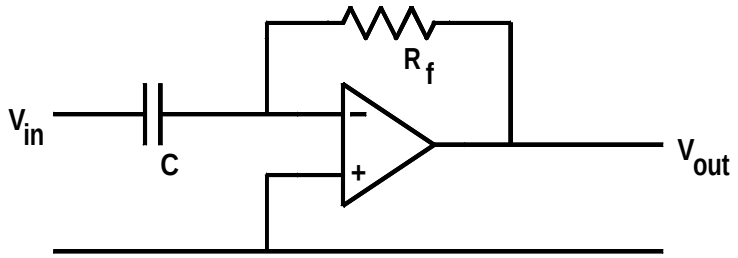
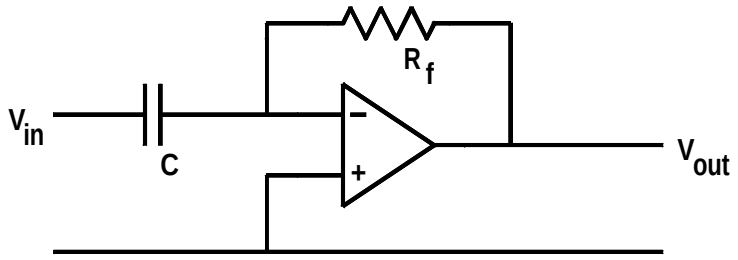


- The output from a differentiator circuit is given by:

$$V_{out} = -CR_f \frac{dV_{in}}{dt}$$

- The output voltage is the time rate of change of the input voltage signal.



Charge on the capacitor is

$$Q = C \times (V_{in} - 0) = C \times V_{in}$$

Input current is time rate of change of charge

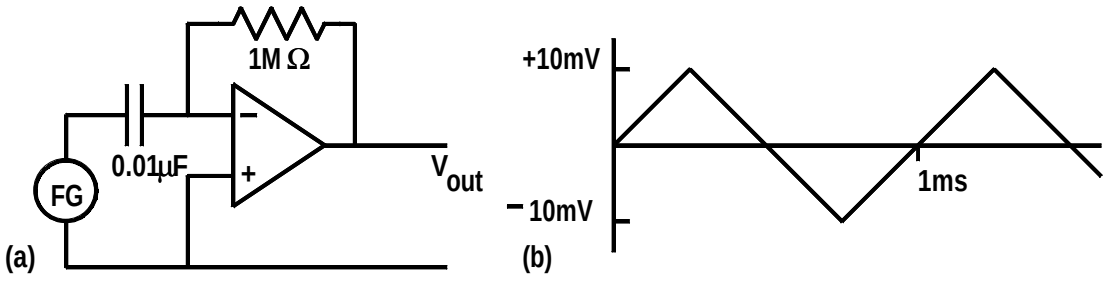
$$I_{in} = \frac{dQ}{dt} = C\frac{dV_{in}}{dt}$$

Which also flows in feedback resistor, R_f,

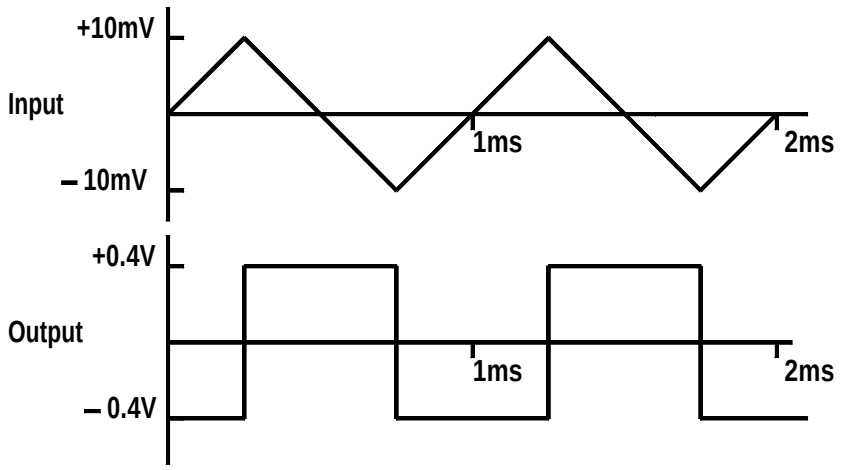
$$I_{in} = I_f = \frac{0 - V_{out}}{R_f} = -\frac{V_{out}}{R_f}$$

Which gives equation for differentiators:—

$$V_{out} = -CR_f\frac{dV_{in}}{dt}$$



Function generator, FG, gives output triangular waveform of frequency $1kHz$ and amplitude $10mV$



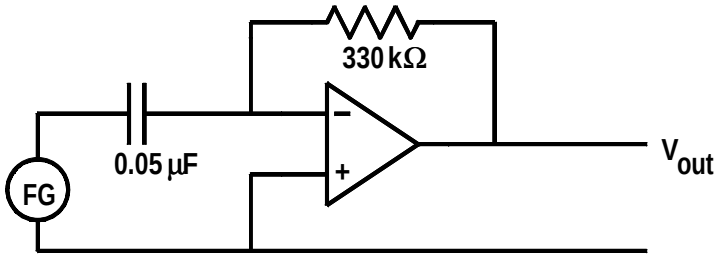
$$CR = 0.01\mu F \times 1M\Omega = 10^{-2}\text{seconds}$$

Period of waveform $T = \frac{1}{f} = \frac{1}{1000} = 1ms$ The input waveform goes from $\pm 10mV$ to $\mp 10mV$ in $0.5ms$ and therefore the rate of change of the input signal is

$$\left|\frac{dV_{in}}{dt}\right| = \frac{10mV - (-10mV)}{0.5 \times 10^{-3}sec} = \pm 40\frac{V}{sec}$$

$$V_{out} = \pm 10^{-2}sec \times 40\frac{V}{sec} = \pm 0.4V$$

Note sign of output and alignment.



Calculate the output voltage waveform for an input triangular waveform of frequency 250Hz and of amplitude 30mV.

Unit 44 Differentiator Circuit