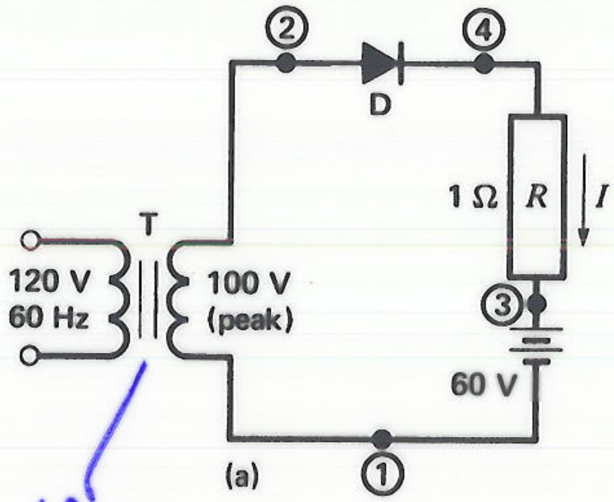
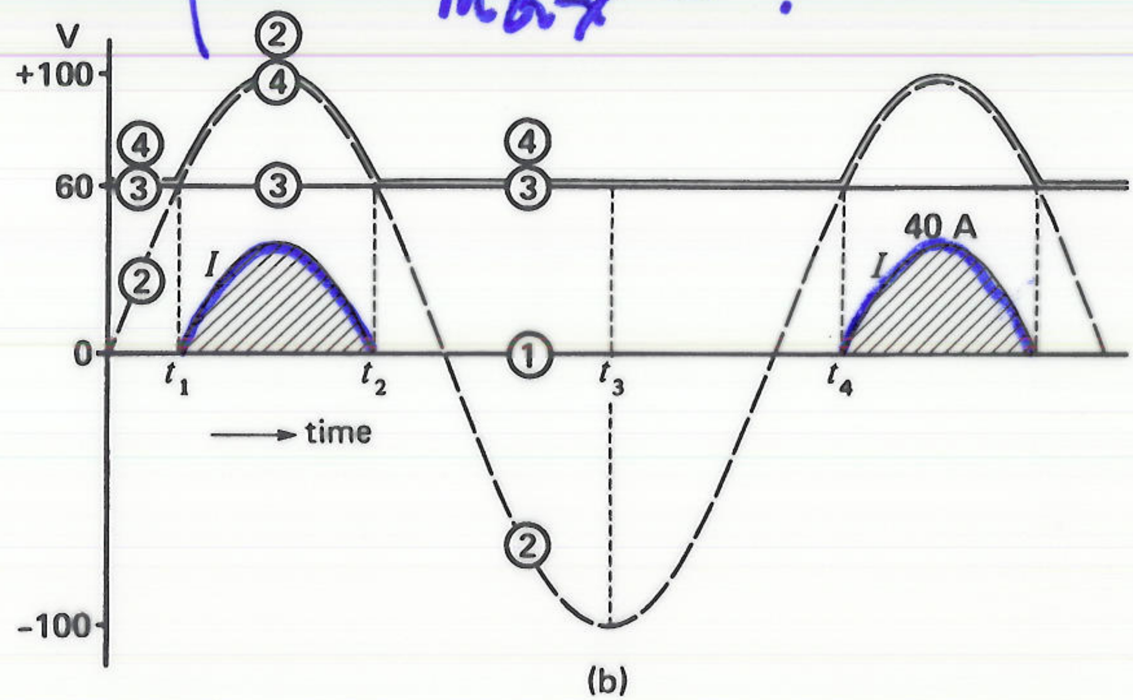
Figure 21-11 a. Simple battery charger circuit. b. Corresponding voltage and current waveforms.

diode limits i_R

$i_{max} = ?$



step down



Any losses to charge battery? $I_{Rms}^2 R$

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① What is the P.F. below high or low

