Fundamentals of Dynamics (7)

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Two-degree-of-freedom Positioning Mechanism (4)

Access Control (1)

Access Control Force $f_1(t) = 0 \quad \text{for } t > T$

$$\left(f_2(t) = 0 \quad \text{for} -\infty < t < \infty \right)$$

Initial Condition $x_1(0) = x_2(0) = 0, \ \dot{x}_1(0) = \dot{x}_2(0) = 0$

Final Condition $x_1(T) = x_2(T) = S, \ \dot{x}_1(T) = \dot{x}_2(T) = 0$

No residual vibration

where

T : Access Time (s)

S : Access Stroke (m)

Access Control (2)

Final Condition for each mode

$$y_1(T) = \frac{S}{\alpha},\ \dot{y}_1(T) = 0$$

$$y_2(T) = 0,\ \dot{y}_2(T) = 0$$

No residual vibration

Access Control (3)

Modal Equation of Motion $$\ddot{y}_2 + \lambda_2 y_2 = \beta\, f_1$$

Stationary Initial Condition $$y_2(0) = 0, \dot{y}_2(0) = 0$$

Transient Response of the Vibration mode

$$y_2(t) = \frac{\beta}{\omega_2}\int_0^t \sin\{\omega_2(t-\tau)\} f_1(\tau)\, d\tau$$

$$\dot{y}_2(t) = \beta\int_0^t \cos\{\omega_2(t-\tau)\} f_1(\tau)\, d\tau$$

Access Control (4)

Amplitude of Residual Vibration

$$A_R = \sqrt{\{y_2(T)\}^2 + \left\{\frac{\dot{y}_2(T)}{\omega_2}\right\}^2} = \frac{|\beta|}{\omega_2}|F(i\omega_2)|$$

where

$$F(i\omega) = \int_{-\infty}^{\infty} f_1(t)\exp(-i\omega t)\,dt$$

Access Control (5)

No Residual Vibration Condition

$$y_2(T) = 0,\ \dot{y}_2(T) = 0 \Longleftrightarrow \left| F(i\omega_2) \right| = 0$$

Access Control (6)

(a) Multi-switch Bang-Bang Control

(b) Dead Beat Control