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JIA Jiyuan 20210122 HW#05-1 Class 01

```
clear;clc;
```

Problem 1:

a.

```
clear; clc;
A = [2 1;3 -9];
B = [5; 7];
r1 = rank(A);
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
X = A\B;
disp("answer is ")
disp(X);

% b.
clear; clc;
A = [-8 -5;-2 7];
B = [4; 10];
r1 = rank(A);
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
X = A\B;
disp("answer is ")
disp(X);

% c.
clear; clc;
A = [12 -5 0;-3 4 7; 6 2 3];
B = [11; -3; 7];
r1 = rank(A);
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
X = A\B;
```

```
disp("answer is ")
disp(X);

% d.
clear; clc;
A = [6 -3 4;12 5 -7; -5 2 6];
B = [41; -26; 16];
r1 = rank(A);
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
X = A\B;
disp("answer is ")
disp(X);
```

```
rank(A) is 2
rank([A,B]) is 2
answer is
    2.4762
    0.0476

rank(A) is 2
rank([A,B]) is 2
answer is
   -1.1818
    1.0909

rank(A) is 3
rank([A,B]) is 3
answer is
    1.1183
    0.4839
   -0.2258

rank(A) is 3
rank([A,B]) is 3
answer is
    2.0035
   -2.6848
    5.2312
```

Problem 2:

a.

```
clear; clc;
disp("C = B \ (A \ B - A)");
% b.
clear;
A = [7 9; -2 4];
B = [4 -3; 7 6];
r1 = rank(A*B);
r2 = rank([A*B,B-A*A]);
```

```
disp("rank(A*B) is "+r1);
disp("rank([A*B,B-A*A]) is "+r2);
C = A*B\(B-A*A);
disp("answer is ")
disp(C);
```

```
C = B \ (A \ B - A)
rank(A*B) is 2
rank([A*B,B-A*A]) is 2
answer is
   -0.8536   -1.6058
    1.5357    1.3372
```

Problem 3:

a.

```
clear; clc;
A = [-2 1;-2 1];
B = [-5; 3];
r1 = rank(A);
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
if r1==r2&&r1==size(A,1)
    X = A\B;
    disp("answer is ")
    disp(X);
else
    disp("singular matrix");
end
```

```
% b.
clear;
A = [-2 1;-8 4];
B = [3; 12];
r1 = rank(A);
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
if r1==r2&&r1==size(A,1)
    X = A\B;
    disp("answer is ")
    disp(X);
else
    disp("singular matrix");
end
```

```
% c.
clear;
A = [-2 1;-2 1];
B = [-5; -5.00001];
r1 = rank(A);
```

```
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
if r1==r2&&r1==size(A,1)
    X = A\B;
    disp("answer is ")
    disp(X);
else
    disp("singular matrix");
end

% d.
clear;
A = [1 5 -1 6; 2 -1 1 -2; -1 4 -1 3; 3 -7 -2 1];
B = [19; 7; 30; -75];
r1 = rank(A);
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
if r1==r2
    X = A\B;
    disp("answer is ")
    disp(X);
else
    disp("singular matrix");
end
```

