EE210: Microelectronics-I

Lecture-28 :Output Stage-2

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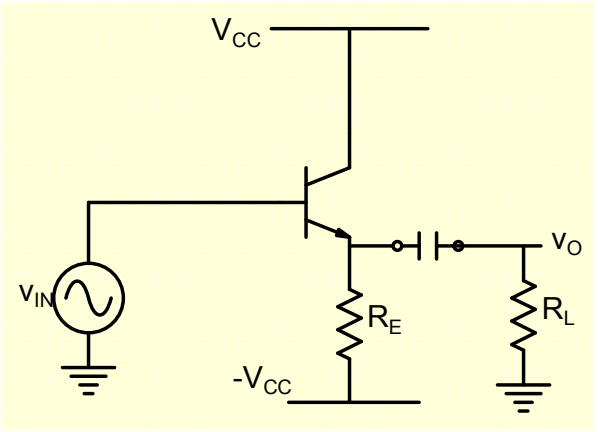
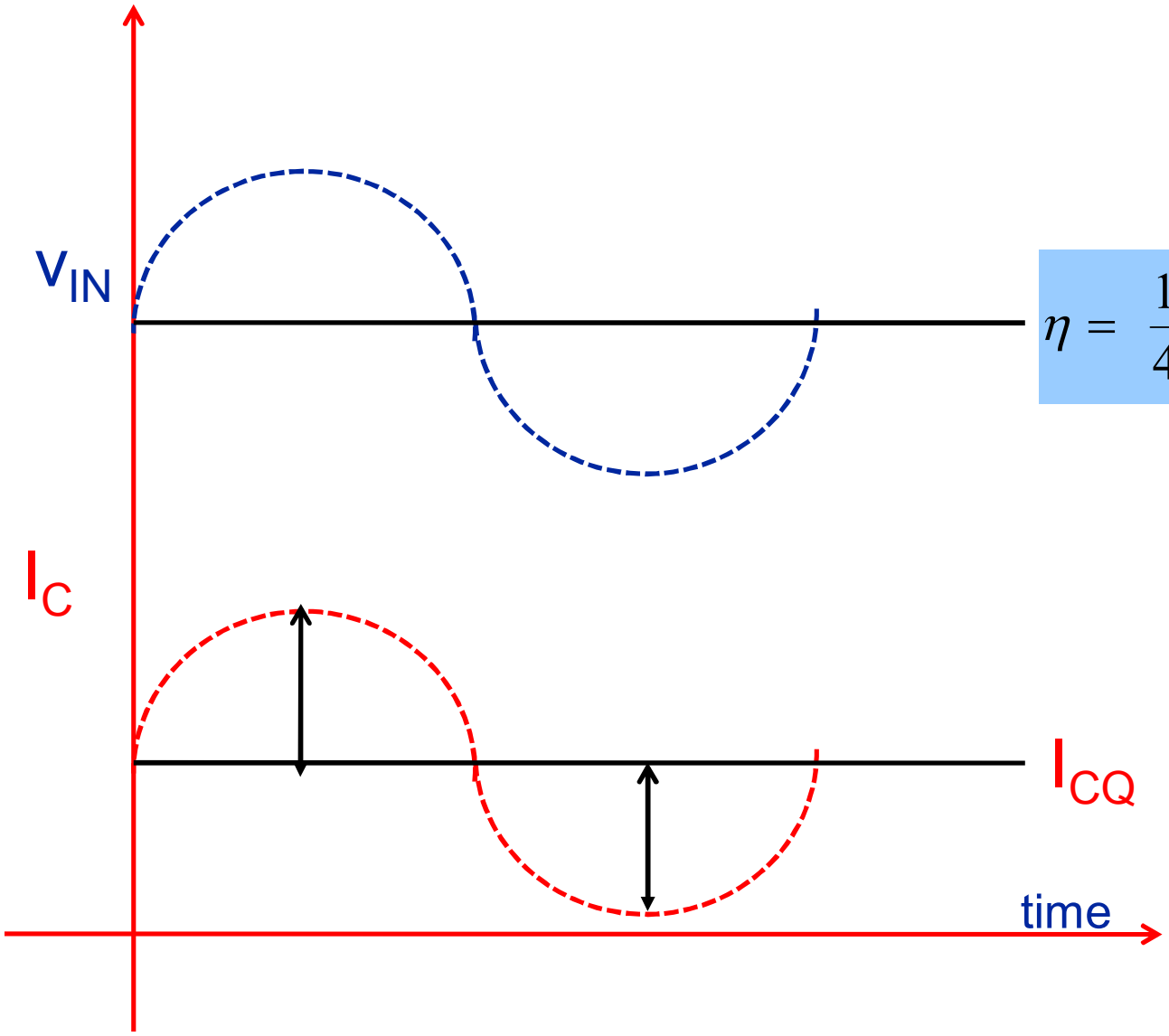
Class A Amplifier

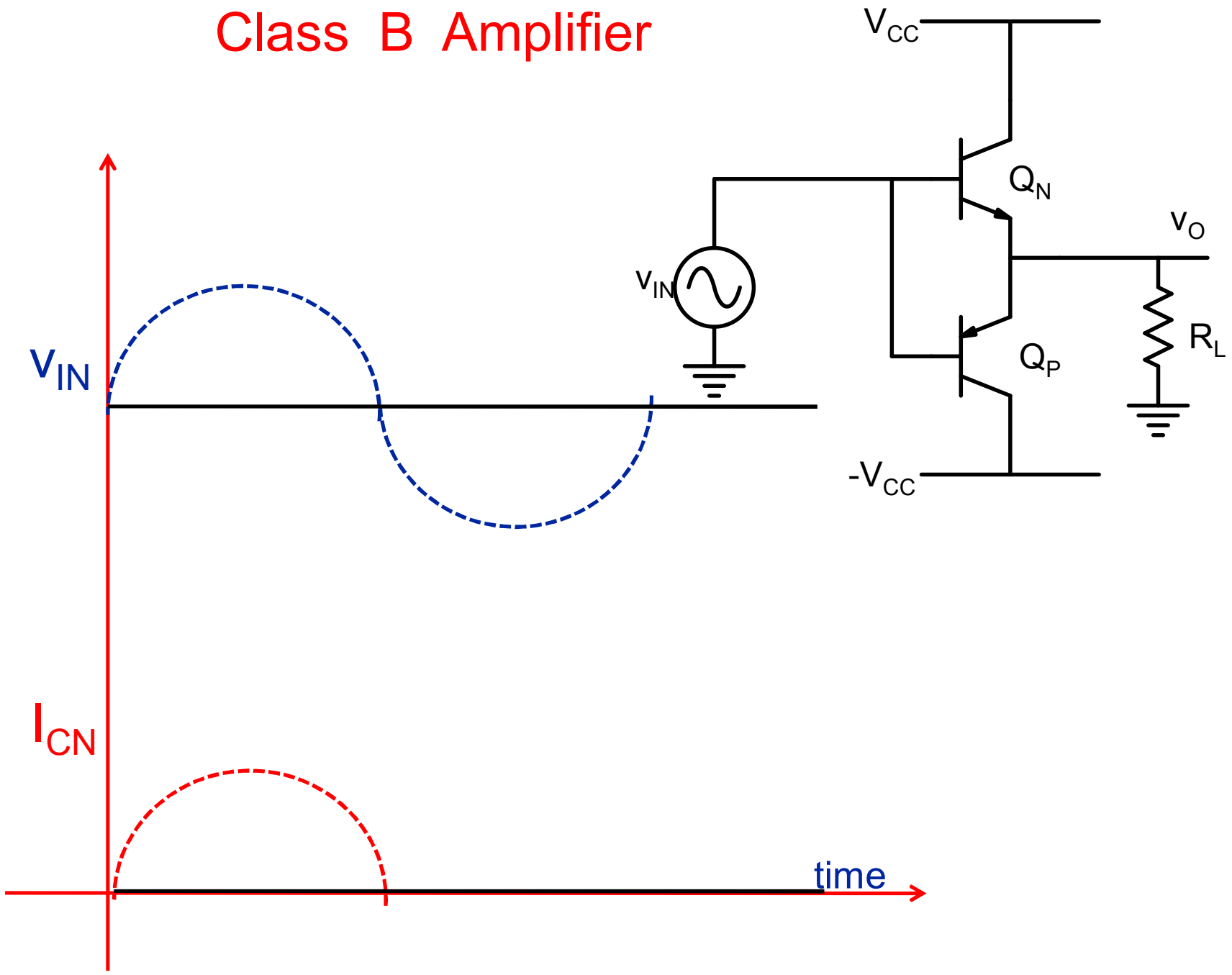




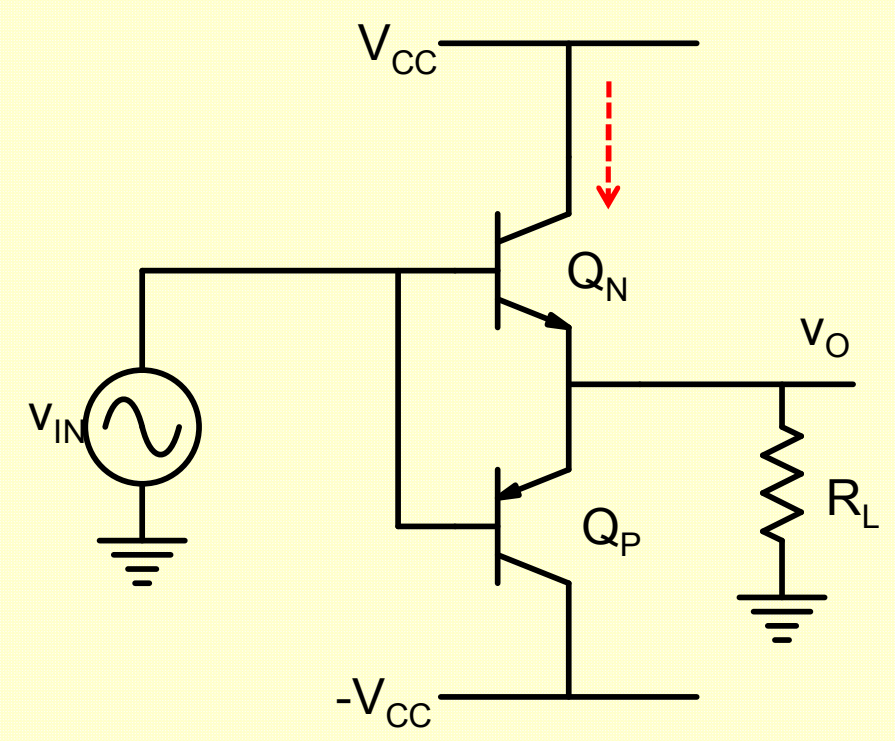
$$\eta = \frac{1}{4} \times \left(\frac{v_{op}}{V_{CC}} \right) \left(\frac{v_{op}}{I_E \times R_L} \right) < 25\%$$

An efficient amplifier should take power from the supply only when power is to be delivered to the load !

