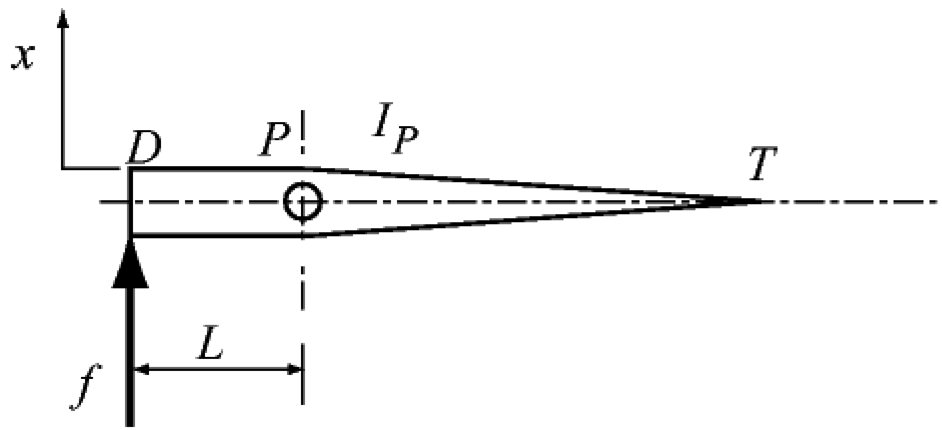
Fundamentals of Dynamics (14)

Department of Mechanical and Control Engineering

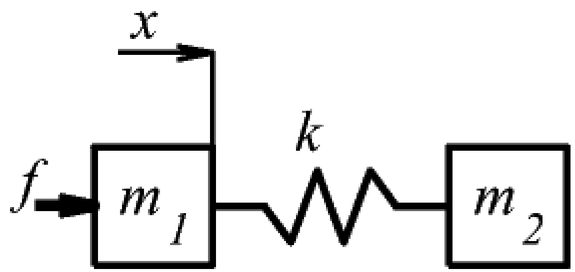
Hiroshi Yamaura

Exercise (2)

Example (1-1)



(a) Rotary Positioning Mechanism



(b) Two-DOF analytical model

The notation *P* is a pivot, *D* is a driving point and *T* is a positioning point. The moment of inertia of the mechanism around the pivot axis, *IP*, is 1.00×10^{-6} kgm2 and the length of *DP*, *L*, is 10mm.

Example (1-2)

Figure (a) shows a rotary positioning mechanism. Compliance frequency response function at the point *D* has an anti-resonance frequency and a resonance frequency in a frequency region less than 9kHz.

Anti-resonance frequency (Hz)	:	4382
Resonance frequency (Hz)	:	8000

In this frequency range, the positioning mechanism can be modeled as a two degrees-of-freedom mechanism shown in Fig.(b), where m_1(kg), m_2(kg) and k(N/m) are effective masses and effective stiffness.

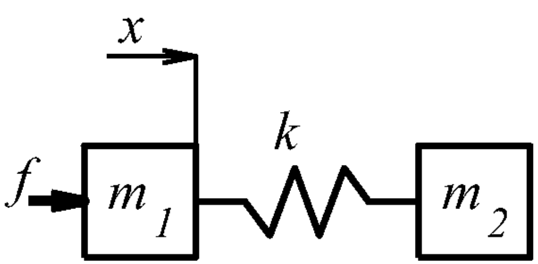
Identify these physical parameters in the analytical model.

Example (2)

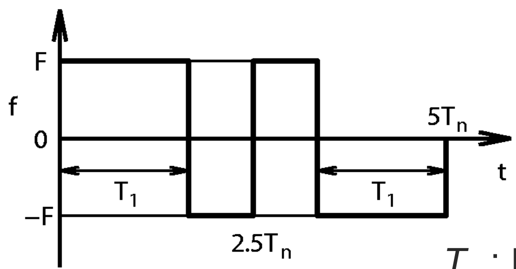
Consider a two-DOF positioning mechanism shown in Fig.(a) and a case of the multi-switch bang-bang driving force Fig.(b).

(1) Derive the periods T_1 (s) (>1.25T_n) from the no residual vibration condition.

(2) Derive the amplitude of the driving force F (N) corresponding to an access stroke S (m) of the positioning mechanism.



(a) Two-DOF model



T_n : Natural Period (s)

(b) Multi-switch bang-bang control

Example (3)

The equation of torsional motion of a shaft depicted in the figure is expressed by the following equation.

$$\rho I_P \frac{\partial^2 \theta}{\partial t^2} - G I_P \frac{\partial^2 \theta}{\partial x^2} = 0$$

where θ (t,x) is a torsional angle, ρ is density, and G is modulus of transverse elasticity of the shaft.

Show the free response against a set of given initial angular displacement and velocity distribution, θ (0,x) and $\dot{\theta}$ (0,x).

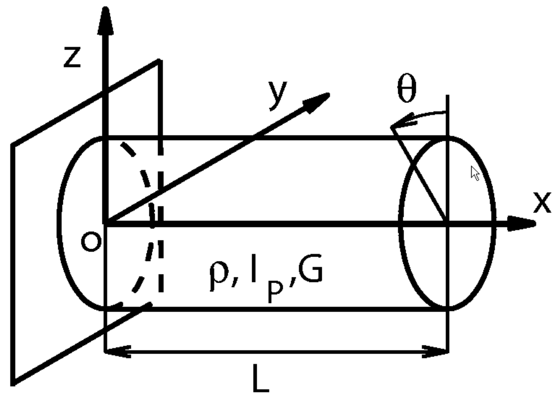


Fig. Torsional vibration of a fixed-free shaft