ECE 320 - Quiz #6 - Name ____________________

Spring 2023 - H Bridges, DC to DC, SCR, Fourier Transforms, Boolean Logic

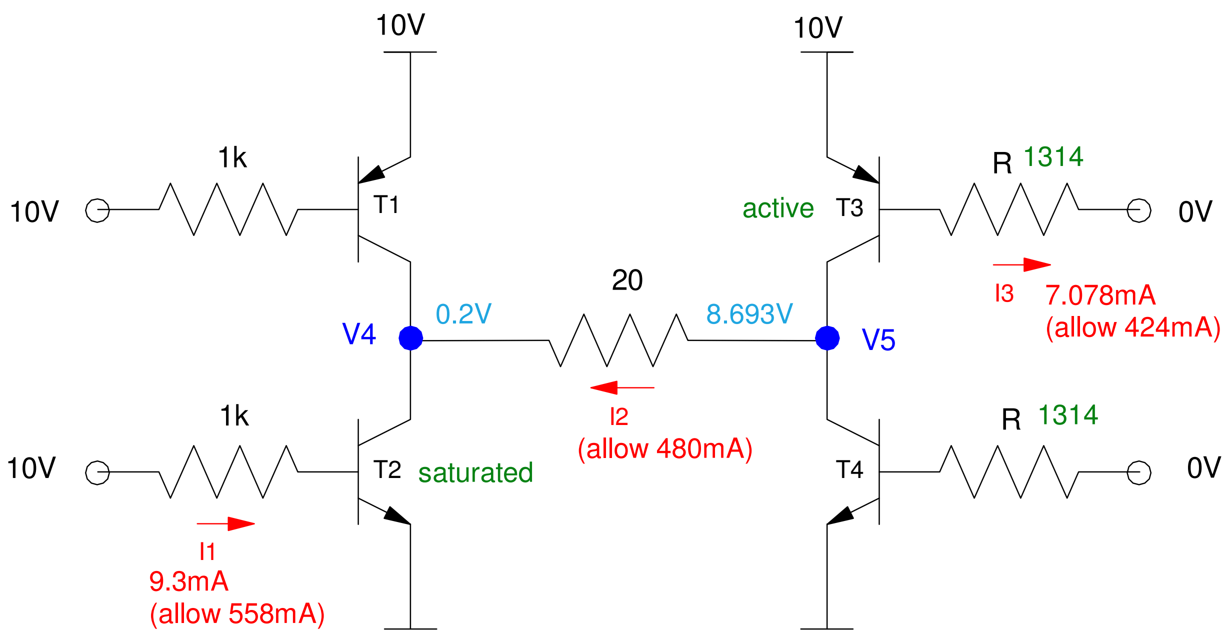
H-Bridge Analysis:

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

- | Vbe | = 0.7V
- | Vce | = 0.2V when saturated
- Current gain = β = 60

Let R = 800 + 100*(your birth month) + (your birth date)

R 800 + 100*mo + day	I1	I2	I3	V4	V5
1314	**9.3mA**	**424mA**	**7.078mA**	**0.2V**	**8.693V**



First, determine the currents

$$I_1 = \left(\frac{10V - 0.7V}{1k}\right) = 9.3mA \qquad \textit{allows 558mA (60x)}$$

$$I_3 = \left(\frac{10V - 0.7V}{1314\Omega}\right) = 7.078mA \qquad \textit{allows 424mA (60x)} \qquad \textit{<<<< winner!!}$$

$$\max(I_2) = \left(\frac{10V - 0.2V - 0.2V}{20\Omega}\right) = 480mA$$

I3 limits the current, meaning T3 is in the active mode

T2 is saturated (V4 = 0.2V)

