Quiz II

ECSE 1010

Fall 2017

Name _____

Section 1 or 2: MR 12 noon to 1:50pm or MR 4:00 to 5:50 pm

Part B (80 Points)

1. (10 Pts) _____
2. (10 Pts) _____
3. (10 Pts) _____
4. (30 Pts) _____
5. (10 Pts) _____
6. (10 Pts) _____

Total _____

Draw circuit diagrams for all problems, especially as you simplify the circuits.

Be sure to fully annotate plots, even when the problem does not ask you to do this.

Show all of your work

Almost all problems can be solved using more than one method. Check your answers by using a second method.

At least skim through the entire quiz before you begin and then start with the problems you know best.

The proctor will only answer clarification questions where wording is unclear or where there may be errors/typos. No other questions will be responded to.

Inductance Specs – From Digilent Parts Kit Website

Electrical Specifications (@ 25 °C)

Part Number	Inductance (μH)	Tol.	Q (Min.)	Test Frequency		SRF (MHz) Typ.	DCR (Ω) Max.	I dc (A)
				L	Q			
RL622-1R0K-RC	1.0	±10 %	20	7.96 MHz	7.96 MHz	150	0.013	10
RL622-1R5K-RC	1.5	±10 %	20	7.96 MHz	7.96 MHz	130	0.016	8.5
RL622-2R2K-RC	2.2	±10 %	20	7.96 MHz	7.96 MHz	100	0.021	6.5
RL622-3R3K-RC	3.3	±10 %	20	7.96 MHz	7.96 MHz	79	0.025	5.5
RL622-4R7K-RC	4.7	±10 %	20	7.96 MHz	7.96 MHz	51	0.030	4.3
RL622-6R8K-RC	6.8	±10 %	20	7.96 MHz	7.96 MHz	29	0.035	3.7
RL622-100K-RC	10	±10 %	50	2.52 MHz	2.52 MHz	14	0.045	3.0
RL622-120K-RC	12	±10 %	50	2.52 MHz	2.52 MHz	13	0.050	2.7
RL622-150K-RC	15	±10 %	40	2.52 MHz	2.52 MHz	12	0.056	2.3
RL622-180K-RC	18	±10 %	40	2.52 MHz	2.52 MHz	11	0.061	2.2
RL622-220K-RC	22	±10 %	40	2.52 MHz	2.52 MHz	9.2	0.070	2.0
RL622-270K-RC	27	±10 %	30	2.52 MHz	2.52 MHz	8.5	0.080	1.7
RL622-330K-RC	33	±10 %	30	2.52 MHz	2.52 MHz	7.8	0.090	1.6
RL622-390K-RC	39	±10 %	30	2.52 MHz	2.52 MHz	6.9	0.10	1.5
RL622-470K-RC	47	±10 %	30	2.52 MHz	2.52 MHz	6.5	0.16	1.4
RL622-560K-RC	56	±10 %	30	2.52 MHz	2.52 MHz	5.4	0.18	1.3
RL622-680K-RC	68	±10 %	30	2.52 MHz	2.52 MHz	4.9	0.21	1.2
RL622-820K-RC	82	±10 %	30	2.52 MHz	2.52 MHz	4.1	0.23	1.1
RL622-101K-RC	100	±10 %	20	796 KHz	796 KHz	3.7	0.28	0.91
RL622-121K-RC	120	±10 %	20	796 KHz	796 KHz	3.4	0.32	0.84
RL622-151K-RC	150	±10 %	20	796 KHz	796 KHz	3.2	0.37	0.75
RL622-181K-RC	180	±10 %	20	796 KHz	796 KHz	2.8	0.58	0.69
RL622-221K-RC	220	±10 %	20	796 KHz	796 KHz	2.7	0.65	0.64
RL622-271K-RC	270	±10 %	20	796 KHz	796 KHz	2.4	0.75	0.57
RL622-331K-RC	330	±10 %	20	796 KHz	796 KHz	2.3	0.85	0.54
RL622-391K-RC	390	±10 %	20	796 KHz	796 KHz	2.1	1.0	0.48
RL622-471K-RC	470	±10 %	20	796 KHz	796 KHz	1.9	1.1	0.46
RL622-561K-RC	560	±10 %	20	796 KHz	796 KHz	1.8	1.4	0.41
RL622-681K-RC	680	±10 %	20	796 KHz	796 KHz	1.6	1.6	0.38
RL622-821K-RC	820	±10 %	20	796 KHz	796 KHz	1.5	1.8	0.38
RL622-102K-RC	1000	±10 %	50	252 KHz	252 KHz	1.3	2.9	0.29
RL622-122K-RC	1200	±10 %	50	252 KHz	252 KHz	1.1	4.0	0.13
RL622-152K-RC	1500	±10 %	20	252 KHz	252 KHz	1.0	6.1	0.08
RL622-182K-RC	1800	±10 %	20	252 KHz	252 KHz	1.0	6.4	0.08
RL622-222K-RC	2200	±10 %	20	252 KHz	252 KHz	0.9	6.8	0.08
RL622-272K-RC	2700	±10 %	20	252 KHz	252 KHz	0.9	7.7	0.08
RL622-332K-RC	3300	±10 %	20	252 KHz	252 KHz	0.7	9.0	0.08
RL622-392K-RC	3900	±10 %	20	252 KHz	252 KHz	0.6	14	0.08
RL622-472K-RC	4700	±10 %	20	252 KHz	252 KHz	0.5	16	0.05
RL622-562K-RC	5600	±10 %	20	252 KHz	252 KHz	0.4	18	0.05
RL622-682K-RC	6800	±10 %	20	252 KHz	252 KHz	0.4	19	0.05
RL622-822K-RC	8200	±10 %	20	252 KHz	252 KHz	0.3	21	0.05
RL622-103K-RC	10,000	±10 %	40	79.6 KHz	79.6 KHz	0.3	25	0.05

