HKN ECE 342 Review Session 3

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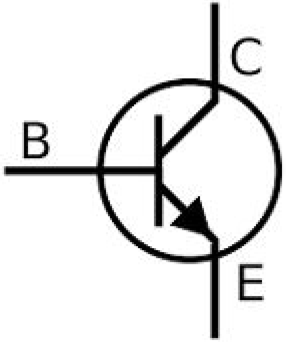
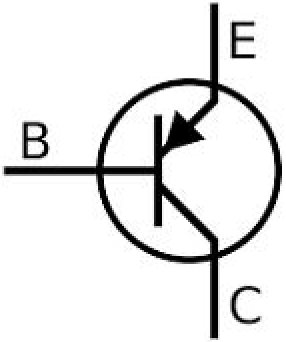
BJT's



NPN
Bipolar Junction
Transistor

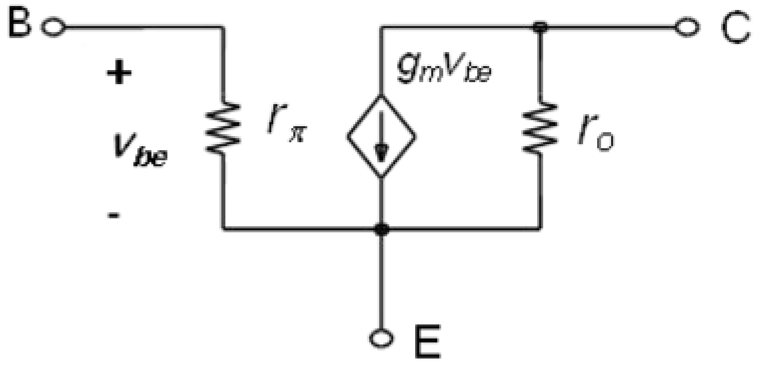


PNP
Bipolar Junction
Transistor

BJT Operating Point

- Three regions of operation:
- Cutoff
- Saturation
- Forward Active
  - $V_T = kt/q$
  - $I_C = \beta I_B$
  - $I_E = I_C + I_B$
  - $\beta = g_m R_\pi$

BJT Incremental Model



Gain Calculation

$A_v = -G_M R_{out}$

G_M = Small signal transconductance, ratio of i_{out} to v_{in}

R_{OUT} = Equivalent incremental output resistance

R_{IN} = Equivalent incremental input resistance

Common Amplifier Topologies

1. Diode-tied Transistor
   a. What is overdrive voltage here?
   b. Is this always in saturation?
2. Common Emitter/Collector/Gate
   a. Purpose of each topology?
   b. equations
3. Common Emitter with Degeneration
4. Common Collector with Modulation
5. Cascode

