

Assignment no 1 : ME762 : Introduction to Robotics –

Submission Monday 29th August 2022, 10 pm in Mookit . Solve the problems on A4 size sheets and then scan and upload as a single pdf file. NOTE : DO NOT upload separate image files.

Numbers in [] indicate difficulty level on a scale of 50.

Q1

[15] A vector ${}^A P$ is rotated about \hat{Y}_A by 30 degrees and is subsequently rotated about \hat{X}_A by 45 degrees. Give the rotation matrix that accomplishes these rotations in the given order.

Q2. (a)

[16] A frame $\{B\}$ is located initially coincident with a frame $\{A\}$. We rotate $\{B\}$ about \hat{Z}_B by 30 degrees, and then we rotate the resulting frame about \hat{X}_B by 45 degrees. Give the rotation matrix that will change the description of vectors from ${}^B P$ to ${}^A P$.

Q2(b) If the coordinates of a point P in frame B is given by (1,1,1) find its coordinate in frame A?

Q2 (C) If in the question above the frame B is first rotated about Z_A by 30 degrees and then about X_A by 45 degrees , what will be the combined rotation matrix.

Q2(d) If the coordinate of a point P in frame B is given by (1,1,1) what is its coordinate in frame A?

Q3.

[13] ${}^A_B R$ is a 3×3 matrix with eigenvalues 1, e^{+ai} , and e^{-ai} , where $i = \sqrt{-1}$. What is the physical meaning of the eigenvector of ${}^A_B R$ associated with the eigenvalue 1?

Q4. A frame B is rotated about the Z axis of frame A by 60 degrees and then translated by 1,1,1 units in the x,y,z directions of A. If the coordinate of a point P in frame B is given by (3,3,3), what is its coordinate in frame A?

Q5.

[15] Given

$${}^A_B T = \begin{bmatrix} 0.25 & 0.43 & 0.86 & 5.0 \\ 0.87 & -0.50 & 0.00 & -4.0 \\ 0.43 & 0.75 & -0.50 & 3.0 \\ 0 & 0 & 0 & 1 \end{bmatrix},$$

what is the (2,4) element of ${}^B_A T$?

Q6.

[21] The following frame definitions are given as known:

$${}^U_A T = \begin{bmatrix} 0.866 & -0.500 & 0.000 & 11.0 \\ 0.500 & 0.866 & 0.000 & -1.0 \\ 0.000 & 0.000 & 1.000 & 8.0 \\ 0 & 0 & 0 & 1 \end{bmatrix},$$

$${}^B_A T = \begin{bmatrix} 1.000 & 0.000 & 0.000 & 0.0 \\ 0.000 & 0.866 & -0.500 & 10.0 \\ 0.000 & 0.500 & 0.866 & -20.0 \\ 0 & 0 & 0 & 1 \end{bmatrix},$$

$${}^C_U T = \begin{bmatrix} 0.866 & -0.500 & 0.000 & -3.0 \\ 0.433 & 0.750 & -0.500 & -3.0 \\ 0.250 & 0.433 & 0.866 & 3.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

Draw a frame diagram (like that of Fig. 2.15) to show their arrangement qualitatively, and solve for ${}^B_C T$.

Q7.

[15] Referring to Fig. 2.25, give the value of ${}^A_B T$.

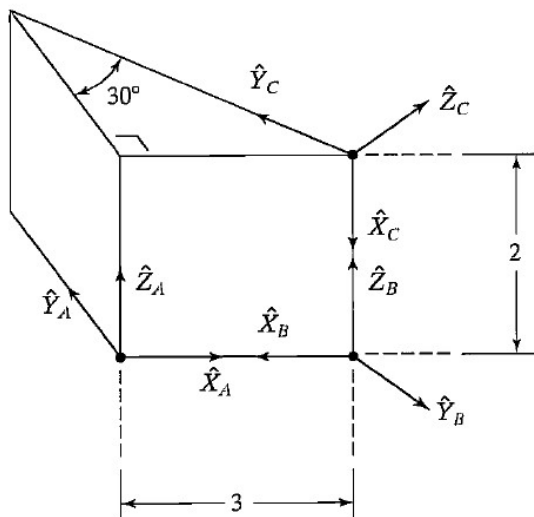


FIGURE 2.25: Frames at the corners of a wedge.