Indian Institute of Information Technology Vadodara

MA202: Numerical Techniques Lab
Semester: IV
Lab 2

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Section : **2A**

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Note: I have made PDF from next page using matlab only. They are in parts. I have merged them all.

Question-1

```
docondition()
function docondition()
    for i = 7:12
        A = hilb(i);
        conditon = cond(A);
        d = det(A)*det(inv(A));
        disp(['Size of Matrix is ' num2str(i)])
        disp('Condition number of matrix(A) is :')
        disp(conditon)
 disp('det(A)det(inv(A)) of matrix(A) is :')
 disp(d)
 disp('Discrepancy of A*inv(A) with I is: ')
 disp(abs(d - det(eye(i))))
 fprintf('\n');
 end
end
```

```
Size of Matrix is 7
Condition number of matrix(A) is :
   4.7537e+08

det(A)det(inv(A)) of matrix(A) is :
    1.0000

Discrepancy of A*inv(A) with I is:
   2.6953e-09


Size of Matrix is 8
Condition number of matrix(A) is :
   1.5258e+10

det(A)det(inv(A)) of matrix(A) is :
    1.0000

Discrepancy of A*inv(A) with I is:
   1.8417e-08


Size of Matrix is 9
Condition number of matrix(A) is :
   4.9315e+11

det(A)det(inv(A)) of matrix(A) is :
    1.0000

Discrepancy of A*inv(A) with I is:
   7.2094e-07
```

```
Size of Matrix is 10
Condition number of matrix(A) is :
   1.6025e+13

det(A)det(inv(A)) of matrix(A) is :
    1.0000

Discrepancy of A*inv(A) with I is:
   2.0467e-05


Size of Matrix is 11
Condition number of matrix(A) is :
   5.2211e+14

det(A)det(inv(A)) of matrix(A) is :
    1.0003

Discrepancy of A*inv(A) with I is:
   2.5457e-04


Warning: Matrix is close to singular or badly scaled. Results may be
inaccurate. RCOND =  2.602837e-17.
Size of Matrix is 12
Condition number of matrix(A) is :
   1.6284e+16

det(A)det(inv(A)) of matrix(A) is :
    0.9730

Discrepancy of A*inv(A) with I is:
    0.0270
```

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Question-2

```
for i = [1,10,100,1000,10000,100000]
    disp("Value of i :-");
    disp(i);
    x = fun(i);
    y = fun2(i);
    fprintf("Value of equation-1 at %d: %20.18f \n",i,x);
    fprintf("Value of equation-2 at %d : %20.18f\n",i,y);
    fprintf("Value Difference : %20.18f\n\n",y-x);
end
function f = fun(x)
    f = sqrt(x)*(sqrt(x+1)-sqrt(x));
end
function f = fun2(x)
    f = sqrt(x)/(sqrt(x+1)+sqrt(x));
end
```

```
Value of i :-
     1

Value of equation-1 at 1: 0.414213562373095145
Value of equation-2 at 1 : 0.414213562373095090
Value Difference : -0.000000000000000056

Value of i :-
    10

Value of equation-1 at 10: 0.488088481701514754
Value of equation-2 at 10 : 0.488088481701515475
Value Difference : 0.000000000000000722

Value of i :-
   100

Value of equation-1 at 100: 0.498756211208899458
Value of equation-2 at 100 : 0.498756211208902733
Value Difference : 0.000000000000003275

Value of i :-
        1000

Value of equation-1 at 1000: 0.499875062461021868
Value of equation-2 at 1000 : 0.499875062460964859
Value Difference : -0.000000000000057010

Value of i :-
       10000

Value of equation-1 at 10000: 0.499987500624854420
Value of equation-2 at 10000 : 0.499987500624960890
Value Difference : 0.000000000000106470
```

```
Value of i :-
      100000

Value of equation-1 at 100000: 0.499998750005928860
Value of equation-2 at 100000 : 0.499998750006249937
Value Difference : 0.000000000000321076
```

