INSTRUCTIONS TO CANDIDATES

1. This paper consists of 2 questions. Please answer ALL questions.

2. Please write programs by using MATLAB / Octave to complete the test. One program for each question.

3. The program MUST NOT a function code.

4. The program MUST NOT require for any input.

5. Indicate which software you are using in the first line of your code (as comment). Follow by student ID and Question number.

6. Figure plotting (if any) can be done by any software. If the figure is plotted by Matlab/Octave, include the source code in the same m-file of the question. Otherwise, screenshot the source code of the figure plotting.

7. You need to copy all your codes, output results and images (if any) into single WORD file then save it as PDF-file. Use the given template.

8. Name your PDF-file as the format StudentID_CourseCode_PT2.pdf.

9. Name your M-files as the format StudentID_CourseCode_PT2_Q#.m.

10. Attached both the PDF-file and M-files of your code upon submission.

11. Communication between candidates in any means is forbidden. Answers must be entirely individual candidate's independent effort. If you are found sharing your solutions with other candidates, or suspected of doing so, you would be penalized accordingly.

Student Declaration

By attempting this exam, I acknowledge that

• I agree to be bound by the university's rules, codes of conduct, and other policies relating to examinations

• I have read and understand the examination conduct requirements for this exam

• I am aware of the university's rules regarding misconduct during examinations

• I am not in possession of, nor do I have access to, any unauthorised material during this examination

In attempting this examination and submitting an answer, candidates are undertaking that the work they submit is a result of their own unaided efforts and that they have not discussed the questions or possible answers with other persons during the examination period. Candidates who are found to have participated in any form of cooperation or collusion or any activity which could amount to academic misconduct in the answering of this examination will have their marks withdrawn and disciplinary action will be initiated.

Guo Yiming

(Student Signature Required)

Student Name: Guo Yiming

Student ID: PHY2009481

Q1

Output result

(a)--

i	t_i	y_i	w_i	|y_i-w_i|
0	0.00	0.5000000000	0.5000000000	0.000000e+00
1	0.20	0.8292986209	0.8292933333	5.287587e-06
2	0.40	1.2140876512	1.2140762107	1.144051e-05
3	0.60	1.6489405998	1.6489220170	1.858276e-05
4	0.80	2.1272295358	2.1272026849	2.685081e-05
5	1.00	2.6408590858	2.6408226927	3.639304e-05
6	1.20	3.1799415386	3.1798941702	4.736840e-05
7	1.40	3.7324000166	3.7323400729	5.994372e-05
8	1.60	4.2834837878	4.2834094983	7.428948e-05
9	1.80	4.8151762678	4.8150856946	9.057321e-05
10	2.00	5.3054719505	5.3053630007	1.089498e-04

(b)--

l	t_i	y_i	w_i	|y_i-w_i|
0	0.00	0.5000000000	0.5000000000	0.000000e+00
1	0.10	0.6574145410	0.6574143750	1.659622e-07
2	0.20	0.8292986209	0.8292982760	3.449225e-07
3	0.30	1.0150705962	1.0150700584	5.377794e-07
4	0.40	1.2140876512	1.2140869057	7.454764e-07
5	0.50	1.4256393646	1.4256383956	9.690017e-07
6	0.60	1.6489405998	1.6489393904	1.209388e-06
7	0.70	1.8831236463	1.8831221786	1.467708e-06
8	0.80	2.1272295358	2.1272277907	1.745076e-06
9	0.90	2.3801984444	2.3801964018	2.042642e-06
10	1.00	2.6408590858	2.6408567242	2.361585e-06
11	1.10	2.9079169880	2.9079142849	2.703112e-06
12	1.20	3.1799415386	3.1799384702	3.068444e-06
13	1.30	3.4553516662	3.4553482074	3.458811e-06
14	1.40	3.7324000166	3.7323961411	3.875438e-06
15	1.50	4.0091554648	4.0091511453	4.319531e-06
16	1.60	4.2834837878	4.2834789955	4.792258e-06
17	1.70	4.5530263041	4.5530210094	5.294732e-06
18	1.80	4.8151762678	4.8151704398	5.827979e-06
19	1.90	5.0670527789	5.0670463859	6.392915e-06
20	2.00	5.3054719505	5.3054649602	6.990307e-06

