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Math 18 B01

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Exercise 5.1:

A)

Setting Vectors:

```
>> v = [2; 0; -1]

v =

     2     0    -1

>> w = [1; 3; 3]

w =

     1     3     3

>> x = [6; 1; -3]

x =

     6     1    -3

>> y = [1; 0; 2]

y =

     1     0     2

>> z = [2; -15; -1]

z =

     2   -15    -1
```

```
>> dot(v ,w)   >> dot(v ,x)   >> dot(v ,y)   >> dot(v ,z)   >> dot(w ,z)

ans =          ans =          ans =          ans =          ans =

    -1              15              0               5               0


>> dot(w ,y)   >> dot(w ,z)   >> dot(x ,y)   >> dot(x ,z)   >> dot(y ,z)

ans =          ans =          ans =          ans =          ans =

     7             -46              0               0               0
```

Based on our data, the orthogonal subsets include {v, y}, {w, z}, {x, y}, {x, z} and {y, z}. The maximum number of nonzero orthogonal vectors that you can possibly find in R^3 is 3. This is because if vectors are orthogonal to each other, they are also linearly independent. And because our subset is in R^3, we can have at most 3 pivotal columns for an augmented matrix of vectors.

b)

```
>> x = x/norm(x); y = y/norm(y); z = z/norm(z);
>> W = [x y z]

W =

    0.8847    0.4472    0.1319
    0.1474         0   -0.9891
   -0.4423    0.8944   -0.0659
```

Exercise 5.2

a)

```
>> W*W'

ans =

    1.0000    0.0000   -0.0000
    0.0000    1.0000   -0.0000
   -0.0000   -0.0000    1.0000
```

Multiplying a matrix by its transpose gets us the identity matrix.

b)

```
>> a = [1;1;0]

a =

     1
     1
     0

>> b = [2;0;3]

b =

     2
     0
     3


>> norm(b)

 =

    3.6056

>> norm(W*b)

ans =

    3.6056
```

The norms are the same.

```
>> dot(a, b)

ans =

     2

>> dot(W*a, W*b)

ans =

     2
```

c)

```
>> inv(W)

ans =

    0.8847    0.1474   -0.4423
    0.4472         0    0.8944
    0.1319   -0.9891   -0.0659

>> W'

ans =

    0.8847    0.1474   -0.4423
    0.4472         0    0.8944
    0.1319   -0.9891   -0.0659
```

We can see that the inverse of W and W’ are the same matrix.

Exercise 5.3

a)

```
>> vbar = (dot(v ,w)/dot(w, w))*w

vbar =

   -0.0526
   -0.1579
   -0.1579

>> z = v - vbar

z =

    2.0526
    0.1579
   -0.8421

>> vsum = z + vbar

vsum =

     2
     0
    -1
```

b)

```
>> dot(z, vbar)

ans =

  -2.7756e-17
```

When analyzing this value, we can conclude that z is orthogonal to vbar. This is because although the value isn't exactly zero, there are expected computational rounding errors that may cause a negligible change from zero.

Exercise 5.4

```
>> z = [3;3;3];

>> (dot(z,x)/dot(x,x))*x+(dot(z,y)/dot(y,y))*y

ans =

    3.3652
    0.2609
    2.8174
```

Exercise 5.5

```
>> a = [1; 2; 1]

a =

     1
     2
     1

>> b = [2; 1; 2]

b =

     2
     1
     2

>> c = [1; 1; 2]
```

```
c =

     1
     1
     2

>> set = [a b c]

set =

     1     2     1
     2     1     1
     1     2     2

>> [Q, R] = qr(set)

Q =

   -0.4082    0.5774   -0.7071
   -0.8165   -0.5774   -0.0000
   -0.4082    0.5774    0.7071


R =

   -2.4495   -2.4495   -2.0412
         0    1.7321    1.1547
         0         0    0.7071

>> v = eig(Q)

v =

  -0.6392 + 0.7690i
  -0.6392 - 0.7690i
   1.0000 + 0.0000i

>> norm(v(2))

ans =

    1.0000

>> norm(v(3))
```

```
ans =

     1
```

Both the second and third eigenvalues are equal to 1.