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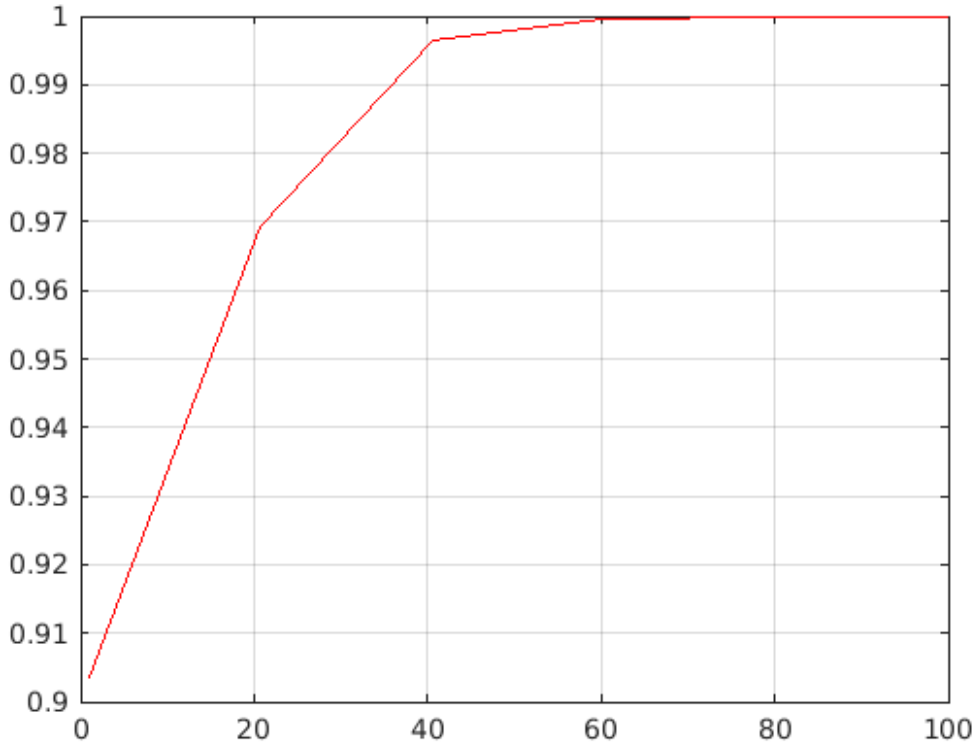
Question-3

```
x = [1,10,100,1000,10000,100000];
func1 = function1(x);
func2 = function2(x);
for i = [1,10,100,1000,10000,100000]
    disp("Value of i :-");
    disp(i);
    x = function1(i);
    y = function2(i);
    fprintf("Value of equation-1 at %d: %20.18f \n",i,x);
    fprintf("Value of equation-2 at %d : %20.18f\n",i,y);
    fprintf("Value Difference between eq1 and eq2 : %20.18f\n\n",x-y);
end
plot(linspace(1, 100, 6), func1 - func2, 'color','red')
grid on
function f = function1(x)
    f = sqrt(2*(x.^2) + 1) - 1;
end
function f = function2(x)
    f = (2.*x.^2)./(sqrt(2.*x.^2) + 1) - 1;
end
```

```
Value of i :-
     1

Value of equation-1 at 1: 0.732050807568877193
Value of equation-2 at 1 : -0.171572875253809820
Value Difference between eq1 and eq2 : 0.903623682822687013

Value of i :-
    10

Value of equation-1 at 10: 13.177446878757825388
Value of equation-2 at 10 : 12.208176506262260475
Value Difference between eq1 and eq2 : 0.969270372495564914

Value of i :-
   100

Value of equation-1 at 100: 140.424891727022355781
Value of equation-2 at 100 : 139.428377656192310496
Value Difference between eq1 and eq2 : 0.996514070830045284

Value of i :-
        1000

Value of equation-1 at 1000: 1413.213915926441359261
Value of equation-2 at 1000 : 1412.214268980229462613
Value Difference between eq1 and eq2 : 0.999646946211896648

Value of i :-
```

```
       10000

Value of equation-1 at 10000: 14141.135659086288796971
Value of equation-2 at 10000 : 14140.135694436628909898
Value Difference between eq1 and eq2 : 0.99996464659887073

Value of i :-
      100000

Value of equation-1 at 100000: 141420.356240845052525401
Value of equation-2 at 100000 : 141419.356244380498537794
Value Difference between eq1 and eq2 : 0.99996464553987607
```



