Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE- SEMESTER–V (NEW) EXAMINATION – WINTER 2020**

**Subject Code:3151911 Date:29/01/2021**

**Subject Name:Dynamics of Machinery**

**Time:10:30 AM TO 12:30 PM Total Marks: 56**

**Instructions:**

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

| | | | MARKS |
|---|---|---|---|
| **Q.1** | **(a)** | Define following terms.<br>i. Degree of freedom<br>ii. Resonance<br>iii. Damping ratio | **03** |
| | **(b)** | Differentiate static balancing and dynamic balancing. | **04** |
| | **(c)** | A heavy machine, weighing 3000 N, is supported on a resilient foundation. The static deflection of the foundation due to the weight of the machine is found to be 7.5 cm. It is observed that the machine vibrates with an amplitude of 1 cm when the base of the foundation is subjected to harmonic oscillation at the undamped natural frequency of the system with an amplitude of 0.25 cm. Find<br>a. the damping constant of the foundation,<br>b. the dynamic force amplitude on the base, and<br>c. the amplitude of the displacement of the machine relative to the base. | **07** |
| **Q.2** | **(a)** | Define inertia force and inertia couple. State D′ Alembert principle. | **03** |
| | **(b)** | Classify types of vibration. | **04** |
| | **(c)** | The crank and connecting rod of a vertical single cylinder gas engine running at 1800 rpm are 60 mm and 240 mm respectively. The diameter of piston is 80 mm and the mass of the reciprocating parts is 1.2 kg. At a point during the power stroke when the piston has moved 20 mm from the top dead center position, the pressure on the piston is 800 kN/m$^2$. Determine<br>i. Net force on the piston<br>ii. Thrust in the connecting rod<br>iii. Thrust on the sides of cylinder walls<br>iv. Engine speed at which the above values are zero. | **07** |
| **Q.3** | **(a)** | Define following terms.<br>i. Turning moment diagram<br>ii. Coefficient of fluctuation of energy regarding flywheel<br>iii. Critical or whirling speed of shaft | **03** |
| | **(b)** | Explain in what way the gyroscopic couple affects the motion of an aircraft while taking a turn. | **04** |
| | **(c)** | Each wheel of a motorcycle is of 600 mm diameter and has a moment of inertia of 1.2 kg.m$^2$. The total mass of the motorcycle and the rider is 180 kg and the combined center of mass is 580 mm above the ground level when the motorcycle is upright. The moment of inertia of the rotating parts of the engine is 0.2 kg.m$^2$. The engine speed is 5 times the speed of the wheels and is in the same sense. Determine the angle of heel necessary when the motorcycle takes a | **07** |

turn of 35 m radius at a speed of 54 km/hr.

**Q.4** **(a)** Define following terms. **03**

i. Over damped system
ii. Logarithmic decrement
iii. Under damped system

**(b)** Sketch displacement vs time graph showing over damped, critically damped and under damped vibration system. **04**

**(c)** Derive formula for natural frequency of the system shown in Figure 1. Assume the pulleys to be frictionless and of negligible mass. **07**

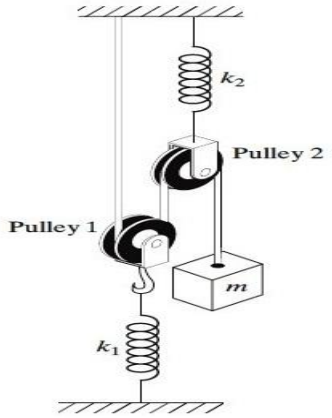


Figure 1 Pulley System.

**Q.5** **(a)** Define following terms. **03**

i. Gyroscopic couple
ii. Shaking couple in reciprocating mass Critical damping constant
iii. Secondary accelerating force in reciprocating mass

**(b)** Discuss effects of partial balancing in locomotives in 300 words. **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.6** **(a)** List conditions must be fulfilled for complete balancing of reciprocating parts. **03**

**(b)** Describe critical speed of shaft carrying single rotor and having no damping in 250 words. **04**

**(c)** A rotor of mass 4 kg is mounted on 1 cm diameter shaft at a point 10 cm from one end. The 25 cm long shaft is supported by bearings. Calculate the critical speed. If the center of gravity of the disc is 0.03 mm away from the geometric center of rotor, find the deflection of the shaft when its speed of rotation is 5000 r.p.m. Take $E$ = 1.96 x $10^{11}$ N/m$^2$. Find critical speed when the rotor is mounted midway on the shaft. **07**