Exercise 5.6
a)

```
>> B = [1 75; 1 100; 1 128; 1 159; 1 195]

B =

     1    75
     1   100
     1   128
     1   159
     1   195

>> d = [15; 23; 26; 34; 38]

d =

    15
    23
    26
    34
    38

>> [Q, R] = qr(B, 0)

Q =

   -0.4472   -0.5950
   -0.4472   -0.3313
   -0.4472   -0.0359
   -0.4472    0.2912
   -0.4472    0.6710


R =

   -2.2361 -293.8193
         0   94.7903
```

```
>> x = Q(:, 1)
y = Q(:, 2)

x =

   -0.4472
   -0.4472
   -0.4472
   -0.4472
   -0.4472


y =

   -0.5950
   -0.3313
   -0.0359
    0.2912
    0.6710

>> v = dot(x,d)*x + dot(y,d)*y

v =

   16.5379
   21.2640
   26.5572
   32.4176
   39.2232
```

b)

```
>> c = B\v

c =

    2.3596
    0.1890

>> B*c - v

ans =

   1.0e-14 *
```

```
    0.7105
   -0.7105
   -0.3553
         0
         0
```

c)

```
>> cl = lscov(B, d, eye(5))

cl =

    2.3596
    0.1890
```

The MATLAB answer is the same as our calculated answer.

Exercise 5.7

a)

Because cl = [2.3596; 0.1890], we know that b = 2.3596 and m = 0.1890.
So, we get the equation y = 0.1890x + 2.3596

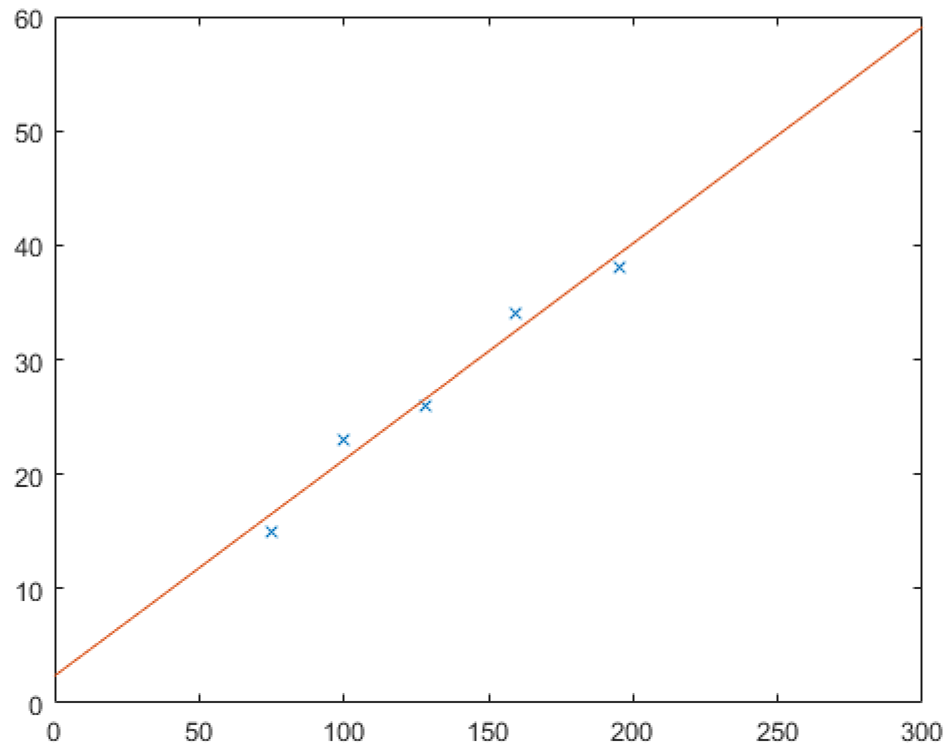
b)

```
>> y = 0.1890*35 + 2.3596

y =

    8.9746

>> y = 0.1890*170 + 2.3596

y =

   34.4896

>> y = 0.1890*290 + 2.3596

y =

   57.1696
```

c)

```
x = B(:,2);
y = d;
t = 0:1:300;
```

```
z = polyval([c(2);c(1)],t);;
plot(x,y,'x',t,z)
```



As we can see from the graph, our line is a fairly decent approximation of the data set.