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Question-4

```
for i = 1:4
    n = [-20 -19 19 20];
    func1 = f1(n(i));
    func2 = f2(n(i));
    fprintf('f1(%d) is: %25.15e\n', n(i), func1);
    fprintf('f2(%d) is: %25.15e\n', n(i), func2);
    fprintf('Difference between function is: %25.15e\n\n',abs(func1 -
func2));
end
disp("Function 2 is better than Function 1")
disp("to avoid overflow/underflow")
function f = f1(n)
    x = 36; y = 1e16;
    f = (y.^n)/exp(1).^(n.*x);
end
function f = f2(n)
    x = 36; y = 1e16;
    f = (y/exp(1).^x).^n;
end
```

```
f1(-20) is:     4.920646149013654e-08
f2(-20) is:     4.920700930264205e-08
Difference between function is:     5.478125055142845e-13

f1(-19) is:     1.141367814854855e-07
f2(-19) is:     1.141367814854855e-07
Difference between function is:     1.323488980084844e-23

f1(19) is:     8.761417546430180e+06
f2(19) is:     8.761417546430182e+06
Difference between function is:     1.862645149230957e-09

f1(20) is:                        NaN
f2(20) is:     2.032230802424132e+07
Difference between function is:                      NaN

Function 2 is better than Function 1
to avoid overflow/underflow
```

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Table of Contents

Question-5

```
x = 9.8^201;
y = 10.2^199;
disp('Result :-')
z1 = sqrt(x^2+y^2)/y; %equation-1
fprintf("z1 = %20.18f \n",z1);
z2 = sqrt((x/y)^2+1); %equation-2
fprintf("z2 = %20.18f \n",z2);
disp('Equation 2 is better in terms of power resisting the overflow')
```

```
Result :-
z1 =                  Inf
z2 = 1.000560870111334433
Equation 2 is better in terms of power resisting the overflow
```

Question-6

```
x = 9.8^-201;
y = 10.2^-199;
disp("Result :-")
z1 = sqrt(x^2+y^2)/y; %equation1
fprintf("z1 = %20.18f \n",z1);
z2 = sqrt((x/y)^2+1); %equation2
fprintf("z2 = %20.18f \n",z2);
disp("equation2 is better in terms of the power of resisting
 underflow.")
```

```
Result :-
z1 = 0.000000000000000000
z2 = 29.870086546285236295
equation2 is better in terms of the power of resisting underflow.
```

Question-7

```
A=[1;2];
b=[2.9;3.9];
X=lineq(A,b);
disp('Result :-')
disp(X);
function X=lineq(A,b)
    m=size(A,1);
    n=size(A,2);
    %critically determined case
```

```
    if m==n
        %checking for singular matrix
        if cond(A) > 1e14
            X=pinv(A)*b;
        else
            X = inv(A)*b;
        end
    else
        %underdetermined case
        if m<n
            X=A'*pinv(A*A')*b;
        %overdetermined case
        else
            X=pinv(A'*A)*A'*b;
        end
    end
end
```

Result :-

```
    2.1400
```

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Question-8

```
A=[1 2;3 4];
b=[-1;-1];
disp('Result : ')
X=lineq(A,b);
disp("a)")
disp(X);
A=[1 2;2 4];
b=[-1;-1];
X=lineq(A,b);
disp("b)")
disp(X);
A=[1 2];
b=3;
X=lineq(A,b);
disp("c)")
disp(X);
A=[1;2];
b=[2.9;3.9];
X=lineq(A,b);
disp("d)")
disp(X);
function X=lineq(A,b)
    m=size(A,1);
    n=size(A,2);
    %critically determined case
    if m==n
        %checking for singular matrix
        if cond(A) > 1e14
            X=pinv(A)*b;
        else
            X = inv(A)*b;
        end
    else
        %underdetermined case
        if m<n
            X=A'*pinv(A*A')*b;
        %overdetermined case
        else
            X=pinv(A'*A)*A'*b;
        end
    end
end
```

```
Result :
a)
    1.0000
   -1.0000

b)
   -0.1200
```

```
   -0.2400
```

```
c)
    0.6000
    1.2000
```

```
d)
    2.1400
```

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