12/8/2020

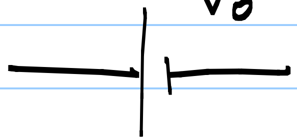
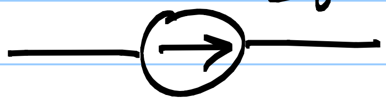
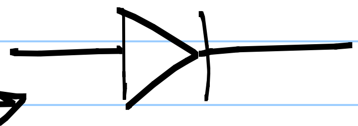
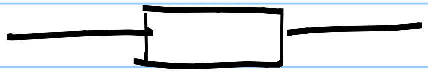
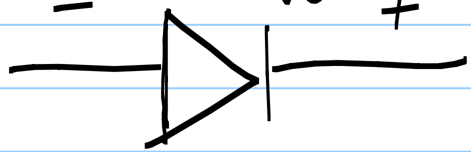
Lecture 5

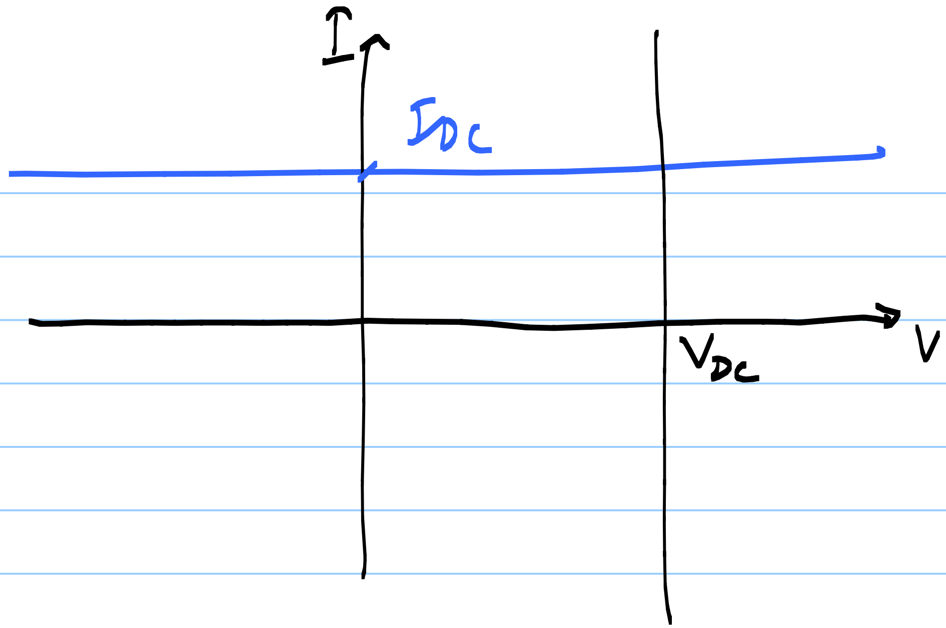
1) Find operating point
   - → solve non-linear equations
   - → incremental Δvs & Δis are dependent on the Q-pt (r_is are dep. on Q-pt.)

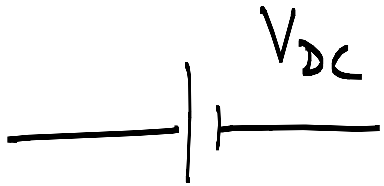
2) Draw the incremental equivalent circuit (linear network) and solve for Δvs & Δis

3) Total Vs and Is

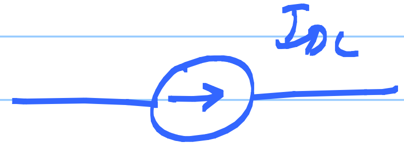
   = Quiescent V/I + Incremental V/I

Element	Incremental equivalent
 R	 R
 V_o	 short circuit
 I_o	 open circuit
 $+\ V_D\ -$, I_D	$r_D = \frac{V_t}{I_D}$ 
$I = f(V)$  I_o, $+\ V_o\ -$	$r = \frac{1}{f'(V_o)}$ 
 $-\ V_o\ +$	 open circuit



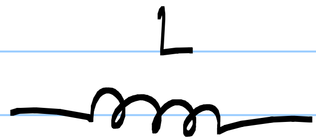


$$r_{V_{DC}} = \frac{1}{f'(V)} = 0$$

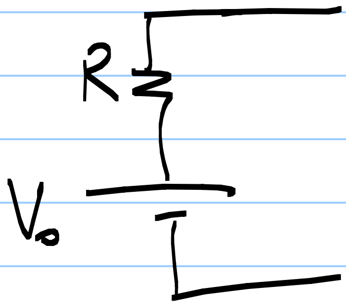


$$r_{I_{dc}} = \frac{1}{f'(V)} = \infty$$

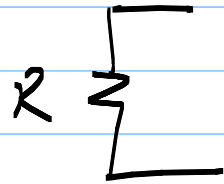
HW :