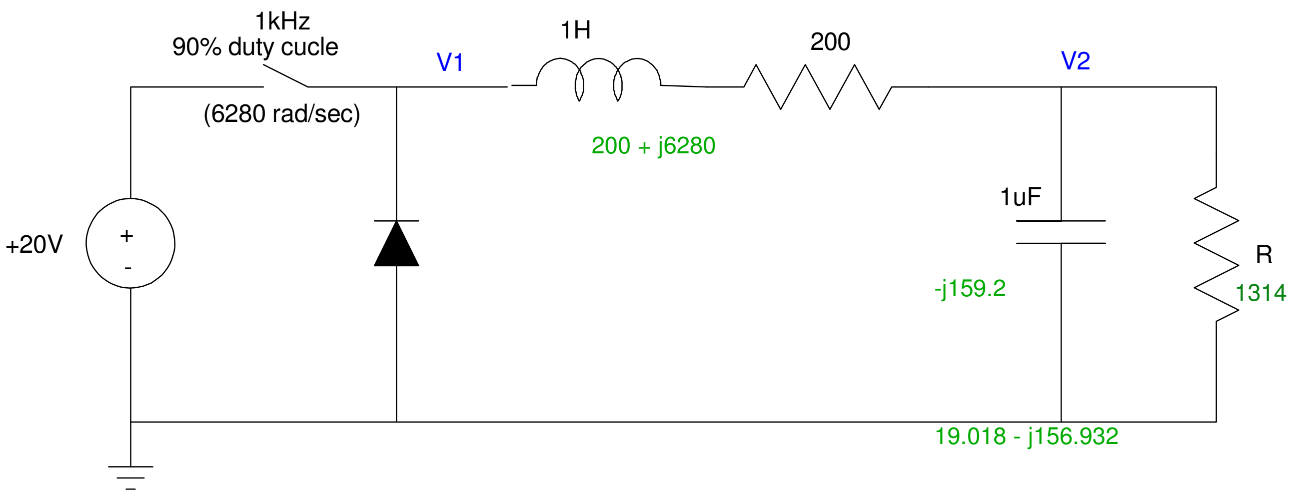
$$V_5 = V_4 + 442mA \cdot 20\Omega = 8.693V$$

DC to DC Converter: Analysis

2) Determine the voltages at V1 and V2 (both DC and AC). Assume

- R = 800 + 100*(your birth month) + (your birth date)

R 800 + 100*mo + day	V1		V2	
	DC	AC (V1pp)	DC	AC (V2pp)
1314	**17.97V**	**20.7Vpp**	**15.56V**	**0.534Vpp**



DC Analysis

$$V_1(DC) = (0.9)(20V) + (0.1)(-0.7V) = 17.93V$$

$$V_2(DC) = \left(\frac{1314}{1314+200}\right) V_1(DC) = 15.56V$$

AC Analysis

$$V_1(AC) = 20.7V_{pp}$$

$$V_2(AC) = \left(\frac{(19.018-j156.932)}{(19.018-j156.932)+(200+j6280)}\right)(20V_{pp})$$