Class B Amplifier



Maximum Efficiency



$$P_L = \frac{v_{op}^2}{2R_L}$$

$$i_{CN} = \frac{v_{op}\sin(\omega t)}{R_L} \quad for \quad 0 \le t \le T/2$$
$$= 0 \quad for \quad T/2 \le t \le T$$

$$P_S = 2\frac{1}{T}\int_0^T V_{CC} \times i_{CN}\, dt$$

For two supplies

$$P_S = 2\frac{V_{CC} \times v_{op}}{\pi R_L}$$

$$\eta = \frac{\pi}{4} \times \frac{v_{op}}{V_{CC}} \times 100$$

$$v_{CE} > V_{CEsat}$$

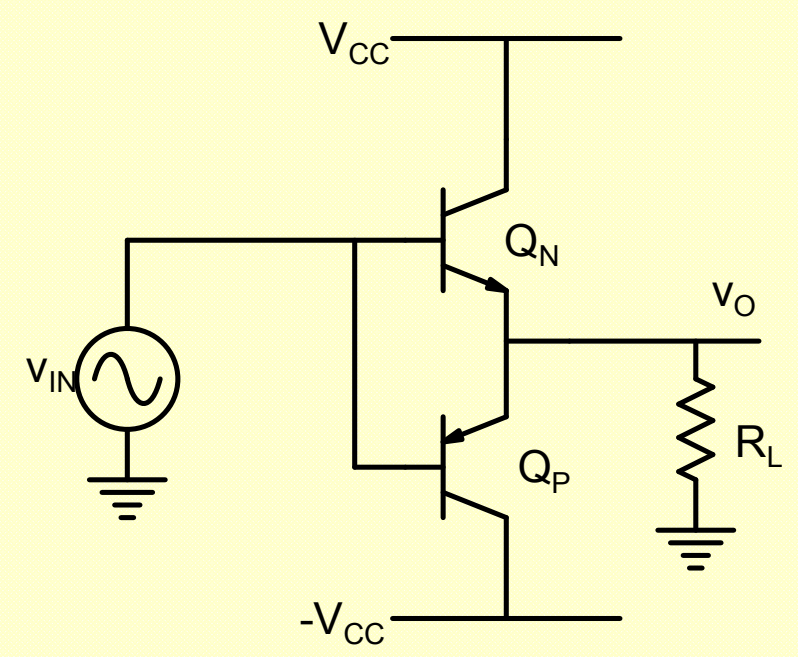
$$V_{CC} - v_{op}\sin(\omega t) > V_{CEsat}$$

