

Name: \_\_\_\_\_

Matric number: \_\_\_\_\_

Frame B is attached to a rigid plate (ABC) as shown in Fig. 1. Point D is at edge AC of the plate and its location is indicated in Fig. 1. The plate is located in Frame A as shown in Fig. 2. Frame F is located at a fixed position and orientation with respect to Frame A and  ${}^A T_F$  is known.

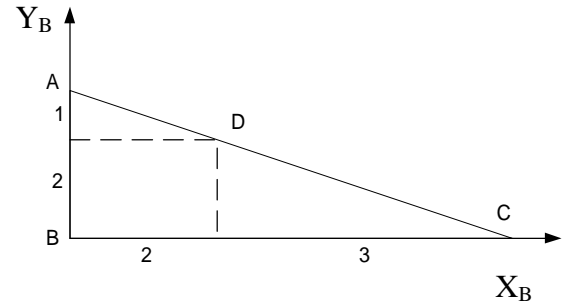


Fig. 1

1. Determine the homogeneous transformation matrix  ${}^A T_B$  (Fig 1) that describes the position and orientation of the plate in Frame A.

Ans:

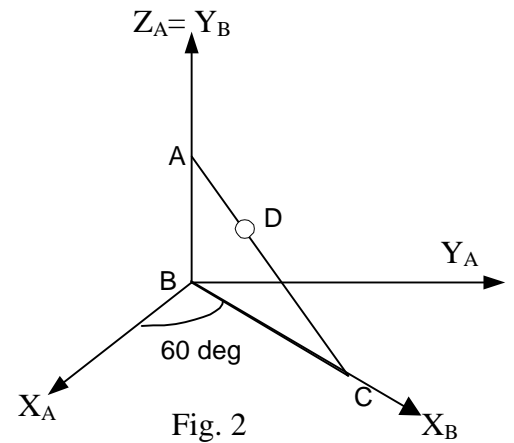


Fig. 2

2. The plate is initially at  ${}^A T_B$  (Fig. 1) and it undergoes the following motion in sequence:

- a. rotation about  $X_B$  by 20 degrees.
- b. rotation about  $Y_A$  by 30 degrees
- c. rotation about  $Z_F$  by 40 degrees

Determine the new position of point D in Frame A after the above three motions. You can express your answer in terms of an expression involving matrix and vector sums and/or products. You need not simplify nor evaluate your answers.

Ans:

Ans to Quiz #1

18 Jan 2000

1. By Inspection

$${}^A T_B = \begin{pmatrix} \cos 60^\circ & 0 & \sin 60^\circ & 0 \\ \sin 60^\circ & 0 & -\cos 60^\circ & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$$2. {}^B P_D = \begin{pmatrix} 2 \\ 2 \\ 0 \\ 1 \end{pmatrix}$$

↳  $\text{Rot}(z, 60^\circ) \text{Rot}(x, 90^\circ)$  OR  
 $\text{Rot}(x, 90^\circ) \text{Rot}(y, 60^\circ)$

$${}^A P_{D_1} = {}^A T_B \text{Rot}(x, 20^\circ) {}^B P_D$$

$${}^A P_{D_2} = \text{Rot}(y, 30^\circ) {}^A P_{D_1}$$

$${}^F P_{D_2} = {}^F T_A {}^A P_{D_2} = {}^A T_F^{-1} {}^A P_{D_2}$$

$${}^F P_{D_3} = \text{Rot}(z, 40^\circ) {}^F P_{D_2}$$

$${}^A P_{D_3} = {}^A T_F {}^F P_{D_3}$$

∴

$${}^A P_{D_3} = {}^A T_F \text{Rot}(z, 40^\circ) {}^A T_F^{-1} \text{Rot}(y, 30^\circ) {}^A T_B \text{Rot}(x, 20^\circ) {}^B P_D =$$