Question 1

6 pts

Write the MATLAB code for the function **make_wv1** that realizes the t, wv vector as called by **[t,wv] = make_wv1(K1, alpha1, K2, alpha2, f2, A, f, tSpan);** All input but **tSpan** are scalar values. The input vector **tSpan** get assigned into the output vector **t** as returned by the function.

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Question 2

3 pts

Write MATLAB code that uses the **make_wv1** function to make the **t**, **wv** vector pair. We'll be using this waveform (you've downloaded its description) to answer the remaining Part I questions. The values **K1**, **alpha1**, **K2**, **alpha2**, and **A** should respectively take on the values of **15**, **5000**, **25**, **2000**, and **5**. The respective frequencies for **f2** and **f** should be **25 kHz** and **10 kHz.** Finally, the **tSpan** vector should define a time sequence that last for **3 msec** such that the representative time interval between adjacent element is **1 msec.** Given these values (you can assign them into variables first or pass them into **make_wv1** anonymously), write the MATLAB code that applies **make_wv1** to obtain this desired vector pair.

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Question 3

3 pts

(Easy question!) Given the above waveform, as time gets "large" the function should describe a sinusoid with a given amplitude and frequency. To answer this question, simply write down the values of the amplitude and frequency for this sinusoid.

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Question 4

2 pts

Write MATLAB code to plot this function such that the time axis is shown in **msec**. No scaling is required for the **wv** axis.

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Question 5

4 pts

Write MATLAB code to realize a plot showing just the first **200 msec** of the waveform. For this problem, the time axis should be in **msec**.

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Question 6

3 pts

Either use the plot or write a MATLAB expression that will determine the maximum overshoot value of the function. (Four points credit for the

MATLAB expression -- just 3 points if you use the plot.) Write down the value you obtained accurate to 3 decimal places (a 4th place is optional).

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Question 7

4 pts

Write MATLAB code to realize a plot showing the waveform from **2.8 msec** through **3.0 msec**. The plot here should show the time axis expressed in **msec**.

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Question 8

2 pts

During the time span from **2.8 msec** to **3.0 msec**, can we strictly say the waveform has achieved steady state? Explain your answer with some numbers. If you use the plot, the answer is worth 2 point (if correct!); if you use MATLAB code and obtain the correct answer, you will receive 3 points credit.

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For this part, you are given a vector **x** containing 50000 values. The element values are contained in the file PartIIValues.mat. Download the file by clicking on its link. Then move the downloaded file into your Working Directory. You'll put the **x** vector into your Workspace with the Command

load('PartIIValues');

You can verify a correct download by inspection of the values of **x(1)** and **x(50000)** using the Command **[x(1) x(50000)]**. If you see the values 2**1.1000** and **27.6000**, you'll know you've gotten a valid download. If you're not getting these values, speak up lest you get all the wrong numbers as answers to all six questions for this part.

Question 9

5 pts

Write the MATLAB code to find the lowest and highest values contained in **x** and the mean value over all elements of **x**. Be sure to show the answers MATLAB gave you as part of the answer.

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Question 10

5 pts

Write the MATLAB code (and the answer MATLAB gives you) to find the count of the number of elements in **x** less than or equal to the value **8.3**

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Question 11

5 pts

Write the MATLAB code and the value MATLAB gives you to find the count of the number of elements lying between the values of **15.0** and **25.0**, inclusive. (The values of **15.0** and **25.0** should be included in the count.)

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Question 12

1 pts

Write the MATLAB code and the value MATLAB gives you to find the count of all elements in **x** exactly equal to the values of either **19.0** or **19.1**

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Question 13

5 pts

Write the MATLAB code to find both the value and the index of the 10th smallest value and the 10th largest value in **x**. Write down the answers MATLAB gives you as **x(???) = ???** for both elements. I should be able to distinguish which value represents the 10th smallest vs. the 10th largest without your specifying which is which ;-)

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Question 14

5 pts

There are five elements in **x** whose values are greater than **80**. Write the MATLAB code to find the values (not the indices!) of these elements and then write down these five values. MATLAB gives you.

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For this part, you are to write two MATLAB functions, that when invoked, will make a piecewise continuous waveform.

To make the first waveform, we suggest you use the **make_ramp.m** (https://drive.google.com/file/d/1jQFZWR2BN05JLHeALejWbwmfpl7ft1iX/view?usp=sharing) file to make the piecewise linear functions of the waveform. Use of this function will make your task much easier.

