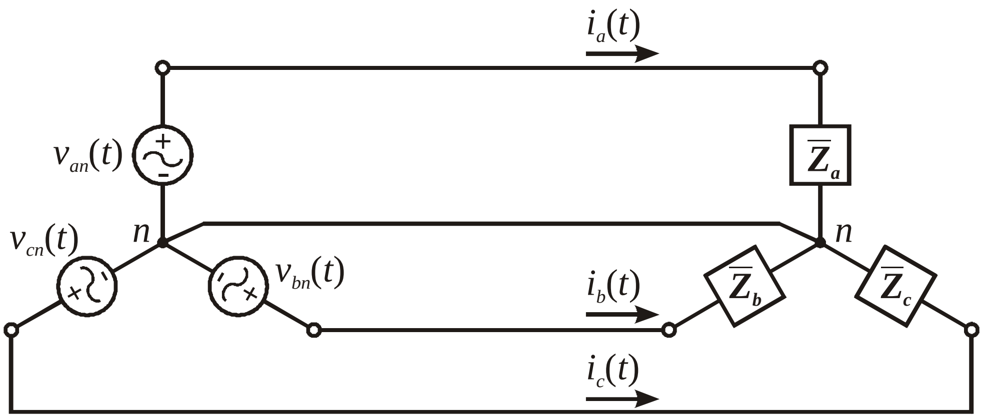
Three-phase unbalanced Wye-load power example



Define some constants for the source & load.

$V := 120 \quad V_{rms}$ $\qquad Za := 20 \ \Omega \qquad \theta a := 20 \cdot \frac{\pi}{180}$

$Zb := 15 \ \Omega \qquad \theta b := 15 \cdot \frac{\pi}{180} \qquad Zc := 25 \ \Omega \qquad \theta c := -25 \cdot \frac{\pi}{180}$

$Ia := \frac{V}{Za} \qquad Ib := \frac{V}{Zb} \qquad Ic := \frac{V}{Zc}$

$Ia = 6 \quad A_{rms} \qquad Ib = 8 \quad A_{rms} \qquad Ic = 4.8 \quad A_{rms}$

$n := 0 .. 200 \qquad wt_n := n \cdot \frac{2 \cdot \pi}{180}$

Define phase voltages and currents.

$van_n := \sqrt{2} \cdot V \cdot \cos(wt_n) \qquad ia_n := \sqrt{2} \cdot Ia \cdot \cos(wt_n - \theta a)$

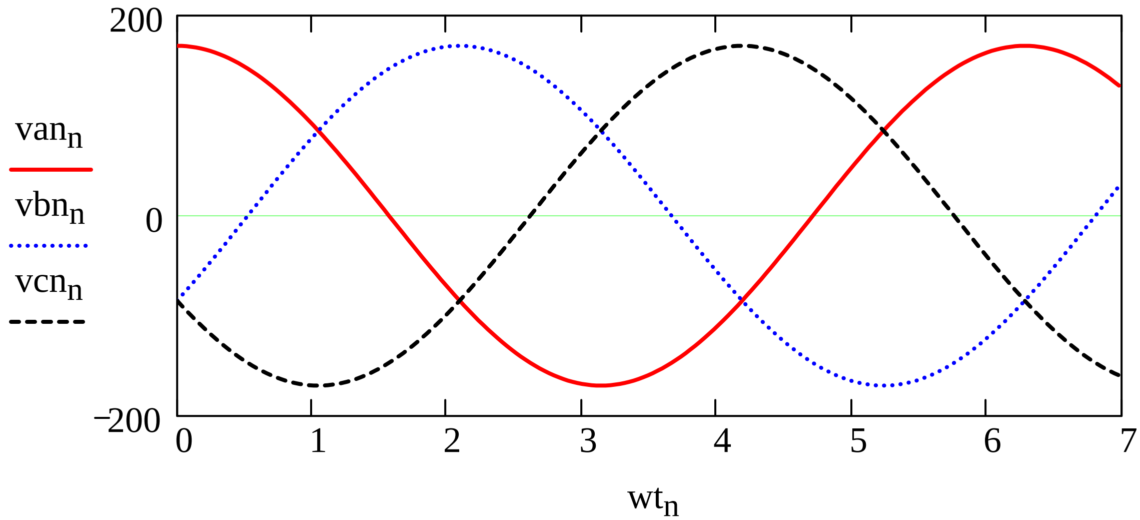
$vbn_n := \sqrt{2} \cdot V \cdot \cos\left(wt_n - 120 \frac{\pi}{180}\right) \qquad ib_n := \sqrt{2} \cdot Ib \cdot \cos\left(wt_n - 120 \frac{\pi}{180} - \theta b\right)$

