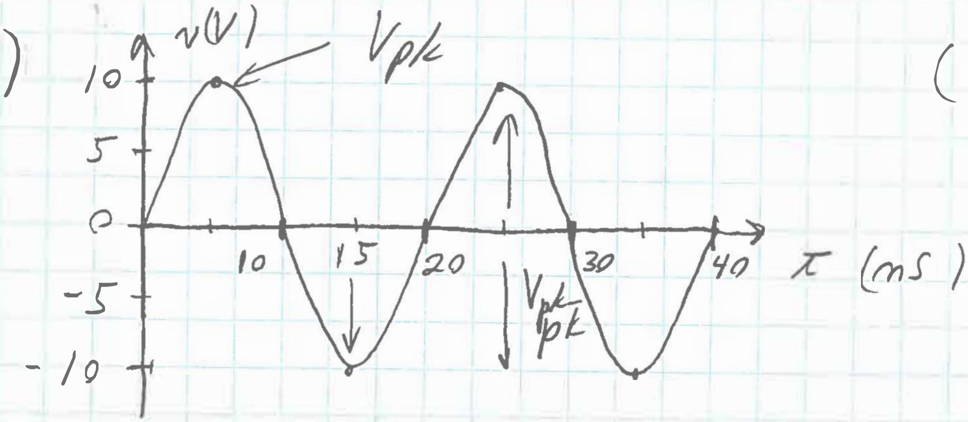
CHAPTER 13 PROBLEMS

(1)



(FIG 13.85)

FIND:

a) PEAK VALUE?

$\boxed{V_{pk} = 10V}$

b) INSTANTANEOUS VALUE ($v(t)$) AT $t = 15$ ms & 20 ms?

@ 15 ms, $v(t) = -10V$

@ 20 ms, $v(t) = 0V$

c) PEAK - PEAK VALUE?

$\boxed{V_{p\text{-}p} = 20V}$

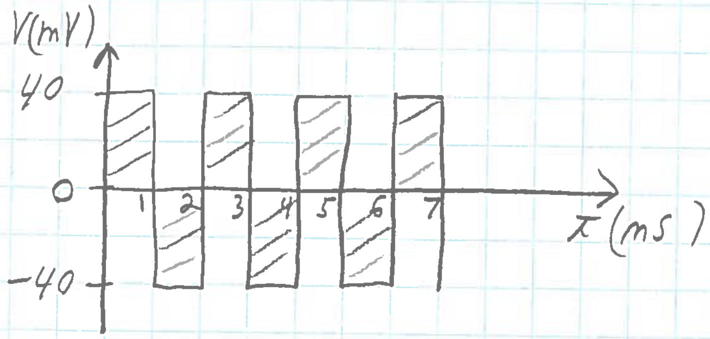
d) PERIOD OF $v(t)$?

$\boxed{T = 20 \text{ ms}}$

e) HOW MANY CYCLES ARE SHOWN?

$\boxed{2}$

(3) FOR THE PERIODIC SQUARE WAVE IN FIG. 13.87:



FIND:

a) $\boxed{V_{pk} = 40\,mV}$

b) INSTANTANEOUS VALUE AT 1.5 ms & 5.1 ms

$$\boxed{\begin{array}{l} @\ t = 1.5\,ms,\ v(t) = -40\,mV \\ @\ t = 5.1\,ms,\ v(t) = -40\,mV \end{array}}$$

c) $V_{pk\text{-}pk} = 40\,mV - (-40\,mV) = \boxed{80\,mV}$

d) THE PERIOD, T

$\boxed{T = 2\,ms}$

e) HOW MANY CYCLES ARE SHOWN?

