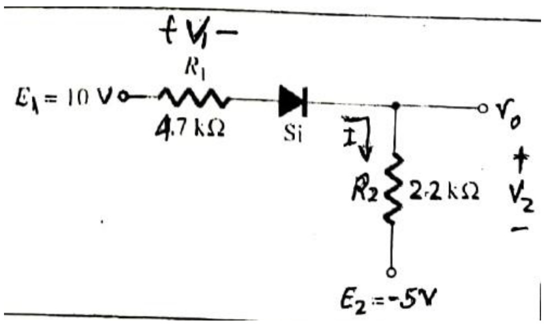
Q.3a **Sol**.



The resulting current through the circuit is

$$I = \frac{E_1 + E_2 - V_D}{R_1 + R_2} = \frac{10\text{ V} + 5\text{ V} - 0.7\text{ V}}{4.7\text{ k}\Omega + 2.2\text{ k}\Omega} = \frac{14.3\text{ V}}{6.9\text{ k}\Omega}$$

$$\cong \mathbf{2.07\ mA}$$

and the voltages are

$$V_1 = IR_1 = (2.07\text{ mA})(4.7\text{ k}\Omega) = \mathbf{9.73\ V}$$

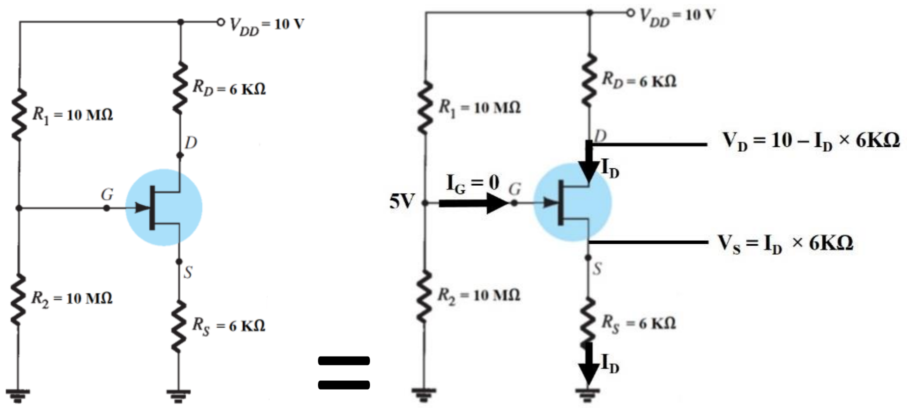
$$V_2 = IR_2 = (2.07\text{ mA})(2.2\text{ k}\Omega) = \mathbf{4.55\ V}$$

Applying Kirchhoff's voltage law to the output section in the clockwise direction results in

$$-E_2 + V_2 - V_o = 0$$

and $$V_o = V_2 - E_2 = 4.55\text{ V} - 5\text{ V} = \mathbf{-0.45\ V}$$

Q.3c **Sol**.



At the gate node due to potential divider, voltage will be $\mathbf{V_G = 5V}$ and **Transistor will be ON & in Saturation**.

So, $V_{GS} = 5 - 6K\Omega \times I_D$

Now, I_D is given by $I_D = \frac{1}{2}\mu_n C_{OX}\frac{W}{L}\left(V_{GS} - V_{TH}\right)^2 = \frac{1}{2}\times 10^{-3}\left(5 - 6K\Omega \times I_D - 1\right)^2$ (**for Tr is in Saturation**.)

So,

$18 \times I_D^{\,2} - 25 I_D + 8 = 0$; I_D = 0.89 mA & 0.5 mA

If we take 0.89 mA then, $V_S = 6\times10^3 \times 0.89\times10^{-3} = 5.34V$

So, $\mathbf{V_S > V_G}$, which makes **transistor OFF**.

Now if we take $\boldsymbol{I_D = 0.5mA}$

$\boldsymbol{V_S} = 6\times10^3 \times 0.5\times10^{-3} = \mathbf{3V}$

So, $\boldsymbol{V_{GS}} = 5 - 3 = \mathbf{2V}$

$\boldsymbol{V_D} = 10 - 6\times10^3 \times 0.5\times10^{-3} = \mathbf{7V}$, ***& Current through R₁ & R₂*** *will be = 10/20MΩ* = $\mathbf{0.5\ \mu A}$

So, $\boldsymbol{I_D = 0.5mA,\ I_G = 0A,\ V_G = 5V,\ V_D = 7V,\ V_S = 3V}$, ***Current through*** $\boldsymbol{R_1}$ ***&*** $\boldsymbol{R_2 = 0.5\mu A}$