GENERAL DESCRIPTION OF SIGNALS

- **Time Constant** It refers only to exponential waveforms .It is a useful measure of the decay of an exponential .
- Defined as the time interval for an exponential function to decrease to 37 % of its initial value or increase to 63% of its final value
- Consider an exponential waveform described by

  $r(t) = K e^{-t/T} u(t)$ from the plot of this function we see that when $t = T$,

  $r(t) = 0.37\, r(0)$

  also $r(4T) = 0.02\, r(0)$. This shows that the larger the time constant ,the longer it requires for the waveform to reach 37 % of its peak value. In circuit analysis ,the common time constants are the factors RC and RL .
- RMS Value , D-C Value , Duty Cycle and Crest Factor are other terms which describe only Periodic Waveforms.

GENERAL DESCRIPTION OF SIGNALS (CONTD)

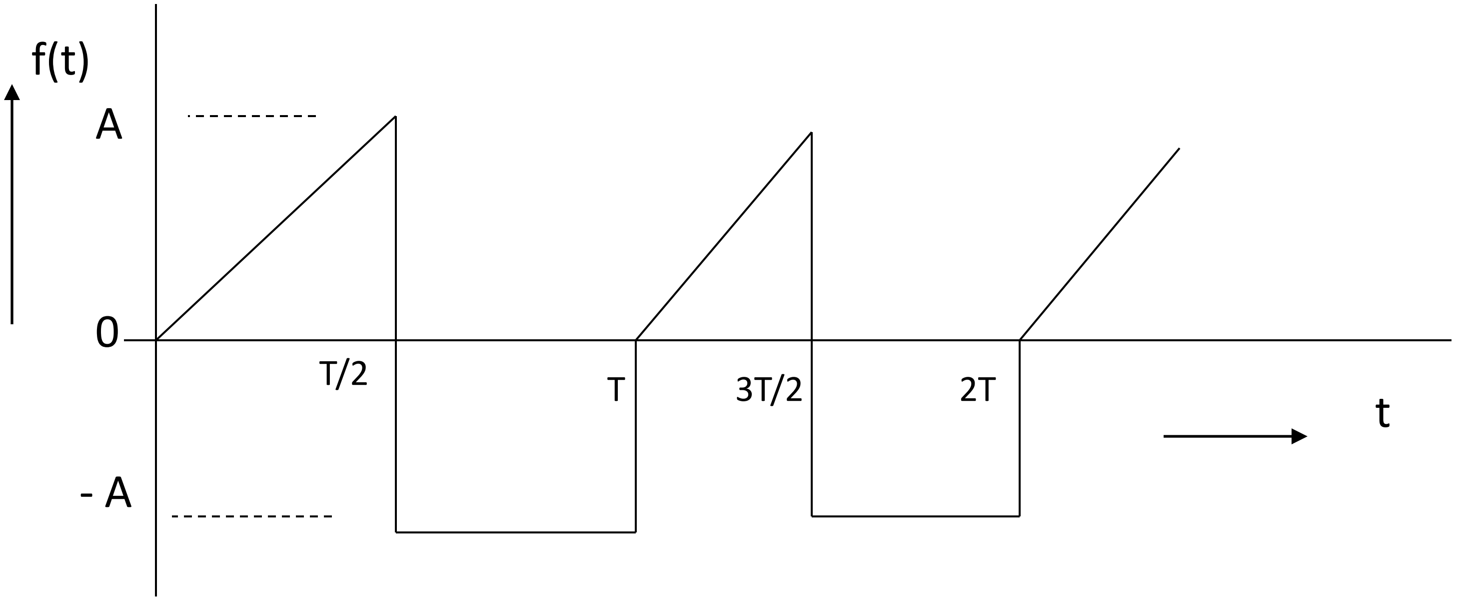
- **RMS Value** The rms or root mean square value of a periodic waveform e (t) is defined

$$e_{rms} = \left[1/T \int_0^T e^2(t)\, dt \right]^{1/2}$$ where T is the period . If the waveform is not periodic ,the term rms does not apply .

