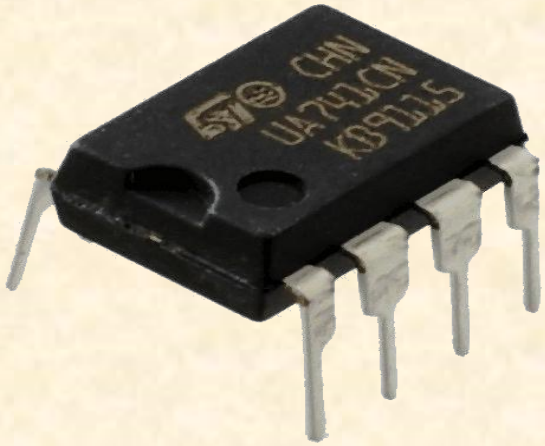
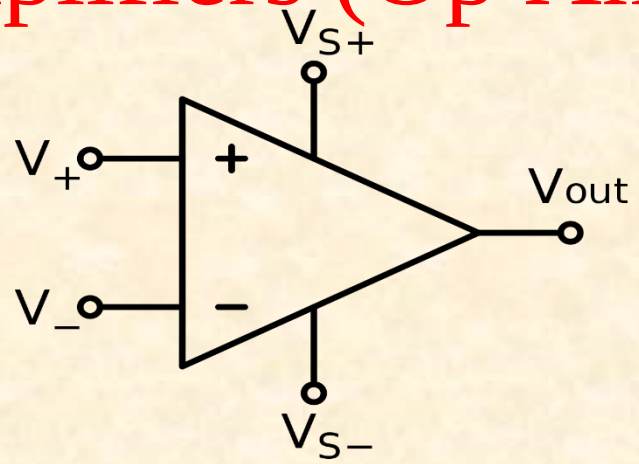
# Operational Amplifiers (Op Amps)

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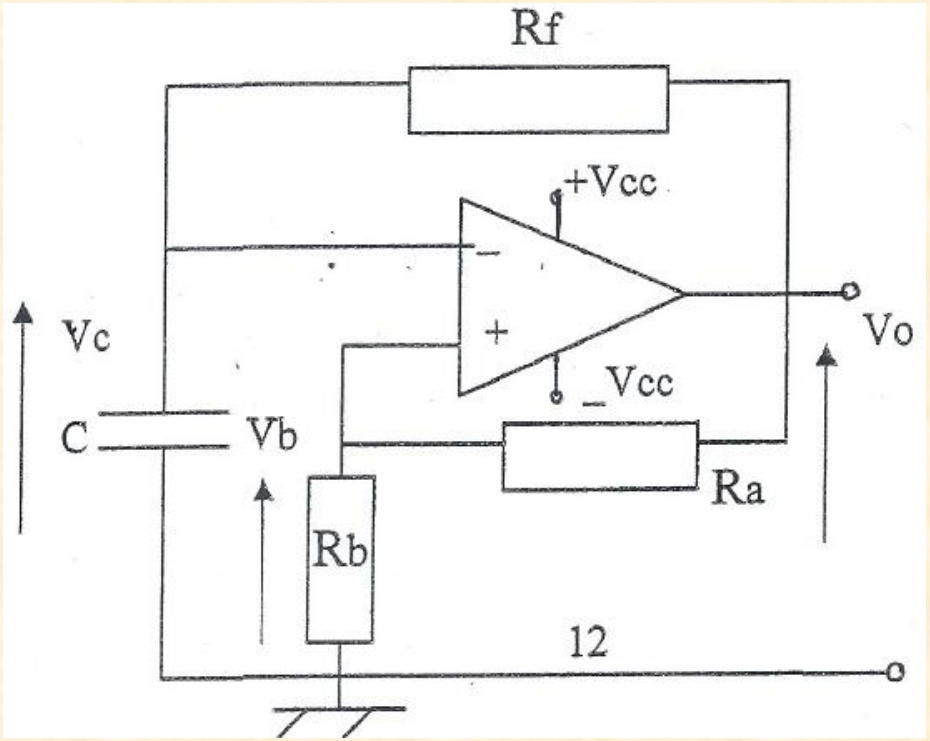
# Outline

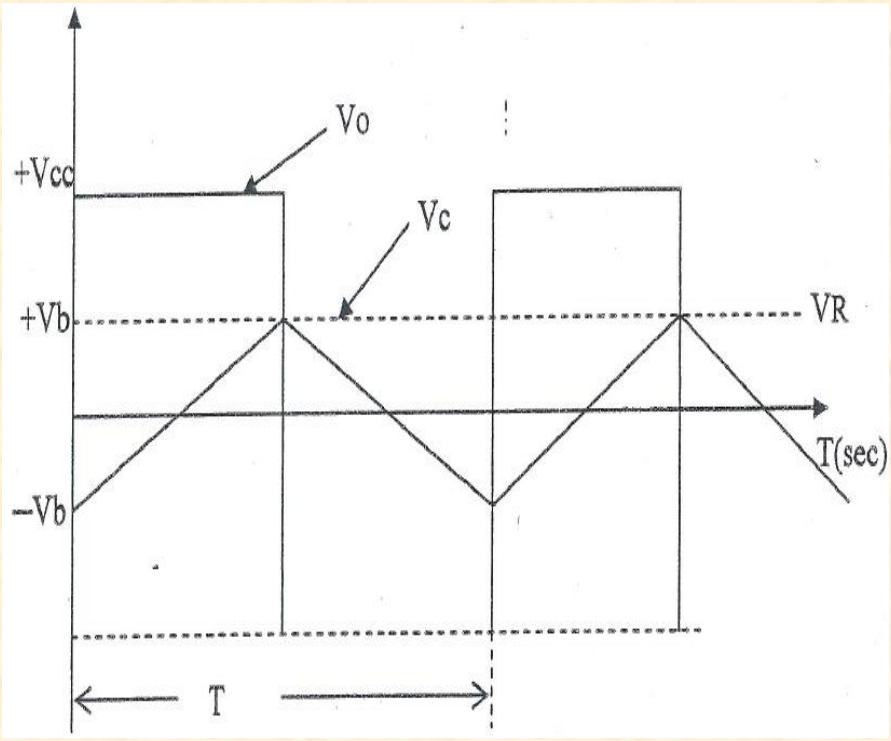
Non-Linear Application of Op-Amp

- Op-amp Signal Generator
- Example
- Op-amp Zero Crossing Detector
- Example
- The Comparator