① Fig 21.11
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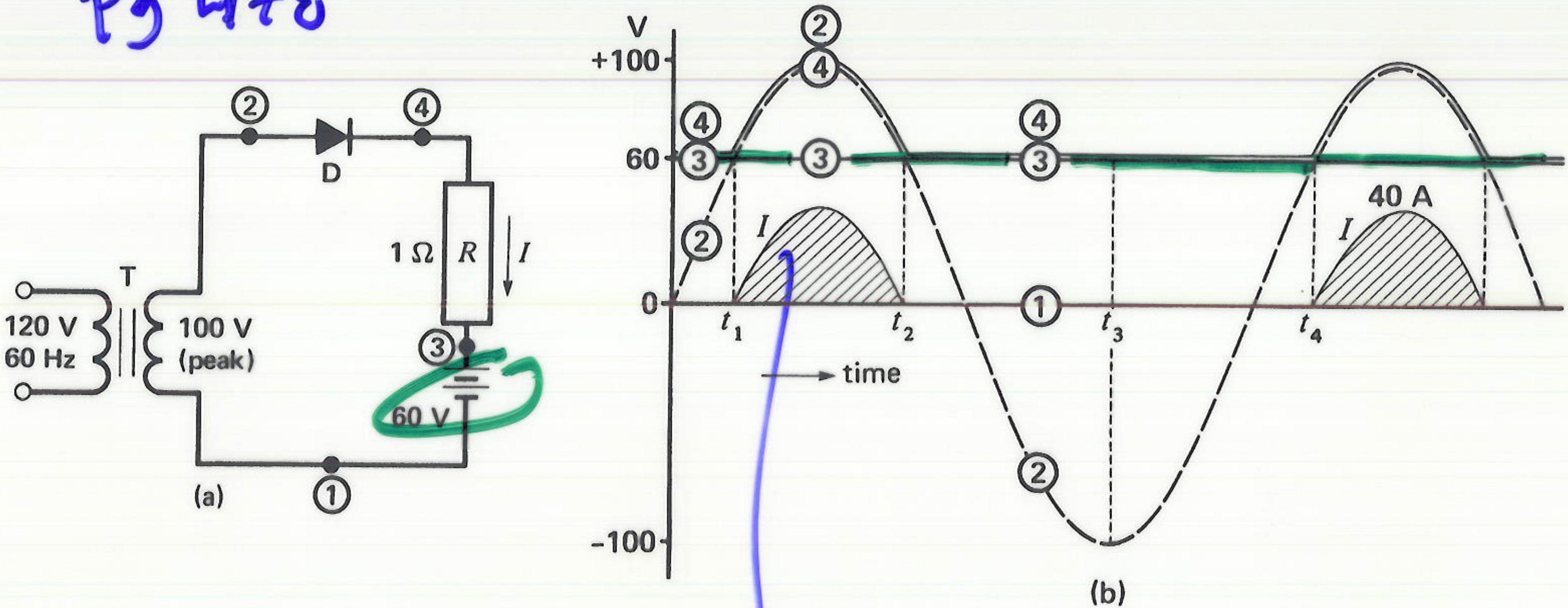


I follows V if?

② What can we add to increase P.F. that has no real power loss?

