GUJARAT TECHNOLOGICAL UNIVERSITY

BE-5 SEMESTER – OLD PAPER – S22 TO S25 – QUESTION BANK

Subject Name & Code:

Dynamics of Machinery- 3151911

Unit 1: Dynamic Force Analysis of Mechanisms

Repeated Questions:

1. **State and Explain D'Alembert's Principle.**
   - **Appeared In:** Winter 2023 (Q3(b)), Summer 2022 (Q1(a)), Summer 2025 (Q3(b))
   - **Marks:** 03 to 04
   - **Description:** A fundamental theory question. Must be prepared with a suitable application example.
2. **Analytical Method for Slider-Crank Mechanism:**
   - **Question:** *"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° from IDC. The crank shaft speed is 450 rpm. Using analytical method, determine: (i) Velocity and acceleration of the slider, (ii) Angular velocity and angular acceleration of the connecting rod."*
   - **Appeared In:** Summer 2023 (Q2(c) - OR part), Summer 2022 (Q2(c) - OR part)
   - **Marks:** 07
   - **Description:** A very important numerical problem. The values change, but the method remains the same.
3. **Forces in IC Engine / Steam Engine Mechanism:**
   - **Question:** *"Find (i) thrust on connecting rod, (ii) piston side thrust, (iii) torque acting on the crank shaft, (iv) load on main bearings when crank is at a given angle."* (Variants exist for steam engines).
   - **Appeared In:** Winter 2023 (Q3(c)), Winter 2024 (Q1(c))
   - **Marks:** 07
   - **Description:** A comprehensive numerical that tests the application of dynamic force analysis on engines.
4. **Define Inertia Force and Inertia Couple.**
   - **Appeared In:** Winter 2022 (Q5(a)), Summer 2022 (Q1(a))
   - **Marks:** 03

Other Important Questions:

1. **Dynamically Equivalent System:**
   - **Question:** *"Explain the Dynamical Equivalent System of two masses."*
   - **Appeared In:** Summer 2024 (Q1(b))

- **Marks:** 04
- **Question:** *"What are the requirements of an equivalent dynamically system?"*
- **Appeared In:** Winter 2022 (Q2(a))
- **Marks:** 03

2. **Inertia Torque Calculation:**
   - **Question:** *"Determine the inertia torque on the crankshaft when the crank has turned 40° from IDC."* (Data for reciprocating parts and connecting rod inertia is given).
   - **Appeared In:** Summer 2025 (Q3(c))
   - **Marks:** 07
   - **Description:** A more advanced numerical involving the inertia of the connecting rod.
3. **Analyze forces like Piston effort and force acting along the connecting rod.**
   - **Appeared In:** Summer 2024 (Q1(c))
   - **Marks:** 07

Unit 2: Turning Moment Diagrams and Flywheel

Repeated Questions:

1. **Flywheel Design for Multi-cylinder Engine:**
    - **Question:** *"The turning moment diagram for a multi-cylinder engine is given (scale and areas provided). If the total fluctuation of speed is not to exceed ±x% of the mean, find the necessary mass of the flywheel of radius R."*
    - **Appeared In:** Summer 2022 (Q3(c)), Winter 2022 (Q3(c))
    - **Marks:** 07
    - **Description:** A very common and important numerical problem.
2. **Flywheel in Punching Press:**
    - **Question:** *"A flywheel is attached to a punching press. Given max/min speed, energy per hole, punching time, etc., find (i) power required by the motor, and (ii) mass of the flywheel."*
    - **Appeared In:** Winter 2023 (Q2(c) - OR part), Summer 2025 (Q3(c))
    - **Marks:** 07
    - **Description:** A classic application-based numerical.
3. **Draw and Explain Turning Moment Diagrams:**
    - **Question:** *"Draw the turning moment diagram for a four-stroke IC engine / Multi-cylinder engine."*
    - **Appeared In:** Summer 2022 (Q1(b)), Winter 2023 (Q3(a))
    - **Marks:** 04
4. **Define Key Terms:**
    - **Questions:** *"Define: Coefficient of Fluctuation of Energy, Coefficient of Fluctuation of Speed, Maximum Fluctuation of Energy."*
    - **Appeared In:** Winter 2022 (Q1(a)), Winter 2023 (Q2(a))
    - **Marks:** 03

