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Question Paper Code: U5702

B.E./B.Tech. DEGREE EXAMINATION, APRIL 2024

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 length of the crank and connecting rod are 150 mm and 600 mm. The crank position is 60° from the inner dead center. The crankshaft speed is 400 r.p.m. Find the acceleration in m/s^2 of the slider. CO1- U
(a) 101.5 (b) 100.6 (c) 98.6 (d) 97.6
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 inclination of the crank with the line of stroke is CO1- U
(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. The speed at which the shaft runs so that the additional deflection from the axis of rotation of the shaft becomes infinite is CO1- U
(a) whirling speed (b) rotational speed
(c) stabilizing speed (d) reciprocating speed
6. Keeping the mass moment of inertia of both the shafts in a two rotor system same, if the length of one shaft is doubled what should be the effect on the length of other shaft? CO1- U
(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. Gyroscopic effect is not observed in ships during CO1- U
- (a) pitching (b) banking (c) rolling (d) steering

PART – B (5 x 2= 10Marks)

11. The lengths of crank and connecting rod of vertical reciprocating engine are 300 mm and 1.5 m respectively. If the crank rotates at 200 rpm, find the velocity of piston at $\theta = 40^\circ$. CO2- App
12. List the effect of partial balancing of locomotives. CO1 -U
13. State the natural frequency of torsional vibration of a simple system. CO1 - U
14. Specify the importance of vibration isolation. CO1 - U
15. Depict the effect of gyroscopic couple in ships during pitching. CO1 - U

PART – C (5 x 16= 80Marks)

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: 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 CO2 - App (16)

OR

- (b) A horizontal cross compound steam engine develops 300 kW at 90 r.p.m. The coefficient of fluctuation of energy as found from CO2 - App (16)

the turning moment diagram is to be 0.1 and the fluctuation of speed is to be kept within $\pm 0.5\%$ of the mean speed. Find the weight of the flywheel required, if the radius of gyration is 2 metres.

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)

OR

- (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) 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 - App (16)

OR

- (b) The measurements on a mechanical vibrating system show that it has a mass of 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: 1. critical damping coefficient, 2. Damping factor, 3. Logarithmic decrement, and 4. ratio of two consecutive amplitudes. CO3 - App (16)

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 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: CO3 - App (16)
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) 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: CO4 - App (16)
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 bowfalling 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.
- (b) 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; and 2. tension in the upper arm. CO4 - App (16)