V_{AC}

V_{DC}

When $V_{AC} > V_{DC}$

di/dt up

When $V_{AC} < V_{DC}$

di/dt down

$$i_L(t) = \frac{\int V_L(t)\,dt}{L}$$ Volt-sec

Assumes $L \neq f(i_L)$ No saturation

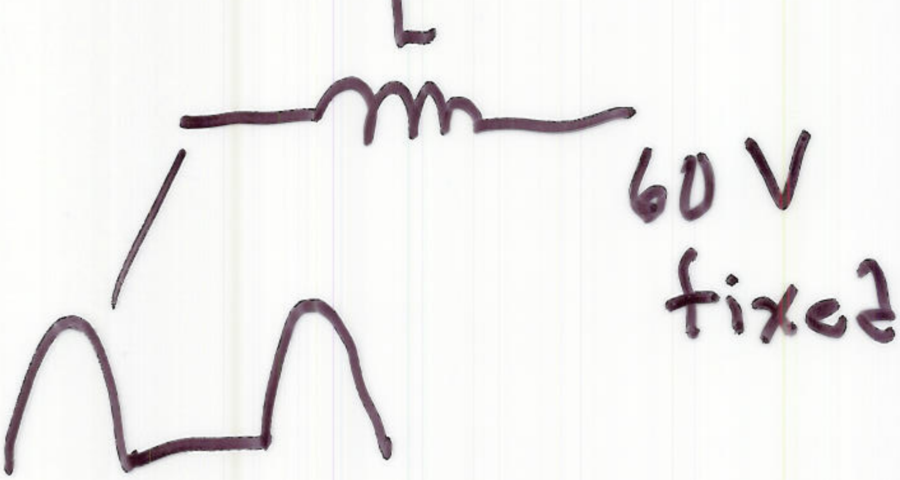
$\int V_L(t)\,dt$ just area

$i_L(t)$ will be stretched out compared to $i_R(t)$

Replace D-R (lossy)
with
D-L $\left(\begin{matrix}\text{ideal}\\ \text{lossless}\end{matrix}\right)$

ideally L has no losses

$\frac{e_L}{L}dt \Rightarrow$ i (charge) changes are slow



$\Delta V_L(t) = ?$

$i_L(t) = ?$

Figure 21-12 a. Battery charger using a series inductor. b. Corresponding voltage and current waveforms.

