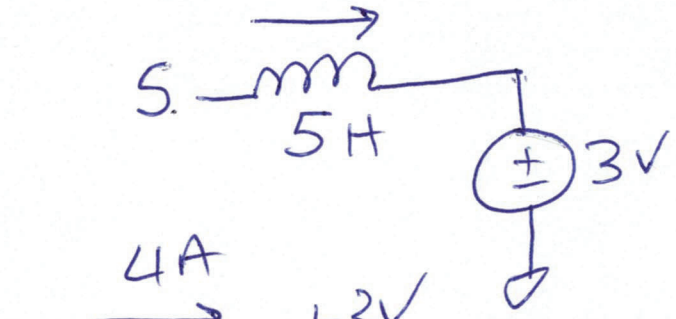
EE 442 / ECG 642
Power Electronics
Dec. 7, 2022
Lecture 24

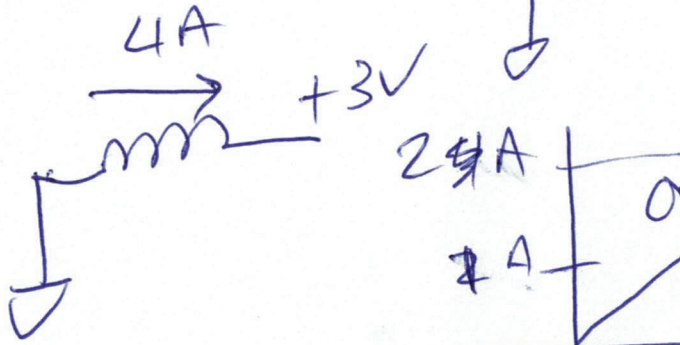
$$V = L\frac{di}{dt}$$

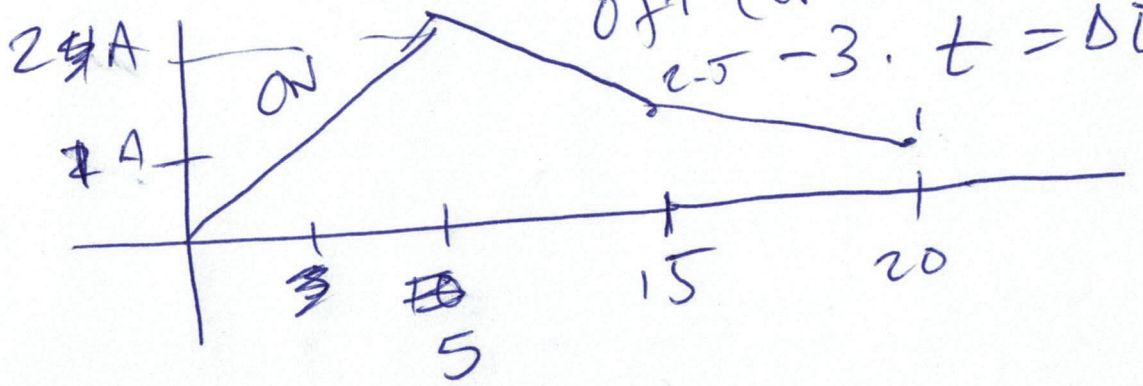
$$5 - 3 = 5 \cdot \frac{\Delta i}{t}$$



$$\frac{2}{5} \cdot t = \Delta i$$

$$0 - 3 = \frac{\Delta i}{t}$$





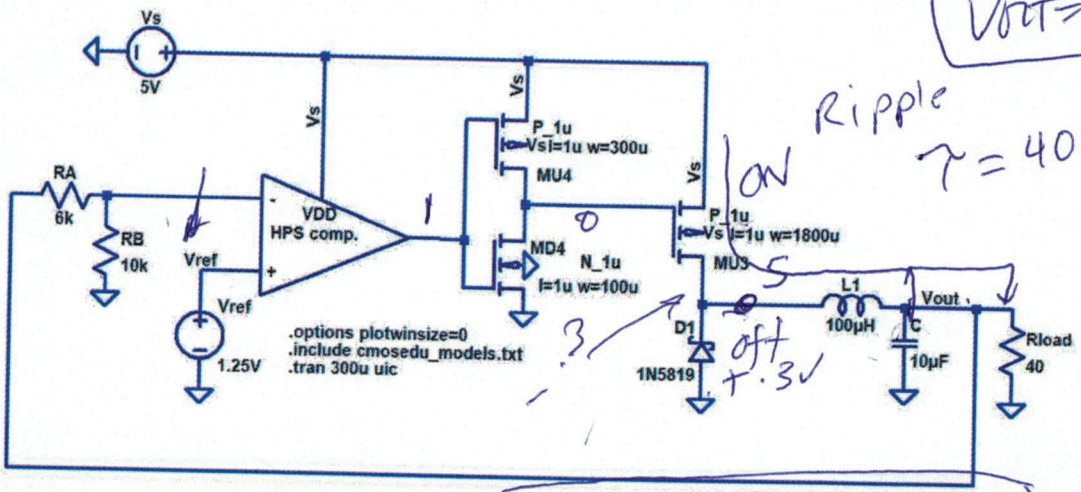
$$-3 \cdot t = \Delta i$$

$1.25 = V_{OUT} \cdot \frac{10K}{10K+6K}$

$V_{OUT} = 1.25 \cdot \frac{16}{10} = 1.25 \cdot \frac{8}{5} = 2V$

9. For the following circuit, determine the current in the inductor, ~~the average output voltage~~, and the ripple in the output voltage. As always, show your hand calculations for credit. Assume steady-state operation. (25 points)

