ECE 363 QUIZ 5 (F19) NAME:_____

1 problem for 20 pts

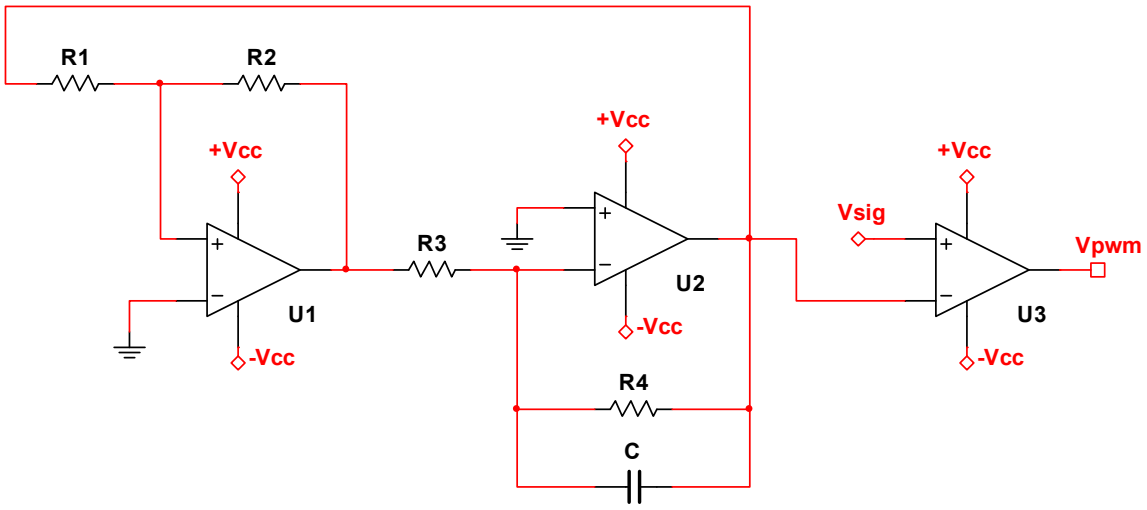
Pulse Width Modulator

Consider the pulse width modulator shown in the figure below. The circuit uses three op amps (two for the triangle wave generator, one for the comparator). The desired specs are the following:

- Triangle wave: 8 volt peak-to-peak (within 5%) at 4 kHz (within 5%)
- All op amps powered with split power supplies (+/- 12 V).
- Assume $V_{SAT(+)} = +(V_{CC} - 1)$ and $V_{SAT(-)} = -(V_{CC} - 1)$
- $V_{SIG} = +2$ V
- Use standard 5% resistor and 10% capacitor values.

The following formulas may be useful:

- Triangle wave frequency: $f = R_2 / (4R_1R_3C)$
- Threshold voltage: $V_{TH} = (R_1/R_2)(V_{SAT(+)} - V_{SAT(-)}) / 2$
- Reference voltage: $V_{REF} = (V_{SAT(+)} + V_{SAT(-)}) /2$



a) Choose R_1 and R_2. Remember that R_2 is typically in the 100 kohm range.

b) Choose R_3 and C. Remember that C is typically between 1 nF and 100 nF.

c) Choose an appropriate value for R_4.

d) Based on your component values, compute the actual frequency and peak-to-peak amplitude to confirm they satisfy the design requirements.

e) Sketch the PWM output over a 1 ms interval and include the duty cycle. Note: Be careful with analyzing the input connections to the comparator.

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(extra sheet for work)

Standard Resistor Values (±5%)						
1.0	10	100	1.0K	10K	100K	1.0M
1.1	11	110	1.1K	11K	110K	1.1M
1.2	12	120	1.2K	12K	120K	1.2M
1.3	13	130	1.3K	13K	130K	1.3M
1.5	15	150	1.5K	15K	150K	1.5M
1.6	16	160	1.6K	16K	160K	1.6M
1.8	18	180	1.8K	18K	180K	1.8M
2.0	20	200	2.0K	20K	200K	2.0M
2.2	22	220	2.2K	22K	220K	2.2M
2.4	24	240	2.4K	24K	240K	2.4M
2.7	27	270	2.7K	27K	270K	2.7M
3.0	30	300	3.0K	30K	300K	3.0M
3.3	33	330	3.3K	33K	330K	3.3M
3.6	36	360	3.6K	36K	360K	3.6M
3.9	39	390	3.9K	39K	390K	3.9M
4.3	43	430	4.3K	43K	430K	4.3M
4.7	47	470	4.7K	47K	470K	4.7M
5.1	51	510	5.1K	51K	510K	5.1M
5.6	56	560	5.6K	56K	560K	5.6M
6.2	62	620	6.2K	62K	620K	6.2M
6.8	68	680	6.8K	68K	680K	6.8M
7.5	75	750	7.5K	75K	750K	7.5M
8.2	82	820	8.2K	82K	820K	8.2M
9.1	91	910	9.1K	91K	910K	9.1M

Standard Capacitor Values (±10%)							
10pF	100pF	1000pF	.010μF	.10μF	1.0μF	10μF	**100 μF**
12pF	120pF	1200pF	.012μF	.12μF	1.2μF		
15pF	150pF	1500pF	.015μF	.15μF	1.5μF	**15 μF**	**150 μF**
18pF	180pF	1800pF	.018μF	.18μF	1.8μF		
22pF	220pF	2200pF	.022μF	.22μF	2.2μF	22μF	**220 μF**
27pF	270pF	2700pF	.027μF	.27μF	2.7μF		
33pF	330pF	3300pF	.033μF	.33μF	3.3μF	33μF	**330 μF**
39pF	390pF	3900pF	.039μF	.39μF	3.9μF		
47pF	470pF	4700pF	.047μF	.47μF	4.7μF	47uF	**470 μF**
56pF	560pF	5600pF	.056μF	.56μF	5.6μF		
68pF	680pF	6800pF	.068μF	.68μF	6.8μF	**68 μF**	**680 μF**
82pF	820pF	8200pF	.082μF	.82μF	8.2μF		