Code No: R2021034 **R20** SET - 1

II B. Tech I Semester Regular/Supplementary Examinations, January - 2023
KINEMATICS OF MACHINERY
(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions, each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) In a crank and slotted lever quick return mechanism, as shown in the fig:1, the driving crank length is 75mm. The distance between the fixed centres is 200mm and the length of the slotted lever is 500mm. Find the ratio of the times taken on the cutting and idle strokes. Determine the effective stroke also. [7M]

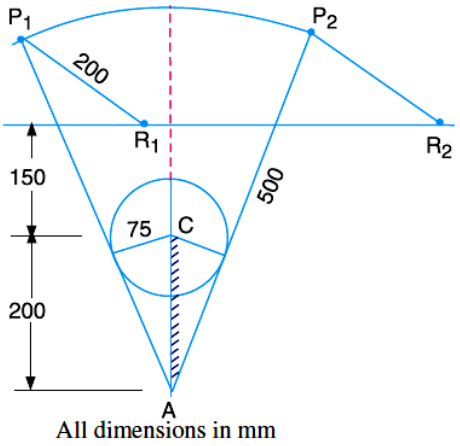
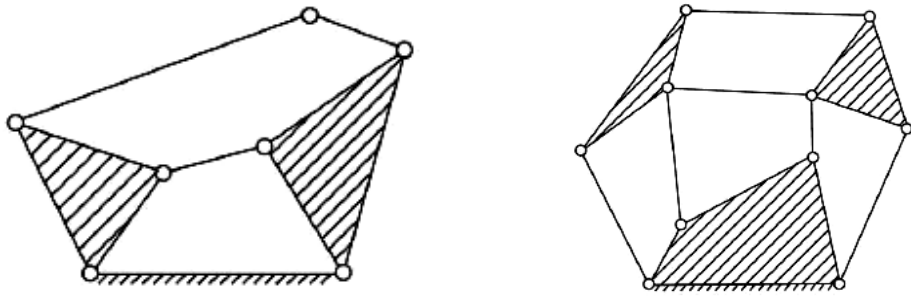


Fig: 1

b) Write notes on complete and incomplete constraints in lower and higher pairs, illustrating your answer with neat sketches. [7M]

OR

2 a) For the kinematic linkage shown in the fig:2(a), determine the degrees of freedom (F). [7M]



(i) (ii)

Fig: 2(a)
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b) A Whitworth quick return motion mechanism, as shown in the fig:2(b), has the following particulars: [7M]

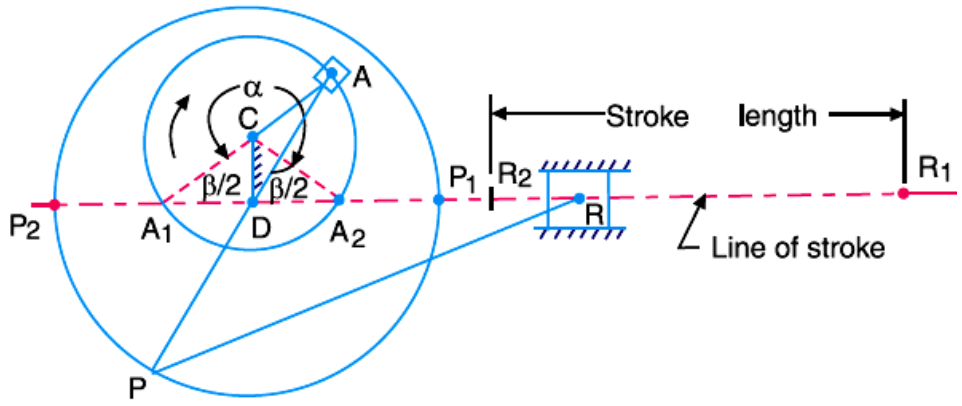

Fig:2b

Length of stroke = 150 mm ; Driving crank length = 40 mm;

$\frac{\text{Time of cutting stroke}}{\text{Time of return stroke}} = 2$

Find the lengths of CD and PD. Also determine the angles α and β.