$V_{OUT} = 2V$



Ripple

$\tau = 40 \cdot 10\mu F$

T_{ON} = Time Comp output is ~~low~~ high

$I_{AVG} = \frac{2}{40} = 50mA$

T_{off} = Time comp out is ~~high~~ low

$V = L\frac{di}{dt}$

$5 - 2 = 100\mu H \cdot \frac{\Delta I}{T_{ON}}$

$\Delta I = T_{ON} \cdot \frac{3}{100\mu}$

$T_{ON} \cdot \frac{3}{100\mu} = \frac{2.3}{100\mu} \cdot T_{off}$

$\frac{T_{ON}}{T_{off}} = \frac{2.3}{3}$

T_{off}

$-.3 - 2 = 100\mu \cdot \frac{\Delta I}{T_{off}}$

$\Delta I = T_{off} \cdot \frac{-2.3}{100\mu}$

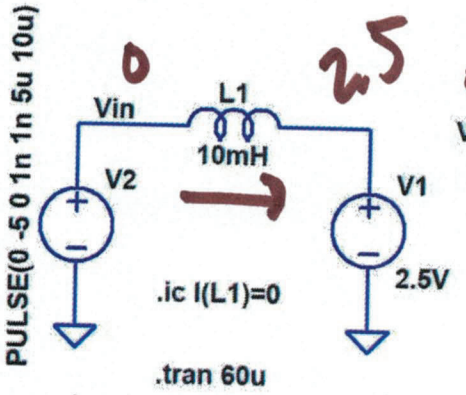
$I = C\frac{dV}{dT} \Rightarrow 50mA = 10\mu \cdot \frac{\Delta V}{T_{off}}$

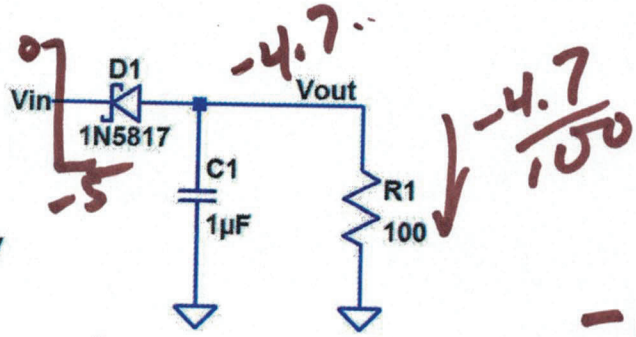
$\Delta V_{ripple} = \frac{50mA \cdot T_{off}}{10\mu F}$

