ElecEng 2FL3
Assignment 2
Vector Algebra and Coordinate Systems

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Assignment 2 is derived and extended from the Examples and Exercises Set 1 of "Electromagnetics I: MATLAB Experiments Manual for EE2FH3" by Dr. M.H. Bakr and Chen He. This Manual is freely available for download from the A2L course page. It is recommended that, before you start working on this assignment, you study the Example in Set 1 of the Manual. It will teach you how to use MATLAB to solve simple problems in vector algebra.

1 Instructions

By completing this exercise you will gain experience using The Mathworks® MATLAB® software. You will work with vectors in three coordinate systems.

You must first solve the assigned problem *analytically*. This analytical solution must be submitted through the A2L course website in PDF file format. The solution can be either handwritten or typed.

Then, a MATLAB® code must be written that solves the same problem. If your code works correctly, the answers should be the same as your analytical solution. You must submit your MATLAB (***.m) file through the A2L course website.

2 Problem Statement

2.1 Rectangular Coordinates

The vectors $\mathbf{A}_1$ and $\mathbf{A}_2$ are defined at the point P. Find:

a) the dot product $\mathbf{A}_1 \cdot \mathbf{A}_2$,

b) the projection of $\mathbf{A}_1$ onto $\mathbf{A}_2$,

c) the angle between $\mathbf{A}_1$ and $\mathbf{A}_2$,

d) the cross product $\mathbf{A}_1 \times \mathbf{A}_2$,

e) the distance from the origin to the line defined by $\mathbf{A}_1$ at P,

f) the distance from the origin to the plane defined by $\mathbf{A}_1$ and $\mathbf{A}_2$ at P.

The values of the vectors $\mathbf{A}_1$ and $\mathbf{A}_2$ and the point P are assigned to you based on your student number. See the instructions at the end of the document.

2.2 Cylindrical Coordinates

Transform the rectangular coordinates of P into cylindrical ones. Then, transform $\mathbf{A}_1$ and $\mathbf{A}_2$ into cylindrical-component form. Finally, find the dot product between the so transformed vectors. Is it the same as the dot product obtained in the rectangular coordinate system?

2.3 Spherical Coordinates

Transform the rectangular coordinates of P into spherical ones. Transform $\mathbf{A}_1$ and $\mathbf{A}_2$ into spherical-component form. Find the cross product between the so transformed $\mathbf{A}_1$ and $\mathbf{A}_2$. Transform the so found cross product into rectangular component form. Is it the same as the cross product obtained in the rectangular coordinate system?

2.4 MATLAB

Write a MATLAB® code that implements your solution for Section 2.1.

3 Selecting the Values

The attached page shows 100 sets of values (variations) for $\mathbf{A}_1$, $\mathbf{A}_2$ and P in a rectangular coordinate system. Select the set the number of which corresponds to the last two digits of your student ID number.