**Q.7** **(a)** Illustrate free torsional vibration of two rotor system in 150 words. **03**

**(b)** Explain critical speed of shaft having multiple rotors in 200 words. **04**

**(c)** Four masses $A$, $B$, $C$ and $D$ carried by a rotating shaft at radii 80 mm, 100 mm, 160 mm and 120 mm respectively are completely balanced. **07**

Masses *B*, *C* and *D* are 8 kg, 4 kg, and 3 kg respectively. Determine the mass *A* and the relative angular position of the four masses if the planes are spaced 500 mm apart. Draw couple polygon, force polygon and diagram shows angular position of masses.

**Q.8** **(a)** Define following terms. **03**

i. Amplitude ratio
ii. Transmissibility
iii. Vibrometer

**(b)** Define balancing machine. Describe any one type of a static balancing machine in 150 words with neat sketch. **04**

**(c)** Derive equation of motion for mass, spring, viscous damped and harmonic exited forced vibration system for single degree of freedom. Derive general solution of equation of motion. Prove that **07**

$$Magnificaton\ \ Factor = \frac{1}{\sqrt{\left(1-r^2\right)^2 + \left(2\zeta r\right)^2}}$$

where $r$ is frequency ratio and $\zeta$ is damping ratio.

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# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–V (NEW) EXAMINATION – WINTER 2021**

**Subject Code:3151911 Date:17/12/2021**

**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.**

| | | | MARKS |
|---|---|---|---|
| **Q.1** | **(a)** | Explain the function of flywheel and how it is different from governor? | **03** |
| | **(b)** | Explain effect of gyroscopic couple on aeroplane. | **04** |
| | **(c)** | The following data refers to an outside cylinder uncoupled locomotive;<br>Weight of rotating parts per cylinder 300 Kg<br>Weight of reciprocating parts per cylinder 270 Kg<br>Angle between cranks $90^0$<br>Crank Radius 300 mm<br>Distance between wheels 1550 mm<br>Distance between cylinder centers 1750 mm<br>Diameter of driving wheels 2000 mm<br>Radius of balancing weight 700 mm<br>If whole of the revolving and 2/3 of reciprocating masses are to be balanced, determine the magnitude and position of the balancing mass required in the planes of driving wheels. | **07** |
| **Q.2** | **(a)** | What are the requirements of an equivalent dynamically system? | **03** |
| | **(b)** | Define the terms i) Longitudinal vibrations, ii) damped vibrations, iii) resonance, iv) amplitude of vibration | **04** |
| | **(c)** | Find the natural frequency of the system shown in figure 2.1.<br>Given $K_1=K_2=1500$ N/m and $K_3 = 2000$ N/m, m = 5 Kg. | **07** |

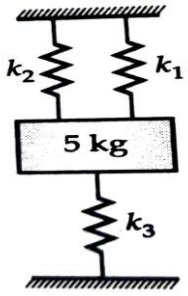


Figure 2.1

**OR**

| | | | |
|---|---|---|---|
| | **(c)** | Derive an expression for equation of motion of under-damped system. | **07** |
| **Q.3** | **(a)** | Explain the term hammer blow and how to control it. | **03** |
| | **(b)** | A gun barrel having mass of 560 Kg is designed with the following data;<br>Initial recoil velocity 36 m/s, recoil distance on firing 1.5 m.<br>Calculate the spring constant, natural frequency of vibration and damping coefficient of the spring. | **04** |

