Reg. No.												

Question Paper Code	11551

B.E./B.Tech. - DEGREE EXAMINATIONS, NOV/DEC 2022

Fifth Semester

Mechanical Engineering

20MEPC503 - THEORY OF MACHINES

(Regulations 2020)

Duration: 3 Hours Max. Marks: 100

PART - A (10 × 2 = 20 Marks)

Answer ALL Questions

		Marks, K-Level, CO
1.	Write Grashof's law.	*2,K2, CO1*
2.	State the difference between lower and higher pairs.	*2,K1, CO1*
3.	Define pressure angle of gears.	*2,K1, CO2*
4.	What are the different types of Follower motions?	*2,K2, CO2*
5.	State D-Alembert's principle.	*2,K1, CO3*
6.	Write the importance of balancing.	*2,K2, CO4*
7.	What is the function of Flywheel?	*2,K2, CO4*
8.	How will you find the natural frequency of transverse vibration?	*2,K2, CO5*
9.	Write the expression for natural frequency of a torsional vibration.	*2,K2, CO5*
10.	Write the expression to find maximum efficiency of screw jack.	*2,K2, CO6*

PART - B (5 × 13 = 65 Marks)

Answer ALL Questions

11.	a)	Explain the inversions of Double slider crank mechanism with neat sketches.	*13,K2,CO1*
		OR	
	b)	In a four bar chain ABCD, link AD is fixed and the crank AB rotates at 10 radians per second clockwise. Lengths of the links are A B = 60 mm; BC = CD = 70 mm; DA = 120 mm. When angle DAB = 60° and both B and C lie on the same side of AD, find 1. Angular velocities (magnitude and direction) of BC and CD; and 2. Angular acceleration of BC and CD.	*13,K3,CO1*
12.	a)	The following data relate to a pair of 20° involute gears in mesh: Module = 6 mm, Number of teeth on pinion = 17, Number of teeth on gear = 49; Addenda on pinion and gear wheel = 1 module. Find: 1. The number of pairs of teeth in contact; 2. The angle turned through by the pinion and the gear wheel when one pair of teeth is in contact, and 3.	*13,K3,CO2*

The ratio of sliding to rolling motion when the tip of a tooth on the larger wheel (i) is just making contact, (ii) is just leaving contact with its mating tooth, and (iii) is at the pitch point.

OR

b) A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described below : *13,K3,CO2*

1. To raise the valve through 50 mm during 120° rotation of the cam ;
2. To keep the valve fully raised through next 30°;
3. To lower the valve during next 60°; and
4. To keep the valve closed during rest of the revolution i.e. 150° ;

The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm. Draw the profile of the cam when the line of stroke of the valve rod passes through the axis of the cam shaft. The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion.

13. a) Four masses A, B, C and D as shown below are to be completely balanced. 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: a. The magnitude and the angular position of mass A; and b. The position of planes A and D. *13,K3,CO4*

	A	B	C	D
Mass (kg)	—	30	50	40
Radius (mm)	180	240	120	150

OR

b) A rotating shaft carries four masses *A*, *B*, *C* and *D* which are radially attached to it. The mass centres are 30 mm, 38 mm, 40 mm and 35 mm respectively from the axis of rotation. The masses *A*, *C* and *D* are 7.5 kg, 5 kg and 4 kg respectively. *13,K3,CO4*

The axial distances between the planes of rotation of *A* and *B* is 400 mm and between *B* and *C* is 500 mm. The masses *A* and *C* are at right angles to each other. Find for a complete balance,

a. the angles between the masses *B* and *D* from mass *A*,
b. the axial distance between the planes of rotation of *C* and D
c. the magnitude of mass *B*.

14. a) A vertical shaft of 5 mm diameter is 200 mm long and is supported in long bearings at its ends. A disc of mass 50 kg 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 0.25 mm from the geometric axis of the shaft. (Take E = 200 GN/m^2). *13,K3,CO5*

OR

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 0.85m radius of gyration located at the 95 mm diameter end and the second having a mass of 700 kg and 0.55m 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. *13,K3,CO5*

15. a) The pitch of 50 mm mean diameter threaded screw of a screw jack is 12.5 mm. The coefficient of friction between the screw and the nut is 0.13. Determine the torque required on the screw to raise a load of 25 kN, assuming the load to rotate with the screw. Determine the ratio of the torque required to raise the load to the torque required to lower the load and also the efficiency of the machine. *13,K3,CO6*

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: a. When the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h. b. 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. *13,K3,CO6*

PART C (1 × 15 = 15 Marks)

16. a) (i) The crank and connecting rod of a petrol engine, running at 1800 r.p.m., are 50 mm and 200 mm respectively. The diameter of the piston is 80 mm and the mass of the reciprocating parts is 1 kg. At a point during the power stroke, the pressure on the piston is 0.7 N/mm^2, when it has moved 10 mm from the inner dead centre. Determine: a. Net load on the gudgeon pin, b. Thrust in the connecting rod. *5,K3,CO3*

(ii) A leather belt is required to transmit 7.5 kW from a pulley 1.2 m in diameter, running at 250 r.p.m. The angle embraced is 165° and the coefficient of friction between the belt and the pulley is 0.3. If the safe working stress for the leather belt is 1.5 MPa, density of leather 1 Mg/m3 and thickness of belt 10 mm, determine the width of the belt taking centrifugal tension into account. *10,K3,CO6*

OR

b) (i) 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. *5,K3,CO3*

(ii) A porter governor has equal arms each 250 mm long and pivoted 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. *10,K3,CO6*