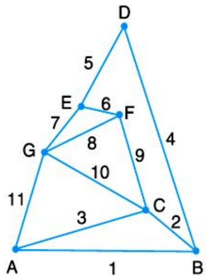
Assignment 1:- Introduction of Mechanisms and Machines

Assignment 1.1

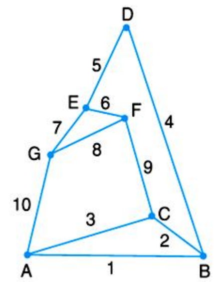
1. Define the following terms with the Figure:

a.) Link, b.) Higher Pair, c.) Kinematic link, d.) Kinematic pair, e.) Kinematic chain, f.) Ternary Joint, g.) Degrees of freedom.

2. Check following is kinematic chain or not.



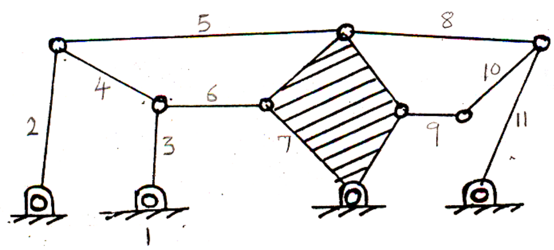
(*a*) Looked chain having binary, ternary and quaternary joints.



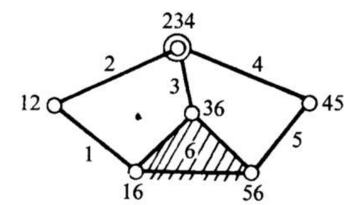
(*b*) Kinematic chain having binary and ternary joints.

Assignment 1.2

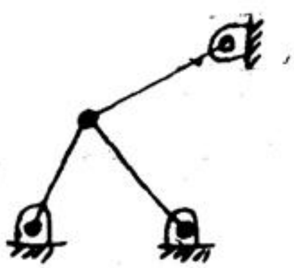
3 Determine the Degree of Freedom for following;



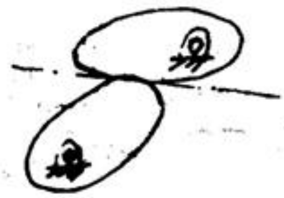
(a)



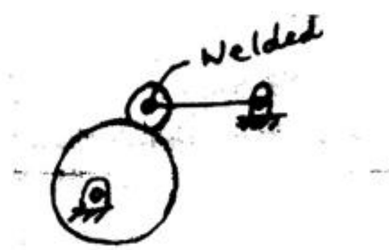
(b)



(c)

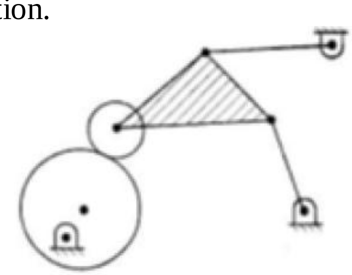


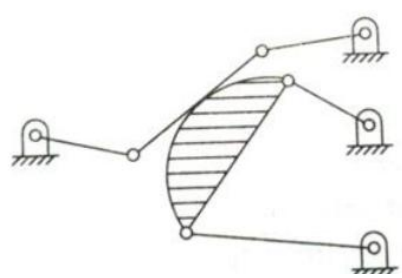
(d)



(e)

4 Apply Kutzbach's criterion to find degree of freedom of the following mechanisms and also predicts the motion.





5 Write the types of inversion of single slider crank mechanism. Discuss the Crank and slotted lever quick return motion mechanism with a neat sketch

6 Define a straight line motion mechanism. Give its classification. And with a neat sketch of Hart's Mechanism prove that it Produces an exact straight line motion.

