3 diodes only

3pt / 3ϕ rectifer

is analagous to

1pt / 1ϕ rectifer

full wave 1ϕ

$0.9\ E_s$

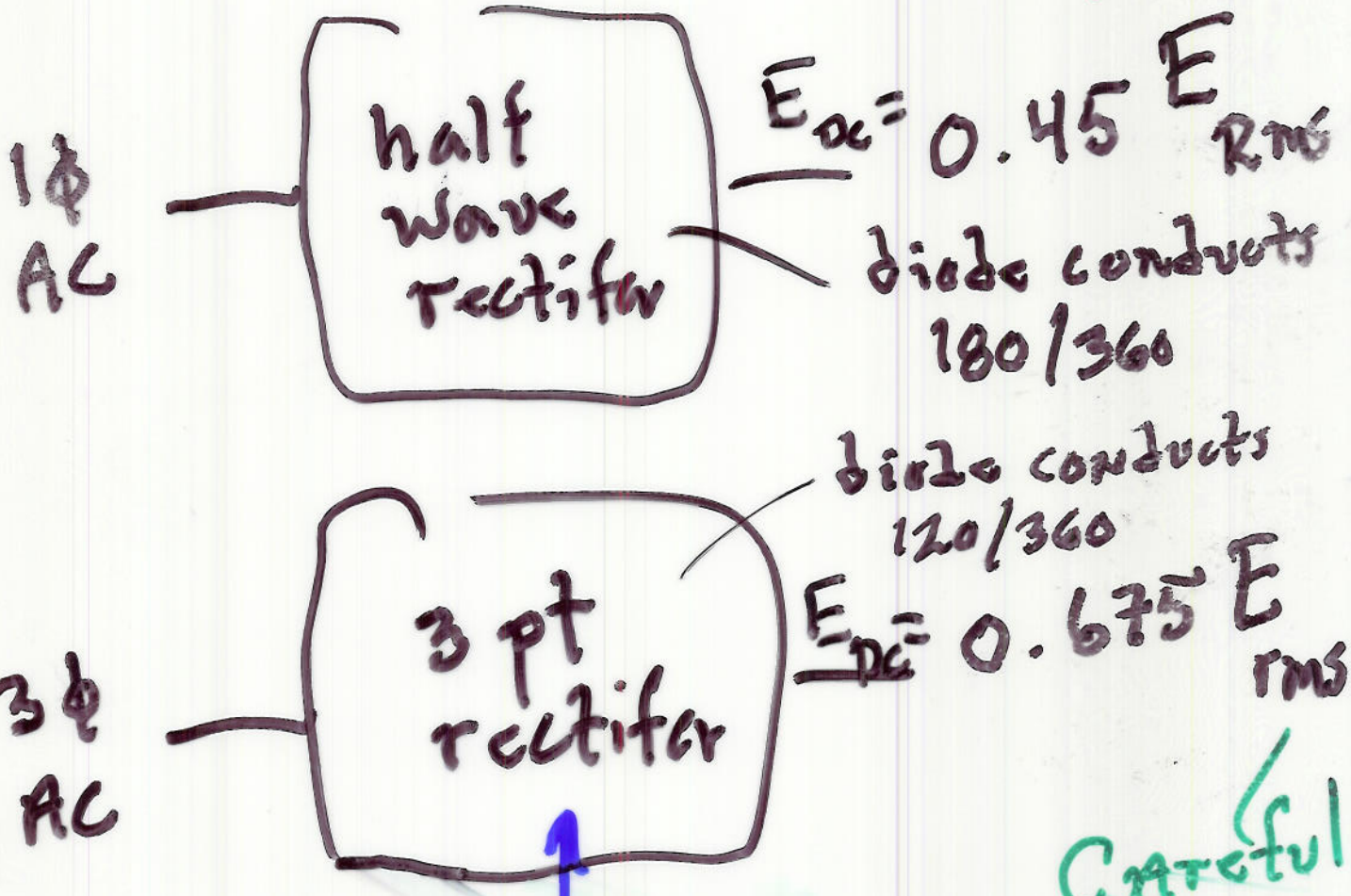
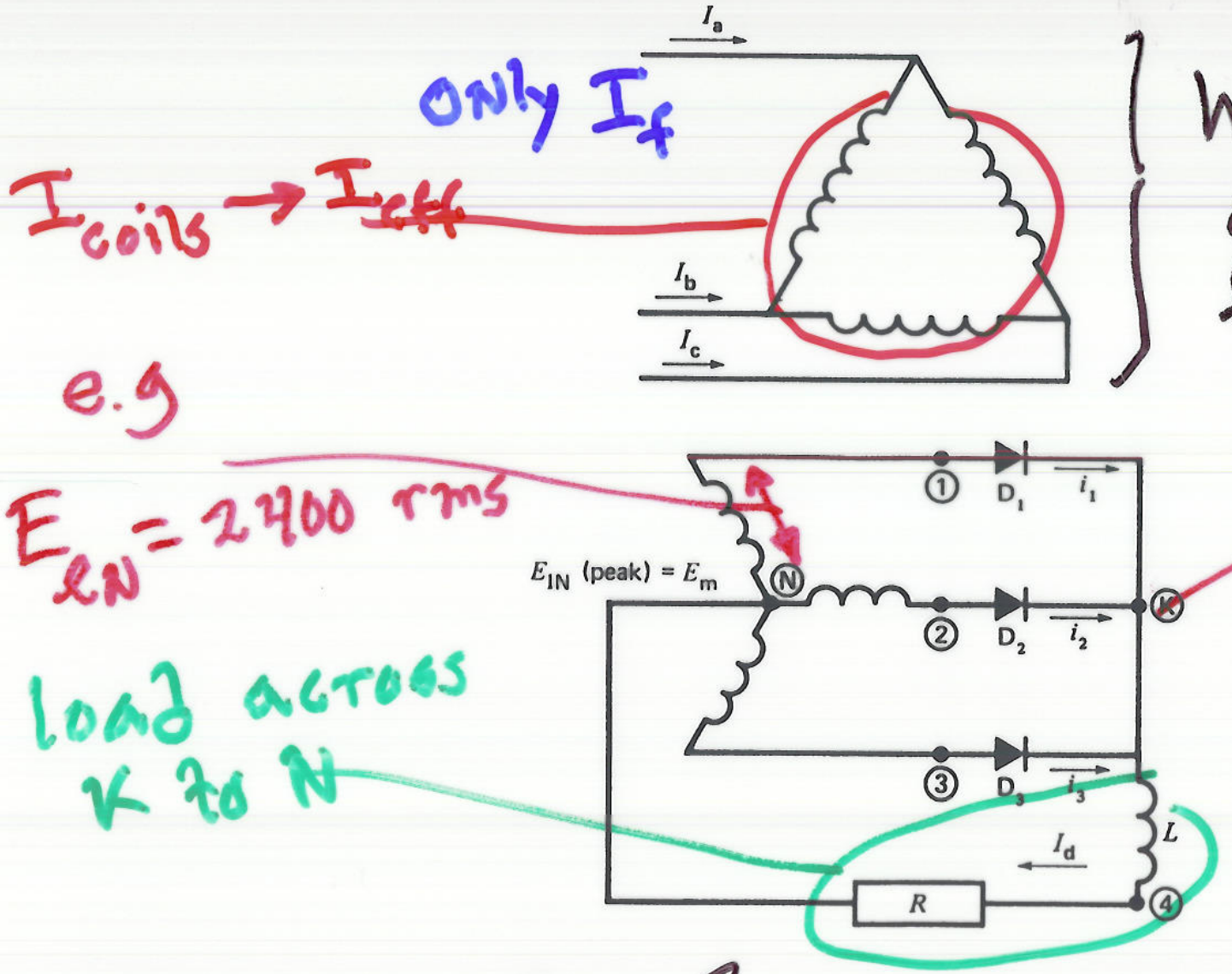


