Unit 5: Introduction to programming

1. Using the top-down design approach, write an algorithm for making a sandwich.
2. Write a simple script that will calculate the volume of a hollow sphere,

   $$\frac{4\pi}{3}(r_o^3 - r_i^3)$$

   where r_i is the inner radius and r_o is the outer radius. Assign a value to a variable for the inner radius, and also assign a value to another variable for the outer radius. Then, using these variables, assign the volume to a third variable. Include comments in the script. Use **help** to view the comments in your script.
3. Write a statement that prompts the user for his/her favorite number.
4. Write a statement that prompts the user for his/her name.
5. Write an **input** statement that will prompt the user for a real number, and store it in a variable. Then, use the **fprintf** function to print the value of this variable using 2 decimal places.
6. Experiment, in the Command Window, with the **fprintf** function for real numbers. Make a note of what happens for each. Use **fprintf** to print the real number 12345.6789.
   - without specifying any field width
   - in a field width of 10 with 4 decimal places
   - in a field width of 10 with 2 decimal places
   - in a field width of 6 with 4 decimal places
   - in a field width of 2 with 4 decimal places
7. Experiment, in the Command Window, with the **fprintf** function for integers. Make a note of what happens for each. Use **fprintf** to print the integer 12345.
   - without specifying any field width
   - in a field width of 5
   - in a field width of 8
   - in a field width of 3
8. When would you use **disp** instead of **fprintf**? When would you use **fprintf** instead of **disp**?
9. Write a script called *echostring* that will prompt the user for a string, and will echo print the string in quotes:

```
>> echostring
Enter your string: hi there
Your string was: 'hi there'
```

10. If the lengths of two sides of a triangle and the angle between them are known, the length of the third side can be calculated. Given the lengths of two sides (b and c) of a triangle, and the angle between them α in degrees, the third side a is calculated as follows:

    $$a^2 = b^2 + c^2 - 2\,b\,c\,\cos(\alpha)$$

    Write a script *thirdside* that will prompt the user and read in values for b, c, and α (in degrees), and then calculate and print the value of a, with 3 decimal places. The format of the output from the script should look exactly like this:

    ```
    >> thirdside
    Enter the first side: 2.2
    Enter the second side: 4.4
    Enter the angle between them: 50

    The third side is 3.429
    ```

    For more practice, write a function to calculate the third side, so the script will call this function.

11. Write a script that will prompt the user for a character, and will print it twice; once left-justified in a field width of 5, and again right-justified in a field width of 3.
12. Write a script *lumin* that will calculate and print the luminosity L of a star in Watts. The luminosity L is given by $L = 4\pi d^2\, b$ where d is the distance from the sun in meters and b is the brightness in Watts/meters^2. Here is an example of executing the script:

    ```
    >> lumin
    This script will calculate the luminosity of a star.
    When prompted, enter the star's distance from the sun
      in meters, and its brightness in W/meters squared.

    Enter the distance: 1.26e12
    Enter the brightness: 2e-17
    The luminosity of this star is 399007399.75 watts
    ```

13. A script "iotrace" has been written. Here's what the desired output looks like:

```
>> iotrace
Please enter a number: 33
Please enter a character: x
Your number is 33.00
Your char is       x!
```

Fix this script so that it works as shown previously:

```
mynum = input('Please enter a number:\n ');
mychar = input('Please enter a character: ');
fprintf('Your number is %.2f, mynum)
fprintf('Your char is %c!\n', mychar)
```

14. Write a script that assigns values for the *x* coordinate and then *y* coordinate of a point, and then plot this using a green +.
15. Plot **sin(x)** for *x* values ranging from 0 to π (in separate Figure Windows):
    using 10 points in this range
    using 100 points in this range
16. When would it be important to use **legend** in a plot?
17. Why do we always suppress all assignment statements in scripts?
18. Atmospheric properties such as temperature, air density, and air pressure are important in aviation. Create a file that stores temperatures in degrees Kelvin at various altitudes. The altitudes are in the first column and the temperatures in the second. For example, it may look like this:

```
1000    288
2000    281
3000    269
```