UNIT-II

3 a) Enumerate the difference between Davis Steering gear and Ackermann Steering gear mechanisms. [6M]

b) Two shafts are connected by a Hooke's joint. The driving shaft revolves uniformly at 500r.p.m. If the total permissible variation in speed of a driven shaft is not to exceed 6% of the mean speed, find the greatest permissible angle between the centre lines of the shafts. Also determine the maximum and minimum speed of the driven shaft. [8M]

OR

4 a) Sketch a pantograph, explain its working and show that it can be used to reproduce to an enlarged scale of a pantograph. [7M]

b) In a Davis steering gear, the distance between the pivots of the front axle is 1 metre and the wheel baseis 2.5 metres. Find the inclination of the track arm to the longitudinal axis of the car, when it is moving along a straight path. [7M]

UNIT-III

5 a) Locate all the instantaneous centresof the mechanism as shown in the fig: 5. The lengths of various links are: AB = 150 mm; BC = 300 mm; CD = 225 mm; and CE = 500mm. [9M]

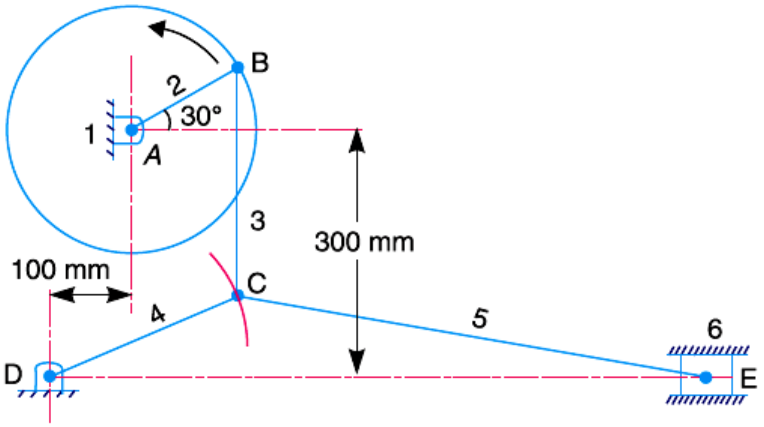

Fig: 5

When the crank AB rotates in the anticlockwise direction at a uniform speed of 240r.p.m. Find i) Velocity of the slider E, and ii) Angular velocity of the links BC and CE.

b) Define rubbing velocity at a pin joint. What will be the rubbing velocity at pin joint when the two linksmove in the same and opposite directions? [5M]

OR

6 a) State and prove the 'Aronhold Kennedy's Theorem' of three instantaneous centres. [5M]

b) The oscillating link OAB of a mechanism,as shown in the fig: 6, is pivoted at O andis moving at 90 r.p.m. anticlockwise. If OA= 150 mm ; AB = 75 mm, andAC = 250 mm, calculate: [9M]

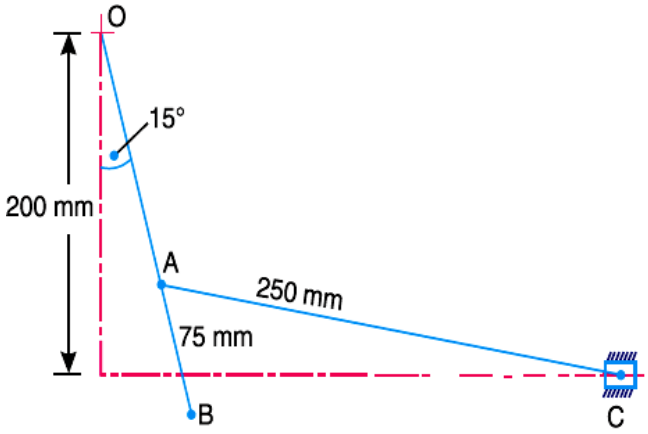

Fig: 6

i) The velocity of the block C;
ii) The angular velocity of the link AC; and
iii) The rubbing velocities of the pins at O, A and C, assuming that these pinsare of equal diameters of 20 mm.

