INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

DATE – APRIL, 2016, TIME – 3 Hrs., FULL MARKS – 100, DEPT – ME

No. OF STUDENTS – 140, END SPRING SEMESTER EXAMINATION

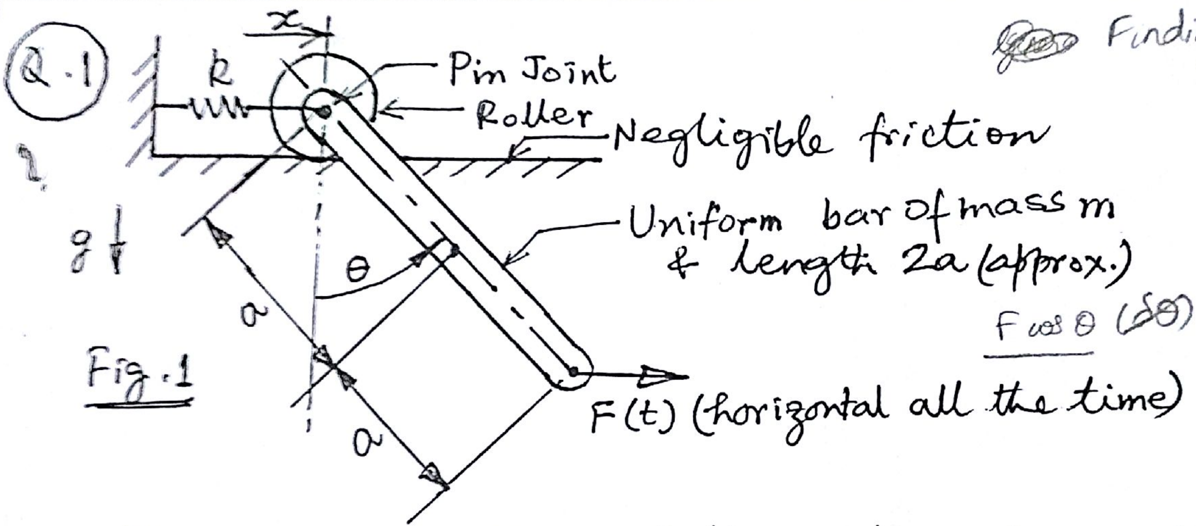
→ SUBJECT No. ME 22004 / ME 30606, DYNAMICS OF MACHINES

3rd YR. B. TECH (H)

INSTRUCTIONS: ANSWER EITHER Q.4 OR Q.5, DO NOT ANSWER BOTH. Q.1, 2 & 3 ARE COMPULSORY. ALL ANSWERS MUST BE IN DECIMAL FORM, WHEREVER APPROPRIATE. CLEARLY MENTION YOUR ASSUMPTIONS, IF ANY.

Q.1

Finding g



$F \cos\theta\,(\delta\theta) = Q\,\delta\theta$

Fig. 1

Study fig. 1. Mass of the roller is negligible. The roller moves horizontally & the uniform bar swings in vertical plane. Using x & θ as generalized coordinates, obtain the nonlinear DEOM using the Lagrange equations. [15 marks]

Q.2

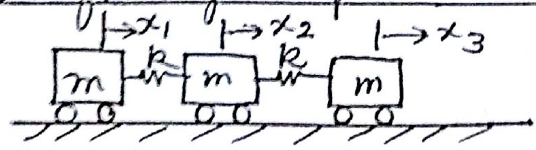


Fig. 2

semi-def
$|k| = 0$
$\omega_1 = 0$

PTO

Consider the system in fig. 2. Neglect inertia of wheels. Obtain the DEOM by Newton's method with FBDs. Find the natural frequencies. [10]

$\omega_3 > \omega_2 > \omega_1$

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Q.3

massless rigid extension of middle block

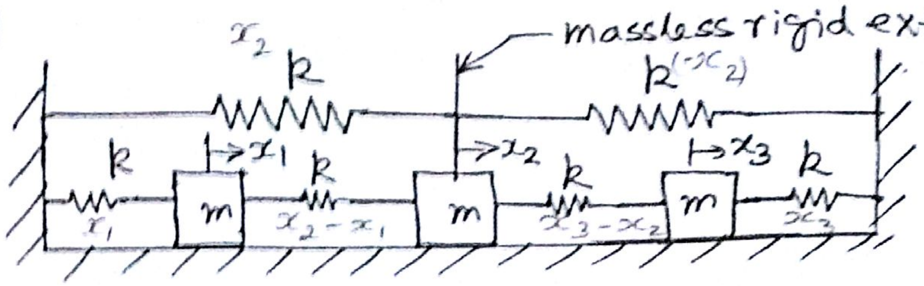

Fig. 3

$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{x}}\right) - \frac{\partial T}{\partial x} + \frac{\partial U}{\partial x} = 0$

(a) For the system in fig. 3, write expressions for Kinetic and potential energies & obtain the mass & stiffness matrices [m] & [k] from these expressions without obtaining the DEOM. [10 marks] T, U

(b) Obtain the flexibility matrix [a] using the definition of a flexibility influence coefficient. Draw appropriate FBDs. [15]

a_{ij} → Force on j, defl of i

(c) Obtain ω_1 by the Rayleigh method using an appropriate static deflection vector as the trial modal vector. [15]

$kx - m\omega^2 x = 0$
$\omega^2 = \frac{x^T k x}{x^T m x}$

(d) Obtain ω_1 & $\{X_1\}$ be the MI method starting with trial vector $\{u\} = \{1 \; 1 \; 1\}^T$. [15 marks]

Q.4 See fig. 4. Obtain ω_1, ω_2, $\{X_1\}$ & $\{X_2\}$.

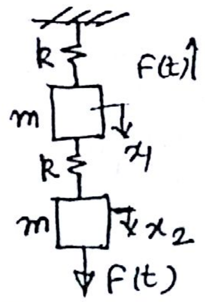

Fig. 4

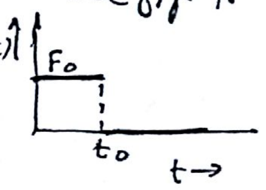

Fig. 5

Using modal analysis, for $t > t_0$ obtain the forced response of the system in fig. 4. The forcing function is shown in fig. 5. [20 marks] Duhamel!

$\int_0^t F(\tau) g(t-\tau) d\tau$

$g(t) = \frac{1}{m\omega_n} \sin(\omega_n t)$

OR

Q.5 Write notes on:

(a) The tuned damper [10 marks]

(b) Single-plane field balancing of rotors [10 marks]