Figure 21-16 Three-phase, 3-pulse rectifier with inductive filter fed by a 3-phase transformer.



ONLY I_f

$I_{coils} \rightarrow I_{eff}$

Why use Δ on the line for rectifier?

e.g

$E_{LN} = 2400$ rms

load across K to N

E_{out} is or'ed E_{LN}

$E_{LL} = \sqrt{3}\, E_{LN}$

$E_{DC} = ?$

$I_{diode} = ?$ if $I_R = 600$ A

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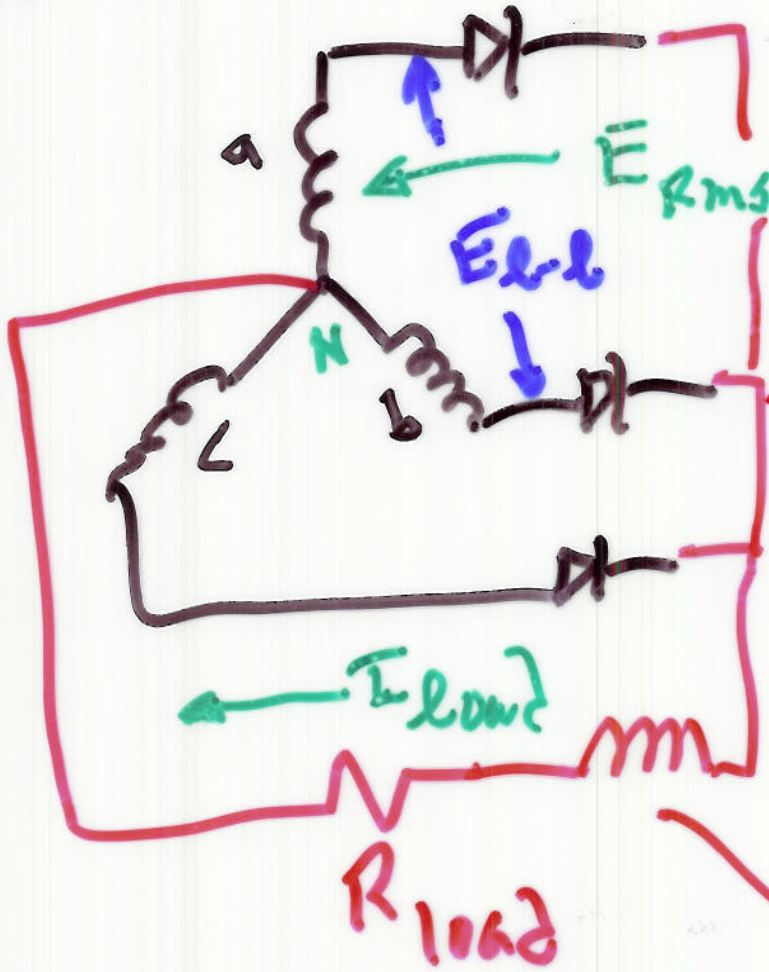
Load is between LINE & NEUTRAL