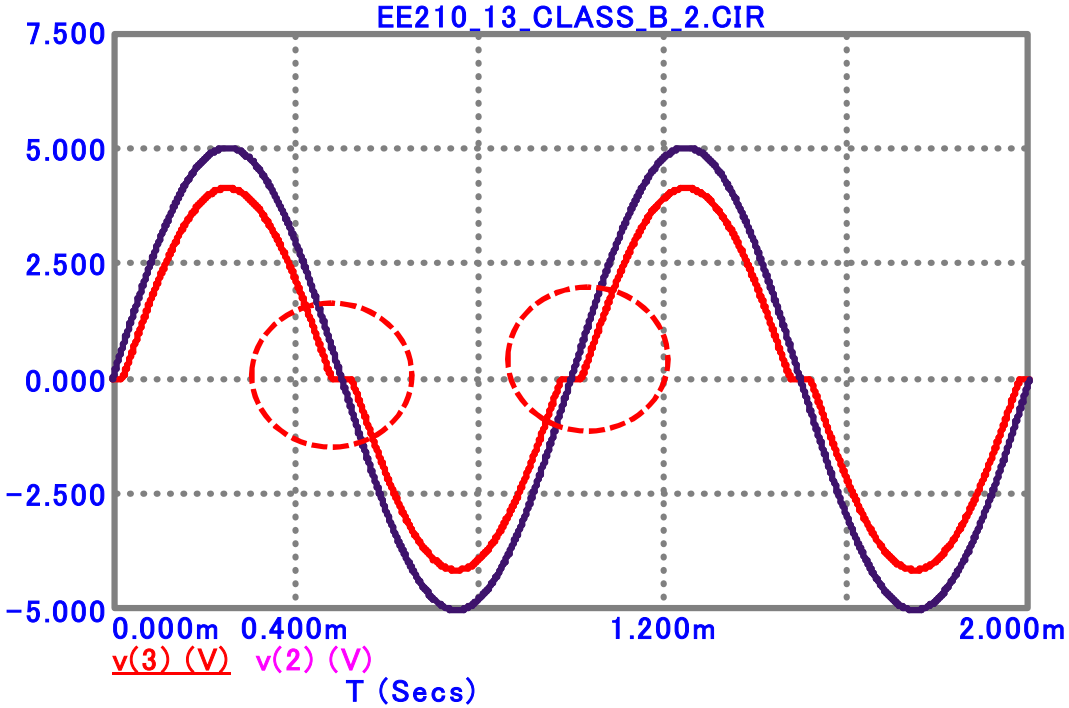
$$v_{op} \le V_{CC} - V_{CEsat}$$

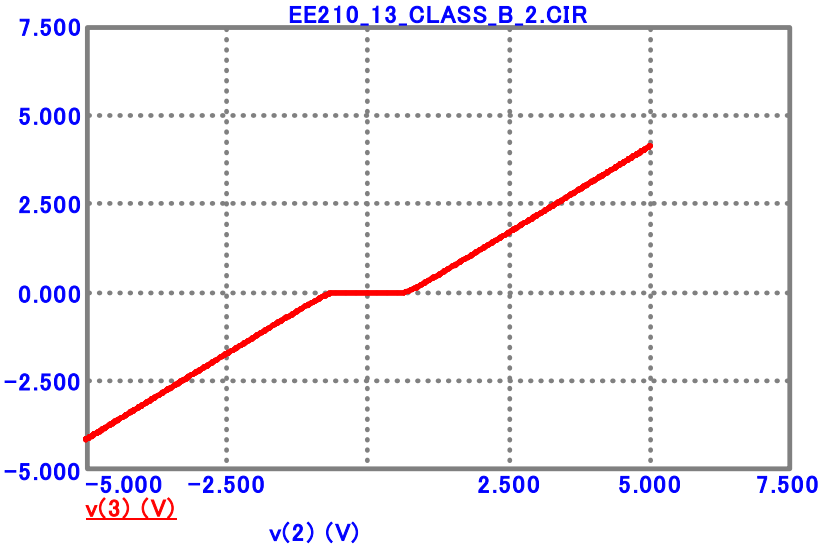
$$\eta_{\max} \cong 78.5\%$$

$$v_{op} \le V_{CC} - V_{BE}$$

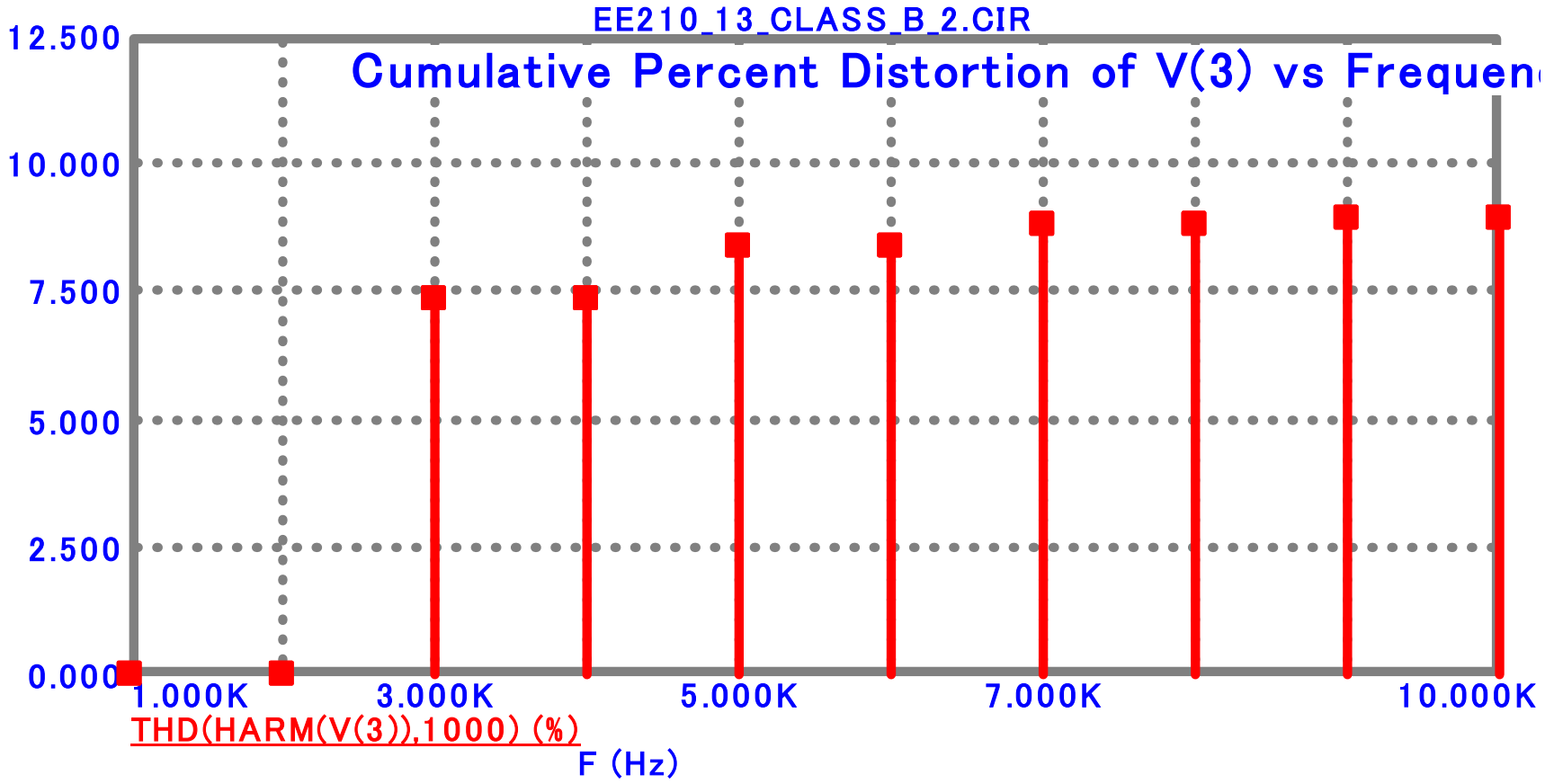
Cross-over Distortion







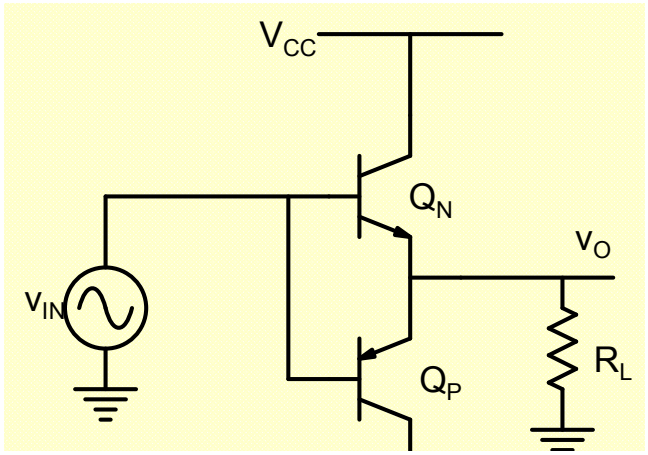
G-Number

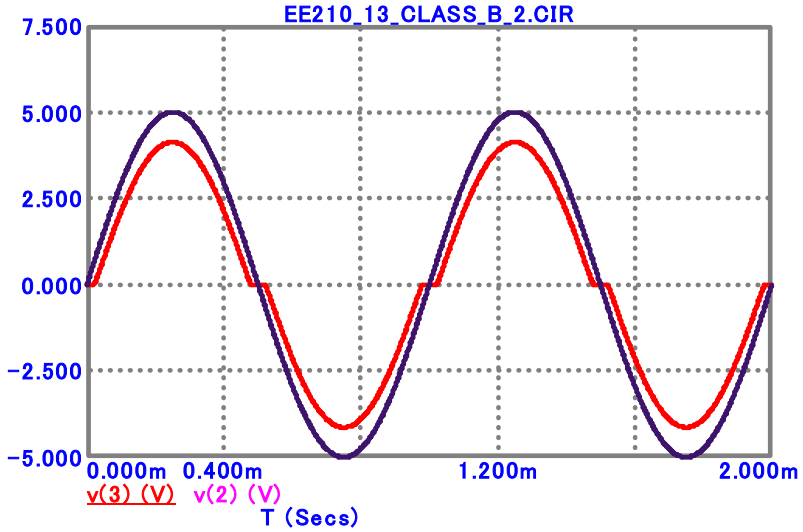


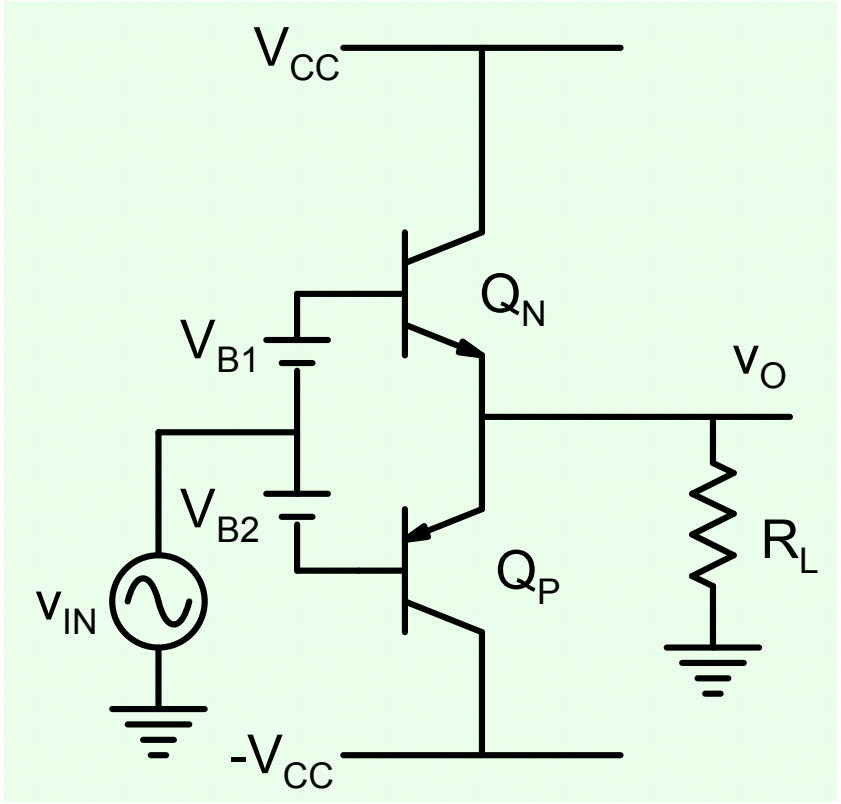
V_{CC} = 5V; V_{in} = 5V

G-Number

Solution



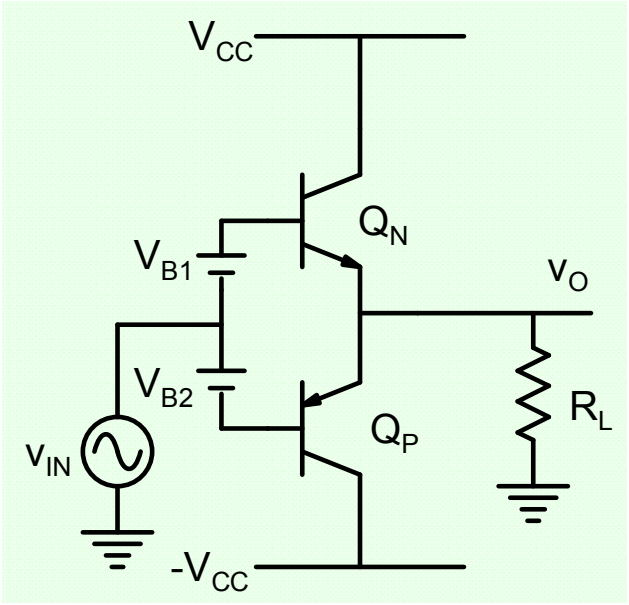


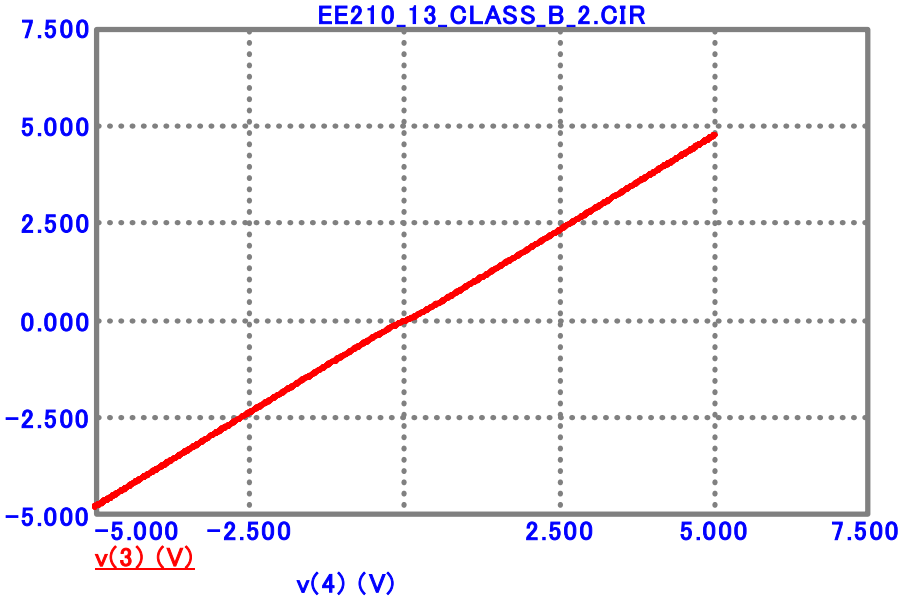


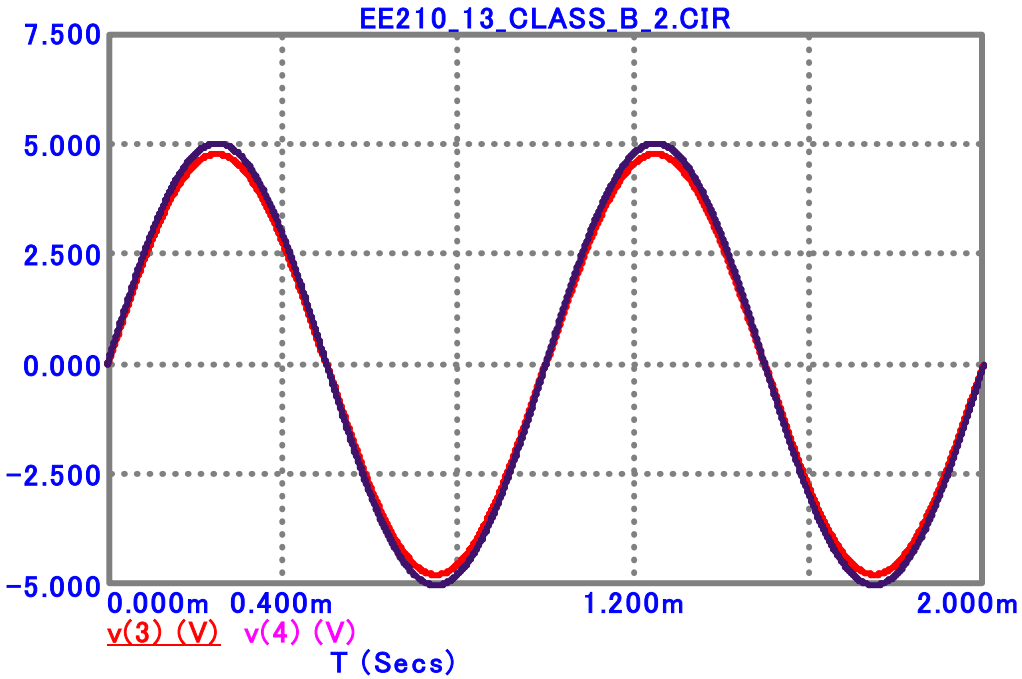