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

Type	R_{int} (Ω)	V_{oc} (V)	Capacity[a] continuous, to 1V/cell (mAh)	@ (mA)	(mAh)	@ (mA)	Size (in)	Weight (gm)	Connec[b]	Comments
9V "1604"										
Le Clanche	35	9	300	1	160	10	0.65x1x1.9	35	S	
Heavy Duty	35	9	400	1	180	10	"	40	S	
Alkaline	2	9	500	1	470	10	"	55	S	280mAh@100mA
Lithium	18	9	1000	25	950	80	"	38	S	Kodak Li-MnO_2

Standard Capacitor Values

STANDARD CAPACITOR VALUES

These are the EIA **standard capacitor values.** These are the values available from most vendors. Non-polarized run from 1pF to 1uf, while electrolytics are available from 0.1uF and higher (not all electrolytic values listed here).

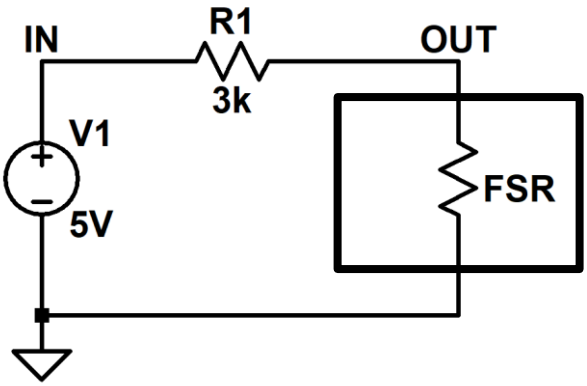
1.0pF	10pF	100pF	.001uF	.01uF	.1uF	1.0uF	10uF
1.2pF	12pF	120pF	.0012uF	.012uF	.12uF	1.2uF	12uF
1.5pF	15pF	150pF	.0015uF	.015uF	.15uF	1.5uF	15uF
1.8pF	18pF	180pF	.0018uF	.018uF	.18uF	1.8uF	18uF
2.2pF	22pF	220pF	.0022uF	.022uF	.22uF	2.2uF	22uF
2.7pF	27pF	270pF	.0027uF	.027uF	.27uF	2.7uF	27uF
3.3pF	33pF	330pF	.0033uF	.033uF	.33uF	3.3uF	33uF
3.9pF	39pF	390pF	.0039uF	.039uF	.39uF	3.9uF	39uF
4.7pF	47pF	470pF	.0047uF	.047uF	.47uF	4.7uF	47uF
5.6pF	56pF	560pF	.0056uF	.056uF	.56uF	5.6uF	56uF
6.8pF	68pF	680pF	.0068uF	.068uF	.68uF	6.8uF	68uF

