KUMARAGURU
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Register Number: ……..

B.E DEGREE EXAMINATIONS: NOV/DEC 2014

(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. When the crank is at the inner dead centre, in a horizontal reciprocating steam engine, then the velocity of the piston will be
   a) Minimum b) Maximum
   c) Zero d) None of these
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) None of these
3. In order to have a complete balance of the several revolving masses in different planes
   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 the above
4. The swaying couple is due to the
   a) Primary unbalanced force b) Secondary unbalanced force
   c) two cylinders of locomotive d) Partial balancing
5. When there is a reduction in amplitude over every cycle of vibration, then the body is said to have
   a) free vibration b) Forced Vibration
   c) Damped Vibration d) None of these.
6. A shaft which carries three rotors will have
   a) One nodes b) Two nodes
   c) Three Nodes d) No Nodes
7. In a Vibration isolation system, if $\omega/\omega_n > 1$, Then the phase difference between the transmitted force and the disturbing force is
   a) 0° b) 180°
   c) 90° d) 270°
8. The equation of motion for a vibrating system with viscous damping is

$$\frac{d^2x}{dt^2} + \frac{c}{m} \times \frac{dx}{dt} + \frac{s}{m} \times x = 0$$

   a) Overdamped b) Underdamped
   c) Critically damped d) None of these

9. A governor is said to be hunting, if the speed of the engine
   a) remains constant at the mean speed
   b) is above the mean speed
   c) is below the mean speed
   d) fluctuates continuously above and below the mean speed.
10. The effect of gyroscopic couple on a Naval ship during rolling is
   a) Zero
   b) Maximum
   c) Minimum
   d) None of these.

PART B (10 x 2 = 20 Marks)

11. What is the function of flywheel and how does it differ from Governor?
12. Define coefficient of fluctuation of energy.
13. List out the condition for complete balancing in rotating masses.
14. Define Hammer Blow.
15. List the types of Vibration.
16. Write the Expression for Natural frequency of Two Rotor system in torsional Vibration.
17. Define Logarithmic Decrement.
18. Define Magnification Factor.
19. Write down the classifications of Centrifugal Governors.
20. List the effect of gyroscopic couple on an Airplane while taking a left turn with the propeller rotating clockwise direction.

PART C (5 x 14 = 70 Marks)

21. a) The crank-pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C., the difference between the driving and the back pressures is 0.35 N/mm^2. The connecting rod length between centres is 1.2 m and the cylinder bore is 0.5 m. If the engine runs at 250 r.p.m. and if the effect of piston rod diameter is neglected, calculate: 1. pressure on slide bars, 2. thrust in the connecting rod, 3. tangential force on the crank-pin, and 4. turning moment on the crank shaft.

(OR)

b) The turning moment diagram for a multicylinder engine has been drawn to a scale of 1mm to 500N-m torque and 1mm to 60° of crank displacement. The intercepted areas between the 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 rpm. The engine has a stroke of 300mm and fluctuation of the speed is not to exceed plus or minus 2% of the mean speed. Determine the suitable diameter and cross section of the flywheel rim for limiting value of the safe centrifugal stress of

7 Mpa. The material density may be assumed as 7200kg/m^3. The width of the rim is to be 5 times the thickness.

22. a) Four masses A, B, C and D as shown below are to be completely balanced. Take Mass M_B =30, M_C=50, M_D=40kg and Radius r_A=180mm, r_B=240mm, r_C=120mm, r_D=150mm. The planes containing masses B and C are 300 mm apart. The angle between planes containing B and C is 90°. B and C make angles of 210° and 120° respectively with D in the same sense. Find :

1. The magnitude and the angular position of mass A ; and
2. The position of planes A and D.

(OR)

b) The following data refers to a two cylinder locomotive with cranks at 90° interval. Reciprocating mass per cylinder = 300 kg, Crank radius = 0.3 meter, Driving wheel diameter = 1.8meter, Distance between cylinder centre line = 0.65 meter. Distance between driving wheel centre plane =1.55 meter. Determine 1.) Fraction of the reciprocating masses to be balanced, if the hammer blow is not to exceed 46 KN at 96.5km.p.h; 2) The variation in tractive Effort and 3) the Maximum Swaying Couple.

23. a) A Shaft 1.5 m long, supported in flexible bearings at the ends carries two wheels each of mass 50 Kg. one wheel is situated at the centre of the shaft and other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75mm and internal diameter 40 mm. the density of the shaft material is 7700 kg/m^3 and its modulus of Elasticity is 200 GN/m^2. Find the natural frequency of transverse vibrations of the shaft, taking into account the mass of the Shaft

(OR)

b) A two cylinder engine and flywheel coupled to a propeller are approximated to a 3-rotor system in which the engine is equivalent to a rotor of moment of inertia 800 kg-m^2 ,the flywheel to a second rotor of 320 kg-m^2 and the propeller to a third rotor of 20 kg-m^2. The first and second rotor being connected by 50mm diameter and 2 meter long shaft and second and third rotor being connected by a 25 mm diameter and 2metre long shaft. Take modulus of rigidity as 80 GN/m^2. Determine 1. Natural frequencies of torsional vibrations. 2. The position of nodes.

24. a) The mass of a single degree damped vibrating system is 7.5 kg and makes 24 free oscillations in 14 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.25 of its initial value after five oscillations. Determine : 1. stiffness of the spring, 2. logarithmic decrement, and 3. damping factor,

i.e. the ratio of the system damping to
critical damping.

(OR)

b) A single-cylinder engine of total mass 200 kg is to be mounted on an elastic support which permits vibratory movement in vertical direction only. The mass of the piston is 3.5 kg and has a vertical reciprocating motion which may be assumed simple harmonic with a stroke of 150 mm. It is desired that the maximum vibratory force transmitted through the elastic support to the foundation shall be 600 N when the engine speed is 800 r.p.m. and less than this at all higher speeds.

1. Find the necessary stiffness of the elastic support, and the amplitude of vibration at 800 r.p.m., and

2. If the engine speed is reduced below 800 r.p.m. at what speed will the transmitted force again becomes 600 N?

25. a) A governor of the Proell type has each arm 250 mm long. The pivots of the upper and lower arms are 25 mm from the axis. The central load acting on the sleeve has a mass of 25 kg and the each rotating ball has a mass of 3.2 kg. When the governor sleeve is in mid-position, the extension link of the lower arm is vertical and the radius of the path of rotation of the masses is 175 mm. The vertical height of the governor is 200 mm. If the governor speed is 160 r.p.m. when in mid-position, find: 1. length of the extension link

(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 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship:

1. When the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h.

2. When the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees.

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