Voltages V_{B1} and V_{B2} are chosen such that both transistors are ON but conducting small current.

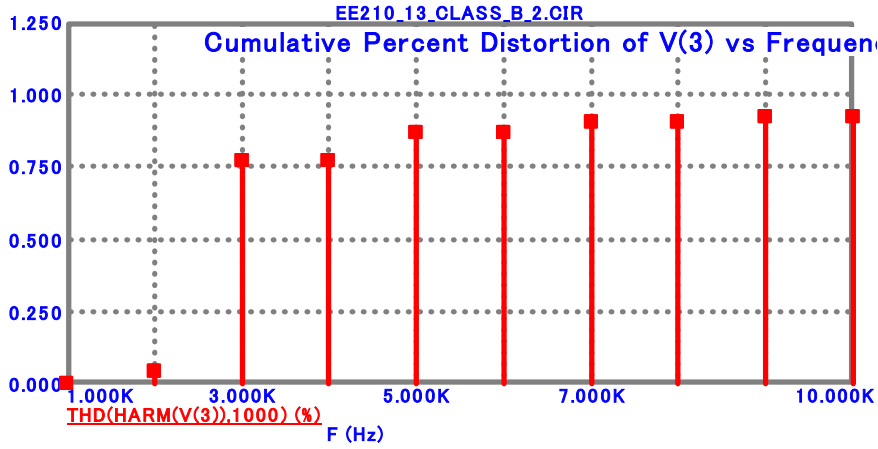
The amplifier now works from $V_{IN} = 0$ onwards

VB = 0.65V



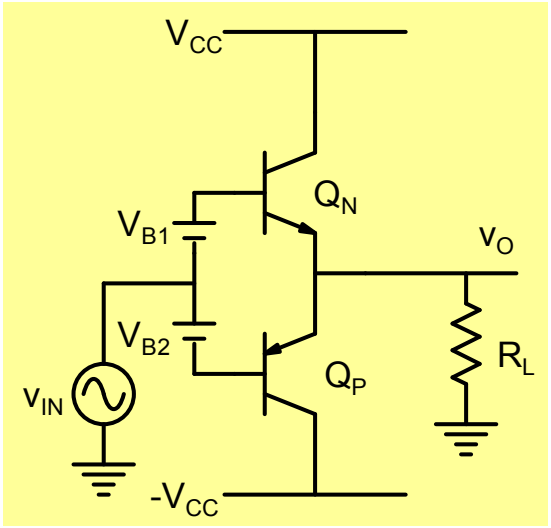






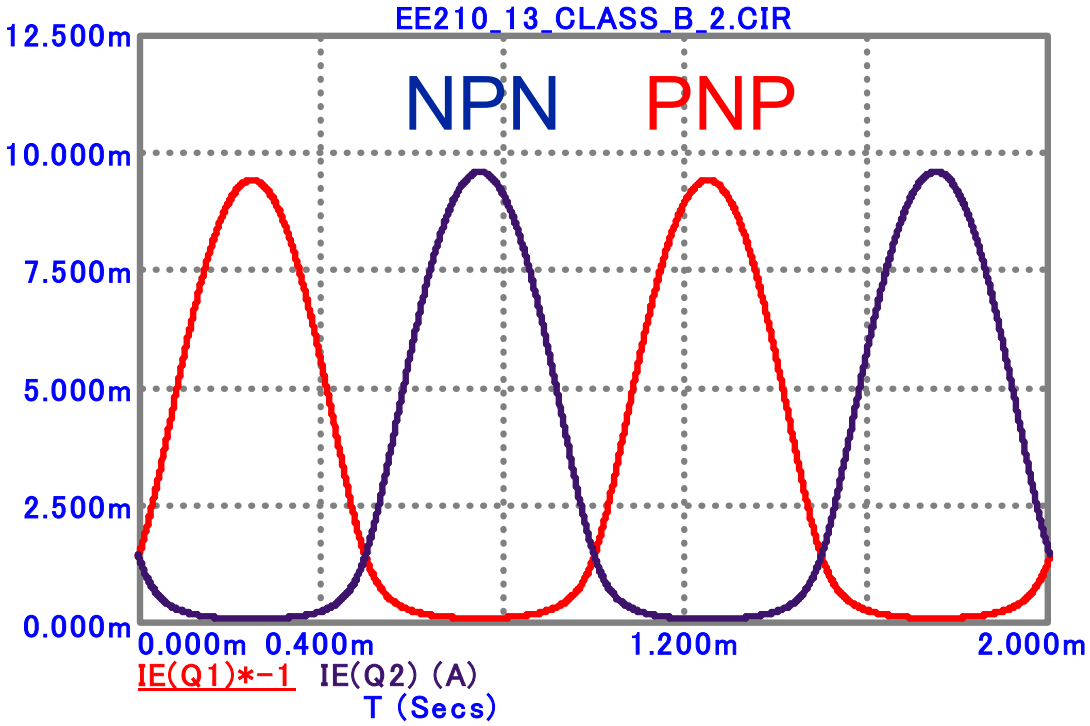
G-Number

Class AB Amplifier



V_{CC} = 5V; V_{in} = 1V; V_B =0.7V

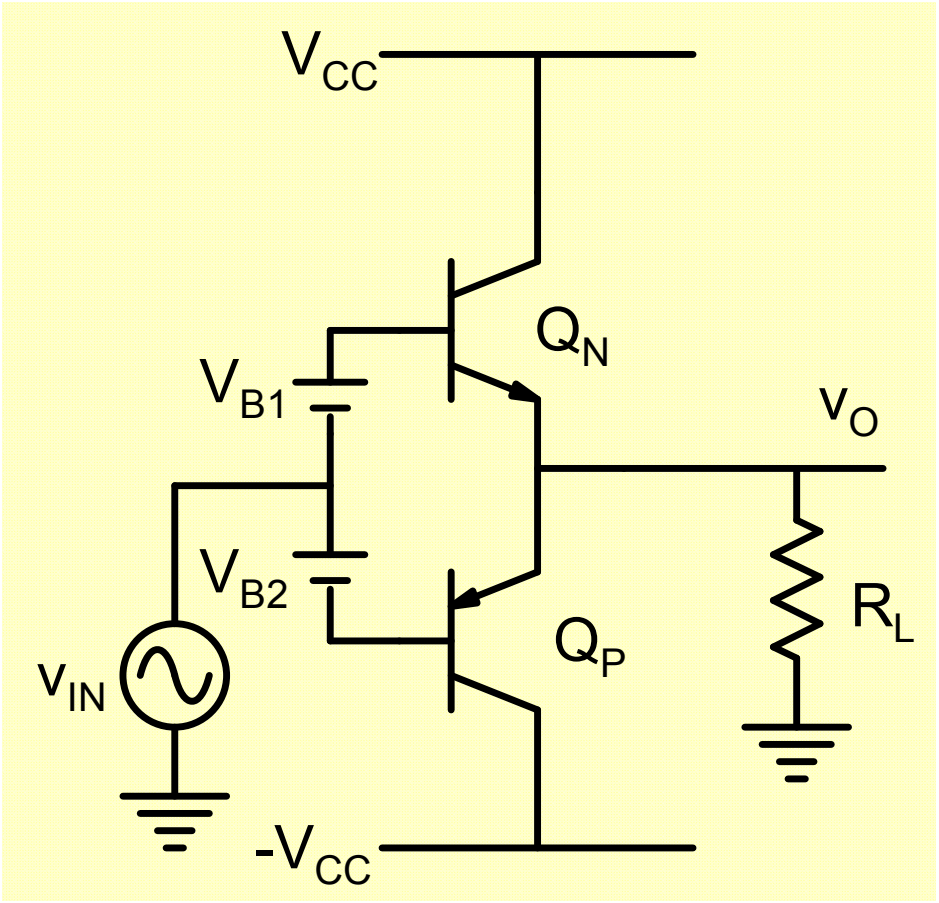
Current sourced by each transistor



Each transistor conducts for more than half the cycle

There is some standby power dissipation and efficiency is a little lower.

