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## Fifth Semester B.E. Degree Examination, July/August 2021 Dynamics of Machines

Time: 3 hrs.

Max. Marks: 100

**Note: Answer any FIVE full questions.**

- 1 a. Discuss the static equilibrium of
  - i) Two forces
  - ii) Three forces
  - iii) Member with two forces and a torque. (06 Marks)
- b. A four bar mechanism under the action of two external forces is shown in Fig.Q.1(b). Find the required input torque on the link AB for static equilibrium. The dimensions of the links are AB = 50mm, BC = 66mm, CD = 55mm, CE = 25mm, CF = 30mm, angle BAD = 60° and AD = 100mm. (14 Marks)

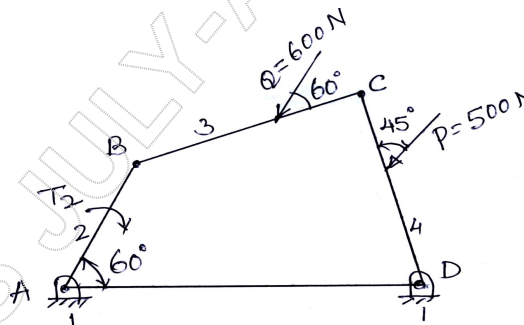


Fig.Q.1(b)

- 2 a. Explain in brief D'Alembert's principle and state why it is used. (06 Marks)
- b. The piston diameter of an internal combustion engine is 125mm and the stroke is 220mm. The connecting rod is 4.5 times the crank length and has a mass of 50kg. The mass of the reciprocating parts is 30kg. The centre of mass of the connecting rod is 170mm from the crank pin centre and the radius of gyration about an axis through the centre of mass is 148mm. The engine runs at 320rpm. Find the magnitude and the direction of the inertia force and the corresponding torque on the crank shaft when the angle turned by the crank is 140° from the inner dead centre using Analytical method. (14 Marks)
- 3 a. Explain static balance and dynamic balance as applied to revolving masses in different planes. (04 Marks)
- b. A shaft carries three masses in planes A, B and C. Planes B and C are 600mm and 1200mm from plane A. Masses in planes A, B and C are 50kg, 40kg and 60kg respectively at a radius of 25mm. The angular position of mass B and C with A are 90° and 210° respectively. Find the unbalanced force and couple if the shaft revolves at 300rpm. Also find the position and magnitude of balancing mass required at 100mm radius in planes "L" and "M" midway between A and B between B and C. (16 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.

- 4 a. Explain the terms primary balancing and secondary balancing as used for balancing of reciprocating masses. (05 Marks)
- b. A four cylinder vertical engine has cranks 300mm long. The planes of rotation of first, third and fourth crank are 750mm, 1050mm and 1650mm respectively from that of the second crank and their reciprocating masses are 150kg, 400kg and 250kg respectively.
- Find the mass of the reciprocating parts for the second cylinder and the relative angular positions of the cranks in order that the engine may be complete primary balance.
  - If each connecting rod of all four cylinders to 1.35m long and the speed is 300rpm find maximum unbalanced secondary force and couple and crank positions at which maximum unbalanced secondary force and couple occur. (15 Marks)
- 5 a. Derive an expression for speed of a porter governor with usual notations taking friction in to account. (10 Marks)
- b. In a Hartnell Governor the length of ball and sleeve arms are 12 and 10cm respectively. The distance of fulcrum of the bell crank lever from the governor axis is 140mm. Mass of each governor ball is 4kg. When the governor runs at the mean speed of 300rpm, the ball arm is vertical and sleeve arm is horizontal. For an increase of speed of 4% the sleeve moves 10mm upward. Neglecting friction, find:
- Minimum equilibrium speed if total sleeve movement is 20mm.
  - Spring stiffness
  - Sensitiveness of Governor
  - Spring stiffness if Governor is to be isochronous at 300rpm. (10 Marks)
- 6 a. Analyze the stability of a two wheel vehicle taking left turn. Derive the necessary equations. (10 Marks)
- b. A ship is propelled by a turbine rotor which has a mass of 2500 kg and has a speed of 3200rpm clockwise direction when viewed from stern. The rotor has a radius of gyration of 0.4m. Determine the gyroscopic couple and its effect when.
- The ship steers to the left in a curve of 80m radius at a speed of 15 knots (1 knot = 1860 m/h).
  - The ship pitches 5 degrees above and 5 degrees below the normal position and the bow is descending with its maximum velocity. The motion due to pitching is simple harmonic motion and the periodic time of 40 seconds.
  - The ship rolls and at the instant, its angular velocity is 0.04 rad/sec clockwise when viewed from stern.
  - Also find the maximum angular acceleration during pitching. (10 Marks)
- 7 a. Briefly explain with neat sketches of Free, Forced, damped, undamped, longitudinal vibrations. Transverse and Torsional vibrations. (10 Marks)
- b. Determine the equation of motion and the natural frequency of the system shown in Fig.Q.7(b), by using Newtons method and energy method. (10 Marks)

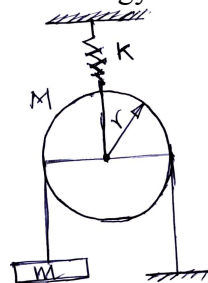


Fig.Q.7(b)

- 8 a. Define logarithmic decrement and derive the equation for same. (10 Marks)  
b. A body of mass 7.5kg is suspended from a helical spring and makes damped oscillations. The time for 60 oscillation is 35sec and ratio of first to seventh displacement is found to be 2.5. Find: i) Stiffness of spring ii) Logarithmic decrement iii) Damping factor iv) Damping resistance and v) If the oscillations were critically damped, what is the damping resistance? (10 Marks)
- 9 a. Derive an expression for steady state amplitude of vibration of mass in a spring mass damper system, when the mass is subjected to harmonic excitation. (10 Marks)  
b. A machine supported symmetrically on four springs has a mass of 80kg. The mass of the reciprocating parts is 2.2kg which move through a vertical stroke of 100mm with simple harmonic motion. Neglecting damping, determine the combined stiffness of the springs so that the force transmitted to the foundation is  $\frac{1}{20}$ th of the impressed force. The machine crank shaft rotates at 800rpm. If under actual working conditions, the damping reduces the amplitudes of successive vibrations by 30%, find the  
i) Force transmitted to the foundation at 800rpm.  
ii) Force transmitted to the foundation at resonance.  
iii) Amplitude of the vibrations at resonance. (10 Marks)
- 10 a. Derive an expression for the natural frequency of free transverse vibrations for a simply supported beam or shaft carrying several loads by using  
i) Dunkerley's method  
ii) Energy method. (10 Marks)  
b. The following data relate to a shaft held in long bearings:  
Length of shaft = 1.2m  
Diameter of shaft = 14mm  
Mass of a rotor at mid point = 16kg  
Eccentricity of centre of mass of rotor from centre of rotor = 0.4mm  
Modulus of elasticity of shaft material =  $200\text{GN/m}^2$   
Permissible stress in shaft material =  $70 \times 10^6\text{N/m}^2$   
Determine the critical speed of the shaft and the range of speed over which it is unsafe to run the shaft. Assume the shaft to be massless. (10 Marks)

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