Amrita School of Engineering, Bangalore-35

23MAT117-Linear Algebra

Lab Session Sheet -4

(Span of vectors)

Standard basis vectors: The set {<1, 0>, <0, 1>} represents the basis vectors for the standard Euclidean space $\mathbb{R}^2$.

Random vectors: Randomly generated vectors within a certain range or distribution.

Linearly independent vectors: Any set of linearly independent vectors.

Linearly dependent vectors: Any set of linearly dependent vectors.

Vectors spanning a plane: Three non-collinear vectors in $\mathbb{R}^3$ can span a plane.

Vectors spanning a line: Two linearly independent vectors in $\mathbb{R}^2$ or three vectors in $\mathbb{R}^3$ that lie on the same line.

Code

```
% Standard basis vectors in R^2
standard_basis = [1, 0; 0, 1];

% Random vectors within a certain range or distribution
num_random_vectors = 5;
range_min = -5;
range_max = 5;
random_vectors = range_min + (range_max - range_min) *
rand(num_random_vectors, 2);

% Linearly independent vectors
```

```
linearly_independent = [1, 2; 3, 1];

% Linearly dependent vectors
linearly_dependent = [1, 2; 2, 4]; % Second vector is a multiple of the first

% Vectors spanning a plane in R^3
v1 = [1, 0, 0];
v2 = [0, 1, 0];
v3 = [0, 0, 1];
vectors_spanning_plane = [v1; v2; v3];

% Vectors spanning a line in R^2 or R^3
v4 = [1, 1];
v5 = [2, 2];
vectors_spanning_line = [v4; v5];

% Display the vectors
disp("Standard basis vectors:");
disp(standard_basis);

disp("Random vectors:");
disp(random_vectors);

disp("Linearly independent vectors:");
disp(linearly_independent);

disp("Linearly dependent vectors:");
disp(linearly_dependent);

disp("Vectors spanning a plane:");
disp(vectors_spanning_plane);

disp("Vectors spanning a line:");
disp(vectors_spanning_line);
```

- **3D Scatterplot of space spanned by given vectors / 3D Scatterplot of a Vector Space given basis vectors**

➤ **Span of one vector:**

```
b1=[1;1;1]          % enter basis vector as a column vector
pts=[]
for i=1:1000
k1=-1+2*rand(1)         %generates 1000 random numbers(scalars) between -1
and 1
 pts=[pts,k1*b1];
                        %generates 1000 points in the span set in the form of
3×1000 matrix
end
scatter3(pts(1,:),pts(2,:),pts(3,:),1);
            %gives the scatterplot of generated 1000 points. Each point size is
given as 1.
```

✔ (Check 'help scatter3' to find the variety of scatter3 options w.r.t. size and colour.)

➤ **Span of two vectors:**

```
b1=[1;0;0]              % enter one basis vector as a column vector
b2=[0;1;0]              % enter second basis vector as a column vector
pts=[]
for i=1:10000
k1=-1+2*rand(1)         %generates 10000 random numbers(scalars) between
-1 and 1
k2=-1+2*rand(1)         %generates 10000 random numbers(scalars) between
-1 and 1
```

```
pts=[pts,k1*b1+k2*b2];
                    %generates 10000 points in the span set in the form of
3×10000 matrix
end
scatter3(pts(1,:),pts(2,:),pts(3,:),1);
                %gives the scatterplot of generated 10000 points. Each point size
is given as 1.
```

Practice Questions

1. Find a 3D scatter plot of the span of the vector (1,0,2).
2. Find a 3D scatter plot of the span of the vector (1,3,5).
3. Find a 3D scatter plot of the span of the vector (-6,-3,1).
4. Find a 3D scatter plot of the span of the vector (0,-3,7).
5. Find a 3D scatter plot of the span of the vector (1,0,1).
6. Find a scatter plot of the span of the vectors (1,0,2) and (1,3,5).
7. Find a scatter plot of the span of the vectors -6,-3,1) and (0,-3,7).
8. Find a scatter plot of the span of the vectors (2,5,1) and (1,1,-6).
9. Find a scatter plot of the span of the vectors (1,2,3) and (-2,1,4).
10. Find a 3D scatter plot of the span of the vectors (1,1,0) and (0,1,0). Is the span set same as XY plane?
11. Find a scatter plot of the span of the vectors (1,2) and (-2,1).
12. Find a scatter plot of the span of the vectors (1,0) and (0,1).