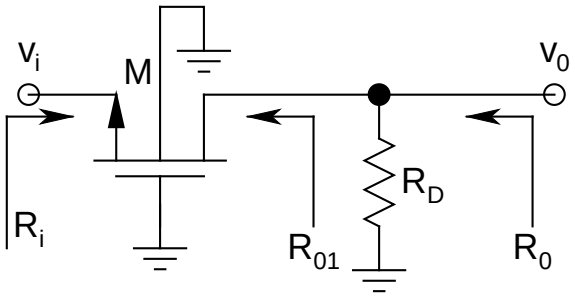
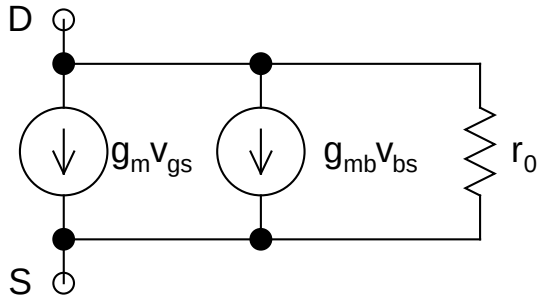
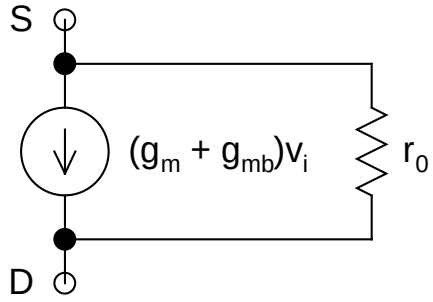
- ***Common-Gate*** (CG):



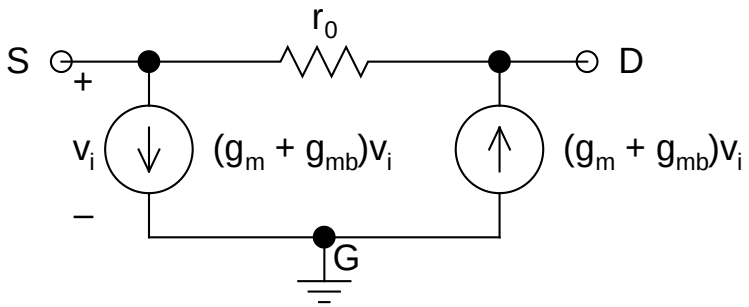
ac Schematic



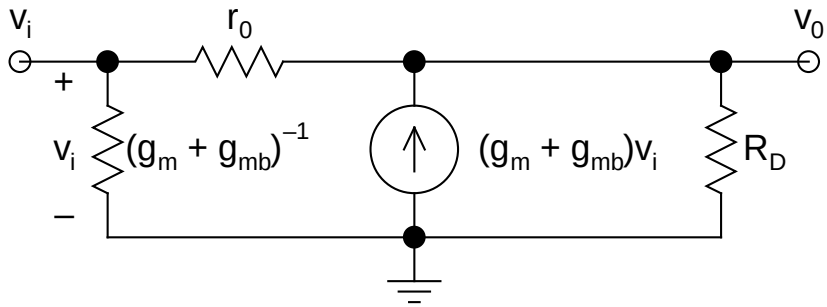
ac Low-Frequency Model for M



Simplified ac Low-Frequency Model for M



Rerouting the current source between S and D to S to G and then from G to D



Final ac Low-Frequency Equivalent for CG Stage

- ***G and B both ground***:

  $\Rightarrow v_{gs} = v_{bs} = -v_i$

  $\Rightarrow g_m v_{gs}$ and $g_{mb} v_{bs}$ can be ***combined to a single current source*** $(g_m + g_{mb})v_i$, ***flowing from S to D***

- ***Reroute this current source from S to G and then from G to D*** (***the circuit remains invariant***)

  $\Rightarrow$ Leads to the ***final ac low-frequency equivalent*** of the CG stage

- ***Note again that r_0 appears between input and output*** (***similar to CB stage***)

- ***Neglect r_0 for now***
- Noting that $v_1 = v_i$:

$$A_v = \frac{v_0}{v_i} = \frac{(g_m + g_{mb}) v_1 R_D}{v_i} = +(g_m + g_{mb}) R_D$$

- ***Identical result to a CB stage***, if ***body effect is neglected***
- $R_i = (g_m + g_{mb})^{-1}$
- $R_0 = R_{01} \| R_D$

  $R_{01} \rightarrow \infty$ (***Why***?)

