

Analysis and Synthesis of Mechanisms

Time : 3 Hours

Full Marks : 100

Answer: **Group – A & Group – B** [50+50 = 100]

Group – A

[Answer question **no.1 (Compulsory)** and **any two** from the rest] [10+2x20=50]

Note: All the notations used in any formula should be specified clearly to get full credit.

1. Answer as per instruction/choose the most appropriate option as the case may be:
[2x5=10]

- (i) Draw a slider-crank mechanism and show the different types of kinematic pairs relative to motion.
- (ii) In a four-bar mechanism, crank =50 mm, lever =60 mm, coupler = 90 mm and fixed link =30mm. Draw the mechanism. State and explain the type of mechanism (i.e. whether double-crank, double-rocker or crank-rocker)
- (iii) State and explain the number of degree of freedom for a two dimensional mechanism. Give an example with a neat sketch.
- (iv) You have two sets of links of length 15m, 6m. Prepare a mechanism so that one revolution of one link causes two revolutions of the other link. Show with a neat sketch.
- (v) Draw the configuration of a gear train which is used in simple lathes where back gear is used to give a slow speed to the head stock spindle. State the name of that gear train.

2.(a) A kinematic chain is given in **Fig.1**. Draw all the inversions if one of the turning pairs is replaced by a sliding pair. State the type of mechanism (i.e. crank-crank, double-rocker or crank-rocker) and the application of each inversion.

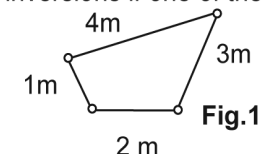


Fig.1

$$[(1+\frac{1}{2}+\frac{1}{2})\times 4=8]$$

$$[8+(2\frac{1}{2}+2\frac{1}{2})+(4+2+1)=20]$$

- (b) A kinematic linkage is shown in **Fig. 2**. Calculate (i) the number of pairs having one degree of freedom, (ii) the number of degrees of freedom using Gruebler's criterion.

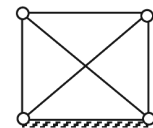


Fig. 2

- 7.(a) Show that Paucellier mechanism can be used to trace a straight line.
(8+6+6=20)
 - (b) Sketch a mechanism which is used on a test machine to produce vibration. State the name of that mechanism.
 - (c) In a Hooke's joint the maximum permissible variation in speed of the driven shaft is 0.12. If the driving shaft rotates at 380 rpm find the maximum and minimum speeds of the driven shaft.
8. Sketch and explain the following mechanisms along with their applications.
- (i) Toggle mechanism, (5x4=20)
 - (ii) Lazy Tong mechanism,
 - (iii) Intermittent motion mechanism,
 - (iv) Elliptical trammel mechanism,
 - (v) Parallel-crank four bar mechanism.
- 9.(a) The centre to centre distance between the two sprockets of a chain drive is 0.8m. The chain drive is used to reduce the speed from 220 rpm to 100 rpm. On the driving sprocket has 20 teeth and a pitch circle diameter of 0.5 m. Determine the number of teeth on the driven sprocket and pitch of the chain.
[5+(1+2)+12=20]
- (b) What is cam? Discuss various types of cams.
 - (c) A cam for operating the exhaust valve of an oil engine. It is required to give constant acceleration and deceleration motion during opening of the valve and uniform velocity during closing of the valve each of which corresponds to 120° of cam rotation. The valve must remain in the fully open position for 30° of cam rotation. The lift of the valve is 25 mm and the least radius of the cam is 40 mm which rotates at 300 rpm. The follower is provided with a roller of radius 20mm and its line of stroke passes through the axis of the cam. Draw the profile of the cam in a suitable scale.

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- (c) In a Whitworth quick return mechanism the distance between the fixed centers is 60 mm and the length of the driving crank is 85 mm. The length of the slotted lever is 155 mm and the length of the connecting rod is 140 mm.
 (i) Draw the configuration diagram of the mechanism showing the direction of cutting stroke,
 (ii) Find the ratio of the time of cutting stroke to the time of return stroke,
 (iii) Why quick return mechanism is provided in the shaper machine.