Your best of the two efforts on this part will carry a weight of 15 points, and your worst will weigh in at just 10 points.

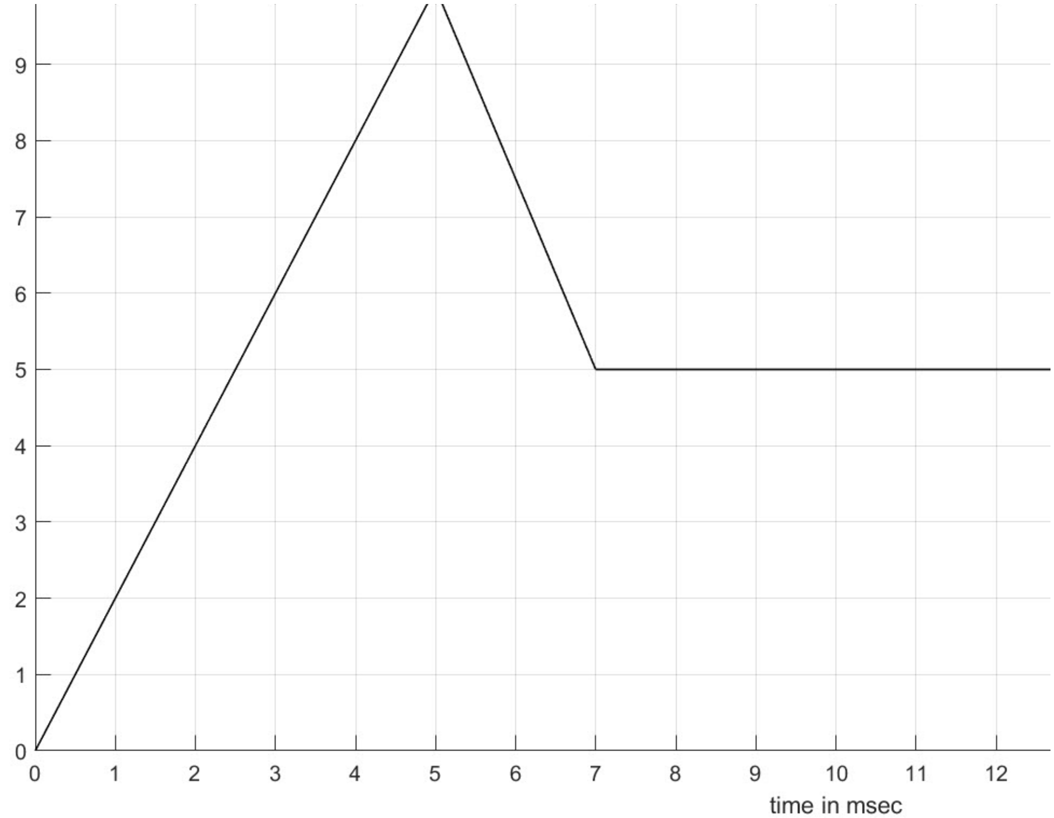
Question 15

12.5 pts

You are to write the MATLAB code for the function **make_wv3a** as invoked in the Command window by

[t, wv] = make_wv3a( );

where, as shown by the picture below, the waveform consists of five piecewise linear components. If you make use of the function **make_ramp.m** (https://drive.google.com/file/d/1jQFZWR2BN05JLHeALejWbwmfpl7ft1iX/view?usp=sharing) , an m-file that returns a straight-line **t**, **wv** as per the input specifications, this work will be simplified greatly. Here's how the waveform should appear:



As you can see from the figure, for the first **5 msec**, the waveform traces out a straight with a starting value of **0** and an ending value of **10**.

The second segment, lasting for **2 msec** has the line starting with a value of **10** and ending with a value of **5**.

The third segment is a line with a constant value of **5**, lasting for **6 msec**.

We describe the fourth segment as a line whose value starts at **5** and ends at **10**. The time duration of this line is **2 msec**.

The final segment has a starting value of **10** and a final value of **0**. It lasts for **5 msec**.

