$$q(t) = a_0 + a_1 t + a_2 t^2 + \dots + a_n t^n$$

$$\left.\begin{aligned} q(0) &= q_0 \\ q(t_f) &= q_f \\ q'(t_1) &= q_1 \\ q^2(t_1) &= q_2 \\ &\vdots \\ q^n(t_n) &= q_m \end{aligned}\right\} \text{Conditions}$$

Then $a_0 = q_0 \longrightarrow (1)$

$$a_0 + a_1 t_f + \dots + a_n t_f^n = q_n \longrightarrow (2)$$

$$\cancel{a_0 +}\; 0 + a_1 + 2a_2 t_1 + 3a_3 t_1^2 + \dots + n a_n t_1^{n-1} = q_1 \longrightarrow (3)$$

$$0 + 0 + 2a_2 + 6a_3 t_1 + \dots + n(n-1) a_n t_1^{n-2} = q_2 \longrightarrow$$

$$\vdots$$

$$0 + 0 + 0 + 0 + \dots + n!\, a_n = q_m \longrightarrow$$

Then

$$\begin{bmatrix} 1 & 0 & \dots & & & 0 \\ 1 & t_f & t_f^2 & \dots & & t_f^n \\ 0 & 1 & 2t_1 & \cancel{3t_1^2} & \dots & n t_1^{n-1} \\ 0 & 0 & 0 & 6t_1 & \dots & n(n-1) t_1^{n-2} \\ \vdots & & & & & \vdots \\ 0 & 0 & 0 & 0 & \dots & n! \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ \vdots \\ a_n \end{bmatrix} = \begin{bmatrix} q_0 \\ q_f \\ q_1 \\ q_2 \\ \vdots \\ q_m \end{bmatrix}$$

$$Ma = b$$

$$\boxed{a = M^{-1} b}$$