A   **Reg. No. :**

| Question Paper Code: U5702 |

B.E./B.Tech. DEGREE EXAMINATION, NOV 2023

Fifth Semester

Mechanical Engineering

21UME502 - DYNAMICS OF MACHINERY

(Regulation 2021)

Duration: Three hours   Maximum: 100 Marks

PART A - (10 x 1 = 10 Marks)

1. The net force acting on the crosshead pin is known as   CO1- U

    (a) crank pin effort   (b) crank effort   (c) piston effort   (d) shaft effort

2. In vehicle, the flywheel is placed in between   CO1- U

    (a) engine and clutch   (b) clutch and propeller shaft

    (c) propeller shaft and differential   (d) before engine

3. The primary unbalanced force is maximum when the angle of   CO1- U
    inclination of the crank with the line of stroke is

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

4. The swaying couple is due to the   CO1- U

    (a) primary unbalanced force   (b) secondary unbalanced force

    (c) two cylinders of locomotive   (d) partial balancing

5. When a body is subjected to transverse vibrations, the stress induced in   CO1- U
    a body will be

    (a) shear stress   (b) bending stress

    (c) tensile stress   (d) compressive stress

6. Keeping the mass moment of inertia of both the shafts in a two rotor   CO1- U
    system same, if the length of one shaft is doubled what should be the
    effect on the length of other shaft?

    (a) Doubled   (b) Halved

    (c) Constant   (d) Increased to 4 times

7. If the damper is not provided and the system is in resonance, then the isolation factor is   CO1- U

    (a) 0   (b) 1/2   (c) 1/4   (d) Infinity

8. Magnification factor is the ratio of the maximum displacement due to forced vibrations to the deflection due to   CO1- U

    (a) dynamic force   (b) static force   (c) torsion   (d) compression

9. During upward pitching, gyroscopic couple will tend to move the ship towards   CO1- U

    (a) Star-board   (b) Port side   (c) No motion   (d) Left side

10. Degree of freedom for gyroscope rotor is   CO1- U

    (a) 1   (b) 3   (c) 2   (d) 5

PART – B (5 x 2= 10Marks)

11. Explain crank effort and crank pin effort.   CO1- U

12. Why rotating masses are to be dynamically balanced?   CO1 -U

13. Describe damping and damped vibration.   CO1 - U

14. Describe transmissibility and transmissibility ratio.   CO1 - U

15. Depict the effect of gyroscopic couple in ships during pitching.   CO1 - U

PART – C (5 x 16= 80Marks)

16. (a) 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, 3. Thrust on the cylinder walls, and 4. Speed above which, other things remaining same, the gudgeon pin load would be reversed in direction.   CO2 - App   (16)

OR

(b) 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 - App   (16)

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17. (a) Four masses m_1, m_2, m_3 and m_4 are 200 kg, 300 kg, 240 kg and 260 kg respectively. The corresponding radii of rotation are 0.2 m, 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.   CO2 - App   (16)

<div align="center">OR</div>

(b) A four cylinder vertical engine has cranks 150 mm long. The planes of rotation of the first, second and fourth cranks are 400 mm, 200 mm and 200 mm respectively from the third crank and their reciprocating masses are 50 kg, 60 kg and 50 kg respectively. Find the mass of the reciprocating parts for the third cylinder and the relative angular positions of the cranks in order that the engine may be in complete primary balance.   CO2 - App   (16)

18. (a) The mass of a machine is 100 kg. Its vibrations are damped by a viscous dash pot which diminishes amplitude of vibrations from 40 mm to 10 mm in three complete oscillations. If the machine is mounted on four springs each of stiffness 25 kN/m, find (a) the resistance of the dash pot at unit velocity, and (b) the periodic time of the damped vibration.   CO3 - App   (16)

<div align="center">OR</div>

(b) A steel shaft 1.5 m long is 95 mm in diameter for the first 0.6 m of its length, 60 mm in diameter for the next 0.5 m of the length and 50 mm in diameter for the remaining 0.4 m of its length. The shaft carries two flywheels at two ends, the first having a mass of 900 kg and 0.85 m radius of gyration located at the 95 mm diameter end and the second having a mass of 700 kg and 0.55 m radius of gyration located at the other end. Determine the location of the node and the natural frequency of free torsional vibration of the system. The modulus of rigidity of shaft material may be taken as 80 GN/m^2.   CO3 - App   (16)

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19. (a) A machine part of mass 2 kg vibrates in a viscous medium. CO3 - App (16)
Determine the damping coefficient when a harmonic exciting force of 25 N results in a 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.

OR

(b) A vibratory body of mass 150 kg supported on springs of total CO3 - App (16)
stiffness 1050 kN/m has a rotating unbalance force of 525 N at a speed of 6000 rpm. If the damping factor is 0.3, determine:
1. The amplitude caused by the unbalance and its phase angle
2. The transmissibility
3. The actual force transmitted and its phase angle

20. (a) A Porter governor has equal arms each 250 mm long and pivoted CO4 - App
on the axis of rotation. Each ball has a mass of 5 kg and the mass of the 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 minimum and maximum speeds and range of speed of the governor. (16)

OR

(b) The mass of the turbine rotor of a ship is 20 tonnes and has a CO4 - App (16)
radius of gyration of 0.60 m. Its speed is 2000 r.p.m. The ship pitches $6°$ above and $6°$ below the horizontal position. A complete oscillation takes 30 seconds and the motion is simple harmonic. Determine the following:
1. Maximum gyroscopic couple, 2. Maximum angular acceleration of the ship during pitching, and 3. The direction in which the bow will tend to turn when rising, if the rotation of the rotor is clockwise when looking from the left.

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