B.E DEGREE EXAMINATIONS: MAY 2015

(Regulation 2013)

Fourth Semester

MECHATRONICS ENGINEERING

U13MCT403**:** Dynamics of Machinery

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

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. The maximum fluctuation of energy is

   a) Ratio of max and min energies   b) Sum of max and min energies

   c) Difference of max and min energies d) Difference of max and min energies from the mean energy

2. The amount of energy absorbed by a fly wheel is found from ………… diagram.

3. Static balancing involves balancing of

   a) Forces   b) Couples

   c) Forces and couple   d) Masses

4. The primary unbalanced force is maximum when the angle of crank with the line of stroke is …………. degree.

5. A hartnell governor is a ………… type of governor

   a) Dead weight   b) Pendulum type

   c) Inertia   d) Spring loaded

6. The gyroscopic acceleration is given by …………..

7. The particle of a body moves in ………… axis for longitudinal vibrations.

   a) In a circle about   b) Parallel to

   c) Perpendicular to   d) Away from

8. The frequency of damped vibrations is always ………… the natural frequency

9. In a damped force vibrations, the ratio of maximum deflection to the static deflection is known as

   a) Damping factor   b) Critical damping factor

   c) Magnification factor   d) Logarithmic decrement

10. In a three rotor torsional vibratory system ………… number of nodes are expected.

PART B (10 x 2 = 20 Marks)

(Not more than 40 words)

11. Distinguish random vibration and cyclic vibration with examples.

12. List any four passive vibration isolators.

13. Calculate the "I_{yy}" for the given cross section about the centroidal axis. (All dimensions in mm)
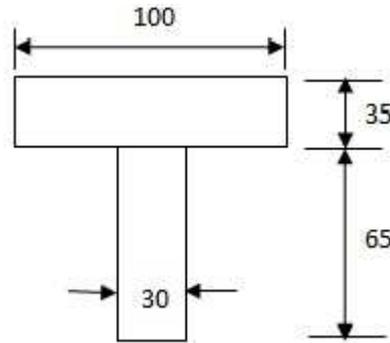
14. A rotating machine is generating excessive vibration. This vibration is due to unbalancing of masses and it can be controlled by adding counter weight. Justify, why the addition of weight reduced the vibration?

15. Argue whether a motor bike has a fly wheel or not.

16. What is a gyroscopic couple?

17. A flywheel with a mass of 3kN has a radius of gyration of 1.6 m. find the energy stored in the flywheel when its speed increases from 315 rpm to 340 rpm.

18. State D' Alembert's principle.

19. In what way balancing of reciprocating mass is different from rotating mass?

20. In your own words comment on the primary and the secondary unbalance in reciprocating engines.

PART C (5 x 14 = 70 Marks)

(Not more than 400 words)

Q. No. 21 is Compulsory

21.   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 rpm. On the expansion stroke with a crank 20° from top dead centre, the gas pressure is 700kN/m2. Determine: 1. Net force on the piston, 2. Resultant load on the gudgeon pin, 3. Thrust on the cylinder walls, and 4. Speed above which, other things remaining same, the gudgeon pin load would be reversed in direction.

22. a) 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.

(OR)

b) (i) A single cylinder reciprocating engine has speed 240rpm, stroke 300 mm, mass (6) of reciprocating parts 50kg, mass of revolving parts at 150mm radius 37kg. If two third of the reciprocating parts and all the revolving parts are to be balanced, find : 1. The balance mass required at a radius of 400mm, and 2. The residual unbalanced force when the crank has rotated 60° from top dead centre.

(ii) Four masses m1, m2, m3and m4 are 200kg, 300kg, 240kg and 260 kg (8) respectively. The corresponding radii of rotation are 0.2m, 0.15 m, 0.25 m and 0.3 m respectively and the angles between successive masses are 45°, 75° and 135°. Find the position and magnitude of the balance mass required, if its radius of rotation is 0.2 m using analytical method.

23. a) (i) Illustrate a Centrifugal governor and describe its working mechanism. (7)
   (ii) Explain various terms used in a governor. (7)

(OR)

b) Each wheel of a four wheeled rear engine automobile has a moment of inertia of 2.4kg.m^2 and an effective diameter of 660mm. The rotating parts of the engine have a moment of inertia of 1.2kg.m^2. The gear ratio of the engine to the back wheel is 3 to 1. The engine axis is parallel to the rear axle and the crank shaft rotates in the same sense as the road wheels. The mass of the vehicle is 2200kg and the centre of the mass is 550mm above the road level. The track width of the vehicle is 1.5m. Determine the limiting speed of the vehicle around a curve with 80m radius so that all the four wheels maintain contact with the road surface.

24. a) (i) Derive the natural frequency of the free longitudinal vibration system using "Equilibrium method". (7)

   (ii) A cantilever beam having a diameter and length of 50mm and 300 mm respectively. The beam has a mass of 100kg hung at its free end. The Young's modulus for the shaft material is $200GN/m^2$. Determine the frequency of longitudinal and transverse vibrations of the shaft. (7)

(OR)

   b) (i) A vibrating system consists of a mass of 50kg, a spring with a stiffness of 30kN/m and a damper. The damping provided is only 20% of the critical value. Find; 1. The damping factor, 2. Critical damping coefficient, 3. Natural frequency of damped vibrations, 4. Logarithmic decrement and 5. Ratio of two consecutive amplitudes. (8)

   (ii) A circular shaft of length 0.75m and shaft diameter of 50 mm is supported freely at the ends. The beam carries 2 masses; first mass is 90kg acting at 0.25m from the left end and the second mass of 60kg acting at 0.40m from the left end. Find the natural frequency of transverse vibration using Dunkerley's method. Assume $E = 200 \ GN/m^2$. (6)

25. a) A vertical shaft of 5mm diameter is 200mm long and is supported in long bearings at its ends. A disc of mass 50kg is attached to the centre of the shaft. Neglecting any increase in stiffness due to the attachment of the disc to the shaft, find the critical speed of rotation and the maximum bending stress when the shaft is rotating at 75% of the critical speed. The centre of the disc is 0.25mm from the geometric axis of the shaft. $E = 200 \ GN/m^2$.

(OR)

   b) A vertical steel shaft 15mm diameter is held in long bearings 1 meter apart and carries at its middle a disc of mass 15kg. The eccentricity of the centre of gravity of the disc from the centre of the rotor is 0.30mm. The modulus of elasticity for the shaft material is 200GN/m2 and the permissible stress is 70MN/m2. Determine: 1. The critical speed of the shaft and 2. The range of speed over which it is unsafe to run the shaft. Neglect the mass of the shaft.

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