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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree Regular and Supplementary Examination December 2022 (2019 Scheme)

Course Code: MET 301

Course Name: MECHANICS OF MACHINERY

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks)

1 What do you mean degree of freedom (mobility) of a planar mechanism? How is it determined?

2 Name any three approximate straight line motion mechanisms

3 Define Grashof's law with an example of double crank inversion mechanism

4 Obtain the expression for acceleration of the cam follower when it is in simple harmonic motion

5 Define pressure angle for (i) Gear and (ii) Cam

6 Write three advantages of involute gear tooth profile over cycloid profile

7 How do you take into account the friction at sliding pairs for force analysis? Give example.

8 What do you mean by spin, precession and gyroscopic plane?

9 State the necessary conditions to achieve the static and dynamic balancing of rotating masses

10 What do you mean by primary and secondary unbalance in reciprocating engines?

PART B

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

Module -1

11 For the four bar linkage given in Fig.1, O_1O_2= 420mm, O_1A = 150 mm, AB = 300 mm, O_2B = 250 mm, AC=230, BC = 170 mm. $\theta = 60^0$. The crank rotates with a uniform angular velocity of 1500 rpm. 14

i. What is the transmission angle? Measure and mark it in the configuration diagram.

ii. Using instantaneous centre method, Determine the angular velocities of link 3, link 4, and also the velocities at point A, B and C.

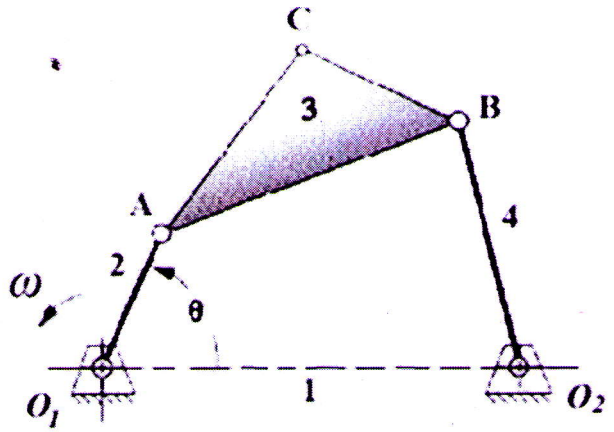

Fig. 1

12 In the toggle mechanism shown in Fig. 2, The crank OA rotates at a uniform speed of 200 rpm counter-clockwise (ccw). For the given configuration, O_1A = 200 mm, AB = 400 mm, O_2B = 300 mm, and BC = 500 mm. Determine (a) velocity of slider C (b) angular velocities of links AB, O_2B, and BC, (c) rubbing velocities on the pins of 25 mm diameter at A and C. (c) Torque required at crank O_1A for a force of 1000N at C. 14

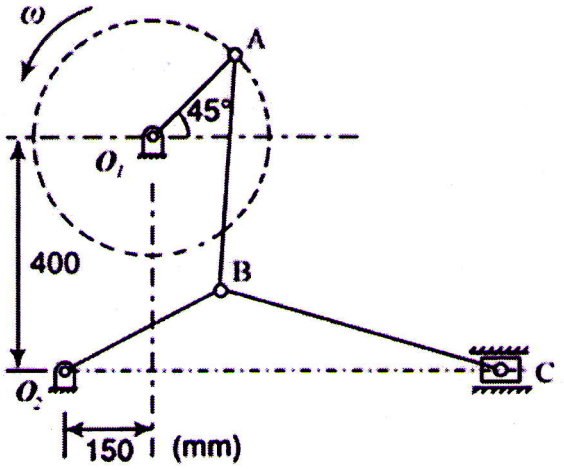

Fig. 2

Module -2

13 For the shaper mechanism shown in Fig. 3, the crank OA (link 2) is 75 mm, slotted lever CD is 355 mm and the link DE is 100 mm. The crank rotates at 200 rpm in clockwise direction. When crank makes an angle 30^0 with horizontal, determine 14

(i) Velocity of cutting tool attached with the slider link 6 (ii) Angular acceleration of slotted lever CD (iii) linear acceleration of slider link

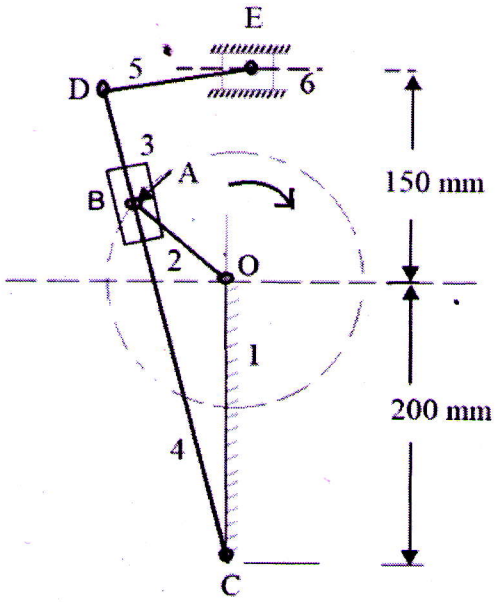

Fig. 3

14 A disc cam profile is to be synthesized to give simple harmonic motion (SHM) to a knife edge offset follower during out stroke of 50 mm. The angle of ascent is 120°, dwell 60°, and angle of descent 90° and the follower to dwell for the remaining cam rotation. The minimum radius of cam is 50 mm. (i) Draw the profile of the cam when when the knife-edge follower is offset by 20 mm. (ii) Calculate the maximum velocity and acceleration during ascent and descent when the camshaft revolves at 240 rpm and plot the velocity and acceleration diagram 14

