Reg No.:_____ Name:_____

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (R,S) Exam April 2025 (2019 Scheme)

Course Code: RAT202

Course Name: KINEMATICS AND DYNAMICS OF MECHANISMS

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks) Marks

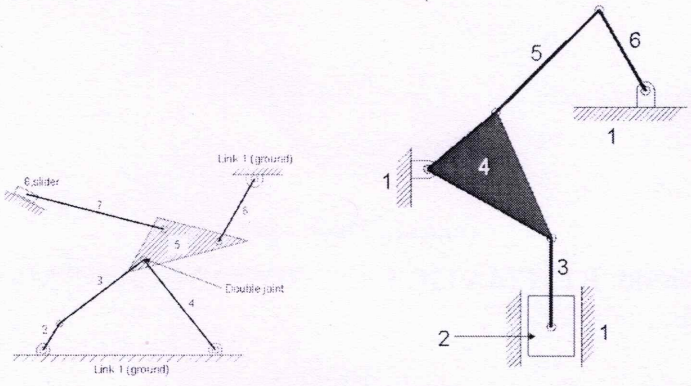
1	What is a machine? Giving example, differentiate between a machine and a structure.	3
2	Write notes on complete and incomplete constraints in lower and higher pairs, illustrating your answer with neat sketches.	3
3	A rigid link PQ of length 2 m rotates about the pinned end Q with a constant angular acceleration of 12 rad/s². When the angular velocity of the link is 4 rad/s, the magnitude of the resultant acceleration (in m/s²) of the end P.	3
4	What is the Coriolis acceleration component?	3
5	Draw different types of followers?	3
6	What do you mean by Principle of Virtual Work? Explain	3
7	Derive an equation for the acceleration inertia forces on a body.	3
8	Explain how a rigid body is in pure rotation, when it is undergoing fixed axis rotation.	3
9	Write the relation of principal moments and principal axes?	3
10	Define a. Damped and undamped vibration b. Critical damping	3

PART B

(Answer one full question from each module, each question carries 14 marks)

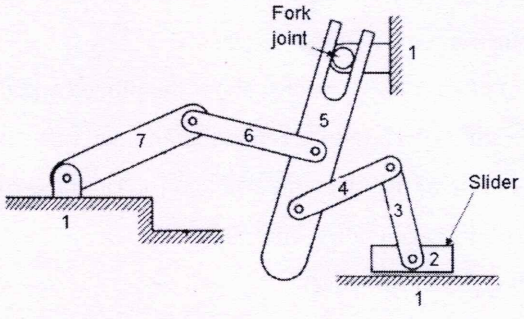
Module -1

11	a)	Find the degree of freedom of the mechanism given below.	10

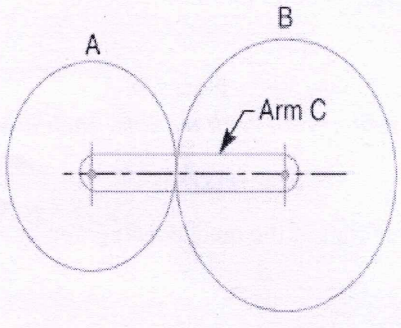


a b

b) Find the mobility or degree of freedom of the following mechanism 4



12 In an epicyclic gear train, an arm carries two gears A and B having 36 and 45 teeth respectively. If the arm rotates at 150 r.p.m. in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed, makes 300 r.p.m. in the clockwise direction, what will be the speed of gear B? 14



Module -2

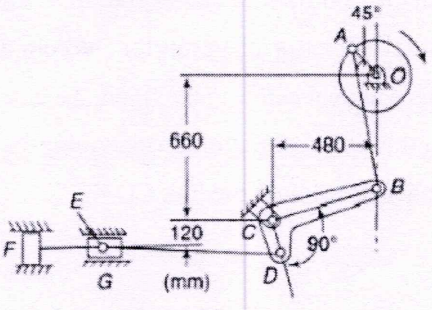
13 An engine crankshaft drives a reciprocating pump through a mechanism as shown below. The crank rotes in the clockwise direction at 160 r,p.m. The diameter of the pump piston at F is 200 mm. Dimensions of the various links are 14