V_{OUT} ripple

$V = L \frac{dI}{dT}$

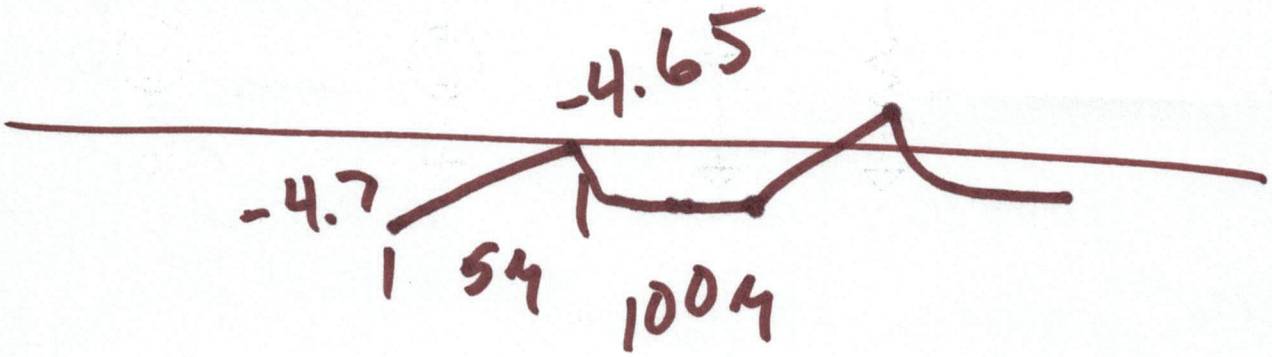
8. Determine the currents flowing in L1 and R1 in the following circuits. (10 points)





$0 - 2.5 = 10m \cdot \frac{\Delta I}{5\mu} \rightarrow \Delta I = \frac{-12.5\mu}{10m} = -1.25mA$

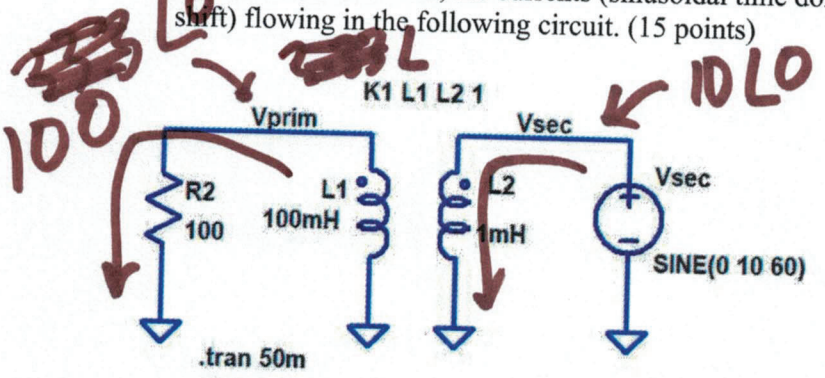
$-5 - 2.5 = 10m \cdot \frac{\Delta I}{5\mu} \quad \Delta I = \frac{-37.5\mu}{10m} = -3.75mA$