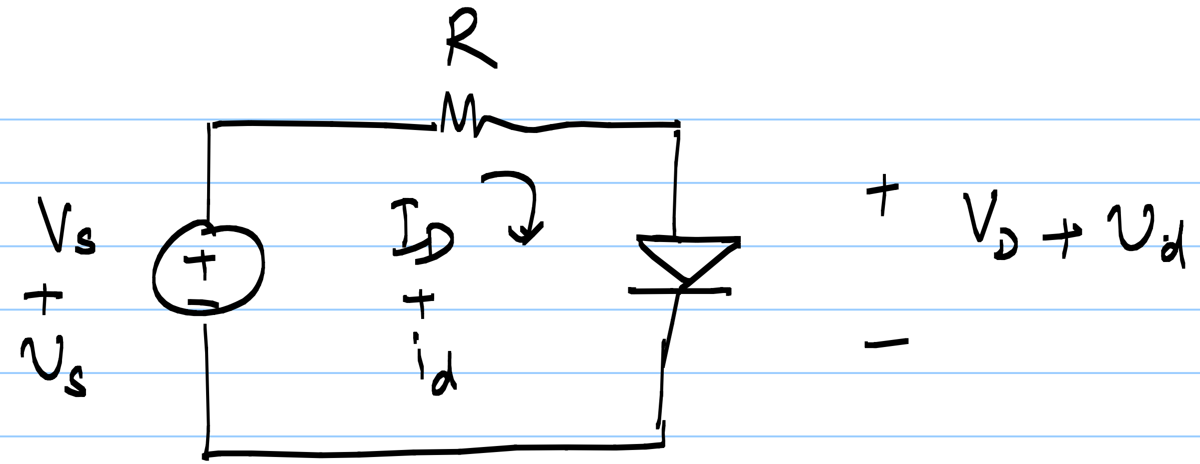


Inc. eq.

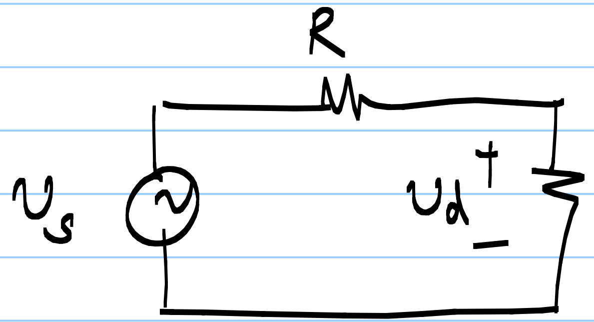


$\Longrightarrow$





Is it possible for $v_d > v_s$?

