Analogue Electronics 1 (EE204FZ)

Tutorial 2

Q1. Circle the correct answer.

1. A certain depletion-type MOSFET is biased at V_{GS} = 0 V. Its datasheet specifies I_{DSS} = 20 mA and the value of the drain current _____.
A. 0 A
B. cannot be determined
C. 20 mA
D. very high

2. The effective channel length of an n-channel MOSFET in saturation decreases with an increase in _____.
A. drain voltage
B. gate voltage
C. source voltage
D. body voltage

3. The main advantage of CMOS is its_____.
A. high power rating
B. lower power consumption
C. small signal operation
D. switching capability

4. Which of the following statements on using MOSFETs as resistors is NOT true? _____.
A. Device resistance can be voltage controlled
B. In the triode region ($V_{GS} > V_T$ and V_{DS} is small), MOSFETs can be used as adjustable resistors with high resistance values
Low
C. MOSFET resistors usually have smaller footprints than other on-chip resistors
D. MOSFET resistors can be very precise

5. When an input signal reduces the channel size of a MOSFET, the process is called _____.
A. gate charging
B. enhancement
C. substrate connecting
D. depletion

Q2. Answer the following questions.

1. How would you create a small and voltage controllable resistor using a MOSFET? State the two advantages of this device.

2. Figure Q2 shows a circuit implementation of an inverter using MOSFETs. Explain its operation. In your explanation, explain why the use of MOSFETs can lead to a very power efficient implementation for logic gates.

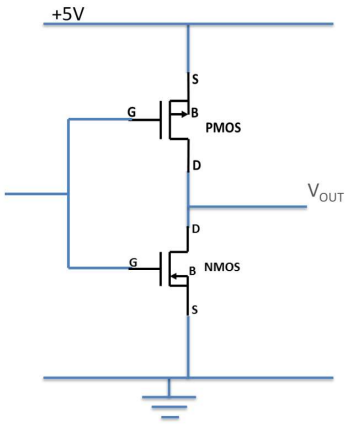

Fig. Q2

Q3. Determine in which mode (depletion, enhancement or neither) each depletion-type MOSFET in Fig Q3 is biased. Explain your reason briefly.

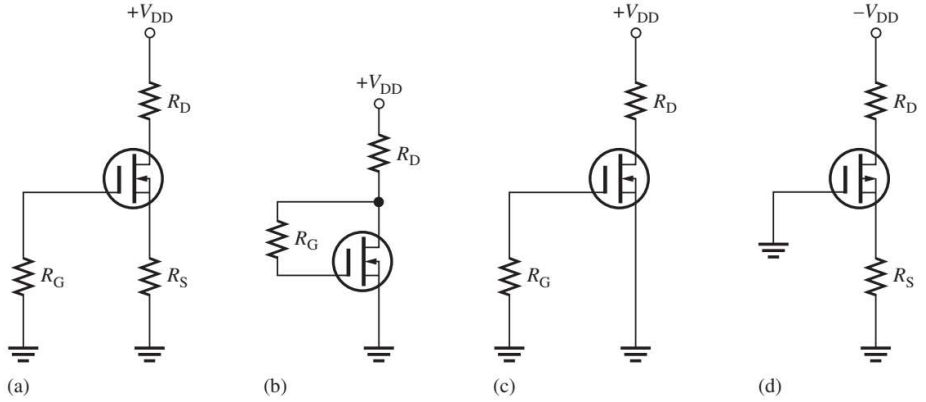

Fig Q3

Q4. An enhancement-type PMOS transistor in Fig Q4 has $\mu_p C_{ox}(W/L) = 80\ \mu A/V^2$, $|V_T| = 1.5$ V and $|\lambda| = 0.02\ V^{-1}$. The gate is connected to ground and the source to +5 V. Find the drain current for V_D = +4 V, +1.5 V, 0 V, and -5 V.

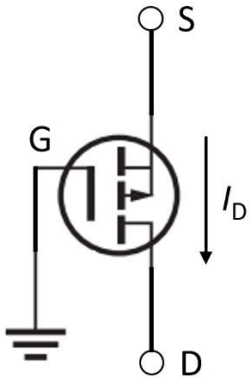

Fig Q4

Q5. The MOSFET circuit shown in Fig Q5 uses a MOSFET with $\mu_n C_{ox}(W/L) = 250\ \mu A/V^2$, $V_T = 0.5$ V. For $R = 100$ ohm and $V_{DD} = +5$ V, solve MOSFET's device current and drain voltage, and indicate whether the device is operating in the saturation region or the triode region.

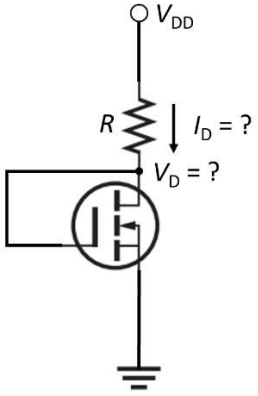

Fig Q5