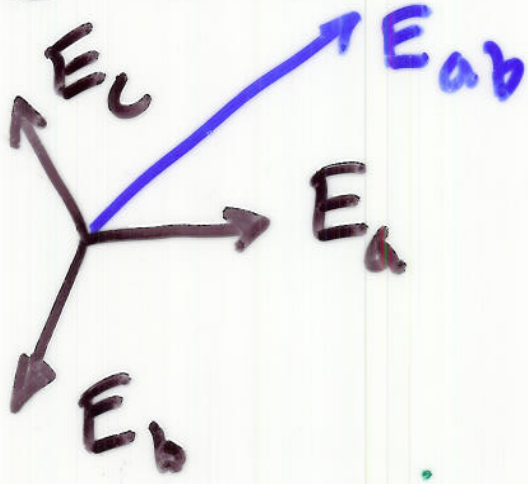


"Key" "Large" L ⇒ i is a □-wave

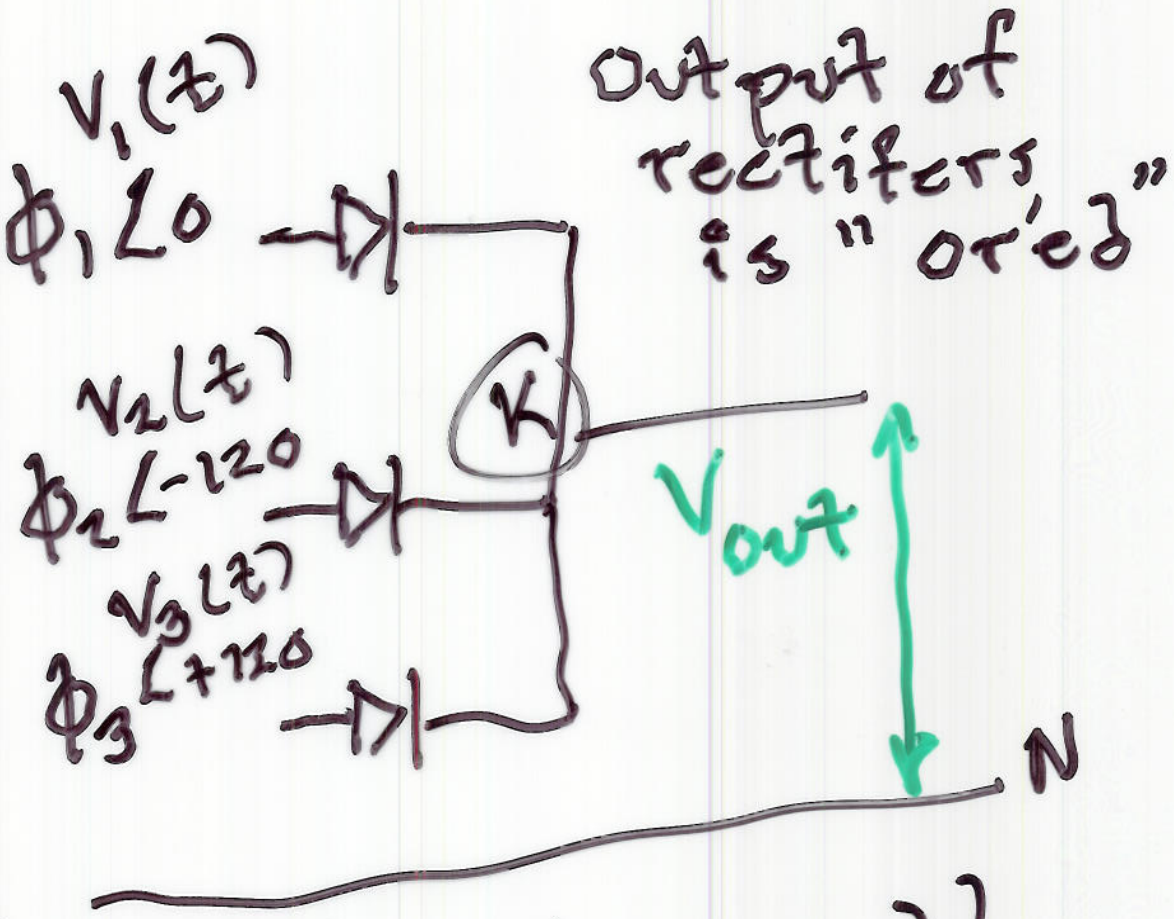
$E_{ll} = \sqrt{3}\, E_{l-N}$

use for

Diode P.I.V. = ?



Each diode peak $i = I_{DC} = I_{load}$ } But $I_{AV(diode)} = I_L/3$



Output of rectifiers is "or'd"

$V(60^\circ)$ → $\frac{V_{max}\ (sinusoid)}{2}$

Recall

With 3 phases the "OR" One phase dominates for only 120° Circuit changes

$-60 \rightarrow 60^\circ$ $V_0 = V_1(t)$ largest @ K

$60 \rightarrow 180$ $V_0 = V_2(t)$ "

$180 \rightarrow 300$ $V_0 = V_3(t)$ "

Summary 3 Point

(1) Every 120° diode conduction changes due to

Phase 1 largest $|V_{in}|$ $-60 \rightarrow +$

$\Rightarrow$ diode 1 ON D_2 off D_3

Phase 2 largest $|V_{in}|$ $+60 \rightarrow +120$

$\Rightarrow$ diode 2 ON D_1 off D_3

(2) i_{diode}^{AV} ON $\left(\frac{120}{360}\right) = \frac{1}{3}$ time on $\frac{2}{3}$ off

(3) $\Rightarrow$ i_{coil} (transformer) $\approx$

$\frac{1}{3}$ ON $\frac{2}{3}$ off

3Φ ½ wave rectifier

3 point rectifier

$E_{DC}(\text{eff}) = 0.675\, E_{rms}$

Minimum Voltage:

$\Delta E_{L-R} = \frac{E_{pk}}{2}$

3 half waves of

$E_m - \frac{E_m}{2} = \frac{E_m}{2}$

$E_{pk} - \frac{E_{pk}}{2} = \frac{E_{pk}}{2}$

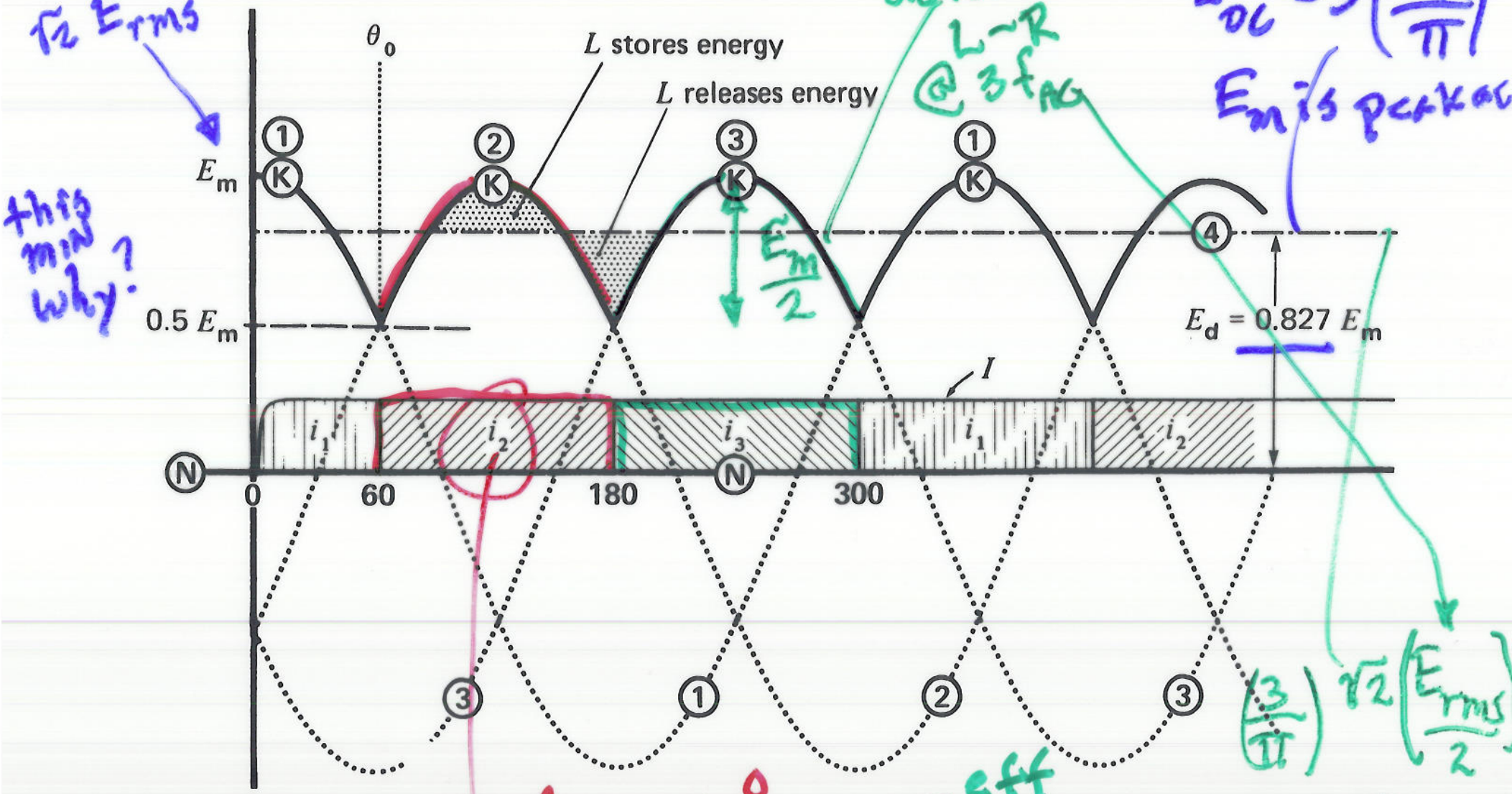
$$E_{AV}^{3pt} = 3\left(\frac{\frac{E_{pk}}{2}}{\pi}\right) = \frac{3E_{pk}}{2\pi} = \frac{3\sqrt{2}\,E_{rms}}{2\pi}$$

$$E_{AV}^{3pt} = \underbrace{\frac{3}{\sqrt{2}}\left(\frac{1}{\pi}\right)}_{.675} E_{rms}^{L-L} \quad \text{or} \quad (.675)$$

E_{AV}^{6pt} (full wave rectifier) = ? guess

Longer term

Figure 21-17 Voltage and current waveforms in a 3-phase, 3-pulse rectifier.



Voltage across L~R @ $3f_{AC}$

$E_{DC} = 3\left(\frac{E_m}{\pi}\right)$

E_m is peak ac

$\sqrt{2}\,E_{rms}$

this min why?

