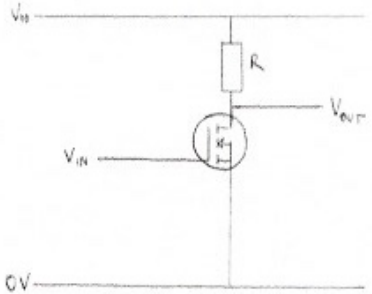
Morgan Scaife

Digital Electronics 4

1.



D, S, G ?

2. Note: $V_{in} = V_{GS}$

$V_{out} = V_{DS}$

The MOSFET has resistance R_{DS}

$V_{DS} = V_{DD} \cdot \frac{R_{DS}}{R + R_{DS}}$

$R_{DS} = \frac{V_{DS}}{I_{DS}}$

$\therefore V_{DS} = V_{DD} \cdot \frac{V_{DS}}{RI_{DS} + V_{DS}}$

Assuming $V_{DS} \neq 0$,

$RI_{DS} + V_{DS} = V_{DD}$

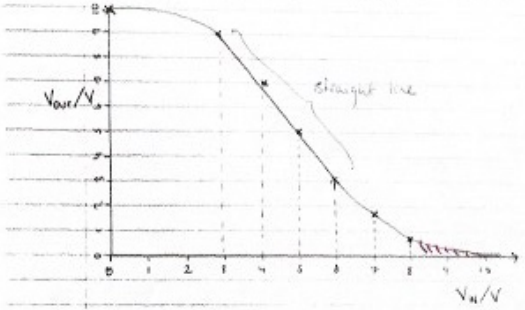
$\therefore V_{DS} = V_{DD} - I_{DS} R$

$= 10V - 500 I_{DS}\ \Omega$

V_{IN}/V	I_{DS}/mA	V_{OUT}/V
0	0	10
3	2	9 ✓
4	6	7
5	10	5 ✓
6	14	3 ✓

For $V_{IN} \geq 7V$, the constant part of the characteristic no longer applies ~~the ohmic part~~.

V_{IN}/V	I_{DS}/mAV^{-1}	V_{DS}	V_{OUT}/V
7	9 V_{DS}	$10V - \frac{9}{11} V_{DS}$	$\frac{2}{11} \approx 1.818$ ✓
8	$\frac{4}{1}/2$ V_{DS}	$10V - \frac{4}{5} V_{DS}$	$\frac{8}{9} \approx 0.889$? (? c)



3. $V_{IN} = 8V$

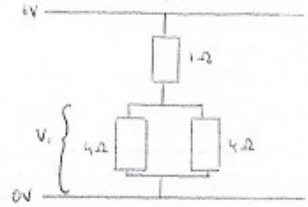
$V_{out} = V_{DS} = \frac{5}{9} V$

$V_R = V_{DD} - V_{DS}$
$= (10 - \frac{5}{9}) V$
$= \frac{85}{9} V$

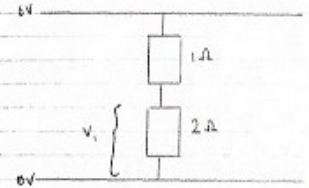
155 mW @ $V_{DS} = 1.2V$

$P_R = \frac{V_R^2}{R} = \frac{(\frac{85}{9})^2}{600} W = \frac{1681}{19440} W \approx 166$ mW

4. The circuit is equivalent to



and also to

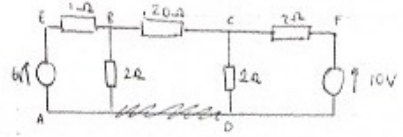


a. $V = IR$
$6V = I \cdot 3\Omega$
$I = 2A$ ✓

b. $V_1 = V \frac{R_1}{R_1 + R_2} = 6V \frac{2}{3} = 4V$ ✓

c. $2I \cdot 2A$
$I = 1A$ $P = ?$ $P = 4W$

5 labelling more nodes



- $I_{EB} + I_{AB} + I_{CB} = 0$
$\Rightarrow I_{EB} + I_{AB} = I_{BC}$ ①

- $I_{FC} + I_{DC} + I_{BC} = 0$
$\Rightarrow -I_{FC} - I_{DC} = I_{BC}$ ②

- $V_{AB} + V_{EB} + V_{BA} = 0$
$\rightarrow 6 = 2I_{AB} - I_{CB}$ ③

- $V_{DA} + V_{FC} + V_{CD} = 0$
$\Rightarrow 10 + 2I_{DC} - 2I_{FC}$
$\Rightarrow 5 = I_{DC} - I_{FC}$ ④

~~$V_{AE} + V_{EB} + V_{BC} + V_{CF} + V_{FD} + V_{DC} + V_{CE} + V_{BA} = 0$~~
~~$\Rightarrow I_{CB} - 2I_{FC} + 2I_{DC} - 6I_{AB} = 4$~~ ⑤

From ②

$I_{EB} = 2I_{AB} - 6$

From ④

$I_{DC} = I_{BC} - 5$

Substituting into ① and ②

$3I_{AB} - 6 = -2I_{DC} + 5 = I_{BC}$

$I_{DC} = \frac{10}{4} = 5/2$

$I_{BC} = -5 + 5 = 0$ V

∴ there is no current flowing through the 6Ω resistor

b $I_{AB} = \frac{I_{BC} \cdot 6}{3} = 2A$

$V_{AB} = I_{AB} \cdot 2\Omega = 4V$ V

$V_{AC} = V_{AB} + V_{BC} = 4V$ V

$V_{AD} = V_{AC} - V_{DC}$

$= 4 - 5/2 \cdot 2$

$= -1V$ V