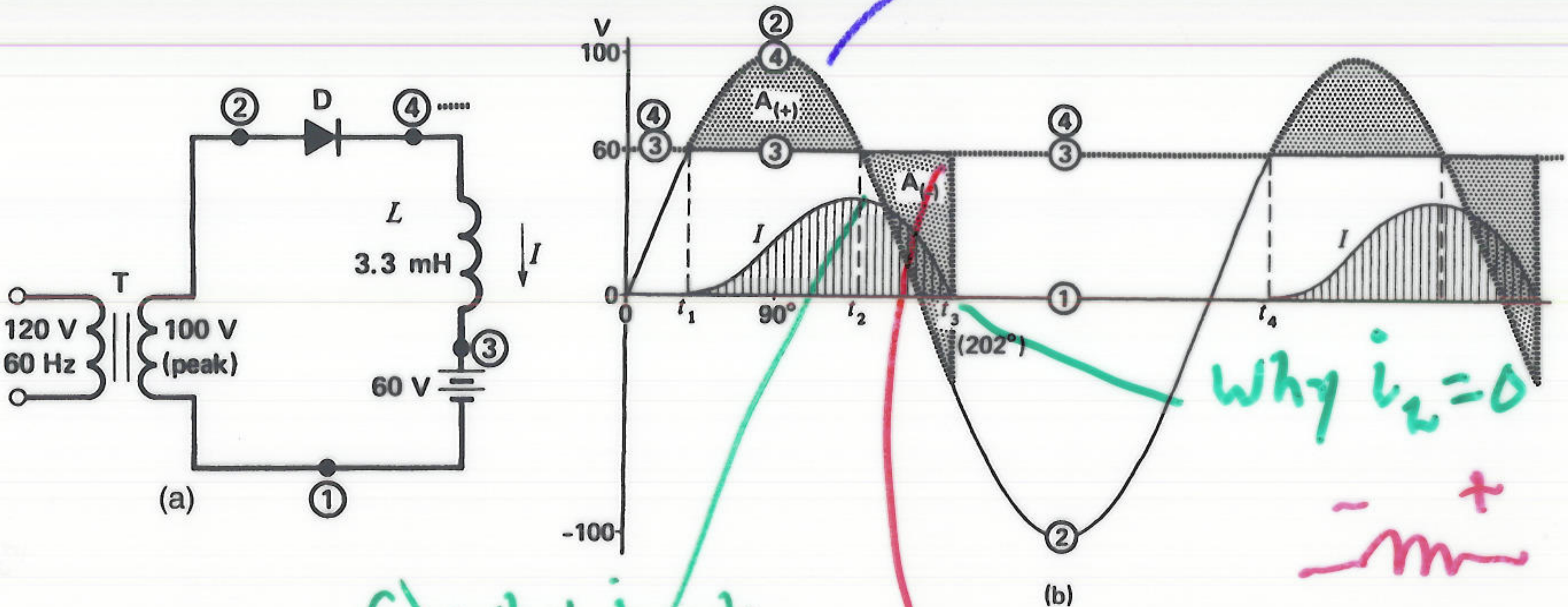
Qualatative $i_L(t)$

(1) $V_{ac} > 60 \Rightarrow$

$+ \quad -$

i

t



(2) $V_{ac} < 60$

$- \quad +$

i

dt

(3) why i peak here

why $i_L = 0$

$\Delta i = \frac{e_L \, dt}{L}$ } volt-sec can be $\pm$

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PET when i(t) overlaps v(t)

① Fig 21.12
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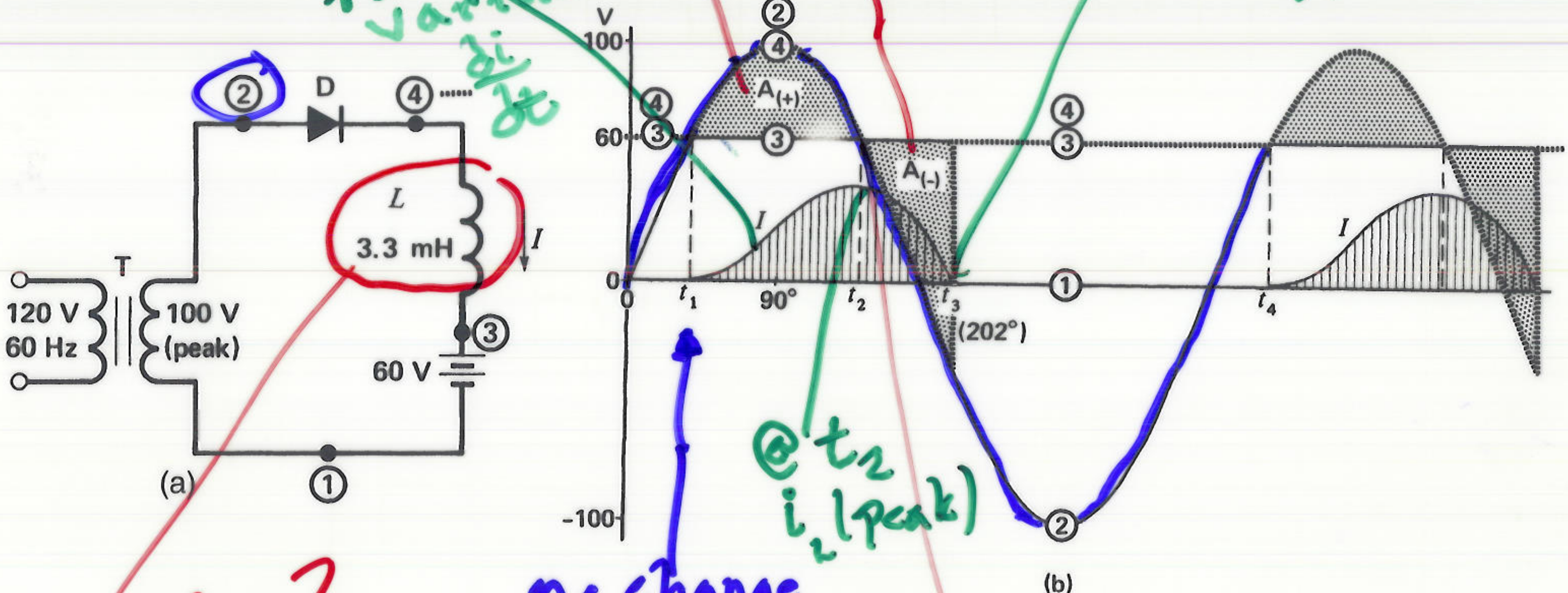
$\frac{A^+}{L}$ i increases

$\frac{A^-}{L}$ i decreases

Note big change in i_{off} time

slow ramp-up variable $\frac{di}{dt}$



Lossless?

