ASSIGNMENT – 1 INTRODUCTION OF MACHINES AND MECHANISMS

(1) Distinguish between:

(i) Mechanism and machine; (ii) Analysis and synthesis of mechanisms;

(iii) Kinematics and dynamics.

(2) Define: kinematic link, kinematic pair, and kinematic chain.

(3) What are rigid and resistant bodies? Elaborate.

(4) State and explain types of constrained motion.

(5) Define kinematic pair. How it is classified?

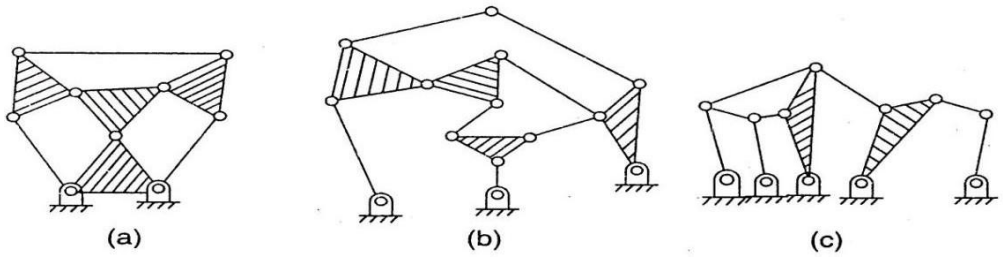
(6) What do you mean by degree of freedom of a kinematic pair? How are pairs classified? Give examples.

(7) Define Grashof's law. State how is it helpful in classifying the four-link mechanisms into different types?

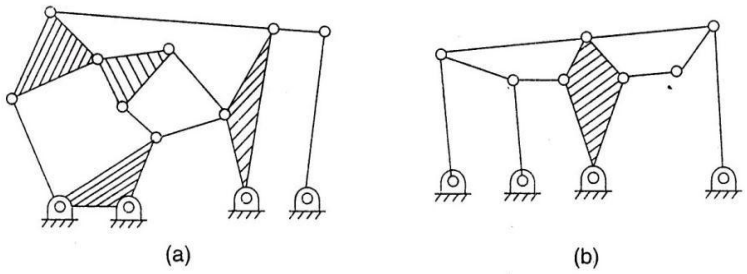
(8) Describe various inversions of a slider-crank mechanism giving examples.

(9) What are quick-return mechanisms? Where are they used? Discuss the functioning of any one of them.

(10) For the kinematic linkages shown in Figure, find the number of binary links ( ), ternary links ( ), other links ( ), total links N, loops L, joints or pairs ( ), and degree of freedom (F).



(11) Show that the linkages shown in *Figure* are structures. Suggest some changes to make them mechanisms having one degree of freedom. Number of links should be changed by more than 1.



ASSIGNMENT – 2 SYNTHESIS OF MECHANISM

(1) Define the following term related to synthesis:

a. Type synthesis

b. Number synthesis

c. Dimensional synthesis

d. Function generation

e. Path generation

f. Body guidance

(2) Explain two position synthesis of slider crank mechanism.

(3) Explain two position synthesis of crank and rocker mechanism.

(4) Explain three position synthesis.

(5) Explain Freudenstein"s equation.

(6) Explain Bloch method of synthesis.

(7) Four bar crank–rocker quick return linkage for specified time ratio = 1:1.25 with 45 output rocker motion. Design the synthesis.

(8) Using Bloch method , synthesis and also draw a four bar linkages to meet the following specifications of angular position, velocities and accelerations at one of its positions are

ASSIGNMENT – 3 VELOCITY AND ACCELERATION ANALYSIS

(1) Describe the procedure to construct diagram of a four-link mechanism.

(2) What is velocity of rubbing? How is it found?

(3) What is instantaneous centre of rotation? How do you known the number of instantaneous centres in a mechanism?

(4) State and prove the Kennedy's theorem as applicable to instantaneous centres of rotation of three bodies. How is it helpful in locating various instantaneous centres of a mechanism?

(5) State and explain angular velocity ratio theorem as applicable to mechanisms.

(6) What are centripetal and tangential components of acceleration? When do they occur? How are they determined?

(7) Describe the procedure to draw velocity and acceleration diagrams of a four-link mechanism. In what way the angular accelerations of the output link and the coupler are found?

(8) What is an acceleration image? How are they helpful in determining the accelerations of offset points on a link?

(9) What is Coriolis acceleration component? In which cases does it occur? How is it determined?

(10) Explain the procedure to construct Klein's construction to determine the velocity and acceleration of a slider-crank mechanism.