To make this waveform viable, you must make the increment between adjacent elements of the **t**-vector to represent a time duration of **1 msec.**

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Question 16

12.5 pts

For this second question, you are to write the MATLAB code for the function **make_wv3b,** where it again returns a **t**, **wv** vector pair that describes a waveform. I

The described waveform should trace out one complete period of a sinewave with a specified frequency **f** and an amplitude **A**. The next segment should trace out the same waveform for two more complete periods where now the amplitude is just **A/2**. The final segment should again trace out the sinusoid for a final complete period with an amplitude of **A**. (We remind you that the formula for period **T** is given by **1/f**.)

Note: We have provided an auxiliary function, sinewave.m, if you wish to use it. It returns a t, wv vector pair that's a sinewave where the values to make the wave are found (as always) in the inputs of the function. You can use it if you wish; it's not necessary.

make_wv3b should receive three scalar inputs: **A**, f, and incr. The value of **incr** specifies the represented time duration between adjacent elements of the **t** vector. Two typical calls (and plots) to this function might look like

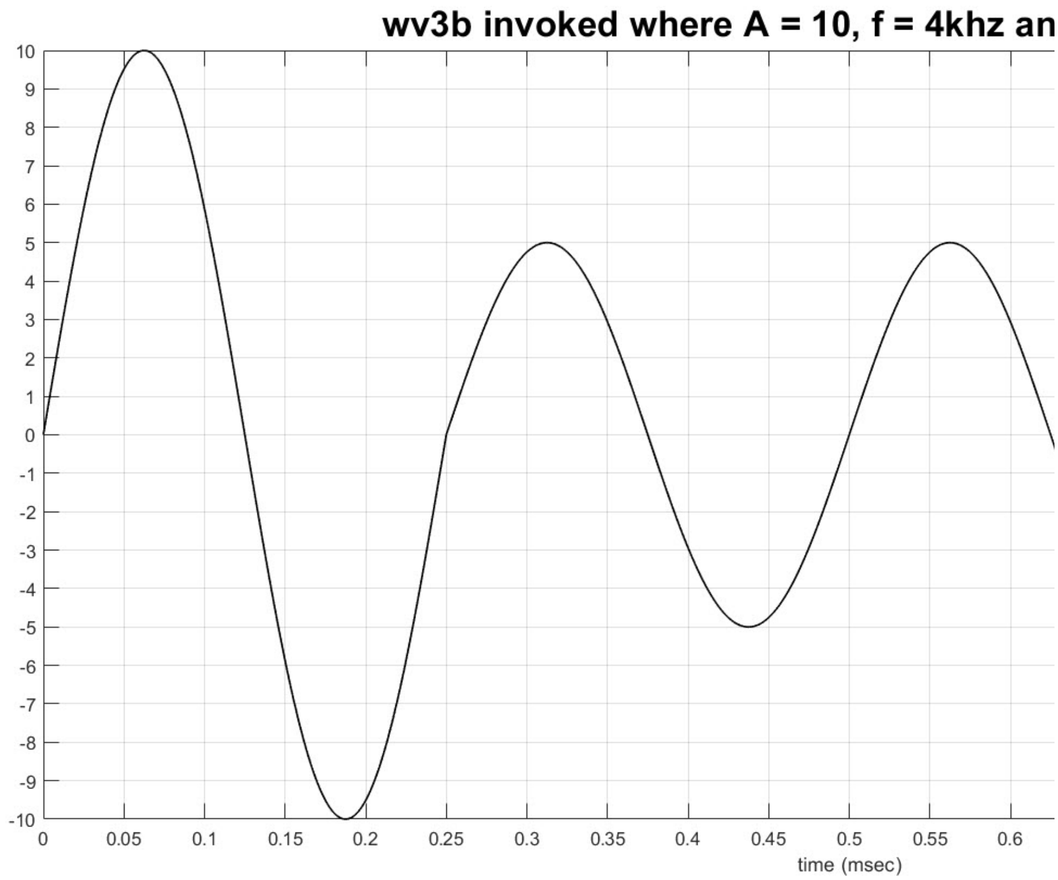
```
[t1, wv3b1] = make_wv3b(10, 4e03, 1e-06);
plot(t1/1e-03, wv3b1);
```

