11.10 CHAPTER SUMMARY

- The speed of circuits is limited by various capacitances that the transistors and other components contribute to each node.
- The speed can be studied in the time domain (e.g., by applying a step) or in the frequency domain (e.g., by applying a sinusoid). The frequency response of a circuit corresponds to the latter test.
- As the frequency of operation increases, capacitances exhibit a lower impedance, reducing the gain. The gain thus rolls off at high signal frequencies.
- To obtain the frequency response, we must derive the transfer function of the circuit. The magnitude of the transfer function indicates how the gain varies with frequency.
- Bode's rules approximate the frequency response if the poles and zeros are known.
- A capacitance tied between the input and output of an inverting amplifier appears at the input with a factor equal to one minus the gain of the amplifier. This is called the Miller effect.
- In many circuits, it is possible to associate a pole with each node, i.e., calculate the pole frequency as the inverse of the product of the capacitance and resistance seen between the node and ac ground.
- Miller's theorem allows a floating impedance to be decomposed into to grounded impedances.
- Owing to coupling or degeneration capacitors, the frequency response may also exhibit roll-off as the frequency falls to very low values.
- Bipolar and MOS transistors contain capacitances between their terminals and from some terminals to ac ground. When solving a circuit, these capacitances must be identified and the resulting circuit simplified.
- The CE and CS stages exhibit a second-order transfer function and hence two poles. Miller's approximation indicates an input pole that embodies Miller multiplication of the base-collector or gate-drain capacitance.
- If the two poles of a circuit are far from each other, the "dominant-pole approximation" can be used to find a simple expression for each pole frequency.
- The CB and CG stages do not suffer from the Miller effect and achieve a higher speed than CE/CS stages, but their lower input impedance limits their applicability.
- Emitter and source followers provide a wide bandwidth. Their output impedance, however, can be inductive, causing instability in some cases.
- To benefit from the higher input impedance of CE/CS stages but reduce the Miller effect, a cascode stage can be used.
- The differential frequency response of differential pairs is similar to that of CE/CS stages.