Суммарный импульс:

$$Q_x(t) = (Mc + M_{1c})\frac{d}{dt}x_c(t) + (x_1(t) - r)\frac{d}{dt}M_1(t) + M_1(t)\frac{d}{dt}x_1(t) \tag{7}$$

$$Q_y(t) = (Mc + M_1 c)\frac{d}{dt}y_c(t) + y_1(t)\frac{d}{dt}M_1(t) + M_1(t)\frac{d}{dt}y_1(t) \tag{8}$$

Производная от суммарного импульса:

$$\frac{d}{dt}Q_x(t) = (M_c + M_{1c})\frac{d^2}{dt^2}x_c(t) + 2\left(\frac{d}{dt}x_1(t)\right)\frac{d}{dt}M_1(t) + \cancel{(x_1(t) - r)\frac{d^2}{dt^2}M_1(t)} + M_1(t)\frac{d^2}{dt^2}x_1(t)$$

$$\frac{d}{dt}Q_y(t) = (M_c + M_{1c})\frac{d^2}{dt^2}y_c(t) + 2\left(\frac{d}{dt}y_1(t)\right)\frac{d}{dt}M_1(t) + \cancel{y_1(t)\frac{d^2}{dt^2}M_1(t)} + M_1(t)\frac{d^2}{dt^2}y_1(t)$$

Применяя ур-ие Мещерского: , учитывая: $\frac{d}{dt}m = \frac{d}{dt}M_1(t)$

$$\frac{d}{dt}Q_x(t) = (M_c + M_{1c})\frac{d^2}{dt^2}x_c(t) + 2\left(\frac{d}{dt}x_1(t)\right)\frac{d}{dt}M_1(t) + M_1(t)\frac{d^2}{dt^2}x_1(t) = \left(\frac{d}{dt}m\right)u - \left(\frac{d}{dt}m\right)\left(u - \frac{d}{dt}x_1(t)\right) \tag{14}$$

$$\frac{d}{dt}Q_y(t) = (M_c + M_{1c})\frac{d^2}{dt^2}y_c(t) + 2\left(\frac{d}{dt}y_1(t)\right)\frac{d}{dt}M_1(t) + M_1(t)\frac{d^2}{dt^2}y_1(t) = \left(\frac{d}{dt}m\right)u - \left(\frac{d}{dt}m\right)\left(u - \frac{d}{dt}y_1(t)\right) \tag{15}$$

Чуть-чуть развернем, раскроем скобки:

$$\frac{d}{dt}Q_x(t) = (M_c + M_{1c})\frac{d^2}{dt^2}x_c(t) + \left(\frac{d}{dt}x_1(t)\right)\frac{d}{dt}M_1(t) + \cancel{\left(\frac{d}{dt}x_1(t)\right)\frac{d}{dt}M_1(t)} + M_1(t)\frac{d^2}{dt^2}x_1(t) = \cancel{\left(\frac{d}{dt}m\right)u} - \cancel{\left(\frac{d}{dt}m\right)u} + \cancel{\frac{d}{dt}x_1(t)\left(\frac{d}{dt}m\right)}$$

$$\frac{d}{dt}Q_y(t) = (M_c + M_{1c})\frac{d^2}{dt^2}y_c(t) + \left(\frac{d}{dt}y_1(t)\right)\frac{d}{dt}M_1(t) + \cancel{\left(\frac{d}{dt}y_1(t)\right)\frac{d}{dt}M_1(t)} + M_1(t)\frac{d^2}{dt^2}y_1(t) = \cancel{\left(\frac{d}{dt}m\right)u} - \cancel{\left(\frac{d}{dt}m\right)u} + \cancel{\frac{d}{dt}y_1(t)\left(\frac{d}{dt}m\right)}$$

После сокращения:

$$\frac{d}{dt}Q_x(t) = (M_c + M_{1c})\frac{d^2}{dt^2}x_c(t) + \left(\frac{d}{dt}x_1(t)\right)\frac{d}{dt}M_1(t) + M_1(t)\frac{d^2}{dt^2}x_1(t)$$

$$\frac{d}{dt}Q_y(t)=(M_c+M_{1c})\frac{d^2}{dt^2}y_c(t)+\left(\frac{d}{dt}y_1(t)\right)\frac{d}{dt}M_1(t)+M_1(t)\frac{d^2}{dt^2}y_1(t)$$

После интегрирования:

$$Q_x(t)=(M_c+M_{1c})\frac{d}{dt}x_c(t)-r\frac{d}{dt}M_1(t)+M_1(t)\frac{d}{dt}x_1(t) \quad (16)$$

$$Q_y(t)=(M_c+M_{1c})\frac{d}{dt}y_c(t)+M_1(t)\frac{d}{dt}y_1(t) \quad (17)$$