GUJARAT UNIVERSITY
BE SEMESTER VI (MECH) EXAMINATION
Mechanical Vibrations and Balancing of Machines
Question Bank

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1) Differentiate between following
   a) Static balancing and dynamic balancing
   b) i) coupled and uncoupled locomotives. ii) inside and outside cylinder locomotive
2) A line shaft carries five pulleys P, Q, R, S & T equally spaced along the shaft. The masses of the pulleys P, R, and S are 10, 8, and 16 Kg respectively. The eccentricity of all pulley masses can be assumed equal. The angular distance between P and R is 90^0 and R and S is 135^0 measured in the same direction. Find the masses of pulley Q and T and their angular positions, so that the shaft is completely balanced.
3) Derive an expression for variation in tractive force, swaying couple and hammer blow for an uncoupled two cylinder locomotive engine.
4) A two cylinder locomotive has the following specifications;

Reciprocating mass per cylinder	= 306 Kg
Crank radius	= 300 mm
Angle between cranks	= 90^0
Driving wheels diameter	= 1800 mm
Distance between cylinder centers	= 650 mm
Distance between driving wheel planes	= 1550 mm

   Determine
   a) The fraction of reciprocating masses to be balanced, if the hammer blow is not to exceed 46 KN at 96.5 Km/hr.
   b) The variation in tractive force.
5) A four stroke five cylinder in-line engine has a firing order of 1-4-5-3-2-1. The centers lines of cylinders are spaced at equal intervals of 15 cm, the reciprocating parts per cylinder have a mass of 1.5 kg, the piston stroke is 10 cm and the connecting rods are 17.5 cm long. The engine rotates at 600 rpm. Discuss the primary and secondary balancing, values of maximum unbalanced forces and couples about the central plane.
6) Find the particular displacement, velocity and acceleration equations for a follower that returns 10 mm in 60^0 of cam rotation, using 2-3 polynomial and sketch the curves.
7) Write a short note on a) Mathematical model of cam and follower considering their elasticity. b) Polydyne cam
8) Explain:-Jump phenomenon in cam
9) Explain the terms: (Any Five)
   i) Natural frequency, ii) Damping, iii) forced vibration, iv) magnification factor,
   v) displacement transmissibility, vi) logarithmic decrement
9) Derive an expression for critical speed of a shaft carrying rotor and having damping.
10) An electric motor weighs 25 kg and is mounted on a rubber pad which deflects by 1 mm due to motor weight. The rotor weight is 5 kg and has an eccentricity of 0.1 mm and rotates at 1500 rpm. Find the amplitude of vibration of the motor and the force transmitted to the foundation under the following conditions;
    i) there is no damping,
    ii) damping factor is 0.1.

11) A seismic instrument is used to find the magnitude of vibration of a machine tool structure. It gives a reading of relative displacement of 0.4 μm. The natural frequency of the seismic instrument is 5 Hz. The machine tool structure is subjected to a kinematic excitation at a frequency of 2 Hz. Find the magnitude if acceleration of the vibrating machine tool structure. Assume that the damping of the seismic instrument is negligible.
12) In a 60^0 V engine, two connecting rods operate on a common crank pin. Stroke of each piston 8 cm and length of each connecting rod is 16 cm. If the engine speed is 2000 rpm and the mass of reciprocating parts per cylinder is 1 kg; find the values of maximum primary and secondary unbalances. Describe clearly a method by which such forces may be balanced.
13) A refrigerator weighing 30 kg is to be supported by three springs, each having stiffness of K (N/m). If the unit operates at 580 rpm, find K, if only 10 % of the shaking force is to be transmitted to the supporting structure. Neglect damping.
14) Write a short note on a) Vibration isolation materials & b) Seismic instruments
15) The following data refer to a two cylinder uncoupled locomotive:

Rotating mass per cylinder	= 280 Kg
Reciprocating mass per cylinder	= 300 Kg
Distance between wheels	= 1400 m
Distance between cylinder centers	= 600 mm
Diameter of treads of driving wheels	= 1800 mm
Crank radius	= 300 mm
Radius of centre of balance mass	= 620 mm
Locomotive speed	= 50 Km / hr
Angle between cylinder cranks	= 90^0
Dead load on each wheel	= 3.5 tonne