Show that for a periodic waveform which is triangular in period 0 to T/2 with amplitude increasing from 0 to A v and rectangular in next half period T/2 to T with amplitude - A v during this half period .The rms value works out to be

$$\sqrt{2/3}\ A\ v$$

Ex : find rms value of the waveform shown below



- rms VALUE = $A \sqrt{2/3}$

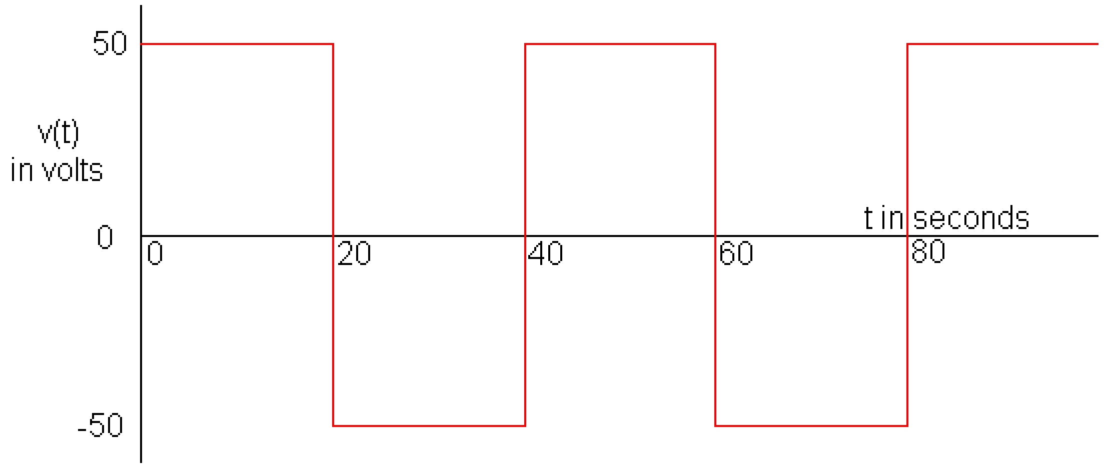
Solution

- $$E_{rms} = \left[1/T \left\{ \int_0^{T/2} (2A\,t/T)^2\,dt + \int_{T/2}^{T} A^2\,dt \right\}\right]^{1/2}$$

$$= \left[1/T \left\{ (4A^2/T^2)\, t^3/3 \Big|_0^{T/2} \right\} + A^2 t \Big|_{T/2}^{T} \right\} \Big]^{1/2}$$

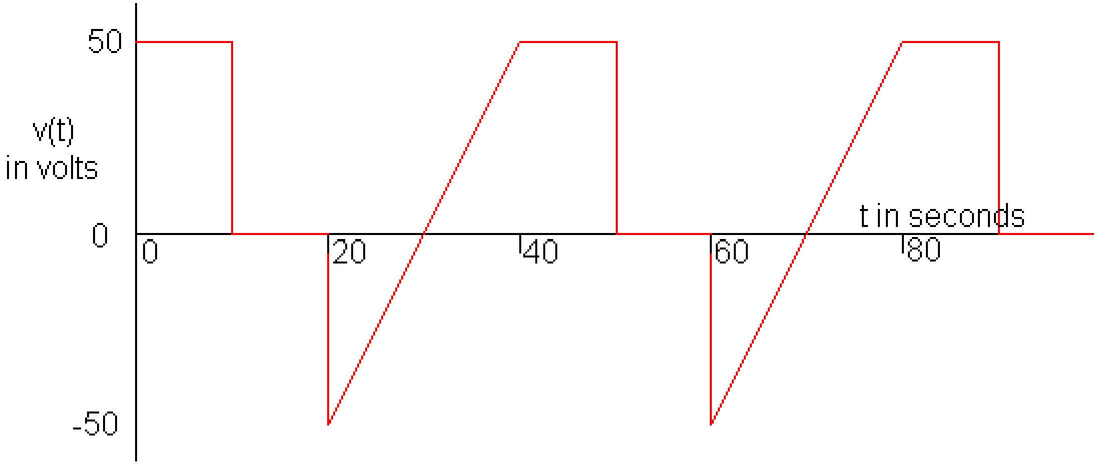
$$= \quad A \sqrt{2/3}$$

- Find rms value of the waveform shown below



$$V_{rms} = \{[50^2 + (-50)^2]/2\}^{1/2} = \{[2500 + 2500]/2\}^{1/2} = \{2500\}^{1/2} = 50\ V$$

FIND THE RMS AND VALUE OF THE WAVEFORM SHOWN BELOW



Solution

$$V_{rms} = \sqrt{\frac{1}{40}\left[\int_0^{t_1} v^2\,dt + \int_{t_1}^{t_2} v^2\,dt + \int_{t_2}^{40} v^2\,dt\right]}$$

$$V_{rms} = \sqrt{\frac{1}{40}\left[\int_0^{10} v^2\,dt + \int_{10}^{20} v^2\,dt + \int_{20}^{40} v^2\,dt\right]}$$

$$V_{rms} = \sqrt{\frac{1}{40}\left[\int_0^{10} 2500\,dt + \int_{10}^{20} 0\,dt + \int_{20}^{40} (5t - 150)^2\,dt\right]}$$