How do we realize the battery?

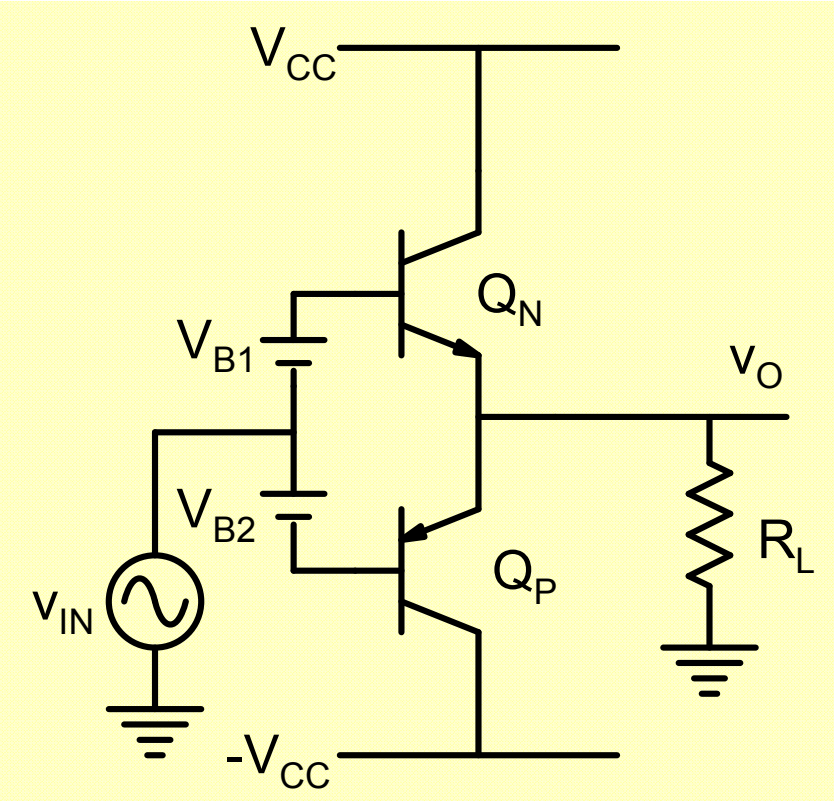


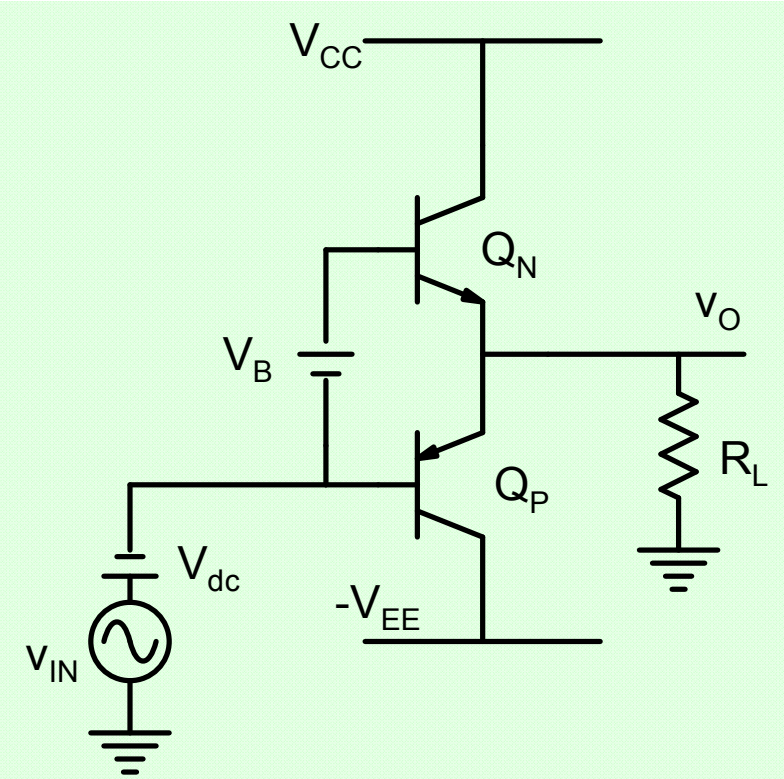
We need to bias the transistors at about ~0.7 Volts.

A slight increase in voltage would significantly increase standby power dissipation

