Analogue Electronics 1 (EE204FZ)

Tutorial 3

Q1. Circle the correct answer.

1. For which region of operation is a MOSFET represented by its small-signal model?
A. Triode
B. Saturation
C. Cut-off
D. Independent of the region

2. Channel length modulation is taken into consideration in the small-signal model by ________.
A. placing a resistor between gate and source
B. placing a capacitor between gate and drain
C. placing a resistor between source and drain
D. none of the above

3. The small-signal output resistance of a MOSFET _____________.
A. decreases with V_{GS}
B. increases proportionally with V_{GS}
C. independent of V_{GS}
D. increases exponentially with V_{GS}

increase proportionally with V−ds

4. For an ideal MOSFET the output resistance is ____________.
A. zero
B. infinity
C. of the order of tens of ohms
D. of the order of thousands of ohms

5. In a MOSFET, the ratio of output current change against an input voltage change is called ________.
A. transconductance
B. siemens
C. resistance
D. gain

Q2. Answer the following questions.

1. In small-signal analysis of FET amplifier circuits, what is the criteria for something to be considered small? Please ensure you use some technical adjectives.

2. Define the term "clipping" and explain how it may be minimised in a MOSFET amplifier.

3. Draw the small-signal equivalent circuit model for the MOSFET circuit in Figure Q2. Clearly label the model components and pin names.

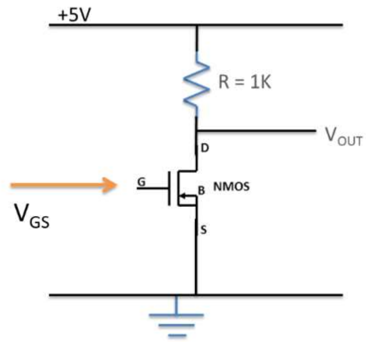

Fig. Q2

Q3. An NMOS transistor is biased in the saturation region at a constant V_{GS}. The drain current is I_D = 3 mA at V_{DS} = 5 V and I_D = 3.4 mA at V_{DS} = 10 V. Determine λ and r_o.

Q4. Consider the circuit in Figure Q4. The circuit parameters are V_{DD} = 3.3 V, R_D = 8 kΩ, R_1 = 240 kΩ, R_2 = 60 kΩ, and R_{Si} = 2 kΩ. The transistor parameters are V_T = 0.4 V, $\mu_n C_{ox}$ = 100 µA/V^2, W/L = 80, and λ = 0.02 V^{-1}. (a) Determine the quiescent (operating point) values I_{DQ} and V_{DSQ}. (b) Find the small-signal parameters g_m and r_o. (c) Determine the small-signal voltage gain.

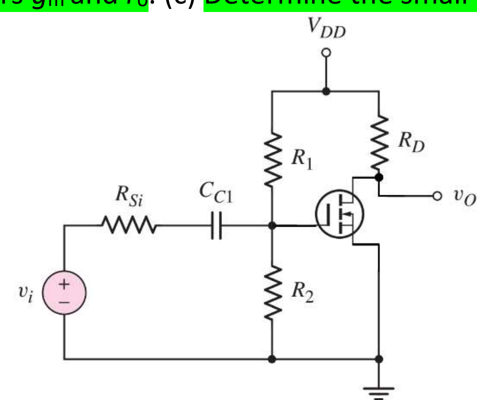

Fig. Q4

Q5. For the NMOS common-source amplifier in Figure Q5, the transistor parameters are: V_T = 0.8 V, $\mu_n C_{ox}(W/L)$ = 1 mA/V^2, and λ = 0. The circuit parameters are V_{DD} = 5 V, R_S = 1 kΩ, R_D = 4 kΩ, R_1 = 225 kΩ, and R_2 = 175 kΩ. (a) Calculate the quiescent (operating point) values I_{DQ} and V_{DSQ}. (b) Determine the small-signal voltage gain for $R_L = \infty$. (c) Determine the value of R_L that will reduce the small-signal voltage gain to 75 percent of the value found in part (b).

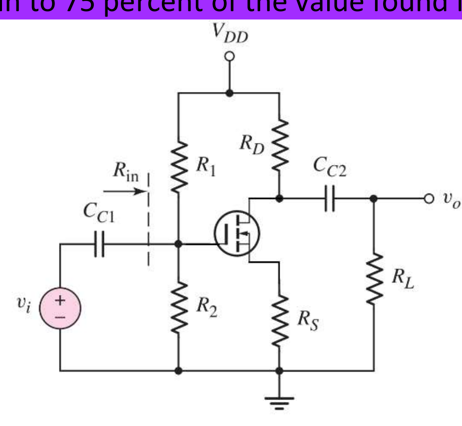

Fig Q5