$\boxed{3\frac{1}{2}}$

(6) FIND THE FREQUENCY OF A REPEATING WAVEFORM WHOSE PERIOD IS:

a) 1 SECOND , $f = 1/T = \frac{1}{1\text{ SEC}} = \boxed{1\text{ HZ}}$

b) $\frac{1}{16}$ SECOND , $f = \frac{1}{T} = \boxed{16\text{ HZ}}$

c) 40 mS , $f = \frac{1}{40\text{ mS}} = \boxed{25\text{ HZ}}$

d) 25 μS , $f = \frac{1}{25\,\mu S} = \boxed{40\text{ kHZ}}$

(8) FIND THE PERIOD OF A SINUSOIDAL WAVEFORM THAT COMPLETES 80 CYCLES IN 24 mS.

$\frac{24\text{ mS}}{80\text{ CYCLES}} = 300\,\mu S/\text{CYCLE}$

OR $\boxed{T = 300\,\mu S}$

(9) WHAT IS THE FREQUENCY OF A PERIODIC WAVEFORM THAT COMPLETES 42 CYCLES IN 6 SECONDS?

$\frac{42\text{ CYCLES}}{6\text{ SECONDS}} = 7\ \frac{\text{CYCLES}}{\text{SECOND}}$ OR $\boxed{f = 7\text{ HZ}}$

(10) FOR THE OSCILLOSCOPE PATTERN OF FIG. 13.89

a) DETERMINE THE PEAK AMPLITUDE

$$V_{pk} = (2.5\,DIV) \cdot \left(\frac{50\,mV}{DIV}\right) = \boxed{125\,mV}$$

b) FIND THE PERIOD

$$T = (3.2\,DIV) \cdot \left(\frac{10\,\mu S}{DIV}\right) = \boxed{32\,\mu S}$$

c) CALCULATE THE FREQUENCY

$$f = \frac{1}{T} = \boxed{31{,}250\,HZ}$$

(12) CONVERT FROM DEGREES TO RADIANS

a) $40° \rightarrow 40°\left(\frac{\pi\,RAD}{180°}\right) = \boxed{\frac{2}{9}\pi \text{ OR } 0.698 \text{ RADIANS}}$

b) $60° \rightarrow 60°\left(\frac{\pi\,RAD}{180°}\right) = \boxed{\pi/3 \text{ RADIANS}}$

c) $135° \rightarrow 135°\left(\frac{\pi\,RAD}{180°}\right) = \boxed{\frac{3}{4}\pi \text{ RADIANS}}$

d) $170° \rightarrow 170°\left(\frac{\pi\,RAD}{180°}\right) = \boxed{\frac{17}{18}\pi \text{ RADIANS}}$

(13) CONVERT FROM RADIANS TO DEGREES

a) $\frac{\pi}{3} \rightarrow \frac{\pi}{3}\left(\frac{180°}{\pi\ \text{RAD}}\right) = \boxed{60°}$

b) $1.2\pi \rightarrow 1.2\pi\left(\frac{180°}{\pi\ \text{RAD}}\right) = \boxed{216°}$

c) $\frac{1}{10}\pi \rightarrow \frac{1}{10}\pi\left(\frac{180°}{\pi\ \text{RAD}}\right) = \boxed{18°}$

d) $0.6\pi \rightarrow 0.6\pi\left(\frac{180°}{\pi\ \text{RAD}}\right) = \boxed{108°}$

(14) FIND THE ANGULAR VELOCITY (ω), GIVEN T =

a) 1.8 Sec, $\omega = \frac{2\pi}{T} = \frac{2\pi}{1.8\ \text{Sec}} = \boxed{\begin{array}{c} 1.11\pi\ \text{RAD/SEC} \\ \text{OR} \\ 3.49\ \text{RAD/SEC} \end{array}}$

b) 0.3 mS, $\omega = \frac{2\pi}{0.3\ \text{mS}} = \boxed{\begin{array}{c} 6.67\pi \times 10^{3}\ \text{RAD/SEC} \\ \text{OR} \\ 20{,}944\ \text{RAD/SEC} \end{array}}$

c) 8 μS, $\omega = \frac{2\pi}{8\ \mu\text{S}} = \boxed{\begin{array}{c} 250\pi \times 10^{3}\ \text{RAD/SEC} \\ \text{OR} \\ 785.4 \times 10^{3}\ \text{RAD/SEC} \end{array}}$

d) 4×10^{-6} Sec, $\omega = \frac{2\pi}{4 \times 10^{-6}\ \text{Sec}} = \boxed{\begin{array}{c} 500{,}000\pi\ \text{RAD/SEC} \\ \text{OR} \\ 1.571 \times 10^{6}\ \text{RAD/SEC} \end{array}}$