no change on i on time

@ t_2
i_L(peak)

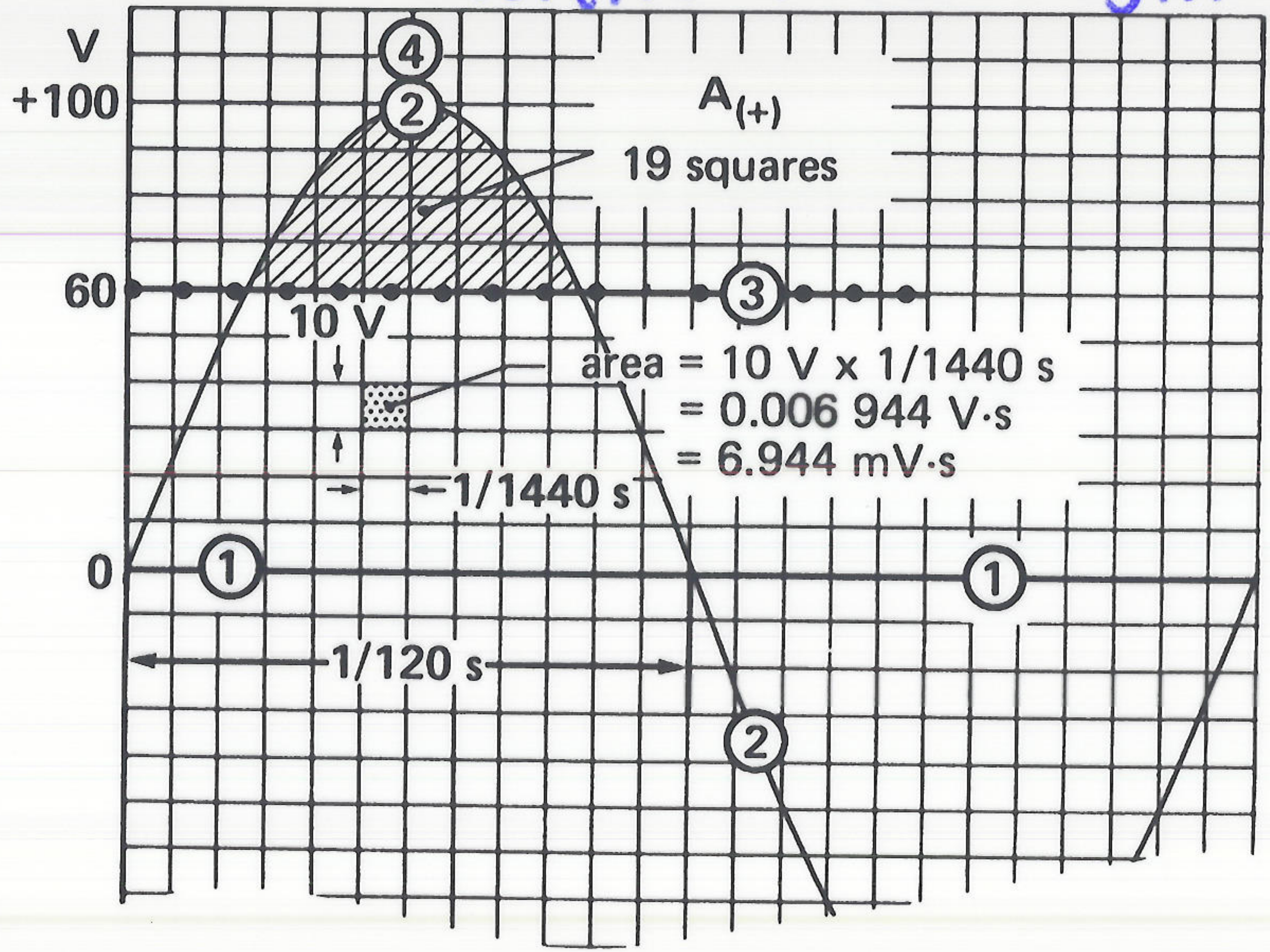
For steady stat
$A^+ + A^- = ?$

How to calculate i(peak)?