3)

$$\frac{I_s}{I_p} = \frac{V_p}{V_s} = \frac{N_1}{N_2} = \sqrt{\frac{L_p}{L_s}}$$

7. Determine, and sketch, the currents (sinusoidal time domain equations that show phase shift) flowing in the following circuit. (15 points)



$$\sqrt{\frac{100}{1}} = 10 = \frac{V_p}{V_s}$$

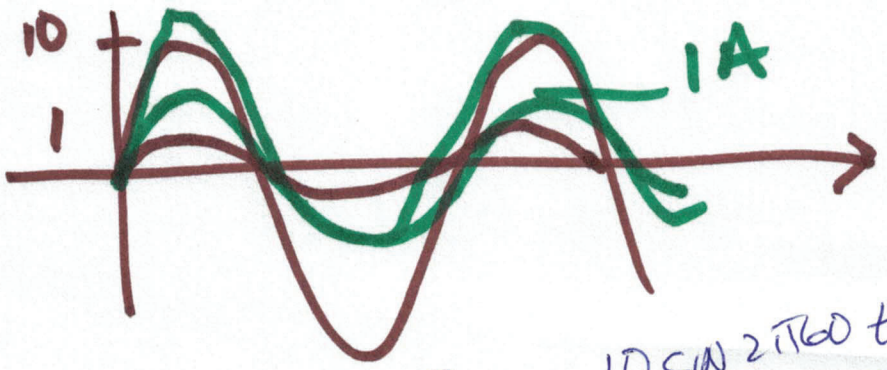
$V_{sec} = 10 \angle 0$

$V_{pri} = 100 \angle 0$

$I_{pri} = \frac{100 \angle 0}{100} = 1 \angle 0$

$I_{sec} = 10 \angle 0$

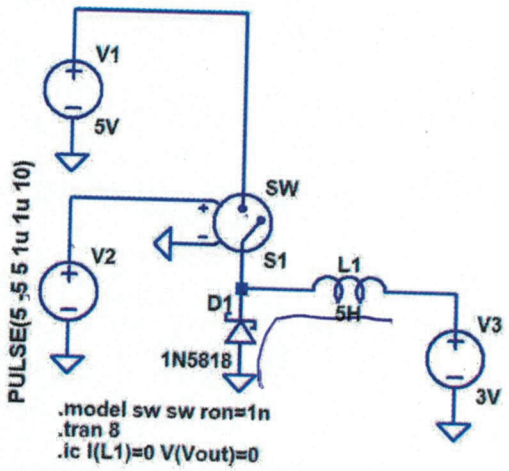
$I_{mag} = \frac{10 \angle 0}{j \cdot 2\pi \cdot 60 \cdot 10^{-3}} = 2.65 \angle -90$



$I_{sec} = 10 \sin 2\pi 60 t + 2.65 \sin(2\pi 60 t - 90)$

4)