(16) FIND THE FREQUENCY + PERIOD OF SINE WAVES HAVING AN ANGULAR VELOCITY OF

a) $W = 754$ RAD/SEC

$$T = \frac{2\pi}{W} = \frac{2\pi}{754\ \text{RAD/SEC}} \cong \boxed{8.33\ \text{mS}}$$

$$f = \frac{1}{T} = \boxed{120\ \text{HZ}}$$

b) $W = 12$ RAD/SEC

$$T = \frac{2\pi}{W} = \frac{2\pi}{12\ \text{RAD/SEC}} = \boxed{\frac{\pi}{6}\ \text{OR}\ 523.6\ \text{mS}}$$

$$f = 1/T = \boxed{1.91\ \text{HZ}}$$

c) 6000 RAD/SEC

$$T = 2\pi/W = \frac{2\pi}{6000\ \text{RAD/SEC}} \cong \boxed{1.047\ \text{mS}}$$

$$f = 1/T = \boxed{954.9\ \text{HZ}}$$

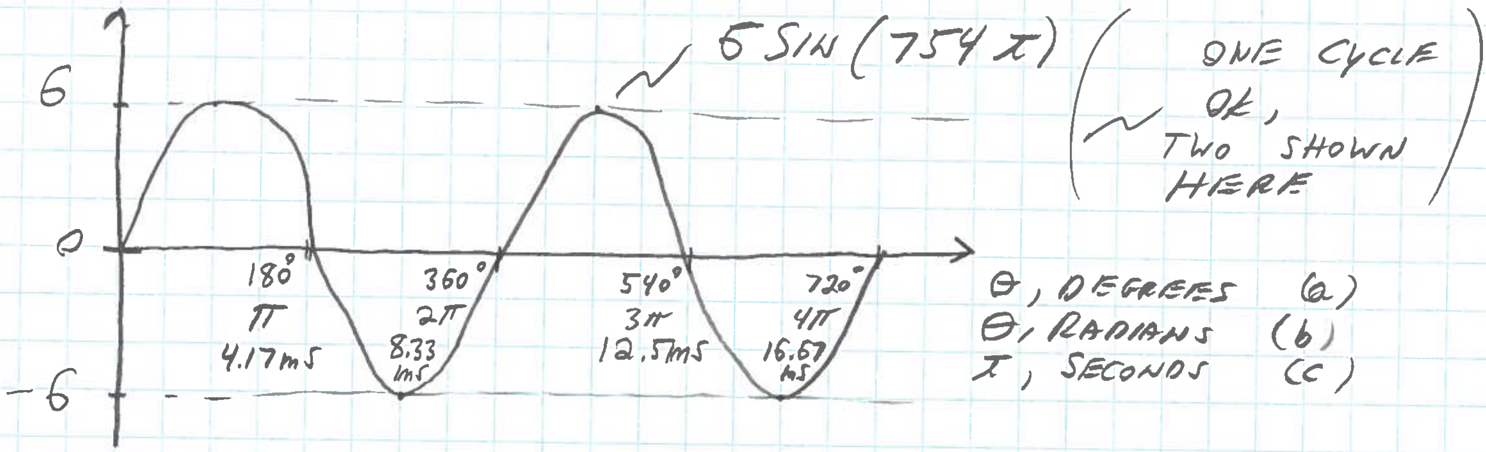
d) 0.16 RAD/SEC

$$T = \frac{2\pi}{W} = \frac{2\pi}{0.16\ \text{RAD/SEC}} \cong \boxed{39.27\ \text{SECONDS}}$$