UNIT-IV

7 a) An open belt drive connects two pulleys 1.2 m and 0.5 m diameter on parallel shafts 3.6 m apart. The belt has a mass of 1 kg/m length and the maximum tension in it is not to exceed 2kN. The 1.2m pulley, which is the driver, runs at 200 r.p.m. Due to the belt slip on one of the pulleys, the velocity of the driven shaft is only 450 r.p.m. If the coefficient of friction between the belt and the pulley is 0.3, find: [8M]

i) Torque on each of the two shafts
ii) Power transmitted
iii) Power lost in friction, and
iv) Efficiency of the drive.

b) What are the different types of motion with which a follower can move? Explain them with neat sketches. [6M]

OR

8 a) Discuss relative merits and demerits of belt, rope and chain drive for transmission of power. [6M]

b) Design a cam to raise a valve with simple harmonic motion through 50 mm in 1/3 of a revolution, keep if fully raised through 1/12 revolution and to lower it with harmonic motion in 1/6 revolution.The valve remains closed during the rest of the revolution. The diameter of the roller is 20 mm and the minimum radius of the cam is 25 mm. The diameter of the camshaft is 25 mm. The axis of the valve rod passes through the axis of the camshaft. If the camshaft rotates at uniform speed of 100 r.p.m.; find the maximum velocity and acceleration of a valve during raising and lowering. [8M]

UNIT-V

9 a) An epicyclic bevel gear train, as shown in the fig: 9, has fixed gear B meshing with pinion C. Thegear E on the driven shaft meshes with the pinion D. The pinions C and D are keyed to a shaft, which revolves in bearings on the arm A. The arm A is keyed to the driving shaft. The numbers of teeth are: $T_B = 75$, $T_C = 20$, $T_D = 18$ and $T_E = 70$. Find the speed of the driven shaft, if i) the driving shaft makes 1000 r.p.m., and ii) the gear B turns in the same sense as the driving shaft at 400r.p.m., the driving shaft still making 1000 r.p.m. [8M]

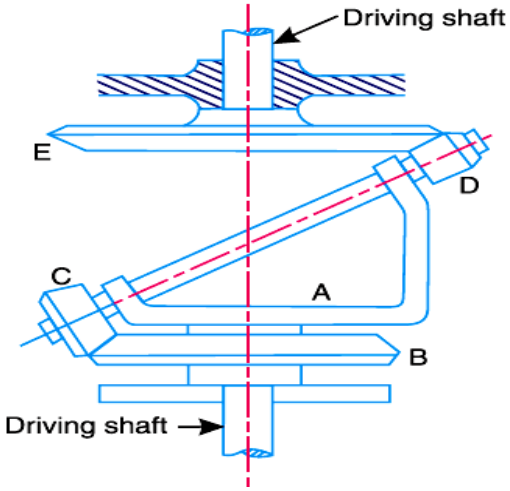

Fig: 9

b) Derive an expression for minimum number of teeth required on a pinion to avoid interference when it gears with a rack. [6M]

OR

10 a) What are the various types of the torques in an epicyclic gear train? [6M]

b) Two shafts inclined at an angle of 65° and with a least distance between them of 175 mm are to be connected by spiral gears of normal pitch 15 mm to give a reduction ratio 3:1. Find suitable diameters and numbers of teeth. Also, Determine the efficiency if the spiral angles are determined by the condition of maximum efficiency. The friction angle is 7°. [8M]

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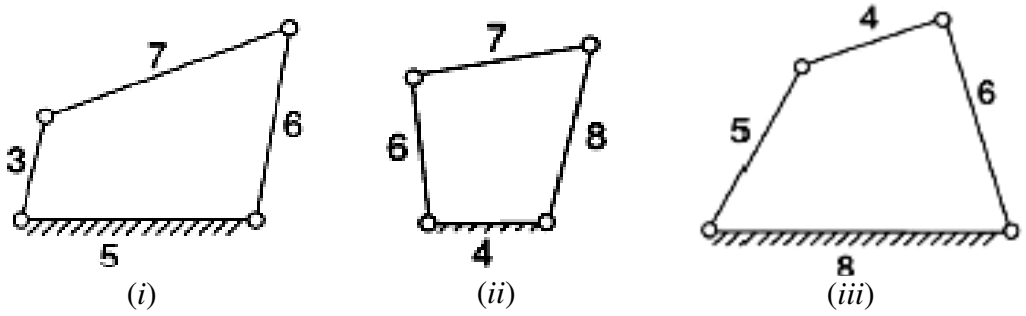
UNIT-I

1 a) Define Four Bar Mechanism. Fig: 1 shows some four-link mechanisms in which the figures indicate the dimensions in mm of length. Indicate the type of each mechanism, whether it is crank-rocker or double crank or double rocker. [9M]



