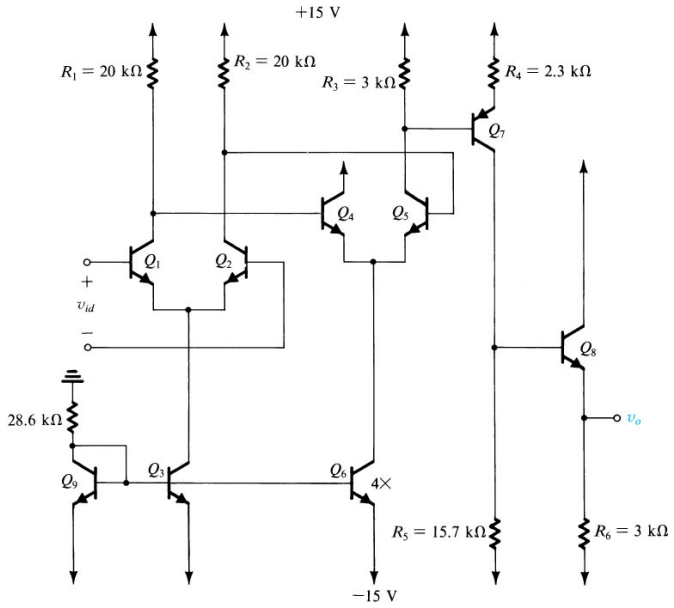
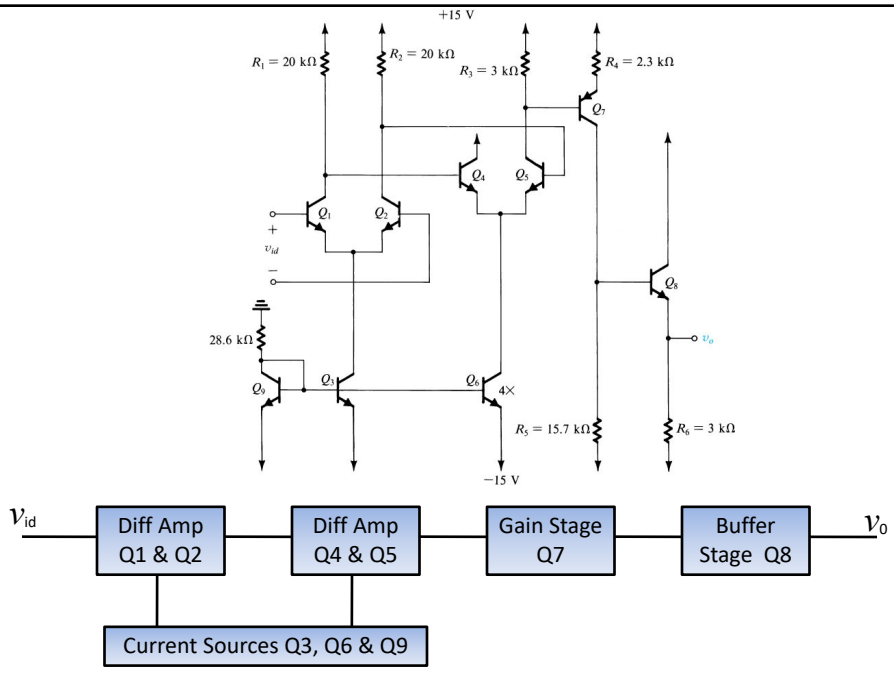
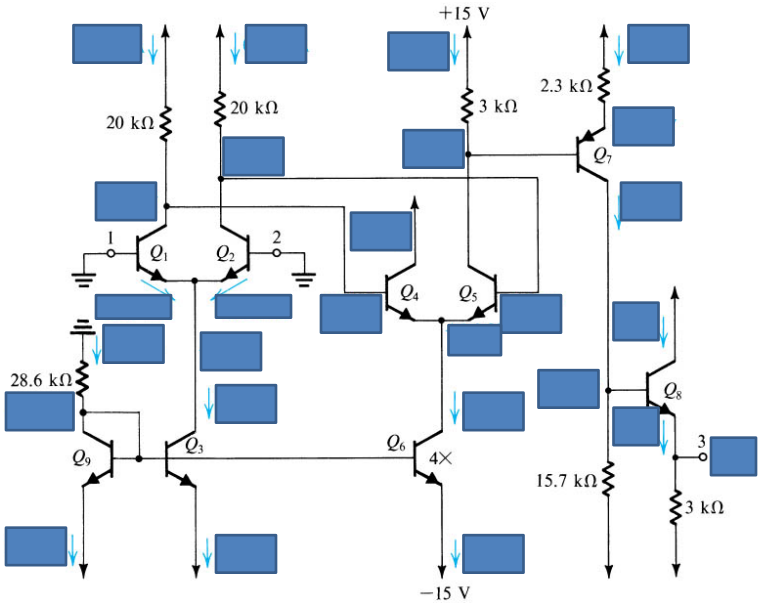