$$f = \frac{1}{T} = \boxed{25.47\ \text{mHZ}}$$

(20) SKETCH $6 \sin(754\,t)$ WITH THE ABSCISSA

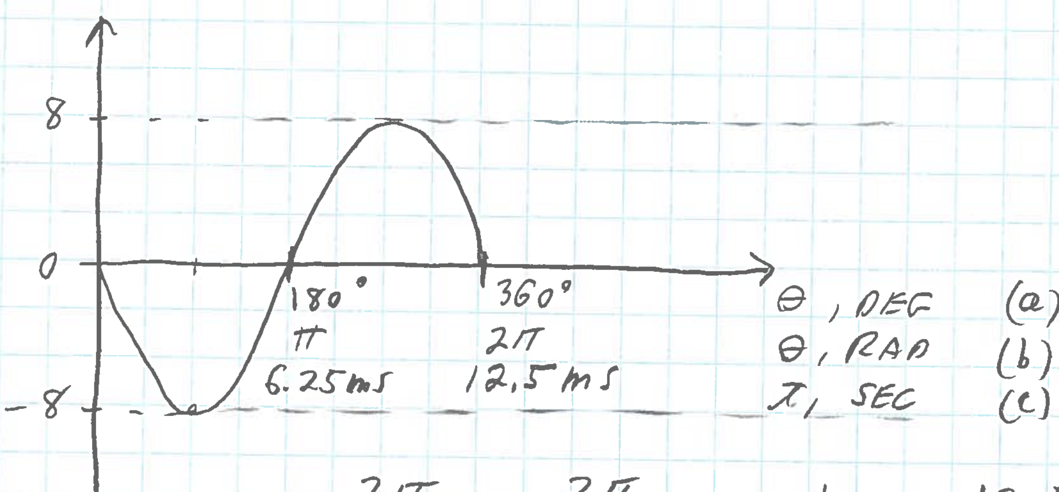
a) ANGLE IN DEGREES
b) " " RADIANS
c) TIME IN SECONDS



$$T = \frac{2\pi}{\omega} \doteq 8.33\ \text{ms}$$

(21) SKETCH $-8 \sin(\overbrace{2\pi\, 80}^{\omega}\, t)$ WITH THE ABSCISSA

a) ANGLE IN DEGREES
b) " " RADIANS
c) " " SECONDS



$$T = \frac{2\pi}{\omega} = \frac{2\pi}{2\pi\, 80} = \frac{1}{80} = 12.5\ \text{ms}$$

(23) GIVEN $i = 0.5 \sin(\alpha)$, FIND i @ $\alpha = 72°$

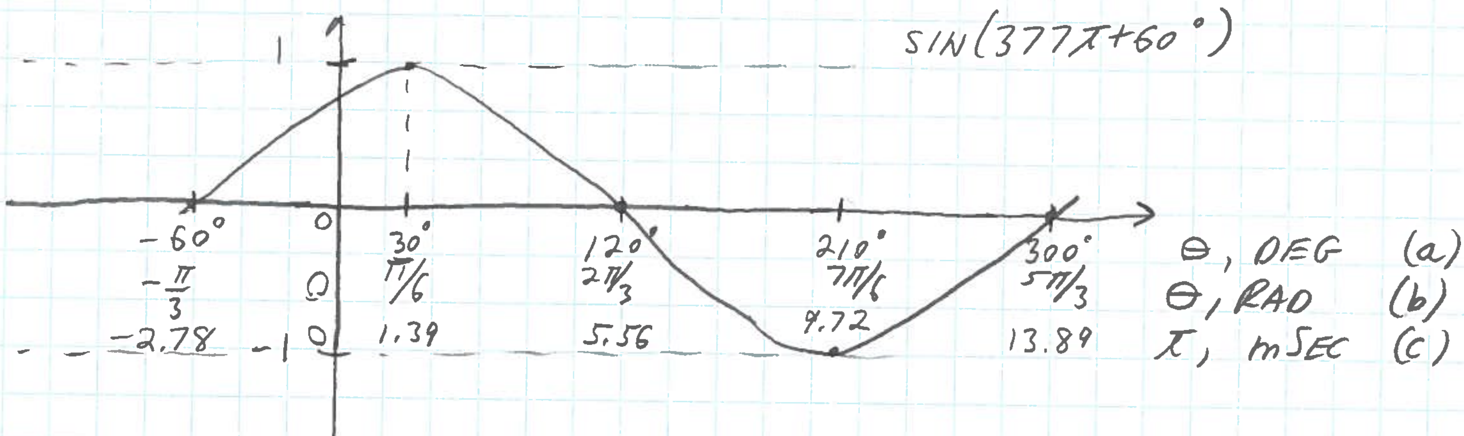
$$i(72°) = 0.5 \sin(72°) = \boxed{0.476}$$