Some Typical LED Specs

1206 smd LEDs 3.2x1.6x1.1MM		Forward voltage		Dominant wavelength		Luminous Intensity		Viewing angle
Part number	Emitting Color	(V) IF=20mA		IF=20mA		(mcd) IF=20mA		
		TYP	MAX	MIN	MAX	TYP	MAX	(degree)
SS-1206R	Red	2.1	2.3	640	650	650	660	120
SS-1206Y	Yellow	2.2	2.8	590	600	550	560	120
SS-1206O	Orange	2.2	2.8	635	645	470	480	130
SS-1206B	Blue	3.2	3.4	465	475	650	660	120
SS-1206G	Plain Green	3.2	3.4	568	573	420	430	120
SS-1206JG	Jade-green	3.2	3.4	530	540	590	600	120
SS-1206W	White	3.2	3.4	X=0.285	Y=0.295	500	800	120
SS-1206P	Pink	3.2	3.4	----	---	300	400	120
SS-1206UV	UV(Purple)	3.2	3.4	380	400	120	160	120

Problem 1 (10 Pts) – Experimentally Determining an Input Impedance

Nearly all loads can be characterized by some kind of simple input impedance. For example, the two analog input channels on the Analog Discovery board have an input resistance of 1MΩ and an input capacitance of 24pF. The circuit at the right is set up to determine the resistance of a Fore Sensitive Resistor (FSR) under two applied force conditions. FSR's are robust polymer thick film devices that exhibit a decrease in resistance with increase in force applied to the surface of the sensor.



The voltage across FSR is measured using Analog Discovery when 100g and 1000g weights are placed on the FSR. The data for these two measurements are given below.

Trial	Force = m*g [kg*m/s^2]	V(OUT)
1	0.98 N	3.7603V
2	9.8 N	1.667V

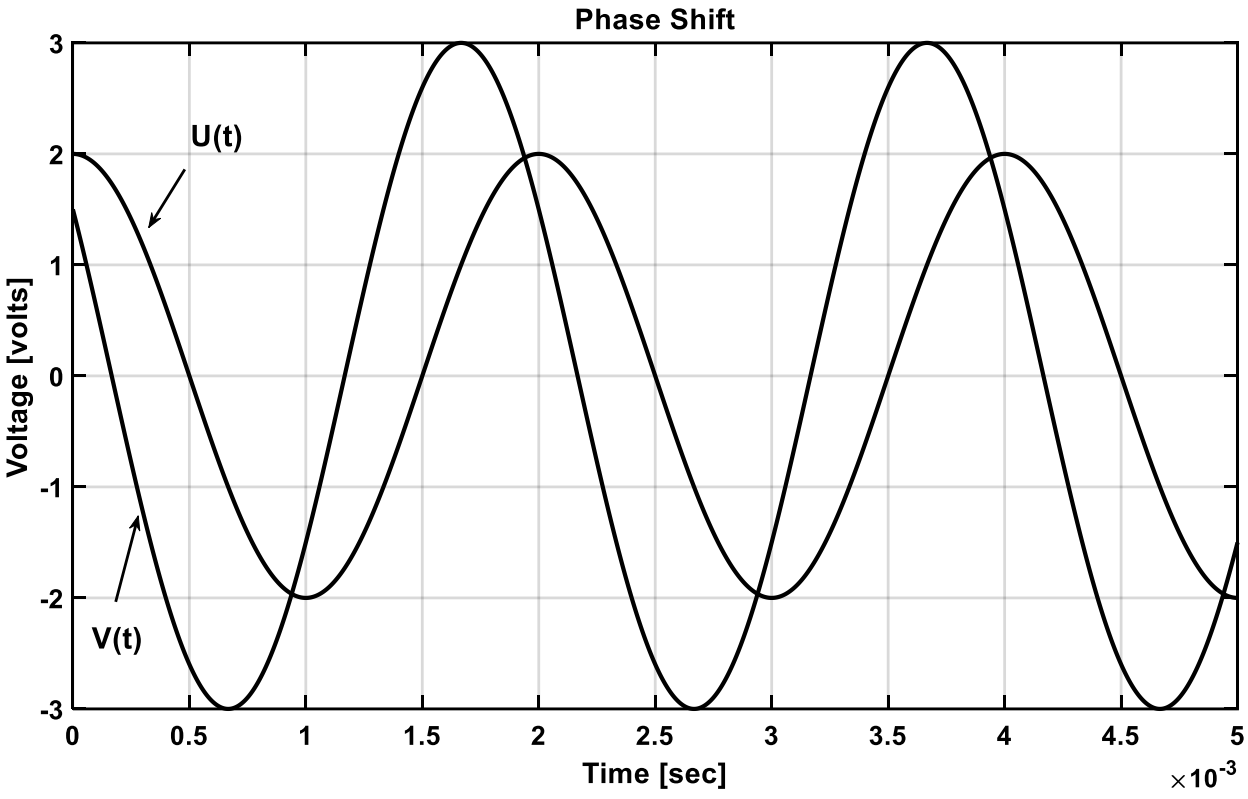
a. (4 Pts) Determine the unknown resistance FSR when the smaller weight is placed on sensor.