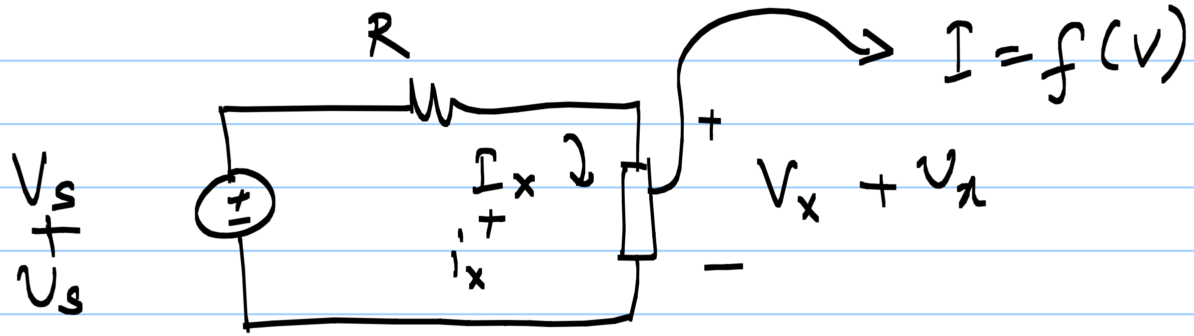


$$r_d = \frac{V_t}{I_D}$$

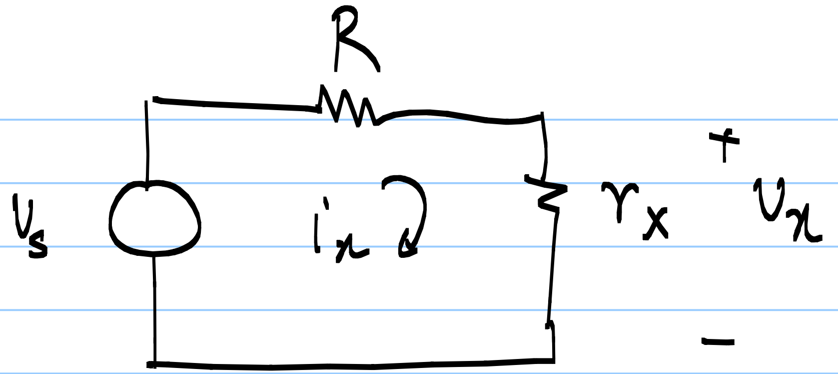
$$v_d = \frac{r_d}{R + r_d} \cdot v_s$$

small-signal gain $= \dfrac{v_d}{v_s}$

$$= \frac{r_d}{R + r_d}$$



$$r_x = \frac{1}{f'(V_x)}$$

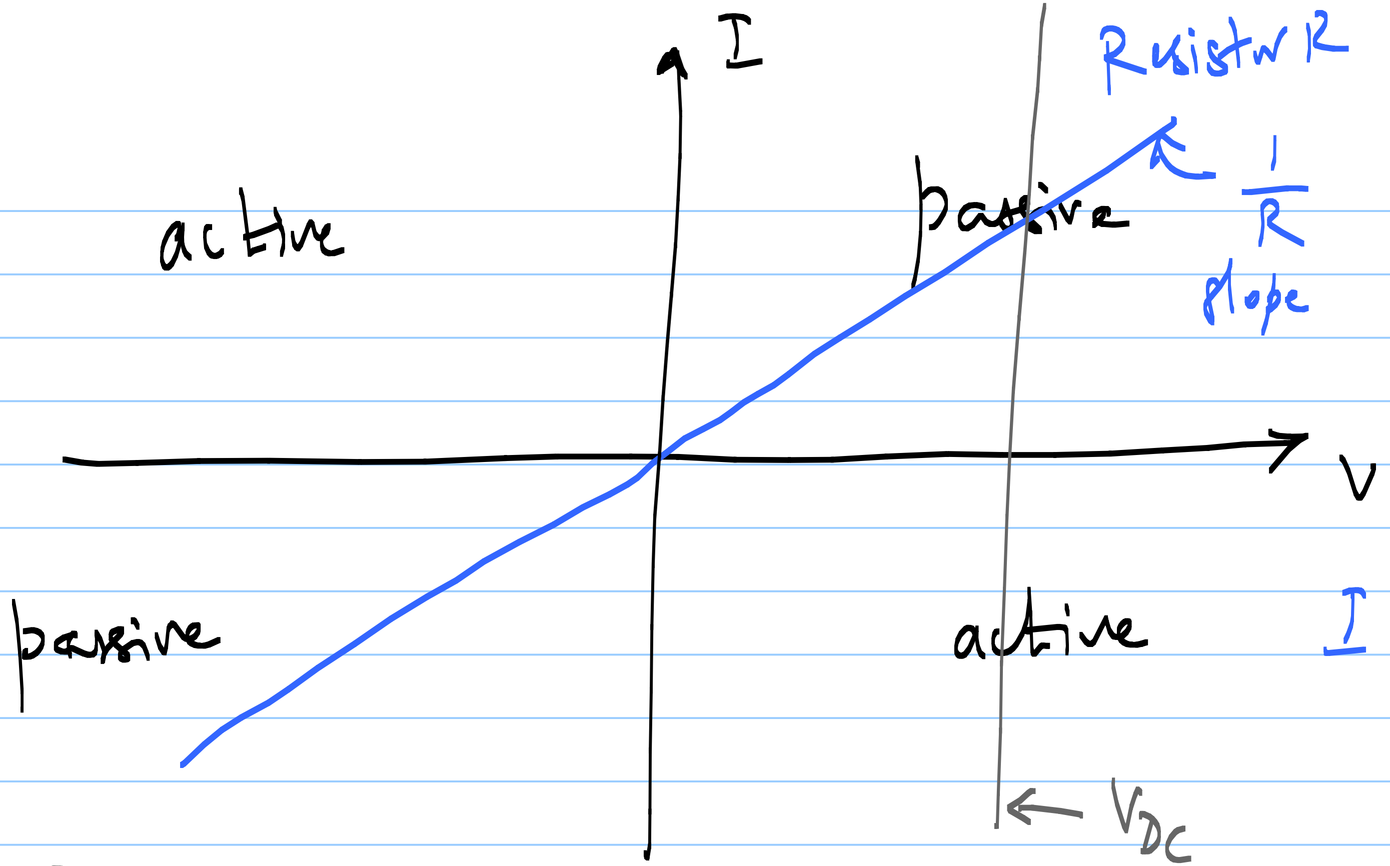


