1.

a. Given our axis parameters of [a , b, c] to get the composite matrix, we would need to get the individual rotation matrices for the x , y and z dimensions and then multiply them in order of rotation. As such our three rotation matrices would be $R_x(a)$, $R_y(b)$ and $R_z(c)$. We then multiply them together to get $M = R_z(c)\, R_y(b) R_x(a)$

b. Our Rotation matrix from $\mathcal{A}$ to $\mathcal{B}$ is M, the joint's co-ordinates in $\mathcal{A}$ as p and our Rotation matrix in B is defined as N. To get the points new co-ordinate system we first apply the transformation matrix M on the points p to convert the points from $\mathcal{A}$ to B (let this be denoted as q). Therefore, we get the formula q=Mp.
After that we apply transformation matrix N to these points q to get our new points in B. Let us denote these new points as x for clarity.
Therefore, to get our points in system $\mathcal{A}$, we need to find the inverse of M (denoted as M-1) to get our points from system $\mathcal{B} \rightarrow \mathcal{A}$. This gives us the formula $M^{-1}x$. Recall that the formula for x is Nq and the formula for q is Mp, we can combine the 2 formulae to give us M-1NMp to give us the points in system A. In conclusion, our transformation matrix N' is $M^{-1}NM$.

c. Given that l is the length and our direction vector is d. We can get the value of p by performing the following formula: p = l * d/|d|

d. Recall that $N' = M^{-1}NM$ is the rotation matrix for the local co-ordinate space we found that p = l * d/|d|and $M = R_z(c)\, R_y(b) R_x(a)$. We also know that M_0 is the transformation matrix from parent's local system to global system. Therefore, the final formula $p' = M_0 N' p$ which can be expanded to $M_0\, (M^{-1}NM)$ (l * d/|d|)

[Part 2 link]