An interesting question: How can the principal modes be excited, that is, under what kind of initial conditions would m_1 & m_2 execute simple harmonic oscillations? We now answer it:

→ Suppose our example system is executing the first principal mode. Then,

$$x_1 = X_{11}\sin(\omega_1 t+\phi_1)$$
$$\& \quad x_2 = \mu_1 X_{11}\sin(\omega_1 t+\phi_1)$$

Hence, $x_1(0) = X_{11}\sin\phi_1$

$$x_2(0) = \mu_1 X_{11}\sin\phi_1.$$

So, $\boxed{x_2(0) = \mu_1 x_1(0)}$ ---(iii)

Now, $\dot{x}_1 = X_{11}\omega_1\cos(\omega_1 t+\phi_1)$

$$\& \quad \dot{x}_2 = \mu_1 X_{11}\omega_1\cos(\omega_1 t+\phi_1)$$

& so, $\dot{x}_1(0) = X_{11}\omega_1\cos\phi_1$

$$\& \quad \dot{x}_2(0) = \mu_1 X_{11}\omega_1\cos\phi_1$$

Thus, $\boxed{\dot{x}_2(0) = \mu_1 \dot{x}_1(0)}$ ---(iv)

We say that (iii) and (iv) are the necessary conditions for 1st pr. mode. That is, while the system is executing 1st pr. mode, these conditions are automatically satisfied.

Similarly, the necessary conditions for the 2nd pr. mode are:

$$x_2(0) = \mu_2 x_1(0) \text{ ---(v)}$$
$$\& \quad \dot{x}_2(0) = \mu_2 \dot{x}_1(0) \text{ ---(vi)}$$