A lower value of bias voltage may result in some crossover distortion

Solution

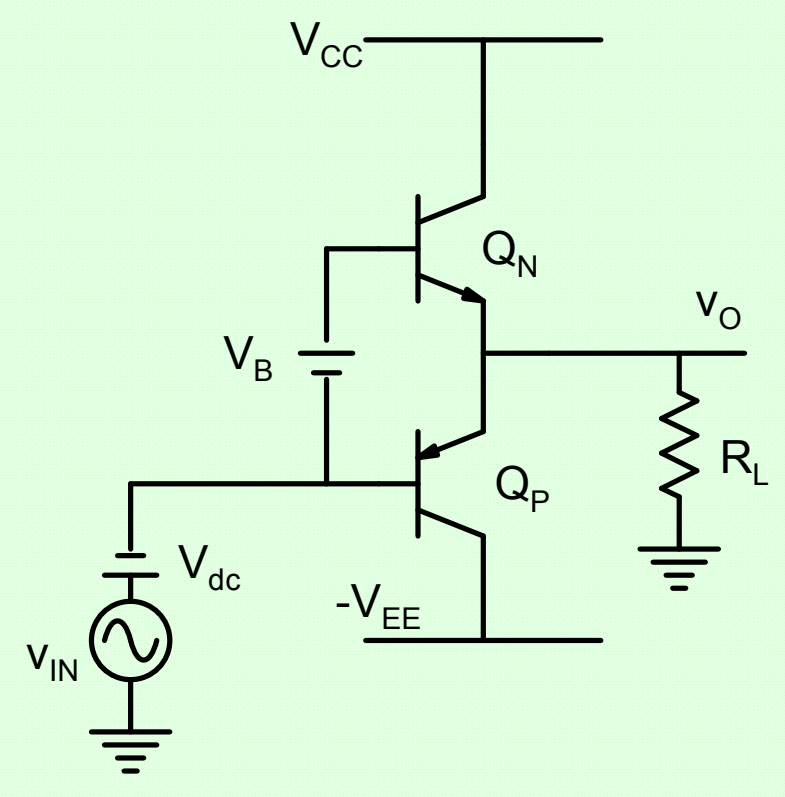


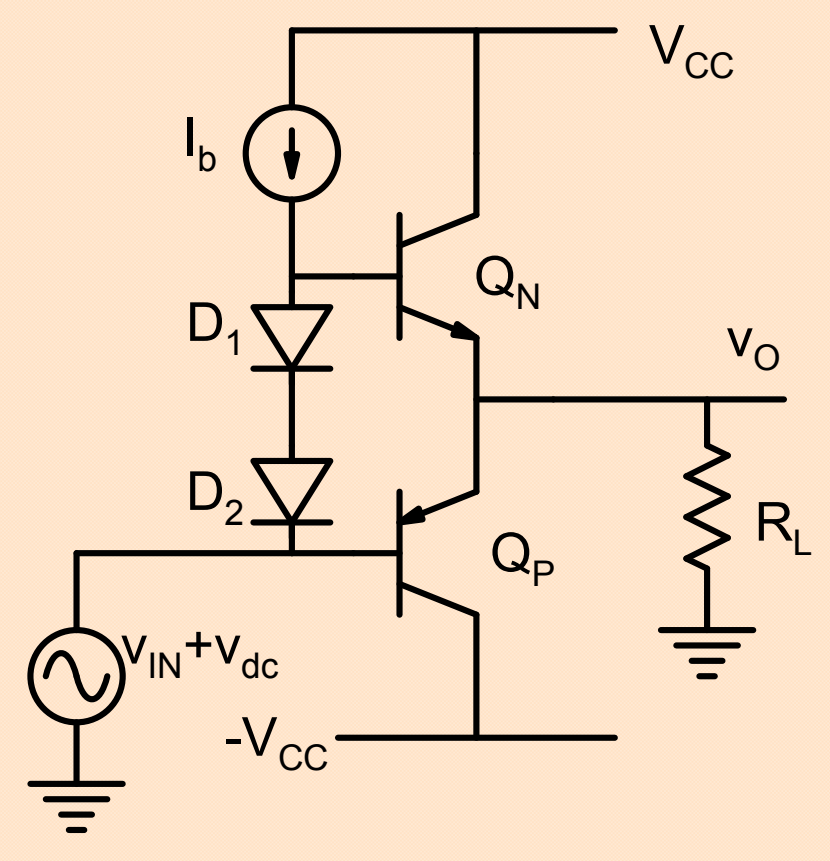


$$V_{BN} - V_{BP} \cong 0.65 + 0.65 = 1.3V$$

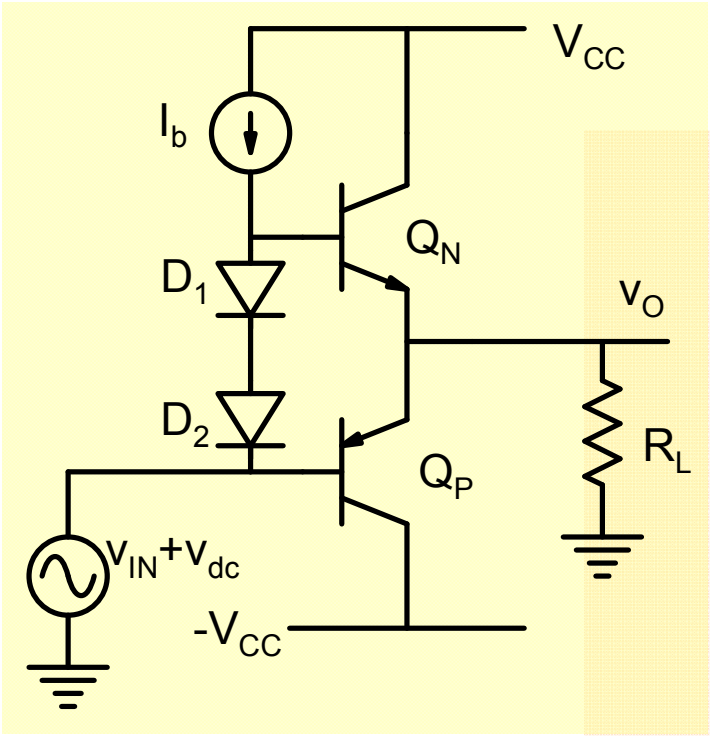
V_{dc} ~0.65V; V_B ~ 1.3V

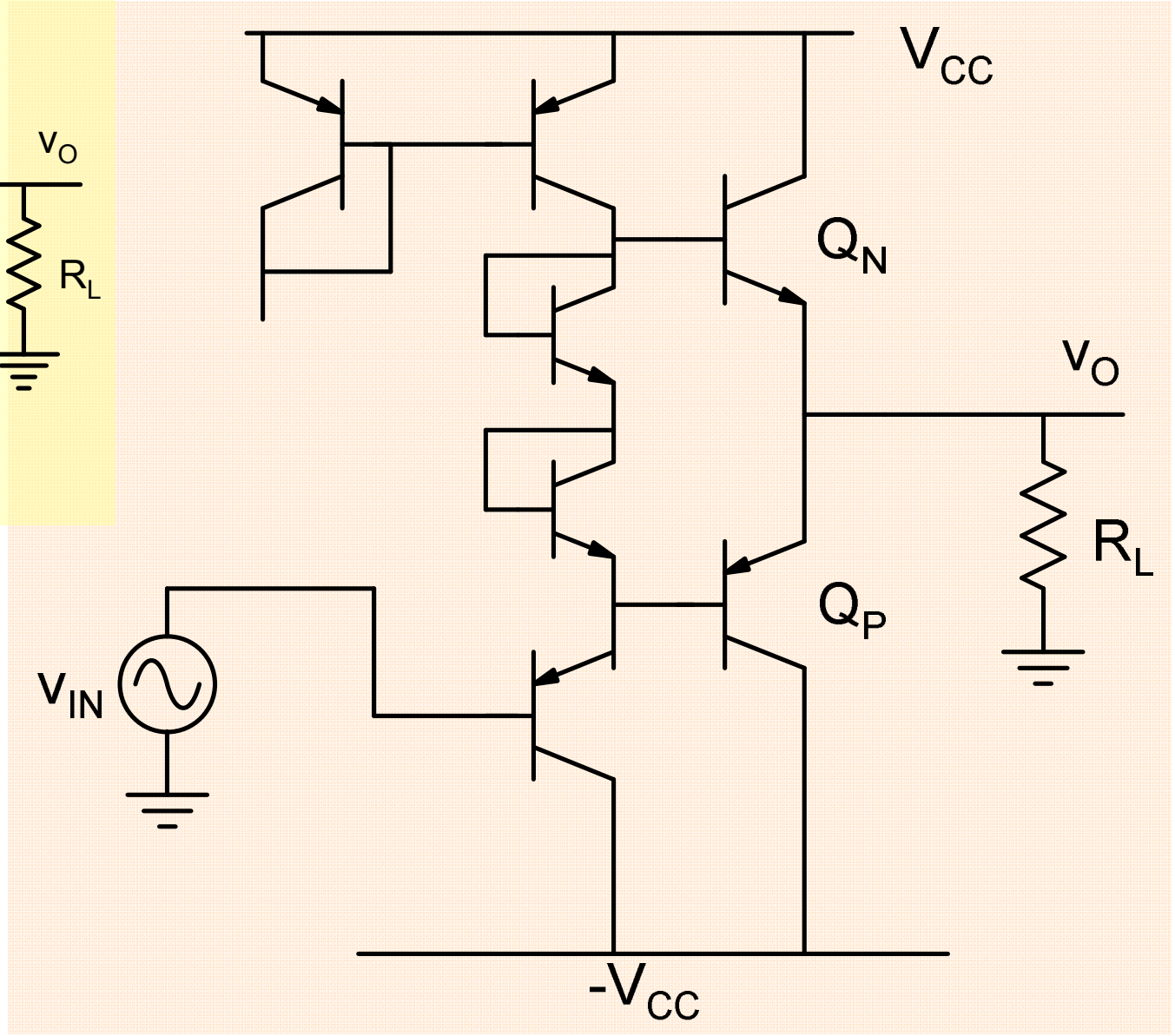
Solution

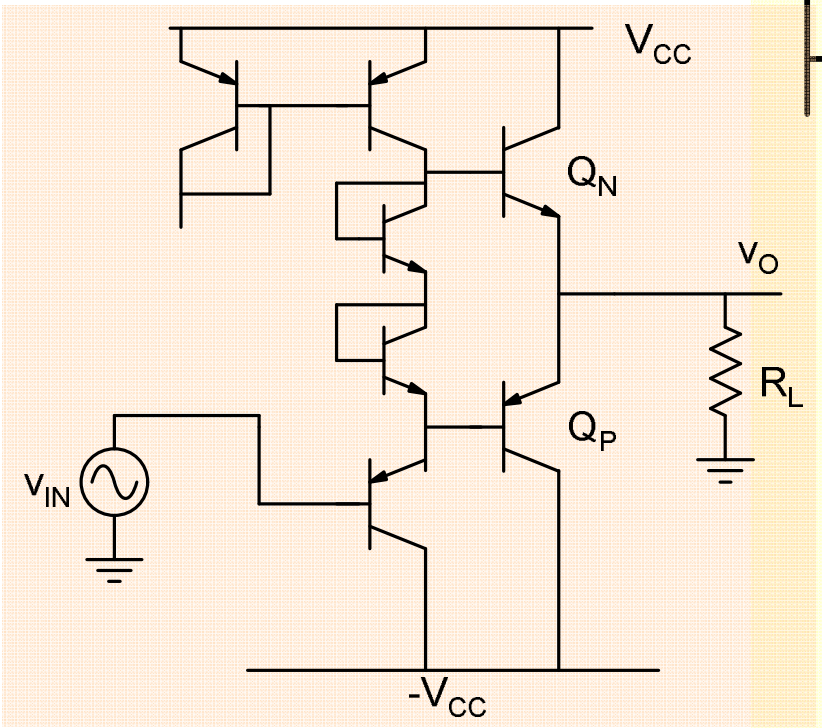


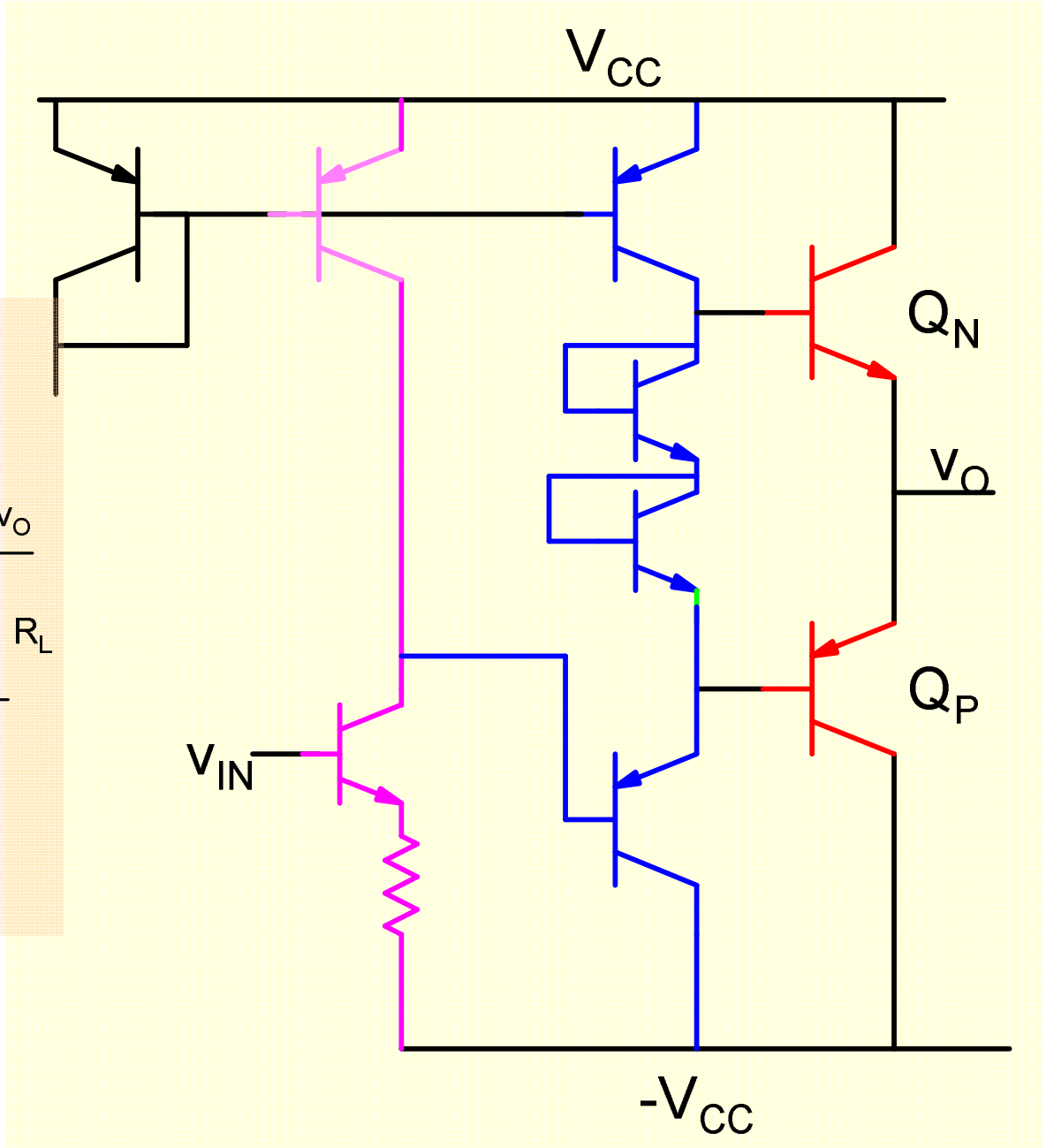


$$V_{BN} - V_{BP} \cong 0.65 + 0.65 = 1.3V$$

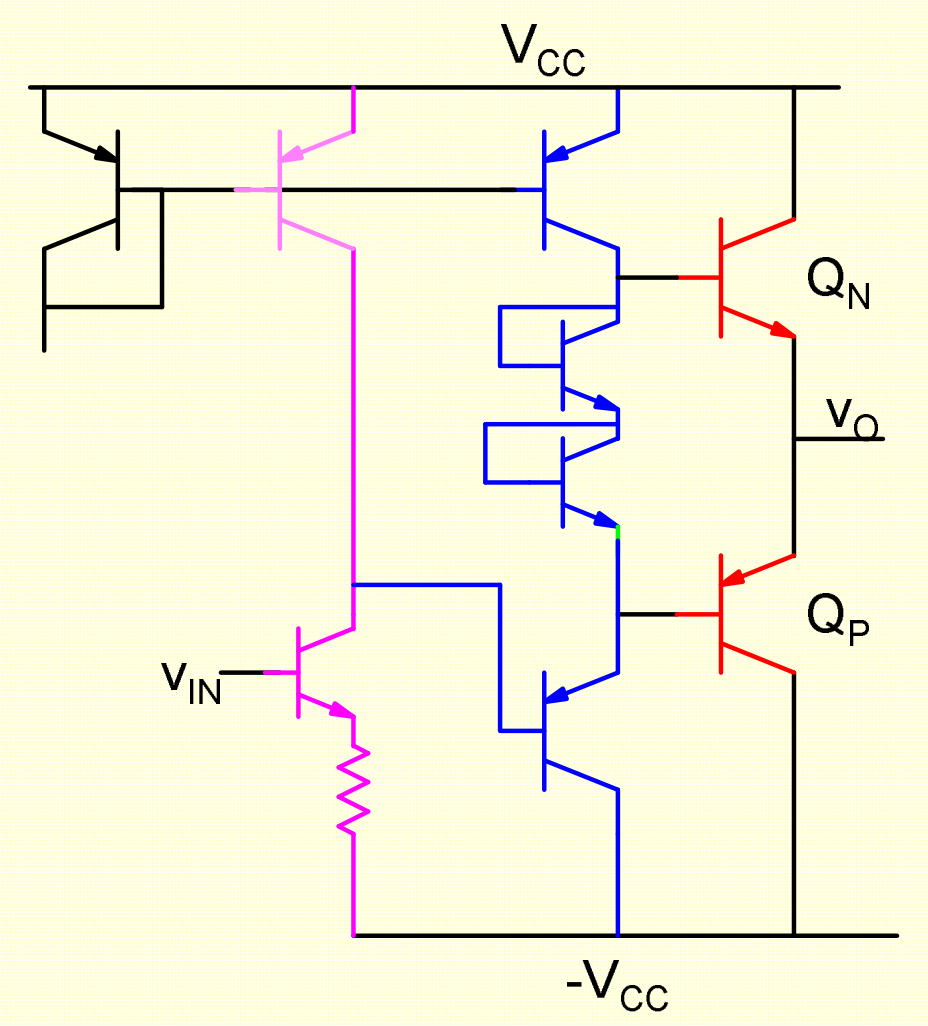