and

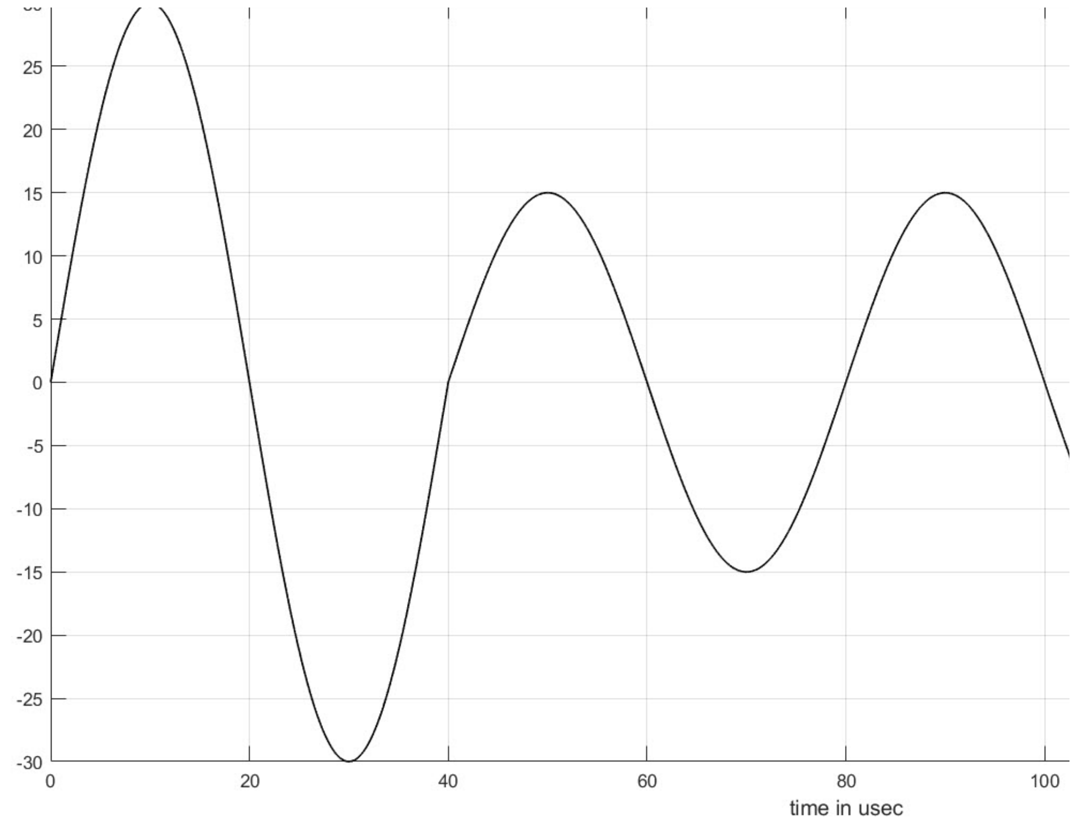
```
[t2, wv3b2] = make_wv3b(50, 25e03, 1e-090;
```

plot(t/1e-06, wv3b2);

where the respective plots are shown as



and



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For this part, you need to apply Fourier analysis on a given waveform that has a period of **1 msec** and a fundamental frequency of **1 kHz**. You'll need to know this information to answer most of the questions to this part.

The vector pair describing this waveform is contained in the PartIVWaveform.mat file. The file PartIVFourierInfo.mat contains the Fourier information about this waveform. You should load the data contained in these files into your workspace before starting this part. Download the file into your workspace, and then get the required information you need viat the coded sequence:

```
load('PartIVWaveform');
load('PartIVFourierInfo');
```

If you have access to the files in the fourier_analysis_toolbox (you should!), you can now go on to answer the questions for this part.

If you don't have access to the **four_analysis_toolbox** (really??), you can download the three m-files you'll need from the links:

get_rms_value.m (https://drive.google.com/file/d/1-9O2CnulV5Fw0TbWDzXcdHb9dzmOlyQc/view?usp=sharing) **sum_fouriers.m (https://drive.google.com/file/d/1mSeghGUfStusHJGZ3PMBoGdyL17mO0kT/vi usp=sharing)** **sum_powers.m (https://drive.google.com/file/d/1F6qyefsTRZMorhiYiu6LAW9QPXzxfcmr/view? usp=sharing)**

Note that I haven't given you the link to the file that gets you the Fourier information, viz. **fouriers.m**. ***The omission is deliberate.*** You don't need it, nor do I recommend you actually invoke this function to get this information. It's all provided for you in the **PartIVFourierInfo.mat** file.