b. (4 Pts) Determine the unknown resistance FSR when the heavier weight is placed on sensor.

c. (2 Pts) Which of the two measurements is more accurate (the closest, in percentage error) to the actual value?

Problem 2 (10 Points) – Phase

In the Matlab generated plot below, two cosinusoidal voltages are shown vs time. $U(t) = \cos(\omega t)$ and $V(t) = \cos(\omega t + \theta)$. The magnitudes of the two voltages are not the same. The vertical scale is 1V/Div and the horizontal scale is 0.5ms/Div



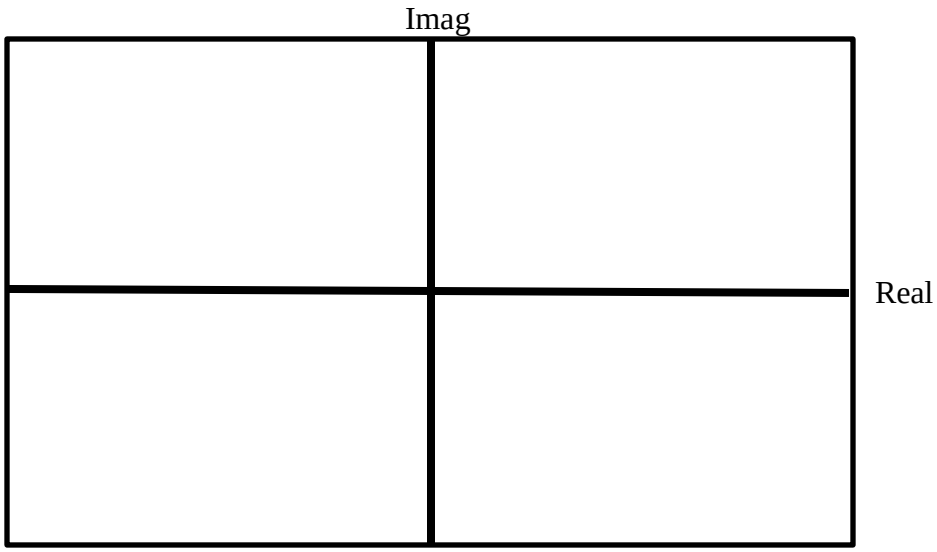
a. (2 Pts) Determine the frequency *f in Hertz* and ω *in Radians.*

b. (2 Pts) Determine the phase of *V* in degrees. *Be sure to specify its sign and remember it can have any value from -360 degrees to +360 degrees.*

c. (2 Pts) What is the amplitude of V in Volts?

