Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–V EXAMINATION – WINTER 2025

Subject Code:3151911 Date:02-12-2025

Subject Name:Dynamics of Machinery

Time:10:30 AM TO 01:00 PM Total Marks:70

Instructions:

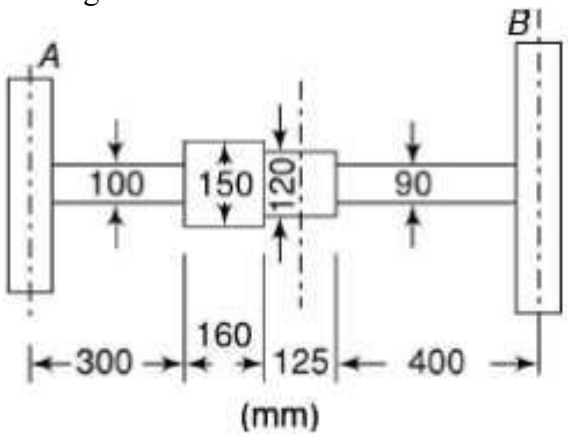
1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

			MARKS
Q.1	**(a)**	State Lami's theorem and give suitable example	**03**
	(b)	Explain the term 'Coefficient of fluctuation of speed' and 'Coefficient of fluctuation of energy'.	**04**
	(c)	The turning moment diagram for a multicylinder engine has been drawn to a scale 1 mm = 600 N-m vertically and 1 mm = 3° horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows : + 52, – 124, + 92, – 140, + 85, – 72 and + 107 mm^2; when the engine is running at a speed of 600 rpm If the total fluctuation of speed is not to exceed ± 1.5% of the mean, find the necessary mass for the flywheel with radius 0.5m.	**07**
Q.2	**(a)**	Define and Differentiate the terms 'static balancing' and 'dynamic balancing'. State the necessary conditions to achieve them.	**03**
	(b)	"The balancing of rotating parts is crucial for high speed systems" Justify the statement.	**04**
	(c)	A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions.	**07**
		OR	
	(c)	Derive the equation for the following terms pertaining to locomotives: i) Tractive force ii) Swaying couple iii) Hammer blow	**07**
Q.3	**(a)**	What are the causes and effects of vibrations?	**03**
	(b)	Discuss briefly with neat sketches the longitudinal, transverse and torsion, free vibrations.	**04**
	(c)	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. Determine the frequency of longitudinal and transverse vibrations of the shaft.	**07**
		OR	

Q.3 **(a)** Define: **03**
a) Frequency
b) Period
c) Resonance

(b) List the Methods to find the natural frequency of a vibrations in a system with free longitudinal vibration. **04**
Discuss any one of them.

(c) The shaft shown in figure carries two masses. **07**



The mass A is 300 kg with a radius of gyration of 0.75 m and the mass B is 500 Kg with a radius of gyration of 0.9 m. Determine the frequency of the torsional vibrations. It is desired to have the node at the mid-section of the shaft of 120 mm diameter by changing the diameter of the section having a 90 mm diameter. What will be the new diameter?

Q.4 **(a)** Define free vibrations, forced vibrations and damped vibrations. **03**

(b) Define Logarithmic Decrement and derive expression of it with usual notations. **04**

(c) Explain the term 'Half frequency whirl' Derive the governing equation for the same. **07**

OR

Q.4 **(a)** Define: 1) Magnification Factor 2) Frequency Ratio **03**

(b) Explain the terms 'under damping', 'critical damping' and 'over damping' **04**

(c) With usual notations; Derive the equation to find the natural frequency of shaft carrying several loads undergoes transvers vibrations using Dunkerley's method. **07**

Q.5 **(a)** Define terms used in a Naval Ship: **03**
i) Steering
ii) Pitching
iii) Rolling

(b) An Aero plane makes a complete half circle of 50 meters radius, towards left, when flying at 200 km/hr. The rotary engine and the Propeller of the plane have a mass of 400 kg and a radius of gyration of 0.3m.The engine rotates at 2400 rpm clockwise when viewed from the rear. Find the Gyroscope Couple on the Aircraft and state its effect on it. **04**

(c) A shaft of diameter 40mm is supported in two bearings 2.5 m apart. It carries three discs of mass 250kg, 500kg, and 200kg are 0.6m, 1.5m and 2m from the left end bearing. Assuming the mass of the shaft 190 kg/m^2. Determine the critical speed of the shaft. **07**
Young's modulus of the material of shaft =211 GN/m^2.

