I_{DQ}}$$

$$r_o \cong \frac{1}{\lambda I_{DQ}}$$

$V_{DS2}(\text{sat}) = V_{GS} - V_{TN}$ [1]

$V_{GS} = V_{DS2}(\text{sat}) + V_{TN}$

$= 0.3 + 0.5 = 0.8$ V [1]

$I_{REF} = (V^+ - V_{GS} - 0) / R_1$ [1]

$R_1 = (V^+ - V_{GS} - 0) / I_{REF}$

$= (2 - 0.8) / (50\mu) = 24$ kΩ [1]

$I_{REF} = (k'_n / 2)\,(W/L)_1\,[V_{GS} - V_{TN}]^2$ [1]

$(W/L)_1 = I_{REF} / \{(k'_n / 2)\,[V_{GS} - V_{TN}]^2\}$ [1]

$= (50\mu) / \{(80\mu/2)\,[0.8 - 0.5]^2\}$

$= 13.889$ [1]

$I_O = (k'_n / 2)\,(W/L)_2\,[V_{GS} - V_{TN}]^2$ [1]

$(W/L)_2 = I_O / \{(k'_n / 2)\,[V_{GS} - V_{TN}]^2\}$ [1]

$= (100\mu) / \{(80\mu/2)\,[0.8 - 0.5]^2\}$

$= 27.778$ [1]

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Question:

For a MOSFET current source circuit in **Figure 1** the transistor parameters are V_{TN} **= 0.5 V**, λ **= 0,** and k'_n **= 100 µA/V²**. **Design** the circuit such that V_{DS2}**(sat) = 0.3 V**, I_{REF} **= 50 µA**, and the load current is I_O **= 80 µA.** Show clearly all calculations as marks are given according to this.

[10 marks]

Answer:

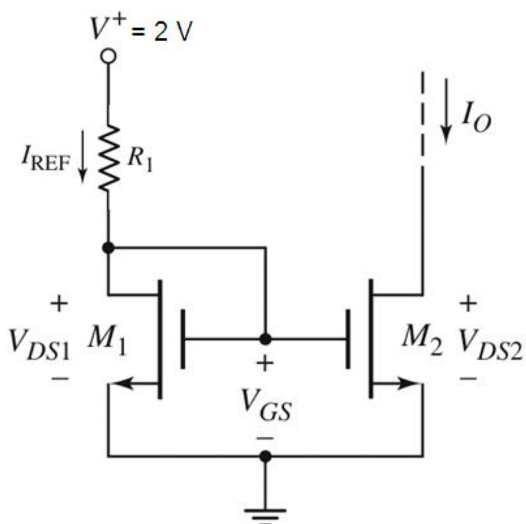

Figure 1

$;\mathrm{N-MOSFET}$

$v_{DS}(\mathrm{sat}) = v_{GS} - V_{TN}$

$i_D = K_n[v_{GS} - V_{TN}]^2$

$K_n = \frac{k'_n}{2} \cdot \frac{W}{L}$

$;\mathrm{P-MOSFET}$

$v_{SD}(\mathrm{sat}) = v_{SG} + V_{TP}$

$i_D = K_p[v_{SG} + V_{TP}]^2$

$K_p = \frac{k'_p}{2} \cdot \frac{W}{L}$

$;\mathrm{Small\ signal}$

$g_m = 2\sqrt{K_? I_{DQ}}$

$r_o \cong \frac{1}{\lambda I_{DQ}}$

V_{DS2}(sat) = $V_{GS} - V_{TN}$ **[1]**
V_{GS} = V_{DS2}(sat) + V_{TN}
= 0.3 + 0.5 = 0.8 V **[1]**

