

# Microelectronics Circuit Analysis and Design

Donald A. Neamen

## Chapter 10

### *Integrated Circuit Biasing and Active Loads*

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Chapter 10-1

In this chapter, we will:

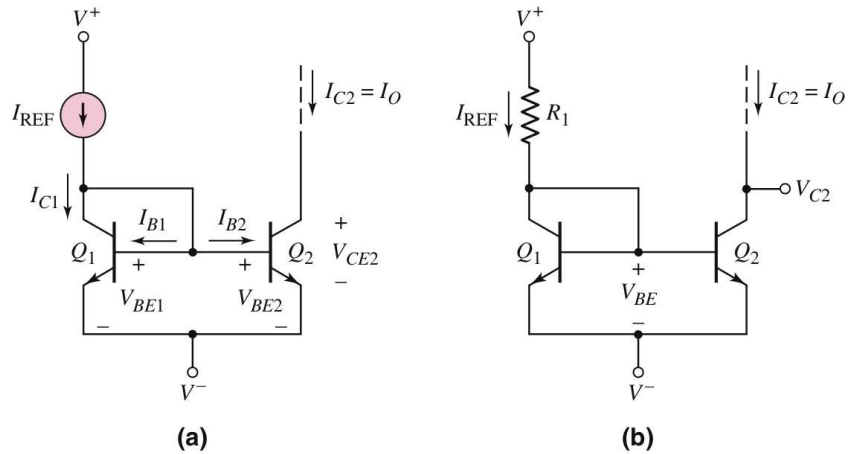
- Analyze and understand the characteristics of various bipolar circuits used to provide a constant output current.
- Analyze and understand the characteristics of various MOSFET (and a few JFET) circuits used to provide a constant output current.
- Analyze the dc characteristics of amplifier circuits using transistors as load devices (active loads).
- Analyze the small-signal characteristics of amplifier circuits with active loads.
- Design an NMOS current source circuit to provide a specified bias current and output resistance.

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## 2-Transistor Current Source



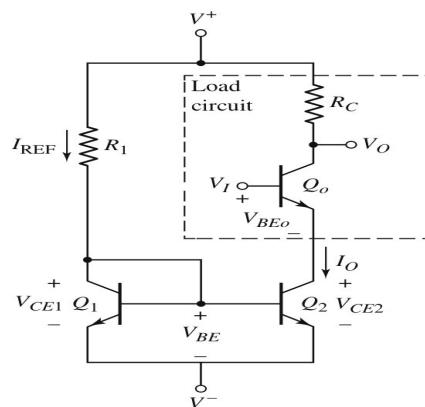
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## DC Equivalent Circuit: 2-Transistor Current Source



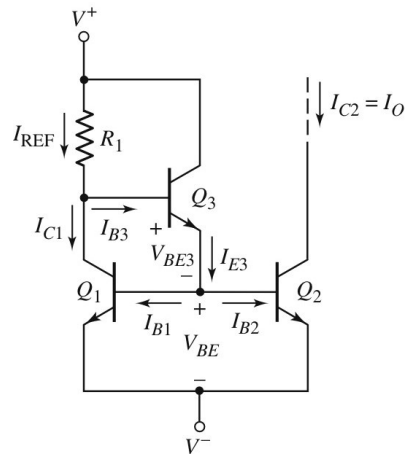
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### 3-Transistor Current Source



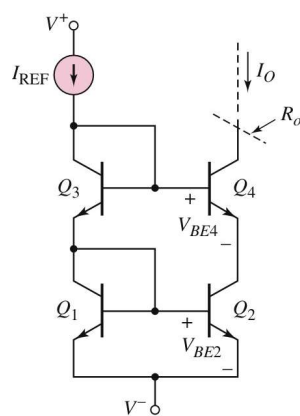
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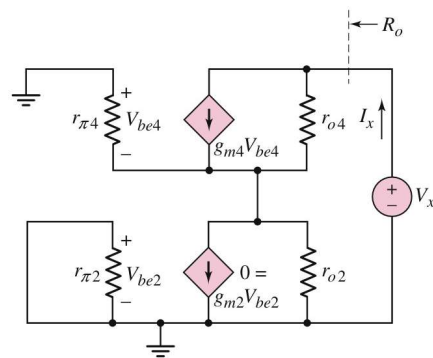
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### Bipolar Cascode Current Mirror