| | | | |
|---|---|---|---|
| | **(c)** | The crank and connecting rod of a steam engine are 300 mm and 1500 mm in length respectively. The crank rotates at 180 rpm clockwise. Determine the velocity and acceleration of the piston when the crank is at 40 degrees from the inner dead center position. Also determine the position of the crank for zero acceleration of the piston. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.3** | **(a)** | Explain in brief vibration isolation and isolation materials. | **03** |
| | **(b)** | Explain the following terms with neat sketch, i) axis of spin, ii) angular velocity of spin, iii) axis of precession, iv) angular velocity of precession. | **04** |
| | **(c)** | The turning moment diagram for a petrol engine is drawn to the following scales; turning moment 1 mm = 5 N-m, crank angle 1 mm = $1^0$. The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line taken in order are 295, 685, 40, 340, 960, 270 $mm^2$. The rotating parts are equivalent to a mass of 36 Kg at a radius of gyration of 150 mm. Determine the coefficient of fluctuation of speed when the engine runs at 1800 rpm. | **07** |
| **Q.4** | **(a)** | Why reciprocating massed are partially balanced? | **03** |
| | **(b)** | Explain method of balancing of radial engines. | **04** |
| | **(c)** | Find the angle of inclination with respect to the vertical of a two wheeler negotiating a turn for the following given data;<br>Combined mass of the vehicle with its rider is 250 Kg,<br>Moment of inertia of the engine flywheel 0.3 Kg-$m^2$,<br>Moment of inertia of each road wheel 1 Kg-$m^2$,<br>Speed of engine flywheel 5 times that of road wheels and in the same direction,<br>Height of center of gravity of rider with vehicle = 0.6 m,<br>Two wheeler speed 90 kmph, wheel radius = 300 mm, radius of turn = 50 m. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Explain the working principle of seismic instruments. | **03** |
| | **(b)** | Differentiate between static balancing and dynamic balancing system. State the 2 practical example of each. | **04** |
| | **(c)** | A spring-mass-dashpot system having stiffness of 30 KN/m, mass of 100 Kg has the damping only 25 % of the critical value. Determine, the damping ratio, the critical damping coefficient, the natural frequency of damped vibration, logarithmic decrement and ratio of two successive amplitudes. | **07** |
| **Q.5** | **(a)** | Why balancing of rotating and reciprocating masses is necessary? What are effects of unbalancing? | **03** |
| | **(b)** | Define damping. Explain different ways of providing the damping for reducing vibrations. | **04** |
| | **(c)** | A machine of mass 1000 Kg is acted upon by an external force of 2450 N at 1500 rpm. To reduce the effect of vibration, isolators or rubbers having a static deflection of 2 mm under machine weight and an estimated damping factor of 0.2 are used. Determine the amplitude of vibration of machine and force transmitted to the foundation. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Explain with neat sketch any one type of frequency measuring instrument. | **03** |
| | **(b)** | Derive an expression for critical speed of shaft carrying a single rotor and having damping. | **04** |
| | **(c)** | Explain the torsional vibration of three rotor system. | **07** |

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# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–V (NEW) EXAMINATION – SUMMER 2021**

**Subject Code:3151911 Date:05/10/2021**

**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)** | Explain the terms: i) fluctuation of energy, ii) fluctuation of speed, iii) Energy stored in flywheel | **03** |
| | **(b)** | Explain effect of gyroscopic couple on naval ship. | **04** |
| | **(c)** | A shaft carries four masses A, B, C & D placed in parallel planes, perpendicular to shaft axis and in the same order along the shaft. The masses of B and C are 36 kg and 25 kg and both are assumed to be concentrated at a radius of 150 mm, while the masses A and D are both at a radius of 200 mm. The angle between the radius of B and C is $100^0$ and that between B and A is $190^0$, both angles being measured in the same sense. The planes containing A and B are 250 mm apart and those containing B and C are 500 mm apart. If the shaft is to be in complete dynamic balance, find<br>Find : i) The magnitude of mass A and D ;<br>ii) the distance between planes C and D;<br>iii) The angular position of mass D. | **07** |
| **Q.2** | **(a)** | State and explain D'Alembert's principle. | **03** |
| | **(b)** | Define the terms i) natural frequency, ii) damping, iii) free vibrations, iv) forced vibrations | **04** |
| | **(c)** | A 5 kg mass attached to the lower end of a spring, whose upper end is fixed, vibrates with a time period of 0.45 sec. Determine the time period when a 2.5 kg mass is attached to the mid-point of the same spring with the upper and lower ends fixed. | **07** |
| | | **OR** | |
| | **(c)** | An electric motor is supported on a spring and a dashpot. The spring has the stiffness 6400 N/m and the dashpot offers resistance of 125 Ns/m. The unbalanced mass 0.5 kg rotates at 50 mm radius and the total mass of vibratory system is 20 kg. The motor runs at 400 rpm.<br>Determine (i) damping factor, (ii) amplitude of vibration and phase angle. | **07** |
| **Q.3** | **(a)** | Explain the terms variation of tractive effort and swaying couple. | **03** |
| | **(b)** | Derive an expression for equation of motion of critically damped system. | **04** |

**(c)** The following data relate to a horizontal reciprocating engine: **07**

Mass of reciprocating parts = 120 kg, Crank length = 90 mm,
Engine speed = 600 rpm, Connecting rod Mass = 90 kg,
Length between centres = 450 mm,
Distance of center of mass from big end centre = 180 mm,
Radius of gyration about an axis through centre of mass = 150 mm.

