Ref No. Ex/PG/ME/T/112A/2018

Master of Mechanical Engineering, 2018

(1^{st} semester)

Theory of Mechanical Vibration

Time : 3 hours

Full marks : 100

Answer any five questions

All questions are for 20 marks.

1) Using Duhamel's integral or otherwise, obtain the time domain response of an undamped 1 dof system subjected to a rectangular pulse shown in Fig Q1.
What is Response spectrum? What is it's utility during dynamic system design?

2) Consider the system shown in Fig Q2. Obtain the response of the system subject to the initial conditions – $\{x(0)\} = \{1\ 0\}$ *and* $\{\dot{x}(0)\} = \{0\ 0\}$.
Explain whether it is possible to obtain pure modes in the response with proper initial conditions (mathematical deductions not required).

3) Consider the system shown in Fig Q3. The mass is 'm' and Polar mass moment of inertia about CG is 'J'. Obtain the equation of motion of the system. Calculate it's natural frequency.
What engineering systems can this model?

4) Consider the geared system shown in Fig Q4. Consider the gears massless. Write the equation of motion of the system. Hence find it's natural frequencies and mode shapes.
What are the different rules for quickly solving geared systems? Compare them so far accuracy of results are considered.

5) (i) Explain how to obtain the transient response of a multi degree of freedom system subjected to an arbitrary load using the principle of mode superposition.
(ii) Draw the amplitude vs frequency curve of a 2 dof system subjected to a harmonic force. Show the phase relationship between the two degrees of freedom. Show the zones in which the response will resemble the 1^{st} and the 2^{nd} mode.

6) (i) Define displacement transmissibility and force transmissibility. Write their expressions. Plot them. Where are they used and why?

(ii) Write the expression for response of a rotor. Draw the nondimensional response vs nondimensional frequency curve for the rotor. Show how with operation below, at and above critical, the position of the centre of mass changes.

(iii) When is an accelerometer used? Is it a relative or absolute measuring instrument? Briefly discuss the principle of a piezoelectric accelerometer, inductive accelerometer, capacitive accelerometer. Which one of them is an active measuring instrument?

(iv) Briefly discuss the various methods of obtaining natural frequency and mode shapes of a system. Discuss the advantages and limitations.

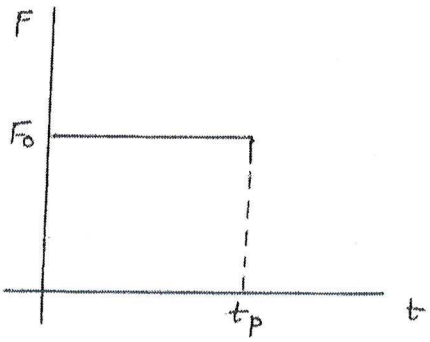


Fig – Q1.

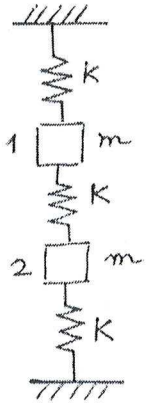


Fig – Q2.

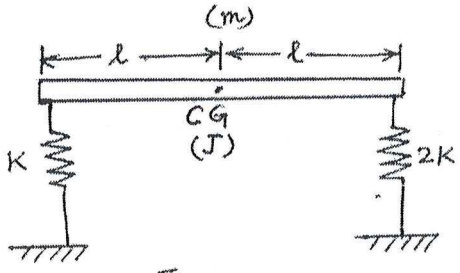
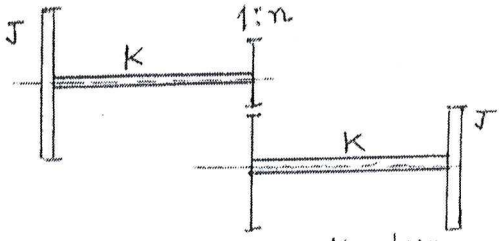


Fig – Q3.



Gears – Massless

Fig – Q4.