(a)

Small-signal equivalent circuit



(b)

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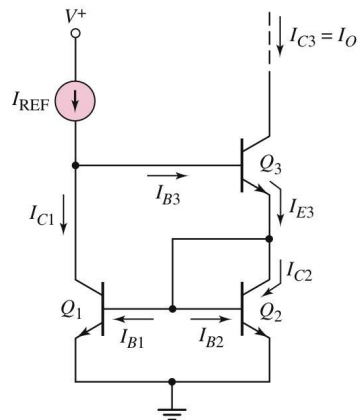
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## Other Current Source

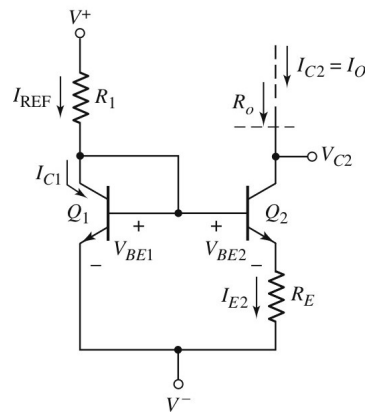
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## Problem-Solving Technique: BJT Current Source Circuits

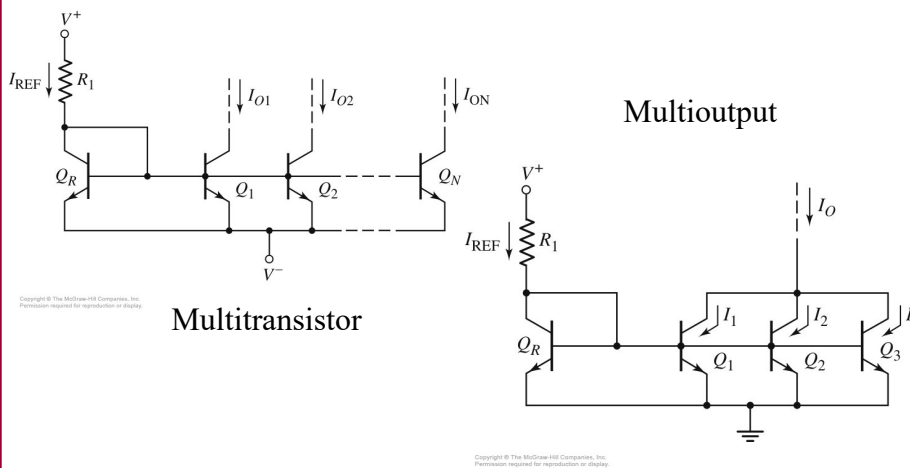
1. Sum currents at various nodes to find relation between reference and bias currents
2. Place test voltage at output node and analyze small-signal equivalent circuit to find output resistance.
  - a. Reference current is a constant
    - i. Some base voltages may be constant or at ac ground.

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## Multitransistor and Multioutput Current Mirror

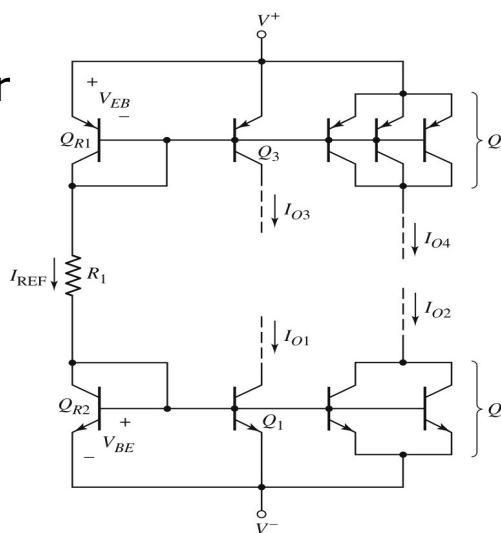


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## Generalized Current Mirror