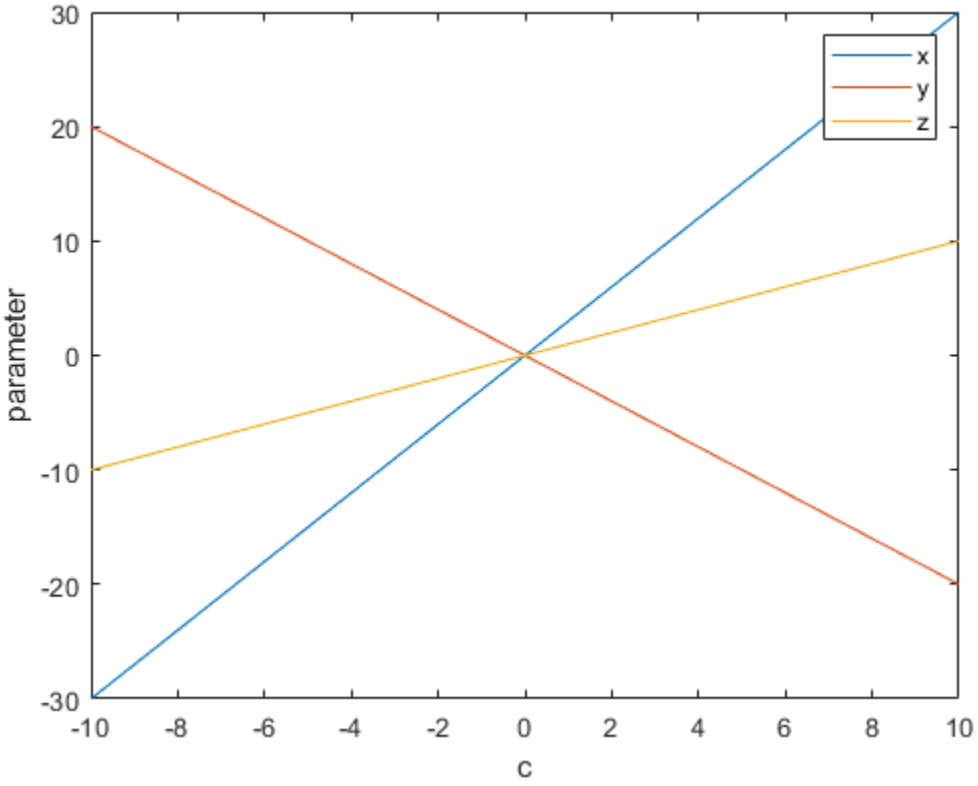
```
rank(A) is 1
rank([A,B]) is 2
singular matrix
rank(A) is 1
rank([A,B]) is 1
singular matrix
rank(A) is 1
rank([A,B]) is 2
singular matrix
rank(A) is 4
rank([A,B]) is 4
answer is
    5.0000
   14.6250
  -12.1250
  -11.8750
```

Problem 4:

```
clear; clc;
syms c;
A = [1 -5 -2; 6 3 1; 7 3 -5];
B = [ 11*c; 13*c; 10*c];
X = A\B;
disp(X);
```

```
c = -10:0.1:10;
x = 3*c;
y = -2*c;
z = c;
plot(c,x,c,y,c,z);
legend("x","y","z");
xlabel("c");
ylabel("parameter")
```

```
 3*c
-2*c
   c
```



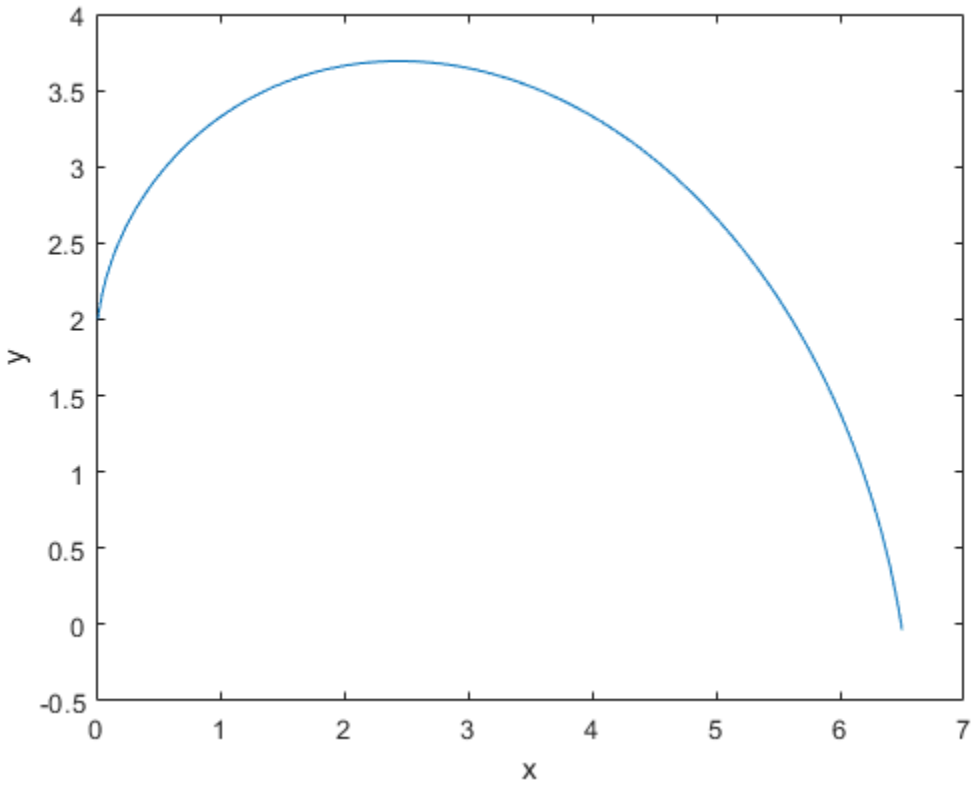
Problem 5:

a.

```
clear; clc;
syms tf theta1_tf theta1_0 a1 a2 a3 b1 b2 b3;
A = [tf^3 tf^4 tf^5;
    3*tf^2 4*tf^3 5*tf^4;
    6*tf 12*tf^2 20*tf^3];
b = [theta1_tf - theta1_0;0 ;0];
X1 = [a1; a2; a3];
X2 = [b1; b2; b3];
```

```
disp("A = ");
disp(A);
disp("b = ");
disp(b);
disp("X1 = ");
disp(X1);
disp("X2 = ");
disp(X2);
% b.
A = [8 16 32;
    12 32 80;
    12 48 160];
b1 = [62; 0; 0];
b2 = [107; 0; 0];
X1 = A\b1;
X2 = A\b2;
fprintf("\ta1 = %.3f\n \ta2 = %.3f\n \ta3 = %.3f
\n",X1(1),X1(2),X1(3));
fprintf("\tb1 = %.3f\n \tb2 = %.3f\n \tb3 = %.3f
\n",X2(1),X2(2),X2(3));
disp("theta1 = -19 +77.5*t^3-58.13*t^4+11.625*t^5")
disp("theta2 = 44 +133.75*t^3-100.3125*t^4+20.0625*t^5")
% c.
clear;
A = [8 16 32;
    12 32 80;
    12 48 160];
b1 = [62; 0; 0];
b2 = [107; 0; 0];
X1 = A\b1;
X2 = A\b2;
t = 0:0.001:2;
theta1 = -19 +77.5*t.^3-58.13*t.^4+11.625*t.^5;
theta2 = 44 +133.75*t.^3-100.3125*t.^4+20.0625*t.^5;
x = 4*cos(theta1/180*pi)+3*cos((theta1+theta2)/180*pi);
y = 4*sin(theta1/180*pi)+3*sin((theta1+theta2)/180*pi);
plot(x,y);
xlabel("x");
ylabel("y");

A =
[  tf^3,    tf^4,    tf^5]
[3*tf^2,  4*tf^3,  5*tf^4]
[  6*tf, 12*tf^2, 20*tf^3]

b =
theta1_tf - theta1_0
                  0
                  0

X1 =
a1
a2
a3
```

```
X2 =
b1
b2
b3

 a1 = 77.500
  a2 = -58.125
  a3 = 11.625
 b1 = 133.750
  b2 = -100.313
  b3 = 20.063
theta1 = -19 +77.5*t^3-58.13*t^4+11.625*t^5
theta2 = 44 +133.75*t^3-100.3125*t^4+20.0625*t^5
```



Problem 6:

```
clear; clc;
Ta = 150;
Tb = 20;
A = [0.036 1 0 0;4.01 -1 1 0;0.408 0 -1 1; 0.038 0 0 -1];
B = [20; 0; 0; -10];
r1 = rank(A);
r2 = rank([A,B]);
disp("rank(A) is "+r1);
disp("rank([A,B]) is "+r2);
```

```
X = A\B;
fprintf("\tq = %.2f W \n \tT1 = %.2f celcius\n \tT2 = %.2f celcius\n
 \tT3 = %.2f celcius",X(1)*10,X(2),X(3),X(4));
```

```
rank(A) is 4
rank([A,B]) is 4
 q = 22.26 W
  T1 = 19.92 celcius
  T2 = 10.99 celcius
  T3 = 10.08 celcius
```

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