Find the magnitude and the direction of inertia torque on the crankshaft when the crank has turned $30^0$ from the inner dead centre.

**OR**

**Q.3** **(a)** Explain the following terms with neat sketch, i) axis of spin, ii) angular velocity of spin, iii) axis of precession, iv) angular velocity of precession. **03**

**(b)** Draw the transmissibility curve and state the conclusions drawn from it. **04**

**(c)** A single cylinder double acting steam engine develops 150 kW at a mean speed of 80 r.p.m. The coefficient of fluctuation of energy is 0.1 and the fluctuation of speed is ± 2% of mean speed. If the mean diameter of the flywheel rim is 2 metre and the hub and spokes provide 5% of the rotational inertia of the flywheel, find the mass and cross-sectional area of the flywheel rim. Assume the flywheel is made of Cast iron having density of 7200 kg/$m^3$. **07**

**Q.4** **(a)** Why reciprocating massed are partially balanced? **03**

**(b)** Explain method of balancing of inline engines. **04**

**(c)** A 2.2 tonne racing car has a wheel base of 2.4 m and a track of 1.4 m. The centre of mass of the car lies at 0.6 m above the ground and 1.4 m from the rear axle. The equivalent mass of engine parts is 140 Kg with radius of gyration of 150 mm. The back axle ratio is 5. The engine shaft and flywheel rotates clockwise when viewed from front. Each wheel has a diameter of 0.8 m and a moment of inertia of 0.7 $Kgm^2$. **07**

Determine the load distribution on the wheels when the car is rounding a curve of 100 m radius at a speed of 75 Km/hr to the left.

**OR**

**Q.4** **(a)** Explain in brief vibration isolation and isolation materials. **03**

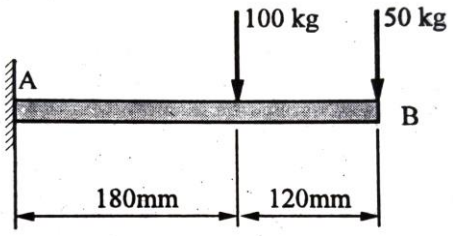
**(b)** A damper offers resistance of 0.05 N at constant velocity of 0.04 m/sec. The damper is used with spring having stiffness 9 N/m. Determine the damping and frequency of the system when the mass of the system is 0.10 Kg. **04**

**(c)** Derive an expressions for primary and secondary unbalanced forces in a V - Engine. **07**

**Q.5** **(a)** Differentiate between static balancing and dynamic balancing. **03**

**(b)** Derive an expression for logarithmic decrement. **04**

**(c)** Using Dunkerley's method, find the natural frequency of transverse vibration of the system shown below. Take E = 1.96 x $10^{11}$ N/ $m^2$, and $I_x$ = 4.0 x $10^{-7}$ $m^2$. **07**

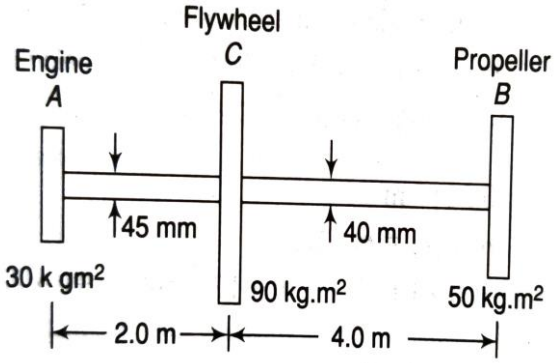


**OR**

**Q.5** **(a)** Explain with neat sketch construction of vibration measurement instrument. **03**

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

**(c)** A torsional system is shown in figure 5.1. Find the frequencies of torsional vibrations and the positions of the nodes. Also find the amplitude of vibrations. Assume G = 84 x $10^{10}$ N/$m^2$. **07**

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# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE - SEMESTER–V(NEW) EXAMINATION – SUMMER 2022**

