Solution for question #1:

(a) For the RPP planar robot:

$$p_x = d_2 S\theta_1 - d_3 C\theta_1 \tag{3.1}$$

$$p_y = -d_2 C\theta_1 - d_3 S\theta_1 \tag{3.2}$$

Joint 1: revolute, Z(out), so, $\xi_1 t_1 = 1$

Joint 2: prismatic, $\xi_2 t_2 = 0$

Joint 3: prismatic, $\xi_3 t_3 = 0$

$$J(q) = \begin{bmatrix} \frac{\partial P_x}{\partial \theta_1} & \frac{\partial P_x}{\partial d_2} & \frac{\partial P_x}{\partial d_3} \\ \frac{\partial P_y}{\partial \theta_1} & \frac{\partial P_y}{\partial d_2} & \frac{\partial P_y}{\partial d_3} \\ \xi_1 t_1 & \xi_2 t_2 & \xi_3 t_3 \end{bmatrix} = \begin{bmatrix} d_2 C\theta_1 + d_3 S\theta_1 & S\theta_1 & -C\theta_1 \\ d_2 S\theta_1 - d_3 C\theta_1 & -C\theta_1 & -S\theta_1 \\ 1 & 0 & 0 \end{bmatrix} \tag{3.3}$$

(b) Finding conditions where det(J)=0 for the singular configurations:

Using the equation of determinate for 3 x 3 matrix given in the hint, one can easily calculate,

$$\det(J) = J_{11}(J_{33}J_{22} - J_{32}J_{23}) - J_{21}(J_{33}J_{12} - J_{32}J_{13}) + J_{31}(J_{23}J_{12} - J_{22}J_{13})$$

one can easily calculate,

$$\det(J) = 0 - 0 + 1 \times [-S\theta_1 \times S\theta_1 - (-C\theta_1) \times (-C\theta_1)] = -1$$

Since the determinate is non-zero, **there is no singular configuration for this RPP robot.**

Solution for Question #2:

(a) We have the forward solution,

$$P_y = d_2 + a_3 S\theta_3$$

$$P_z = d_1 - a_3 C\theta_3 \tag{4.1}$$

Joint 1: prismatic, $\xi_1 t_1 = 0$

Joint 2: prismatic, $\xi_2 t_2 = 0$

Joint 3: revolute, Z points out of the page so $\xi_3 t_3 = 1$.

$$J(q) = \begin{bmatrix} \frac{\partial P_x}{\partial d_1} & \frac{\partial P_x}{\partial d_2} & \frac{\partial P_x}{\partial \theta_3} \\ \frac{\partial P_z}{\partial d_1} & \frac{\partial P_z}{\partial d_2} & \frac{\partial P_z}{\partial \theta_3} \\ \xi_1 t_1 & \xi_2 t_2 & \xi_3 t_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & a_3 C\theta_3 \\ 1 & 0 & a_3 S\theta_3 \\ 0 & 0 & 1 \end{bmatrix} \tag{4.2}$$

(b) Finding conditions where det(J)=0 for the singular configurations:
Using the equation of determinate for 3 x 3 matrix given in the hint, one can easily calculate,

$$\det(J) = J_{11}(J_{33}J_{22} - J_{32}J_{23}) - J_{21}(J_{33}J_{12} - J_{32}J_{13}) + J_{31}(J_{23}J_{12} - J_{22}J_{13})$$

one can easily calculate,

$$\det(J) = 0 - 1 \times [1 \times 1 - 0 \times a_3 C\theta_3] + 0 = -1$$

Since the determinate is non-zero, **there is no singular configuration for this PPR robot.**