OR

Q.5 **(a)** Define: **03**

i) Axis of spin
ii) Plane of Precession
iii) Axis of Gyroscopic Reaction
iv) Plane of Gyroscopic Couple

Show each in an illustrative diagram.

(b) The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45m and a speed of 3000 rpm clockwise when looking from stern. Determine the Gyroscopic Couple and its effect upon the ship. **04**

i. When the ship is steering to the left on a curve of 100m radius at a speed of 36 km/hr.
ii. When the ship is pitching in a Simple Harmonic Motion, The bow failing with its Maximum Velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12^0.

(c) Prove that the critical or whirling speed is the same as the natural frequency of transverse vibration with usual notations. **07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code:3151911 Date:17-12-2024

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.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	What is the significance of inertia forces in reciprocating engines?	**03**
	(b)	Why is the correction couple applied while considering the inertia of the connecting rod of a reciprocating engine?	**04**
	(c)	In a vertical double-acting steam engine, the connecting rod is 4.5 times the crank. The weight of the reciprocating parts is 120 kg and the stroke of the piston is 440 mm. The engine runs at 250 rpm. If the net load on the piston due to steam pressure is 25 kN when the crank has turned through an angle of 120° from the top dead centre. Solve for thrust in the connecting rod, pressure on slide bars, and tangential force on the crank pin, thrust on the bearings, and turning moment on the crankshaft using the above information.	**07**
Q.2	**(a)**	Compare the effect of Primary and Secondary Unbalanced Forces of Reciprocating Masses.	**03**
	(b)	Explain the following terms using neat sketches and equations 1. Variation of Tractive Force 2. Swaying Couple	**04**
	(c)	A four-crank engine has two outer cranks set at 120° to each other, and their reciprocating masses are each 400 kg. The distance between the lanes of rotation of adjacent cranks are 450 mm, 750 mm, and 600 mm. If the engine is to be in complete primary balance, find the reciprocating mass and the relative angular position for each of the inner cranks. If the length of each crank is 300 mm, the length of each connecting rod is 1.2 m and the speed of rotation is 240 rpm., Calculate the maximum secondary unbalanced force.	**07**
		OR	
	(c)	A shaft supported in bearings that are 1.6 m apart projects 400 mm beyond bearings at each end. It carries three pulleys one at each end and one at the centre of its length. The masses of the end pulleys are 40 kg and 22 kg and their centres of mass are 12 mm and 18 mm respectively from the shaft axes. The mass of the centre pulley is 38 kg and its centre of mass is 15 mm from the shaft axis. The pulleys are arranged in a manner that gives static balance. Calculate the (i) relative angular positions of the pulleys and (ii) dynamic forces developed on the bearings when the shaft rotates at 210 rpm.	**07**

Q.3 **(a)** Illustrate following terms in context to mechanical vibration **03**

1. Period of vibration
2. Cycle
3. Frequency

(b) Derive the expression for natural frequency of free longitudinal vibration through "Energy method". **04**

(c) The mass of a turbine rotor of a ship is 8000 kg and has a radius of gyration of 0.75 m. It rotates at 1800 rpm clockwise when viewed from the stern. Determine the gyroscopic effects in the following cases: (a) If the ship traveling at 100 km/h steers to the left along a curve of 80 m radius. (b) If the ship is pitching and the bow is descending with maximum velocity. The pitching is with simple harmonic motion with periodic time of 20 s and the total angular movement between extreme positions is 10°. (c) If the ship is rolling with an angular velocity of 0.03 rad/s clockwise when looking from stern. **07**

In each case, determine the direction in which the ship tends to move.

OR

Q.3 **(a)** Explain following terms with neat sketches: **03**

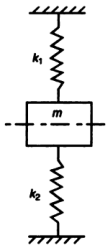
1. Longitudinal vibration
2. Lateral vibration
3. Torsional vibration

(b) Derive the expression for natural frequency of free longitudinal vibration through "Rayleigh's method" **04**

(c) A turbine rotor of a ship is of 2000 kg mass and has a radius of gyration of 0.8 m. Its speed is 2000 rpm. The ship pitches 5° above and below the mean position. A complete oscillation takes place in 20 s and the motion is simple harmonic. Calculate (a) the maximum couple tending to shear the holding down bolts of the turbine, (b) the maximum acceleration of the ship during pitching, and (c) the direction in which the bow will tend to turn while rising, if the rotation of the rotor is clock-wise, when looking from aft. **07**

Q.4 **(a)** Discuss the effect of inertia of the shaft in longitudinal and transverse vibrations. **03**