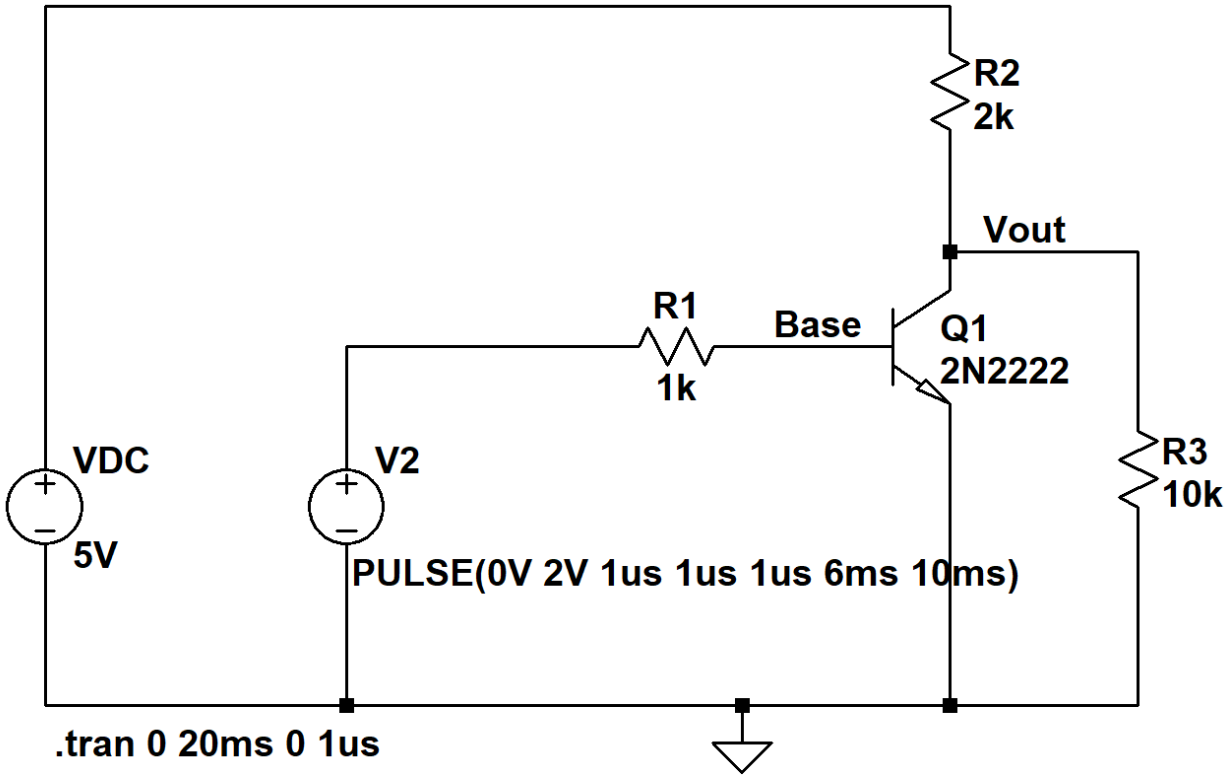
d. (2 Pts) What is the phasor form of $\tilde{V} = ?$

e. (2 Pts) Plot the point for the phasor voltage on the complex plane. *Plot the point that represents its value as a complex number. Be sure to fully label the plot.*



Problem 3 (10 Pts) – Transistor as a Switch

In the circuit below, the 2N3904 NPN transistor is being used as a switch. The pulsed source produces a square voltage wave with a 1.0V amplitude and a 1.0V offset. R2 = 2kΩ and R3 = 10kΩ.