Quantative

Figure 21-12c See Example 21-1.

Positive V-sec region



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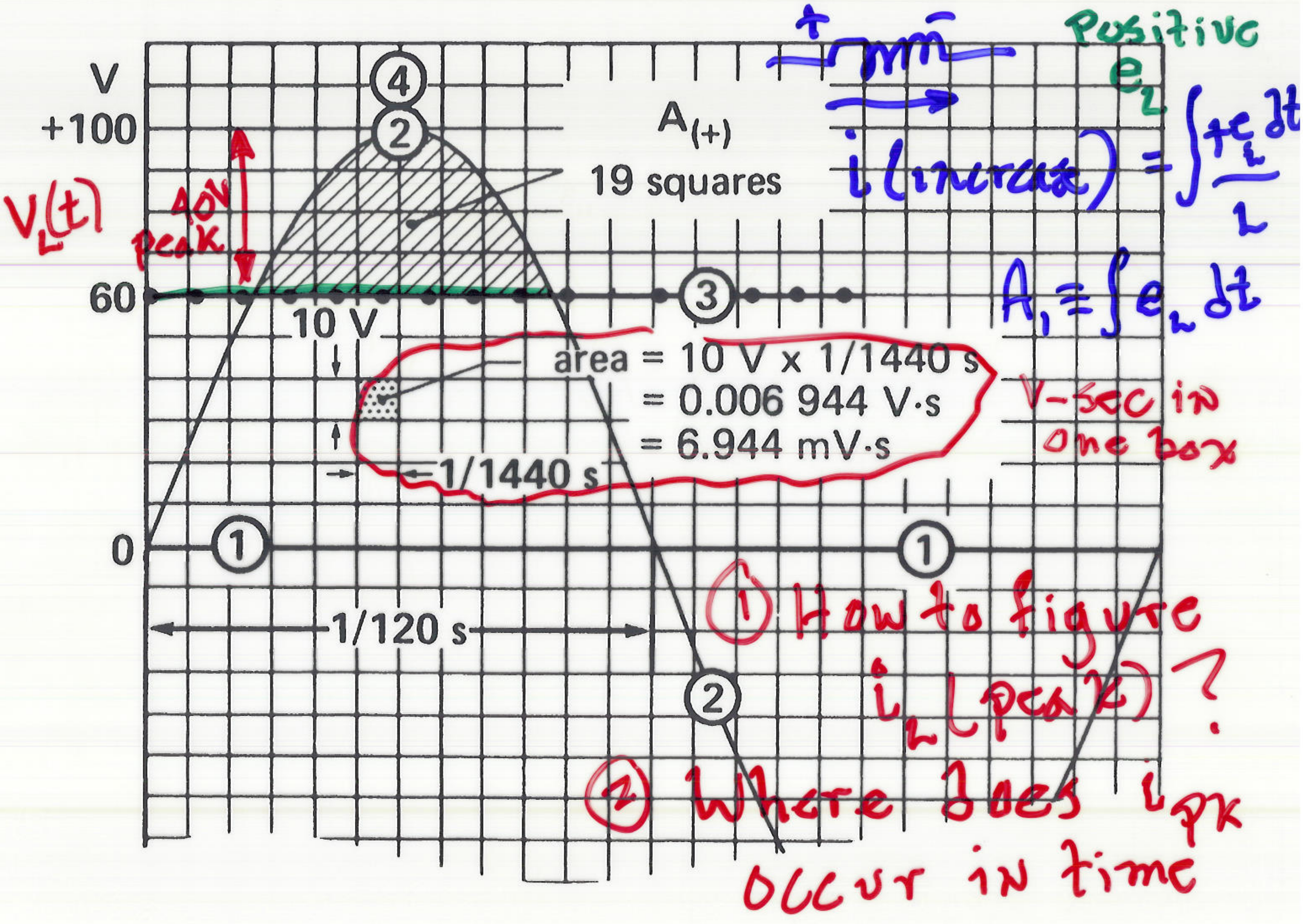