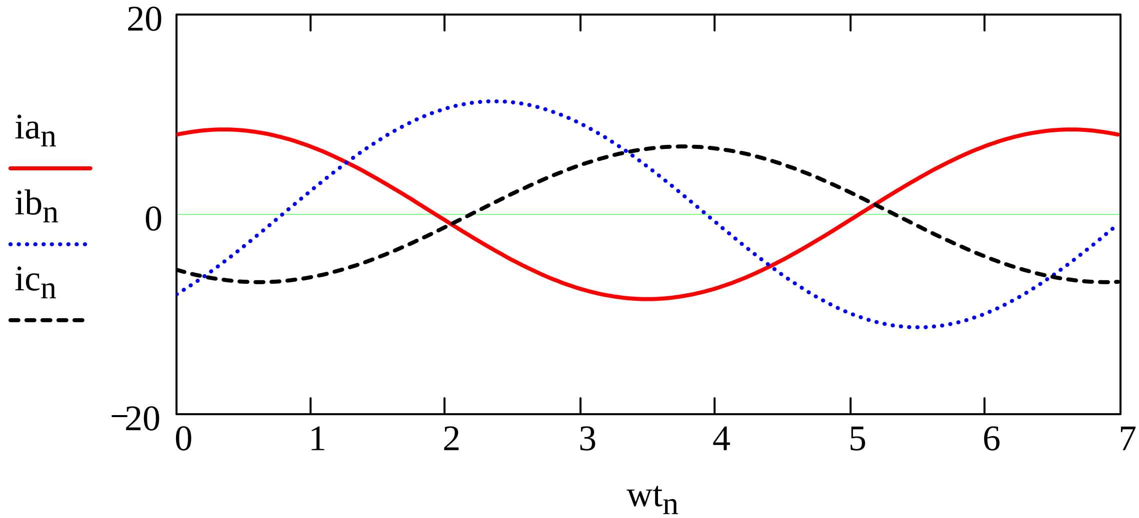
$vcn_n := \sqrt{2} \cdot V \cdot \cos\left(wt_n - 240 \frac{\pi}{180}\right) \qquad ic_n := \sqrt{2} \cdot Ic \cdot \cos\left(wt_n - 240 \frac{\pi}{180} - \theta c\right)$