Assignment 2 Graphical and Analytical Linkage Synthesis

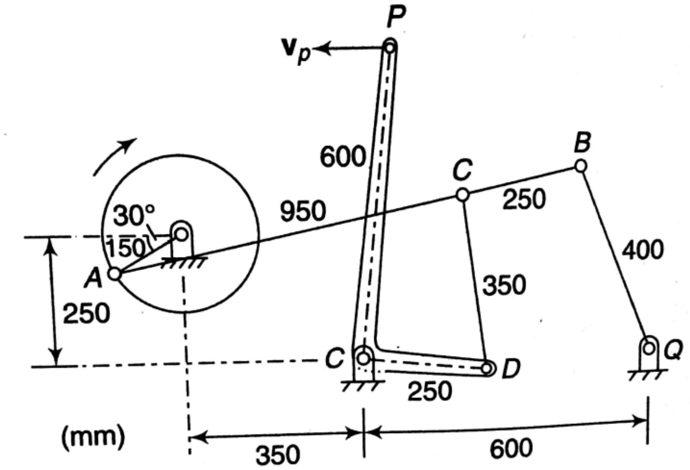
1. Construct two position synthesis of single slider crank mechanism by relative pole method.
2. List and describe the three phases of synthesis.
3. Explain function generation, path generation and motion generation.
4. Synthesize a four bar chain mechanism by using Freudenstein's Equation for the following positions of input-output links. The input link "b" coupler link "c" and output link "d" makes angles θ, β and φ respectively along fixed link "a" Synthesize the mechanism for following three successive position with length of fixed link = 50mm. $\theta_1 = 180^o$, $\varphi_1 = 90^o$, $\theta_2 = 135^o$, $\varphi_2 = 80^o$, $\theta_3 = 90^o$, $\varphi_3 = 60^o$.
5. Solve problem no 4 by using graphical method
6. Synthesize a four bar mechanism to guide a rod AB through three consecutive positions A_1B_1, A_2B_2 and A_3B_3 . the coordinate points are $A_1(2,6)$, $A_2(8.86,6.60)$, $A_3(12,6)$, $B_1(2,0)$, $B_2(5,2)$, $B_3(6,6)$. Use graphical as well as analytical method to solve this problem.
7. A four bar mechanism is to be designed, by using three precision points, to generate the function $y = x^{1.5}$, for the range $1 \le x \le 4$ .Assuming 30° starting position and 120° finishing position for the input link and 90° starting position and 180° finishing position for the output link, find the values of x, y, θ and φ corresponding to the three precision points.
8. A slider crank mechanism for its three positions $\theta_{12} = 40^o$, $\theta_{13} = 80^o$ of the input link and three positions $S_{12} = 1.8$ cm and $S_{13} = 4.8$ cm of the output slider block is to be synthesized. Let us assume the value of eccentricity e = 0.9 cm
9. Design a four bar mechanism so that $\theta_{12} = 45^o$ and $\varphi_{12} = 55^o$. Both input and output cranks should move in the same direction. Use the graphical method

Assignment 3 Velocity and Acceleration Analysis

1 In a slider crank mechanism, the lengths of the crank and the connecting rod are 200 mm and 800 mm respectively. Locate all the I-Centre of the mechanism for the crank position when it has turned 30^0 from the inner dead centre. Find the velocity of the slider and the angular velocity of the connecting rod if the crank rotates at 40 rad/sec.

2 In a four-link mechanism, the crank AB rotates at 36 rad/sec. The lengths of the links are: AB=200 mm, BC=400 mm, CD=450 mm and AD=600 mm. Link AD is fixed. Determine (1) Velocity of mid-point of link BC (2) Angular velocity of link BC and CD. Use Instantaneous Centre method

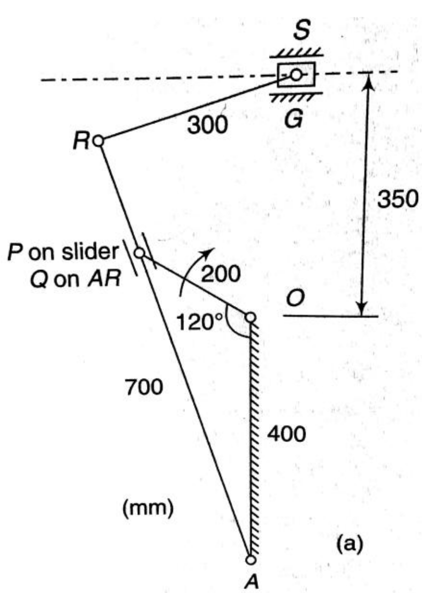
3 Locate all the I-Centres of the mechanism shown below.