(27) SKETCH $\sin(377t + 60°)$ WITH THE ABSCISSA

a) ANGLE IN DEGREES
b) " " RADIANS
c) TIME IN SECONDS

$\omega = 377\ \text{RAD/SEC}$ $\therefore$ $T = \frac{2\pi}{\omega} = \underline{16.67\ \text{ms}}$

60° PHASE SHIFT OR $\pi/3$ RADIANS



FOR t VALUES: RECALL $\omega = \theta/t$

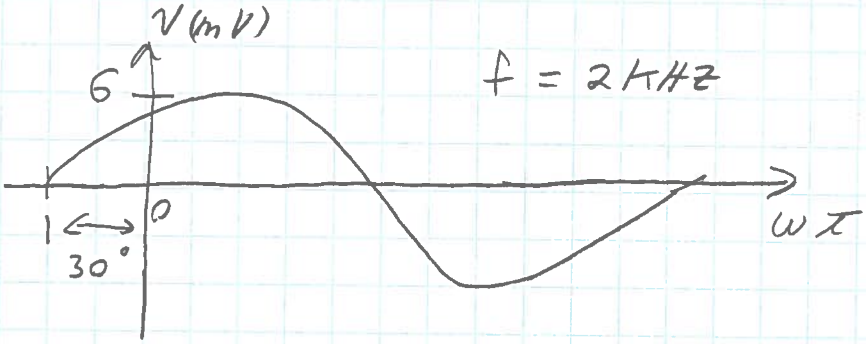
$$\therefore t = \theta/\omega$$

exs) FOR $\theta = 0$, $t = 0/377 = 0$ SEC

FOR $\theta = 7\pi/6$, $t = \frac{7\pi/6}{377} = 9.72$ mS

& SO ON...

(29) WRITE THE ANALYTICAL EXPRESSION WITH θ IN DEGREES. (FIG 13.91)