Variation #	A1≡(A1x,A1y,A1z)	A2≡(A2x,A2y,A2z)	P≡(x,y,z)
00	(0.40,0.70,0.00)	(0.30,0.10,0.10)	(2.80,3.70,4.60)
01	(0.50,0.40,0.70)	(0.20,0.90,0.00)	(7.30,4.60,6.40)
02	(0.10,0.20,0.80)	(1.00,0.30,0.70)	(9.10,9.10,1.00)
03	(0.00,0.10,0.90)	(0.10,0.40,1.00)	(5.50,7.30,3.70)
04	(0.70,0.90,0.00)	(0.80,1.00,0.80)	(3.70,8.20,1.90)
05	(0.40,0.90,0.30)	(0.30,0.10,0.00)	(7.30,2.80,2.80)
06	(0.50,0.00,0.60)	(0.10,0.60,0.70)	(1.90,4.60,7.30)
07	(0.40,0.00,0.50)	(0.70,0.50,1.00)	(6.40,9.10,1.90)
08	(0.10,0.80,0.40)	(0.10,1.00,0.30)	(8.20,7.30,9.10)
09	(0.60,0.80,0.30)	(0.20,0.90,0.40)	(10.00,7.30,6.40)
10	(0.10,1.00,0.40)	(0.60,0.40,0.20)	(9.10,6.40,1.00)
11	(0.60,0.30,0.50)	(0.90,0.30,0.90)	(6.40,1.00,10.00)
12	(0.70,1.00,0.10)	(0.10,1.00,0.70)	(1.00,8.20,8.20)
13	(0.20,0.90,0.50)	(0.60,0.90,0.10)	(3.70,6.40,10.00)
14	(0.60,0.00,0.80)	(0.20,0.80,0.40)	(9.10,8.20,6.40)
15	(0.10,0.00,0.10)	(0.00,0.10,0.20)	(7.30,6.40,1.00)
16	(0.00,1.00,0.60)	(0.20,0.20,0.80)	(2.80,6.40,10.00)
17	(0.60,0.60,0.30)	(1.00,0.60,0.40)	(6.40,8.20,7.30)
18	(0.20,0.00,0.40)	(0.60,0.20,0.80)	(1.00,2.80,8.20)
19	(0.20,0.70,0.50)	(1.00,0.20,0.00)	(8.20,8.20,9.10)
20	(1.00,0.00,0.20)	(0.60,1.00,1.00)	(6.40,10.00,7.30)
21	(0.10,0.10,0.50)	(0.00,1.00,0.90)	(1.00,1.90,3.70)
22	(0.10,0.80,0.30)	(1.00,0.60,0.90)	(9.10,9.10,5.50)
23	(0.30,0.90,0.60)	(0.20,0.80,0.60)	(1.00,4.60,7.30)
24	(1.00,0.00,1.00)	(0.40,1.00,0.60)	(9.10,6.40,6.40)
25	(0.30,0.60,0.80)	(0.90,0.80,0.70)	(9.10,3.70,7.30)
26	(0.40,0.40,0.40)	(0.40,0.30,0.60)	(4.60,10.00,7.30)
27	(0.90,0.50,0.80)	(0.60,0.80,0.50)	(8.20,6.40,5.50)
28	(0.30,0.00,0.40)	(0.00,1.00,0.10)	(8.20,9.10,7.30)
29	(0.60,0.10,0.50)	(0.30,0.20,0.60)	(3.70,10.00,10.00)
30	(0.20,0.10,0.20)	(0.50,0.80,0.20)	(2.80,9.10,4.60)
31	(0.60,0.20,0.10)	(0.50,0.50,0.10)	(6.40,5.50,7.30)
32	(0.10,0.80,0.20)	(0.50,0.80,0.00)	(3.70,9.10,9.10)
33	(0.50,0.90,1.00)	(0.90,0.90,0.10)	(7.30,7.30,6.40)
34	(0.80,0.00,0.80)	(0.80,0.20,0.20)	(6.40,3.70,8.20)
35	(0.40,0.80,1.00)	(0.30,0.10,0.90)	(5.50,10.00,7.30)
36	(1.00,0.60,0.50)	(0.10,0.30,0.00)	(1.90,8.20,1.00)
37	(0.40,0.90,0.70)	(0.70,0.20,0.40)	(6.40,10.00,2.80)
38	(0.20,0.20,0.80)	(0.50,0.00,0.50)	(2.80,8.20,3.70)
39	(0.00,0.60,0.90)	(0.40,0.80,0.50)	(5.50,10.00,8.20)
40	(0.00,0.70,0.50)	(1.00,0.20,0.20)	(1.00,4.60,1.90)
41	(0.60,0.80,0.70)	(0.80,0.30,0.90)	(4.60,9.10,6.40)
42	(0.10,0.00,0.00)	(0.00,0.50,0.10)	(1.00,8.20,4.60)
43	(0.80,0.40,0.40)	(0.50,0.50,0.80)	(4.60,9.10,1.00)
44	(0.80,0.10,0.60)	(0.00,0.50,0.00)	(10.00,9.10,8.20)
45	(1.00,0.10,0.10)	(0.20,0.60,0.90)	(10.00,7.30,8.20)