Question 17 3 pts

Write MATLAB code that realizes the vector pair **t**, **wv4N**. The pair describes a waveform that retains the shape of **t**, **wv4** but normalizes it to have an rms value of **10** rather than its original value. As part of this work, you will need to obtain the rms value of the original waveform. Include this value as part of the answer to the question.

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Question 18

3 pts

Write the code that assigns values into the Fourier information (scalar **N** and vectors **f**, **A**, and **theta**) you'll need to answer the remaining questions that relate to the **t**, **wv4N** waveform.

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Question 19

3 pts

Write the code to find the value of dc power contained in the waveform. Also write down the value MATLAB gave you.

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Question 20

3 pts

Then write the code that sums the powers of the dc and all the sinusoidal components contained in the waveform. Include the value MATLAB gave you, and also write down the value it should be if there were no computational error.

1-point extra credit: Write down in one sentence or less how you could get a more nearly accurate value for this power sum.

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Question 21

5 pts

Write the code to obtain a quick-and-dirty table (an unformatted matrix expression) of the dc power and the powers contained in the first fifteen harmonics of the waveform. Write the code to display the values of the frequencies as integer harmonics (Recall: the fundamental frequency of the waveform is 1 kHz). Write down the text of the table MATLAB gave you. You can express all powers accurate to just two decimal places.

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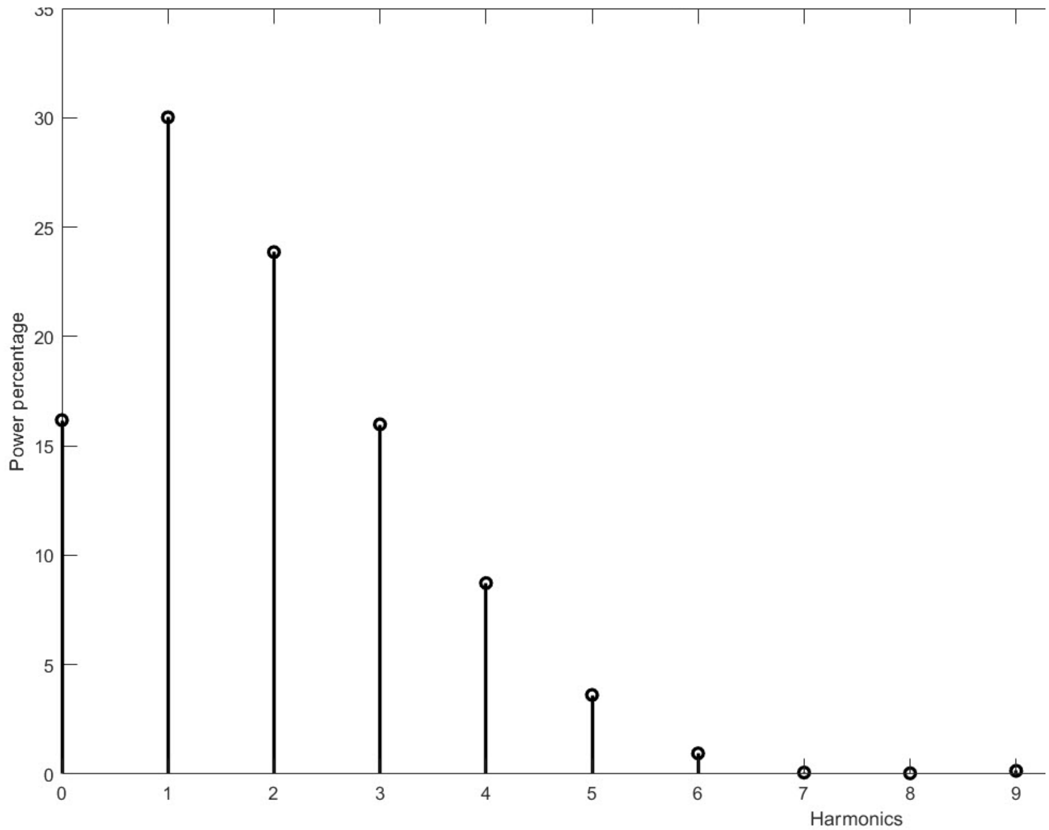
Question 22

4 pts

Using the matrix of the table you obtained in the previous question, write the code that realizes a **stem** plot of the powers contained in the dc component plus the first fifteen harmonics. The plot should look like the following (formatted -- you don't need to do that) figure:



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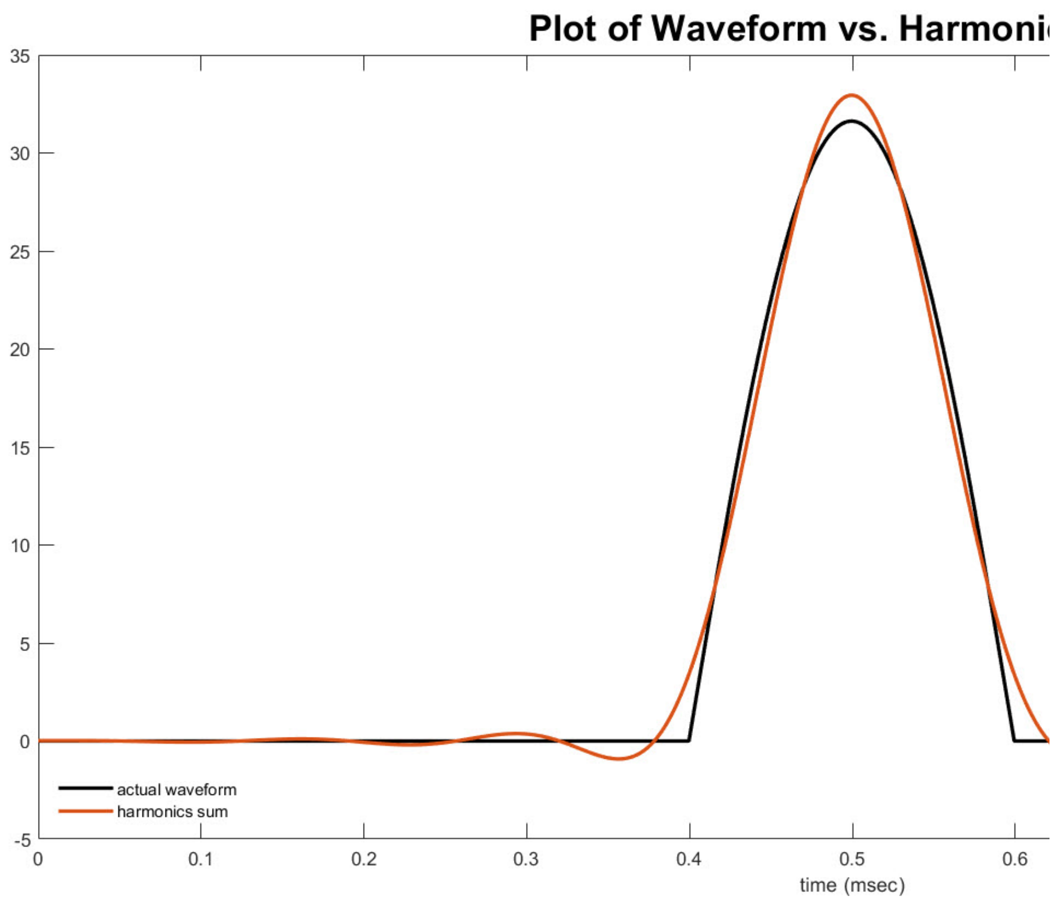
Question 23

4 pts

Finally, write the code to obtain a **t**, **wv7** vector pair that describes the sum of the dc component plus the first seven harmonics of the waveform. Then write a line of code that plots this waveform and the **wv4N** waveform on the same time axis. Use a conversion divisor to express the time in **msec**. The plot should look like the (formatted) figure below where, again, you don't have to deal with the formatting):



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For this question, you are to set up and solved a differential equation in the same manner you did on Assignment 5. Information about the form of the solution, the maximum overshoot value, the peak value of the steady state, and the time required to achieve steady state are all part of this question.

The RLC circuit we are using has an inductance value of **40 mH,** a resistance of **2 kW**, and a capacitance of **100 pF.** The voltage source is a sinusoid with a peak value of **5 volts** and a frequency of **50 kHz.**

There are many short answers to this part, but they all belong to the same overall question. The skills require your use of **dsolve** and **ezplot** to get the correct answers.

Some of you may not be able to get a decent plot for some reason or other. On (at least some) of these questions requiring that you read a plot, I've provided plots for you, as best I can. It would be better if you use the plot MATLAB gives you, because your reading of the provided plots won't be as accurate.