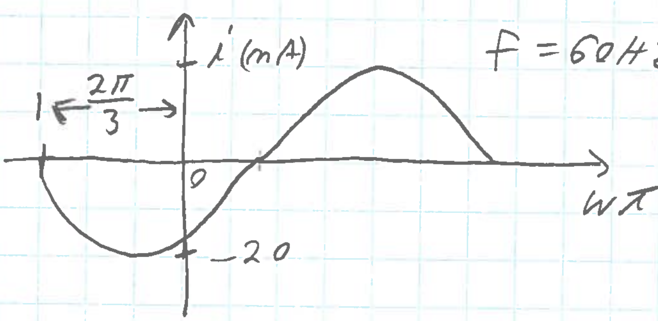
$f = 2\,KHZ$

(a) $6 \sin(\omega t + \theta)$

$\omega = \frac{2\pi}{T}$ OR $2\pi f = 4000\pi$

$\theta = +30°$

$\therefore$ $\boxed{v(t) = 6 \times 10^{-3} \sin(4000\pi t + 30°)\ V}$



$f = 60\,HZ$

(b) $-20 \sin(\omega t + \theta)$

$\omega = 2\pi f = 120\pi$

$\theta = +2\pi/3$ RADIANS OR $120°$

$\therefore$ $i(t) = -20 \times 10^{-3} \sin(120\pi t + 120°)\ A$

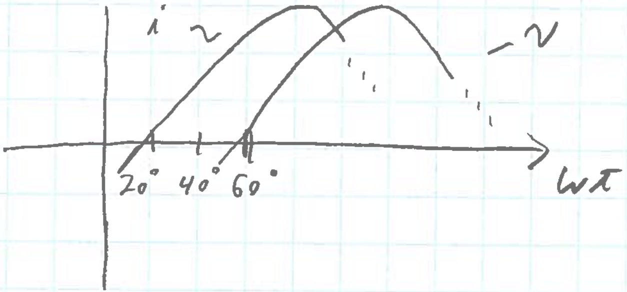
OR

$20 \times 10^{-3} \sin(120\pi t - 60°)\ A$

(34) FIND THE PHASE RELATIONSHIP

$v = 0.2 \sin(\omega t - 60^\circ)$

$i = 0.1 \sin(\omega t - 20^\circ)$



$\boxed{i \text{ LEADS } v \text{ BY } 40^\circ}$

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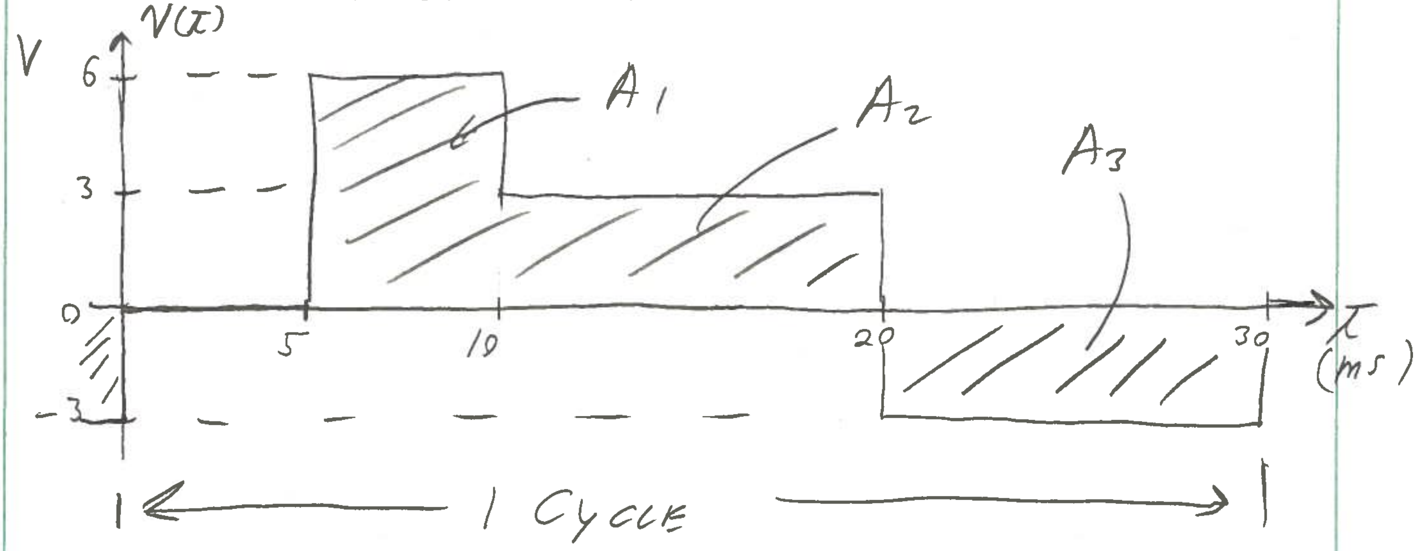
FIND THE AVERAGE VALUE OF



$$\text{AVERAGE VALUE} = \frac{\text{AREA UNDER THE CURVE}}{\text{LENGTH UNDER CURVE}}$$