46	(1.00,0.40,0.20)	(0.10,0.10,0.80)	(1.90,2.80,9.10)
47	(0.30,1.00,0.20)	(0.50,0.30,1.00)	(4.60,4.60,5.50)
48	(1.00,0.00,0.70)	(0.90,0.00,0.50)	(3.70,9.10,6.40)
49	(0.70,0.40,0.60)	(0.30,0.00,0.60)	(3.70,5.50,10.00)
50	(0.40,0.20,0.40)	(1.00,1.00,0.90)	(10.00,2.80,1.00)
51	(0.20,0.30,0.10)	(0.60,0.40,0.80)	(2.80,7.30,2.80)
52	(0.60,0.30,0.00)	(0.20,0.70,0.50)	(5.50,1.90,6.40)
53	(1.00,0.80,0.60)	(1.00,0.90,0.60)	(1.00,1.90,1.00)
54	(0.40,0.40,1.00)	(0.10,1.00,0.80)	(9.10,6.40,7.30)
55	(0.50,0.00,0.30)	(0.50,0.80,0.50)	(5.50,1.90,1.00)
56	(0.80,0.30,1.00)	(0.20,0.30,0.50)	(8.20,5.50,1.90)
57	(0.30,0.50,0.70)	(0.80,0.10,0.00)	(5.50,8.20,1.00)
58	(0.70,0.70,0.40)	(1.00,0.70,0.00)	(5.50,9.10,9.10)
59	(0.70,0.70,0.60)	(0.30,0.60,0.70)	(3.70,9.10,2.80)
60	(0.80,0.80,0.20)	(0.20,0.20,0.10)	(4.60,1.00,1.90)
61	(0.70,0.80,0.00)	(0.20,0.20,1.00)	(7.30,6.40,3.70)
62	(0.90,0.40,1.00)	(0.70,0.50,0.10)	(10.00,1.90,2.80)
63	(0.40,0.40,0.10)	(0.80,0.20,0.70)	(8.20,2.80,6.40)
64	(0.80,0.70,0.60)	(0.30,0.80,1.00)	(4.60,8.20,1.00)
65	(0.90,0.20,0.40)	(0.30,0.00,0.90)	(4.60,5.50,5.50)
66	(0.10,0.20,0.00)	(0.50,0.20,0.30)	(1.90,8.20,1.90)
67	(1.00,0.10,0.60)	(0.00,0.80,0.20)	(5.50,8.20,1.90)
68	(0.60,0.20,0.80)	(0.70,0.10,0.90)	(1.00,9.10,6.40)
69	(0.50,0.70,0.80)	(0.40,0.80,0.80)	(6.40,4.60,7.30)
70	(0.00,0.80,0.90)	(0.20,0.10,0.20)	(3.70,9.10,5.50)
71	(0.30,0.10,0.30)	(0.60,0.30,0.50)	(4.60,9.10,4.60)
72	(0.30,0.70,0.20)	(0.50,0.30,0.60)	(9.10,4.60,8.20)
73	(0.90,0.00,0.60)	(1.00,0.50,0.20)	(9.10,2.80,7.30)
74	(0.50,1.00,0.60)	(0.90,0.00,1.00)	(1.00,3.70,10.00)
75	(0.00,0.90,0.90)	(0.40,0.20,0.80)	(5.50,1.90,10.00)
76	(0.90,0.50,0.90)	(0.40,0.70,0.40)	(5.50,2.80,10.00)
77	(0.30,0.10,0.10)	(0.00,0.70,0.60)	(8.20,5.50,8.20)
78	(0.70,0.80,0.40)	(0.70,0.10,0.30)	(1.90,4.60,2.80)
79	(0.80,0.40,0.30)	(0.30,0.70,0.20)	(8.20,3.70,5.50)
80	(0.30,0.10,0.70)	(0.70,0.70,0.20)	(7.30,2.80,4.60)
81	(0.40,0.30,0.00)	(0.60,0.70,0.60)	(7.30,1.90,1.90)
82	(0.50,0.90,0.20)	(0.50,0.40,0.50)	(1.90,3.70,2.80)
83	(0.90,0.80,0.40)	(0.60,0.10,0.50)	(3.70,9.10,7.30)
84	(0.50,0.40,0.60)	(0.90,0.80,0.60)	(10.00,1.00,10.00)
85	(0.00,0.20,0.40)	(0.10,0.60,0.00)	(3.70,1.00,7.30)
86	(0.70,0.40,0.20)	(0.80,0.30,0.80)	(5.50,5.50,1.00)
87	(0.70,0.30,0.20)	(0.40,0.40,0.50)	(10.00,4.60,8.20)
88	(0.60,0.90,0.30)	(0.20,1.00,0.00)	(10.00,6.40,4.60)
89	(1.00,0.00,0.50)	(0.00,0.60,0.10)	(6.40,10.00,9.10)
90	(0.50,0.40,0.90)	(0.50,0.40,0.20)	(1.00,4.60,1.00)
91	(0.30,0.50,1.00)	(0.10,0.70,0.50)	(8.20,1.90,1.00)
92	(0.40,0.80,0.20)	(0.80,0.30,0.20)	(1.00,4.60,4.60)

93	(0.70,0.00,0.10)	(0.00,0.10,0.70)	(4.60,3.70,6.40)
94	(1.00,0.90,0.70)	(1.00,0.00,0.00)	(5.50,3.70,10.00)
95	(0.50,0.50,0.90)	(0.40,0.90,0.20)	(3.70,3.70,6.40)
96	(0.20,0.70,0.10)	(0.10,0.90,0.20)	(4.60,6.40,5.50)
97	(0.20,0.00,0.30)	(0.00,0.70,0.70)	(4.60,8.20,5.50)
98	(0.90,0.40,0.00)	(0.90,0.70,0.90)	(10.00,1.00,2.80)
99	(0.50,0.20,1.00)	(1.00,0.60,1.00)	(3.70,9.10,4.60)