(11) In a four-link mechanism, the crank AB rotates at 36 rad/s. The lengths of the links are: AB = 200 mm, BC = 400 mm, CD = 450 mm and AD = 600 mm. AD is the fixed link. Ate the instant when AB is at right angle to AD, determine the velocity of

(i) the mid-point of link BC,

(ii) a point on link CD, 100 mm from the pin connecting the links CD and AD.

(6.55 m/s; 1.45m/s)

ASSIGNMENT – 4 SPECIAL MECHANISMS

(1) Explain Hart straight line motion mechanism with the help of neat sketch and prove that tracing point describes a straight line path.

(2) Derive the equation for finding out the ratio of angular velocities of two shafts of Hooke's joint.

(3) Explain Peaucellier mechanism with neat sketch.

(4) What is condition for correct steering? Sketch and explain Devis steering gear mechanism. Also explain Ackermann steering gear mechanism.

(5) A Hook's joint is used to connect two shafts inclined at an angle 20 degree. Find maximum and minimum velocity of driven shaft and the angles of which the driven shaft will have the same speed as that of the driving shaft which rotates at 240 rpm.

(6) A universal joint is used to connect two shafts which are inclined at 20 degree and the speed of the driving shaft is 1500 rpm.Find extreme angular velocity of the driven shaft and its maximum acceleration

ASSIGNMENT – 5 GEARS

(1) Draw the gear teeth profile and define different terms related to gear.

(2) Explain law of Gearing.

(3) Derive equation for Length of path of contact, Arc of contact and Contact ratio.

(4) What is interference? How it should be avoided? Derive the equation for minimum numbers of teeth on pinion/wheel to avoid interference.

(5) Derive equation for efficiency of spiral gears.

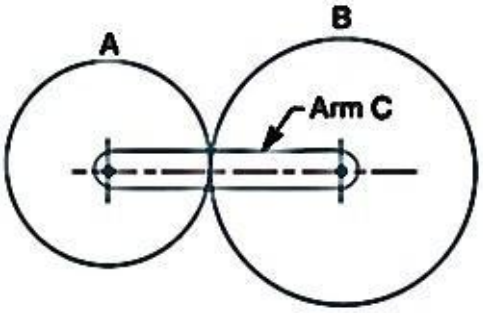
(6) Each of two gears in a mesh has 48 teeth and a module of 8 mm. the teeth are of 200 involute profiles. The arc of contact is 2.25 times the circular pitch. Determine the addendum.

(7) Two involute gears in mesh have 200 pressure angle. The gear ratio is 3 and the number of teeth on the pinion is 24. The teeth have a module of 6 mm. the pitch line velocity is 1.5 m/s and the addendum equal to one module. Determine the angle of action of the pinion (The angle turned by the pinion when one pair of teeth is in the mesh) and the maximum velocity of sliding.

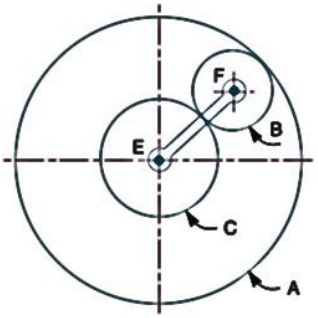
(8) Two 20^{o} involute spur gears have a module of 10 mm. The addendum is equal to one module. The larger gear has 40 teeth while the pinion has 20 teeth. Will the gear interference with the pinion?

ASSIGNMENT – 6 GEAR TRAINS

(1) 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?

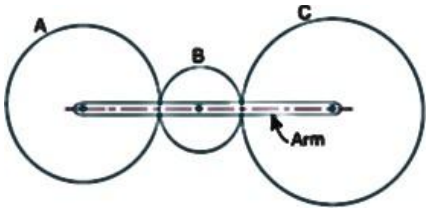


(2) An epicyclic gear consists of three gears A, B and C as shown in figure. The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 18 r.p.m. If the gear A is fixed, determine the speed of gears B and C.

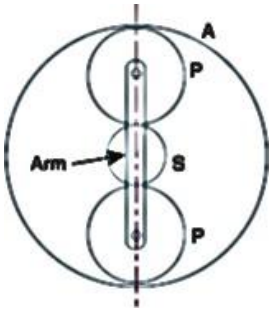


(3) In an epicyclic gear train, as shown in figure. The numbers of teeth on wheels A, B and C are 48, 24 and 50 respectively. If the arm rotates at 400 r.p.m. clockwise,

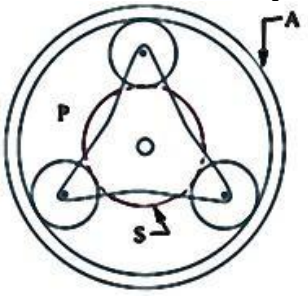
Find: 1. Speed of wheel C when A is fixed
2. Speed of wheel A when C is fixed.



