Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI • EXAMINATION – SUMMER 2013

Subject Code: 161901 **Date: 24-05-2013**

Subject Name: Dynamics of Machinery

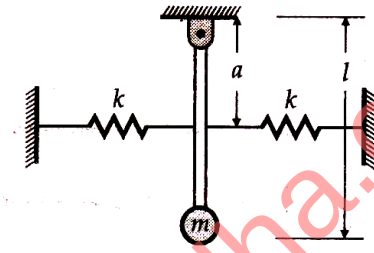
Time: 10.30 am - 01.00 pm **Total Marks: 70**

Instructions:

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

Q.1 **(a)** Derive an equation of motion of single degree under damped system. **08**

(b) A pendulum consists of a stiff weightless rod of length ôlô carrying a mass ómô on its end as shown in figure below. Two springs each of stiffness ôKô are attached to the rod at a distance ôaô from the upper end. Determine the frequency for small oscillation. **06**



Q.2 **(a)** 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. **08**

(b) What is Force Transmissibility? Why is it importance in mechanical vibrations? Explain with neat sketch Frequency response curve of force transmissibility. **06**

OR

(b) Define the terms: **06**

Natural frequency, damping, forced vibration, magnification factor, displacement transmissibility, logarithmic decrement

Q.3 **(a)** A two cylinder locomotive has the following specifications; **07**

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.

The variation in tractive force.

(b) 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. Determine the values of maximum primary and secondary unbalanced forces and couples about the central plane. **07**

OR

Q.3 **(a)** Derive an expression for logarithmic decrement. What is the significance of logarithmic decrement? **07**

(b) 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 **07**

i) the damping factor of the structure

ii) the effective mass and stiffness of the structure.

Q.4 **(a)** Explain in detail vibration measuring instruments. **07**

(b) 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 εm. 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 of acceleration of the vibrating machine tool structure. Assume that the damping of the seismic instrument is negligible. **07**

OR

Q.4 **(a)** Derive an expression for Torsionally Equivalent Shaft System. **07**

Q.4 **(b)** 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. **07**

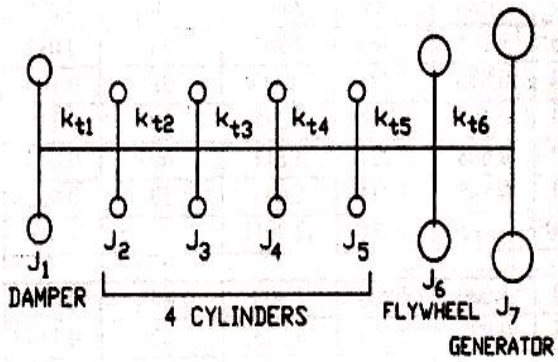
Q.5 **(a)** Derive an expression for critical speed of a shaft carrying rotor and without damping. **07**

(b) 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. **07**

OR

Q.5 **(a)** A cantilever shaft of 50 mm diameter and 300 mm long has a disc of mass 100 Kg at its free end. The Youngôs modulus for the shaft material is 200 GPa. Determine the frequency of longitudinal and transverse vibration of the shaft. **07**

(b) A four cylinder engine whose shaft is coupled to a damper at one end and a generator at the other end has a flywheel mounted on the shaft between the engine and the generator. A schematic of the system is shown in figure below with the values of the rotor inertias and the stiffness of the shafts. Estimate the two lowest natural frequencies using Holzerôs method. **07**



$J_1 = 10\ \text{kg-m}^2$
$J_2 = J_3 = J_4 = J_5 = 1.5$
$J_6 = 20$
$J_7 = 120$
$k_{t1} = 40 \times 106\ \text{N-m/rad}$
$k_{t2} = k_{t3} = k_{t4} = 30 \times 10^6$
$k_{t5} = 60 \times 10^6$
$k_{t6} = 10 \times 10^6$

****