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VASAVI COLLEGE OF ENGINEERING *(Autonomous)*, HYDERABAD

B.E. (Mech. Engg.) III Year II-Semester Main Examinations, May-2017

Mechanical Vibrations

Time: 3 hours Max. Marks: 70

Note: Answer ALL questions in Part-A and any FIVE from Part-B

Part-A (10 × 2 = 20 Marks)

1. Derive the expression for damped natural frequency of a single degree freedom system of spring-mass damper.
2. Define logarithmic decrement.
3. Discuss the behavior of geometrical symmetric system natural frequency and mode shapes.
4. Write the Eigen values and Eigen vector of rigid body.
5. Prove that mode shapes are orthogonal with respect to mass matrix.
6. Define Mode participation factor.
7. What is the difference between linear and non-linear vibration and explain with an example.
8. Explain mode superposition method.
9. Calculate the bandwidth, if the maximum frequency set on the analyzer (F-max) is 4000 Hz and the resolution is set as 1600 lines.
10. Describe the theory of the seismic instrument and also give an ideal working range for vibrometer and accelerometer.

Part-B (5 × 10 = 50 Marks)

11. a) Derive the general solution of over damped response of SDOF damped system. [5]

    b) A load of mass, m as shown in Figure 1 supported by two springs of each stiffness k is attached to a slider-crank mechanism via a damper. Coefficient of viscous resistance of damper is C. Slider-crank mechanism executes reciprocating motion described by the equation $x = r*\sin(\omega t)$. Setup the differential equation of motion for the load. [5]

Figure 1

Contd... 2

12. a) Describe the selection procedure of secondary mass and spring in Dynamic Vibration absorber. [4]

b) Determine the normal modes of vibration of a car as shown in Figure 2, simulated by the simplified two-DOF system with the following numerical values. $K_1 = 200$kN/m, $K_2 = 250$kN/m, $l_1 = 1$m, $l_2 = 1.5$m, $m = 1500$ kg, and $J = 300$ kg m^2. The elasticity of the tires may be ignored. [6]

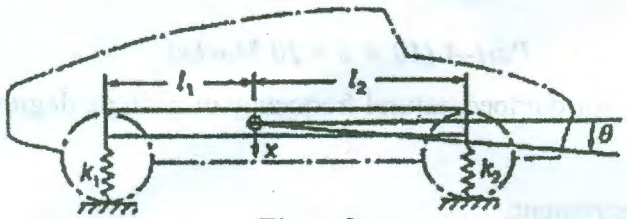

Figure 2

13. a) Define Static and Dynamic coupling with an example? [4]

b) Determine the stiffness and mass matrix for the system shown in Figure 3. [6]

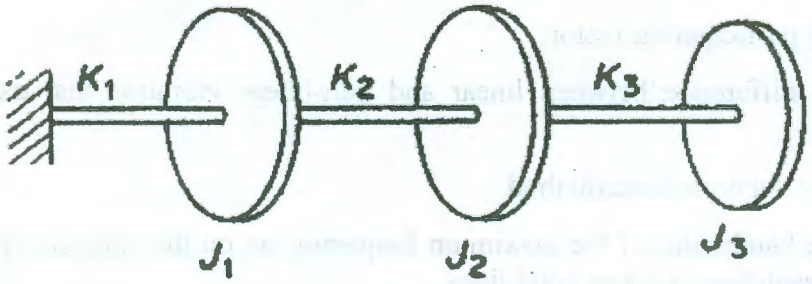

Figure 3

14. a) Derive the differential equation of motion for the longitudinal vibration of rods and write the general solution for the derived differential equation with proper assumptions. [5]

b) Determine the natural frequency of a simple supported beam. Sketch the first three mode shapes? [5]

15. a) Discuss the different types of shakers used in vibration testing? [5]

b) A test engineer is working to develop a measurement strategy that might be used to evaluate the sloshing phenomena in a water tank. He decided to measure natural frequency, vibration response on tank walls due to fluid impact. Suggest suitable sensors to measure above parameters with proper reasoning. Assume necessary operating conditions. [5]

16. a) Show that for high values of frequency of excitation in forced harmonic response, the magnification factor approaches zero. [3]

b) A transformer with dimensions (Transformer Length, L = 6.80 m Transformer Width, B = 5.10 m Transformer Height above top of Pedestal, H = 5.00 m) and Total weight of Transformer (with oil) = 1000.00 kN is placed on two "I" cross-section's steel beams with roller supports at the end of a beam. Beam length is same as Transformer length and moment of inertia is 0.624m4. Electro-magnetic force is dominant at two times of line frequency and line frequency in India is 50 Hz. Calculate the force transmissibility. If you observed resonance in the system, suggest possible modifications to avoid resonance without changing total mass within the system. [7]

Contd... 3

17. Answer any *two* of the following:

a) Show that the natural period of oscillation of the fluid in a U-tube manometer shown in Figure 4 is $\tau = 2\pi\sqrt{\frac{l}{2g}}$ by using energy method. [5]

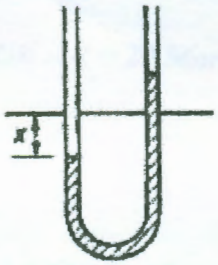

Figure 4

b) Derive the Equation of motion for torsional vibration of rod? [5]

c) Discuss the typical instrumentation used in modal analysis with schematic diagram? [5]