V_{CC}
I_b
Q_N
D_1
v_O
D_2
R_L
Q_P
$v_{IN}+v_{dc}$
$-V_{CC}$

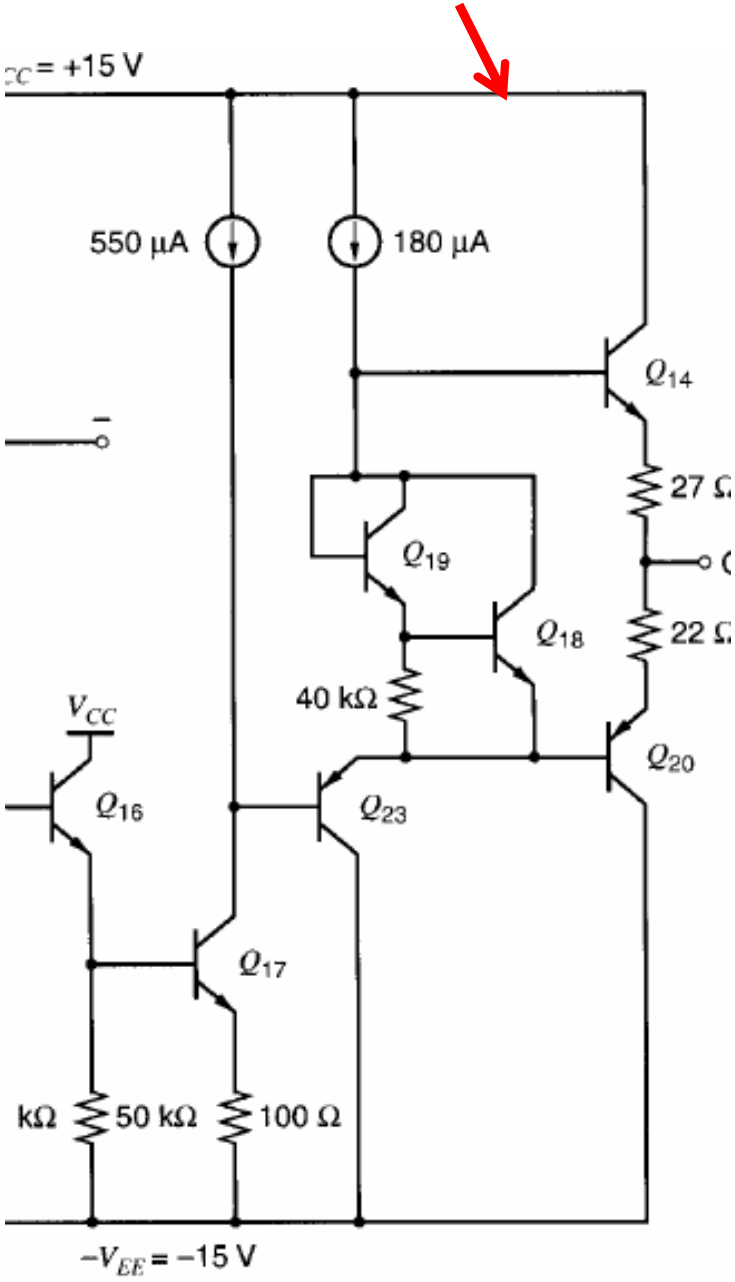

V_{CC}
Q_N
v_O
R_L
Q_P
v_{IN}
$-V_{CC}$


V_{CC}
Q_N
v_O
R_L
Q_P
v_{IN}
$-V_{CC}$


V_{CC}
Q_N
v_O
Q_P
v_{IN}
$-V_{CC}$

Simplified 741 opamp schematic from Gray & Meyer





Simplified 741 opamp schematic from Gray & Meyer

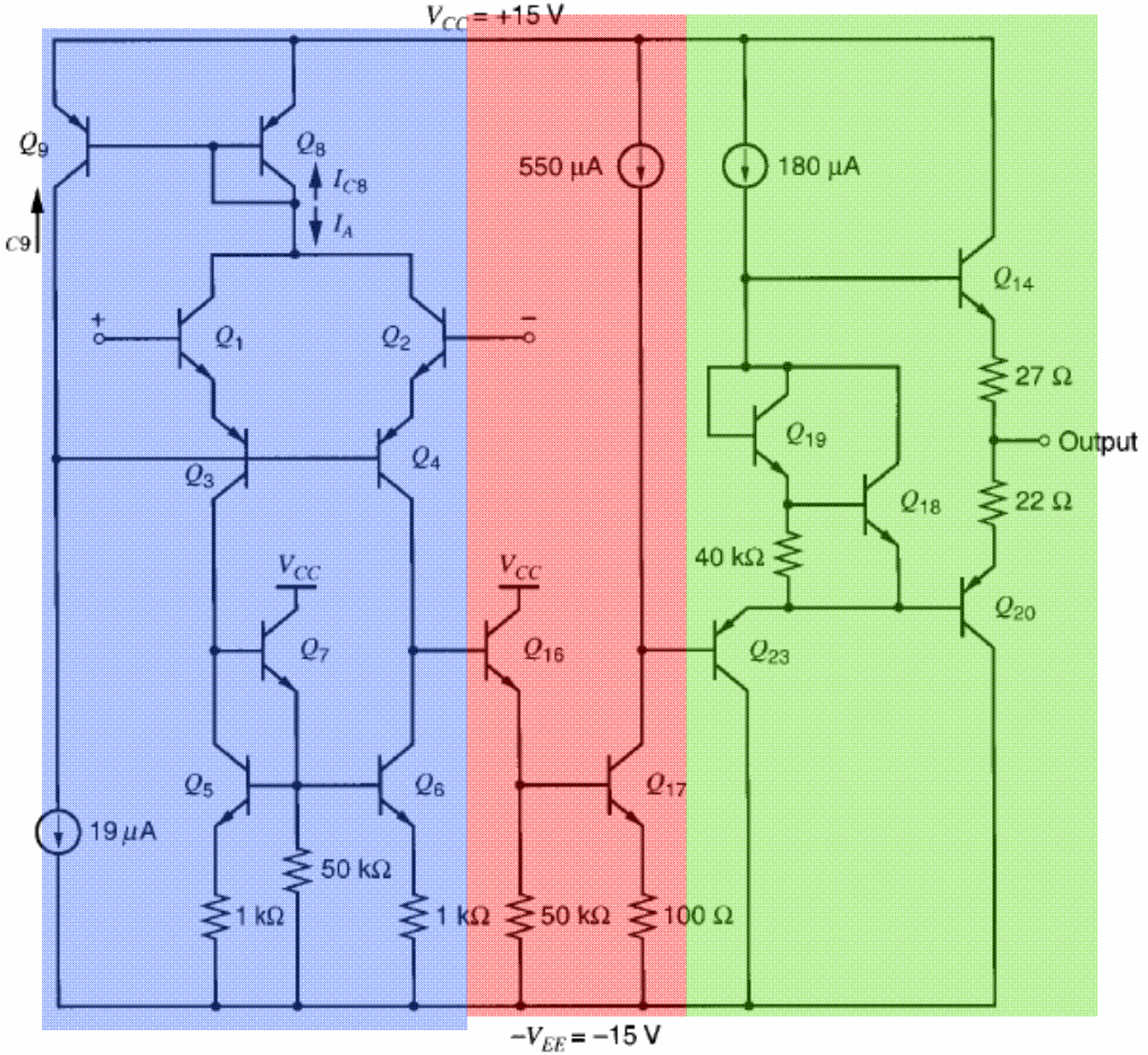
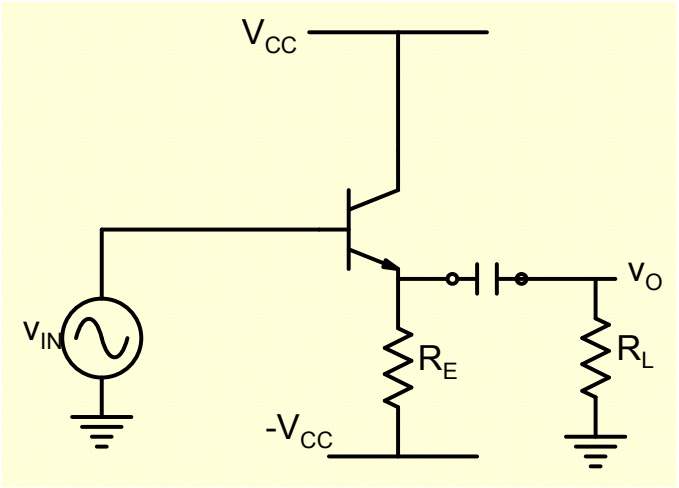
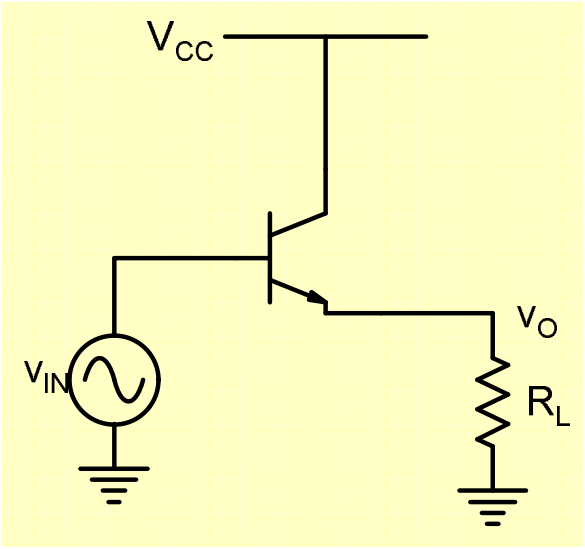
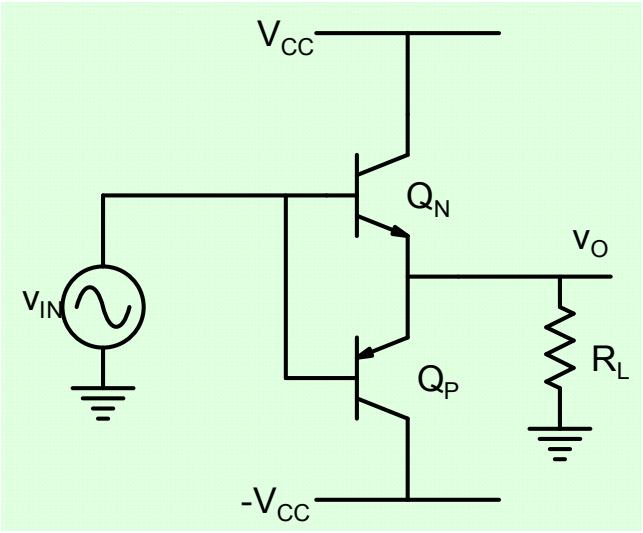