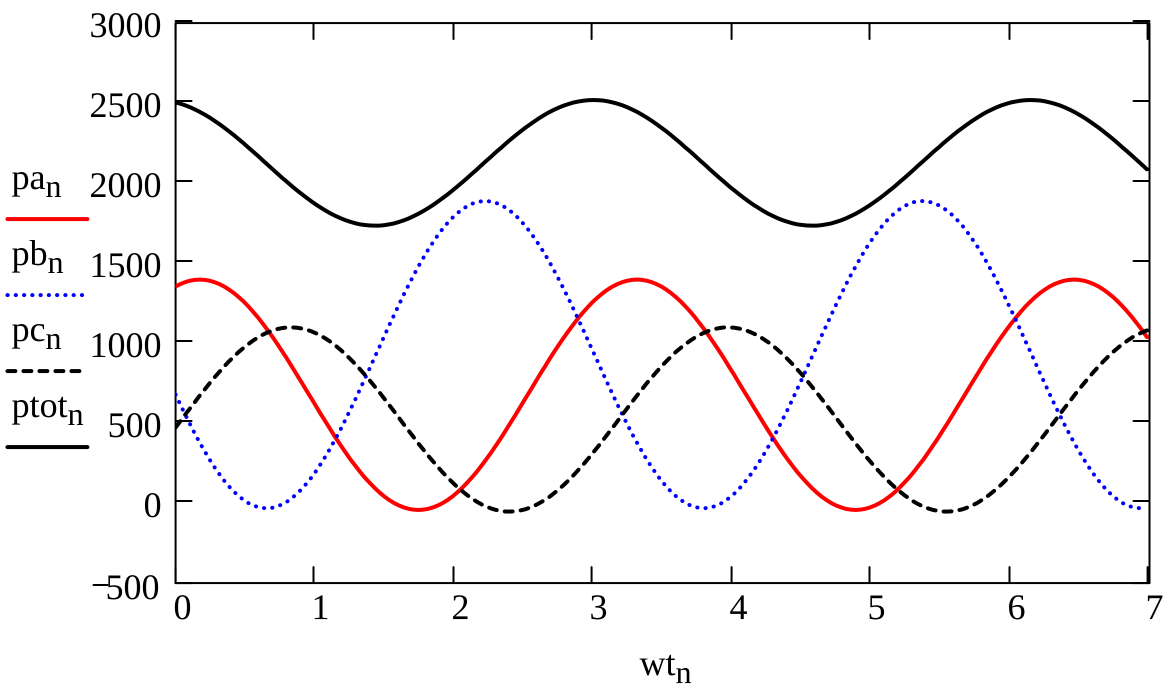
Calculate instantaneous power to each phase.

$pa_n := van_n \, ia_n \qquad pb_n := vbn_n \, ib_n \qquad pc_n := vcn_n \, ic_n \qquad ptot_n := pa_n + pb_n + pc_n$

3_phase_unbalanced_wye_load.mc







Calculate apparent power S to each phase.

$Sa := V \cdot Ia$ $Sa = 720$ VA

$Sb := V \cdot Ib$ $Sb = 960$ VA

$Sc := V \cdot Ic$ $Sc = 576$ VA

$Stot := Sa + Sb + Sc$ $Stot = 2256$ VA

Calculate time-ave real power P to each phase.

$Pa := V \cdot Ia \cdot \cos(\theta a)$ $Pa = 676.579$ W

$Pb := V \cdot Ib \cdot \cos(\theta b)$ $Pb = 927.289$ W

$Pc := V \cdot Ic \cdot \cos(\theta c)$ $Pc = 522.033$ W

$Ptot := Pa + Pb + Pc$ $Ptot = 2125.9$ W

Calculate reactive power Q to each phase.

$Qa := V \cdot Ia \cdot \sin(\theta a)$ $Qa = 246.255$ VAR

$Qb := V \cdot Ib \cdot \sin(\theta b)$ $Qb = 248.466$ VAR

$Qc := V \cdot Ic \cdot \sin(\theta c)$ $Qc = -243.428$ VAR

$Qtot := Qa + Qb + Qc$ $Qtot = 251.293$ VAR

Calculate power factor (pf) for each phase.

$pf\_a := \cos(\theta a)$ $pf\_a = 0.9397$ lagging since $Q_a > 0$ & $\theta_a > 0$

$pf\_b := \cos(\theta b)$ $pf\_b = 0.9659$ lagging since $Q_b > 0$ & $\theta_b > 0$

$pf\_c := \cos(\theta c)$ $pf\_c = 0.9063$ leading since $Q_c < 0$ & $\theta_c < 0$

$pf\_tot := \frac{Ptot}{Stot}$ $pf\_tot = 0.9423$ lagging since $Q_{tot} < 0$

Not typically done as pf most important on per phase basis.