19. Generate a random integer *n*, create a vector of the integers 1 through *n* in steps of 2, square them, and plot the squares.
20. Create a 3×6 matrix of random integers, each in the range of 50–100. Write this to a file called *randfile.dat*. Then, create a new matrix of random integers, but this time make it a 2×6 matrix of random integers, each in the range of 50–100. Append this matrix to the original file. Then, read the file (which will be to a variable called *randfile*) just to make sure that it worked!
21. A particular part is being turned on a lathe. The diameter of the part is supposed to be 20,000 mm. The diameter is measured every 10 min and the results are stored in a file called *partdiam.dat*. Create a data file to simulate this. The file will store the time in minutes and the diameter at each time. Plot the data.
22. Create a file called "testtan.dat" comprised of two lines with three real numbers on each line (some negative, some positive, in the—1 to 3 range). The file can be created from the Editor, or saved from a matrix. Then, **load** the file into a matrix and calculate the tangent of every element in the resulting matrix.

23. Write a function *calcrectarea* that will calculate and return the area of a rectangle. Pass the length and width to the function as input arguments.

Renewable energy sources such as biomass are gaining increasing attention. Biomass energy units include megawatt hours (MWh) and gigajoules (GJ). One MWh is equivalent to 3.6 GJ. For example, one cubic meter of wood chips produces 1 MWh.

24. Write a function *mwh_to_gj* that will convert MWh to GJ.
25. List some differences between a script and a function.
26. In quantum mechanics, the angular wavelength for a wavelength λ is defined as $\lambda/2\pi$. Write a function named *makeitangular* that will receive the wavelength as an input argument, and will return the angular wavelength.
27. Write a *fives* function that will receive two arguments for the number of rows and columns, and will return a matrix with that size of all fives.
28. Write a function *isdivby4* that will receive an integer input argument, and will return **logical** 1 for **true** if the input argument is divisible by 4, or **logical false** if it is not.
29. Write a function *isint* that will receive a number input argument *innum*, and will return 1 for **true** if this number is an integer, or 0 for **false** if not. Use the fact that *innum* should be equal to **int32(innum)** if it is an integer. Unfortunately, due to round-off errors, it should be noted that it is possible to get **logical** 1 for **true** if the input argument is close to an integer. Therefore the output may not be what you might expect, as shown here.

```
>> isint(4)
ans =
     1
>> isint(4.9999)
ans =
     0
>> isint(4.99999999999999999999999999)
ans =
     1
```

30. A Pythagorean triple is a set of positive integers (a,b,c) such that $a^2+b^2=c^2$. Write a function *ispythag* that will receive three positive integers (a, b, c in that order) and will return **logical** 1 for **true** if they form a Pythagorean triple, or 0 for **false** if not.
31. A function can return a vector as a result. Write a function *vecout* that will receive one integer argument and will return a vector that increments from the value of the input argument to its value plus 5, using the colon operator. For example,

```
>> vecout(4)
ans =
     4   5   6   7   8   9
```

32. Write a function that is called *pickone*, which will receive one input argument *x*, which is a vector, and will return one random element from the vector. For example,

```
>> pickone(4:7)
ans =
       5
>> disp(pickone(-2:0))
-1
>> help pickone
pickone(x) returns a random element from vector x
```

33. The conversion depends on the temperature and other factors, but an approximation is that 1 in. of rain is equivalent to 6.5 in. of snow. Write a script that prompts the user for the number of inches of rain, calls a function to return the equivalent amount of snow, and prints this result. Write the function, as well!
34. In thermodynamics, the Carnot efficiency is the maximum possible efficiency of a heat engine operating between two reservoirs at different temperatures. The Carnot efficiency is given as

$$\eta = 1 - \frac{T_C}{T_H}$$

where T_C and T_H are the absolute temperatures at the cold and hot reservoirs, respectively. Write a script *carnot* that will prompt the user for the two reservoir temperatures in Kelvin, call a function to calculate the Carnot efficiency, and then print the corresponding Carnot efficiency to 3 decimal places. Also write the function.
35. Many mathematical models in engineering use the exponential function. The general form of the exponential decay function is:

$$y(t) = Ae^{-\tau t}$$

where A is the initial value at $t = 0$, and τ is the time constant for the function. Write a script to study the effect of the time constant. To simplify the equation, set A equal to 1. Prompt the user for two different values for the time constant, and for beginning and ending values for the range of a *t* vector. Then, calculate two different *y* vectors using the above equation and the two time constants, and graph both exponential functions on the same graph within the range the user specified. Use a function to calculate *y*. Make one plot red. Be sure to label the graph and both axes. What happens to the decay rate as the time constant gets larger?