(*i*) (*ii*) (*iii*)

Fig.1

b) What is a machine? Giving example, differentiate between a machine and a structure. [5M]

OR

2 a) Sketch and explain any two inversions of a double slider crank chain. [7M]

b) In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres O and C is 210mm. The driving crank CP is 75 mm long. The pin Q on the slotted lever, 360 mm fromthe fulcrum O, is connected by a link QR 100 mm long, to a pin R on the ram. The line of stroke of R is perpendicular to OC and intersects OC produced at a point 150 mm from C. Determine the ratio of times taken on the cutting and return strokes. [7M]

UNIT-II

3 a) What are straight line mechanisms? Describe one type of exact straight line motion mechanism with the help of a sketch. [7M]

b) Two inclined shafts are connected by means of a universal joint. The speed of the driving shaft is 1000r.p.m. If the total fluctuation of speed of the driven shaft is not to exceed 12.5% of this, what is the maximum possible inclination between the two shafts? With this angle, what will be the maximum acceleration to which the driven shaft is subjected and when this will occur? [7M]

OR

4 a) What is the condition for correct steering? Sketch and show the two main types of steering gears and discuss their relative advantages. [7M]
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b) The distance between the fixed centres O and O_1 of a Watt's straight line motion, as shown in the fig:4, is 250 mm. The lengths of the three moving links OB, BA and AO_1 are 150 mm, 75 mm and 100 mm respectively. Find the position of a point P on BA which gives the best straight line motion. [7M]

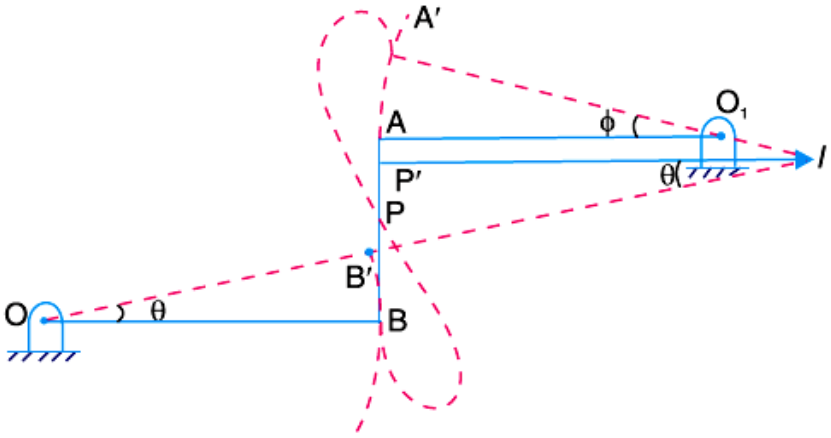

Fig: 4

UNIT-III

5 a) Sketch a quick return motion of the crank and slotted lever type and explain the procedure of drawing the velocity and acceleration diagram, for any given configuration of the mechanism. [7M]

b) In a link work, as shown in the fig:5, the crank AB rotates about A at a uniform speed of 150 r.p.m.The lever DC oscillates about the fixed point D, being connected to AB by the connecting link BC. The block F moves, in horizontal guides being driven by the link EF, when the crank AB is at 30°. The dimensions of the various links are : [7M]
AB = 150 mm; BC = 450 mm; CE = 300 mm; DE = 150 mm; and EF = 350 mm.
Find, for the given configuration, i) velocity of slider F, ii) angular velocity of DC, and iii) rubbing speed at pin C which is 50 mm in diameter.