I_{REF} = (V^+ - V_{GS} - 0) / R_1 **[1]**
R_1 = (V^+ - V_{GS} - 0) / I_{REF}
= (2 – 0.8) / (50µ) = 24 kΩ **[1]**

I_{REF} = (k'_n / 2) $(W/L)_1$ $[V_{GS} - V_{TN}]^2$ **[1]**
$(W/L)_1$ = I_{REF} / {(k'_n / 2) $[V_{GS} - V_{TN}]^2$} **[1]**
= (50µ) / {(100µ/2) $[0.8 - 0.5]^2$}
= 11.111 **[1]**

I_O = (k'_n / 2) $(W/L)_2$ $[V_{GS} - V_{TN}]^2$ **[1]**
$(W/L)_2$ = I_O / {(k'_n / 2) $[V_{GS} - V_{TN}]^2$} **[1]**
= (80µ) / {(100µ/2) $[0.8 - 0.5]^2$}
= 17.778 **[1]**

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Question:

For a MOSFET current source circuit in **Figure 1** the transistor parameters are $\boldsymbol{V_{TN} = 0.5}$ **V**, $\boldsymbol{\lambda = 0}$**,** and $\boldsymbol{k'_n = 80}$ **μA/V²**. **Design** the circuit such that $\boldsymbol{V_{DS2}}$**(sat) = 0.3 V**, $\boldsymbol{I_{REF} = 100}$ **μA**, and the load current is $\boldsymbol{I_O = 50}$ **μA.** Show clearly all calculations as marks are given according to this.

[10 marks]

Answer:

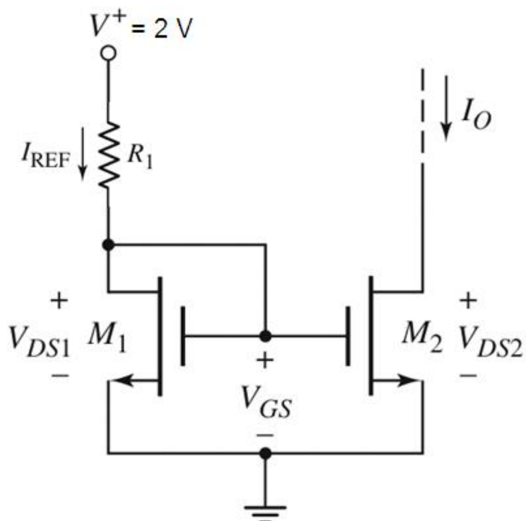

Figure 1

; N – MOSFET

$$v_{DS}(\text{sat}) = v_{GS} - V_{TN}$$

$$i_D = K_n[v_{GS} - V_{TN}]^2$$

$$K_n = \frac{k_n'}{2} \cdot \frac{W}{L}$$

; P – MOSFET

$$v_{SD}(\text{sat}) = v_{SG} + V_{TP}$$

$$i_D = K_p[v_{SG} + V_{TP}]^2$$

$$K_p = \frac{k_p'}{2} \cdot \frac{W}{L}$$

; Small signal

$$g_m = 2\sqrt{K_? I_{DQ}}$$

$$r_o \cong \frac{1}{\lambda I_{DQ}}$$

$V_{DS2}(\text{sat}) = V_{GS} - V_{TN}$ **[1]**

$V_{GS} = V_{DS2}(\text{sat}) + V_{TN}$

$= 0.3 + 0.5 = 0.8$ V **[1]**

$I_{REF} = (V^+ - V_{GS} - 0) / R_1$ **[1]**

$R_1 = (V^+ - V_{GS} - 0) / I_{REF}$

$= (2 - 0.8) / (100\mu) = 12$ kΩ **[1]**

$I_{REF} = (k'_n / 2)\,(W/L)_1\,[V_{GS} - V_{TN}]^2$ **[1]**

$(W/L)_1 = I_{REF} \,/\, \{(k'_n / 2)\,[V_{GS} - V_{TN}]^2\}$ **[1]**

$= (100\mu) / \{(80\mu/2)\,[0.8 - 0.5]^2\}$

$= 27.778$ **[1]**

$I_O = (k'_n / 2)\,(W/L)_2\,[V_{GS} - V_{TN}]^2$ **[1]**

$(W/L)_2 = I_O \,/\, \{(k'_n / 2)\,[V_{GS} - V_{TN}]^2\}$ **[1]**

$= (50\mu) / \{(80\mu/2)\,[0.8 - 0.5]^2\}$

$= 13.889$ **[1]**

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EEEB273 - Quiz 2 :
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Date: 27 June 2016 Time: 15 minutes