V
+100
60
0
$A_{(+)}$
19 squares
10 V
area = 10 V x 1/1440 s
= 0.006 944 V·s
= 6.944 mV·s
1/1440 s
1/120 s
$V_L(t)$
40V Peak
Positive e_L
i (increase) $= \int \frac{+e_L}{L} dt$
$A_1 = \int e_L\, dt$
V-sec in one box
1 How to figure i_L (peak)?
2 Where does i_{pk} occur in time

Specific Case (with L load)

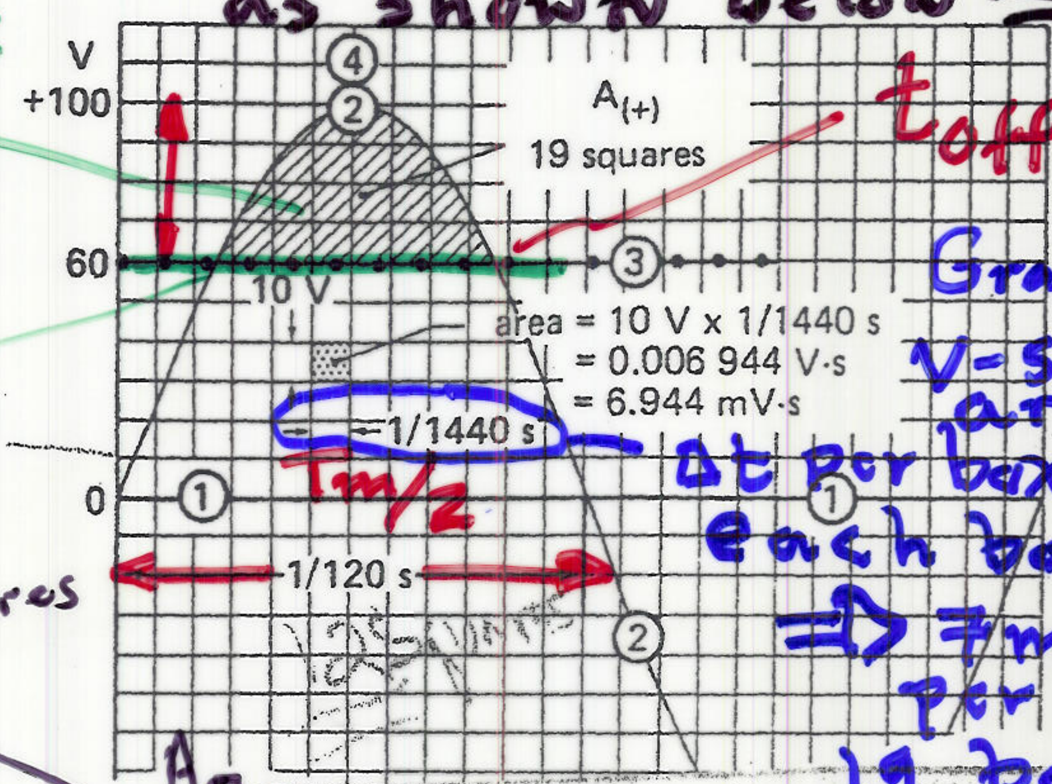
$$i_{pk} \sim \frac{\int dt \left(+V_L\right)}{L} \Big\} \text{V-s}$$

or do graphically

If L = 3.3 μH
and area of +V-sec
as shown below ⟹ Δi

+V-sec interval area

t_{on} $V_{ac} > 60$



Graphical V-sec area:
Δt per box
each box 10V
⟹ 7 mV-sec per box
19 boxes

19 squares

$$i_{pk} = \frac{\overbrace{(19\,\text{□})(7)}^{A_D}\ \frac{\text{mV-sec}}{\text{□}}}{3.3\,\mu H} = 40\,A = \frac{\int v\,dt}{L}$$

Since $\Delta V^L_{max} = 40V$ ⟹ replace "L" by R = 1Ω for same i

eg $\frac{40}{1} = 40$ A.

But "L" has
1. bigger P.F.
2. "No" losses