ECE 320 - Quiz #6 - Name _____

H Bridges, DC to DC Converters, Fourier Transforms

H-Bridge Analysis:

1) Determine the voltages and currents for the following H-bridge. Assume ideal 3904 & 3906 transistors:

- | Vbe | = 0.7V
- | Vce | = 0.2V when saturated
- Current gain = β = 100

Let R = 900 + 100*(your birth month) + (your birth date

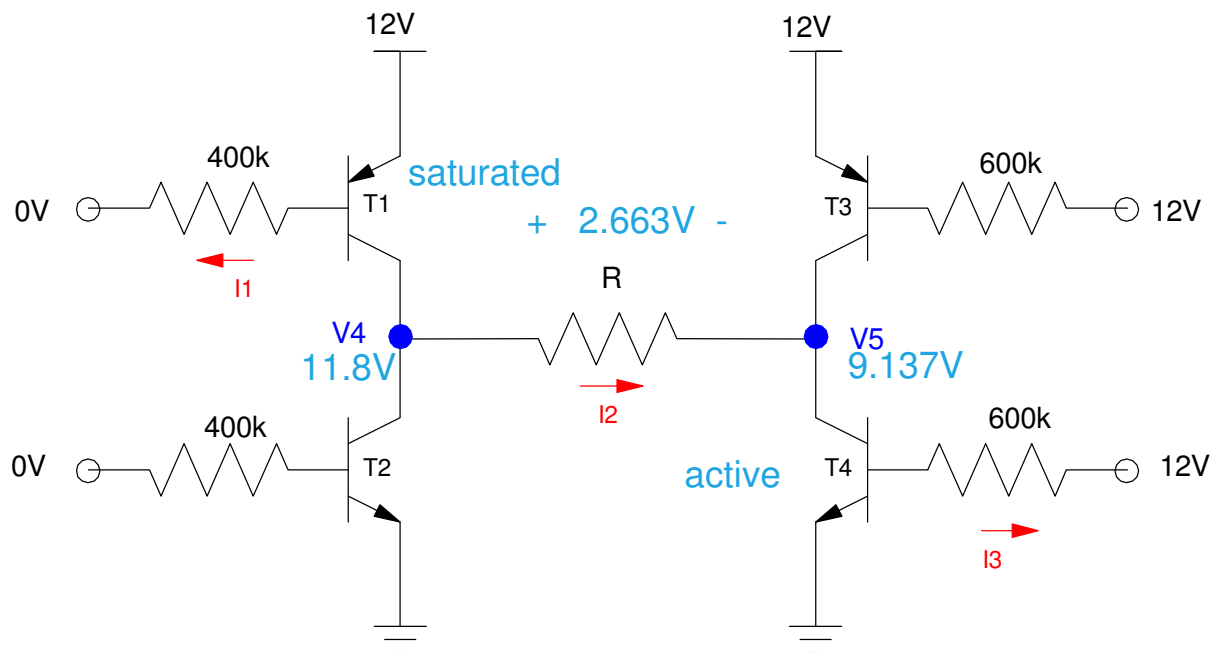| R 900 + 100*mo + day	I1	I2	-I3	V4	V5
1414	28.25uA	1.883mA	18.83uA	11.8V T1 is saturated	9.137V T4 is active

$$I_1 = \left(\frac{12V-0.7V}{400k} \right) = 28.25\mu A \qquad \textit{allows 2.825mA}$$

$$I_3 = \left(\frac{12V-0.7V}{600k} \right) = 18.83\mu A \qquad \textit{allows 1.883mA} \qquad \textit{<<< winner!}$$

$$\max(I_2) = \left(\frac{12V-0.2V-0.2V}{1414\Omega} \right) = 8.204mA$$

$$V_4 = 12V - 0.2V$$

$$V_5 = V_4 - 1.883mA \cdot 1414\Omega$$

H-Bridge Analysis:

2) Determine the voltages and currents for the following H-bridge. Assume ideal 3904 & 3906 transistors:
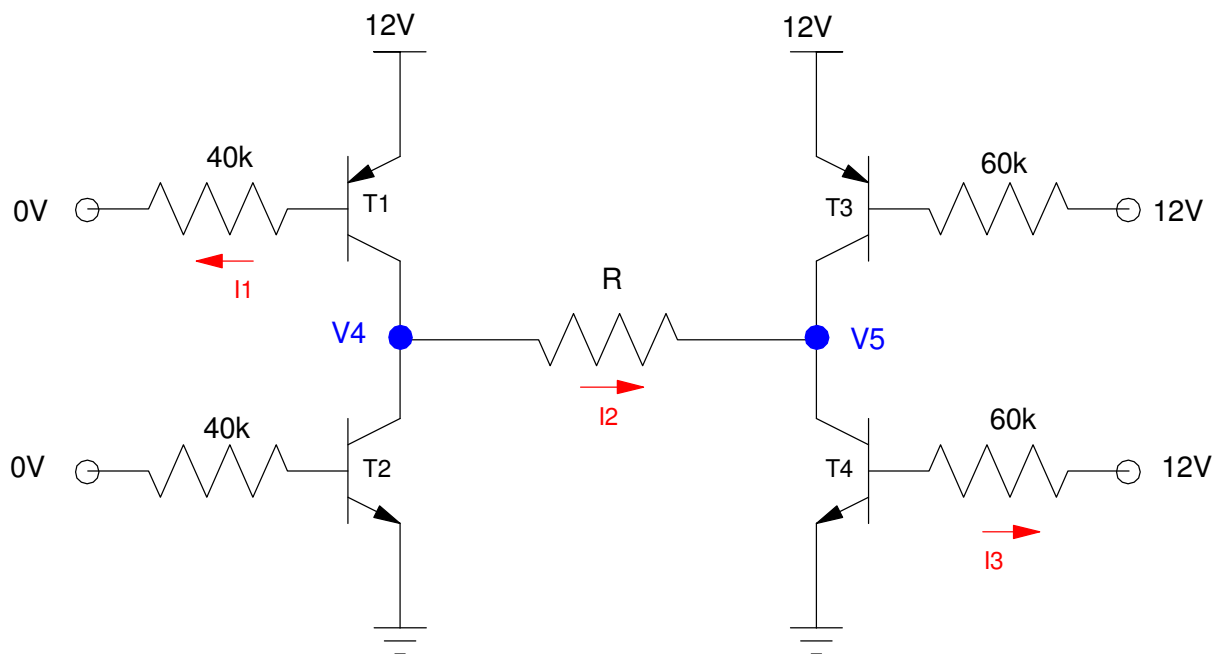
- | Vbe | = 0.7V
- | Vce | = 0.2V when saturated
- Current gain = beta = 100

R 900 + 100*mo + day	I1	I2	-I3	V4	V5
1414	282.5uA	8.204mA	188.3uA	11.8V T1 is saturated	0.2V T4 is saturated

$$I_1 = \left(\frac{12V-0.7V}{40k\Omega} \right) = 282.5\mu A \qquad \text{allows 28.25mA}$$

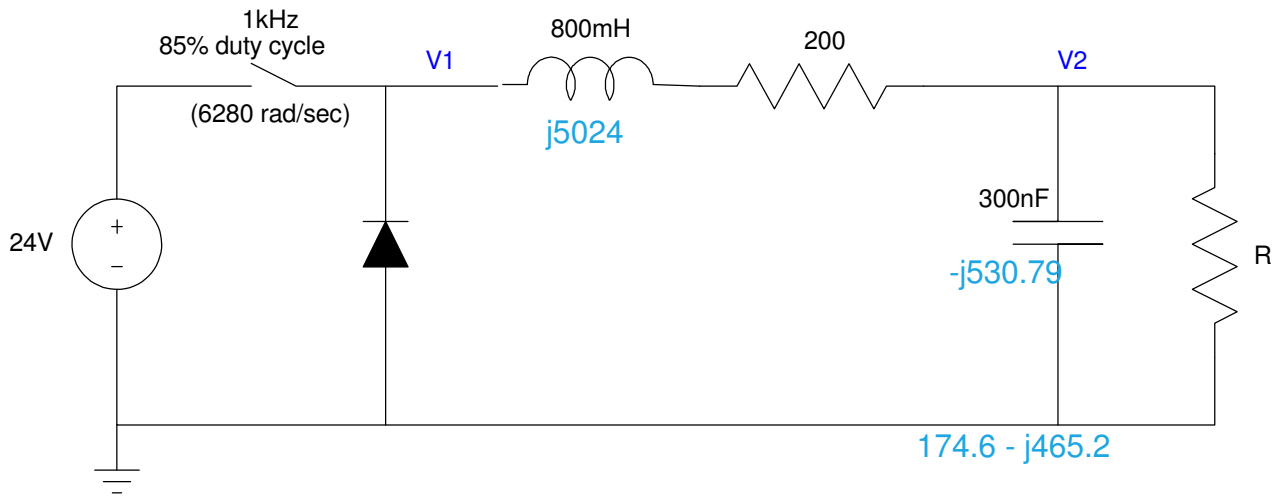$$I_3 = \left(\frac{12V-0.7V}{60k\Omega} \right) = 188.3\mu A \qquad \text{allows 18.83mA}$$

$$\max (I_2) = \left(\frac{12V-0.2V-0.2V}{1414\Omega} \right) = 8.204mA \qquad \text{<<< Winner!}$$

