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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (S, FE) Examination December 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	How kinematic pairs are classified according to the mechanical constraint?	3
2	Define the Kutzbach's Criterion.	3
3	Explain the procedure for finding the velocity of a link in a four-bar mechanism.	3
4	What is a centripetal component of acceleration?	3
5	Explain the method to reduce a dynamic analysis problem into an equivalent problem of static equilibrium.	3
6	What are the conditions of a body to be in equilibrium under the action of two forces, three forces and two forces and a torque?	3
7	Describe the principle of virtual work.	3
8	Define principal axes and principal moment of inertia.	3
9	Explain free, damped, and forced vibrations.	3
10	What is meant by under-damping, over damping and critical damping?	3

PART B

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

Module -1

11 With neat sketches, explain the construction, working, applications and advantages of 14

i. Flat belt drive.

ii. V belt drive.

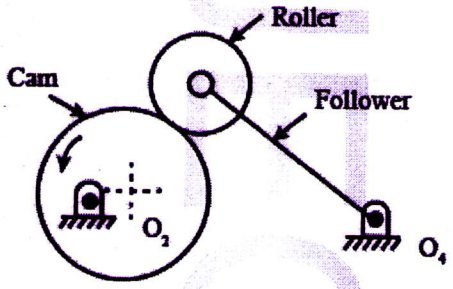
iii. Chain drive.

iv. Compound gear train.

v. Epicyclic gear train.

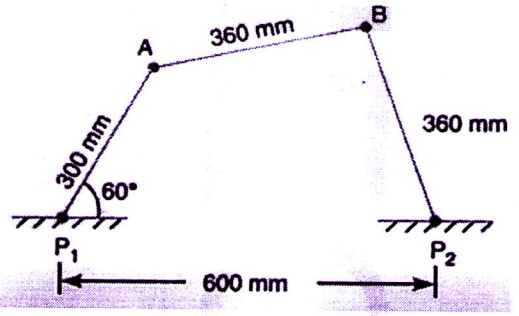
12 a Define the term degrees of freedom. Explain with an example, how Kutzback's equation can be used for determining optimal number of electric actuators to be mounted on a particular joint to create a rotary motion in a planar mechanism. 8

b Calculate the degrees of freedom of the mechanism. 6



Module -2

13 The dimensions and configuration of the four bar mechanism, shown in fig are as follows: $P_1A = 300$ mm; $P_2B = 360$ mm, $AB = 360$ mm, and $P_1P_2 = 600$ mm. The angle $AP_1P_2 = 60^0$. The crank P_1A has an angular velocity of 10 rad/s and an angular acceleration of 30 rad/s^2, both clockwise. Determine the angular velocities of P_2B, and AB. 14



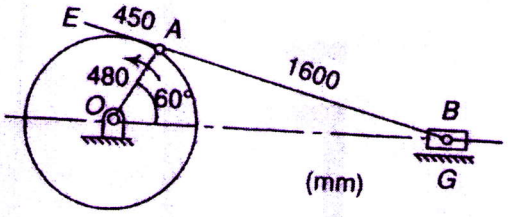
14 For the configuration of a slider-crank mechanism shown in figure, calculate: 14

(i) The acceleration of the slider at B.

(ii) The acceleration of the point E.

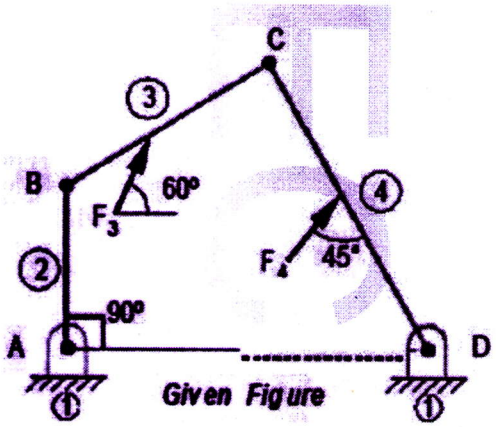
(iii) The angular acceleration of the link AB.

OA rotates at 20 rad/s counter-clock wise.



Module -3

15 A four-bar mechanism as shown in figure is subjected to two forces $F_3 = 2000$ N at 60^0 from horizontal at mid-point of link 3 and F4 = 4000 N at 45^0 from link 4 at mid-point of link 4. The dimensions of links are AB = 0.3 m, BC =0.4 m, CD = 0.45m and AD = 0.6m. Perform static force analysis and determine resisting torque on link 2. 14

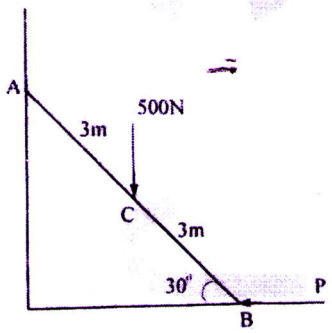


16 a) Explain the principle of virtual work to determine unknown static force in a planar mechanism with the help of an example. 8

b) Describe how the free body diagrams are helpful in finding out the various forces acting on the mechanisms? 6

Module -4

17 A ladder AB of length 6 m and weight 500 N is supported by smooth surfaces at A and B as shown in figure. Using principle of virtual work find the force P to be applied at the end B for the equilibrium of the ladder. 14



18 Derive Euler's equation of rigid body rotation motion. 14

Module -5

19 Determine the equivalent spring stiffness and the natural frequency of the following vibrating systems when, 14

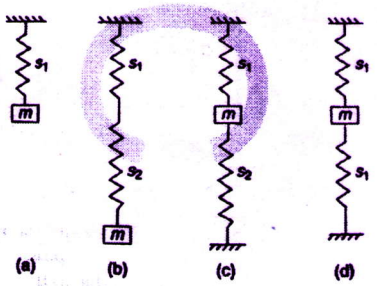
(a) the mass is suspended to spring.

(b) the mass is suspended at the bottom of two springs in series.

(c) the mass is fixed in between two springs.

(d) the mass is fixed to the midpoint of a spring.

Take S1 = 5 N/mm, S2 = 8 N/mm, m = 10kg



20 A vibrating system consists of a mass of 50 kg, a spring of stiffness, 30 kN/m and a damper. The damping provided is only 20% of the critical value. 14

Determine:

i. The damping factor.

ii. The natural frequency of damped vibrations.

iii. The critical damping coefficient.

iv. The logarithmic decrement.

v. The ratio of two consecutive amplitude.

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