4 OAB is a slider crank mechanism with O fixed. Crank OA rotates at 20 rad/sec counter clockwise when the crank is at an angle of 60^0 with inner dead centre. Determine (1) Acceleration of slider B (2) Angular velocity and acceleration of link AB (3) Acceleration of mid-point of link AB. Take OA=480 mm, AB=1600 mm

5 A crank and rocker mechanism ABCD has the following dimensions: AB=0.75 m, BC=1.25 m, CD=1 m, AD= 1.5 m. AD is fixed and point F is located on link CD at CF= 500 mm. Angular velocity of crank AB= 20.94 rad/sec counter-clockwise and a deceleration of 280 rad/sec^2 when the crank angle DAB=60^0. Find (1) Linear velocity and acceleration of C and F (2) Angular velocity and acceleration of links BC and CD

6 A quick-return mechanism of shaper machine are OA= 400 mm, OP= 200 mm, AR= 700 mm, RS= 300 mm. For the configuration shown in below determine linear velocity and acceleration of cutting tool S when the crank OP rotates at 210 rpm



Assignment 4 Cam and Follower

1 Construct a cam, with a minimum radius of 50 mm, rotating clockwise at a uniform speed, is required to give a knife edge follower the motion as described below:

1. To move outwards through 40 mm during 100° rotation of the cam
2. To dwell for next 80°
3. To return to its starting position during next 90°, and
4. To dwell for the rest period of a revolution i.e. 90°.

Draw the profile of the cam when the line of stroke of the follower is off-set by 15 mm. The ascent of the follower is to take place with uniform acceleration and retardation while descent of the follower is to take place with constant velocity.

2 Flat face follower is moved with S.H.M by a disc cam. Follower rises for 30 mm during the cam rotation of 120°, remains in the same position during 30° of cam rotation, follower returns to original position during further 120° of rotation of cam and then for last 90° of rotation follower remains stationary. Minimum radius of cam is 25 mm and the diameter of the circular flat face of follower is 25 mm. Draw the cam profile.

3 A cam rotating at 150 rpm. Operates a reciprocating roller follower of radius 2.5 cm. the follower axis is offset by 2.5 cm to the right. The least radius of cam is 5 cm and stroke of the follower is 5 cm. ascent takes place with radial motion and descent takes place with uniform acceleration and retardation. Ascent takes place during 75^0 and descent during 90^0 of cam rotation. Dwell between ascent and descent is 60^0. Draw the cam profile.

Assignment: 5 Belt, rope, and chain drive

1 A shaft rotating at 200 r.p.m. drives another shaft at 300 r.p.m. and transmits 6 kW through a belt. The belt is 100 mm wide and 10 mm thick. The distance between the shafts is 4m. The smaller pulley is 0.5 m in diameter. Calculate the stress in the belt, if it is an open belt drive, Take $\mu = 0.3$.

2 **A** belt runs over a pulley of 800 mm diameter at a speed of 180 rpm. The angle of the lap is 165° and the maximum tension in the belt is 2kN. Determine the power transmitted if thecoefficient of friction is 0.3.

3 A belt drive transmits 8 kW of power from a shaft rotating at 240 rpm to another shaft rotating at 160 rpm. The belt is 8 mm thick. The diameter of smaller pulley is 600 mm and the two shafts are 5 m apart. The coefficient of friction is 0.25. If the maximum stress in the belt is limited to 3 N/mm2. Find the width of the belt for (i) open belt drive and (ii) crossed belt drive.

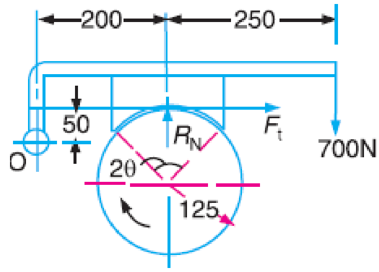
4 The grooves on the pulleys of a multiple rope drive have an angle of 50° and accommodate rope of 22 mm diameter having a mass of 0.8 kg/metre length for which a safe operating tension of 1200 N has been laid down. The two pulleys are of equal size. The drive is designed for max power conditions. Speeds of both pulleys are 180 rpm. Assuming μ =0.25. Determine the diameter of pulleys and no. of ropes when power is transmitted 150 kW.

