Active circuits

- have one or more devices that require an external power supply to operate correctly

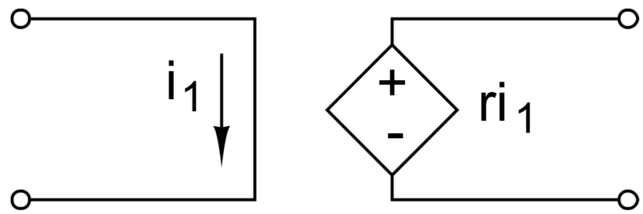
Recall the proportionality property:

$$y=Kx$$

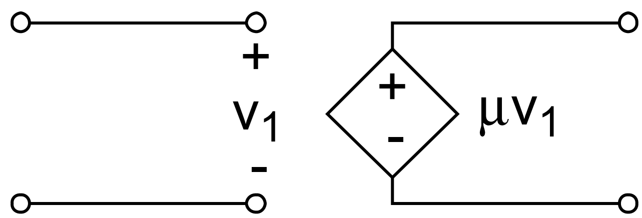
Assuming y and x have the same units (A or V), what is the maximum that K could be for the circuits we have studied so far?

Signal amplification:

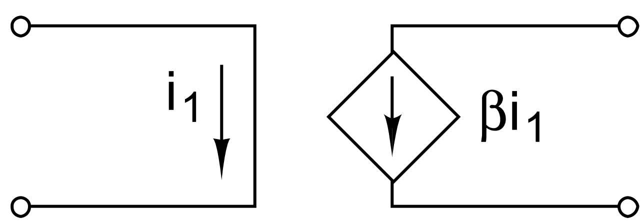
Linear dependent sources:



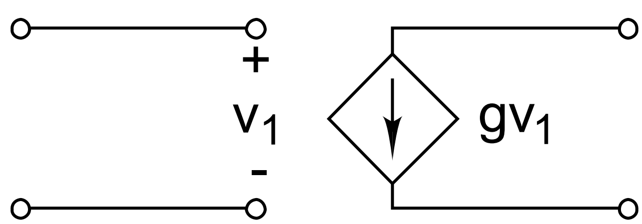
(a) CCVS



(b)VCVS



(c) CCCS



(d) VCCS

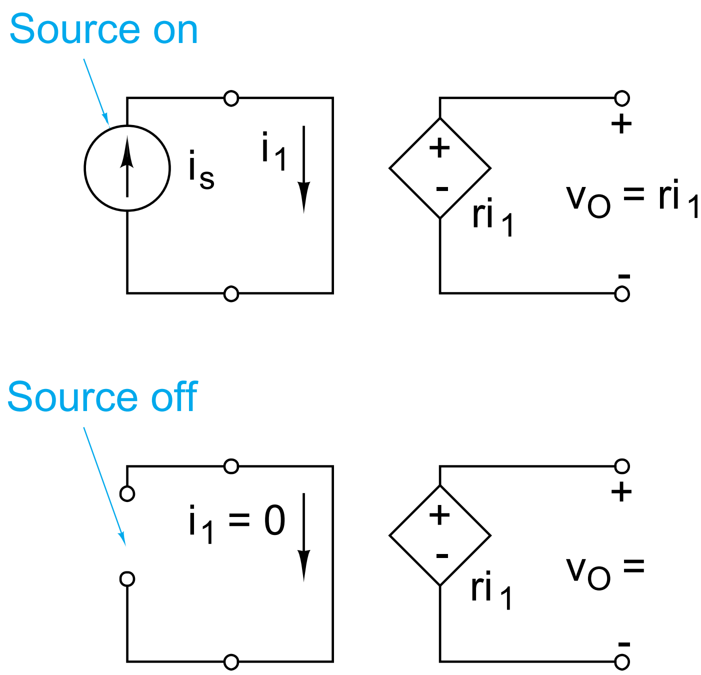
voltage gain
transresistance

current gain
transconductance

Warning,

Linear dependent sources are MODELS used to represent complicated circuits and or phenomena, they do not represent discrete devices.

The presence of active devices makes our analysis a bit more complicated...

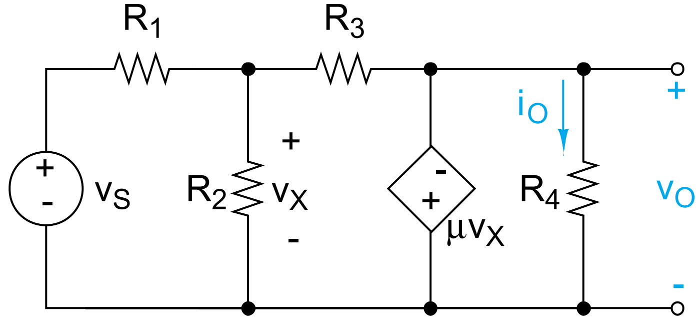


E.g., superposition principle,

The response due to all <u>independent</u> sources acting simultaneously is equal to the sum of the responses due to each <u>independent</u> source acting one at a time.

