Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – SUMMER 2024

Subject Code: 3151911 Date:31-05-2024

Subject Name: Dynamics of Machinery

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	Explain the Whirling Speed of a Shaft	**03**
	(b)	Explain the Dynamical Equivalent System of two masses.	**04**
	(c)	Analyze the forces like Piston effort and force acting along the connecting rod.	**07**
Q.2	**(a)**	Illustrate the various types of vibrations.	**03**
	(b)	List the characteristics of Static balancing and Dynamic balancing.	**04**
	(c)	The mass of a single degree damped vibrating system is 7.5 kg and makes 24 free oscillations in 14 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.25 of its initial value after five oscillations. Determine : 1. stiffness of the spring, 2. logarithmic decrement, and 3. damping factor, i.e. the ratio of the system damping to critical damping.	**07**
		OR	
	(c)	A shaft 1.5 m long, supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7700 kg/m^3 and its modulus of elasticity is 200 GN/m^2. Find the lowest whirling speed of the shaft, taking into account the mass of the shaft.	**07**
Q.3	**(a)**	List the criteria for selection of reference plane for balancing masses rotating in multiple plane.	**03**
	(b)	Apply Rayleigh's method to derive natural frequency of free transverse vibrations for a shaft subjected to a number of point loads.	**04**
	(c)	Analyze the effect of unbalanced forces on V-engine and derive the relation for secondary unbalanced force.	**07**
		OR	
Q.3	**(a)**	Explain the concept of imaginary crank in secondary unbalanced forces.	**03**
	(b)	Examine the effect of Magnification Factor on vibrating system.	**04**
	(c)	Justify the statement "Balancing of primary unbalanced force is partial".	**07**
Q.4	**(a)**	Apply Rayleigh's method to determine natural frequency of free longitudinal vibration.	**03**
	(b)	A cantilever shaft 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 GN/m^2. Determine the frequency of longitudinal and transverse vibrations of the shaft.	**04**
	(c)	The rotor of the turbine of a ship has a mass of 2500 kg and rotates at a speed of 3200 rpm counter-clockwise when viewed from stem. The rotor has radius of gyration of 0.4 m. Determine the gyroscopic couple and its effect when (i) the ship steers to the left in a curve of 80 m radius at a speed of 15 knots (1 knot = 1860 m/h) (ii) the ship pitches 5 degrees above and 5 degrees below the normal position and the bow is descending with its maximum velocity-the pitching	**07**

motion is simple harmonic with a periodic time of 40 seconds (iii) the ship rolls and at the instant, its angular velocity is 0.4 rad/s clockwise when viewed from stem. Also find the maximum angular acceleration during pitching.

OR

Q.4 **(a)** Anlyse the effect of Natural Frequency of Free Transverse Vibrations. **03**

(b) An instrument vibrates with a frequency of 1 Hz when there is no damping. When the damping is provided, the frequency of damped vibrations was observed to be 0.9 Hz. Find 1. the damping factor, and 2. logarithmic decrement. **04**

(c) A rear engine automobile is travelling along a track of 100 metres mean radius. Each of the four road wheels has a moment of inertia of 2.5 kg-m^2 and an effective diameter of 0.6 m. The rotating parts of the engine have a moment of inertia of 1.2 kg-m^2. The engine axis is parallel to the rear axle and the crankshaft rotates in the same sense as the road wheels. The ratio of engine speed to back axle speed is 3:1. The automobile has a mass of 1600 kg and has its centre of gravity 0.5 m above road level. The width of the track of the vehicle is 1.5 m. Calculate the limiting speed of the vehicle around the curve for all four wheels to maintain contact with the road surface. Assume that the road surface is not cambered and centre of gravity of the automobile lies centrally with respect to the four wheels. **07**

Q.5 **(a)** Solve the equation of motion for a forced damped vibration by graphical method. **03**

(b) Compare the Frequency of Free Damped Vibrations under following situations using a graph amplitude vs time period. **04**

- Under damping
- Over damping
- Critical damping

(c) Each crank and the connecting rod of a four-crank in-line engine are 200 mm and 800 mm respectively. The outer cranks are set at 120° to each other and each has a reciprocating mass of 200 kg. The spacing between adjacent planes of cranks are 400 mm, 600 mm and 500 mm. If the engine is in complete primary balance, determine the reciprocating masses of the inner cranks and their relative angular positions. Also find the secondary unbalanced force if the engine speed is 210 rpm. **07**

OR

Q.5 **(a)** Identify the significance of Damping Factor and Logarithmic Decrement for damped vibration **03**

(b) Demonstrate the Dunkerley's method to determine the Natural Frequency of Free Transverse Vibrations For a Shaft Subjected to a Number of Point Loads **04**

(c) A rotor is completely balanced when masses of 2 kg and 1.2 kg are added temporarily in planes A and D each at 200 mm radius as shown in Fig. 1. The balanced mass in the plane A is along the x-axis whereas in the plane D, it is at 120° counter-clockwise. It is desired that the actual balancing is to be done by adding permanent masses in planes B and C, each at 120 mm radius. Determine the magnitudes and the directions of the masses B. **07**

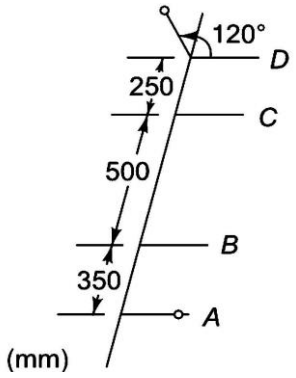

Fig.1