$$\frac{v_x}{v_s} = \frac{r_x}{R + r_x}$$

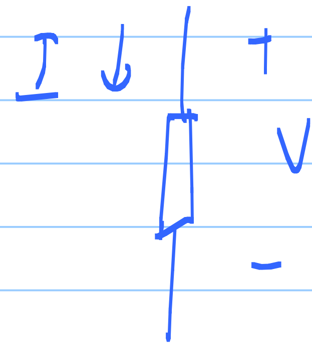
If r_x is negative, it is possible for $\left|\frac{v_x}{v_s}\right|$ to be > 1

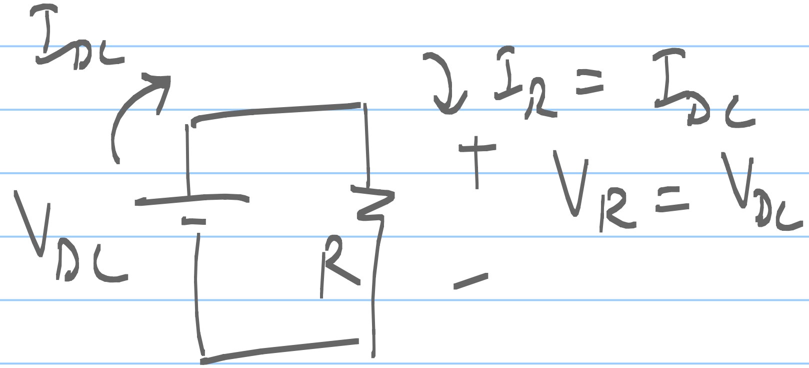
slope of $f(v)$ is negative

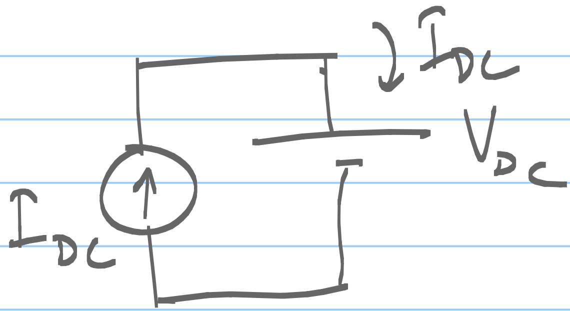
"Tunnel Diode"