Code

```matlab
%MatLab R2022a
%PHY2009481 Q1
clc;clear;close all;
a=0;
b=2;
ya=0.5;
n1=2/0.2;
n2=2/0.1;

f=@(t,y) y-t^2+1;
y=@(t) (t+1)^2-0.5*exp(t);


[t1,w1]=func_rk4(a,b,ya,n1,f);
[t2,w2]=func_rk4(a,b,ya,n2,f);

%print the (a)
y1=[];
abserror1=[];
fprintf("(a)------------------------------------\n")
for i=1:n1+1
    y1(i)=y(t1(i));
    abserror1(i)=abs(y1(i)-w1(i));
end
fprintf("i\tt_i\ty_i\t\tw_i\t\t|y_i-w_i|\n");
for i=1:n1+1
    fprintf("%d      %6.2f\t%6.10f\t%6.10f\t%e\n",i-1,t1(i),y1(i),w1(i),abserror1(i));
end

fprintf("(b)------------------------------------\n")
y2=[];
abserror2=[];
for i=1:n2+1
    y2(i)=y(t2(i));
    abserror2(i)=abs(y2(i)-w2(i));
end
fprintf("i\tt_i\ty_i\t\tw_i\t\t|y_i-w_i|\n");
for i=1:n2+1
    fprintf("%d      %6.2f\t%6.10f\t%6.10f\t%e\n",i-1,t2(i),y2(i),w2(i),abserror2(i));
end



function [t,w] = func_rk4(a,b,ya,N,f)
h=(b-a)/N;
t=[];
w=[];



t(0 +1)=a;
w(0 +1)=ya;
for i=1:1:N
    t(i +1)=a+i*h;

    k1=h*f(t(i-1 +1),w(i-1 +1));
    k2=h*f(t(i-1 +1)+h/2,w(i-1 +1)+1/2*k1);
    k3=h*f(t(i-1 +1)+h/2,w(i-1 +1)+1/2*k2);
    k4=h*f(t(i-1 +1) +h,w(i-1 +1)+k3);

    w(i +1)=w(i-1 +1)+1/6*(k1+2*k2+2*k3+k4);
end
end
```

Q2

Question 2(a):

The L matrix is

1	0	0	0
2	1	0	0
3	4	1	0
-1	-3	0	1

The U matrix is

1	1	0	3
0	-1	-1	-5
0	0	3	13
0	0	0	-13

Question 2(b):

(LY=b) After substitution the Y is

8
-9
26
-26

(UX=Y) After substitution the X is

3
-1
0
2

Code

```matlab
%MatLab R2022a
%PHY2009481 Q2
clc;clear;close all;
A=[1,1,0,3;
    2,1,-1,1;
    3,-1,-1,2;
    -1,2,3,-1];
[n,m]=size(A);

[L,U]=func_LU(A);
fprintf("Question 2(a):\n The L matrix is\n");
disp(L);
fprintf("\n The U matrix is\n");
disp(U);
fprintf("---------------------------------------\nQuestion 2(b):\n");


B=[8;7;14;-7];
% Y=inv(L)*B;
% X=inv(U)*Y;


A1=[L,B];
Y(1)=A1(1,n+1)/A1(1,1);
for i=2:n
    sum=0;
    for j=1:i-1
        sum=sum+A1(i,j)*Y(j);
    end
    Y(i)=(A1(i,n+1)-sum)/A1(i,i);
end

Y=Y';

X=[];
A2=[U,Y];
X(n)=A2(n,n+1)/A2(n,n);
for i=n-1:-1:1
    sum=0;
    for j=i+1:n
        sum=sum+A2(i,j)*X(j);
    end
    X(i)=(A2(i,n+1)-sum)/A2(i,i);
end
X=X';
fprintf("(LY=b) After substitution the Y is \n");
disp(Y);
fprintf("(UX=Y) After substitution the X is \n");
disp(X);


function [L,U]=func_LU(A)
[n,m]=size(A);
for i=1:n-1
    %Check and switch to check pivot to be not 0
    p=i;
    while A(p,i)==0 & p <= n-1
        p=p+1;
    end
    if p==n & A(p,i)==0
        disp("No unique solution found, please check");
```

```matlab
            break
        end
        Atemp=A(i,:);
        A(i,:)=A(p,:);
        A(p,:)=Atemp;
        for j=i+1:n
            m(j,i)=A(j,i)/A(i,i);
            A(j,:)=A(j,:)-m(j,i).*A(i,:);
        end
        Ag{i +1}=A;
    end



% modify into LU factorization

L2=eye(n);
L1=zeros(4,4);
L1(2:n,1:n-1)=m(2:end,:);
L=L1+L2;
U=A(:,1:n);


end
```