DC to DC Converter: Analysis (note: 24V DC power supply)

3) Determine the voltages at V1 and V2 (both DC and AC)

R 900 + 100*mo + day	V1		V2	
	DC	AC (V1pp)	DC	AC (V2pp)
1414	20.295V	24.7Vpp	17.780V	2.6834Vpp

$$V_1(DC) = 0.85 \cdot 24V + 0.15 \cdot (-0.7V) = 20.295V$$

$$V_2(DC) = \left(\frac{1414}{1414+200} \right) \cdot V_1(DC) = 17.780V$$

$$V_1(AC) \approx 24.7V_{pp}$$

$$V_2(AC) \approx \left(\frac{(174.6-j465.2)}{(174.6-j465.2)+(200+j5024)} \right) \cdot V_1(AC)$$
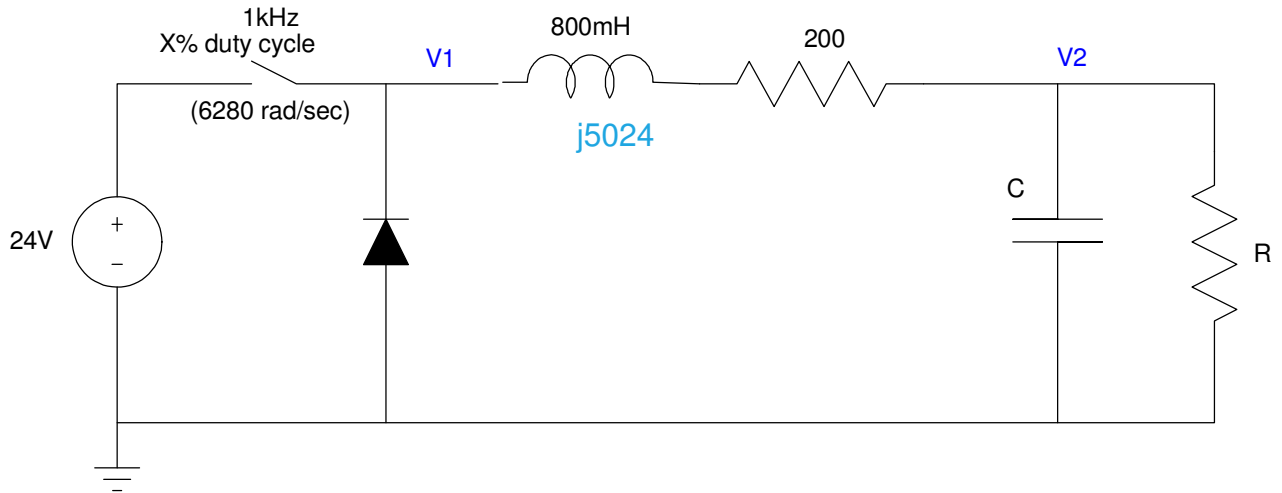
$$V_2(AC) \approx 2.6834V_{pp}$$

DC to DC Converter: Design (note: +24V DC power supply)

4) Determine the duty cycle and C so that

- V2(DC) is 7.50V and
- V2(AC) = 350mVpp

R 900 + 100*mo + day	Duty Cycle (X) %	C
1414	37.5%	1.78uF

$$V_1(DC) = \left(\frac{1414+200}{1414} \right) \cdot 7.50V = 8.561V$$

$$\text{duty cycle} = \left(\frac{8.561V+0.7V}{24V+0.7V} \right) = 37.5\%$$

If C = 0

$$V_2(AC) = \left(\frac{1414}{1414+(200+j5024)} \right) \cdot 20.7V_{pp}$$

$$V_2(AC) = 5.547V_{pp}$$

For V2(AC) = 350mVpp

$$\left| \frac{1}{j\omega C} \right| = \left(\frac{350mV_{pp}}{5.547V_{pp}} \right) \cdot 1414\Omega = 89.223\Omega$$

$$C = 1.78\mu F$$

DC to DC Converter

5) Determine the voltages and currents for the following DC to DC converter. Assume ideal 3904 & 3906 transistors:

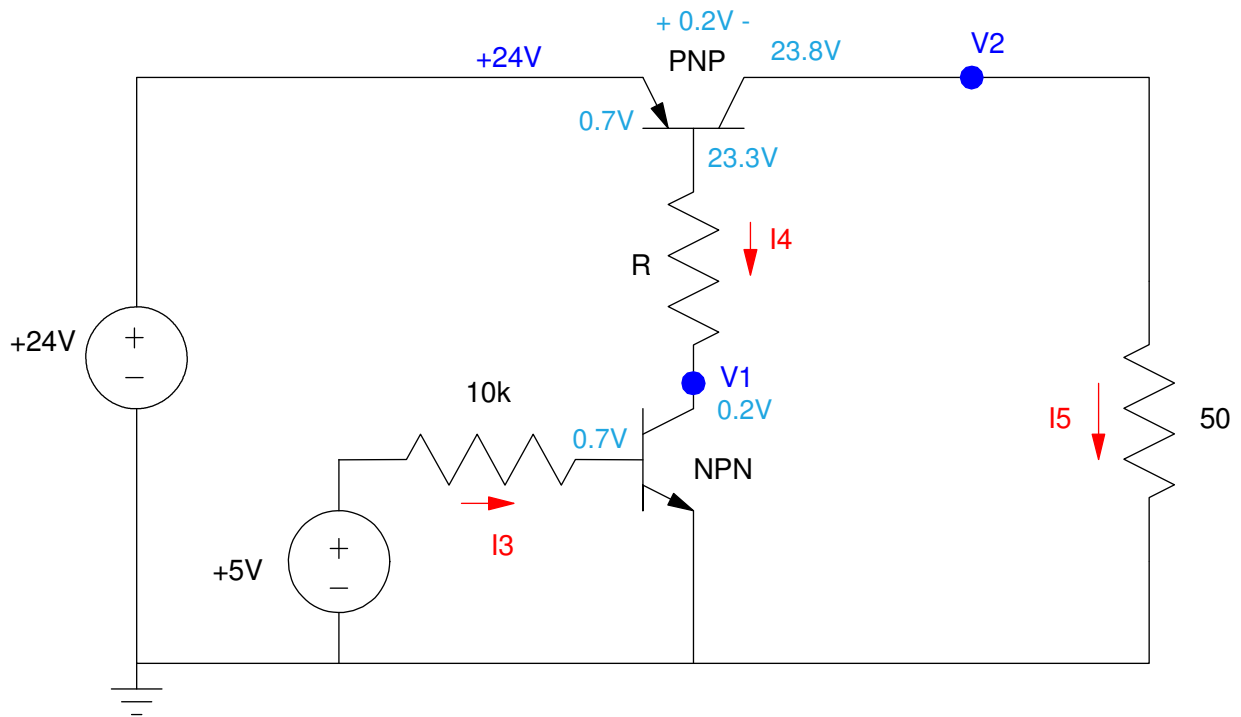- | Vbe | = 0.7V
- | Vce | = 0.2V when saturated
- Current gain = beta = 100

R	V1	V2	I3	I4	I5
900 + 100*mo + day					
1414	0.2V	23.8V	430uA	16.34mA	476mA
	NPN is saturated	PNP is saturated			

Checking if saturated:

$$100I_3 = 43mA > 16.34mA \qquad \text{NPN is saturated}$$

$$100I_4 = 1634mA > 476mA \qquad \text{PNP is saturated}$$

Fourier Transform

6) Determine y(t) given that

$$x(t) = 24 + m\sin(40t) + d\cos(80t)$$

where

- m is your birth month (1..12) and
- d is your birth date (1..31)

m birth month (1..12)	d birth date (1..31)	y(t)
5	14	20.57 - 2.118 cos(40t) + 2.471 sin(40t) + 3.047 cos(80t) + 5.223 sin(80t)

DC

$$Y = \left(\frac{60}{60+10}\right) \cdot 24 = 20.57$$

40 rad/sec

$$Y = \left(\frac{60}{60+(10+j60)}\right)(0 - j5) = -2.118 - j2.471$$

80 rad/sec

$$Y = \left(\frac{60}{60+(10+j1200)}\right)(14 + j0) = 3.047 - j5.223$$