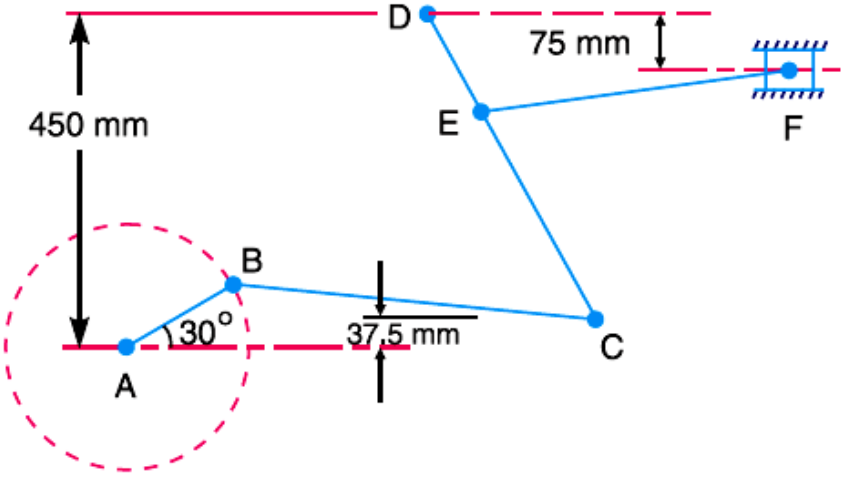

Fig: 5

OR

6 a) In a quick return mechanism, as shown in the fig: 6, the driving crank OA is 60 mm long and rotates at a uniform speed of 200 r.p.m. in a clockwise direction. For the position shown, find i) velocity of the ram R; ii) acceleration of the ram R, and iii) acceleration of the sliding block A along the slotted bar CD. [7M]

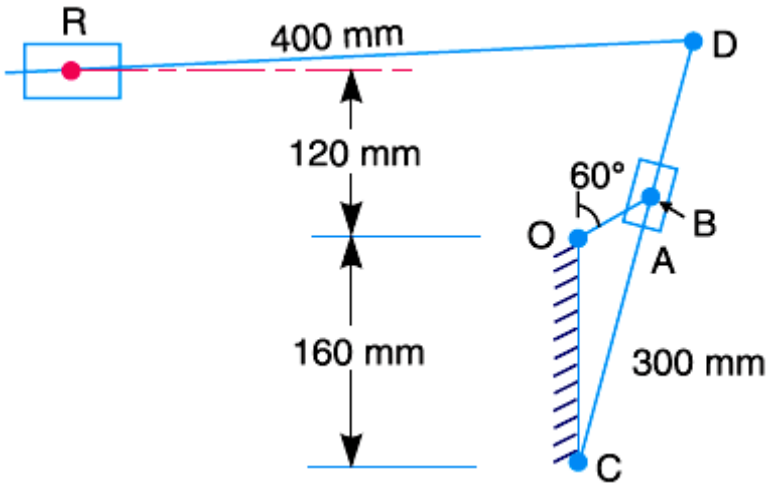

Fig: 6

b) Explain with sketch the instantaneous centre method for determination of velocities of links and mechanisms. [7M]

UNIT-IV

7 a) What is centrifugal tension in a belt? How does it affect the power transmitted? Derive the condition for transmitting the maximum power in a flat belt drive. [7M]

b) A symmetrical tangent cam operating a roller follower has the following particulars: Radius of base circle of cam = 40 mm, roller radius =20 mm, angle of ascent = 75°, total lift = 20mm, speed of cam shaft = 300 r.p.m. Determine: [7M]

i) The principal dimensions of the cam
ii) The equation for the displacement curve, when the follower is in contact with the straight flank, and
iii) The acceleration of the follower when it is in contact with the straight flank where it merges into the circular nose.

OR

8 a) Power is transmitted between two shafts, 3metres apart by an open wire rope passing round two pulleys of 3 metres and 2 metres diameters respectively, the groove angle being 40°. If the rope has amass of 3.7 kg per metre length and the maximum working tension in rope is 20 kN, determine the maximum power that the rope can transmit and the corresponding speed of the smaller pulley. The coefficient of friction being 0.15. [7M]

b) Derive the expressions for displacement, velocity and acceleration for a circular arc cam operating a flat-faced follower [7M]

(i) When the contact is on the circular flank, and
(ii) When the contact is on circular nose.

