Transistor Circuits XIII

Common-Collector circuits:
Two-supply biased
Two-supply biased common-collector circuit
Rearranged ac equivalent
Two-supply biased common-collector “working” into a useful load equivalent ($R_L$)
Signal “sees” $R_E$ and $R_L$ in parallel
AC load $r_L$ is resistance of $R_E$ and $R_L$ in parallel.
Formulas

• $I_E \approx \frac{V_{EE}-V_{BE}}{R_E+\frac{R_B}{h_{FE}}}$

If $h_{FE}$ is large, $R_B$ is not too large ($< 4.7$-kΩ) and $V_{BE} = 0$ V, we can simplify this to:

• $I_E \approx \frac{V_{EE}}{R_E}$

Normally working circuit: $V_{RE} = V_{EE}$, $V_E = 0$ V; this makes $V_{CE}$:

• $V_{CE} \approx V_{CC}$
\begin{itemize}
  \item $I_{E\text{(sat)}} = \frac{V_{CC} + V_{EE}}{R_E}$
  \item $V_{CE\text{(cutoff)}} = V_{CC} + V_{EE}$
  \item $r_L = \frac{R_E R_L}{R_E + R_L}$
\end{itemize}
First example circuit

Referring to the circuit shown, find the dc emitter and collector currents, collector-to-emitter voltage, and collector-to-ground voltage. Determine its $I_{E(sat)}$ and $V_{CE(cutoff)}$. Assume that the base-to-emitter voltage is 0.6 V and that $h_{fe} = h_{FE} = 120$. 
Work for first example

- \( I_E \approx \frac{V_{EE} - V_{BE}}{R_E + R_B / h_{FE}} = \frac{15 - 0.6}{1.2k\Omega + 33k\Omega / 120} = \frac{14.4}{1.2k\Omega + 275\Omega} = \frac{14.4}{1.475k\Omega} = 9.763\text{mA} \) \( \therefore I_C = 9.763\text{mA} \)

- \( V_{CE} \approx V_{CC} = 15V \)

- \( V_C = V_{CE} = 15V \) (Since \( V_E \approx 0V \))

- \( I_{E(sat)} = \frac{V_{CC} + V_{EE}}{R_E} = \frac{15 + 15}{1.2k\Omega} = \frac{30V}{1.2k\Omega} = 25\text{mA} \)

- \( V_{CE(cutoff)} = V_{CC} + V_{EE} = 15 + 15 = 30V \)
Second example circuit

- In the circuit shown, solve for the dc emitter and collector currents, the collector-to-emitter voltage, the collector-to-ground voltage, and find its $I_{E(sat)}$ and $V_{CE(cutoff)}$. Assume that $V_{BE} = 0.5 \text{ V}$ and $h_{fe} = h_{FE} = 80$. 
Work for second example

- \( I_E \approx \frac{V_{EE} - V_{BE}}{R_E + R_B/h_{FE}} = \frac{12 - 0.5}{750\Omega + 15k\Omega/80} = \frac{11.5}{750\Omega + 187.5\Omega} = \frac{11.5V}{937.5\Omega} = 12.267\text{mA} \therefore I_C = 12.267\text{mA} \)
- \( V_{CE} \approx V_{CC} = 12\text{V} \)
- \( V_C = V_{CE} = 12\text{V} \) (Since \( V_E \approx 0\text{V} \))
- \( I_E(\text{sat}) = \frac{V_{CC} + V_{EE}}{R_E} = \frac{12 + 12}{750\Omega} = \frac{24V}{750\Omega} = 32\text{mA} \)
- \( V_{CE(\text{cutoff})} = V_{CC} + V_{EE} = 12 + 12 = 24\text{V} \)
Third example circuit

- If the transistor becomes defective (acts like an open between its collector and emitter leads) in the circuit of the first example, what dc voltages can we expect to measure at the collector and at the emitter with respect to ground?
Work for third example

- $V_C = 15\text{V}$
- $V_E = -15\text{V}$
Fourth circuit example

- Referring to the problem from the second example, if the dc voltage at the emitter with respect to ground measures -12 V, what are the possible causes of this symptom? Can the circuit amplify signals without distortion? Why or why not?
Work for fourth example

• Shorted transistor.
• No!
• No transistor means nothing to do work.
Any questions?

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