Homework assignment – HW5

1.

The standard air density, D, (average of measurements made) at different heights, h, from sea level up to a height of 33 km is given below.

h (km)	0	3	6	9	12	15
D (kg/m^3)	1.2	0.91	0.66	0.47	0.31	0.19
h (km)	18	21	24	27	30	33
D (kg/m^3)	0.12	0.075	0.046	0.029	0.018	0.011

a) Find a polynomial of order 3 that best fits the data.

b) Create set of new values for 100 equally spaced elements of heights in the same range by interpolation using '***spline***' method.

c) Plot the data points (blue circles) and the polynomial (green line).

d) Title the plot, label the axes and add legend.

2.

A circular staircase can be modeled by the parametric equations:

$$x = R\cos\left(2\pi n\frac{t}{h}\right)$$

$$y = R\sin\left(2\pi n\frac{t}{h}\right)$$

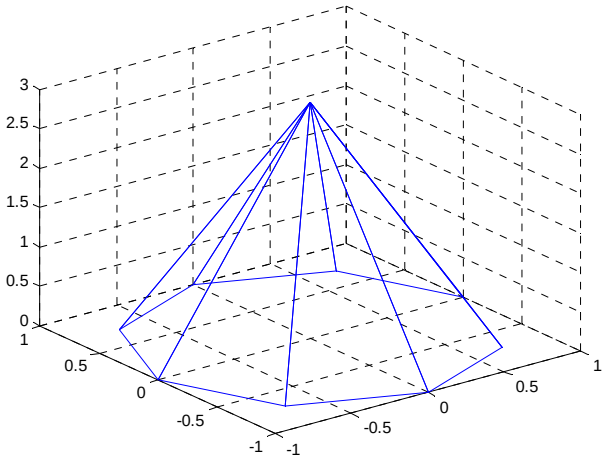
$$z = \frac{t}{h}$$

where R is the radius of the staircase, h is the height of the floors, and n is the number of revolutions that the staircase makes in each floor. A building has 2 floors with $h = 3\,\text{m}$. Make plots of two possible staircases. One with $R = 1.5\,\text{m}$ and $n = 3$, and the other with $R = 4\,\text{m}$ and $n = 2$. Plot the two staircases in the same figure.

3.

Write a user-defined function that draws a pyramid. The inputs of the function will be n- the number of sides of the bases and h- the pyramid height. The name of the function will be **`pyramid`**.

For example, using the function **`pyramid`**(8,3) will give the following output:



4.

Define a function which plots a 3D-mesh, 3D-surface, 3D-contours and a combination of surface and contours for a given set of *x*, *y* and *z* vectors. The function uses subplot to display the four plots in one figure, titles the plots adds grids, colorbar and labels.

Use your function for:

a) $z = -\frac{x^4}{4} - \frac{y^2}{6} \quad -4 \le x \le 4\,, -40 \le y \le 40$

b) $z = \sin(x)\sin(y) \quad -180 \le x \le 180\,,\ -180 \le y \le 180$ in degrees

5.

Determine the solution of the equation $xe^{-x} = 0.2$ in the range of $0 \le x \le 8$.

Plot the function and mark the solution in red diamonds.

6.

Find the minimum and maximum of the function $y = x^3 - 12x^2 + 40.25x - 36.6$ in the range of $0 \le x \le 8$.

Plot the function and mark the maximum and minimum points in black triangles.

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7.

Use numerical integration to calculate the following integral:

$$\int_0^8 (x e^{-x^{0.8}} + 0.2) dx$$

- Calculate 3 times: use **`quad`**, **`quadl`** and **`trapz`** commands.

8.

Plot the following function $y(x)$ in the given range with a solid black line, x in radians:

$$y = e^x \sin(x) - \cos(x)$$
$$-2\pi \le x \le \pi$$

Calculate the 1st derivative and add it to the same plot with a solid green line.

Calculate the 2nd derivative and add it to the same plot with a solid red line.

9-10.

I) Write two user-define functions that calculate the integral value of a given mathematical function without using the function "trapz". Each function should use a different method:

a) Using a loop calculating at each interaction the area of trapezoid between two points and X axis.

b) Using the following formula:

$$area = dx(\frac{y_1 + y_n}{2} + \sum_{i=2}^{i=n-1} y_i)$$

II) Check which method is more efficient? Use the following mathematical function: $e^{x/2}\sin(x) - \frac{x}{2}$ sampling the function at 10,000 points in the interval $-\pi \le x \le \pi$ (x in radians).

Write a script that performs the following operations:

1. Generate 10,000 elements of x and y for the given function.
2. Calculates the integral using each of the functions written in I.
3. Calculates the integral using ***`quadl`***
4. Compare the 3 results and the elapsed time using ***`tic`*** & ***`toc`*** Matlab function.