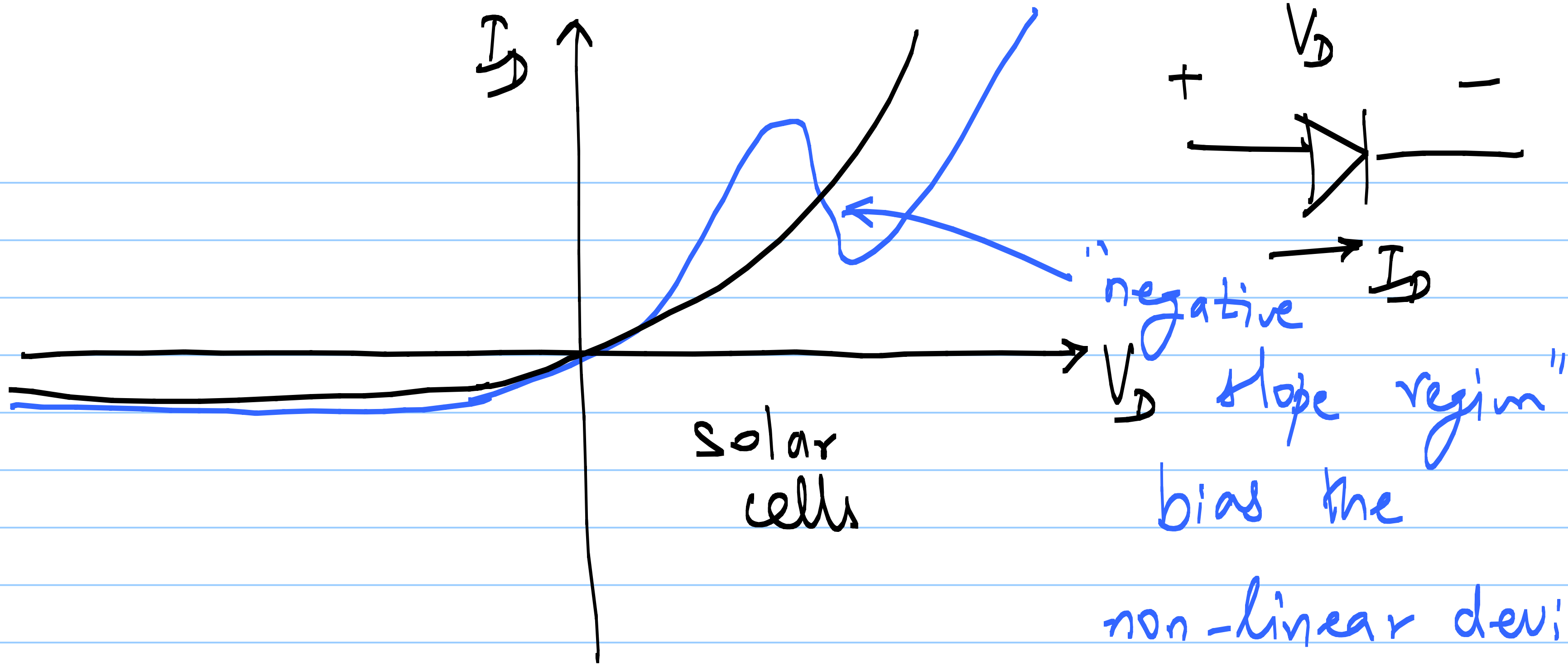


absorbs or dissipates electrical power = passive









bias the non-linear device in this regim to get "gain"

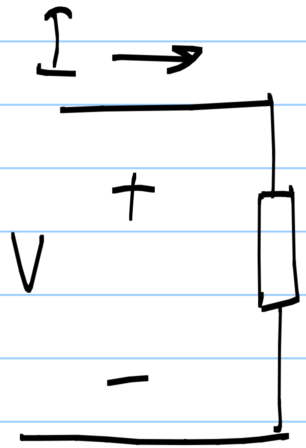
1) Is it possible to get "gain" from purely linear passive devices?

* No power gain possible
* v or i gain possible (transformers ...)

2) Non linear passive devices?

→ incremental / small-signal voltage and power gain possible

→ Battery power is used up (in overall power)



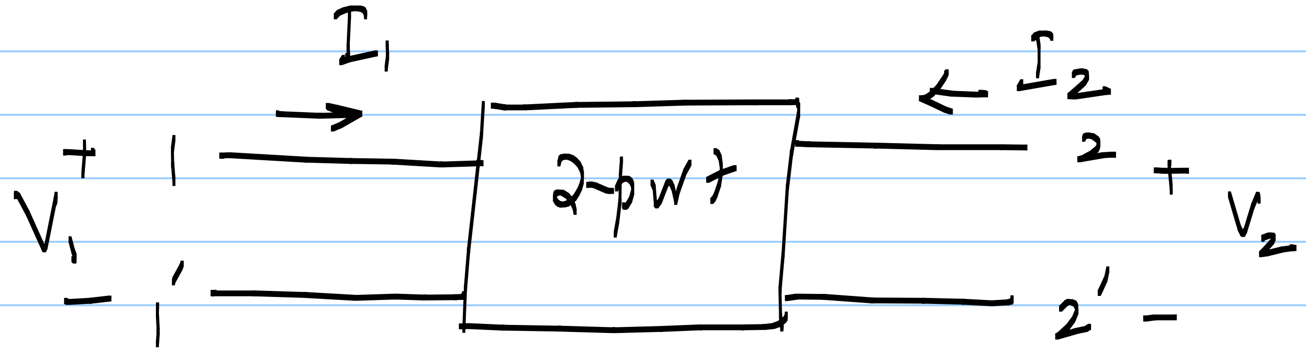
2-T

1-port

$r = \frac{1}{f'(V_Q)}$

1 parameter describes ss behaviour

2-port networks



4 parameters required to describe 2-port network

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

(impedance) Z-parameters

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

(Admittance) Y-parameters