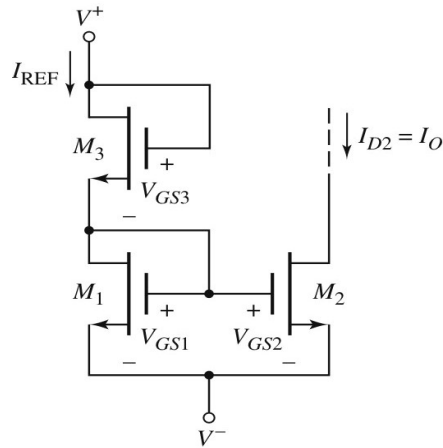


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### MOSFET Current Source



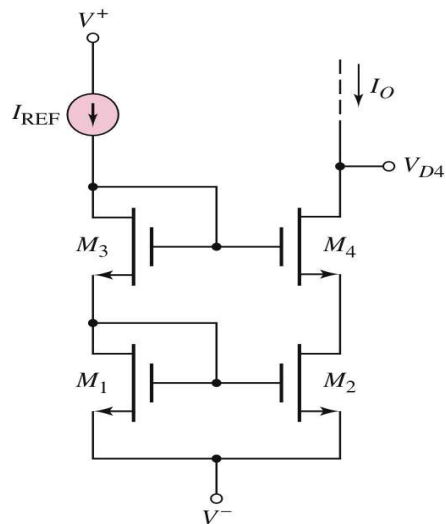
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### MOSFET Cascode Current Source



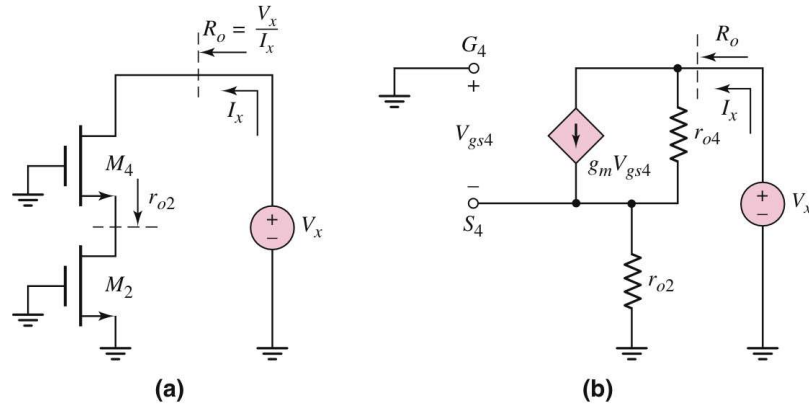
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## Equivalent Circuits for MOSFET Cascode Current Mirror



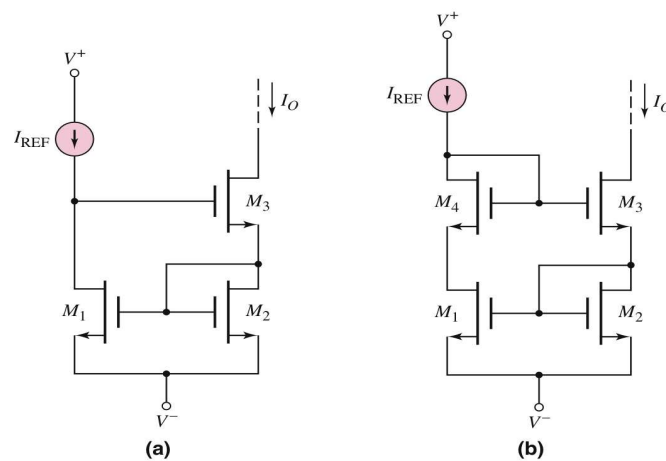
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## MOSFET Wilson Current Source



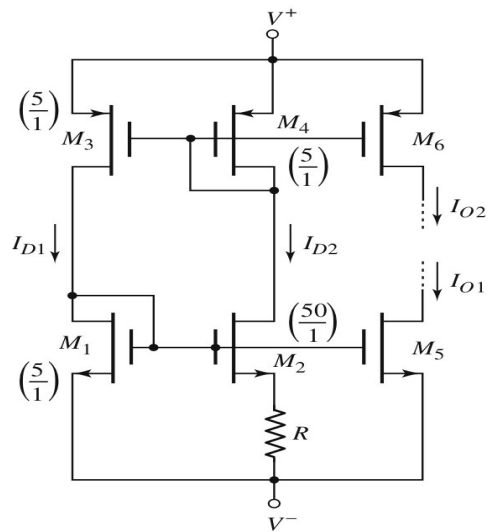
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### Bias-Independent MOSFET Current Mirror