Other Important Questions:

1. **Explain the role of a flywheel. How does it differ from a governor?**
    - **Appeared In:** Summer 2025 (Q1(b))
    - **Marks:** 04
2. **Single-cylinder Engine Flywheel:**
    - **Question:** *"A single cylinder, four-stroke gas engine develops X kW at Y rpm. The work done during expansion is Z times the work during compression. If the total fluctuation of speed is not to exceed ±A%, find the moment of inertia of the flywheel."*
    - **Appeared In:** Winter 2022 (Q3(c))
    - **Marks:** 07

Unit 3: Balancing

Repeated Questions:

1. **Balancing of Masses in Different Planes:**
    - **Question:** *"X number of masses (with given mass, radius, angular position, and axial plane distances) are to be completely balanced by two masses in planes P and Q. Find the magnitude and angular position of the balancing masses."*
    - **Appeared In:** Winter 2022 (Q1(c)), Summer 2023 (Q3(c)), Winter 2023 (Q1(c))
    - **Marks:** 07
    - **Description:** Arguably the most important numerical problem in balancing. The number of masses and values change, but the method (using couples and forces) is consistent.
2. **Difference between Static and Dynamic Balancing:**
    - **Appeared In:** Summer 2022 (Q2(b)), Summer 2024 (Q2(b))
    - **Marks:** 04
3. **Balancing of Reciprocating Masses / Partial Balancing:**
    - **Question:** *"Explain why only a part of the unbalanced force due to reciprocating masses is balanced."*
    - **Appeared In:** Winter 2022 (Q3(a)), Summer 2022 (Q4(b))
    - **Marks:** 03-04
    - **Question:** *"Explain the effects of partial balancing in locomotives (Variation of Tractive Force, Swaying Couple)."*
    - **Appeared In:** Winter 2024 (Q2(b))
    - **Marks:** 04
4. **Balancing of Inline and V-Engines:**
    - **Question:** *"Explain the procedure of balancing of inline engines / V-engines."*
    - **Appeared In:** Summer 2023 (Q3(b)), Summer 2022 (Q3(c)), Winter 2023 (Q5(b)), Summer 2025 (Q1(c))
    - **Marks:** 04 to 07
    - **Description:** A major theoretical and sometimes numerical topic.

Other Important Questions:

1. **Balancing of Multi-cylinder Inline Engine (Primary/Secondary Forces):**
    - **Question:** *"For an in-line four/six-cylinder engine, examine the engine for the balance of primary and secondary forces and couples. Find the maximum unbalanced forces and couples."*
    - **Appeared In:** Winter 2023 (Q5(c)), Winter 2024 (Q2(c))
    - **Marks:** 07
2. **Locomotive Balancing Numerical:**
    - **Question:** *"For an inside cylinder locomotive, if X% of reciprocating masses are to be balanced, determine the magnitude and angular position of balanced masses in the plane of wheels."*
    - **Appeared In:** Summer 2025 (Q4(c))
    - **Marks:** 07
3. **Need and Effects of Balancing:**
    - **Question:** *"Explain the need for balancing and the effects of unbalancing."*
    - **Appeared In:** Winter 2023 (Q1(a)), Summer 2022 (Q5(a))
    - **Marks:** 03

Unit 4: Gyroscope

Repeated Questions:

1. **Gyroscopic Effect on a Naval Ship:**
    - **Question:** *"The rotor of a turbine of a ship has a mass M, radius of gyration k, and speed N rpm. Determine the gyroscopic couple and its effect when: (a) The ship steers left/right on a curve of radius R at speed V. (b) The ship pitches with a simple harmonic motion (given period and angular displacement). (c) The ship rolls."*
    - **Appeared In:** Summer 2024 (Q4(c)), Winter 2022 (Q4(c)), Summer 2025 (Q2(c)), Winter 2024 (Q3(c))
    - **Marks:** 07
    - **Description:** This is the most important and frequently asked numerical in the Gyroscope unit. You must know the formulas for the gyroscopic couple and the precise direction of the ship's motion (steering, pitching, rolling) for all cases.
2. **Define/Derive Gyroscopic Couple:**
    - **Question:** *"What do you understand by a gyroscopic couple? Derive a formula for its magnitude."*
    - **Appeared In:** Summer 2022 (Q3(a)), Summer 2023 (Q5(b))
    - **Marks:** 04
3. **Gyroscopic Effect on an Aeroplane:**
    - **Question:** *"Explain the effect of the gyroscopic couple on an aircraft while taking a turn."* (Often requires a sketch and stating the equation).
    - **Appeared In:** Summer 2022 (Q3(b)), Summer 2025 (Q3(b))
    - **Marks:** 04

