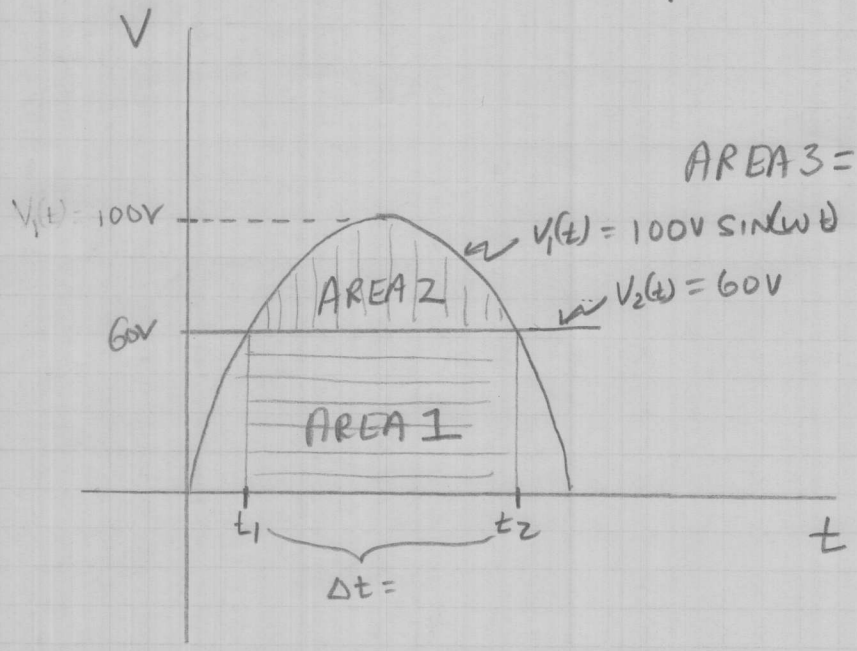
example 21-1 [CALCULATION of RMS Value of periodic waveform]



AREA 3 = AREA 1 + AREA 2

$\omega = 2\pi f = 120\pi = 377$

$V_1(t) = 100 \sin(\omega t) = 100 \sin(377t)$

$t_1 = \frac{1}{377} \sin^{-1}(0.6) = 1.707\,mS$

$t_2 = 8.33\,mS - 1.707\,mS = 6.626\,mS$

$\Delta t = t_2 - t_1 = 6.626\,mS - 1.707\,mS = 4.9195\,mS$

$AREA\,1 = (60V)(4.9195\,mS) = 0.29517\,V \cdot S$

$$Area3 = V_{RMS} * \Delta t$$

$$V_{RMS} = \sqrt{\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} f(t)^2 \, dt}$$

$2w = 2(377) = 754$

$f(t) = 100 \sin(377t)$

$f^2(t) = 10^4 \sin^2(377t)$

From List of Integral of Trig Functions

$$\int \sin^2 ax \, dx = \left[\frac{x}{2} - \frac{1}{4a}\sin(2ax)\right] = \left[\frac{x}{2} - \frac{1}{2a}\sin(ax)\cos(ax)\right]$$

$$V_{RMS} = \sqrt{\left(\frac{10^4}{4.9ms}\right) \int_{t_1}^{t_2} \sin^2(377t) \, dt}$$

$$= \sqrt{\left(\frac{10^4}{4.9ms}\right)\left[\left(\frac{t_2}{2} - \frac{1}{754}\sin(377t_2)\cos(377t_2)\right) - \left(\frac{t_1}{2} - \frac{1}{754}\sin(377t_1)\cos(377t_1)\right)\right]}$$

$t_2 = 6.1626ms$ $\quad$ $t_1 = 1.707ms$

$$= \sqrt{\left(\frac{10^4}{4.9ms}\right)\left[(0.003313 + 0.0006366) - (0.0008535 - 0.0006366)\right]}$$

2.03×10^6 $\quad$ $0.0039496 - 0.0002169$ $\quad$ 0.0037327

$$= \sqrt{(2.03 \times 10^6)(0.0037327)} = \sqrt{7587.6} = 87.1V$$

$Area3 = V_{RMS} * \Delta t = 87.1V * 4.9195ms = 0.4285 V \cdot s$

Area 2 = Area 3 − Area 1

Area 2 = 0.4285 V·S − 0.29517 V·S

Area 2 = 0.1333 V·S

$$I_{max} = \frac{\text{Area 2}}{L} = \frac{0.1333\ V \cdot S}{3.3\ mH} = \boxed{40A}$$

$\int V_L\,dt = L \int I\,dt$

$\text{Area } \Delta = LI$