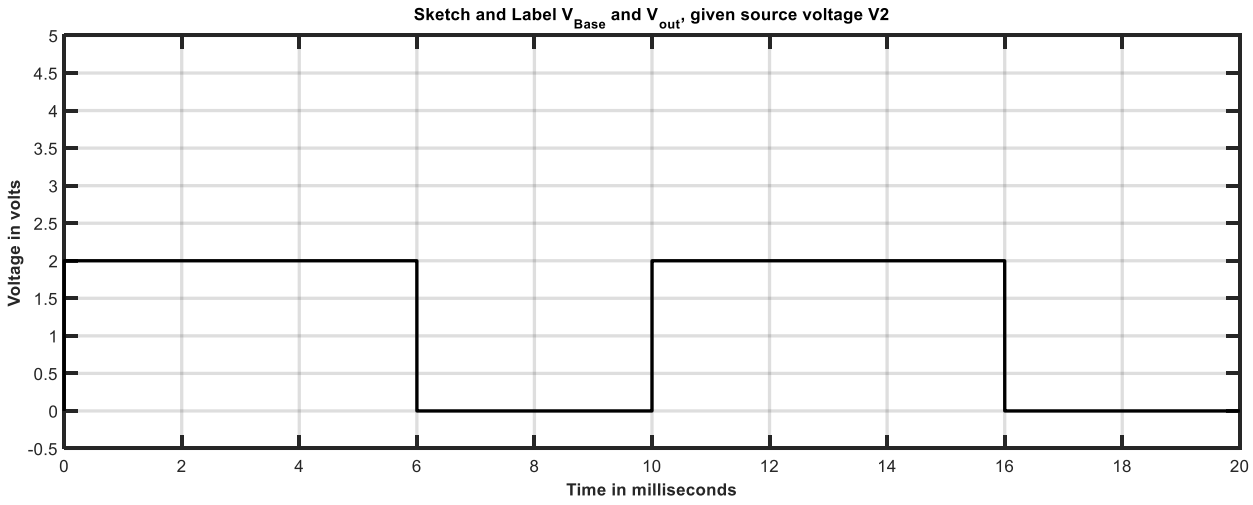


a. (3 Pts) Determine the voltage across resistor R3 when the source voltage Vsource (V2) is at or near its maximum value. Is the switch ON or OFF?

b. (3 Pts) Determine the voltage across the resistor R3 when the source voltage Vsource (V2) is at or near its minimum value. Is the switch ON or OFF?

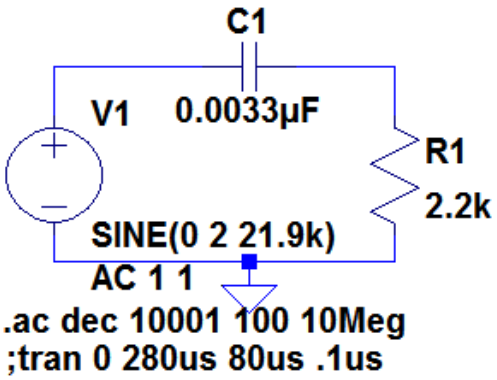
c. (2 Pts) Which of the following is true?
   a. The transistor is ON more than half the time
   b. The transistor is OFF more than half the time
   c. The transistor is ON half the time and OFF half the time
   d. There is not enough information to select an answer from the choices above

d. (2 Pts) A plot of the input source voltage V2 is shown below. Sketch and label the Base voltage V(Base) and the output voltage V(Out) as functions of time on the same plot. The vertical scale is 0.5V/div and the horizontal scale is 2ms/div.



Problem 4 (30 Points) – Phasor Analysis of Filters

A simple filter is configured with an capacitor and a resistor, as shown. For parts a-d of this problem, you are asked for the general functional form of expressions (i.e. in terms of ω, R, C, V1, V(OUT), V(IN)). ***Do not plug in numbers until you are asked to do so.***

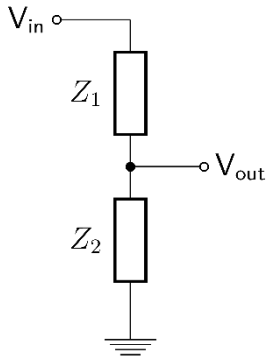


a. (2 Pts) Is this a high pass or a low pass filter?

b. (2 Pts) What are the general forms for the impedances of a resistor and a capacitor as functions of frequency?

