Assignment 2 (Unit 2)

Theory Questions:

1. Derive an expression for determining the dynamic amplitude of vibration for a steady state forced vibration having an harmonic excitation force.
2. Prepare frequency response curve of magnification factor vs frequency ratio and phase angle vs frequency ratio in tabulated form as well as graph.
3. Derive an expression for force transmissibility and explain significance with respect to frequency ratio based on preparation of TR vs FR graph.

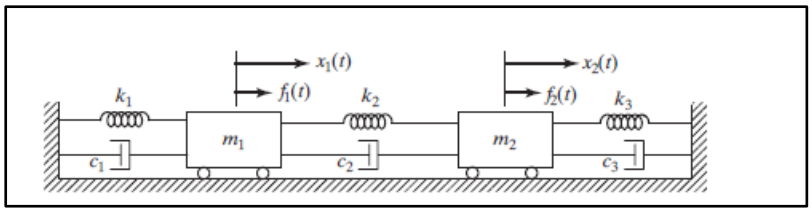
Numerical Questions:

1. A single cylinder has a mass of 100 kg and is acted upon by a vertical unbalanced force of 400 sin ($13\pi t$) Newton acting on it. The cylinder is supported on a spring having equivalent spring stiffness of 60kN/m and a damper which gives damping force of 700 N per unit velocity. Find the force transmitted to the foundation.

2. A machine of mass 1000 kg is acted upon by an external force of 2450 N at 1500 rpm. To reduce the effect of vibration, isolators of rubber having a static deflection of 2 mm under machine weight and an estimated damping factor 0.2 are used. Determine.
    i. Amplitude of Vibrating Machine (X)
    ii. Force Transmitted to the foundation
    iii. Phase lag (ϕ)
    iv. Phase angle between transmitted force and excited force ($\phi - \alpha$),
    v. Speed at which maximum amplitude of vibrations would occurs
3. A machine which runs at a constant speed of 1440 rpm weighs 153 kg. The machine is supported on isolators having a damping factor of 0.2. The machine has a net rotating unbalance of 1.1 kN-mm. Estimate value of the stiffness of the isolator, if the transmitted force is to be less than 8 % of unbalanced force.

4. The rotating machine having total mass of 20 kg, has an eccentric mass of 1.5 kg with eccentricity 25 mm. The machine rotates at 720 rpm. If the amplitude of vibrations which is 20 mm, lags the eccentricity by $\phi = 90^{o}$, determine:

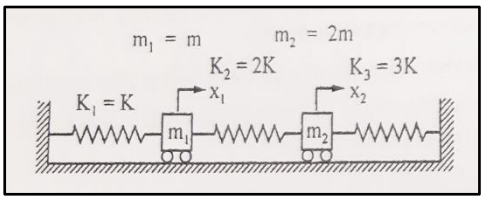
    i. The natural frequency of the system
    ii. The damping factor.
    iii. The amplitude and phase angle when eccentricity mass rotates at 1440 rpm.
5. Consider the following figure for the forced damped vibration shown below (2 degree of freedom):



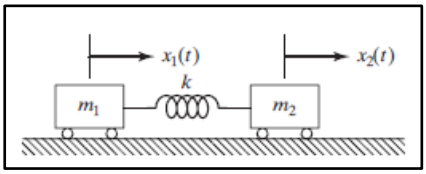
Find the following:

i. Mass matrices, damping matrices and stiffness matrices
ii. Displacement and force vectors

6. Setup the differential equations of motion for the system shown in figure below and determine:
   i. The natural frequencies due to displacement x1 and x2
   ii. The ratio of amplitudes for the two nodes, and
   iii. The principle mode shapes, when K = 40 N/m and mass, m = 10 kg



7. Define Semi-definite system. Find the natural frequencies for the following 2-degree of freedom vibrating system:



Reference books:

1. Dynamics of Machinery by Farazdak Haideri, 5th Edition, Nirali Prakashan
2. Mechanical Vibrations by S.S.Rao, Fifth Edition, Pearson Publicaton