OR iii. The upper arms of a Porter governor has lengths 350 mm and are pivoted on the axis of rotation. The lower arms has lengths 300 mm and are attached to the sleeve at a distance of 40 mm from the axis. Each ball has a mass of 4 kg and mass on the sleeve is 45 kg. Determine the equilibrium speed for a radius of rotation of 200 mm and find also the effort and power of the governor for 1 per cent speed change. **6**

Q.5 i. Explain static and dynamic balancing. **3**

ii. A, B, C and D are four masses carried by a rotating shaft at radii 100, 125, 200 and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C and D are 10 kg, 5 kg, and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. **7**

OR iii Explain the following in two cylinder locomotive **7**
(a) Variation in tractive force
(b) Swaying couple
(c) Hammer blow

Q.6 Attempt any two:

i. Define following terms: **5**
(a) Cycle (b) Time period
(c) Phase difference (d) Natural frequency
(d) Resonance

ii. Derive natural frequency of spring mass system using by- **5**
(a) Energy method (b) Rayleigh's method

iii. Give the basic classification of vibration. **5**

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec-2023
ME3CO34 Dynamics of Machine

Programme: B.Tech. Branch/Specialisation: ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. The essential condition of placing the two masses, so that the system becomes dynamically equivalent is: **1**
(a) $l_1 . l_2 = kG^2$ (b) $l_1 . l_2 = kG$
(c) $l_1 + l_2 = kG^2$ (d) $l_1 = kG$

ii. A rigid body, under the action of external forces, can be replaced by two masses placed at a fixed distance apart. The two masses form an equivalent dynamical system, if: **1**
(a) The sum of two masses is equal to the total mass of the body
(b) The centre of gravity of the two masses coincides with that of the body
(c) The sum of mass moment of inertia of the masses about their centre of gravity is equal to the mass moment of inertia of the body
(d) All of these

iii. In a turning moment diagram, the variations of energy above and below the mean resisting torque line is called: **1**
(a) Fluctuation of energy
(b) Maximum fluctuation of energy
(c) Coefficient of fluctuation of energy
(d) None of these

iv. The maximum fluctuation of energy is the: **1**
(a) Ratio of maximum and minimum energies
(b) Sum of maximum and minimum energies
(c) Difference of maximum and minimum energies
(d) All of these

v. A Hartnell governor is a: **1**
(a) Pendulum type governor
(b) Spring loaded governor
(c) Dead weight governor
(d) Inertia governor

vi. Which of the following governor is pendulum type governor? **1**
(a) Watt governor (b) Porter governor
(c) Pickering governor (d) Hartnell governor

vii. In order to have a complete balance of the several revolving masses in different planes: **1**
(a) The resultant force must be zero
(b) The resultant couple must be zero
(c) Both the resultant force and couple must be zero
(d) None of these

viii. Secondary forces in reciprocating mass on engine frame are: **1**
(a) Of same frequency as of primary forces
(b) Twice the frequency as of primary forces
(c) Four times the frequency as of primary forces
(d) None of these

ix. In Rayleigh's method for finding natural frequency of the system. **1**
(a) The sum of kinetic and potential energy is zero
(b) The sum of kinetic and potential energy is constant
(c) Kinetic energy is zero
(d) Max. kinetic energy is equal to max. potential energy

x. The main properties of a vibrating system are: **1**
(a) Mass and stiffness (b) Mass, stiffness and damping
(c) Stiffness and damping (d) Damping and stiffness

Q.2 i. Define 'inertia force' and 'inertia torque'. **2**

ii. The inertia of the connecting rod can be replaced by two masses concentrated at two points and connected rigidly together. How to determine the two masses so that it is dynamically equivalent to the connecting rod ? Show this. **3**

iii. Explain the condition for equilibrium of: **5**
(a) Two force member
(b) Three force member
(c) Two force and a torque member

OR iv. The following data relate to a connecting rod of a reciprocating engine: **5**
Mass = 55 kg; Distance between bearing centres = 850 mm; Diameter of small end bearing = 75 mm; Diameter of big end bearing = 100 mm; Time of oscillation when the connecting rod is suspended from small end = 1.83 s; Time of oscillation when the connecting rod is suspended from big end = 1.68 s.
Determine:
(a) The radius of gyration of the rod about an axis passing through the centre of gravity and perpendicular to the plane of oscillation.
(b) The moment of inertia of the rod about the same axis.
(c) The dynamically equivalent system for the connecting rod, constituted of two masses, one of which is situated at the small end centre.

Q.3 i. Define flywheel and its application. **2**

ii. Derive an expression for approximate analytical method for velocity and acceleration of the piston and angular velocity and acceleration of the connecting rod. **8**

OR iii. The turning moment diagram for a multi-cylinder engine has been drawn to a scale of 1 mm to 500 N-m torque and 1 mm to 6° of crank displacement. The intercepted areas between output torque curve and mean resistance line taken in order from one end, in sq. mm are –30, +410, –280, +320, –330, +250, –360, +280, –260 sq. mm, when the engine is running at 800 r.p.m. **8**
The engine has a stroke of 300 mm and the fluctuation of speed is not to exceed ± 2% of the mean speed. Determine a suitable diameter and cross-section of the flywheel rim for a limiting value of the safe centrifugal stress of 7 MPa. The material density may be assumed as 7200 kg/m^3. The width of the rim is to be 5 times the thickness.

Q.4 i. Define and explain the following terms relating to governors: **4**
(a) Stability (b) Sensitiveness
(c) Isochronism (d) Hunting

ii. Explain the term height of the governor. Derive an expression for the height in the case of a Watt governor. What are the limitations of a Watt governor? **6**