$Z_R =$ $Z_C =$

c. (3 Pts) This circuit is of the general form shown at the right which is a voltage divider built with two general impedances rather than resistors. Write the general expression for V_{out} in terms of V_{in}, Z_1 and Z_2.



d. (3 Pts) Find the general form of the filter transfer function

$$H(j\omega) = \frac{\tilde{V}_{OUT}}{\tilde{V}_{IN}} = ?$$

For the remainder of this problem, plug in actual numbers for components, voltages, etc.

e. (4 Pts) Evaluate your expression from part d for the given frequency (21.9kHz) and component values. *Your answer should be complex, but you do not need to simplify it yet.*

f. (4 pts) Find the real and imaginary parts of your answer to part e.

$$\mathrm{Re}\{H(j\omega)\} = ? \qquad \mathrm{Im}\{H(j\omega)\} = ?$$

g. (4 Pts) Using your answers to part f, write the transfer function in polar form. That is find the magnitude and phase (in radians and degrees). *Hint: The phase should be near π/n where n is some integer from 1 to 12.*

$$H(j\omega) = |H(j\omega)|e^{j\theta_H} = ?$$

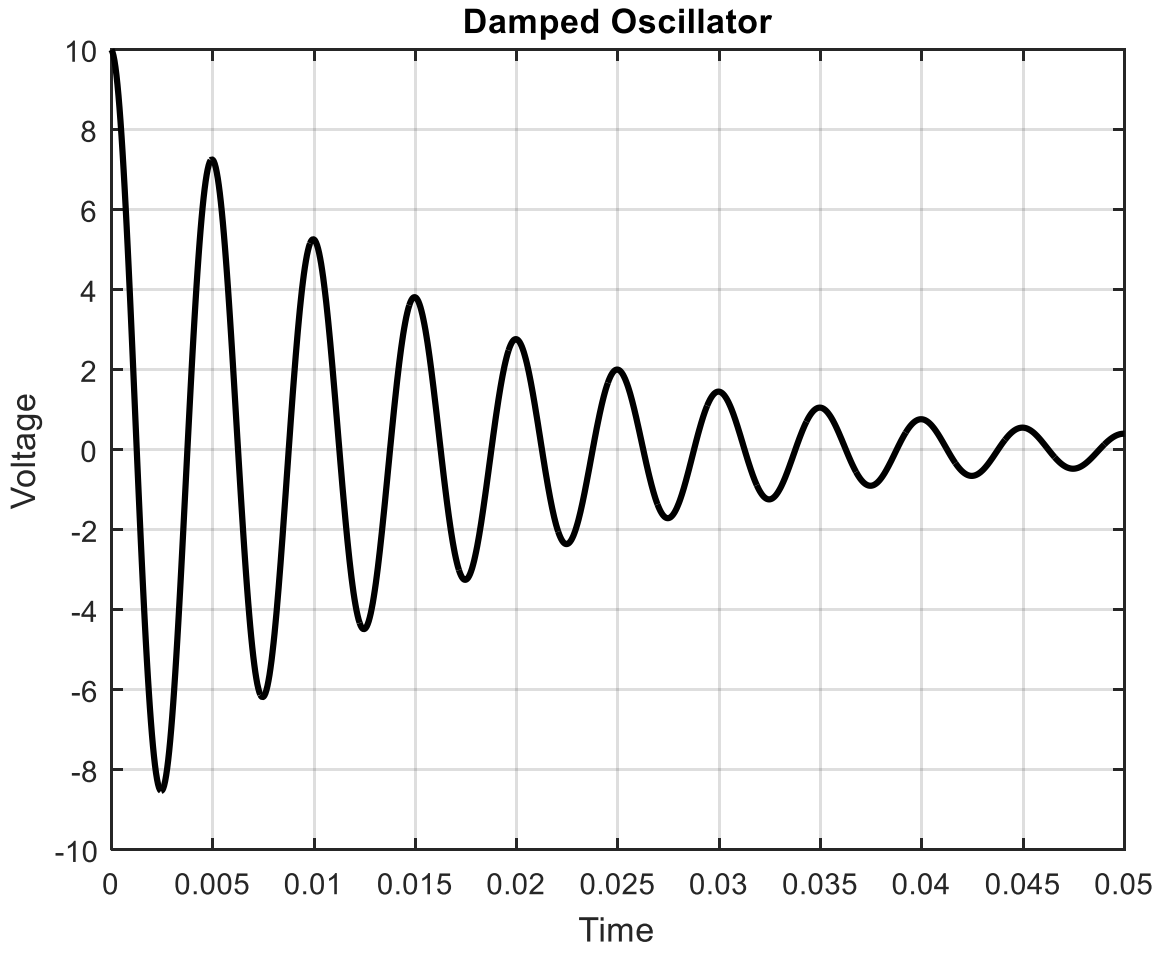
h. (2 Pts) The input voltage is given as $V_{IN}(t) = 5\cos\omega t$. That is, it has a magnitude of 5V, no phase and is at the given frequency. Write the input voltage <u>in phasor form</u> $\tilde{V}_{IN} = ?$