Solution (contd)

$$V_{rms} = \sqrt{\frac{1}{40}\left[\ 25000 \quad + \ 0 \ \ + 16667 \ \right]}$$

$$V_{rms} = \sqrt{41667/40}$$

$V_{rms} = 32.27$ V

This rounds off to $V_{rms} = 32$ V

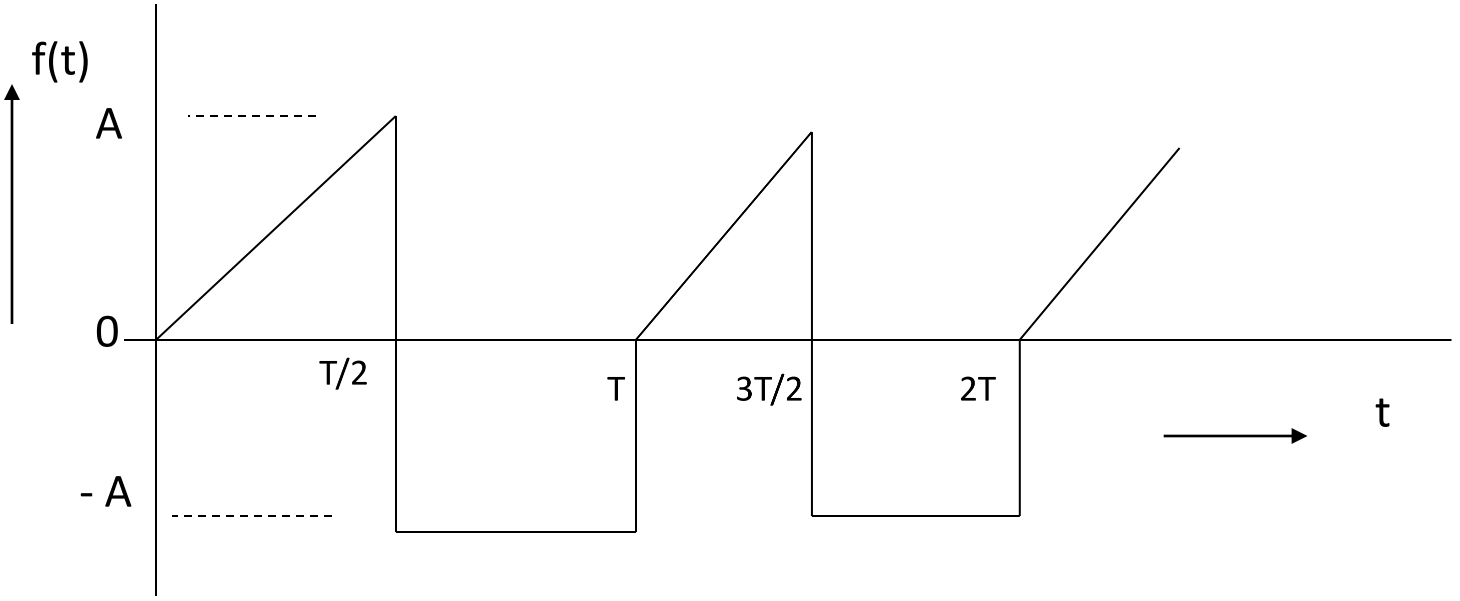
GENERAL DESCRIPTION OF SIGNALS (CONTD)

- **D-C Value** The d-c value (or average value) of a waveform has meaning only when the waveform is periodic . It is the average value of the waveform over one period

$$e_{d-c} = 1/T \int_{0}^{T} e(t)\,dt$$ where T is the period .

The d-c value of the wave form described earlier works out to be - A/4 v.

Ex : find average value of the waveform shown below



AVERAGE VALUE = -A/4

Solution

- $E_{dc} = 1/T \int_{0}^{T} e(t)\, dt$

$$= 1/T \left[\int_{0}^{T/2} (2A/T)\, t\, dt + \int_{T/2}^{T} (-A)\, dt \right.$$

$$= -A/4$$

GENERAL DESCRIPTION OF SIGNALS (CONTD)

- **DUTY CYCLE** The term Duty Cycle , D , is defined as the ratio of the time duration of the POSITIVE CYCLE t_o of a periodic waveform to the period ,T , that is

$$D = \frac{t_o}{T}$$

CREST FACTOR Crest factor is defined as the ratio of the peak voltage(maximum value) of the periodic waveform to the rms value (with the d-c component removed).

Form Factor defined as the ratio of rms value to the average value