Other Important Questions:

1. **Gyroscopic Effect on an Automobile/Four-Wheel Vehicle:**
    - **Question:** *"Explain the effect of the gyroscopic and centrifugal couple on the reaction of the four wheels of a vehicle negotiating a curve."*
    - **Appeared In:** Summer 2022 (Q1(c))
    - **Marks:** 07
    - **Question:** *"A four-wheeled motor car takes a turn. Find the load on each wheel."* (Involves considering both centrifugal and gyroscopic effects).
    - **Appeared In:** Summer 2023 (Q5(c))
    - **Marks:** 07
2. **Active and Reactive Gyroscopic Couple:**
    - **Question:** *"Explain with a neat sketch: (i) Active Gyroscopic Couple (ii) Reactive Gyroscopic Couple."*
    - **Appeared In:** Winter 2022 (Q3(b)), Winter 2023 (Q3(b))
    - **Marks:** 04

Unit 5: Free Vibrations and Damped Free Vibrations

Repeated Questions:

1. **Damped Free Vibration Parameters:**
    - **Question:** *"A damped system has a mass M. It is observed that it makes X oscillations in Y seconds. The amplitude reduces to Z of its initial value after W cycles. Determine: (i) Stiffness, (ii) Logarithmic Decrement, (iii) Damping Factor, (iv) Damping Coefficient."*
    - **Appeared In:** Summer 2024 (Q2(c)), Summer 2022 (Q5(c)), Winter 2024 (Q4(c))
    - **Marks:** 07
    - **Description:** A very common numerical pattern. The values change, but the formulas connecting logarithmic decrement, damping factor, and successive amplitudes are key.
2. **Define Key Terms:**
    - **Questions:** *"Define: Natural Frequency, Damping, Forced Vibration, Free Vibration, Resonance."*
    - **Appeared In:** Summer 2025 (Q2(a)), Winter 2022 (Q2(b)), Winter 2023 (Q1(b)), Summer 2022 (Q4(a))
    - **Marks:** 03
3. **Logarithmic Decrement & Damping Factor from Successive Amplitudes:**
    - **Question:** *"The successive amplitudes of vibrations are A1, A2, A3... Determine the logarithmic decrement and damping factor."*
    - **Appeared In:** Winter 2023 (Q4(c)), Winter 2022 (Q4(c))
    - **Marks:** 07
4. **Find Natural Frequency of Spring-Mass System:**
    - **Question:** *"Find the natural frequency of the system shown in the figure."* (Involves finding equivalent stiffness for combinations of springs).
    - **Appeared In:** Winter 2022 (Q2(c)), Summer 2023 (Q2(c)), Summer 2025 (Q2(c) - OR part)
    - **Marks:** 07

Other Important Questions:

1. **Torsional Vibration - Natural Frequency:**
    - **Question:** *"Two rotors A and B are attached to a shaft. Find the position of the node and the natural frequency of torsional vibration."*
    - **Appeared In:** Summer 2022 (Q5(c))
    - **Marks:** 07
    - **Question:** *"Derive an expression for the natural frequency of torsional vibration of a disc connected at the end of a shaft."*
    - **Appeared In:** Winter 2023 (Q4(a))
    - **Marks:** 03
2. **Damping Types and Comparison:**
    - **Question:** *"Compare the displacement-time curves for Underdamped, Overdamped, and Critically damped systems."*
    - **Appeared In:** Winter 2024 (Q5(a)), Winter 2022 (Q3(b))
    - **Marks:** 03-04
    - **Question:** *"List the types of damping and explain any one." / "Explain the method of dry friction damping."*
    - **Appeared In:** Winter 2023 (Q3(a)), Summer 2025 (Q3(a))
    - **Marks:** 03
3. **Derive Equation for Critically Damped System:**
    - **Appeared In:** Winter 2022 (Q2(c) - OR part), Summer 2025 (Q4(b))
    - **Marks:** 04

