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## GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Fifth Semester – Regular) Examinations, December – 2022

### BPCME5010– Dynamics of Machinery

(Mechanical Engineering)

Time: 3 hrs

Maximum: 70 Marks

#### Answer ALL Questions

The figures in the right hand margin indicate marks.

#### PART – A: (Multiple Choice Questions)

(1 x 10 = 10 Marks)

- Q.1. Answer ALL questions** [CO#] [PO#]
- a. When the crank is at the inner dead centre, in a horizontal reciprocating steam engine, then the velocity of the piston will be \_\_\_\_\_. CO1 PO1
- (i) zero (ii) minimum  
 (iii) maximum (iv) undetermined
- b. The Ackerman steering gear mechanism is preferred to the Davis steering gear mechanism, because CO2 PO1
- (i) Whole of the mechanism in the Ackerman steering gear is on the back of the front wheels (ii) The Ackerman steering gear consists of turning pairs  
 (iii) The Ackerman steering gear is most economical (iv) Both (i) and (ii)
- c. Turning moment diagram is a graph between CO2 PO1
- (i) Torque and Crank angle (ii) Torque and crank radius  
 (iii) Force and crank radius (iv) none of the above
- d. The engine of an aeroplane rotates in clockwise direction when seen from the tail end and the aeroplane takes a turn to the left. The effect of the gyroscopic couple on the aeroplane will be CO3 PO1
- (i) to raise the nose and dip the tail (ii) to dip the nose and raise the tail  
 (iii) to raise the nose and tail (iv) to dip the nose and tail
- e. Which of the following is spring controlled governor \_\_\_\_\_? CO4 PO1
- (i) Hartnell (ii) Hartung  
 (iii) Pickering (iv) All
- f. A governor is said to be hunting, if the speed of the engine CO4 PO1
- (i) remains constant at the mean speed (ii) is above the mean speed  
 (iii) is below the mean speed (iv) fluctuates continuously above and below the mean speed
- g. The frictional torque transmitted by a disc or plate clutch is same as that of CO5 PO1
- (i) flat pivot bearing (ii) flat collar bearing  
 (iii) conical pivot bearing (iv) trapezoidal pivot bearing
- h. When brakes are applied to all the four wheels of a moving car, the distance travelled by the car before it is brought to rest, will be CO5 PO1
- (i) maximum (ii) minimum  
 (iii) zero (iv) None
- i. A disturbing mass  $m_1$  attached to a rotating shaft may be balanced by a single mass  $m_2$  attached in the same plane of rotation as that of  $m_1$  such that CO6 PO1
- (i)  $m_1.r_1 = m_2.r_2$  (ii)  $m_1.r_2 = m_2.r_1$

- (iii)  $m_1 \cdot m_2 = r_1 \cdot r_2$  (iv) none
- j. When there is a reduction in amplitude over every cycle of vibration, then the body is said to have
- (i) free vibration (ii) forced vibration
- (iii) damped vibration (iv) none of these

**PART – B: (Short Answer Questions)**

**(2 x 10 = 20 Marks)**

Q.2. Answer ALL questions

- |   | [CO#] | [PO#] |
|---|-------|-------|
| a. State and explain D'Alembert's principle   | CO1   | PO1   |
| b. Explain why two Hooke's joints are used to transmit motion from the engine to the differential of an automobile.   | CO1   | PO1   |
| c. In a Davis steering gear, the distance between the pivots of the front axle is 1 metre and the wheel base is 2.5 metres. Find the inclination of the track arm to the longitudinal axis of the car, when it is moving along a straight path.               | CO2   | PO2   |
| d. Determine the vertical height of a Watt governor when it rotates at 60 r.p.m. Also find the change in vertical height when its speed increases to 61 r.p.m.  | CO4   | PO2   |
| e. Describe the effect of gyroscopic couple on aeroplane  | CO3   | PO1   |
| f. What is meant by a self-locking and self-energised brake?  | CO1   | PO1   |
| g. A vertical shaft 150 mm in diameter rotating at 100 r.p.m. rests on a flat end footstep bearing. The shaft carries a vertical load of 20 kN. Assuming uniform pressure distribution and coefficient of friction equal to 0.05, estimate frictional torque. | CO5   | PO2   |
| h. Discuss briefly with neat sketches the longitudinal and transverse free vibrations   | CO6   | PO1   |
| i. A vibrating system consists of a mass of 200 kg, a spring of stiffness 80 N/mm and a damper with damping coefficient of 800 N/m/s. Determine the frequency of vibration of the system.   | CO6   | PO2   |
| j. Explain clearly the terms 'static balancing' and 'dynamic balancing'   | CO6   | PO1   |

