

3.1

There will be 1 Non Zero EigenValue in the matrix because the number of Non Zero EigenValues in a Matrix is Equal to the Rank of the Matrix, because the rows of the Matrix are linearly Dependent. Therefore there is 1 Non Zero value in Matrix

3.2

Equation of the Line perpendicular to the line $w_1x + w_2x + w_3 = 0$ is **$w_2x - w_1x + w_3 = 0$** .

Just like on the Previous part of the question here also the rows are linearly Dependent hence the rank of matrix is 1 Hence the Number of Non zero eigen values is one.

3.3

The Covariance matrix is having a full rank because here in the case of points around the line there is a possibility that some points go outside the line's equation hence they wont satisfy the Equation of the line and hence the Covariance matrix will have the Full rank, but here one of the eigen values will be much greater than the other one because the points are concentrated around a particular line and most of them tend to follow the equation of the line but cannot because of the noise, and the Eigen vectors will be Orthogonal to each other with the Larger vector along the line and other smaller vector along perpendicular to the Line.

CODE for 4th Part:

```
import numpy as np
import random
import matplotlib.pyplot as plt

data = []
# Generating Random Points
for z in range(1000):
    x = random.randint(-10,10) + random.randint(-10,10)/10
    y = x+ random.randint(-10,10)/10;
    a = [x,y]
    data.append(a)

# Plotting the Points
x,y = np.array(data).T
mean_x = np.mean(x)
mean_y = np.mean(y)

print ("covariance : ")
covaar_mat = np.cov(x,y)
print(covaar_mat)
```

```

print ("Eigen Values : ")
Eigen_values, Eigen_vectors = np.linalg.eig(covaar_mat)
print(Eigen_values)
print ("Eigen Vectors : ")
print(Eigen_vectors)
plt.scatter(x,y)
plt.arrow(mean_x,mean_y,Eigen_vectors[0][0],Eigen_vectors[1][0],head_width=0.5,head_length
=0.2,color="r")
plt.arrow(mean_x,mean_y,-Eigen_vectors[0][1],-Eigen_vectors[1][1],head_width=0.5,head_lengt
h=0.2,color="g")
plt.show()

```