**Subject Code:3151911 Date:07/06/2022**

**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.**

| | | | MARKS |
|---|---|---|---|
| **Q.1** | **(a)** | Define inertia force and inertia couple. State D′ Alembert principle. | **03** |
| | **(b)** | Draw the turning moment diagram for I). Four stroke Cycle Internal Combustion engine. II). Multi-cylinder Engine. | **04** |
| | **(c)** | Explain the effect of gyroscopic couple and centrifugal couple on the reaction of the four wheels of a vehicle negotiating a curve. | **07** |
| **Q.2** | **(a)** | Define following terms. I). Over damped system II). Logarithmic decrement III). Under damped system | **03** |
| | **(b)** | Differentiate between static balancing and dynamic balancing system. | **04** |
| | **(c)** | Explain briefly the balancing of several mass in same plane. | **07** |
| | | **OR** | |
| | **(c)** | In a slider crank mechanism, the length of the crank and connecting rod are 150 mm and 600 mm respectively. The crank position is $60^o$ from the dead center. The crank shaft speed is 450 r.p.m. (clock wise). Using analytical method, determine: I). Velocity and acceleration of the slider. And II). Angular velocity and angular acceleration of the connecting rod. | **07** |
| **Q.3** | **(a)** | What do you understand by gyroscopic couple? Derive a formula for its magnitude. | **03** |
| | **(b)** | Classify types of vibration. | **04** |
| | **(c)** | The turning moment diagram for a multi-cylinder engine has been drawn to a scale 1mm = 600 N-m vertically and 1 mm = $3^o$ horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as +52,-124,+92,-140,+85,-72 and +107 $mm^2$ , when the engine is running at a speed of 600 r.p.m. If the total fluctuation of speed is not to exceed ± 1.5% of the mean, find the necessary mass of the flywheel of the radius 0.5 m. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Write the short note on primary and secondary balancing. | **03** |
| | **(b)** | Explain in what way the gyroscopic couple affects the motion of an aircraft while taking a turn. | **04** |
| | **(c)** | Discuss the method of Balancing of v- engines and determine the expression for magnitude and direction of resultant primary force. | **07** |
| **Q.4** | **(a)** | Define: I). Natural frequency, II). Damping, III). Forced Vibration. | **03** |
| | **(b)** | Explain partial balancing of reciprocating engine. | **04** |
| | **(c)** | For the system in Fig 1. If $K_1$= 2800 N/m, $K_2$= 1400 N/m, $K_3$= 3800 N/m, $K_4$ = $K_5$ = 700 N/m; find the mass m such that the system will have a natural frequency of 15 Hz. | **07** |

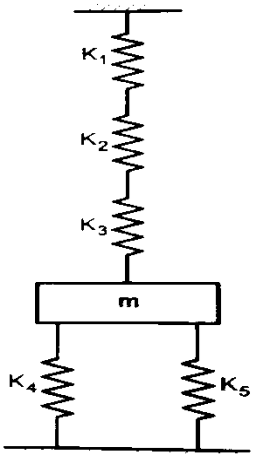


Fig 1.

**OR**

| | | | |
|---|---|---|---|
| **Q.4** | **(a)** | Explain the term magnification factor and obtain expression for it. | **03** |
| | **(b)** | Define logarithmic decrement and derive an expression for it. | **04** |
| | **(c)** | Explain briefly forced vibrations due to rotating unbalance. | **07** |
| **Q.5** | **(a)** | Classify the vibration measuring instruments. | **03** |
| | **(b)** | Clearly explain the working principle of vibrometer and accelerometer. | **04** |
| | **(c)** | A damped vibration system consisting of 40 kg mass executes 20 oscillations in 5 sec. amplitude of vibration decreases to one-eighth of the initial value after 8 complete oscillations. Determine: Logarithmic decrement, Damping factor, Damping co-efficient and spring stiffness. | **07** |

**OR**

| | | | |
|---|---|---|---|
| **Q.5** | **(a)** | Why balancing of rotating and reciprocating masses is necessary? What are effects of unbalancing? | **03** |
| | **(b)** | Write 250 words on Torsionally Equivalent Shaft. | **04** |
| | **(c)** | Two rotors A and B are attached to the ends of a shaft 1.6 m long. The mass of rotor A is 2500 kg and it radius of gyration is 0.8m. The corresponding values for rotor B are 500 kg and 0.5 m respectively. The diameter of shaft is 180 mm for first 0.5 m, 220 mm for next 0.4 m and 100 mm for the remaining length, measuring length, measuring from rotor A. Assuming G = $0.8 \times 10^5$ MPa. For the shaft material, find position of node and natural frequency of torsional vibration. | **07** |

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