A **Reg. No. :** | | | | | | | | | | |

Question Paper Code: 55701

B.E./B.Tech. DEGREE EXAMINATION, MAY 2022

Fifth Semester

Mechanical Engineering

15UME501 -DYNAMICS OF MACHINERY

(Regulation 2015)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. It is numerically equal to the accelerating force in magnitude, but opposite in direction. CO1- R

   (a) Centrifugal force (b)Inertia force (c)Centripetal force (d) gravitational force

2. The balancing of rotating and reciprocating parts of an engine is necessary when it runs at CO1- R

   (a) slow speed (b) medium speed (c) High 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 inthe same plane of rotation as that of m_1 such that CO2- R

   (a) $m_1r_2=m_2r_1$ (b) $m_1r_1=m_2r_2$ (c) $m_1m_2=r_1r_2$ (d) $m_1r_3=m_3r_1$

4. The primary unbalanced force is maximum when the angle of inclination of the crank with the line of stroke is CO2- R

   (a) 0^0 (b)90^0 (c)180^0 (d)360^0

5. In a locomotive, the maximum magnitude of the unbalanced force along the perpendicular to the line of stroke, is known as CO3- R

   (a) Tractive force (b)Swaying couple (c) Hammer blow (d) none of these

6. When there is a reduction in amplitude over every cycle of vibration, then the body is said to have CO3- R

   (a) Free vibration (b) Forced vibration (c) Damped vibration (d) Transverse vibration

7. When a body is subjected to transverse vibrations, the stress induced in a body will be CO4- R

(a) Shear stress (b) Tensile stress (c) Compressive stress (d) Principle stress

8. A shaft carrying two rotors as its ends will have CO4- R

(a) no node (b) One node (c) Two nodes (d) Three nodes

9. A disc spinning on its axis at 20 rad/s will undergo precession when a torque 100 N-m is applied about an axis normal to it at an angular speed, if mass moment of inertia of the disc is the 1 kg-m^2. CO5- R

(a) 2 rad/sec (b) 5 rad/sec (c) 10 rad/sec (d) 20 rad/sec

10. Which of the following is a spring controlled governor? CO5- R

(a) Hartnell (b) Hartung (c) Pickering (d) All of these

PART – B (5 x 2= 10 Marks)

11. What are the three conditions for a rigid body to be an equivalent dynamical system? CO1- U

12. How the different masses rotating in different planes are balanced? CO2- U

13. What is meant by fundamental frequency? CO3- U

14. What do you understand by transmissibility? CO4- U

15. What is meant by Hunting in governors? CO5- U

PART – C (5 x 16= 80 Marks)

16. (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: CO1- App (16)

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) A shaft fitted with a flywheel rotates at 250 r.p.m. and drives a machine. The torque of machine varies in a cyclic manner over a period of 3 revolutions. The torque rises from 750 N-m to 3000 N-m uniformly during 1/2 revolution and remains constant for the following revolution. It then falls uniformly to 750 N-m during the next 1/2 revolution and remains constant for one revolution, the cycle being repeated thereafter. Determine the power required to drive the machine and percentage fluctuation in speed, if the driving torque applied to the shaft is constant and the mass of the flywheel is 500 kg with radius of gyration of 600 mm. CO1- App (16)

17. (a) A shaft carries four masses A, B, C and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70° and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions. CO2- App (16)

Or

(b) The three cranks of a three cylinder locomotive are all on the same axle and are set at 120°. The pitch of the cylinders is 1 metre and the stroke of each piston is 0.6 m. The reciprocating masses are 300 kg for inside cylinder and 260 kg for each outside cylinder and the planes of rotation of the balance masses are 0.8 m from the inside crank. If 40% of the reciprocating parts are to be balanced, find : CO2- App (16)

1. The magnitude and the position of the balancing masses required at a radius of 0.6 m ; and
2. The hammer blow per wheel when the axle makes 6 r.p.s.

18. (a) A shaft 1.5 m long supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm 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 lowest whirling speed of the shaft, taking into account the mass of the shaft. CO3- Ana (16)

Or

(b) A 4-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 the second rotors being connected by 50 mm diameter and 2 m long shaft and the third rotors being connected by a 25 mm diameter and 2m long shaft.
Neglecting the inertia of the shaft and taking its modulus ofrigidityas 80GN/m^2, determine:
1.Natural frequencies of torsional oscillations,and
2. The positrons of the nodes.

CO3- Ana (16)

19. (a) A machine part of mass 2 kg vibrates in a viscous medium. Determine the damping coefficient when a harmonic exciting force of 25 N results in resonant amplitude of 12.5 mm with a period of 0.2 second. If the system is excited by a harmonic force of frequency 4 Hz what will be the percentage increase in the amplitude of vibration when damper is removed as compared with that with damping.

CO4 -Ana (16)

Or

(b) 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.

CO4 -Ana (16)

20. (a) The arms of a Porter governor are 300 mm long. The upper arms are pivoted on the axis of rotation. The lower arms are attached to a sleeve at a distance of 40 mm from the axis of rotation. The mass of the load on the sleeve is 70 kg and the mass of each ball is 10 kg. Determine the equilibrium speed when the radius of rotation of the balls is 200 mm. If the friction is equivalent to a load of 20 N at the sleeve, what will be the range of speed for this position? CO5-App (16)

Or

(b) A ship propelled by a turbine rotor which has a mass of 5 tonnes and a speed of 2100 r.p.m. The rotor has a radius of gyration of 0.5 m and rotates in a clockwise direction when viewed from the stern. Find the gyroscopic effects in the following conditions: 1. The ship sails at a speed of 30 km/h and steers to the left in a curve having 60 m radius. 2. The ship pitches 6 degree above and 6 degree below the horizontal position. The bow is descending with its maximum velocity. The motion due to pitching is simple harmonic and the periodic time is 20 seconds. 3. The ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clockwise when viewed from stern. Determine also the maximum angular acceleration during pitching. Explain how the direction of motion due to gyroscopic effect is determined in each case. CO5-App (16)