i. (3 Pts) Solve for the output voltage in phasor form $\tilde{V}_{OUT} = ?$.

j. (3 Pts) Convert the output voltage back to time varying form $V_{OUT}(t) = ?$

Problem 5 (10 Pts) – Damped Harmonic Oscillator

The voltage shown below is for a typical damped harmonic oscillator. The vertical scale is 2V/Div and the horizontal scale is 0.005s/Div.

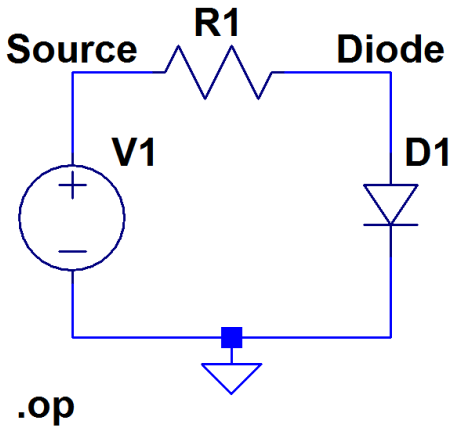


a. (3 Pts) Determine the frequency of the oscillation *f*.

b. (3 Pts) Determine the damping constant of the oscillation $\alpha = 1/\tau$

c. (4 Pts) Write the mathematical expression for the voltage as a function of time in the form $V(t) = V_o e^{-\alpha t} \cos \omega t$.

Problem 6 (10 Pts) – Diodes, Current, Voltage and Power



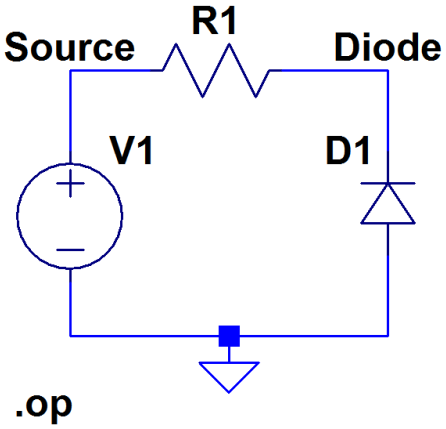
In the diode circuit shown, a white light emitting diode is used. The voltage source is DC and equal to 9V. The resistor R1 is 300Ω. Note that you are not given the load line for this diode, so you must find the typical forward voltage from the LED data provided on p5. *Explain all answers and indicate any assumptions.*

a. (1 Pt) Is the diode ON or OFF in this circuit with the given values for V1 and R1?

b. (2 Pts) Given your answer to part a, what is the voltage across the diode?

c. (2 Pts) What is the current through the diode? *Hint: It is the current through the resistor.*

The diode orientation is now reversed, as shown.



d. (1 Pt) Is the diode ON or OFF in this circuit, with the given values for V1 and R1?

e. (2 Pts) Given your answer to part a, what is the voltage across the diode?

f. (2 Pts) What is the current through the diode? *Hint: It is the current through the resistor.*