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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fourth Semester B.Tech Degree (S, FE) Examination January 2024 (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

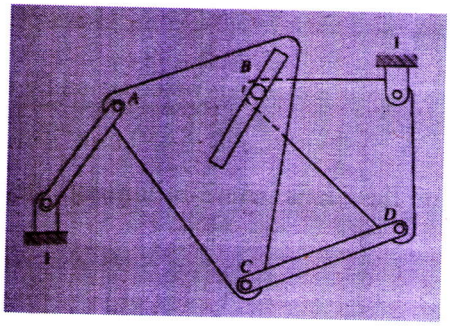
1	Describe the terms links, kinematic pairs and kinematic chain	3
2	Explain loop closure equation with an example	3
3	Explain the procedure to find the velocity of an intermediate point on a link	3
4	What is meant by instantaneous centre of rotation?	3
5	Describe D'Alembert's principle	3
6	What do you mean by dynamically equivalent system? Explain	3
7	Describe forward dynamic analysis problem	3
8	Describe Euler's equation for rigid body rotation about a point.	3
9	What is the relevance of principal moment of inertia in rotation motion	3
10	What are free, damped and forced vibrations? Explain	3

PART B

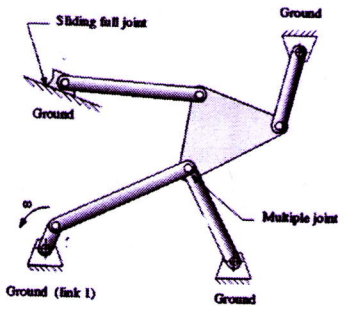
(Answer one full question from each module, each question carries 14 marks)

Module -1

11	Use the Kutzbach's criterion to determine the mobility of the two planar mechanisms illustrated below in fig(a) and fig(b). Clearly number each link and label lower pair by 'L' and higher pair by 'H'.In the figures '1' represents fixed link	14



(a)



(b)

12 a) Compare belt drive and chain drive 5

b) Derive the velocity equation of a 3R open loop planar manipulator using forward kinematics 9

Module -2

13 In a four-link mechanism shown in figure, the dimensions of the links are as under: 14

AB = 50 mm, BC = 66 mm, CD = 56 mm and AD = 100 mm

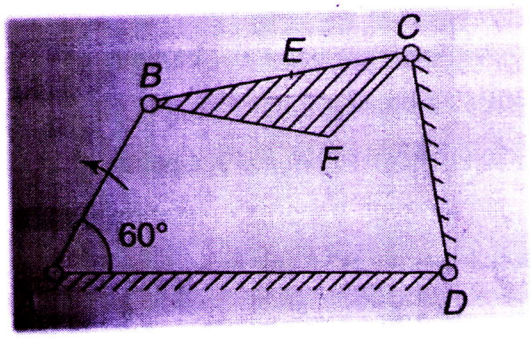
At the instant when $\angle DAB = 60^0$, the link AB has an angular velocity of 10.5 rad/s in the counter-clockwise direction, Determine

(i) the velocity of point C

(ii) the velocity of point E on the link BC when BE = 40 mm

(iii) the angular velocities of the links BC and CD

(iv) the velocity of an offset point F on the link BC if BF = 45 mm, CF = 30 mm and BCF is read clockwise

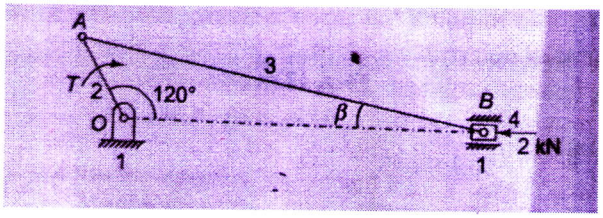


14 a) What are centripetal and tangential components of acceleration? When do they occur? How are they determined? 6

b) Derive the expression for Corioli's component of acceleration on a slider move up with velocity V m/s along a rotating link with clockwise angular velocity ω rad/s 8

Module -3

15 A slider-crank mechanism with the following dimensions is acted up on by a force F = 2kN at B as shown in figure. Given OA = 100 mm, AB = 450 mm. Determine the input torque T on the link OA for the static equillibrium for the given configuration. 14



16 In a vertical double-acting steam engine, the connecting rod is 4.5 times the crank. The weight of the reciprocating parts is 120 kg and the stroke of the piston is 440 mm. The engine runs at 250 rpm. If the net load on the piston due to steam pressure is 25 kN when the crank has turned through an angle of 120^0 form the top dead centre, determine the 14

(i) thrust in the connecting road

(ii) pressure on the slide bars

(iii) tangential force on the crank pin

(iv) thrust on the bearings

(v) turning moment on the crank shaft

Module -4

17 A four-link mechanism is subjected to the following external forces (Fig.1 & Table 1). Determine the shaft torque T_2 on the input link AB for static equilibrium of the mechanism using the principle of virtual work. Assume, the link AB has an instantaneous angular velocity of ω rad/s counter-clockwise 14

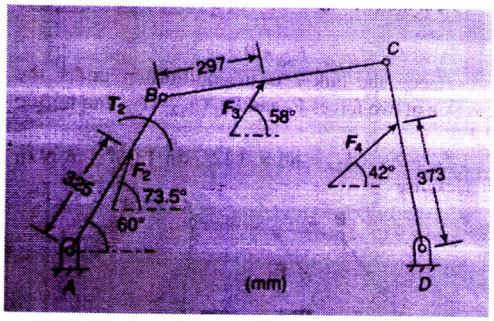


Figure 1.

Table 1

Link	Length	Force	Magnitude	Point of application of force(r)
AB (2)	500 mm	F_2	$80 \angle 73.5^0$ N	325 mm from A
BC (3)	660 mm	F_3	$144 \angle 58^0$ N	297 mm from B
CD (4)	560 mm	F_4	$60 \angle 42^0$ N	373 mm from D
AD (1)	1000 mm	-	Fixed link	

18 Describe the formulation of Newton-Euler equation of motion for the two DOF planar robot manipulator 14

Module -5

19 Explain the following 14

(i) Moment of inertia

(ii) Product of inertia and principal axes

(iii) Rotation matrices

20 In a single-degree damped vibrating system, a suspended mass of 8 kg makes 30 oscillations in 18 seconds. The amplitude decreases to 0.25 of the initial value after 5 oscillations. Determine the 14

(i) stiffness of the spring

(ii) logarithmic decrement

(iii) damping factor, and

(iv) damping coefficient

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