MATH 2221 **B** Mathematics Laboratory II

Lab Assignment 12

Name: _____ Student ID.: _____

In this assignment, you are asked to run `MATLAB` demos to see `MATLAB` at work. The color version of this assignment can be found in your own **H:** drive.

Instructions

1. Start MATLAB, until you see a window with the MATLABprompt "`>>`". This window is called the **Command Window**.
2. After you started have MATLAB, you will automatically be in the directory **H:**. Please enter "`diary on`" after the MATLABprompt `>>` only once to record all your work in H:\diary. No marks will be given if no diary is found.
3. You should write your results on the lab sheet provided, and save the figures in the **H:** drive, in your personal drive.
4. Please read and sign the following declaration before handing in your assignment. Otherwise, no marks will be given.

I declare that the assignment here submitted is original except for source material explicitly acknowledged. I also acknowledge that I am aware of University policy and regulations on honesty in academic work, and of the disciplinary guidelines and procedures applicable to breaches of such policy and regulations, as contained on the website http://www.cuhk.edu.hk/policy/academichonesty/
Signature _____ Date _____

1 (25 marks)		3 (25 marks)	
2 (25 marks)		4 (25 marks)	
		Total	/100 pts

Please read the following carefully:
General Guidelines for Lab Assignment Submission.

- Please sign and date the statement of Academic Honesty.
- Please go to the class and lab indicated by your registered course code via the CUSIS system. If you go to a different lab than the one you are registered for, you will not receive credit for the assignment even if you completed it.
- Write your COMPLETE name and student ID number legibly on the cover sheet (otherwise we will not take any responsibility for your lab). Please write your answers using a black or blue pen, NOT any other color or a pencil.
- Write your solutions on a double-sided printout of this pdf file. Try to fit your answers inside the available space.
- The use of computers/cellular phones/graphing calculators/iPads will NOT be permitted during tests and lab assignments. Please do not use our lab computer to recharge your cellar phone battery.
- In order to make it fair for all students, during the labs and tests, if you touch/press any icons on your cellular phone, our TA will check your phone to determine whether or not you are exchanging messages with another student. If you are found cheating (in the tests or in the lab or on homework assignments), you will automatically get an F grade in this course and your act will be reported to the Department for necessary disciplinary actions.

Exercises

Note: Remember to add `";"` if you want to suppress the output. Marks will be deducted if there is any unnecessary output. Unless specified in the question, you should not print anything on the screen.

1. (25 marks) Open `q1.m`, follow the instructions and fill in the blanks.

   (a) Solve the system of ODEs

   $$\begin{cases} f' &= f - 2g, \\ g\prime &= f + g, \\ f(0) &= 2, \\ g(0) &= 1. \end{cases}$$

   Write down the command in the `q1.m` and write the result in the following box.

   ```
   f = 2*exp(t)*cos(2^(1/2)*t) - 2^(1/2)*exp(t)*sin(2^(1/2)*t)
   g = exp(t)*cos(2^(1/2)*t) + 2^(1/2)*exp(t)*sin(2^(1/2)*t)
   ```

   (b) Consider the following ODE

   $$4y'' + 20y' + 52y = 20, y(0) = 1, y'(0) = 2.$$

   Compute $y(10)$ and show the 5 digits of the result. Write down the command in the `q1.m` and write the result in the following box.

   ```
   0.38462
   ```

Solution

```
% Qustion 1
clear;
close all;
%% q1(a)
sol=dsolve('Df=f-2*g','Dg=f+g','f(0)=2','g(0)=1');
sol.f
sol.g
%% q1(b)
vpa(subs(dsolve('4*D2y+20*Dy+52*y=20','y(0)=1','Dy(0)=2'),10),5)
```

2. (25 marks) Write a script "`q2.m`" to find the Taylor expansion of exponential e^x at $x = 4$ up to n order, $n = 3, 4, 5$. Plot them in the SAME graph. You must follow the instructions as below:

Instructions

(a) Compute the Taylor expansion of $\log(x)$ at $x = 4$ up to the order 3, 4 and 5 respectively;

(b) Use `ezplot` to plot e^x and the above three functions in SAME graph, where $x \in [-10, 10]$;

(c) Add a title as "`exp(x) and its taylor expansion at x = 4. `";

(d) Add a legend for 4 curves as "`exp`", "`3 order`", "`4 order`" and "`5 order`" at the top-right corner of the graph;

(e) Save your figure as `q2.jpg` by using `print('q2.jpg','-djpeg')`.

Note: Please don't need to set line style or color in these curves.

Solution

```
clear; close all

clear

syms x
r = exp(x);
ezplot(r,[-10, 10])
hold on
for i = 3 :5
    ezplot(taylor(r, x, 'ExpansionPoint', 4,'order',i),[-10 10 ])
end
legend('exp','3 order','4 order', '5 order','Location','NorthEast')
title('exp(x) and its taylor expansion at x = 4')
 print('q2.jpg','-djpeg')
```

3. (25 marks) A square matrix A is called diagonalizable if it is similar to a diagonal matrix, i.e., if there exists an invertible matrix P such that $P^{-1}AP$ is a diagonal matrix. According to principal axis theorem, real symmetric matrix is diagonalizable. Write a script "`q3.m`" to check whether an arbitrary 3-by-3 real matrix is diagonalizable.

Instructions

(a) Create an 3-by-3 symbolic real matrix A;

(b) Use lower triangular part of A to generate a symmetric matrix and denote it as A_s;

(c) Compute the Jordan canonical form $J = P^{-1}A_sP$ of A_s by using built-in function `jordan`;

(d) Extract the diagonal of J and create a diagonal matrix J_0 from J;

(e) Compute Frobenius norm of the matrix $(J_0 - J)$;

(f) If the value of above norm is 0, then show that

`The symmetric matrix is diagonalizable.`

Otherwise, just show that "`Error in the checking. `".

Solution

```
clear;

A = sym('a',3,'real');
As = tril(A,-1) + tril(A,0).' ;
[V,D] = jordan(As);
error = norm(diag(diag(D)) - D,'fro');
if error ==0
    disp('The symmetric matrix is diagonable. ')
else
    disp('Error in the checking')
end
```

4. (25 marks) Write a script `q4.m` to plot the surface of the function

$$f(x,y) = \frac{1+\cos(xy)}{1+x^2+y^2}$$

and the mesh of the function

$$g(x,y) = 2 - \cos(\sqrt{x^2+y^2})$$

by using `ezsurf` and `ezmesh` respectively.

Instructions:

(a) Plot these two graphs in SAME figure. For $f(x,y)$ are shown on the right side and $g(x,y)$ are on the left side;

(b) For both two functions, $x \in [-6,6], y \in [-6,6]$, while $z \in [0, \frac{5}{2}]$ for $f(x,y)$ and $z \in [\frac{1}{2}, \frac{7}{2}]$ for $g(x,y)$;

(c) The azimuth of the viewpoint should be 120 and the elevation should be -10 for both two graphs;

(d) Save your figure as `q4.jpg` by using "`print('q4.jpg','-djpeg')`".

Solution

```
close all; clear

syms x y
subplot(1,2,2)
ezsurf((1 + cos(x* y))./(1 + x^2 + y^2),[-6,6,-6,6]);
view([120 -10]);
axis([-6 6 -6 6 0 2.5])
subplot(1,2,1)
ezmesh(2 -cos(sqrt(x^2 + y^2)),[-6,6,-6,6])
axis([-6 6 -6 6 0.5 3.5])
view([120 -10]);
print('q4.jpg','-djpeg')
```