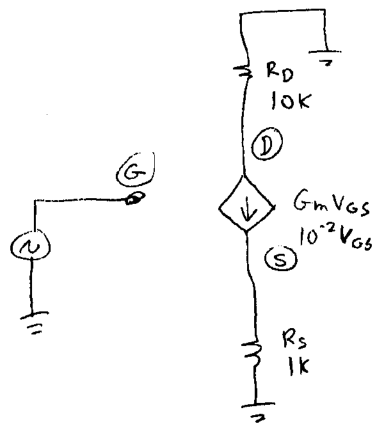
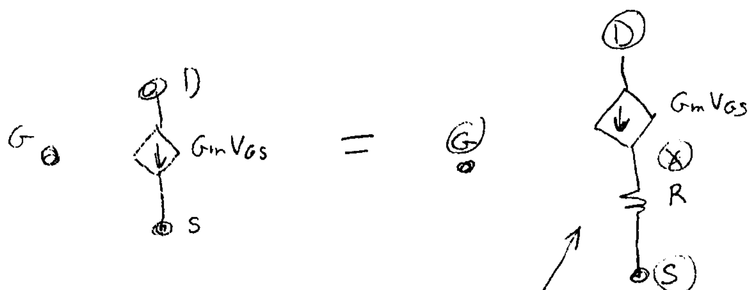
7C ①

Analysis of the amplifier with source resistor --
Another approach---

Use the same model --



You can put a resistor in series with a current source without changing the result.



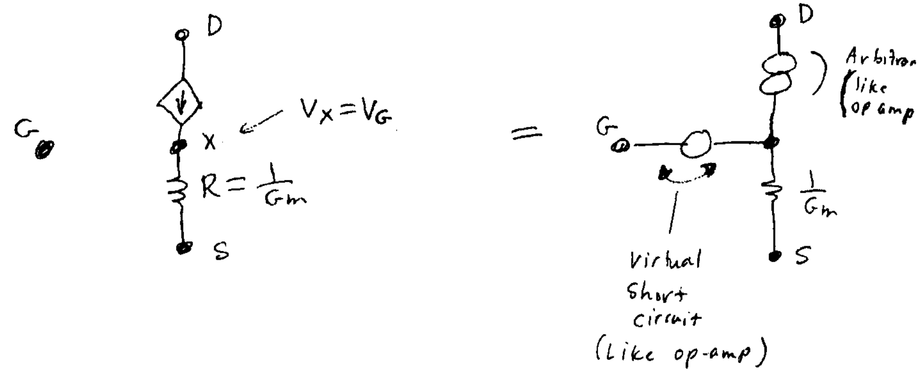
Choose the resistor so $V_X = V_G$

$I = G_m V_{GS}$ $\quad V = V_{GS}$

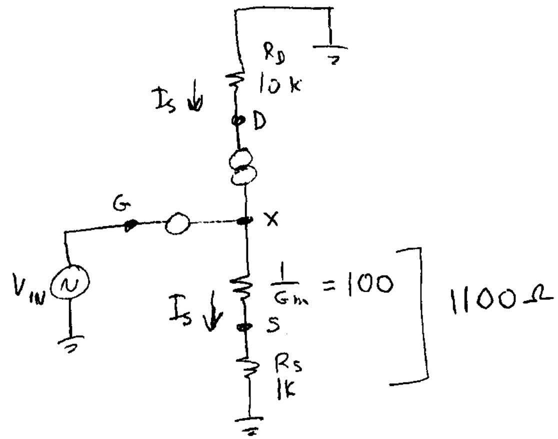
$R = \frac{V}{I} = \frac{V_{GS}}{G_m V_{GS}} = \frac{1}{G_m}$

7C ②

SO -- You can use this model for a MOSFET --



plug in ---



Analysis: $V_X = V_G$

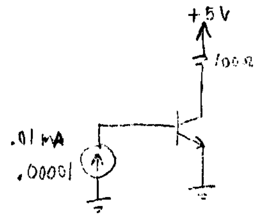
$I_S = \frac{V_S}{R_S} = \frac{V_X}{R_S + \frac{1}{G_m}} = \frac{V_G}{R_S + \frac{1}{G_m}}$ $\quad V_G = I_S (R_S + \frac{1}{G_m})$

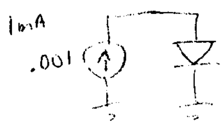
$V_D = -I_S R_D$

$$\frac{V_D}{V_G} = \frac{-I_S R_D}{I_S (R_S + \frac{1}{G_m})} = \frac{-R_D}{R_S + \frac{1}{G_m}}$$

$$= \frac{-10K}{1K + 100} = \frac{-10K}{1.1K} = -9.09$$

```
gnucap> b

>q1 c b 0 nn

>.model nn npn is=1p

>

gnucap> list

Q1  ( c b 0 )  nn  area= 1.
.model  nn  npn  (level=1  kf= 0.  af= 1.  bf= 100.  br= 1.  is= 1.p  nf= 1.  nr= 1.  isc= 0.  c
4= 0.  nc= 2.  ise= 0.  c2= 0.  ne= 1.5  rb= 0.  rbm= 0.  re= 0.  rc= 0.  cjc= 0.  cje= 0.  cjs=
 0.  fc= 0.5  mjc= 0.33  mje= 0.33  mjs= 0.  vjc= 0.75  vje= 0.75  vjs= 0.75  xcjc= 1.  itf= 0.
 ptf= 0.  tf= 0.  tr= 0.  xtf= 0.  xtb= 0.  xti= 3.  eg= 1.11)
*+ ()
gnucap> b

>rc cc c 100

>vcc cc 0 5

>iin 0 b .00001

>

gnucap> pr op v *

gnucap> op

#          v(b)       v(c)       v(cc)      v(Q1)      v(nn)      v(Rc)      v(Vcc)     v(Iin)

 300.15    0.53599    4.9        5.         ??         ??         0.1        5.         -0.53599

gnucap> b

>diode d 0 dd

>.model dd d is=1p

>idiode 0 d .001

>

gnucap> pr op v nodes

gnucap> op

#          v(b)       v(c)       v(cc)      v(d)
 300.15    0.53599    4.9        5.         0.53599
gnucap> EOF on stdin
```





⇒ "is" is "scale current"

$$I_C = I_S\left(e^{\frac{V_{BE}}{nV_T}} - 1\right)$$

Transistor

matches.