UNIT-V

9 a) Two mating involute spur gear of 20° pressure angle have a gear ratio of 2. The number of teeth on the pinion is 20 and its speed is 250 r.p.m. The module pitch of the teeth is 12 mm. If the addendum on each wheel is such that the path of approach and the path of recess on each side are half the maximum possible length, find: i) the addendum for pinion and gear wheel; ii) the length of the arc of contact; and iii) the maximum velocity of sliding during approach and recess. Assume pinion to be the driver. [9M]

b) Explain the procedure adopted for designing the spur wheels. [5M]

OR

10 a) Derive an expression for the velocity of sliding between a pair of involute teeth. State the advantagesof involute profile as a gear tooth profile. [5M]

b) Fig: 10, shows an epicyclic gear train with the following details: [9M]

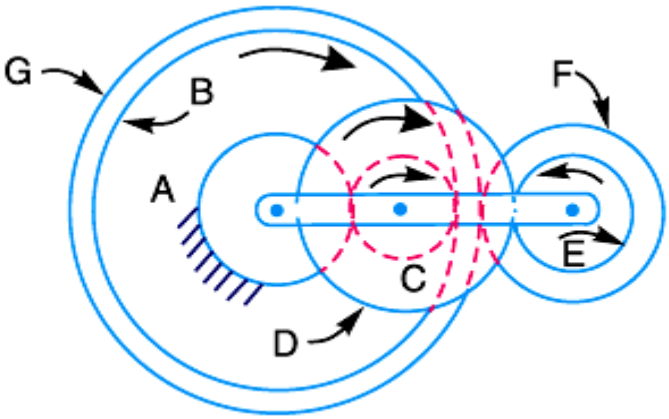

Fig: 10

A has 40 teeth external (fixed gear); B has 80 teeth internal; C - D is a compound wheel having 20 and50 teeth (external) respectively, E-F is a compound wheel having 20 and 40 teeth (external) respectively, and G has 90 teeth (external). The arm runs at 100 r.p.m. in clockwise direction. Determine the speeds for gears C, E, and B.

Code No: R2021034 **R20** SET - 3

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Answer any **FIVE** Questions, each Question from each unit
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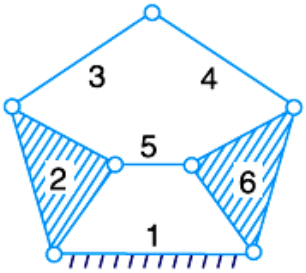
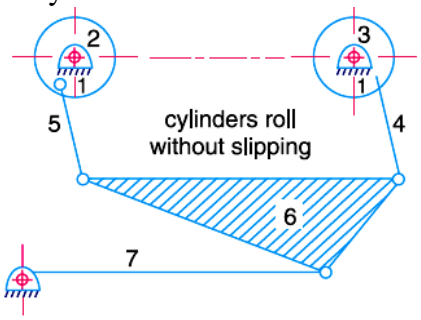
UNIT-I

1 a) Explain the terms: [7M]
i. Lower pair ii. Higher pair iii. Kinematic chain and iv. Inversion.

b) Determine the mobility (degrees of freedom) of the mechanism shown in the Fig:1 using Kutzbach mobility criterion and classify them. [7M]



(*i*)



(*ii*)

Fig:1

OR

2 a) In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres is 240 mm and the length of the driving crank is 120 mm. Find the inclination of the slotted bar with the vertical in the extreme position and the time ratio of cutting stroke to the return stroke. If the length of the slotted bar is 450mm, find the length of the stroke if the line of stroke passes through the extreme positions of the free end of the lever. [7M]

b) Enumerate the differences between Machine and Structure. [7M]
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UNIT-II

3 a) Fig:3 shows a part of the mechanism of a circuit breaker. A and D are fixed centres and the lengths of the links are: AB = 110 mm, BC = 105 mm, and CD = 150 mm. [7M]

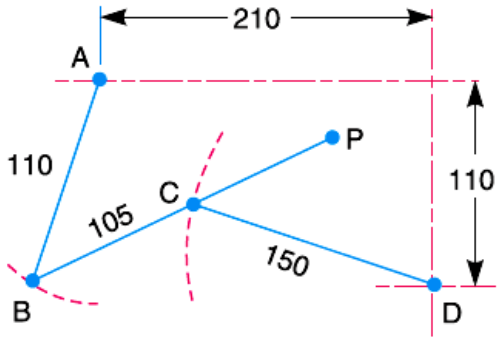

Fig: 3

Find the position of a point P on BC produced that will trace out an approximately straight vertical path 250 mm long.

b) Give a neat sketch of the straight line motion 'Hart mechanism.' Prove that it produces an exact straight line motion. [7M]

OR

4 a) Sketch an intermittent motion mechanism and explain its practical applications. [7M]

b) A Watt's parallel motion has two bars OA and OB pivoted at O and O_1 respectively and joined by the link AB in the form of a crossed four bar mechanism. When the mechanism is in its mean position, the bars OA and O_1B are perpendicular to the link AB. If OA = 75 mm, O_1B = 25 mm and AB = 100 mm, find the position of the tracing point P and also find how far P is from the straight line given by the mean position of AB, when: [7M]

i) OA and OB are in one straight line, and
ii) O_1B and AB are in one straight line.