Question 24 2 pts

In order to use **dsolve** (and to get a sense of the form of the sort of voltage you'd expect to get), you will need to assign values to some scalar variables. Write the MATLAB code to assign these values into the necessary variables.

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Question 25

5 pts

The form of the solution for the voltage across the capacitor is given by

$$v(t) = K \cdot e^{-\alpha t} \cdot sin(2\pi f_h t + \phi) + A \sin(2\pi f t + \theta)$$

You can determine the values of the exponential factor **a**, and the frequencies **f_h** and **f** through knowing a parameter of the given function and through use of some MATLAB code. Write the code you used to find the two values that needed calculations. Then write down the three values you've obtained (one as a given parameter and two via MATLAB code) for the three values as **alpha**= ??? **f_h** = ??? (write it as **fh**, if you want) and **f** = ???

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Question 26

6 pts

You get the relevant part of the other values using MATLAB 's symbolic toolbox to obtain the (messy) algebraic solution to a different equation for the charge, **q**, across the plates of the capacitor as a function of time. You do it with symbolic representation that returns a result to q(t) via the proper set up to return results via a call to **dsolve**. Write the required code (all of it) that enables MATLAB that will give you the values you need via calls to **ezplot**.

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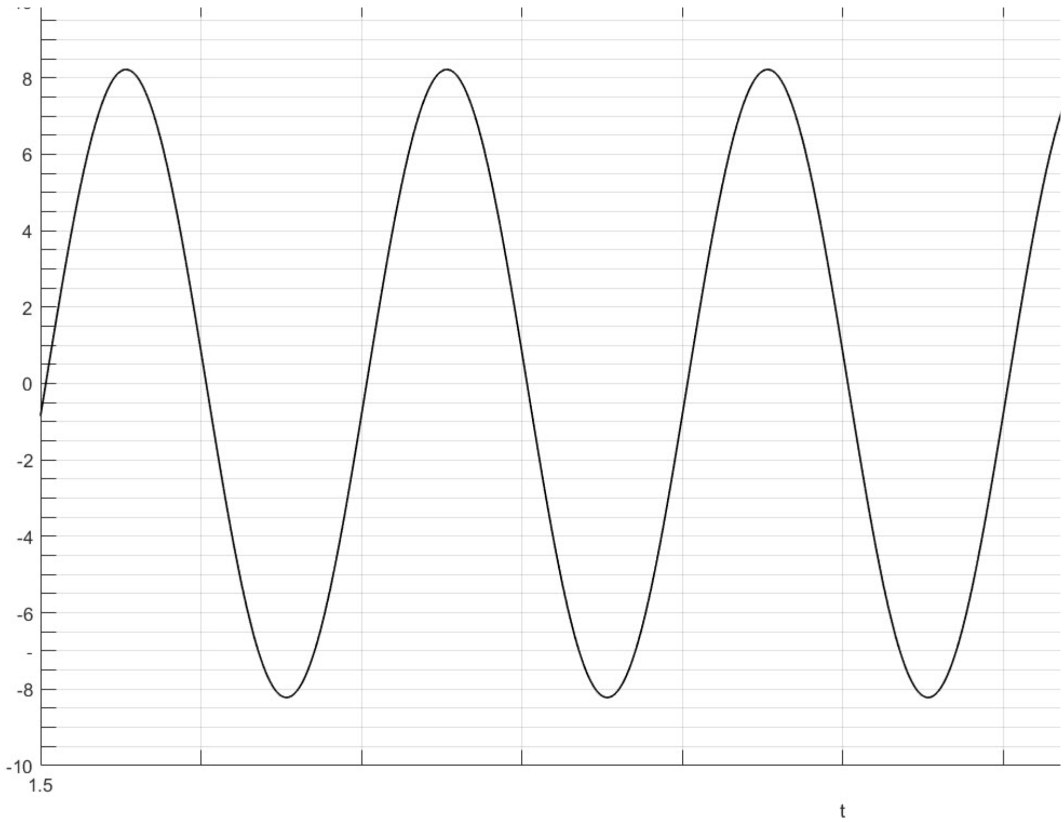
Question 27

4 pts

A proper call to **ezplot** using the **q** expression will show you the peak value of the steady state, i.e. the value of **A** in the description for part b. After 1.5 msec, the system is deep into steady state.

