Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– VI• EXAMINATION–SUMMER 2015

Subject Code: 161901 **Date:01/05/2015**

Subject Name: Dynamics of Machinery

Time: 10:30 am to 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Derive the following expressions, for an uncoupled two cylinder locomotive engine: **07**

1) Variation in tractive force;
2) Swaying couple; and
3) Hammer blow.

(b) A, B, C and D are four masses carried by a rotating shaft at radii 0.1 m, 0.15 m, 0.15 m and 0.2 m respectively. The planes in which the masses rotate are spaced at 500 mm apart and the magnitude of the masses B, C and D are 9 kg, 5 kg and 4 kg respectively. Find the required mass A; and the relative angular settings of the four masses so that the shaft shall be in complete balance. **07**

Q.2 **(a)** Discuss different cases showing the characteristics of the system performance for a damped free vibration. **07**

(b) 1) A steel wire with E = 1.96 x 10^11 N/m^2 is of 2 mm diameter and is 30 mm long. It is fixed at the upper end and carries a mass M kg at its lower end. Find mass M so that frequency of longitudinal vibrations is 4 cycles/sec. **04**

2) Derive the differential equation of motion of a simple spring-mass system by D'Alemberts principle. **03**

OR

(b) The disc of a torsional pendulum has a moment of inertia of 600 kg-cm^2 and is immersed in a viscous fluid. The brass shaft attached to it is of 10 cm diameter and 40 cm long. When the pendulum is vibrating, the observed amplitudes on the same side of the rest position for successive cycles are 9^0, 6^0, 4^0. Determine **07**

1) Logarithmic decrement,
2) Damping torque at unit velocity and
3) The periodic time of vibration.

Assume for the brass shaft, G = 4.4 x 10^{10} N/m^2

What would the frequency be if the disc is removed from the viscous fluid?

Q.3 **(a)** The springs of an automobile trailer are compressed 0.1 m under its own weight. Find the critical speed when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude 0.08 m and wave length of 14 m. What will be the amplitude of vibration at 60 km/hour? **07**

(b) Describe Dunkerley's method to find the natural frequency of a shaft carrying several loads. **07**

OR

Q.3 **(a)** A machine of mass one tonne is acted upon by an external force of 2450 N at a frequency of 1500 r.p.m. To reduce the effects of vibration, isolator of rubber having a static deflection of 2 mm under the machine load and an estimated damping factor = 0.2 are used. Determine (1) the force transmitted to the foundation (2) the amplitude of vibration of machine (3) the phase lag. **07**

(b) Write a short note on vibration isolations. **07**

Q.4 **(a)** An electric motor running at 2250 r.p.m. drives a centrifugal pump running at 650 r.p.m. through a single stage gear reduction. The motor armature has a moment of inertia of 32 kg-m^2 and the pump impeller has a moment of inertia of 84 kg-m^2. The shaft from the pump to the gear is 90 mm diameter and 3.6 m long and that from the motor to the gear is 0.6 m long. What should be the diameter of the shaft from the motor to the gears to ensure that the node for natural torsional vibrations is at the gears? Determine the frequency of these vibrations. The inertia of the shafts and gears may be neglected and the modulus of rigidity for the steel shaft can be taken as 80 GN/m^2. **07**

(b) 1) Clearly explain the working principle of a vibrometer and accelerometer. **04**

2) A vibrometer has a period of free vibration of 2 seconds. It is attached to a machine with a vertical harmonic frequency of 1 Hz. If the vibrometer mass has an amplitude of 2.5 mm relative to the vibrometer frame, what is the amplitude of vibration of machine? **03**

OR

Q.4 **(a)** A vertical shaft of 5 mm diameter is 200 mm long and is supported in long bearing at its ends. A disc of mass 50 kg is attached to the center of the shaft. Neglecting any increase in stiffness due to the attachment of the disc to the shaft, find the critical speed of rotation and the maximum bending stress when the shaft is rotating at 75% of the critical speed. The centre of the disc is 0.25 mm from the geometric axis of the shaft. E = 200 GN/m^2. **07**

(b) Write step by step procedure of Stodola's method to find out fundamental natural frequency of system having three degree of freedom. **07**

Q.5 **(a)** A four cylinder engine has the two outer cranks at 120^0 to each other and their reciprocating masses are each 400 kg. The distance between the planes of rotation of adjacent cranks are 0.4 m, 0.7 m and 0.5 m. Find the reciprocating mass and the relative angular position for each of the inner cranks, if the engine is to be in complete primary balance. Also find the maximum unbalanced secondary force, if the length of each crank is 350 mm, the length of each connecting rod 1.7m and the engine speed is 500 r.p.m. **07**

(b) Explain the method of direct and reverse cranks to determine the unbalance forces in radial engines. **07**

OR

Q.5 **(a)** The cylinder axes of a V-engine are at right angles to each other. The weight of each piston is 2 kg and of each connecting rod is 2.8 kg. The weight of the rotating parts like crank webs and the crank pin is 1.8 kg. The connecting rod is 0.4 m long and its centre of mass is 0.1 m from the crank pin centre. The stroke of the piston is 160 mm. Show that the engine can be balanced for the revolving and the primary force by a revolving counter mass. Also, find the magnitude and the position if its centre of mass from the crankshaft centre is 100 mm. What is the value of the resultant secondary force if the speed is 840 rpm? **07**

(b) Describe the function of a pivoted-cradle balancing machine with the help of a neat sketch. Show that it is possible to make only four test runs to obtain the balance masses in such a machine. **07**

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