Module -3

15 A compound epicyclic gear train is shown in Fig. 4. The gears A, D and E are free to rotate on the axis P. The compound gear B and C rotate together on the axis Q at the end of arm F. All the gears have equal module. The number of teeth on the gears A, B and C are 18, 45 and 21 respectively. The gears D and E are annular gears. The gear A rotates at 120 rpm counter-clockwise and the gear D rotates at 450 rpm clockwise. Find the speed and direction of the arm and the gear E. 14

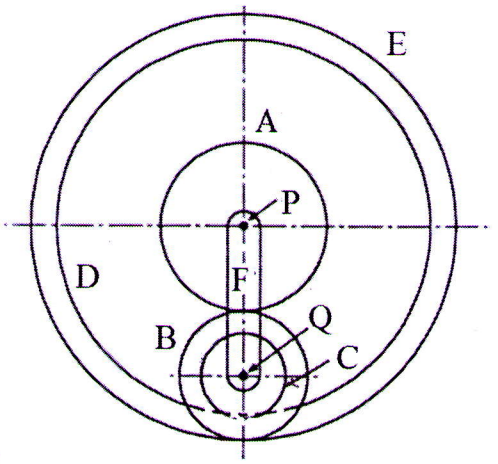

Fig. 4

16 a) What is Freudenstein's equation? How do you synthesize a four-link mechanism to coordinate the input and output angles using this equation? Explain. 8

b) Synthesize a slider-crank mechanism with an eccentricity of 9 mm for the two input positions of input link; $\theta_{12} = 60°$ and output displacement of slider is 16 mm. 6

Module -4

17 a) In the slider-crank mechanism shown in Fig. 5, the value of force applied to the slider is 2 Kn. The link dimensions are AB = 80 mm, BC = 240 mm, and $\theta = 60°$. Determine the forces on various links and driving torque T. 8

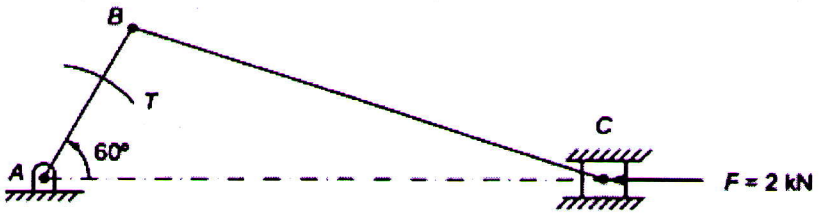

Fig. 5

b) What is the principle of virtual work? Using this principle establish the relation between torque (T) and slider force (F) for the mechanism shown in Fig. 5. 6

18 a) Explain the effect of gyroscopic couple on the motion of an aircraft while taking a turn. 5

b) A racing car of mass 2000 kg has a wheel base of 2 m and track width of 1 m. The C.G. lies midway between the front and rear axles and is 0.4 m above the ground. The engine of the car has a flywheel rotating in a clockwise direction when seen from the front at 6000 rpm. The moment of inertia of the flywheel is 50 kg-m^2. If the car takes a curve of 15 m radius towards right, while running at 9

45 km/h, find the reaction between the wheels and the ground considering the gyroscopic effect of the flywheel and centrifugal effect and weight of the car.

Module -5

19 A shaft carries four masses A, B, C and D of magnitude 150 kg, 200 kg, 300 kg and 250 kg respectively and revolving at radii 70 mm, 60 mm, 50 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 600 mm. The relative position of masses measured anticlockwise is A to B 45°, B to C 60° and C to D 120°. The balancing masses are to be placed in planes L and M. The distance between the planes containing A and L is 100 mm, between L and M is 400 mm and between M and D is 100 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions. 14

20 The cranks and connecting rods of a 4-cylinder in-line engine running at 1800 rpm are 50 mm and 200 mm long respectively. The cylinders are spaced 150 mm apart. If the cylinders are numbered 1 to 4 in sequence from one end, the cranks appear at intervals of 90^0 in an end view in the order 1–4–2–3. Reciprocating mass corresponding to each cylinder is 1.5 kg. Determine (a) the unbalanced primary and secondary forces, and (b) the unbalanced primary and secondary couples with reference to central plane of engine. 14

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