Hands-on Exercise 3

This exercise is designed to give you practice writing functions to solve problems. The problems in this exercise are very common and you will surely encounter similar ones in your research or future classes. As before, the names of helpful functions are provided in **bold** where needed. **Exercise reports must be submitted on the website (超星学习通) before the end of the course.**

What to turn in: Copy the text from your scripts and paste it into a document. **(Use matlab_报告模板.docx)**.If a question asks you to plot or display something to the screen, also include the plot and screen output your code generates. Submit either a *.doc(x) or *.pdf file. Name it as **"学号-姓名-第3次实验报告"**.

Keep all your code in scripts/functions. If a specific name is not mentioned in the problem statement, you can choose your own script names.

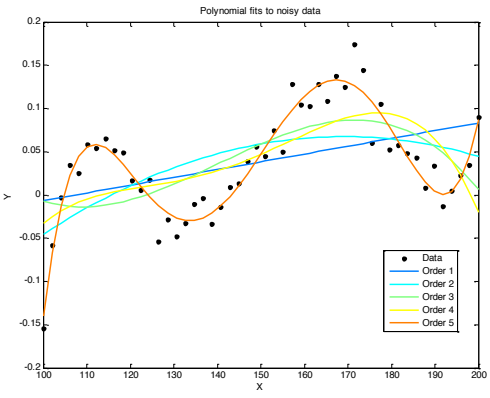
1. **Linear system of equations.** Solve the following system of equations using ****. Compute and display the error vector

$$3a + 6b + 4c = 1$$
$$a + 5b = 2$$
$$7b + 7c = 3$$

2. **Numerical integration.** What is the value of: $\int_0^5 xe^{-x/3}dx$? Use **trapz** or **quad**. Compute and display the difference between your numerical answer and the analytical answer: $-24e^{-5/3} + 9$.

3. **Computing the inverse.** Calculate the inverse of $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ and verify that when you multiply the original matrix by the inverse, you get the identity matrix (**inv**). Display the inverse matrix as well as the result of the multiplication of the original matrix by its inverse.

4. **Fitting polynomials**. Write a script to load the data file `randomData.mat` (which contains variables `x` and `y`) and fit first, second, third, fourth, and fifth degree polynomials to it. Plot the data as blue dots on a figure, and plot all five polynomial fits using lines of different colors on the same axes. Label the figure appropriately. To get good fits, you'll have to use the centering and scaling version of **polyfit** (the one that returns three arguments, see **help**) and its counterpart in **polyval** (the one that accepts the centering and scaling parameters). It should look like this:

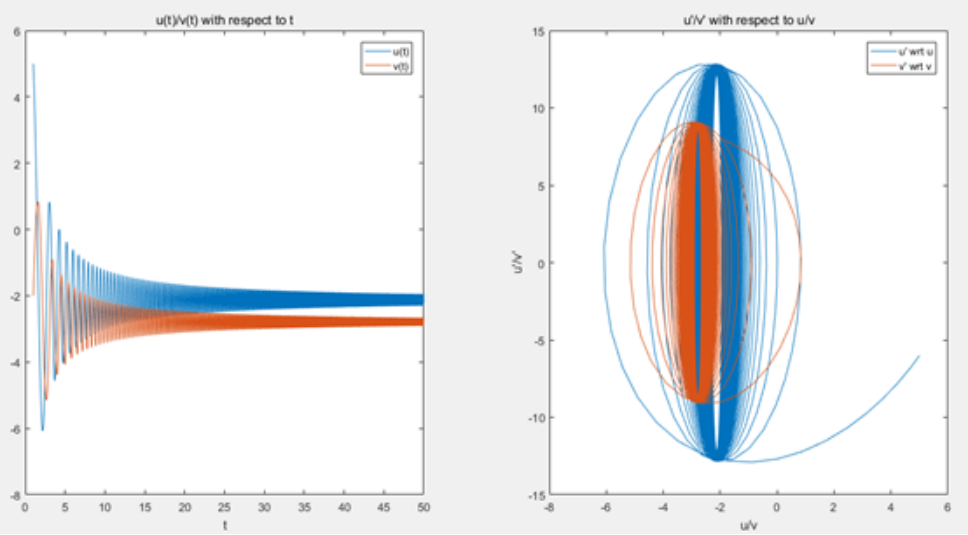


5. solve the following Second order differential equations with ODE.

$$\begin{cases} u'' = -2tv' - ue^{-5t} \\ v'' = tu' - 3ve^{-2t} \end{cases}$$

initial conditions are: $\begin{cases} u(0) = 5 \\ v(0) = -2 \\ u'(0) = -6 \\ v'(0) = 8 \end{cases}$

draw figures to show u(t), v(t) and u'/v' with respect to u/v.
You should see something like this:



6. 某电路元件，两端电压U与流过电流I的实测数据如下表所示。用不同的插值方法（最近邻法、线性法、三次样条法和三次多项式法）计算I=9A时的电压U。

电流 I(A)	0	2	4	6	8	10	12
电压 U(V)	0	2	5	8.2	12	16	21

8. 分别用5阶和7阶多项式在区间[0, 2pi]范围内逼近函数

$$f(x)=e^{-0.5x}+\sin(x)$$

绘图比较哪种多项式拟合效果好。

9. 已知

$$y=e^{-0.5x}\sin(2x)$$

求[0,pi]范围内，y的极值（极大值和极小值）。

10. 洛伦兹(Lorenz)模型的状态方程为：

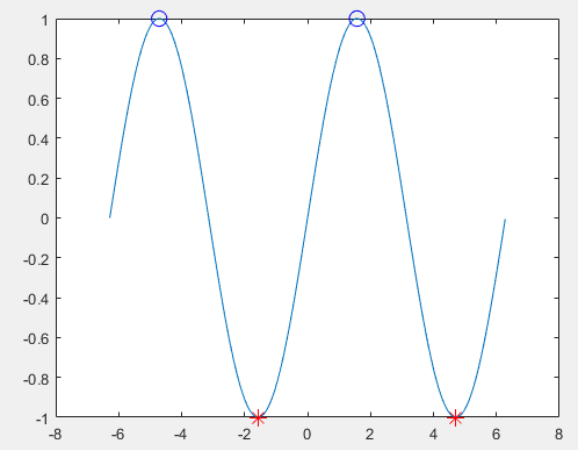
$$\begin{cases} \frac{dx_1(t)}{dt} = -\beta x_1(t) + x_2(t)x_3(t) \\ \frac{dx_2(t)}{dt} = -\delta x_2(t) + \delta x_3(t) \\ \frac{dx_3(t)}{dt} = -x_2(t)x_1(t) + \rho x_2(t) - x_3(t) \end{cases}, \begin{cases} x_1(t) = 0 \\ x_2(t) = 0 \\ x_3(t) = 0 \end{cases}$$

取 $\delta = 10;\ \rho = 28;\ \beta = 8/3$

解该微分方程，并绘制$x_1(t)$~t时间曲线和$x_1(t)$~$x_2(t)$相空间曲线。

Optional Problem

6. Can you find all minima and maxima of a function? Design and implement your solution. Try your solution with simple function such as sin(), as well as complicated function such as that in Exercise3-4.
You might see something like this:



and something like this.