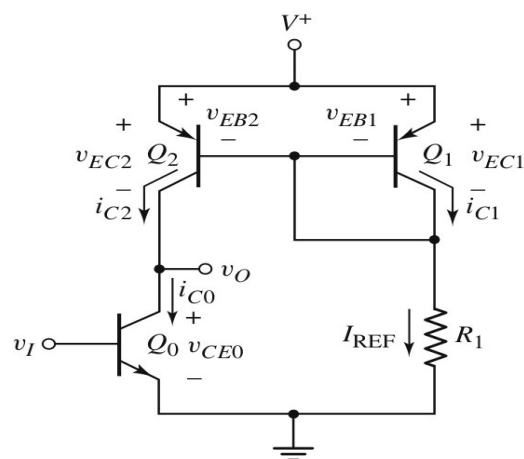
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### BJT Amplifier with Active Load



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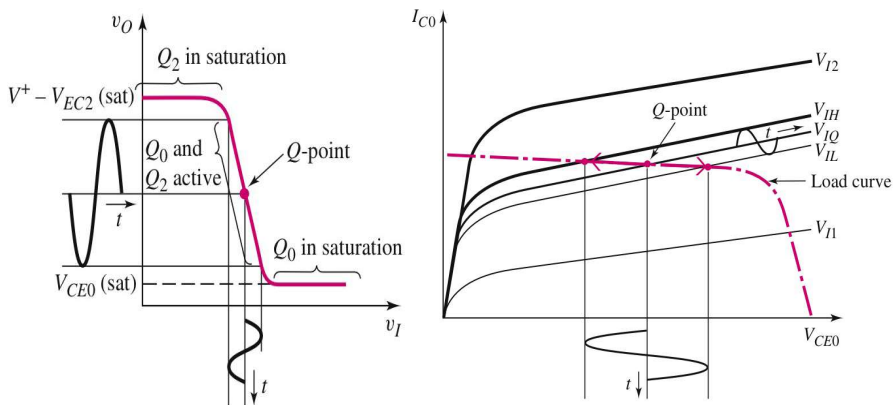
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## Characteristics of Bipolar Circuit with Active Load



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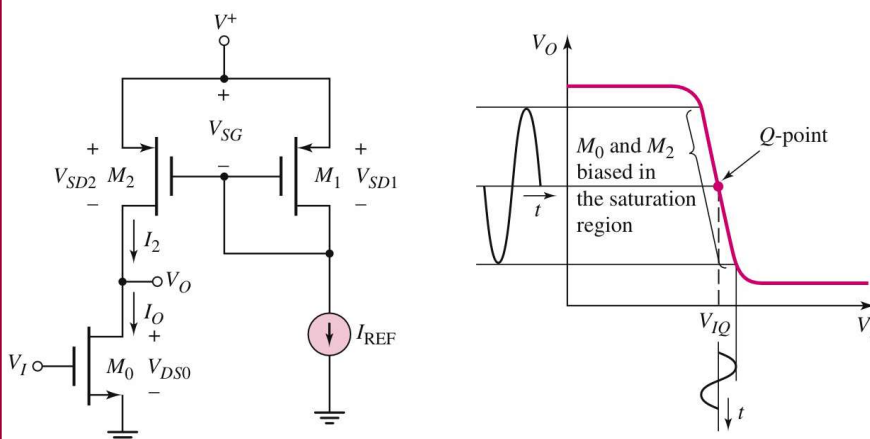
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## MOSFET Amplifier with Active Load



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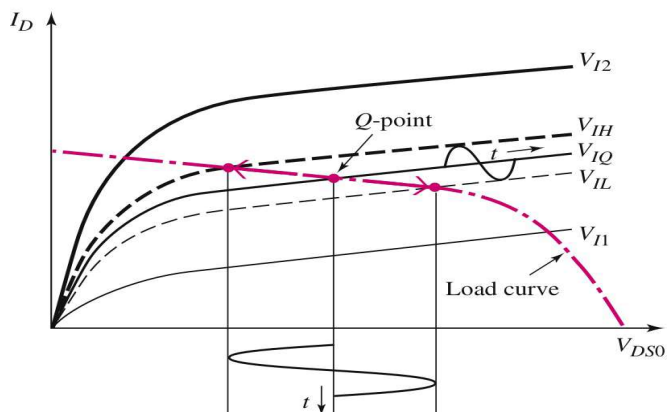
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## Driver Characteristics: MOSFET Amplifier with Active Load



