Reg. No. :

Question Paper Code : 41390

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2018
Third/Fourth Semester
Mechanical Engineering
ME6401 – KINEMATICS OF MACHINERY
(Common to Mechanical Engineering (Sandwich)/Mechatronics Engineering)
(Regulations 2013)

Time : Three Hours   Maximum : 100 Marks

Answer ALL questions
Missing data, if any, may be suitably assumed and stated clearly.

PART – A   (10×2=20 Marks)

1. Define kinematic pair and classify it according to the types of contact.

2. Sketch a crank-rocker mechanism and a slider crank mechanism indicating their input and output motions.

3. How will you find out the total acceleration from its normal and tangential components ?

4. Mention any two motives for doing acceleration analysis of mechanisms or machines.

5. Classify and sketch the translating cam followers based on their position.

6. Sketch and name a specified contour cam, stating its advantage.

7. State the two important similarities of a spur gear pair and helical gear pair.

8. Sketch an ordinary gear train and an epicyclic gear train stating their important difference.

9. In an open belt drive of horizontal type, the slack side of belt should be kept on the top side of pulleys. Why ?

10. What are the advantages of using friction clutches ?

PART – B (5×13=65 Marks)

11. a) i) State and brief the Kutzbach criterion for planar mechanisms and using this criterion, determine the arrangement shown in Fig. 11 (a) as a structure or a constrained mechanism or an unconstrained mechanism. (6)
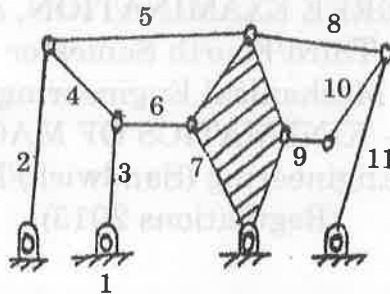

Fig. 11(a)

ii) Define transmission angle of a four bar mechanism and explain its significance. Also, neatly sketch a Crank-Rocker mechanism in its minimum and maximum transmission angle positions. (7)

(OR)

b) i) Define kinematic inversion and neatly sketch an elliptic trammel, i.e., one of the inversion of a double slider crank chain. Also, prove or disprove that all the points on the revolving link of the elliptic trammel will trace ellipses only. (8)

ii) Sketch and brief Peaucellier exact straight line mechanism. (5)

12. a) i) A four-bar mechanism AoABBo has the following lengths :

Fixed link, AoBo – 60 mm; Input link, AoA – 30 mm; Coupler, AB – 45 mm Output link, BBo – 50mm.

Pivot Ao is left of pivot Bo and both pin joints A and B are above the horizontal fixed link. A point C is on the straight extension of the coupler, such that BC = 25 mm. Input link rotates at a constant speed of 20 rpm clockwise. Determine the linear velocities of points B and C separately, and angular velocities of the coupler and the output link, when the input link is 60° counter clockwise from the fixed link. (9)

ii) What is Kinematic Synthesis ? Name the three phases of kinematic synthesis and classify the linkage synthesis problems. (4)

(OR)

b) i) State and prove the Aronhold-Kennedy theorem related to instantaneous centres. (6)

ii) Explain in detail, the concept of Coriolis component of acceleration with neat sketches and equations. (7)

13. a) i) Neatly sketch a cam mechanism with roller follower and indicate the following in the sketch and brief them : Cam profile, Base circle, Prime circle and Pressure angle. **(6)**

   ii) In a cam follower mechanism, 40 mm lift of the follower has to be made in the first 120° rotation of the cam. Draw the displacement diagrams for the following types of motions, separately for each, taking atleast 8 equal divisions of 120° :

   a) Simple harmonic motion

   b) Cycloidal motion. **(7)**

(OR)

b) Draw the cam profile of an offset knife edge follower cam, which rotates in clockwise direction, with both rise and return have Uniform Acceleration and retardation motions, for the following data :

Base circle Diameter of the cam = 50 mm,

Lift of the follower = 48 mm

Offset of follower = 10 mm to the right of cam rotation centre

Cam rotation angles for the follower motions are :

Rise = 80°, First Dwell = 100°, Return = 120° and Second dwell = 60°. Assume the length of the displacement diagram as 180 mm (x-axis) and divide the rise and return rectangles into at least 8 equal divisions each. **(13)**

14. a) i) State the fundamental law of gearing. Prove this law, by considering and neatly sketching two moving curved surfaces in contact. **(10)**

   ii) Name the two types of tooth profiles satisfying the law of gearing and brief any one of them. **(3)**

(OR)

b) i) Explain with neat sketches various classifications of gear trains. **(7)**

   ii) Neatly sketch the gear train called as Fergusson's Paradox. Explain and prove why is it called Paradox, by assuming suitable number of teeth for the gears of this train. **(6)**

15. a) i) State and prove the relationship between angle of friction and co-efficient of friction with suitable sketches. **(5)**

   ii) An open belt running over two pulleys of diameters 600 mm and 200 mm connects two parallel shafts which are 2.5 m apart. The smaller pulley transmits 7.5 kW at 300 rpm. The co-efficient of friction between the pulley and the belt is 0.3. Determine the ratio of tension on tight side, T1 with tension on slack side, T2 and the initial tension on the belt. **(8)**

(OR)

b) i) Neatly sketch a Simple Band Brake and derive the equations for braking torque for both directions of rotation separately and compare them. **(8)**

ii) The outer and inner radii of a flat collar thrust bearing are 120 mm and 72 mm respectively. The total axial thrust is 60 kN and the intensity of uniform pressure is 0.25 MPa. If the coefficient of friction is 0.05 and the shaft rotates at 600 rpm, determine the power lost in overcoming the friction and the number of collars required to withstand the axial thrust. **(5)**

PART – C (1×15=15 Marks)

16. a) i) In a four-bar crank-rocker mechanism, the forward motion of the rocker takes place during the 225° constant speed rotation of the crank. Determine the time-ratio and prove that this mechanism can be used as a quick-return mechanism. **(3)**

ii) For a high speed application using cam mechanism, the motion of the follower should be with gradually changing smooth acceleration and with constant pressure angle for whole cycle of rotation of the cam. Suggest a suitable type of motion and a suitable follower, for this application stating the reasons. **(3)**

iii) Number of teeth on spur gears A, B, C, D and E are 30, 15 45 20 and 75 respectively. The shaft with Gear A is input and the shaft with gear E is output and the gears have to mesh with the same order as mentioned above. Neatly sketch them as a) a Simple Gear Train and b) a Non-reverted Gear Train with gears C and D on a single shaft and find the output speeds of each gear train with sense of rotation when the input shaft rotates 100 rpm in counter clockwise direction. **(9)**

(OR)

b) i) In order to form a four-bar kinematic chain, state and prove the assembly condition of link lengths by selecting suitable link lengths which are within the range of 35 mm to 175 mm and also, satisfying Grashof's law. **(7)**

ii) Data related to a Square Threaded Screw Jack are : Pitch diameter = 60 mm, Pitch of the thread = 16 mm, Load = 30 kN, Co-efficient of friction between screw and nut is 0.2. Determine the ratio of torque required to lower and to raise the load. Also, find the efficiency of the screw jack when the load is raised. **(8)**

_____