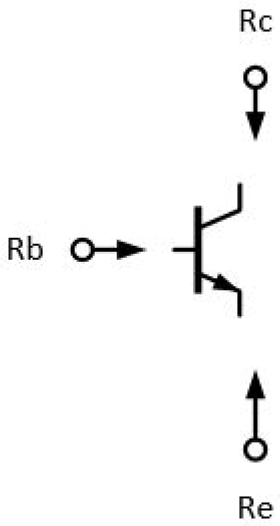
Terminal Impedances of BJT’s

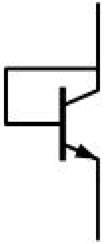
$R_C = r_o$

$R_B = R_\pi$

$R_E = R_\pi/(□+1)$

Diode-Tied = $R_\pi/(□+1)$





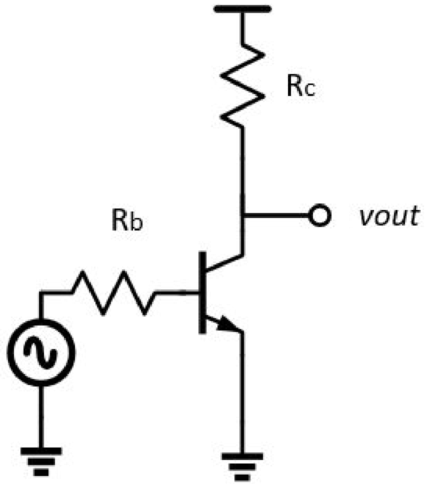
1. Diode Tied Transistor

Common Emitter/Collector/Base

$R_{OUT} = R_c \parallel r_o$

$R_{IN} = R_\pi + R_B$

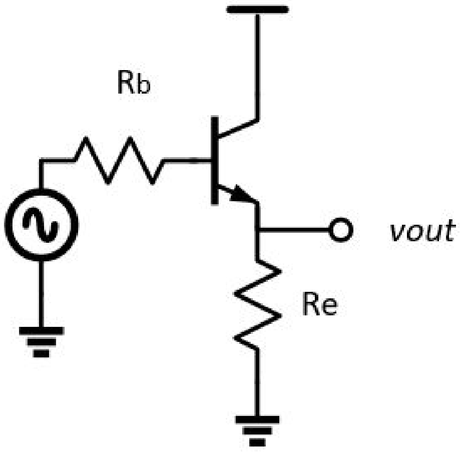
$G_m = \square/(R_\pi + R_B)$



$R_{OUT} = ((R_\pi + R_B)/(\square + 1)) \parallel R_E$

$R_{IN} = R_B + R_\pi + ((\square + 1))R_E$

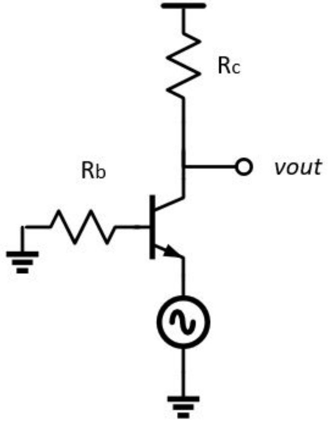
$G_m = -(\square + 1)/(R_\pi + R_B)$



$R_{OUT} = R_c \parallel r_o$

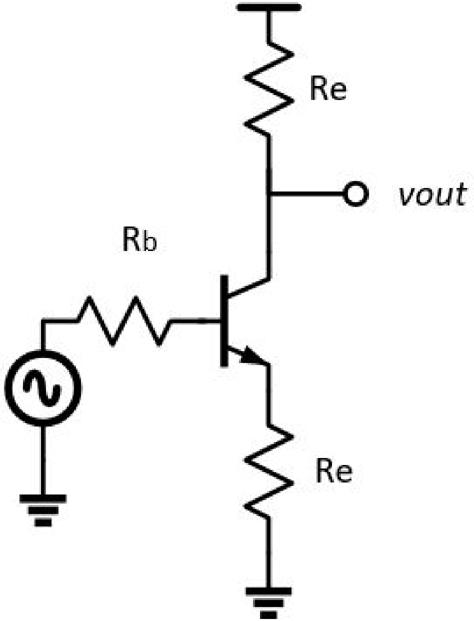
$R_{IN} = (R_\pi + R_B)/(\square + 1)$

$G_m = \square/(R_\pi + R_B)$



Degeneration

When a resistance is “viewed” through the collector, it appears bigger by a factor related to the transconductance.

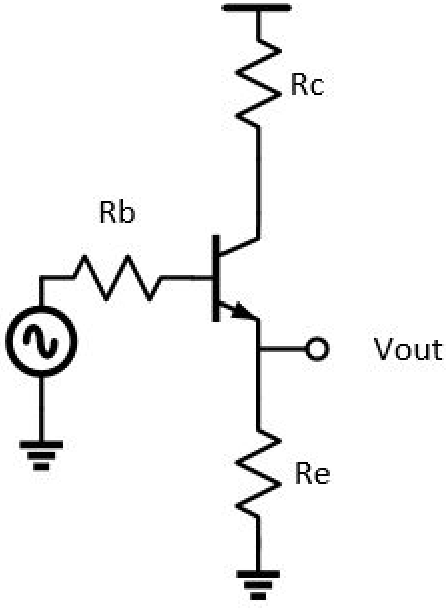


$$G_m = 1/(((R_B+R_\pi)/\beta)+((\beta+1)/\beta)R_E))$$

$$R_{IN} = R_B+R_\pi +((\beta+1))R_E$$

Modulation

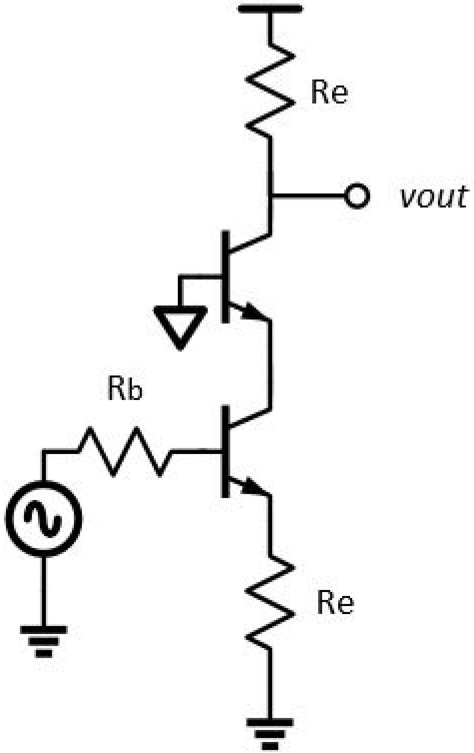
Resistances seen through the Emitter seem smaller.



$$G_m = -(\square+1)/(R_B+R_\pi)$$

$$R_{IN} = R_B+R_\pi +((\square+1))R_E$$

Cascode



Bode Plots

Magnitude

Pole: Roll down by 20 db/dec, 6 db/oct

Zero: Roll up by 20 db/dec, 6 db/oct

Phase: arctan(ω/ω_p)

Usually -90° for poles, +90° for zeros

$\omega_{ugf} = 20\log|A_n| * \omega_{pn}$ where n is the pole located before unity gain frequency