KUMARAGURU
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Register Number: ……..

B.E DEGREE EXAMINATIONS: MAY 2015

Regulation 2009

Fourth Semester

MECHATRONICS ENGINEERING

MCT105**:** Dynamics of Machinery

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. In an engine, the work done by inertia forces in a cycle is
   a) positive b) negative
   c) zero d) unity
2. The ratio of the maximum fluctuation of speed to the mean speed is called
   a) fluctuation of speed b) maximum fluctuation of speed
   c) coefficient of fluctuation of speed d) average speed
3. 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
   a) $m_1.r_2 = m_2.r_1$ b) $m_1.r_1 = m_2.r_2$
   c) $m_1. m_2 = r_2.r_1$ d) $m_1 + m_2 = r_2 + r_1$
4. In a locomotive, the maximum magnitude of the unbalanced force along perpendicular to line of stroke, is known as
   a) tractive force b) swaying couple
   c) hammer blow d) rotating force
5. The frequency of damped vibration is always ---------- the natural frequency.
   a) equal to b) more than
   c) less than d) double
6. A torsional vibratory system having three rotors connected by a shaft has
   a) one node b) two nodes
   c) three nodes d) no node
7. The ratio of maximum displacement of forced vibration to the deflection due to static force, is known as
   a) damping factor b) damping coefficient

c) logarithmic decrement d) magnification factor

8. In vibration isolation system, if ω/ω_n is less than $\sqrt{2}$, then for all values of damping factor, the transmissibility will be

a) less than unity b) equal to unity

c) greater than unity d) zero

9. In a governor if the equilibrium speed is constant for all radii of rotation of balls, then it is

a) stable b) inertia

c) unstable d) isochronous

10. In an automobile, if the vehicle makes a left turn, the gyroscopic torque

a) increases the forces on the outer wheels b) decreases the forces on the outer wheels

c) doesn't affect the forces on wheels d) Zero

PART B (10 x 2 = 20 Marks)

11. State D'Alembert's principle.
12. Define the term: coefficient of fluctuation of energy.
13. Mention the condition for complete balancing of reciprocating engines.
14. What are the effects of partial balancing of locomotives?
15. What do you mean by whirling speed of shaft?
16. Justify the role of damping factor in machine design.
17. Define transmissibility ratio.
18. What is dynamic maginifier?
19. Mention the function of governor. How does it differ from flywheel?
20. What will be the effect of gyroscopic couple on a naval ship during rolling?

PART C (5 x 14 = 70 Marks)

21. a) The crank and connecting rod of a vertical petrol engine, running at 1800 rpm are 60 mm and 270 mm respectively. The diameter of the piston is 100 mm and the mass of reciprocating parts is 1.2 kg. During the expansion stroke when the crank has turned through 20^0 from the TDC, the gas pressure is 650 kN/m^2. Determine:

i) the net force on the piston ii) the net load on the gudgeon pin

iii) the thrust on the cylinder walls

iv) the speed at which the gudgeon pin load is reversed in direction.

(OR)

b) The T-M diagram for a multi cylinder engine has been drawn to a vertical scale

of 1 mm = 650 Nm and a horizontal scale of 1 mm = 4.5^0. The areas of the mean torque line are -28, +380, -260, +310, -300, +242, -380, +265 and -229 mm^2.

The fluctuation of speed is limited to ±1.8% of the mean speed which is 400 rpm. Density of the rim material is 7000 kg/m^3 and width of the rim is 4.5 times its thickness. The centrifugal stress in the rim material is limited to 6 N/mm^2. Neglecting the effect of boss and arms, determine the diameter and the cross section of the flywheel rim.

22. a) 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.

(OR)

b) An inside cylinder locomotive has its cylinder centre lines 0.7 m apart and has a stroke of 0.6 m. The rotating masses per cylinder are equivalent to 150 kg at the crank pin, and the reciprocating masses per cylinder to 180 kg. The wheel centre lines are 1.5 m apart. The cranks are at right angles.

The whole of rotating and 2/3 of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Find the magnitude and direction of the balancing masses, fluctuation in rail pressure, variation of tractive effort and the magnitude of swaying couple at a crank speed of 300 rpm.

23. a) The measurements on a mechanical vibrating system show that it has a mass 8 kg and that the springs can be combined to give an equivalent spring of stiffness 5.4 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass has a velocity of 1 m/s, Find:

i) critical damping coefficient ii) damping factor

iii) logarithmic decrement and iv) ratio of two consecutive amplitudes.

(OR)

b) Determine the natural frequencies of torsional oscillation for the following system. The system is a IC engine coupled to a centrifugal pump through a pair of gears. The shaft from the flywheel of the engine to the gear wheel is of 60 mm diameter and 950 mm length. The shaft from the pinion to the pump is of 40 mm diameter and 300 mm length. The engine speed is ¼ of the pump speed.

$I_{flywheel}$ = 800 kg.m^2; I_{gear} = 15 kg.m^2; I_{pinion} = 4 kg.m^2; I_{pump} = 17 kg.m^2;
Modulus of rigidity of shaft material = 84 GN/mm^2.

24. a) A mass of 10 kg is suspended from one end of helical spring, the other end being fixed. The stiffness of the spring is 10 N/mm. The viscous damping causes the amplitude to decrease to 1/10 of the initial value in four complete oscillations. If a periodic force of 150 cos 50 t N is applied at the mass in the vertical direction, find the amplitude of the forced vibrations. What is its value of resonance?

(OR)

b) The mass of an electric motor is 120 kg and it runs at 1500 rpm. 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 motor is equally distributed among the five springs.
Determine i) stiffness of each spring ii) dynamic force transmitted to the base at the operating speed and iii) natural frequency of the system.

25. a) A porter governor has equal arms each 250 mm long pivoted on the axis of rotation. Each ball has a mass of 5 kg and the mass of central load on the sleeve is 25 kg. The radius of rotation of the ball is 150 mm when the governor begins to lift and 200 mm when the governor is at maximum speed. Find the range of speed, sleeve lift, governor effort and power of the governor with and without consideration friction on the sleeve 10 N.

(OR)

b) The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 rpm clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship.

i) When the ship is steering to the left on a curve of 100 m radius at a speed of 36 kmph.

ii) When the ship is pitching in a SHM, the bow falling with its maximum velocity. The period of pitching is 40 sec and the total angular displacement between the two extreme positions of pitching is 12^0.

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