OA = 170 mm (crank) CD = 170 mm AB = 660 mm DE = 830 mm BC = 510 mm for the position of the crank shown in the diagram, determine

i. Velocity of crosshead E

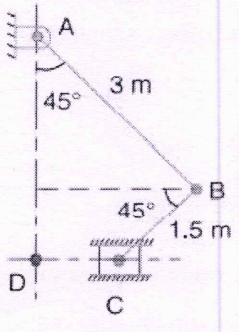
ii. Velocity of rubbing at the pins A, B, C and D, the diameters being 40, 30,30, 50 mm respectively.

iii. Torque required at the shaft Oto overcome a pressure of 300 kN/mm^2 at the pump piston at F



(a)

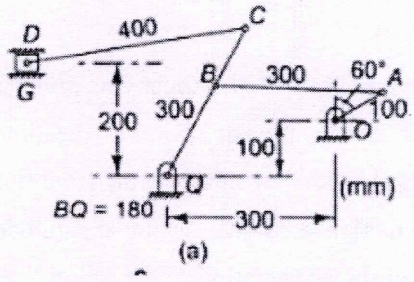
14 In the mechanism shown in Fig. 8.7, the slider C is moving to the right with a velocity of 1 m/s and an acceleration of 2.5 m/s2 . The dimensions of various links are AB = 3 m inclined at 45° with the vertical and BC = 1.5 m inclined at 45° with the horizontal. Determine: 1. the magnitude of vertical and horizontal component of the acceleration of the point B, and 2. the angular acceleration of the links AB and BC. 14



Module -3

15 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 : 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 (a) the line of stroke of the valve rod passes through the axis of the cam shaft, and (b) the line of the stroke is offset 15 mm from the axis of the cam shaft. The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 100 r.p.m. Draw the displacement, the velocity and the acceleration diagrams for one complete revolution of the cam 14

16 In the mechanism shown below in the figure the crank OA, rotates at 210 rpm clockwise. For the given configuration determine the acceleration of the slider D and angular acceleration of the link CD. 14



Module -4

17 The four-bar linkage shown in Figure 1.8A has the dimensions shown in the figure where G refers to centre of mass, and the mechanism has the following mass properties: 14

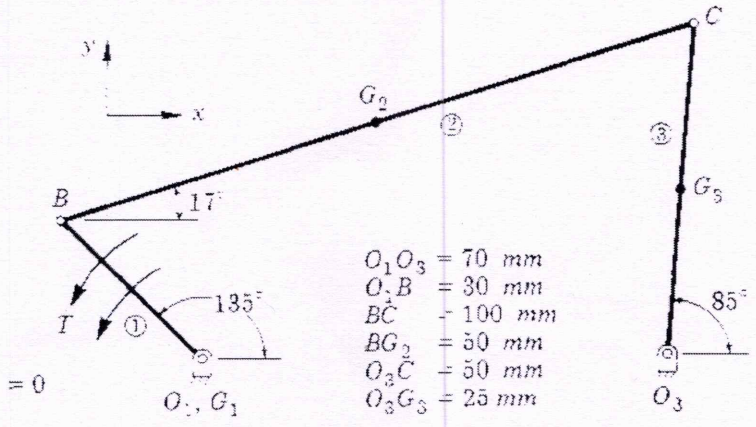
$m_1 = 0.01$ kg $I_{G1} = 20$ kg .mm ^{2}

$m_2 = 0{,}20$kg I_{G2} 400 kg.mm^2

$m_3 = 0{,}30$ kg $I_{G3} = 20$kg. mm^2

Determine the instantaneous value of drive torque T required to produce an assumed motion given by input angular velocity ω = 95 rad/s counter

clockwise and input angular acceleration $a_1 = 0$ for the position shown in the figure. Neglect gravity and friction effects.



18 Explain the procedure of dynamic equivalent system and dynamic analysis of four- link mechanism. 14

Module -5

19 Derive the Euler's equation for rigid body rotation and explain each term. 14

20 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. 14

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