  $\Rightarrow R_0 = R_D$

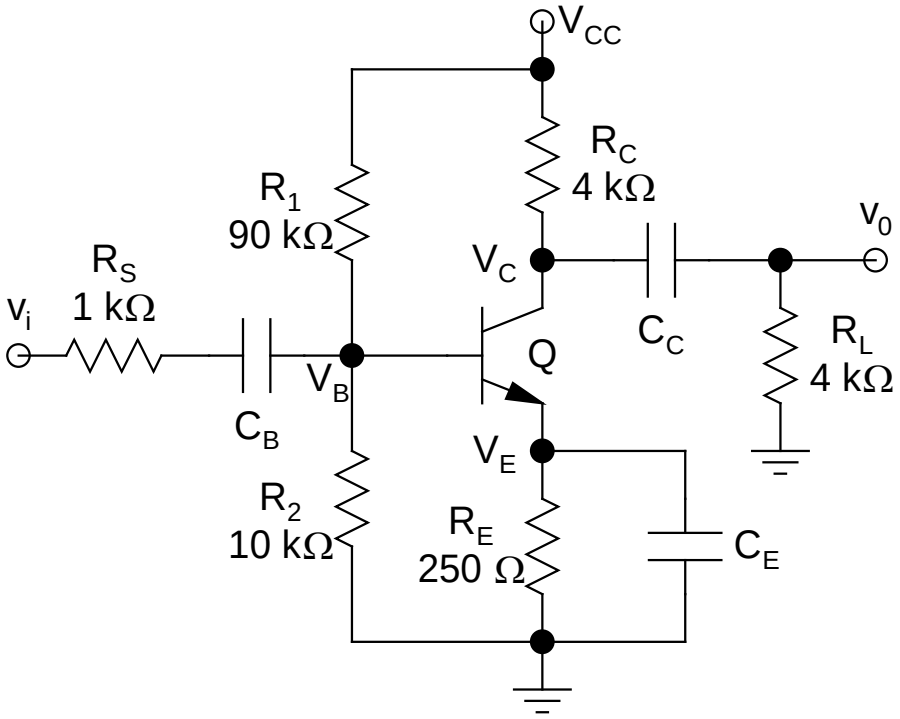
- ***Ex.: Find A_v and R_i with r_0 included***
- ***With r_0 included***, the circuit shows ***three different values*** of R_{01}:
  - ***When excited by a voltage source***, $R_{01} = r_0$
  - ***When excited by an ideal current source***, $R_{01} \rightarrow \infty$ (***Show***)
  - ***If the current source is non-ideal with shunt resistance R_S***:

    $R_{01} = r_0[1 + (g_m + g_{mb})R_S]$ (***Show***)

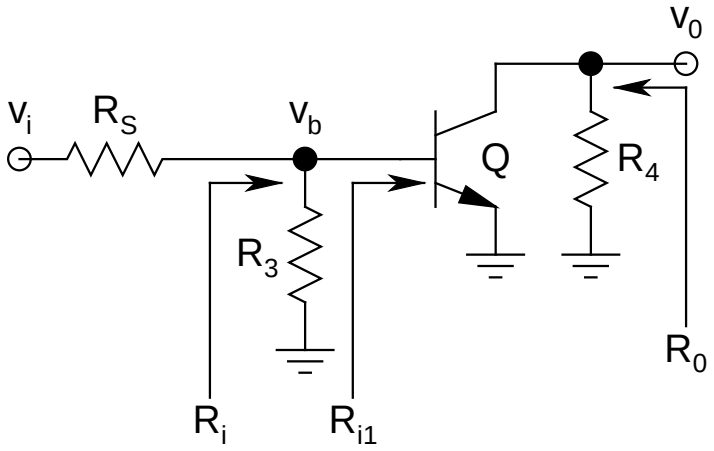
Quick Reckoner for BJT Stages

Topology	A_v	A_i	PG	R_i	R_0
CE	Moderate to Large	Large	Large	Moderate	Moderate
CC	≤ 1	Large	Moderate	Large	Small
CB	Moderate to Large	≤ 1	Moderate	Small	Moderate
CE(D)	Moderate	Large	Moderate	Large	Moderate

- ***The RC-Coupled Amplifier***:
  - ***Immensely popular***, particularly for ***audio circuits***
  - Can be designed to produce ***significant power gain***
  - Several such stages can be ***cascaded*** to produce ***very large gain***
  - Can be used either with ***single-supply*** or ***dual-supply***
  - Used primarily in ***discrete designs*** (***PCB***)



Complete Circuit



ac Schematic

C_B: Base Blocking Capacitor , C_C: Collector Coupling Capacitor
C_E: Emitter Bypass Capacitor , R_S: Source Resistance , R_L: Load Resistance