

University of California
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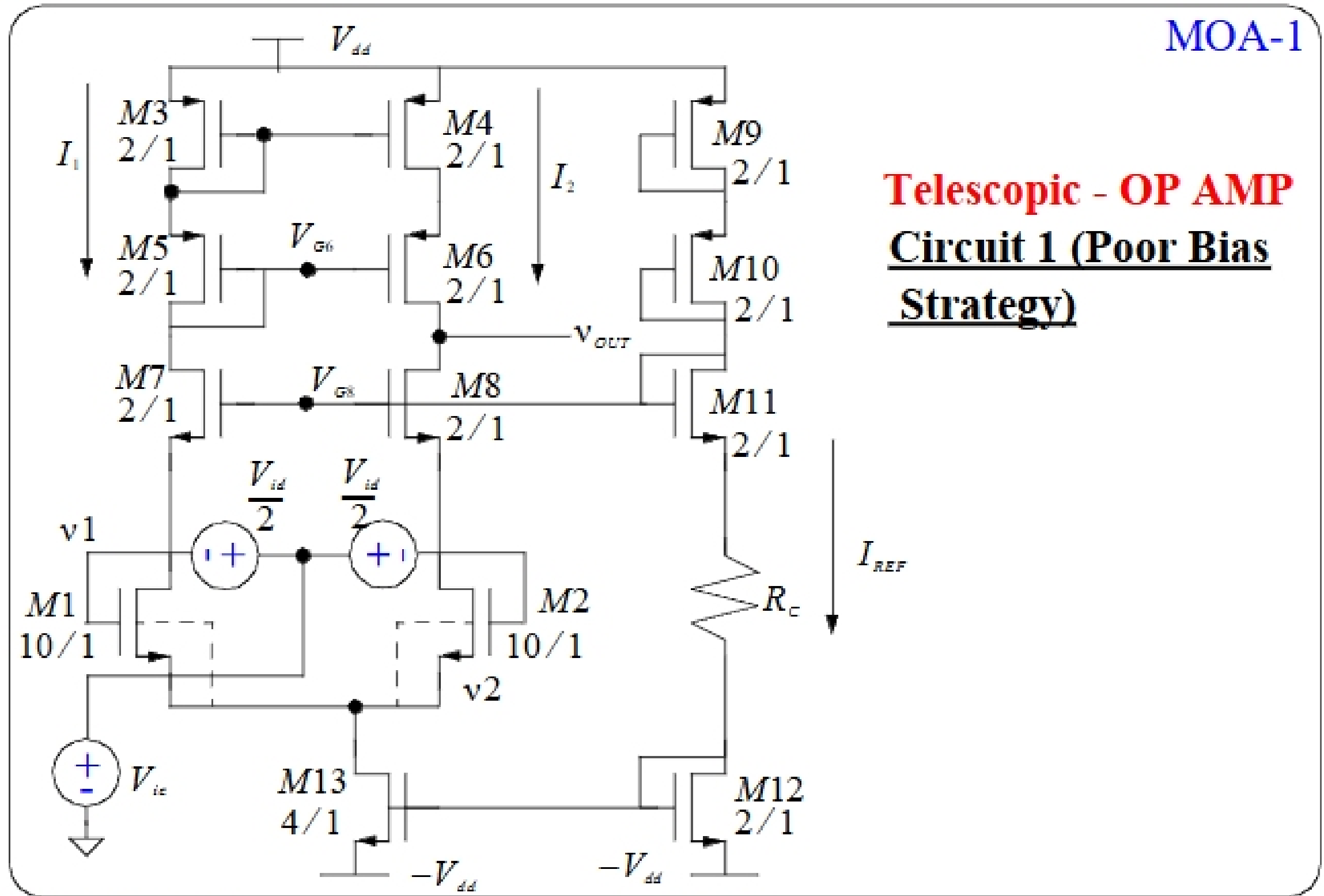
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Analog Circuit Design

**More
on Op Amps
TELESCOPIC and FOLDED CASCODE**

MOA-1



Telescopic - OP AMP
Circuit 1 (Poor Bias Strategy)

Circuit 1 :**Telescopic OP AMP with “BAD” Bias of cascode :**

The currents are balanced so that all transistors have,

$$I_{DS} = I_{REF}$$

except for M13 which has,

$$I_{DS13} = 2 \cdot I_{REF}$$

Since,

$$I_1 = I_2 = I_{REF}$$

then,

$$V_{GS3} = V_{GS4} = V_{GS9} \quad (\text{all W/L's are equal also})$$

This also implies that,

$$V_{DS4} = V_{DS3}$$

similarly,

$$V_{DS5} = V_{DS6}$$

So if the input has,

$$V_{id} = 0$$