Question:

For a MOSFET current source circuit in **Figure 1** the transistor parameters are $\mathbf{V_{TN} = 0.5\ V}$, $\boldsymbol{\lambda = 0}$, and $\mathbf{k'_n = 50\ \mu A/V^2}$. **Design** the circuit such that $\mathbf{V_{DS2}(sat) = 0.3\ V}$, $\mathbf{I_{REF} = 80\ \mu A}$, and the load current is $\mathbf{I_O = 100\ \mu A}$. Show clearly all calculations as marks are given according to this.

[10 marks]

Answer:

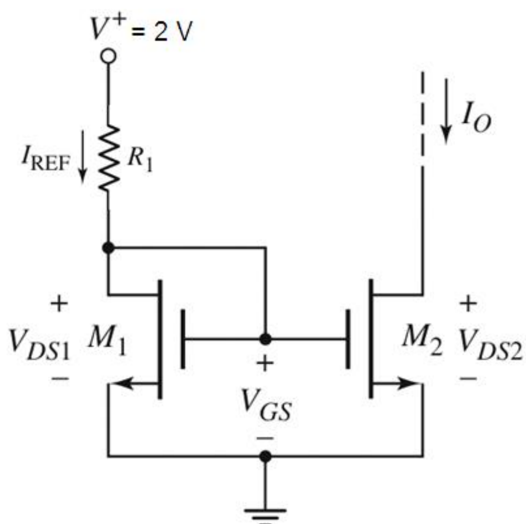

Figure 1

; N – MOSFET

$$v_{DS}(\text{sat}) = v_{GS} - V_{TN}$$

$$i_D = K_n[v_{GS} - V_{TN}]^2$$

$$K_n = \frac{k'_n}{2}\cdot\frac{W}{L}$$

; P – MOSFET

$$v_{SD}(\text{sat}) = v_{SG} + V_{TP}$$

$$i_D = K_p[v_{SG} + V_{TP}]^2$$

$$K_p = \frac{k'_p}{2}\cdot\frac{W}{L}$$

; Small signal

$$g_m = 2\sqrt{K_? I_{DQ}}$$

$$r_o \cong \frac{1}{\lambda I_{DQ}}$$

$V_{DS2}(\text{sat}) = V_{GS} - V_{TN}$ **[1]**
$V_{GS} = V_{DS2}(\text{sat}) + V_{TN}$
$= 0.3 + 0.5 = 0.8\ \text{V}$ **[1]**

$I_{REF} = (V^+ - V_{GS} - 0) / R_1$ **[1]**
$R_1 = (V^+ - V_{GS} - 0) / I_{REF}$
$= (2 - 0.8) / (80\mu) = 15\ \text{k}\Omega$ **[1]**

$I_{REF} = (k'_n / 2)\,(W/L)_1\,[V_{GS} - V_{TN}]^2$ **[1]**
$(W/L)_1 = I_{REF} \,/\, \{(k'_n / 2)\,[V_{GS} - V_{TN}]^2\}$ **[1]**
$= (80\mu) / \{(50\mu/2)\,[0.8 - 0.5]^2\}$
$= 35.556$ **[1]**

$I_O = (k'_n / 2)\,(W/L)_2\,[V_{GS} - V_{TN}]^2$ **[1]**
$(W/L)_2 = I_O / \{(k'_n / 2)\,[V_{GS} - V_{TN}]^2\}$ **[1]**
$= (100\mu) / \{(50\mu/2)\,[0.8 - 0.5]^2\}$
$= 44.444$ **[1]**