University of Louisiana at Lafayette
EECE 260, Fall 2019

Homework Assignment #3

Problem 1

Electrical resistors are said to be connected "in series" if the same current passes through each and "in parallel" if the same voltage is applied over each. If n resistors are connected in series, they will have an equivalent resistance is given by the following equation:

$$R_{eq.} = R_1 + R_2 + R_3 + \ldots + R_n$$

If n resistors are connected in parallel, their equivalent resistance will instead be given by:

$$(1 / R_{eq.}) = (1 / R_1) + (1 / R_2) + (1 / R_3) + \ldots + (1 / R_n)$$

Write a MATLAB script file that first prompts the user for the number of resistors being considered, n, and then asks for the type of connection ('S' for series or 'P' for parallel) linking these resistors. Next, the script must ask the user to enter a positive, floating point resistance value for each of the n resistors. Assume valid input for all resistance values. After collecting all required user input, your script must compute the equivalent resistance of the n resistors for the connection type chosen by the user.

Problem 2

Write a program that first prompts the user for a sequence of unspecified length made up of only zeros and ones and that then translates this string into a sequence of characters. You will do this by translating each set of 5 binary digits in the input sequence into a single-element character array and then appending these arrays successively into one long vector that represents the whole translated sequence. Use the following key for your translations (assume valid user input and that the input binary sequence will have a total number of digits that is a multiple of 5):

Character	Code	Character	Code
"A"	00000	"Q"	10000
"B"	00001	"R"	10001
"C"	00010	"S"	10010
"D"	00011	"T"	10011
"E"	00100	"U"	10100
"F"	00101	"V"	10101
"G"	00110	"W"	10110
"H"	00111	"X"	10111
"I"	01000	"Y"	11000
"J"	01001	"Z"	11001
"K"	01010	"."	11010
"L"	01011	","	11011
"M"	01100	"!"	11100
"N"	01101	"?"	11101
"O"	01110	" "	11110
"P"	01111	"&"	11111

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Example of how the program works:
- Code prompts user for input
- User inputs: 001110100011100110011100
- Code creates an empty character vector for character output
  (`output = '';`)
- Code enters loop
- Code determines first binary sequence ("00111")
- Code sets output vector to "H"
  (`output = strcat(output,'H');`)
- Loop repeats
- Code determine second binary sequence ("01000")
- Code appends "I" to the end of the output vector
  (`output = strcat(output,'I');`)
  …
- Loop ends after all digits in full binary input sequence are read
- Code displays the translated output character vector

Problem 3

The first harmonic of the Fourier series for a zero-centered sawtooth wave of amplitude 1 volt and period 1s is as follows:

$$y_1 = \frac{1}{\pi}\sin(2\pi t)$$

The second harmonic is given by:

$$y_2 = \frac{1}{2\pi}\sin(4\pi t)$$

The third harmonic is given by:

$$y_3 = \frac{1}{3\pi}\sin(6\pi t)$$

and so on. Use a `while` loop/`while` loops to determine the signals representing the sum of the first 3 harmonics, the first 10 harmonics, the first 25 harmonics, the first 50 harmonics, and the first 100 harmonics in this Fourier series, then plot these signals against t in the first 5 subplots of a 3x2 subplot figure. Last, plot the 1V amplitude, 1s period sawtooth wave signal mentioned above in the same 3x2 subplot figure in the bottom-right slot (you will need to use the pre-defined function `sawtooth()`). Use the following line of code to set up the time vector t:

```
t = linspace(-5,5,1000);
```

Problem 4
Write a looping MATLAB program that takes user input for the month, the day of the month, and whether or not it is a leap year (1 for "yes" and 0 for "no"). After getting this data, use a conditional structure to determine how many days have passed so far in the year, including the current day. Make sure to filter out "bad" user input for the month. For the sake of simplicity, you can assume that day and leap year input will always be valid. Write the program such that it only breaks out of the loop when the user provides invalid input. When this occurs, the program must display an error message.

Problem 5
A diode can be thought of as a device that blocks the flow of electric current in one direction. A diode can be used in a circuit to make a so-called half-wave rectifier, as seen in the figure below:
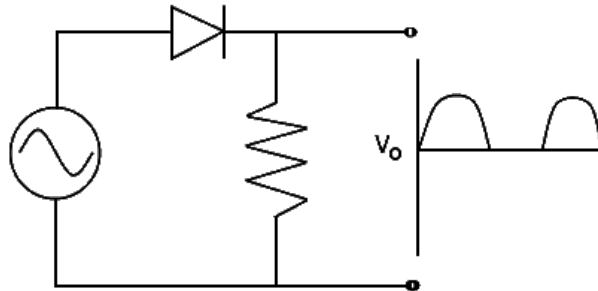
For an ideal diode specifically, the voltage $v_o(t)$ across the load resistance in the figure above is defined by:

$v_o(t_0) = v_S(t_0)$ if $v_S(t_0) > 0$ and $v_o(t_0) = 0$ if $v_S(t_0) \leq 0$

where the function $v_S(t)$ is the AC supply voltage. Suppose the supply voltage is defined as follows:

$v_S(t) = 5e^{-t/2}\cos(2\pi t)$ volts

where time t is in seconds. Given this $v_S(t)$, write a MATLAB script file that uses relational operators to define the output voltage $v_o(t)$ and that then plots $v_o(t)$ against t for the range of $0 \leq t \leq 10$.