

### Voltage Amplifier

$$V_i = V_s * (R_i / (R_i + R_s))$$

$$V_o = A_{vo} V_i * (R_L / (R_L + R_o))$$

### Ideal op-amp:

$$R_i = \text{infinity}$$

$$R_o = 0$$

$$R_L = R_s = 0 \text{ affect on gain}$$

### Four Amplifier Models

#### Voltage Amplifier

$$A_v = V_o / V_i$$

$$R_i = \text{infinity}$$

$$R_o = 0$$

#### Current Amplifier

$$A_v = i_o / i_i$$

$$R_i = 0$$

$$R_o = \text{infinity}$$

#### Transconductance Amp

$$G_m (i \text{ dep.}) = i_o / V_i$$

$$R_i = \text{infinity}$$

$$R_o = \text{infinity}$$

#### Transresistance Amp

$$R_m (v \text{ dep.}) = V_o / i_i$$

$$R_i = 0$$

$$R_o = 0$$

### Source Transformation

$$A_{vo} = A_{is} * (R_o / R_i) = G_m * R_o = R_m / R_i$$

### Inverting vs. Non-Inverting Op-Amp

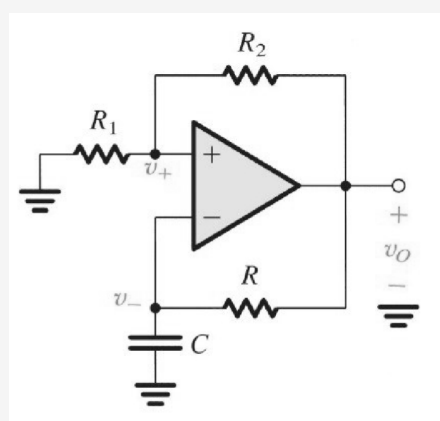
#### Inverting Op-Amp

$$A_v = R_f / R_i$$

#### Non-Inverting Op-Amp

$$A_v = 1 + R_f / R_i$$

### Astable Multivibrator



$$\tau = CR$$

$$T = 2\tau * \ln[(1 + \beta) / (1 - \beta)]$$

$$\beta = R_1 / (R_1 + R_2)$$

### Gain in dB

### Differential Amplifier (CMRR)

$$20 \log |A_d / A_{cm}| = 20 \log |(K+1) / \delta| = 20 \log |$$

$$(K+1) / (4 * \epsilon)|$$

$$\delta = \text{mismatch}$$

$$\epsilon = \text{tolerance}$$

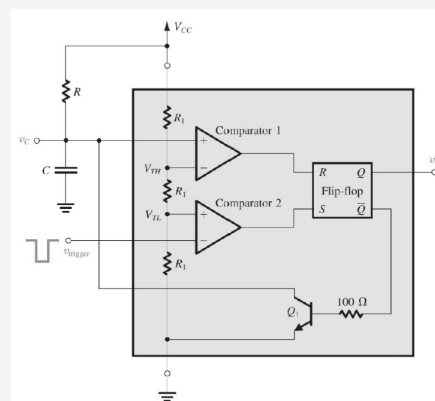
$$A_d = R_2 / R_1 = R_4 / R_3 = K$$

$$V_{cmi} = 0.5(V_1 + V_2)$$

$$V_1 = V_{cmi} - 0.5V_{di}$$

$$V_2 = V_{cmi} + 0.5V_{di}$$

### 555 Timer (Monostable)



$$T = CR * \ln 3 \approx 1.1CR$$

$$V_{TH} = V_{cc}(1 - e^{-T/CR})$$

### Amplifier Class

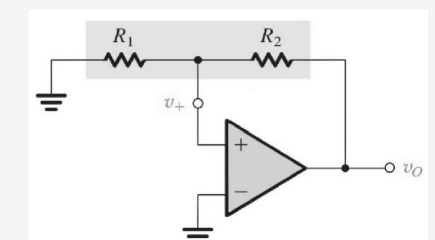
A: Full wave,  $\theta_c = 360 \text{ deg.}$

B: Halfwave  $\theta_c = 180 \text{ deg.}$

C: Between A & B class,  $\theta_c < 180 \text{ deg.}$

D: Small wave

### Bistable Multivibrator



$$\beta = R_1 / (R_1 + R_2)$$

$$V_{TH} - V_{TL} = \beta(L_+ - L_-)$$

$$V_{TL} = -L_+ (R_1 / R_2)$$

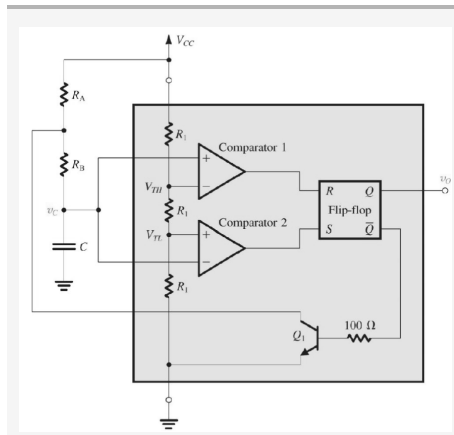
$$V_{TL} = -L_- (R_1 / R_2)$$

### 555 Timer (Astable)

$$A_v = 20\log|A_v| \text{ dB}$$

$$A_i = 20\log|A_i| \text{ dB}$$

$$P_g = 10\log|P_g| \text{ dB}$$



$$\text{Duty Cycle} = (R_A + R_B) / (R_A + 2R_B)$$

$$T = 0.69C(R_A + 2R_B)$$



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