INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

End-Spring Semester 2016-17

Date of Examination: APRIL 2017 Session (~~FN/AN~~) SPRING SEMESTER, 2016-17 Duration 3 hrs

Subject No ME22004 Subject Name: DYNAMICS OF MACHINES

Department ~~Center/School~~: MECHANICAL ENGG.

Specific charts, graph paper, log book etc., required NONE

Special Instructions (if any): MAXM. MARKS - 100

ANSWER ALL QUESTIONS. THE QUESTION PAPER CONSISTS OF TWO PAGES. WRITE YOUR ASSUMPTIONS, IF ANY.

NOTATIONS and ABBREVIATIONS HAVE USUAL MEANINGS. Figures are on page 2. ASSUME DATA IF NECESSARY.

Q1) Neglecting friction and inertia of the wheels, obtain the natural frequencies and modal vectors of the system in figure 1 by analytical method. The DEOM should be derived by Lagrange's equations. [20 marks]

Q2) For the system in fig. 2, obtain the DEOM by Newton's (MOM) method, for torsional small oscillations. Obtain the first two natural frequencies and the associated modal vectors by the MI method. [25 MARKS]

Q3) A cart of mass M translates as in fig. 3. It has a cylindrical surface of radius R and a solid cylinder of mass m and radius r rolls on this surface without slipping. Obtain the non-linear DEOM using Lagrange's equations. Linearize these DEOM stating conditions. [15 marks]

Q4) Write a note on Rayleigh's method for an n-DOF system. [7 marks]

Q5) Consider an n-DOF damped system whose DEOM are:

$[m]\{\ddot{x}\} + [c]\{\dot{x}\} + [k]\{x\} = \{0\}$. If $[c] = \alpha[m] + \beta[k]$, α and β being constants, show how to uncouple the DEOM. [8 marks]

Q6) Obtain the forced response of the system in fig. 4 by modal analysis. The forcing function is shown in fig. 5. [25 marks] **[PTO]**

Fig.1

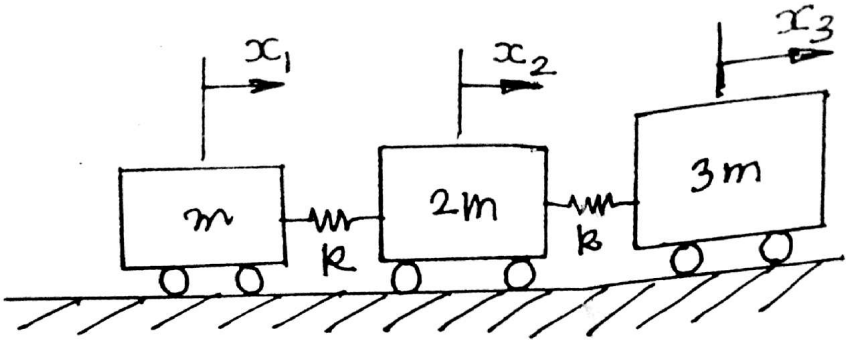


Fig.2

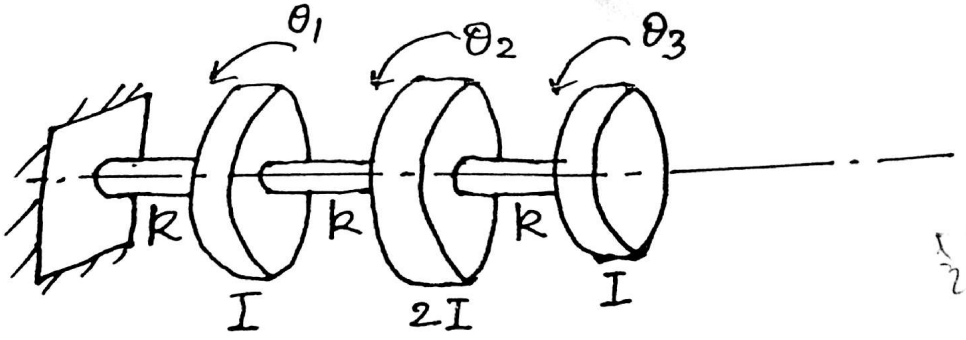
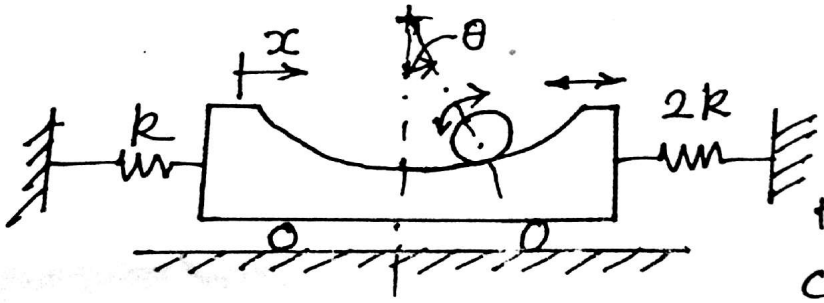


Fig.3



Use x & θ as the generalized coordinates.

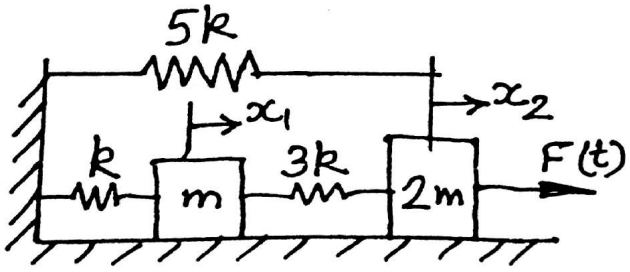


Fig.4

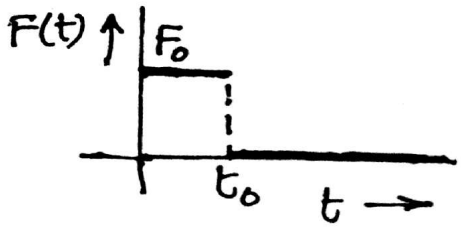


Fig.5