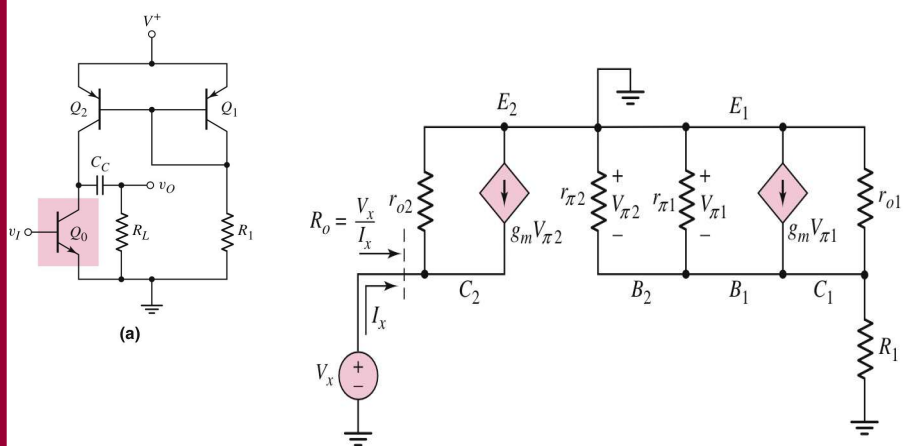
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## Small-Signal Equivalent Circuit: BJT Active Load



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## Problem-Solving Technique: BJT Active Loads

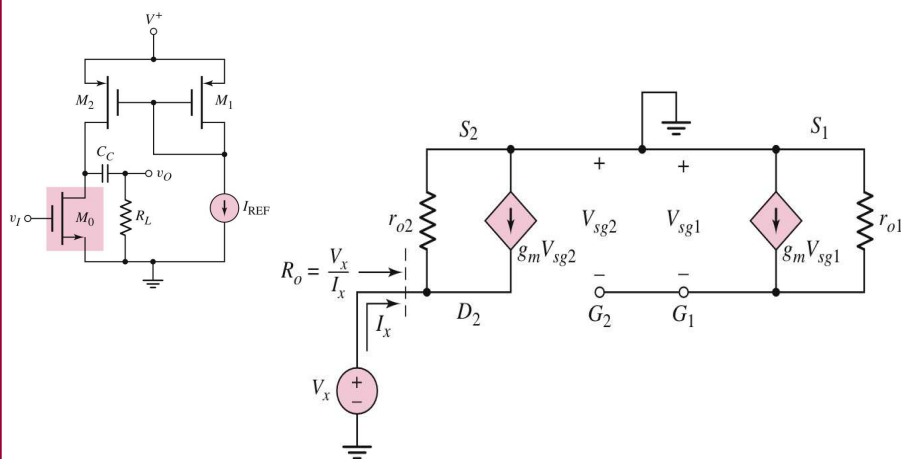
1. Ensure active load devices are biased in forward active mode.
2. Small-signal analysis considers output resistance looking back into output of active load device as well as the equivalent circuit of amplifying transistor.

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## Small-Signal Equivalent Circuit: MOSFET Active Load

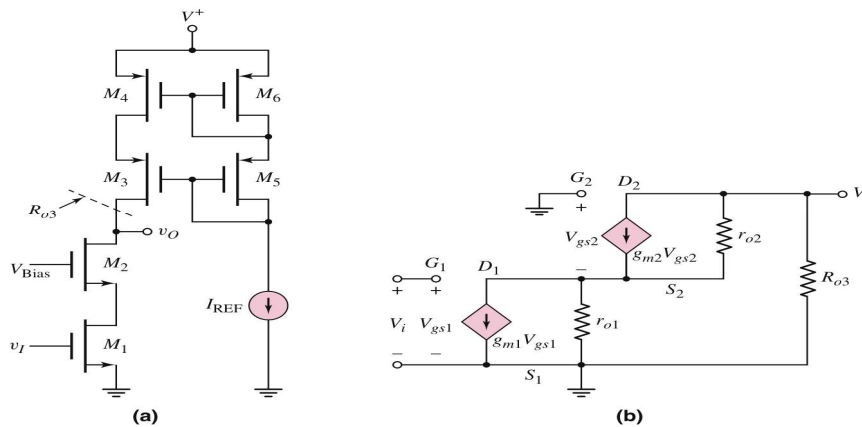


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## MOSFET Cascode Amplifier with Cascode Active Load



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