(b) Evaluate the natural frequency of a vibratory system shown in figure. The mass of block is m and stiffness of springs are k_1 and k_2. **04**



(c) A spring-mass system consists of a spring of stiffness 350 N/m. The mass is 0.35 kg. The mass is displaced 20 mm beyond the equilibrium position and released. The damping coefficient is 14 Ns/m. Calculate (a) critical damping coefficient, (b) damped natural frequency, and (c) logarithmic decrement. **07**

OR

Q.4 **(a)** Explain the term 'dynamic magnifier'. **03**

(b) A cylinder partially depressed slightly and released. Evaluate the natural frequency assuming that it stays upright all the time. Where x = displacement of the cylinder, A = cross sectional area of the cylinder, m = mass of the cylinder, ρ = specific gravity of the river water. **04**

(c) A vibrating system consists of a mass of 30 kg, a spring of stiffness 20 kN/m and a damper of damping factor 0.25. Calculate: **07**
(a) the critical damping coefficient
(b) the natural frequency of damped vibrations
(c) the logarithmic decrement, and
(d) the ratio of two successive amplitudes.

Q.5 **(a)** Compare the displacement-time curves for following damping conditions. **03**
1. Under damped
2. Over damped
3. Critically damped

(b) Represent the expression for natural frequency of free transverse vibrations. **04**

(c) The rotor of a turbine of mass 15 kg is supported at the mid-span of a shaft of span 0.4 m. The rotor has an unbalance of 0.003 kg m. Determine the force exerted on the bearings at a speed of 6000 rpm. The diameter of steel shaft is 25 mm and E = 200 Gpa. **07**

OR

Q.5 **(a)** Explain logarithmic decrement for free damped vibration **03**

(b) Illustrate all the forces graphically for forced damped vibration. **04**

(c) A circular disc having 10 kg mass in mounted at mid span of 25 mm diameter shaft supported by two bearings. Due to manufacturing inaccuracy, the mass centre is shifted by 0.025 mm away from the geometric centre of the disc of the span between two bearings is 500 mm and the shaft rotates at 4000 rpm, determine the amplitude of vibration and reactions on the bearings. Take modulus of elasticity $E = 2 \times 10^{11}$ N/mm^2 **07**

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GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2023

Subject Code:3151911 Date:20-12-2023

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.**
   Simple and non-programmable scientific calculators are allowed.

			MARKS
Q.1	**(a)**	Explain the need of balancing of rotating and reciprocating masses. Explain the effects of unbalancing in rotating and reciprocating masses.	**03**
	(b)	Define the terms: (i) Natural frequency, (ii) damping, (iii) free vibrations, (iv) amplitude of vibration	**04**
	(c)	The four masses P_1, P_2, P_3 and P_4 having their radii of rotation as 100 mm, 120mm, 250 mm and 300 mm respectively. The angles between the masses P_1 & P_2, P_2 & P_3 and P_3 & P_4 are 45^0, 70^0 and 140^0 respectively. Find the position and magnitude of the balancing masses required located at the radius of 350 mm. Use mass value of P1 = 200 KG, P2=250 KG, P3=150 KG,P4=100 KG	**07**
Q.2	**(a)**	Define terms: (i) Turning moment diagram, (ii) Coefficient of fluctuation of energy in case of flywheel, (iii) Critical or whirling speed of shaft	**03**
	(b)	Explain the term vibration isolation. List the different materials used as isolation materials with their applications.	**04**
	(c)	Find the natural frequency of the system shown in figure 2.1. Mass supported by spring is 100 tones. $K_1 = K_2 = K_3 = K_4 = K_5 = K_6 = K = 1000$ N/m.	**07**

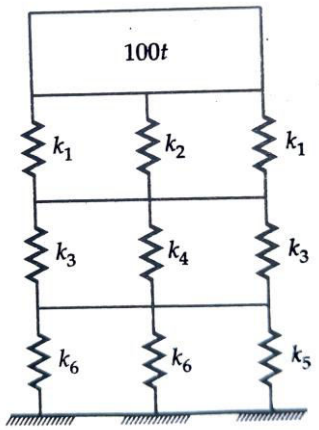


Figure 2.1

OR

	(c)	A flywheel rotating at a maximum speed of 250 rpm and is having radius of gyration of 0.5 m is attached to a punching press. The press is driven by a constant torque electric motor and punches 750 holes per hour. Each punching operation requires 14000 Nm of energy and takes 1.8 seconds. If the speed of the flywheel is not to fall below 225 rpm, find (i) power required by the motor and (ii) mass of the flywheel.	**07**
Q.3	**(a)**	Draw and explain the turning moment diagram of multi-cylinder in line four stroke engine.	**03**
	(b)	State and explain D'Alembert's principle.	**04**

