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 $^AT_F$ is known.

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

Ans:

2. The plate is initially at $^AT_B$ (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

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. \(B_{P_D} = \begin{pmatrix} 2 \\ 2 \\ 0 \\ 1 \end{pmatrix}\)  

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

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

\(F_{P_{D_2}} = F_T A_{P_{D_2}} = A_T f^{-1} A_{P_{D_2}}\)

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

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