**PART – C: (Long Answer Questions)**

**(10 x 4 = 40 Marks)**

Answer ALL questions

- |   | Marks | [CO#] | [PO#] |
|---|-------|-------|-------|
| 3. a. The crank and connecting rod of a steam engine are 0.3 m and 1.5 m in length. The crank rotates at 180 r.p.m. clockwise. Determine the velocity and acceleration of the piston when the crank is at 40 degrees from the inner dead centre position. Also determine the position of the crank for zero acceleration of the piston.   | 5     | CO1   | PO2   |
| b. The mass of flywheel of an engine is 5.5 tonnes and the radius of gyration is 2m. It is found from turning moment diagram that fluctuation of energy is 47KN-m. If the mean speed of the engine is 120 rpm. Find the maximum and minimum speed.  | 5     | CO2   | PO2   |
| (OR)  |       |       |       |
| c. An engine flywheel has a mass of 6.5 tonnes and the radius of gyration is 2 m. If the maximum and minimum speeds are 120 r. p. m. and 118 r. p. m. respectively, find maximum fluctuation of energy.   | 4     | CO2   | PO2   |
| d. 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 <sup>2</sup> , 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 radius 0.5 m. | 6     | CO2   | PO2   |

4. a. Each arm of a Porter governor is 250 mm long. The upper and lower ends of the arms are pivoted to link of 40 mm and 50 mm respectively from the axis of rotation. Each ball has a mass of 6 kg and the sleeve mass is 60 kg. The force of friction on the sleeve of the mechanism is 40 N. Determine the range of speed of governor for extreme radii of rotation of 125 mm and 150 mm. 5 CO4 PO2
- b. The turbine rotor of a ship has a mass of 8 tonnes and a radius of gyration 0.6 m. It rotates at 1800 r.p.m. clockwise, when looking from the stern. Determine the gyroscopic couple, if the ship travels at 100 km/hr and steer to the left in a curve of 75 m radius. 5 CO3 PO2
- (OR)
- c. Define following terminology: 3 CO4 PO1
- i. Sensitiveness of a governor
  - ii. Hunting
  - iii. Isochronism
- d. Each wheel of a motorcycle is of 600 mm diameter and has a moment of inertia of  $1.3 \text{ kg-m}^2$ . The total mass of the motorcycle and the rider is 180 kg and the combined centre of mass is 580 mm above the ground level when the motor cycle is upright. The moment of inertia of the rotating parts of the engine is  $0.25 \text{ kg-m}^2$ . 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 turn of 35 m radius at a speed of 54 km/h. 7 CO1 PO2
5. a. A conical pivot supports a load of 20 kN, the cone angle is  $120^\circ$  and the intensity of normal pressure is not to exceed  $0.3 \text{ N/mm}^2$ . The external diameter is twice the internal diameter. Find the outer and inner radii of the bearing surface. If the shaft rotates at 200 r.p.m. and the coefficient of friction is 0.1, find the power absorbed in friction. Assume uniform pressure. 5 CO5 PO2
- b. A single plate clutch, effective on both sides, is required to transmit 25 kW at 3000 r.p.m. Determine the outer and inner radii of frictional surface if the coefficient of friction is 0.255, the ratio of radii is 1.25 and the maximum pressure is not to exceed  $0.1 \text{ N/mm}^2$ . Also determine the axial thrust to be provided by springs. Assume the theory of uniform wear. 5 CO5 PO2
- (OR)
- c. A band and block brake, having 14 blocks each of which subtends an angle of  $15^\circ$  at the centre, is applied to a drum of 1 m effective diameter. The drum and flywheel mounted on the same shaft has a mass of 2000 kg and a combined radius of gyration of 500 mm. The two ends of the band are attached to pins on opposite sides of the brake lever at distances of 30 mm and 120 mm from the fulcrum. If a force of 200 N is applied at a distance of 750 mm from the fulcrum, find:
- i. maximum braking torque,
  - ii. angular retardation of the drum, and
- The coefficient of friction between blocks and drum may be taken as 0.25. 10 CO5 PO2
6. a. Four masses  $m_1$ ,  $m_2$ ,  $m_3$  and  $m_4$  are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are  $45^\circ$ ,  $75^\circ$  and  $135^\circ$ . Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m. 5 CO6 PO2
- b. A shaft of length 0.75 m, supported freely at the ends, is carrying a body of mass 90 kg at 0.25 m from one end. Find the natural frequency of transverse vibration. Assume  $E = 200 \text{ GN/m}^2$  and shaft diameter = 50 mm. 5 CO6 PO2

(OR)

- |  |   |     |     |
|--|---|-----|-----|
| c. Four masses A, B, C and D are attached to a shaft and revolve in the same plane. The masses are 12 kg, 10 kg, 18 kg and 15 kg respectively and their radii of rotations are 40 mm, 50 mm, 60 mm and 30 mm. The angular position of the masses B, C and D are $60^\circ$ , $135^\circ$ and $270^\circ$ from the mass A. Find the magnitude and position of the balancing mass at a radius of 100 mm. | 5 | CO6 | PO2 |
| d. Establish an expression for the natural frequency of free transverse vibrations for a simply supported beam carrying a number of point loads, by Energy method  | 5 | CO6 | PO1 |

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