1a. $v = L\frac{di}{dt} \rightarrow i(t) = i(0) + \frac{1}{L}\int_0^t v(\tau)d\tau$ for $0 < t < 0.001, 0.001 < t < 0.002, t > 0.002$:

$0 < t < 0.001$: $i(t) = 0 + \frac{6\,mv}{300\,\mu H}\int_0^t d\tau = (20t)A$ since $\frac{6\,mv}{300\,\mu H} = 20\frac{amp}{sec}$.

$001 < t < .002$: $i(t) = (20\frac{amp}{sec})(0.001sec) + \frac{6\,mv}{300\mu H}\int_{0.001}^t (2 - 1000\frac{msec}{sec}\tau)d\tau = (40t - 10000t^2 - 0.01)A$.

$t > 0.002$: $i(t) = (40(0.002) - 10000(0.002)^2 - 0.01)A + \frac{6\,mv}{300\mu H}\int_{0.002}^t 0\tau = 0.03A$.

CHECK: Continuity of $i(t)$ at t=0.001:(0.02A=0.02A OK); t=0.002:(0.03A=0.03A OK). Whew!

1b. See plot below. Note continuity of i(t).

2a. $v = L\frac{di}{dt} = (0.02H)[-2500A_1e^{-2500t} - 7500A_2e^{-7500t}] = -(50A_1e^{-2500t} + 150A_2e^{-7500t})$.
$i(0) = 0.05 = A_1 + A_2$ and $v(0) = 10 = -50A_1 - 150A_2 \rightarrow A_1 = 0.175, A_2 = -0.125$.
$v(t) = -8.75e^{-2500t} + 18.75e^{-7500t}V, t > 0$; $i(t) = 0.175e^{-2500t} - 0.125e^{-7500t}A, t \geq 0$.

2b. $p(t) = i(t)v(t) = 4.375e^{-10000t} - 1.53125e^{-5000t} - 2.34375e^{-15000t}$.
$p(t) = (4.375x - 1.53125x^2 - 2.34375)/x^3 = 0$ where $x = e^{5000t}$ as suggested.
Solving quadratic$\rightarrow x = 0.7143 \rightarrow t < 0; x = 2.143 \rightarrow t = \frac{\log_e 2.143}{5000} = 152.4\mu sec$.

3a. $i = C\frac{dv}{dt} = (0.0000004)\frac{d(-60)}{dt} = 0, t < 0$ (this wasn't the nasty derivative).

3b. $i = C\frac{dv}{dt} = (0.0000004)\frac{d}{dt}[15 - 15e^{-500t}5\cos(2000t) - 15e^{-500t}\sin(2000t)] = (0.0000004) \times (7500)e^{-500t}[\cos(2000t) + 21\sin(2000t)] = 3e^{-500t}[\cos(2000t) + 21\sin(2000t)]mA$.

3c. $v(0^+) = 15 - 15(e^0)(5 + 0) = -60 = v(0^-)$ so $v(t)$ doesn't jump (it better not!).

3d. $i(0^+) = 3(e^0)(1+0) = 3\,mA \neq 0 = i(0^-)$ so $i(t)$ does jump (cap. *current* CAN jump).

3e. Stored energy$=\frac{1}{2}Cv(\infty)^2 = \frac{1}{2}(0.0000004)(15)^2 = 45\mu Joules$.

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4. $(14||6) + 15.8 = 20$. $(20||60) + 5 = 20$. $(20||80) + 24 = 40$. $(40||10) + 12 = 20H$.

5a. $i_o(0) = i_1(0) + i_2(0) = 10 - 5 = 5A$. $(32||8) + 3.6 = 10H$ for (b).

5b. $i_o(t) = i_o(0) - \frac{1}{L}\int_0^t v(\tau)d\tau = 5 - 0.1\int_0^t 1250e^{-25\tau}d\tau = 5e^{-25t}A, t > 0$.

5c. $i(t) = i(0) + \frac{1}{L}\int_0^t v(\tau)d\tau \rightarrow i_1(t) = C_1 + 4e^{-25t}, t > 0$ and $i_2(t) = C_2 + e^{-25t}, t > 0$.
Where C_1 and C_2 are chosen to match the given $i_1(0) = 10$ and $i_2 = -5$.
$\rightarrow i_1(t) = 4e^{-25t} + 6$ and $i_2(t) = e^{-25t} - 6$.

5e. Stored energy$=\frac{1}{2}8(10)^2 + \frac{1}{2}32(-5)^2 + \frac{1}{2}3.6(5)^2 = 845Joules$.

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6. $(4 + j3)(5 + j12) = (4 \cdot 5 - 3 \cdot 12) + j(3 \cdot 5 + 4 \cdot 12) = -16 + j63$.
$(4 + 3j)(5 + j12)^* = (4 + j3)(5 - j12) = (4 \cdot 5 + 3 \cdot 12) + j(3 \cdot 5 - 4 \cdot 12) = 56 - j33$.
$\frac{4+j3}{5+j12} = \frac{4+j3}{5+j12}\frac{5-j12}{5-j12} = \frac{1}{169}(4 + j3)(5 - j12) = \frac{56}{169} - j\frac{33}{169}$ $(5^2 + 12^2 = 169)$.
$1/[(4 + j3)(5 + j12)] = \frac{1}{-16+j63}\frac{-16-j63}{-16-j63} = -\frac{16}{4225} - j\frac{63}{4225}$ $(16^2 + 63^2 = 4225)$.
$(4 + j3)^*(5 + j12) = (4 - j3)(5 + j12) = (4 \cdot 5 + 3 \cdot 12) + j(-3 \cdot 5 + 4 \cdot 12) = 56 + j33$.

Now redo these using polar form (answers don't match perfectly due to rounding):
$4+j3=5e^{j37^o}$; $5+j12=13e^{j67^o}$. Now these are *easy*:
$(4+j3)(5+j12)=5e^{j37^o}13e^{j67^o}=65e^{j104^o}=-16+j63$.
$(4+j3)(5+j12)^*=5e^{j37^o}13e^{-j67^o}=65e^{-j30^o}=56-j33$.
$\frac{4+j3}{5+j12}=5e^{j37^o}/13e^{j67^o}=0.385e^{-j30^o}=0.333-j0.192$.
$1/[(4+j3)(5+j12)]=\frac{1}{5}e^{-j37^o}\frac{1}{13}e^{-j67^o}=0.0154e^{-j104^o}=-0.00372-j0.0149$
$(4+j3)^*(5+j12)=5e^{-j37^o}13e^{j67^o}=65e^{j30^o}=56+j33$.

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7. Magnitude squared=[(25)(65)(100)(169)(125)]/[(676)(65)(625)(125)]=1.
How did I come up with these? Note the various Pythagorean triangles.

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8. HARD WAY: $5\cos(3t)\cos(30^o)-5\sin(3t)\sin(30^o)+5\sin(3t)+5\cos(3t)\cos(210^o)+5\sin(3t)\sin(210^o)=0\cos(3t)+0\sin(3t)=0$ *identically.* Why?
8. EASY WAY: $5e^{j30^o}+5e^{-j90^o}+5e^{-j210^o}=0$. Note $5\sin(3t)=5\cos(3t-90^o)$.
See below right for a pretty picture of why these sum to zero.

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9. UNGRADED: The Norton equivalent box has current flowing through a resistor.
The Thevenin equivalent box has no current flowing. The Norton equivalent is *warmer*.