$A_1 = 6V \times 5ms = 30 V\cdot ms$

$A_2 = 3V \times 10 ms = 30 V\cdot ms$

$A_3 = -3V \times 10 ms = -30 V\cdot ms$

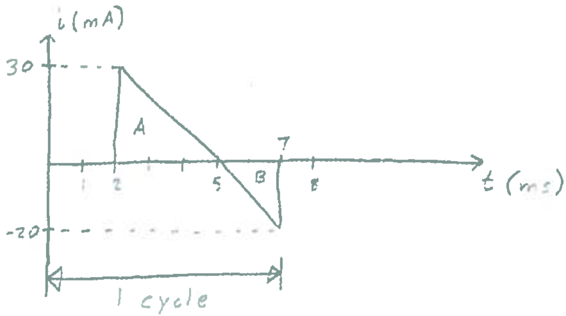
LENGTH = 1 PERIOD = 30 ms

$$\therefore \quad AVE\left(v(t)\right) = \frac{30 V\cdot ms + 30 V\cdot ms + \bar{3}0 V\cdot ms}{30 ms}$$

$$= \frac{30 V\cdot ms}{30 ms} = \boxed{1V}$$

(CH 13)

p (44) Find the average value of the periodic waveform of Fig. 13.101 over one full cycle.



$$f_{avg} = \frac{1}{b-a}\underbrace{\int_a^b f(x)\,dx}_{\text{area of } f(x)} = \frac{A+B}{b-a}$$

$a = 0$
$b = 7$

$A = \frac{1}{2}bh = \frac{1}{2}(5-2)(30) = 45\text{ mA}$ | $B = \frac{1}{2}bh = \frac{1}{2}(7-5)(-20) = -20\text{ mA}$

$$f_{avg} = \frac{A+B}{b-a} = \frac{45\text{mA} - 20\text{ mA}}{7-0} = \frac{25\text{ mA}}{7} \approx \boxed{3.57\text{mA}}$$

(CH13)

P 47 For the waveform in Fig. 13.104:

a) Determine the period

Zero-crossing at vertical axis

Zero-crossing at +2 divisions

$$2 \text{ divisions} \times 0.2 \frac{ms}{div} = \boxed{0.4\ ms = T}$$

b) Find the frequency

$$f = \frac{1}{T} = \frac{1}{0.4ms} = \boxed{2.5\ Hz}$$

c) Determine the average value

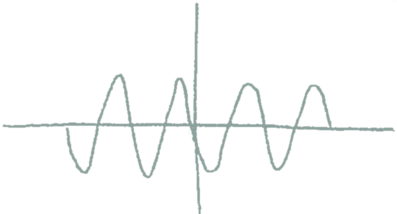
*Recall that a sine-wave function has an average value of 0

This waveform has a vertical offset of -2.5 div, with a vertical sensitivity of 10mV/div, so

$$(-2.5\ div)\left(10\frac{mV}{div}\right) = \boxed{-25\ mV = f_{avg}}$$

d) Sketch the resulting oscilloscope display if the vertical channel is switched from dc to ac.

The vertical offset is the DC component of the signal. Switching to AC-coupling removes this vertical offset.



P13-49

FIND THE RMS VALUE OF

a) $v(t) = 120 \sin(377t + 60^\circ)$ V

b) $i(t) = 6\times10^{-3} \sin(2\pi \cdot 1000 \cdot t)$ A

c) $v(t) = 8\times10^{-6} \sin(2\pi \cdot 5000 \cdot t + 30^\circ)$ V

IN EACH CASE, WE HAVE A SINUSOIDAL VOLTAGE OR CURRENT.

