Solution :

$$R_i = R_1 \| R_2 = 180 \| 470 = 130.15\ k\Omega$$

$$g_m = 2K_n(V_{GSQ} - V_{TN}) = 2(8)(2.5 - 1.5) = 16mA/V$$

$$r_o = \frac{1}{\lambda I_{DQ}} = \frac{1}{0.01 \times 8} = 12.5K\Omega$$

$$A_V = \frac{g_m(R_S \| r_o)}{1 + g_m(R_S \| r_o)} \cdot \frac{R_i}{R_i + R_{si}} = \frac{16(1 \| 12.5)}{1 + 16(1 \| 12.5)} \cdot \frac{130.15}{130.15 + 2} = 0.9226$$

$$R_O = \frac{1}{g_m} \| r_o \| R_S = \frac{1000}{16} \| 12500 \| 1000 = 58.55\Omega$$

TWO MARK QUESTIONS AND ANSWERS

1. Define transconductance of FET.

The change in drain current due to change in gate to source voltage is determined using transconductance. It is denoted as g_m.

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}}$$

where,

ΔI_D=change in drain current

ΔV_{GS}= change in gate to source voltage

2. Define drain resistance of FET.

The small signal drain to source voltage is related to small signal drain current by a parameter called drain resistance. It is denoted as r_d.

$$r_d = \frac{\Delta V_{DS}}{\Delta I_D}$$

where,

ΔI_d=change in drain current.

ΔV_{DS}=change in drain to source voltage.

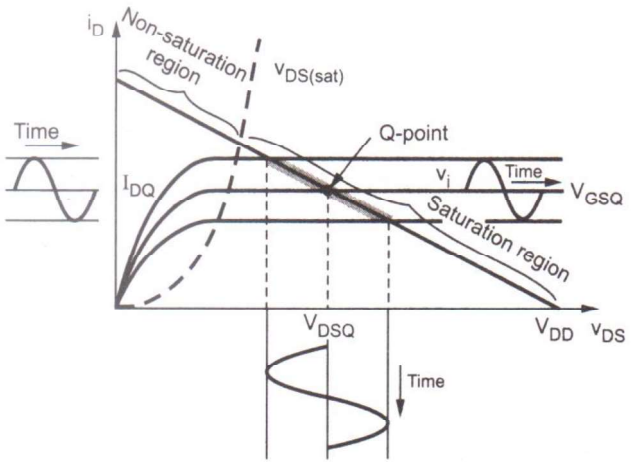
3.Define amplification factor of FET.

Amplification factor of FET is defined as the ratio of change in drain to source voltage to the change in gate to source voltage keeping drain current as constant. It is denoted as μ.

$$\square = g_m \, r_d$$

$$\square = \frac{\Delta V_{DS}}{\Delta V_{GS}}\Big|_{I_D \text{ constant}}$$

4. Explain the operation of MOSFET amplifier with the help of d.c loadline.



Assume the time varying input signal is sinusoidal. D.C loadline and Q point are the functions of V_{GS} , V_{DD} , R_D and the MOSFET parameters. For the output voltage to be a linear function of input voltage, the MOSFET is biased in saturation region. The total gate to source voltage is the sum of V_{GSQ} and V_i. As V_i increases, the instantaneous value of V_{GS} increases, and the bias point moves up the loadline. A larger value of V_{GS} means a larger drain current and a smaller value of V_{DS}.

5. Define transconductance of MOSFET.

The change in drain current due to change in gate to source voltage is determined using transconductance. It is denoted as g_m.

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}} = 2K_n(V_{GSQ} - V_T)$$

Also we can write,

$$g_m = 2\sqrt{K_n I_{DQ}}$$

where,

ΔI_D=change in drain current.

ΔV_{GS}= change in gate to source voltage.

6.Define amplification factor of MOSFET.

Amplification factor of FET is defined as the ratio of change in drain to source voltage to the change in gate to source voltage keeping drain current as constant. It is denoted as μ.

$$\mu = g_m r_o$$

$$\mu = \frac{\Delta V_{DS}}{\Delta V_{GS}}\Big|_{I_D \text{ constant}}$$

7. Define BICMOS technology.

1. Bipolar junction transistors have larger transconductance than MOS transistors biased at same current level and have higher switching speed. Due to large transconductance, they provide larger voltage gains.

2. MOS transistors have infinite input impedance at low frequencies and have high packaging density. Due to almost infinite input impedance, MOS transistors have zero input bias current.

3. The advantages of these two technologies can be utilized by combining bipolar and MOS transistors on same substrate. Such technology is known as BICMOS technology.

8.What are the advantages of BICMOS technology?

1. Larger transconductance due to bipolar transistor.
2. An infinite input resistance.
3. Higher switching speed.
4. Larger voltage gain due to larger transconductance.

9. State the disadvantage of MOSFETs over BJTs.

The transconductance of a bipolar transistor is given by $g_m = \frac{I_{CQ}}{V_T}$. In general, transconductance of MOSFET and the gain are smaller compared to those of BJTs. This is the disadvantage of MOSFETs over BJTs.

REVIEW QUESTIONS

1. Derive the expression for low frequency analysis of FET common source amplifier with fixed bias(8)

2. Derive the expression for low frequency analysis of FET common source amplifier with self bias(bypassed&unbypassed Rs)(8)