$\left(\frac{3}{\pi}\right)\sqrt{2}\left(\frac{E_{rms}}{2}\right)$

ON for 120°

$E_{DC}^{eff} \cong 0.675\,E_{rms}$

Reality check: $0.827 = 0.675\sqrt{2}$

Theodore Wildi
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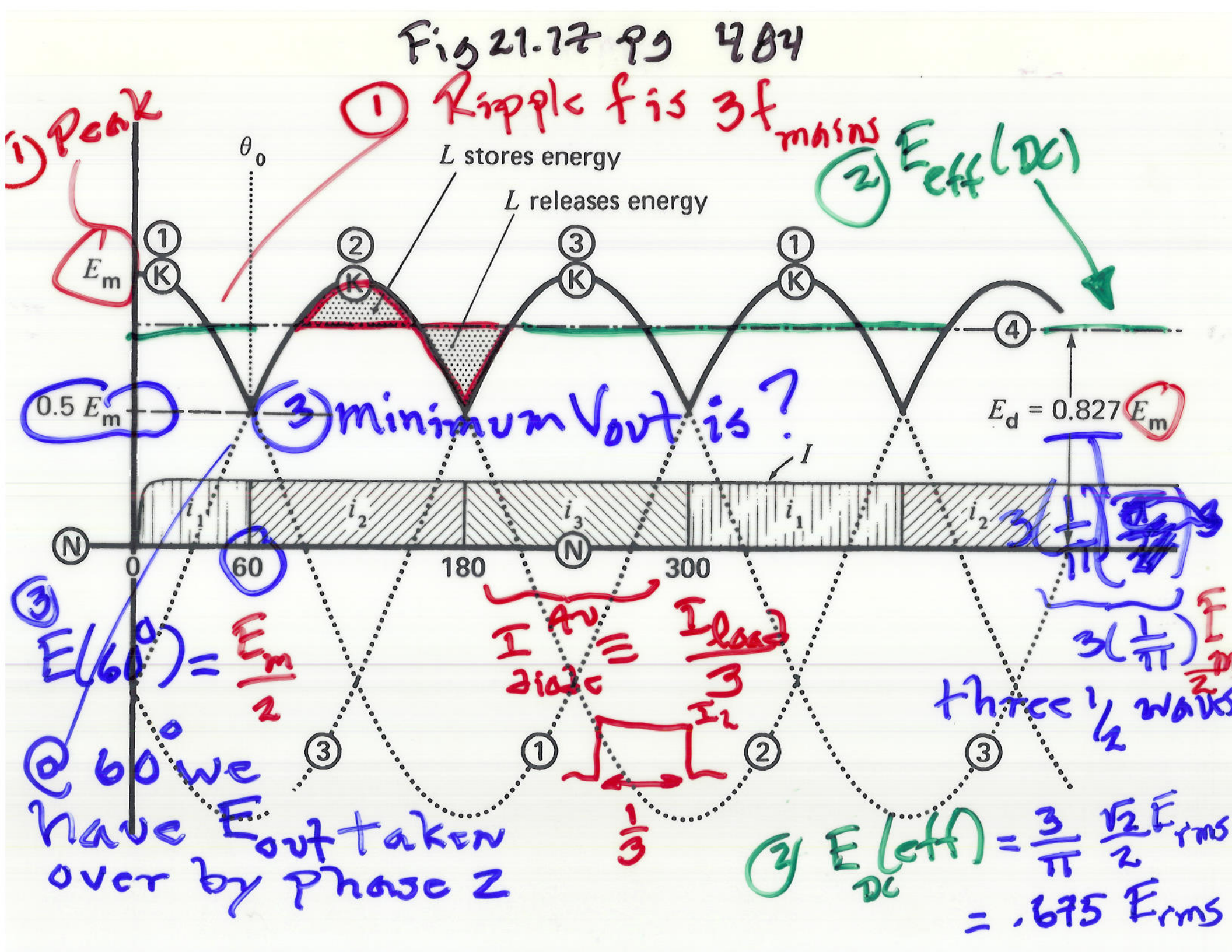

1) Peak

① Ripple f is $3f_{mains}$

② $E_{eff(DC)}$

③ Minimum Vout is ?

③ $E(60^\circ) = \frac{E_m}{2}$

@ 60° we have E_{out} taken over by Phase 2

$I_{AV\,diode} \equiv \frac{I_{load}}{3}$

$\frac{1}{3}$

three ½ waves

$3\left(\frac{1}{\pi}\right)\frac{E_m}{2}$

③ $E_{DC(eff)} = \frac{3}{\pi}\frac{\sqrt{2}}{2}E_{rms}$

$= .675\,E_{rms}$