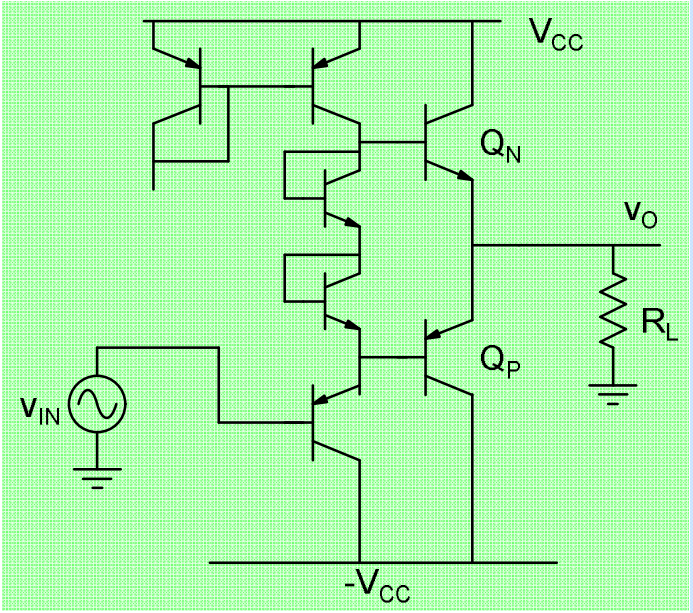
Figure 6.35 Simplified schematic of the 741 with idealized biasing current sources.

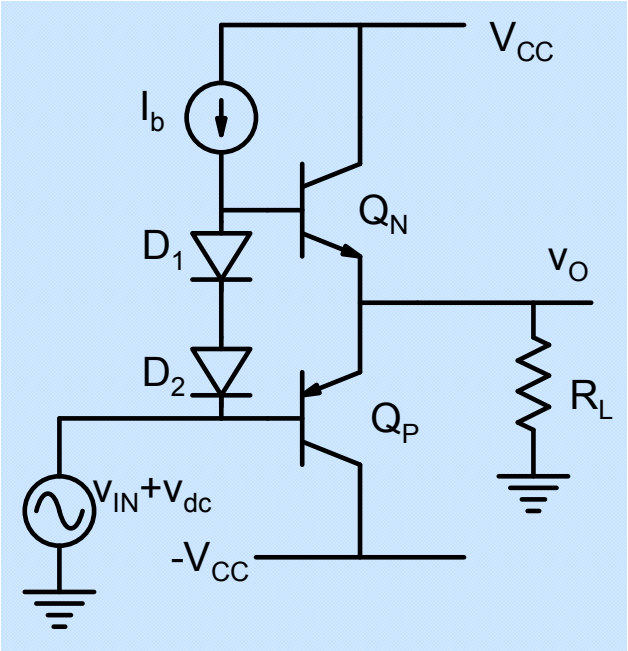
Summary

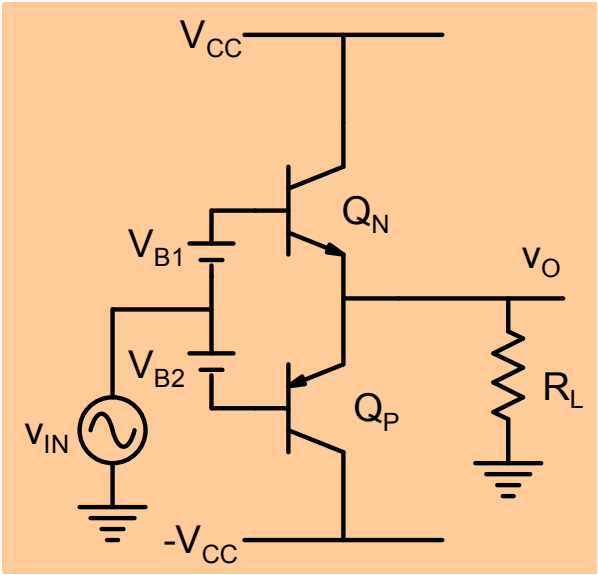

V_{CC}
v_{IN}
R_E
v_O
R_L
$-V_{CC}$


V_{CC}
v_{IN}
v_O
R_L


V_{CC}
Q_N
v_O
v_{IN}
Q_P
R_L
$-V_{CC}$


V_{CC}
Q_N
v_O
R_L
v_{IN}
Q_P
$-V_{CC}$


V_{CC}
I_b
Q_N
D_1
v_O
D_2
Q_P
R_L
$v_{IN}+v_{dc}$
$-V_{CC}$


V_{CC}
Q_N
V_{B1}
v_O
V_{B2}
Q_P
R_L
v_{IN}
$-V_{CC}$