(c) In IC engine mechanism, the crank radius is 400 mm and connecting rod is 950 mm long. The diameter of piston is 100 mm and net gas pressure acting on the piston is 15 MPa. Find (i) thrust on connecting rod, (ii) piston side thrust, (iii) torque acing on the crank shaft. (iv) load on main bearings when crank has made of 45^0 from TDC. **07**

OR

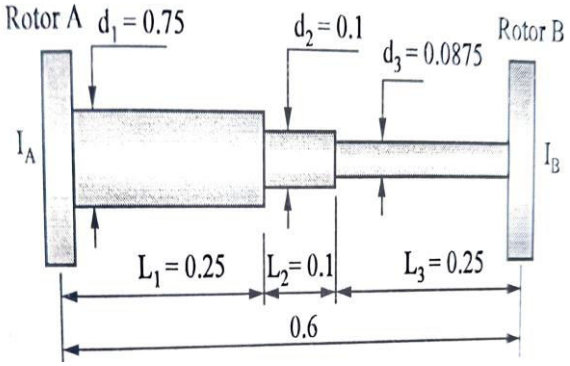
Q.3 **(a)** List the types of damping and explain any one of it. **03**

(b) Explain the effect of active and reactive gyroscopic couple on the aeroplane taking right turn looking from tail end and propeller rotating in clockwise direction. **04**

(c) A turbine rotor weighing 9800 N rotates at 2000 rpm clockwise when viewed from stern. The vessel pitches with an angular velocity of 0.5 rad/sec. Calculate the gyroscopic couple during the rise of the bow if rotor has radius if gyration of 254 mm. Explain the effect of reactive gyroscopic couple on the ship. **07**

Q.4 **(a)** Derive an expression for natural frequency of torsional vibration of a disc connected at the end of the shaft. **03**

(b) Find the equivalent length of the system given below considering the diameter of equivalent shaft as 0.0875 m. **04**



(c) The successive amplitudes of vibrations of vibratory system as obtained under free vibrations are 0.69, 0.32, 0.19, 0.099 units respectively. Determine the damping ratio of the system. Also determine the natural frequency of un-damped vibrations if time period of damped vibration is 0.5 seconds. **07**

OR

Q.4 **(a)** Explain the methods of measurement of displacement and velocity of vibrating bodies. **03**

(b) Draw and explain the two regions of vibration control on transmissibility curve. **04**

(c) A vertical single stage air compressor having a mass of 500 Kg is mounted on springs having stiffness of $1.96 * 10^5$ N/m and damping factor of 0.20. The rotating parts are completely balanced and the equivalent reciprocating parts weigh 20 Kg. The stroke is 0.2 m. Determine the amplitude of steady state vibration of vertical motion and the phase difference between the motion and excitation force if the compressor is operated at 200 rpm. **07**

Q.5 **(a)** **03**

Why the shape of the crank is made like this  ?

(b) Explain the procedure of balancing of V-engines. **04**

(c) In an in-line six-cylinder engine working on two stroke cycle, the cylinder center lines are spaced at 600 mm. In the end view, the cranks are 60° apart and in the order 1-4-5-2-3-6. The stroke of each piston is 400 mm and the connecting rod length is 1 meter. The mass of the reciprocating parts is 200 kg per cylinder and that of rotating parts 100 kg per crank. The engine rotates at 300 r.p.m. Examine the engine for the balance of primary and secondary forces and couples. Find the maximum unbalanced forces and couples. **07**

OR

Q.5 **(a)** What is Hammer blow? Derive an expression for limiting speed required for hammer blow. **03**

(b) Derive an expression for critical speed of shaft carrying a single rotor and having no damping. **04**

(c) A rotor having a mass of 5 kg is mounted midway on a simply supported shaft of diameter 10 mm and length 400 mm. Because of manufacturing tolerances, the CG of the rotor is 0.02 mm away from the geometric center of the rotor. If the rotor rotates at 3000 rpm, find the amplitude of steady state vibrations and the dynamic force transmitted to the bearings. Neglect the effect of damping. Take $E = 2 * 10^{11}$ N/m^2. **07**