$\therefore$ V_{RMS} OR I_{RMS} = $\frac{V_m}{\sqrt{2}}$ OR $\frac{I_m}{\sqrt{2}}$

a) $V_{RMS} = \frac{V_m}{\sqrt{2}} = \frac{120V}{\sqrt{2}} = \boxed{84.85V}$

b) $I_{RMS} = \frac{I_m}{\sqrt{2}} = \frac{6\times10^{-3}A}{\sqrt{2}} = \boxed{4.24\,mA}$

c) $V_{RMS} = \frac{V_m}{\sqrt{2}} = \frac{8\times10^{-6}V}{\sqrt{2}} = \boxed{5.66\,\mu V}$

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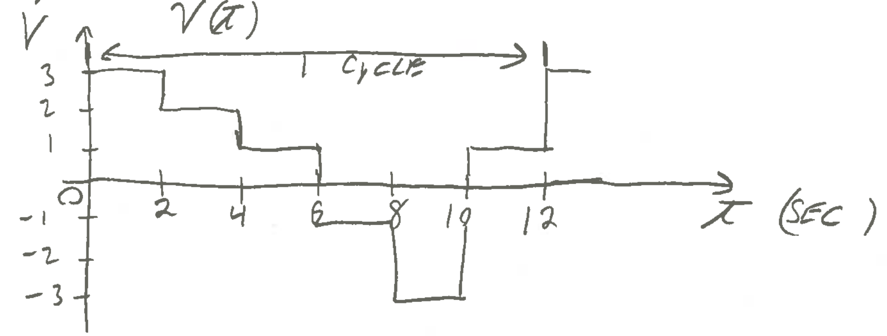
FIND THE RMS VALUE OVER ONE FULL CYCLE :



V_{RMS} → FIND $(v(t))^2$ ← S

→ FIND THE MEAN OF $(v(t))^2$ ← M

→ TAKE THE SQUARE ROOT ← R

$$V_{RMS} = \sqrt{\frac{AREA\,(v(t))^2}{T}}$$

$$= \sqrt{(9V^2)(2\,SEC) + (4V^2)(2\,SEC) + (1V^2)(2\,SEC) + (1V^2)(2\,SEC) + (9V^2)(2\,SEC) + (1V^2)(2\,SEC)}$$

$$= \sqrt{\frac{18V^2SEC + 8V^2SEC + 2V^2SEC + 2V^2SEC + 18V^2SEC + 2V^2SEC}{12\,SEC}}$$

$$= \sqrt{\frac{50\,V^2\cdot SEC}{12\,SEC}}$$

$$V_{RMS} = \sqrt{4.167V^2} = \boxed{2.04V}$$

(CH13)

(P54) For each waveform in Fig. 13.109, determine the period, frequency, average value, and rms value.

Fig a)

a) $T = (4\ \text{div})(10\ \frac{\mu s}{\text{div}}) = \boxed{40\ \mu s}$

b) $f = \frac{1}{T} = \frac{1}{40\ \mu s} = \boxed{25\ kHz}$

c) $V_{max} = (3\ \text{div})(20\ \frac{mV}{\text{div}}) = 60\ mV$

$V_{pp} = (4\ \text{div})(20\ \frac{mV}{\text{div}}) = 80\ mV$

$f_{avg} = V_{max} - \frac{V_{pp}}{2} = 60\ mV - \frac{80\ mV}{2}$

$= \boxed{20\ mV}$

d) $V_{rms} = \sqrt{(f_{avg})^2 + \frac{(V_p)^2}{2}} = \sqrt{(20\ mV)^2 + \frac{(40\ mV)^2}{2}} = \boxed{34.64\ mV}$

Fig b)

a) $T = (2\ \text{div})(50\ \frac{\mu s}{\text{div}}) = \boxed{100\ \mu s}$

b) $f = \frac{1}{T} = \frac{1}{100\ \mu s} = \boxed{10\ kHz}$

c) $V_{max} = 0\ V$

$V_{pp} = (3\ \text{div})(0.2\ \frac{V}{\text{div}}) = 0.6\ V$

$f_{avg} = V_{max} - \frac{V_{pp}}{2} =$

$0 - \frac{0.6\ V}{2} = \boxed{-0.3\ V}$

d) $V_{rms} = \sqrt{(f_{avg})^2 + \frac{(V_p)^2}{2}} = \sqrt{(-0.3\ V)^2 + \frac{(0.3\ V)^2}{2}} = \boxed{367.42\ mV}$