5 The centre to centre distance between two sprockets of a chain drive is 600 mm. The chain drive is used to reduce the speed from 180 rpm to 90 rpm on the driving sprocket has 18 teeth and a pitch circle diameter of 480 mm. Determine:

(i) No. of teeth on the driven sprocket

(ii) Pitch and the length of chain

Assignment 6 Friction, Brakes and clutches.

1	A single block brake is shown in Fig. The diameter of the drum is 250 mm and the angle of contact is 90°. If the operating force of 700 N is applied at the end of a lever and the coefficient of friction between the drum and the lining is 0.35, determine the torque that may be transmitted by the block Brake  All dimensions in mm.
2	A single plate clutch, with both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point in the contact surface is not to exceed 0.1 N/mm2. If the coefficient of friction is 0.3, determine the power transmitted by a clutch at a speed 2500 r.p.m.
3	A multiple disc clutch has five plates having four pairs of active friction surfaces. If the intensity of pressure is not to exceed 0.127 N/mm2, find the power transmitted at 500 r.p.m. The outer and inner radii of friction surfaces are 125 mm and 75 mm respectively. Assume uniform wear and take coefficient of friction = 0.3.
4	A car moving on a level road at a speed 50 km/h has a wheel base 2.8 meters, distance of C.G. from ground level 600 mm, and the distance of C.G. from rear wheels 1.2 meters. Find the distance travelled by the car before coming to rest when brakes are applied, (1)To the rear wheels, (2)to the front wheels, and (3) To all the four wheels. The coefficient of friction between the tires and the road may be taken as 0.6.
5	An effort of 1500 N is required to just move a certain body up an inclined plane of angle 12˚, force acting parallel to the plane. If the angle of inclination is increased to 15˚, then the effort required is 1720 N. find the weight of the body and the co-efficient of friction.
6	A shaft has a number of collars integral with it. External diameter of collars is 400mm and shaft diameter is 250mm. if the uniform intensity of pressure is $35*10^4$ N/m^2, and its co-efficient of friction is 0.05, estimate: (a) Power absorbed in overcoming friction when the shaft runs at 105 rpm. And carries a load of $15*10^4$ N and (b) Number of collars required

Assignment 7 Gear and Gear Train

1 Two involute gears of 20° pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5 mm and the pitch line speed is 1.2 m/s, assuming addendum as standard and equal to one module, find :
1. The angle turned through by pinion when one pair of teeth is in mesh ; and
2. The maximum velocity of sliding.

2 Determine the minimum number of teeth required on a pinion, in order to avoid interference which is to gear with, **1.** a wheel to give a gear ratio of 3 to 1 ; and **2.** an equal wheel. The pressure angle is 20° and a standard addendum of 1 module for the wheel may be assumed.

3 A pair of 20° full depth involute spur gears having 30 and 50 teeth respectively of module 4 mm are in mesh. The smaller gear rotates at 1000 r.p.m. Determine : **1.** Sliding velocities at engagement and at disengagement of pair of a teeth, and **2.** contact ratio.

4 A pair of spiral gears is required to connect two shafts 175 mm apart, the shaft angle being 70°. The velocity ratio is to be 1.5 to 1, the faster wheel having 80 teeth and a pitch circle diameter of 100 mm. Find the spiral angles for each wheel. If the torque on the faster wheel is 75 N-m ; find the axial thrust on each shaft, neglecting friction.

5 The speed ratio of the reverted gear train, as shown in Fig. 13.5, is to be 12. The module pitch of gears A and B is 3.125 mm and of gears C and D is 2.5 mm. Calculate the suitable numbers of teeth for the gears. No gear is to have less than 24 teeth.

6 In an epicyclic gear train, an arm carries two gears A and B having 36 and 45 teeth respectively. If the arm rotates at 150 r.p.m. in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed, makes 300 r.p.m. in the clockwise direction, what will be the speed of gear B ?