Unit 6: Forced Damped Vibrations

Repeated Questions:

1. **Forced Vibration due to Rotating Unbalance:**
    - **Question:** *"A machine of mass M is supported on springs of total stiffness K. It has a rotating unbalance force F at a speed of N rpm. If the damping factor is ζ, determine: (i) the amplitude of forced vibration, (ii) the transmissibility, and (iii) the force transmitted."*
    - **Appeared In:** Summer 2025 (Q5(c)), Winter 2022 (Q5(c)), Summer 2023 (Q3(c))
    - **Marks:** 07
    - **Description:** A fundamental numerical problem for this unit. Practice the formulas for amplitude, transmissibility, and transmitted force.
2. **Magnification Factor and Force Transmissibility:**
    - **Question:** *"Explain the term Magnification Factor and obtain an expression for it."*
    - **Appeared In:** Summer 2022 (Q4(a))
    - **Marks:** 03
    - **Question:** *"Draw the force transmissibility curve and explain the three regions of vibration control."*
    - **Appeared In:** Summer 2025 (Q3(a)), Winter 2023 (Q4(b))
    - **Marks:** 03-04
3. **Vibration Isolation:**
    - **Question:** *"Explain vibration isolation in detail." / "What is vibration isolation? List materials used."*
    - **Appeared In:** Winter 2022 (Q3(a)), Summer 2025 (Q5(a)), Winter 2023 (Q2(b))
    - **Marks:** 03

Other Important Questions:

1. **Analysis of a Vibrating System with Damping:**
    - **Question:** *"A vibrating system is defined by m, k, and c. Determine: (i) Damping factor, (ii) Damped natural frequency, (iii) Logarithmic decrement, (iv) Ratio of two consecutive amplitudes."*
    - **Appeared In:** Winter 2022 (Q4(c))
    - **Marks:** 07
2. **Equation of Motion for Forced Damped Vibration:**
    - **Question:** *"Solve the equation of motion for a forced damped vibration by graphical method." / "Illustrate all the forces graphically for forced damped vibration."*
    - **Appeared In:** Summer 2024 (Q5(a)), Winter 2024 (Q5(b))
    - **Marks:** 03

Unit 7: Critical Speeds of Shafts

Repeated Questions:

1. **Critical/Whirling Speed of a Shaft:**
    - **Question:** *"Explain the whirling speed of a shaft." / "Define critical or whirling speed of a shaft."*
    - **Appeared In:** Summer 2024 (Q1(a)), Winter 2023 (Q2(a))
    - **Marks:** 03
    - **Question:** *"Derive the formula for the critical speed of a shaft carrying a single rotor without damping."*
    - **Appeared In:** Summer 2025 (Q2(b)), Winter 2023 (Q5(b))
    - **Marks:** 04
2. **Critical Speed using Dunkerley's Method:**
    - **Question:** *"A shaft of length L and diameter D, simply supported, carries multiple rotors. Find the critical speed of the shaft using Dunkerley's method."*
    - **Appeared In:** Summer 2025 (Q5(c)), Summer 2024 (Q5(b))
    - **Marks:** 07

Other Important Questions:

1. **Shaft with Single Rotor (Numerical):**
    - **Question:** *"A rotor of mass M is mounted midway on a shaft of diameter D and length L. The CG is offset by e. If the rotor rotates at N rpm, find the amplitude of steady-state vibrations and the dynamic force transmitted to the bearings. Neglect damping."*
    - **Appeared In:** Winter 2023 (Q5(c)), Winter 2024 (Q5(c))
    - **Marks:** 07
2. **Critical Speed considering Shaft Mass:**
    - **Question:** *"A shaft of length L, supported at ends, carries two wheels. The shaft is hollow (given dimensions). Taking into account the mass of the shaft, find the lowest whirling speed."*
    - **Appeared In:** Summer 2024 (Q2(c) - OR part)
    - **Marks:** 07

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