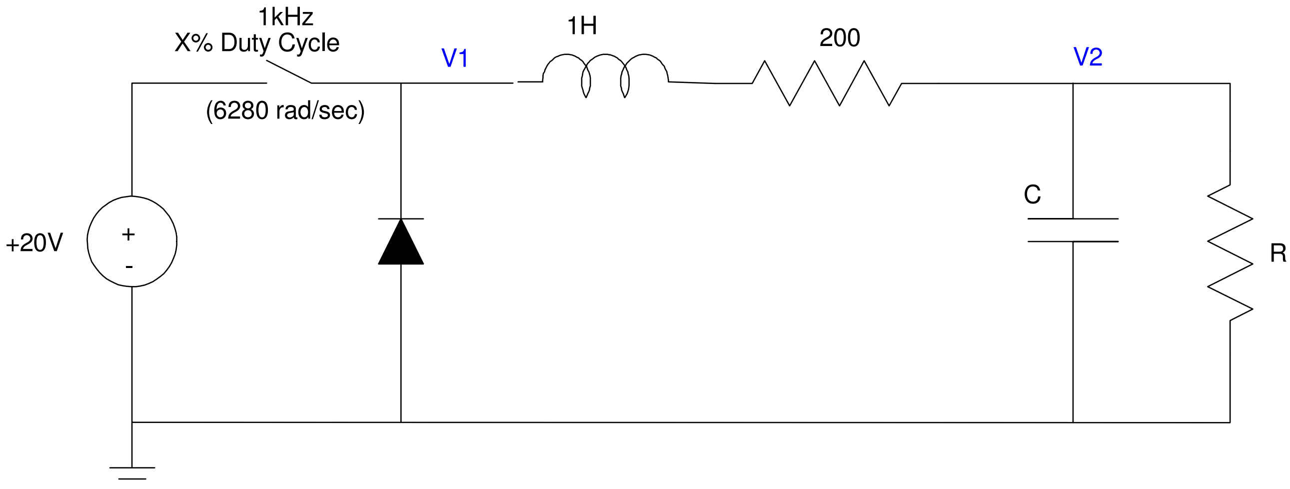
$$|V_2(AC)| = 0.534V_{pp}$$

DC to DC Converter: Design

3) Determine the duty cycle and C so that

- V2(DC) is 11.0V and
- V2(AC) = 250mVpp
- R = 800 + 100*(your birth month) + (your birth date)

R 800 + 100*mo + day	Duty Cycle (X) %	C
1314	**64.6%**	**2.041uF**



DC Analysis

V2(DC) = 11.00V

$$V_1(DC) = \left(\frac{1314+200}{1314}\right) V_2(DC) = 12.674V$$

$$X = \left(\frac{12.674V+0.7V}{20V+0.7V}\right) = 0.646$$

AC Analysis

Assume C = 0

$$V_2(AC) = \left(\frac{1314}{(1314)+(200+j6280)}\right)(20.7V_{pp})$$

$$V_2(AC) = 4.211V_{pp}$$

To reduce this to 250mVpp

$$\left|\frac{1}{j\omega C}\right| = \left(\frac{0.25V_{pp}}{4.211V_{pp}}\right)1314\Omega = 78.018\Omega$$

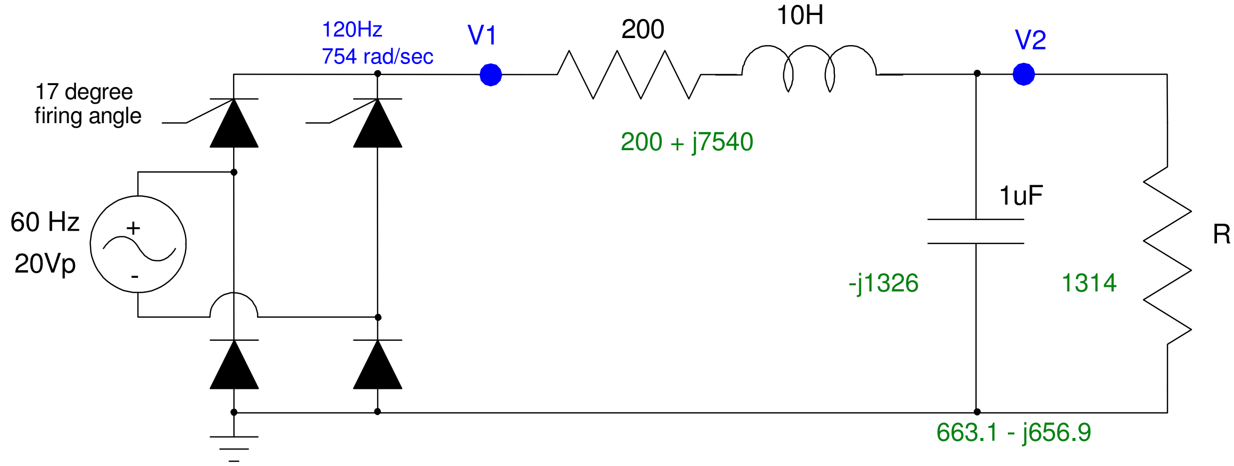
$$C = 2.04\mu F$$

SCR

4) Determine the voltages at V1 and V2 (both DC and AC). Assume

- R = 800 + 100*(your birth month) + (your birth date)
- 17 degree firing angle
- 20Vp 60Hz sine wave as the input

