MATLAB: Assignment 1

Problem 1

The pressure-drop Δp (in Pa) for a fluid flowing in a pipe with a sudden increase in diameter is given by:

$$\Delta p = \frac{1}{2}\left[1-\left(\frac{d}{D}\right)^2\right]^2 \rho\, v^2,$$

where ρ is the density of the fluid, v, the velocity of the flow, and d and D are the diameters of the pipes. Write a program in a *script file* that calculates the pressure-drop Δp. Use $\rho = 700\,\mathrm{kg/m^3}$ at $v = 5\,\mathrm{m/s}$ and the ratios of diameters: $d/D = 0.9, 0.8, 0.7, 0.6, 0.5, 0.2$.

Problem 2

Write an **anonymous** MATLAB function for

$$y(x) = x\, e^{-0.7x}\sqrt{1+x}.$$

The input to the function is x and output is y. **Write the function such that x can be a vector**.

(a) Use the function to calculate $y(8)$.

(b) Use the function to make a plot of the function $y(x)$ for $0 \le x \le 10$.

Problem 3

Write a well-commented script program that graphs the functions $\sin^2 x$, $x^2 - \frac{2^3 x^4}{4!}$, $x^2 - \frac{2^3 x^4}{4!} + \frac{2^5 x^6}{6!}$ for $0 \le x \le 4.5$ on **one plot**. (note: matlab command for $n!$ is `factorial(n)`) Use a sufficiently small step size to make all the graphs smooth.

Problem 4

Use loops to create a *script file* that generates 4×6 matrix in which the value of each element is 2 times its row number minus 3 times its column number. For example, the value of the element $(2, 5)$ is $2 \times 2 - 3 \times 5 = -11$.

Problem 5

The first derivative $\frac{df(x)}{dx}$ of a function $f(x)$ at a point $x = x_0$ can be approximated with the two-point central difference formula:

$$\frac{df}{dx} \approx \frac{f(x_0 + h) - f(x_0 - h)}{2h}.$$

where h is a small number relative to x_0.

Here is a user-defined function that calculates the derivative of a math function by using the two-point central difference formula.

```
function  dfdx2pt = twoptderi(myfunc,x0,h)

% dfdx2pt approximates the derivative using
% the two-point central difference formula
% x0 is the point where the derivative is calculated
% h is a number relative to x0
dfdx2pt = (myfunc(x0+h)-myfunc(x0-h))/(2*h);

end
```

(a) Create the above function (please retype 😄).

(b) Use the user-defined function `twoptderi(myfunc,x0,h)` to calculate the following:

  (i) the derivative of $f(x) = x^3$ at $x_0 = 0.6$ and $h = \frac{x_0}{100}$.

  (ii) the derivative of $f(x) = x^3 e^{2x}$ at $x_0 = 2.5$ and $h = \frac{x_0}{100}$.

  In both cases compare the answer obtained from `twoptderi` with the analytical solution.

Here is the matlab script file that you should modify.

```
clc; clear; close all;
format long % you may want to read about the 'format'

myfunc = @(x)(x^3); % define the function
x0 = 0.6;
h = x0/100;
dfdx2pt = twoptderi(myfunc,x0,h)
```