Given that **q(t)** was properly returned by your MATLAB code (if it was, use it!), write the call to **ezplot** that will show five cycles of the waveform at this time. Use the plot you get to find the steady state value of the voltage across the capacitor. (Don't be alarmed if it's greater than the peak value of the applied voltage! There's also an inductor in the circuit too, right?)

If you used your plot, you can get this value accurate to three decimal places. If you cannot get a plot, well, I've supplied you with mine. You can zoom in on the plot to get a better reading, but I doubt you can pull off three places for this plot. So, you are penalized. But it's better than nothing at all, right? The scale is in volts.



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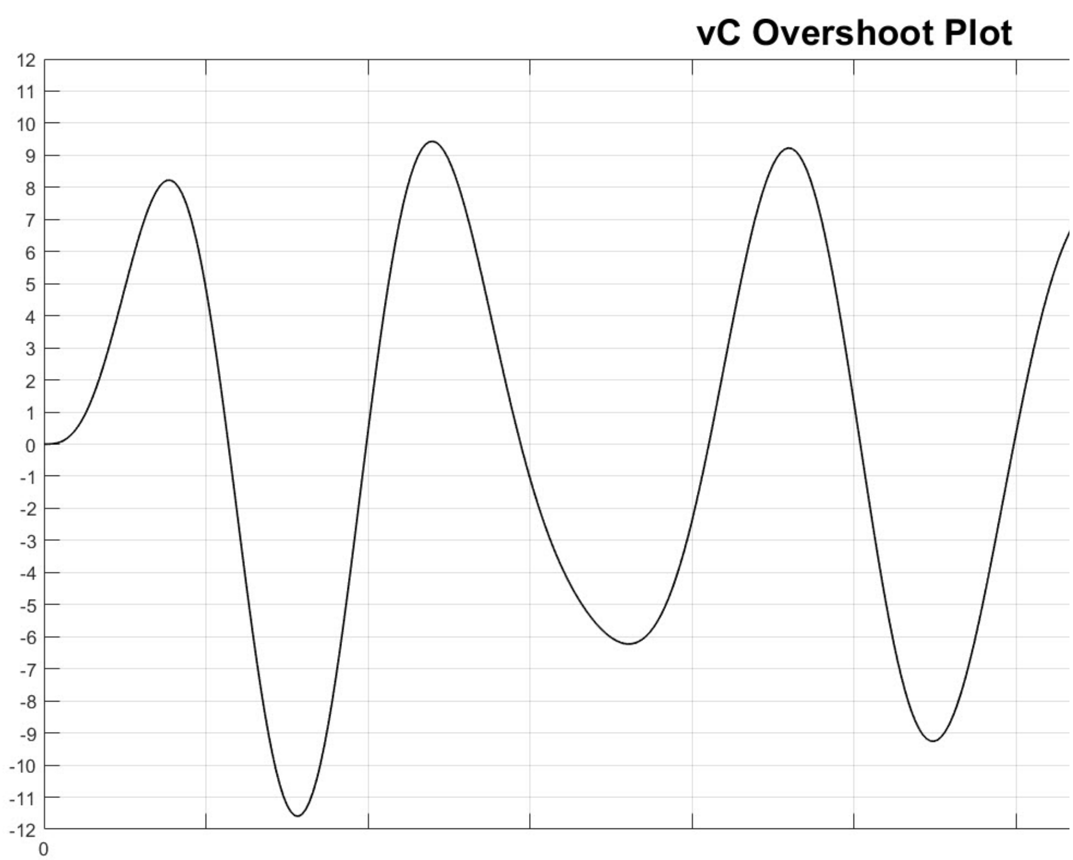
Question 28

4 pts

You can likewise get the overshoot plot by looking at the first **0.1 msec** of the function. Write the **ezplot** code to obtain the value of the voltage across the capacitor for the first **0.1 msec** after the switch is thrown. Note that we define overshoot by ***absolute value***, viz. the largest peak value attained before the system starts to settle down.

From the plot you obtained (if you got it), determine and write down the maximum overshoot value of the system. We are again looking for 3 decimal places. We've likewise provided you with an overshoot plot here, but you are clearly penalized because you need to interpolate just to get that first decimal place. Here's our plot you can use if you need it (for partial credit):



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