Register Number:……..

KUMARAGURU college of technology
character is life

**B.E DEGREE EXAMINATIONS: MAY 2018**

(Regulation 2015)

Sixth Semester

**MECHATRONICS**

U15MCT503**:** Dynamics of Machinery

**COURSE OUTCOMES**

**CO1:** Differentiate and calculate various forces acting on rigid bodies under dynamic conditions
**CO2:** Calculate the energy requirements in flywheel.
**CO3:** Explain the significance of balancing and solve balancing problems related to rotating and reciprocating masses
**CO4:** Differentiate free and forced vibration and their importance in design
**CO5:** Calculate the response for free and forced vibration of systems having single degree of freedom
**CO6:** Summarize and determine various parameters involved in controlling mechanisms such as governors and gyroscopes

**Time: Three Hours** **Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. CO1 [$K_2$]

| List I | List II |
|---|---|
| A. Flywheel | i. Dunkerley Method |
| B. Governor | ii. Turning Moment |
| C. Critical speed | iii. D' Alembert's Principle |
| D. Inertia Force | iv. Speed control on par with load |

| | A | B | C | D |
|---|---|---|---|---|
| a) | ii | i | iii | iv |
| b) | iii | iv | ii | i |
| c) | ii | iv | i | iii |
| d) | iii | i | ii | iv |

2. The ratio of the maximum fluctuation of energy to the, ..... is called coefficient of fluctuation of energy. CO2 [$K_2$]

a) minimum fluctuation of energy b) mean fluctuation of energy
c) ΔE d) work done

3. The effect of hammer blow in a locomotive can be reduced by CO3 [$K_2$]

1. decreasing the speed
2. using two or three pairs of wheels coupled together
3. balancing whole of the reciprocating parts

a) 1,3 b) 1,2,3

c) 1,2 d) 2,3

4. The partial balancing means CO3 [$K_2$]

a) balancing partially the revolving masses b) balancing partially the reciprocating masses

c) best balancing of engines d) all of the above

5. Assertion (A): In a simple harmonic motion, the potential energy reaches its maximum value twice during each cycle CO4 [$K_2$]

Reason (R): Velocity becomes zero twice during each cycle.

a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A

c) A is true but R is false d) A is false but R is true

6. The equation of free vibrations of a system is $\ddot{x} + 36\pi^2 x = 0$ Its natural frequency is CO5 [$K_3$]

a) 6 Hz b) 3π Hz

c) 6π Hz d) 3 Hz

7. Arrange the terms in the increasing order of its time required to come to mean position CO5 [$K_2$]

1. Un-damped system
2. Under-damped system
3. Critically damped system
4. Over damped system

a) 2-3-4-1 b) 1-3-2-4

c) 3-4-2-1 d) 4-1-3-2

8. With symbols having the usual meanings, the single degree of freedom system, represents CO5 [$K_3$]

$m\ddot{x} + c\dot{x} + kx = F \sin \omega t$

a) free vibration with damping b) free vibration without damping

c) forced vibration without damping d) forced vibration with damping

9. Assertion (A): In order to have the same equilibrium speed for the given values of ω, W and h, the masses of balls used in the Proell governor are less than those of balls used in the Porter governor. CO6 [$K_2$]

Reason (R): The ball is fixed to an extension link in Proell governor.

a) Both A and R are Individually true and R is the correct explanation of A

b) Both A and R are Individually true but R is not the correct explanation of A

c) A is true but R is false

d) A is false but R is true

10. A Hartnell governor is a governor of the — CO6 [$K_2$]

a) inertia type

b) pedulum type

c) dead weight type

d) centrifugal type

**PART B (10 x 2 = 20 Marks)**
**(Answer not more than 40 words)**

11. Explain general plane motion. — CO1 [$K_2$]
12. Differentiate coefficient of fluctuation of speed and coefficient of fluctuation of energy. — CO2 [$K_2$]
13. Explain the significance of balancing. — CO3 [$K_2$]
14. Write the equations for Primary and Secondary unbalanced forces in reciprocating masses. — CO3 [$K_2$]
15. Define Degrees of freedom. — CO5 [$K_1$]
16. What is meant by critical speed of shafts? — CO5 [$K_1$]
17. State the significance of vibration control. — CO4 [$K_2$]
18. Explain vibration isolation. — CO5 [$K_2$]
19. Describe Sensitiveness of Governors. — CO6 [$K_2$]
20. State the different types of governors. — CO6 [$K_1$]

**Answer any FIVE Questions:-**
**PART C (5 x 14 = 70 Marks)**
**(Answer not more than 300 words)**

**Q.No. 21 is Compulsory**

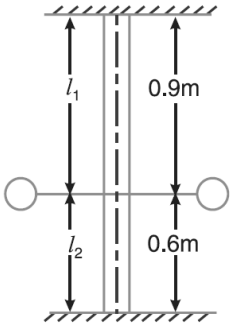
21. A shaft carries four masses in parallel planes A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100° and that between the masses at B and A is 190°, both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine:
1. The magnitude of the masses at A and D; 2. The distance between planes A and D; and 3. the angular position of the mass at D. — CO3 [$K_3$]

22. (i) A vertical petrol engine 100 mm diameter and 120 mm stroke has a connecting rod 250 mm long. The mass of the piston is 1.1 kg. The speed is 2000 r.p.m. On the expansion stroke with a crank 20° from top dead centre, the gas pressure is 700 kN/m$^2$. Determine: 1. Net force on the piston, 2. Resultant load on the gudgeon pin, and 3. Thrust on the cylinder walls. (10) CO1 [$K_3$]
(ii) Describe: D'Alemberts principle and the Principle of superposition. (4) CO1 [$K_3$]

23. The turning moment diagram for a multi-cylinder 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 $mm^2$, 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 radius 0.5 m. CO2 [$K_3$]

24. Differentiate the following and give examples: CO4 [$K_3$]
    (i) Natural frequency and forced frequency (4)
    (ii) Un-damped vibration and Damped vibration (6)
    (iii) Longitudinal and Transverse vibration (4)

25. A flywheel is mounted on a vertical shaft as shown in Figure. The both ends of the shaft are fixed and its diameter is 50 mm. The flywheel has a mass of 500 kg. Find the natural frequencies of longitudinal and transverse vibrations. Take E = 200 $GN/m^2$. CO5 [$K_3$]




26. The mass of an electric motor is 120 kg and it runs at 1500 r.p.m. The armature mass is 35 kg and its C.G. lies 0.5 mm from the axis of rotation. The motor is mounted on five springs of negligible damping so that the force transmitted is one-eleventh of the impressed force. Assume that the mass of the motor is equally distributed among the five springs. Determine : 1. Stiffness of each spring; 2. Dynamic force transmitted to the base at the operating speed; and 3. Natural frequency of the system. CO5 [$K_3$]

27. (i) Describe the effect of Gyroscopic couple on airplanes and ships. (10) CO5 [$K_2$]
    (ii) What is the function of a governor? How does it differ from that of a flywheel? (4) CO5 [$K_2$]

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