Determine
   i) The balancing mass required in the planes of driving wheels of whole of the rotating and two-third of the reciprocating mass are to be balanced.
   ii) The swaying couple
   iii) The variation in tractive force.
16) Define logarithmic decrement. Derive an expression for logarithmic decrement
17) A machine mounted on springs and fitted with a dashpot has a mass of 60 Kg. There are three springs, each of stiffness 12 N/mm. The amplitude of vibrations reduced from 45 to 8 mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine
   i) The damping coefficient
   ii) The ratio of frequencies of damped and undamped vibrations and
   iii) The periodic time of damped vibrations

18) Define the term vibration isolation and transmissibility. Explain with the help of transmissibility vs frequency curves at various damping ratios.
19) A single cylinder vertical diesel engine has a mass of 400 Kg and is mounted on a steel chassis frame. The static deflection owing to the weights of the chassis is 2.4 mm. The reciprocating mass of the engine amounts to 18 Kg and the stroke of the engine is 160 mm. A dashpot with a damping coefficient of 2 Ns/mm is also used to dampen the vibrations. In the steady-state of the vibrations, determine:

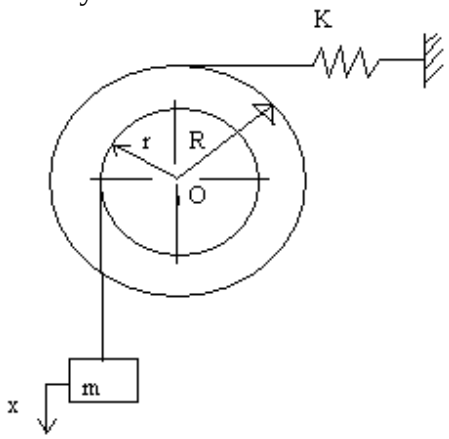
i) The amplitude of the vibrations if the driving shaft rotates at 500 rpm
ii) The speed of the driving shaft when the resonance occurs.

20) Explain direct and reverse crank method of balancing of V-Engines

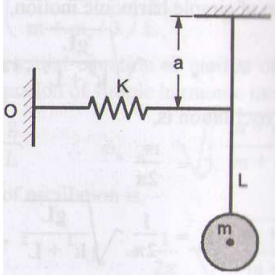
21) What is Force Transmissibility? Why is it importance in mechanical vibrations? Explain with neat sketch Frequency response curve of force transmissibility.

22) A steel bridge structure is deflected at midspan by winching the bridge down and then releasing it. It was observed that the amplitude of frequency decays exponentially from 9 mm to 4 mm at the end of 3 cycles. The frequency of decay is observed to be 1.7 Hz. The test was once again repeated by placing a vehicle of 35000 Kg at midspan and the frequency was observed as 1.52 Hz. Find
i) the damping factor of the structure
ii) the effective mass and stiffness of the structure.
iii) if the vehicles are allowed to pass over the bridge in a row at a speed of 15 Km/hr, what spacing of vehicles should be avoided?

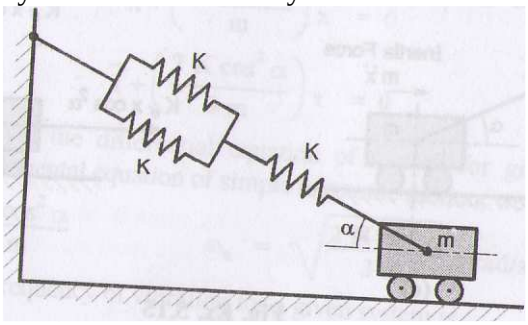
23) Find the natural frequency of the system shown below.



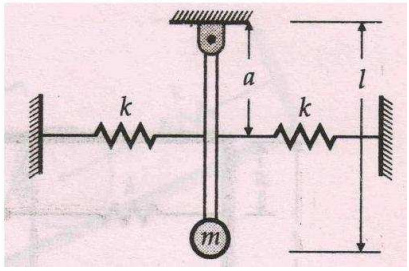
24) Find the natural frequency of vibration of the system shown in figure below.