# OP-AMP Signal Generator

OP-AMP Signal Generator:- It has negative and positive feedback circuits (a) Rf = negative feedback resistance and (b) K= positive feedback coefficient, K = [Rb/Ra+Rb], see figure bellow.



# Cont.

$V_b$= non-linear input of the op-amp (v)

$$V_b = kV_o = \pm kV_{cc} \qquad (1)$$

T = the periodic time of the output/input signals (sec)

$$T = 2R_F C \ln \frac{1+k}{1-k} \qquad (2)$$

F = Frequency of the generated signals (Hz)

$$F = \frac{1}{T} \qquad (3)$$

**Example:-** Op-amp signal generator, if Ra=Rb, Rf =10KΩ, C= 0.1μF, and $V_{cc}$=±18V;Find(1) $V_b$ and (2) Frequency F

SOL.

*(1)* $V_b = kV_o = \pm kV_{cc}$

K= $\frac{R_b}{R_a+R_b} = 0.5$

# Cont.

$$V_b = \pm 0.5 \times 18 = \pm 9$$

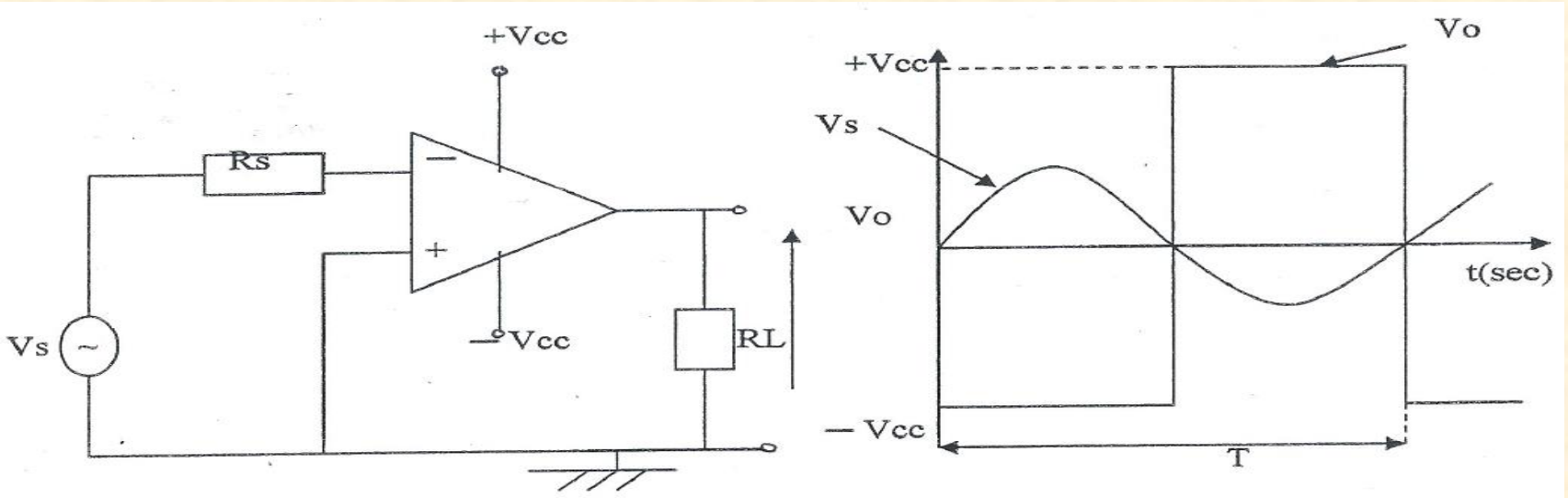
(2) $T = 2R_f C \ln \frac{1+k}{1-k}$

$T = 2\times 10 \times 10^4 \times 0.1 \times 10^{-6} \ln \frac{1+0.5}{1-0.5} = 2.197\times 10^{-3}$

$F = \frac{1}{T} = \frac{1}{2.197\times 10^{-3}} = 455Hz$

# OP-AMP Zero Crossing Detector

OP-AMP Zero Crossing Detector:-This is one of the open loop applications of op-amp , also called sinewave to square wave converter.




$V_O = \pm V_{cc}$ and $F_o = F_i = 1/T = \omega/2\pi$

# Example:

Op-amp, Zero crossing detector has $V_{cc}$=$\pm 15v, V_s = 5sin337t$

a- draw the power circuit diagram,(b) Sketch the input-output waveforms

c- calculate Fo

SOL.

(a) And (b) as shown in Figure above (previous slide)

(c) $F_o = F_i = 1/T$ = ω/2$\pi$ , ω= 377

$F_o$= 377/(2× 3.14) = 60Hz

# The Comparator

The Comparator:- This is also one of the open loop applications of op-amp, it is used to compare two voltages one of it's a dc voltage called reference voltage [$V_R$]