6. Estimate, and sketch, the current flowing in the inductor in the following circuit. (15 points)



$T_{ON} = 5$

$T_{OFF} = 10$

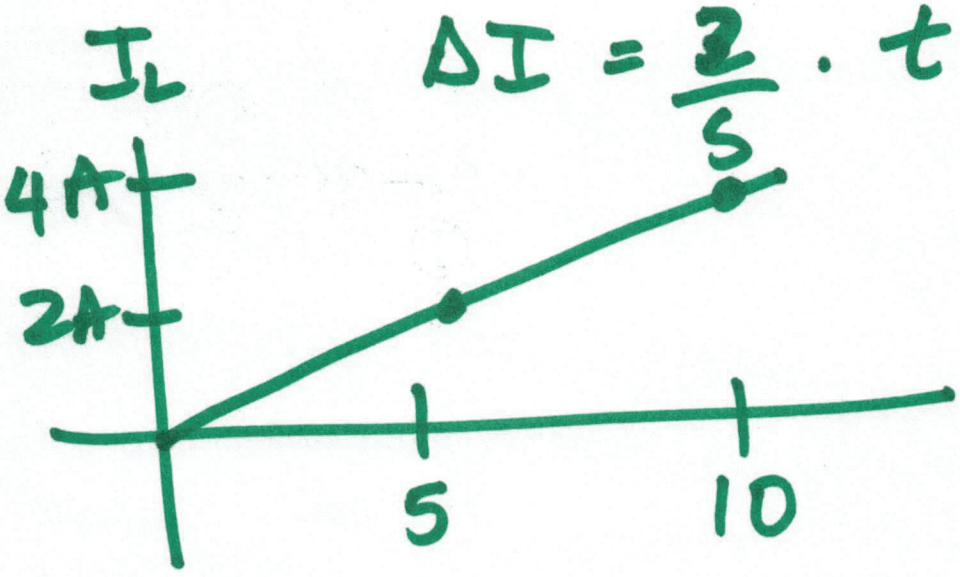
$T_{OFF} = 5$

$T_{ON} = 10$

$V = L \cdot \frac{di}{dT}$

$5 - 3 = 5 \cdot \frac{\Delta I}{t}$

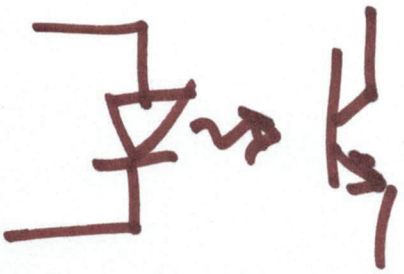
$\Delta I = \frac{2}{5} \cdot t$



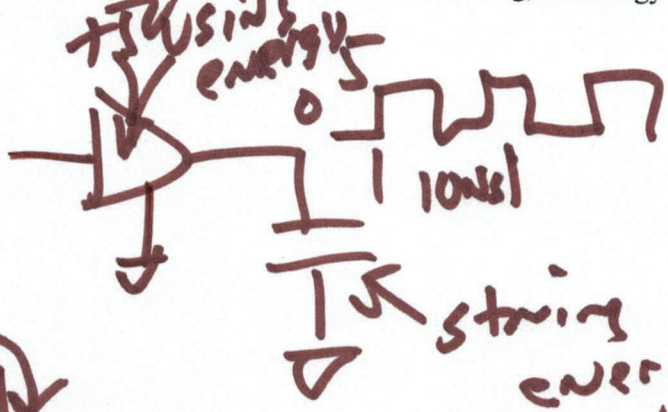
5)

4. Explain how an opto-isolator works? (5 points)

Light in LED shines on Base in BJT acts Base current to operate BJT



5. What is the average power used to charge/discharge a 1uF capacitor between 5V and ground at 100MHz? What is using, and what is storing, the energy in this situation? (5 points)



$CV = Q = 1\mu F \cdot 5 = 5\mu C$

$I_{AVG} = \frac{5\mu C}{10ns} = 500A!$

$P_{AVG} = 5 \cdot 500 = 2.5kW!$

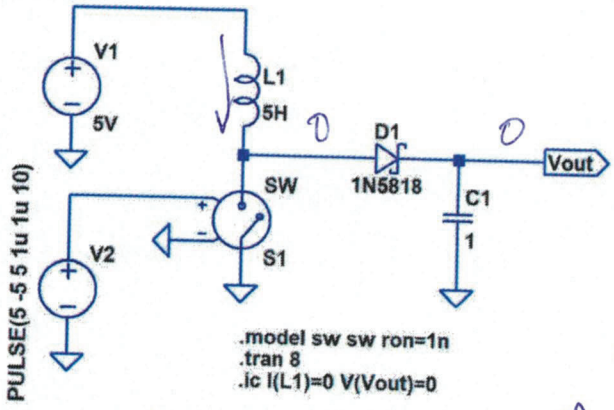
↑ power supply

6)

$$5 = 5 \cdot \frac{dI}{dT} \qquad V = L\frac{di}{dT} = \frac{L}{5} \cdot \frac{5A}{t}$$

$$\Delta I = 1$$

3. *Estimate*, and plot, the output voltage in the following circuit. (15 points)