25) Find the natural frequency of vibration of the system shown in below.



26) Why reciprocating masses are partially balanced? Explain the any one effect of partial balancing in reciprocating masses.
27) Derive an expression for the length of an torsionally equivalent shaft for two rotor system
28) Derive an equation of motion of single degree under damped system
29) A pendulum consists of a stiff weightless rod of length 'l' carrying a mass 'm' on its end as shown in figure below. Two springs each of stiffness 'K' are attached to the rod at a distance 'a' from the upper end. Determine the frequency for small oscillation.



30) A shaft with 3 metres span between two bearings carries two masses of 10 kg and 20 kg acting at the extremities of the arms 0.45 m and 0.6 m long respectively. The planes in which these masses rotate are 1.2 m and 2.4 m respectively from the left end bearing supporting the shaft. The angle between the arms is 60°. The speed of rotation of the shaft is 200 r.p.m. If the masses are balanced by two counter-masses rotating with the shaft acting at radii of 0.3 m and placed at 0.3 m from each bearing centres, estimate the magnitude of the two balance masses and their orientation with respect to the X-axis, i.e. mass of 10 kg.
31) Derive an expression for critical speed of a shaft carrying rotor and without damping.
32) A horizontal shaft of 10 mm diameter is simply supported at both ends by bearings. A rotor of mass 5 Kg is attached at middle of the horizontal shaft. The span between two bearing is 500 mm. The center gravity of the rotor is 2.5 mm offset from the geometric center of the rotor. The equivalent viscous damping at the center of the rotor-shaft may be taken as 52 Ns/m. Find the deflection of the shaft and critical speed of the shaft.
33) A cantilever shaft of 50 mm diameter and 300 mm long has a disc of mass 100 Kg at its free end. The Young's modulus for the shaft material is 200 GPa. Determine the frequency of longitudinal and transverse vibration of the shaft.
34) Two rotors A and B are attached to the ends of a stepped shaft. The shaft is 90 mm diameter for the first 300 mm, 130 mm for next 200 mm and 110 mm for remaining 250 mm length of the shaft. The mass of the rotor A is 45 Kg and radius of gyration is 430 mm. the mass of the rotor B is 55 Kg and radius of gyration is 520 mm. Take modulus of rigidity as 80 x 10^9 N/m^2. Determine the frequency of torsional vibration and position of node on the shaft.
35) What are inline engines? How are they balanced? It is possible to balance then completely?
36) Explain different types of damping with application of each.
37) Explain with neat sketch experimental method to determine damping coefficient
38) In a single degree viscously damped vibrating system, the suspended mass of 16 Kg makes 45 oscillations in 27 seconds. The amplitude of natural vibrations decreases to one fourth of the initial value after 5 oscillations.
    Determine: a) The logarithmic decrement

b) The damping factor and damping coefficient
c) The stiffness of the spring

39) In torsional pendulum, the brass shaft is of diameter 10 cm and length 40 cm and a G = 4500 MN / cm ^{2}. The disc attached at the end has moment of inertia of 5800 N-cm ^{2} and is immersed in viscous fluid. When the pendulum is vibrating the amplitude observed on one side for successive cycles are 10^0, 6^0, 4^0. Determine.
    a. Logarithmic decrement
    b. Periodic time of vibration
    c. Damping torque at unit velocity
    d. What would be the frequency of oscillations the disc removed form viscous fluid

40) Explain the principle of Holzer's method and its uses for determining natural frequency of torsional vibration of three-rotor system

41) Write short notes on a) Displacement pick-ups b) Acceleration pick-ups
c) Measurement of frequency

42) A reciprocating IC engine is coupled to a centrifugal pump through a pair of gears. The shaft from the flywheel of the engine to the gear wheel has a 48 mm diameter and is 800 mm long. The shaft from the pinion to the pump has a 32 mm diameter and is 280 mm long. Pump speed id four times the engine speed. Moments of inertia of flywheel, gear wheel, pinion and pump impeller are 1000 Kg-m^2, 14 Kg-m^2, 5 Kg-m^{2}and 18 Kg-m^{2}respectively. Find the natural frequency of the torsional oscillation of the system. G = 80 GN / m^2.

Submitted by;

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