3. (a) In a slider-crank mechanism, the crank is 500 mm long and rotates at 200 rpm in the counter-clockwise direction. The length of the connecting rod is 1.5 m. When the crank turns 60° from the inner-dead centre, determine the absolute velocity of the slider graphically using relative velocity method.

$$[8+6+(3+3)=20]$$

- (b) Set the indexing head to mill 39 teeth gear.
 (c) Find the mobility of Davis and Ackermann steering gear mechanism.

- 4.(a) A rope drive is required to transmit 190 hp from a pulley of diameter 1 meter running at 510 rpm. The safe pull in each rope is 150 kgf and the weight of the rope per meter length is 0.5 kgf. The angle of lap and groove angle are 160° and 60° respectively and coefficient of friction between the belt and pulley is 0.1. Find the number of ropes required.

$$[8+(2+4)+6=20]$$

- (b) What is a differential gear of an automobile? Explain its function with a neat sketch?

- (c) Find the maximum and minimum transmission angles for the mechanism shown in Fig. 3 The figures indicate the dimensions in standard units of length. Indicate also the type of mechanism.

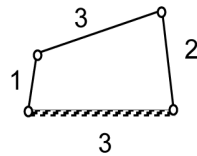


Fig.3

Group – B [Answer question no. 5(Compulsory) and any two from the rest]
 $[10+2 \times 20=50]$

Note: All the notations used in any formula should be specified clearly to get full credit.

5. (i) Which mechanism generates intermittent rotary motion from continuous rotary motion? (1x10=10)
 (a) Elliptical trammel, (b) Geneva mechanism, (c) Scotch yoke Mechanism, (d) Crank and slotted link mechanism, (e) Rotary oscillating converter.

- (ii) A Hooke's joint is used to join two shafts which are - (a) Parallel and intersecting, (b) Parallel and non-intersecting, (c) Non-parallel and intersecting, (d) Non-parallel and non-intersecting.

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- (iii) Transmission angle is the angle between the
 (a) Input link and the coupler, (b) Output link and the coupler,
 (c) Input link and the fixed link, (d) Output link and the fixed link.

- (iv) Inversion of a mechanism means:
 (a) Turning it upside down, (b) Fixing different links in a kinematic chain,
 (c) Changing a higher pair to lower pair, (d) Changing the input and output links

- (v) A kinematic chain is known as a mechanism when:
 (a) None of the links is fixed, (b) One of the links is fixed,
 (c) Two of the links are fixed, (d) All of the links are fixed.

- (vi) Which of the following is an inversion of double-slider crank chain?
 (a) Whitworth quick return mechanism, (b) Reciprocating compressor,
 (c) Scotch yoke, (d) Rotary engine

- (vii) State when pawl and ratchet mechanism is used.

- (viii) Which of the following mechanisms using lower pairs is an exact straight line mechanism?
 (a) Watt mechanism, (b) modified Scott-Russel mechanism,
 (c) Grasshopper mechanism, (d) Scott-Russel mechanism.

- (ix) The most suitable follower motion programme for high-speed engine is
 (a) Uniform acceleration and deceleration, (b) Uniform velocity,
 (c) Simple harmonic motion, (d) Cycloidal.

- (x) State *Grashof's Law* for plane mechanism along with a proper diagram.

- 6.(a) What is an automobile steering gear? Define the fundamental equation of steering gears with a neat sketch. Which steering gear fulfills this condition in all the positions? $[(2+5+1)+6+6=20]$

- (b) Sketch a polar velocity diagram of an Universal coupling and mark its salient features.

- (c) The distance between the steering pivots of a steering gear is 1.3 m. The wheel base is 2.9 m. If the front inner wheel is turned by 16° , what should be the angle turned by the outer front wheel for perfect steering?

[Turn Over]