(4) An epicyclic gear train, as shown in figure has a sun wheel S of 30 teeth and two planet wheels P-P of 50 teeth. The planet wheels mesh with the internal teeth of a fixed annulus A. The driving shaft carrying the sun wheel transmits 4 kW at 300 r.p.m. The driven shaft is connected to an arm which carries the planet wheels.
Determine the speed of the driven shaft and the torque transmitted, if the overall efficiency is 95%.

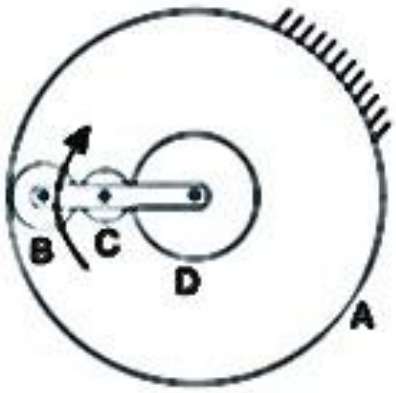


(5) An epicyclic gear train for an electric motor is shown in figure. The wheel S has 15 teeth and is fixed to the motor shaft rotating at 1450 r.p.m. The planet P has 45 teeth, gears with fixed annulus A and rotates on a spindle carried by an arm which is fixed to the output shaft. The planet P also gears with the sun wheel S. Find out the speed of the output shaft.
If the motor is transmitting 2 H.P./1.5 kW, find the torque required to fix the annulus A.



(6) An epicyclic gear train, as shown in figure, is composed of a fixed annular wheel A having 150 teeth. Meshing with A is a wheel B which drives wheel D through an idle

wheel C, D being concentric with A. The wheels B and C are carried on an arm which revolves clockwise at 100 r.p.m. about the axis of A or D. If the wheels B and D have 25 teeth and 40 teeth respectively, find the number of teeth on C and the speed and sense of rotation of C.



ASSIGNMENT – 7 CAM AND FOLLOWERS

(1) What is a cam? What type of motion can be transmitted with a cam and follower combination? What are its elements?

(2) How are the cams classified? Describe in detail.

(3) Discuss various types of cams.

(4) Compare the performance of Knife-edge, roller and mushroom followers.

(5) Define: base circle, pitch circle, trace point, pitch curve and pressure angle.

(6) Deduce expressions for the velocity and acceleration of the follower when it moves with simple harmonic motion.

(7) Draw the profile of a cam that gives a lift of 40 mm to a rod carrying a 20 mm Diameter roller. The axis of the roller passes through the centre of the cam. The least radius of the cam is 50 mm. The rod is to be lifted with simple harmonic motion in a quarter revolutions and is to be dropped suddenly at half revolution. Determine the maximum velocity and maximum acceleration during the lifting. The cam rotates at 60 rpm (0.25 m/s; 3.155 m/s2)

(8) Draw the profile of a cam which is to give oscillatory motion to the follower with uniform angular velocity about its pivot. The base circle diameter is 50 mm, angle of oscillation of the follower 30º and the distance between the cam centre and the pivot of the follower 60 mm. The oscillating lever is 60 mm long with a roller of 8 mm diameter at the end. One oscillation of the follower is completed in one revolution of the cam.

(9) Set out the profile of a cam to give the following motion to a flat mushroom contact face follower:

- Follower to rise through 24 mm during 150º of cam rotation with SHM.
- Follower to dwell for 30º of the cam rotation.
- Follower to return to the initial position during 90º of the cam rotation with SHM.
- Follower to dwell for the remaining 90º of cam rotation.

Take minimum radius of the cam as 30 mm.

(10) A cam is required to give motion to a follower fitted with a roller 50 mm in diameter. The lift of the follower is 30 mm and is performed

- with uniform acceleration for 12 mm, the cam turns through 45º.
- with uniform velocity for 12 mm, the cam turns through next 30º.
- with uniform deceleration for the remainder of the lift, the cam turns through next 45º.

The follower falls through immediately with simple harmonic motion while the cam turns through 120º. Then a period of dwell is followed for 120º of the cam angle.
Construct a lift and fall diagram on a cam angle base. Also draw the outline of the cam. The least radius of the cam is 35 mm. The line of motion of the follower passes through the centre of the cam axis.