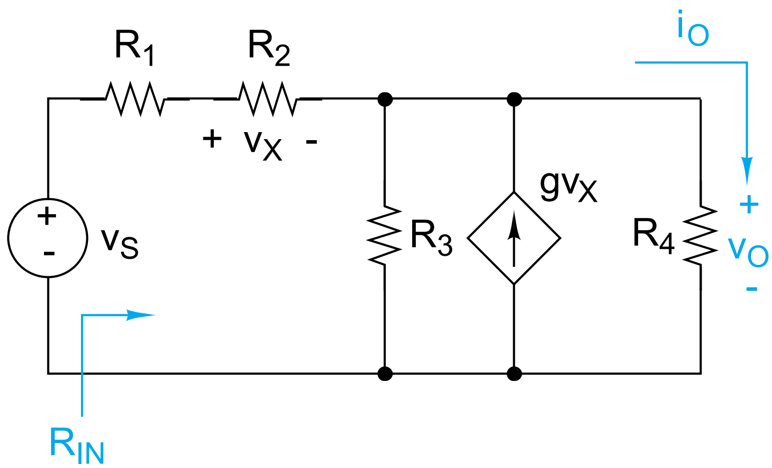
The dependent sources are *controlled* by the independent sources.

There's nothin' up my sleve...



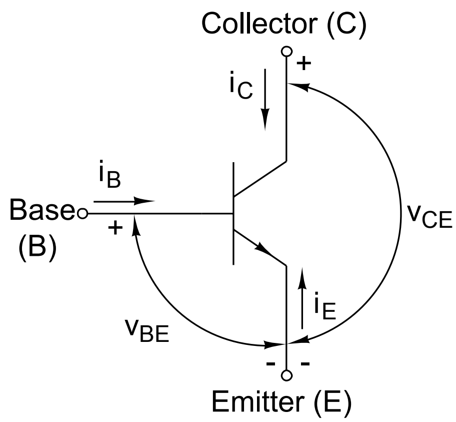
(a) Use note-voltage analysis to find the output, v_o, in terms of the input, v_s (b) Evaluate the i/o relationship as the gain, μ, becomes very large

... watch me pull a rabbit out of a hat.

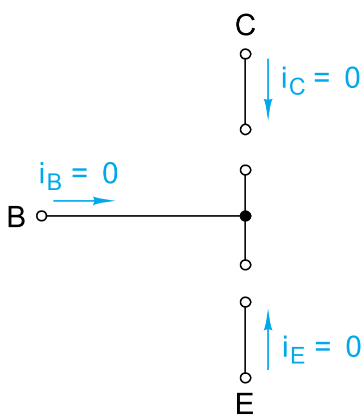


(a) Formulate mesh-current equations for the given circuit
(b) Uses these equations to find v_o and R_{in} when R_1=50Ω, R_2=1kΩ, R_3=100Ω, R_4=5kΩ, and g=100mS

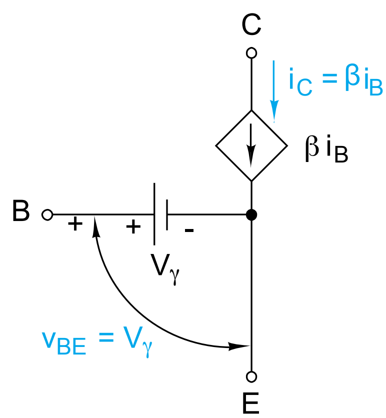
Meet the transistor... in particular, the large signal model of the BJT



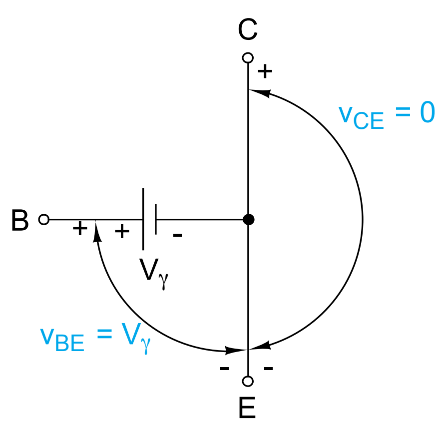
An NPN BJT



Cutoff (OFF)



Active (ON)



Saturation (ON)

KCL still applies to E B C

BJT large signal model:

Cutoff mode: $i_B=i_C=i_E=0$
Active mode: $v_{BE}=V_\gamma$ and $i_C=\beta i_B$
Saturation mode: $v_{BE}=V_\gamma$ and $v_{CE}=0$