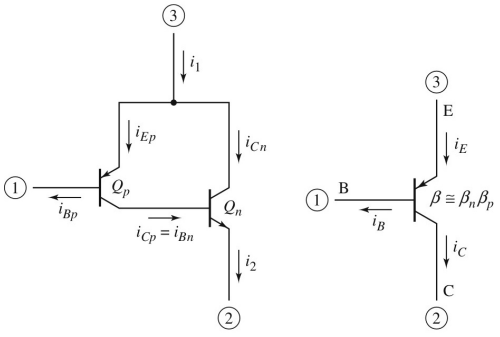
A Four-Stage Bipolar Op Amp



A Four-Stage Bipolar Op Amp



Composite pnp Transistor

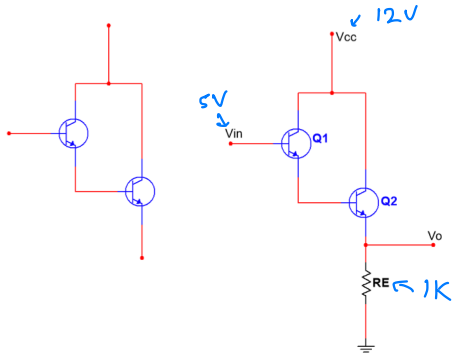


- $\beta \approx \beta_n \times \beta_p$
- β of npn and pnp transistors are not necessarily matched

4

Darlington Pair

Example: Given that Vcc = 12V, Vin = 5V, β_1=80, β_2=120, And R_E = 1k. Determine the output voltage Vo and all DC biasing voltages and currents.



Solution:

$V_o = V_{in} - V_{BE1} - V_{BE2}$ → 5 − 0.7 − 0.7 = 3.6

or, V_o = 3.6 V

$I_{E2} = V_o/R_E$ = 3.6 mA → 3.6/1000

$I_{B2} = I_{E2}/(\beta_2+1)$ → 3.6mA, 120

or, I_{B2} = 29.75 μA

$I_{C2} = I_{B2}\beta_2$ = 3.57 mA

$I_{B1} = I_{E2}$

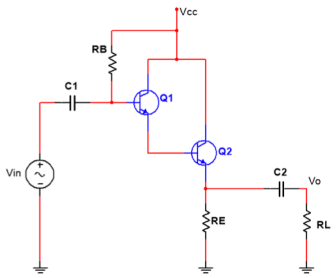
$I_{B1} = I_{E1}/(\beta_1+1)$

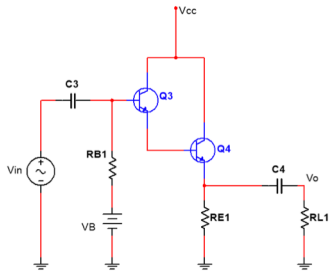
or, I_{B1} = 0.37 μA

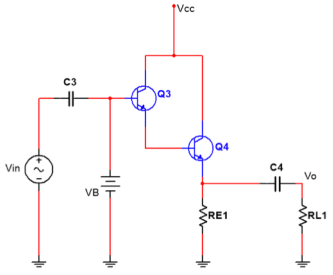
$I_{C1} = I_{B1}\beta_1$ = 29.36 μA

5

AC Voltage Gain of Darlington Pair







Determine

voltage gain = V_o/V_{in} for each circuit shown here.

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