R 800 + 100*mo + day	V1		V2	
	DC	AC (V1pp)	DC	AC (V2pp)
1314	**10.776V**	**25.874Vpp**	**9.353V**	**3.478Vpp**



DC Analysis

$$V_1(DC) = \frac{2}{\pi} \cdot 20V \cdot \cos(17^0) - 1.4V = 10.776V$$

$$V_2(DC) = \left(\frac{1314}{1314+200}\right) V_1(DC) = 9.353V$$

AC Analysis

$$V_1(AC) = 20V \cdot (1 + \sin(17^0)) = 25.847V_{pp}$$

$$V_2(AC) = \left(\frac{(663.1-j656.9)}{(663.1-j656.9)+(200+j6540)}\right)(25.847V_{pp})$$

$$V_2(AC) = 3.4781V_{pp}$$

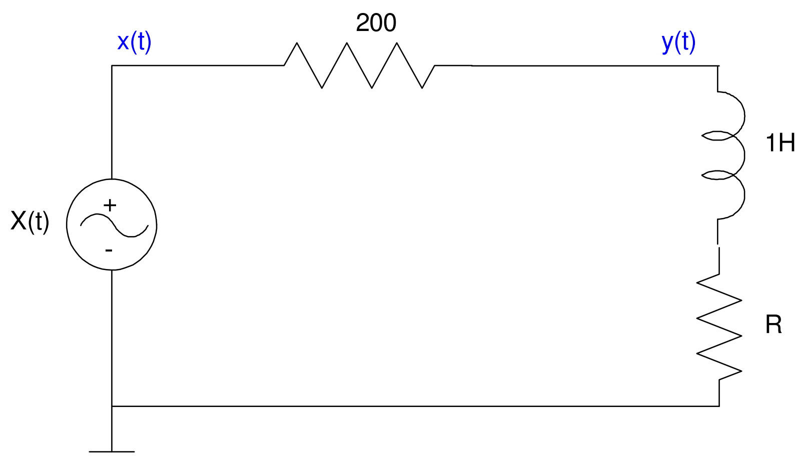
Fourier Transform

5) Determine y(t) given that

$$x(t) = 24 + 5\sin(50t) + 2\cos(100t)$$

- R = 800 + 100*(your birth month) + (your birth date)

R 800 + 100*mo + day	y(t)
1314	**20.830** **+ 0.022 cos(50t) + 4.340 sin(50t)** **+ 1.737 cos(100t) - 0.017 sin(100t)**



Use superposition

x(t) = 24

$$y = \left(\frac{1314}{1314+200}\right)24 = 20.830V$$

x(t) = 5 sin(50t)

$$X \rightarrow -j5$$

$$L \rightarrow j\omega L = j50$$

$$Y = \left(\frac{1314+j50}{(1314+j50)+(200)}\right)(-j5) = 0.022 - j4.340$$

x(t) = 2 cos(100t)

$$X \rightarrow 2$$

$$L \rightarrow j\omega L = j100$$

$$Y = \left(\frac{1314+j100}{(1314+j100)+(200)}\right)(2) = 1.737 + j0.017$$

Boolean Logic

6) Design a circuit using NOR gates to implement Y(A,B,C,D)

Y (AB \ CD)	00	01	11	10
00	x	0	1	1
01	1	1	1	x
11	x	x	0	0
10	x	1	x	0

$$\overline{Y} = \overline{A}\,\overline{B}\,\overline{C} + AC$$

Using DeMorgan's law

$$Y = (A + B + C)\left(\overline{A} + \overline{C}\right)$$

Implement using NOR gates