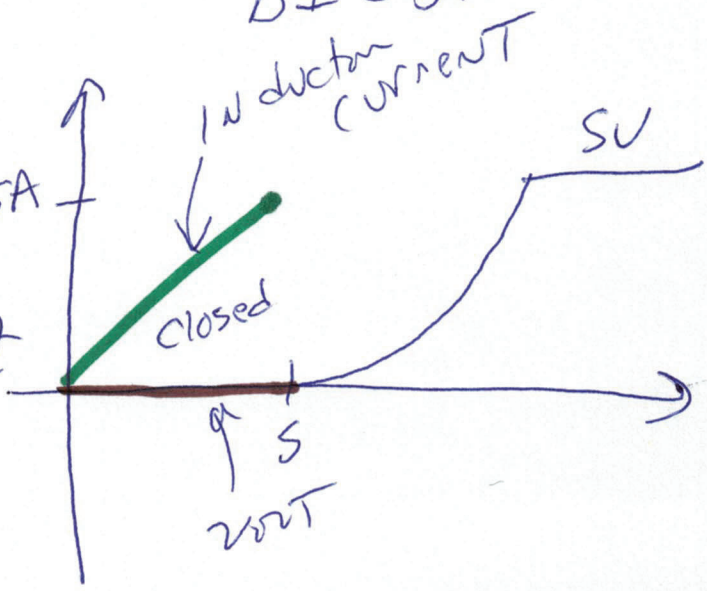
$$5 = 5 \cdot \frac{\Delta I}{5}$$

$$\Delta I = 5A$$

$$I = C\frac{dV}{dT}$$

$$I_L = 1 \cdot \frac{\Delta V \wedge T}{t} = 1A \cdot t$$

$$\Delta V_{OUT} = 1t^2$$



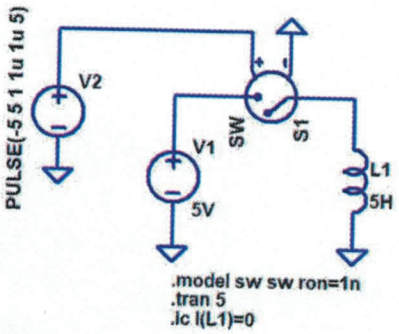
7)

Final Exam – EE 442 and ECG 642 Power Electronics
Fall 2022 – University of Nevada, Las Vegas

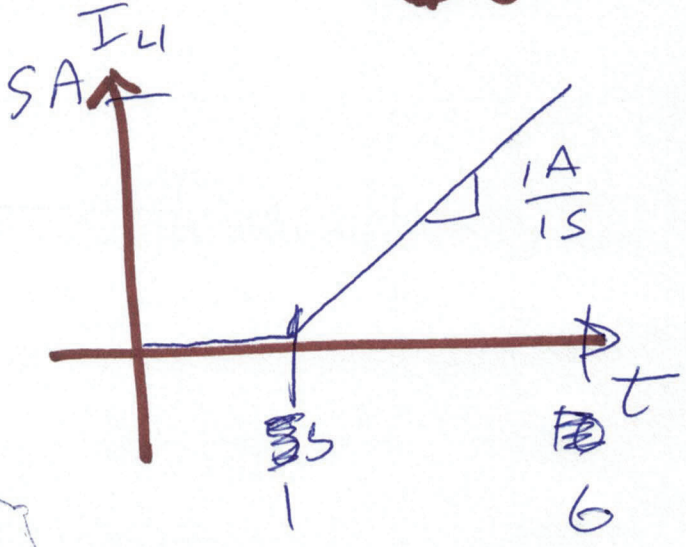
NAME:_____

Closed book and notes.
Show your work for credit and put a box around your answers.

1. Determine, and sketch, the current flowing in the inductor in the following circuit. (5 points)



$5 = 5 \cdot \frac{\Delta i}{\Delta t}$



2. Explain, in your own words, what the difference between reverse recovery time and storage time is in a diode. (5 points)

storage time → time to remove stored charge

reverse recovery time = storage time plus time to charge diode's depletion CAP

2)