How do you deal with these monsters? For now,
1) assume BJT is in active mode
2) do circuit analysis
3) verify assumption:

if $i_B>0$ the transistor can not be in cutoff and if $v_{CE}>0$ the transistor can not be in saturation

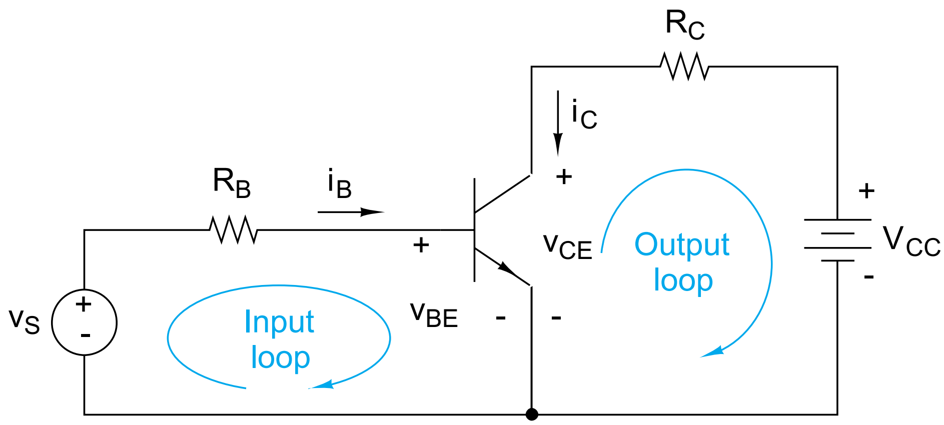
then the assumption is correct

else if $i_B<0$ the transistor is actually in cutoff

then $i_B=i_C=i_E=0$, repeat circuit analysis if necessary

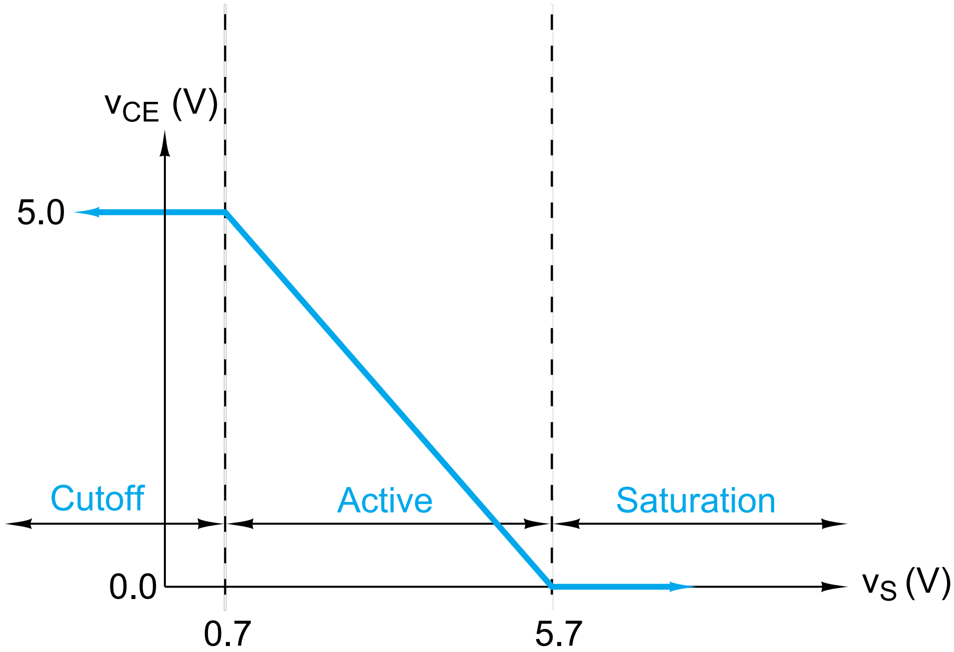
else if $v_{CE}<0$ the transistor is actually in saturation

then $v_{BE}=V_\gamma$ and $v_{CE}=0$, repeat circuit analysis if necessary



$V\_=0.7V$, $\beta=100$, $R_B=100k\Omega$, $R_C=1k\Omega$, $V_{cc}=5V$

(a) Find i_C and v_{CE} when $v_S=3V$, (b) Find the range of the input voltage, v_S, over which the transistor operates in active mode, (c) Plot the output voltage v_{CE} as a function of the input voltage over the range $0<v_S<10V$



Cutoff mode: $i_B = i_C = i_E = 0$
Active mode: $v_{BE} = V_\gamma$ and $i_C = \beta i_B$
Saturation mode: $v_{BE} = V_\gamma$ and $v_{CE} = 0$