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2022

Subject Code:3151911 Date:09-01-2023

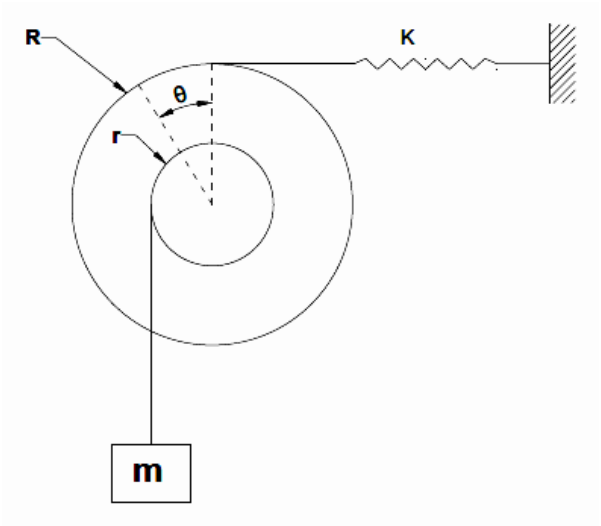
Subject Name:Dynamics of Machinery

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.**
4. **Simple and non-programmable scientific calculators are allowed.**

			Marks
Q.1	**(a)**	Define following terms i) Maximum Fluctuation of Energy ii) Coefficient of Fluctuation of Speed iii) Coefficient of Fluctuation of Energy	**03**
	(b)	Explain effect of gyroscopic couple on Ship during Pitching.	**04**
	(c)	A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions.	**07**
Q.2	**(a)**	What are the requirements of an equivalent dynamically system?	**03**
	(b)	Define the terms i) Periodic motion ii) Free Vibrations iii) Natural Frequency iv) Resonance	**04**
	(c)	Find the natural frequency of the system as shown in figure.	**07**



OR

	(c)	Derive an expression for equation of motion of Critical-damped system	**07**

Q.3 **(a)** Explain why only a part of the unbalanced force due to reciprocating masses is balanced by revolving mass. **03**

(b) Draw & explain the response curves for Overdamped, Underdamped, and Critical damped systems. **04**

(c) What do you mean by piston effort and crank effort? Derive the expression of turning moment at crankshaft in terms of piston effort and angle turn by the crank. **07**

OR

Q.3 **(a)** Explain vibration isolation in detail. **03**

(b) Explain the following terms with neat sketch, **04**

i) Active Gyroscopic Couple
ii) Reactive Gyroscopic Couple

(c) A single cylinder, single acting, four stroke gas engine develops 20 kW at 300 r.p.m. The work done by the gases during the expansion stroke is three times the work done on the gases during the compression stroke, the work done during the suction and exhaust strokes being negligible. If the total fluctuation of speed is not to exceed ± 2 per cent of the mean speed and the turning moment diagram during compression and expansion is assumed to be triangular, find the moment of inertia of the flywheel. **07**

Q.4 **(a)** Why is balancing of rotating parts necessary for high-speed engines? **03**

(b) Discuss the balancing of V-engines. **04**

(c) A ship propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 r.p.m. The rotor has a radius of gyration of 0.5 m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions: **07**

1. The ship sails at a speed of 30 km/h and steers to the left in a curve having 60 m radius.
2. The ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds.
3. The ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clockwise when viewed from stern.

Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case.

OR

Q.4 **(a)** Write a short note on Vibrometer. **03**

(b) Explain the force Transmissibility in detail. **04**

(c) A vibrating system is defined by the following parameters: m (mass) = 3 kg, k (spring stiffness) = 100 N/m, c (viscous damping coefficient) = 3 N.s/m **07**

Determine:

i. Damping factor
ii. Natural frequency of damped vibration
iii. Logarithmic decrement
iv. Ratio of two consecutive amplitudes
v. Number of cycles after which the original amplitude is reduced to a 20 percent.

Q.5 **(a)** Classify types of vibration. **03**

(b) Describe critical speed of shaft carrying single rotor and having no damping. **04**

(c) Explain the torsional vibration of one and two rotor system. **07**

OR

Q.5 **(a)** Define inertia force and inertia couple. State D′ Alembert principle. **03**

(b) Define damping. Explain different ways of providing the damping for reducing vibrations. **04**

(c) A machine having a mass of 100 kg and supported on spring of total stiffness 7.84 X 10^5 N/m has an unbalanced rotating element which results in a disturbing force 392 N at a speed of 3000 rpm. Assuming a damping factor of 0.20, Determine **07**

i) The amplitude of motion due to unbalance
ii) The transmissibility, and
iii) The transmitted force.