UNIT-III

5 a) A mechanism, as shown in the Fig: 5, has the following dimensions: [8M]

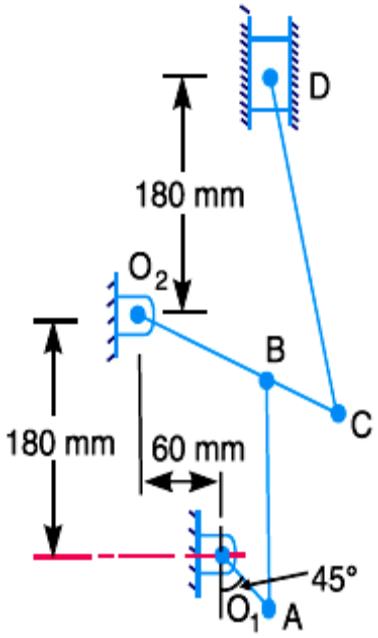

Fig: 5

O_1A = 60 mm; AB = 180 mm; O_2B = 100 mm; O_2C = 180 mm and CD = 270 mm.

The crank O_1A rotates clockwise at a uniform speed of 120 r.p.m. The block D moves in verticalguides. Find, by instantaneous centre method, the velocity of D and the angular velocity of CD.

b) Explain how the velocities of a slider and the connecting rod are obtained in a slider crankmechanism. [6M]

OR

6 a) Fig: 6 shows the mechanism of a quick return motion of the crank and slotted lever type shaping machine. The dimensions of the various links are as follows: OA = 200 mm; AB = 100 mm; OC = 400 mm; and CR = 150 mm.The driving crank AB makes 120° with the vertical and rotates at 60 r.p.m. in the clockwise direction. Find: i) velocity of ram R, and ii) angular velocity of the slotted link OC. [8M]

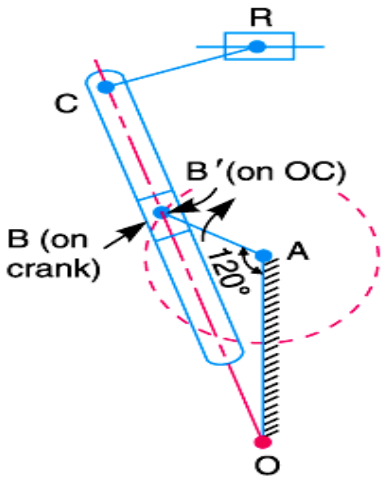

Fig: 6

b) Explain how the acceleration of a point on a link (whose direction is known) is obtained when the acceleration of some other point on the same link is given in magnitude and direction. [6M]

UNIT-IV

7 a) A flat belt, 8 mm thick and 100 mm wide transmits power between two pulleys, running at1600 m/min. The mass of the belt is 0.9 kg/m length. The angle of lap in the smaller pulley is 165° and the coefficient of friction between the belt and pulley is 0.3. If the maximum permissible stress in the belt is 2 MN/m^2, find: i) maximum power transmitted; and ii) initial tension in the belt. [6M]

b) Define the following terms as applied to cam with a neat sketch: [8M]
(i) Base circle (ii) Pitch circle (iii) Pressure angle, and
(iv) Stroke of the follower.

OR

8 a) How does the velocity ratio of a belt drive effect, when some slip is taking place between the belt and the two pulleys? [6M]

b) The suction valve of a four stroke petrol engine is operated by a circular arc cam with a flat faced follower. The lift of the follower is 10 mm; base circle diameter of the cam is 40 mm and the nose radius is 2.5 mm. The crank angle when suction valve opens is 4° after top dead centre and when the suction valve closes, the crank angle is 50° after bottom dead centre. If the cam shaft rotates at 600 r.p.m., determine: i) maximum velocity of the valve, and ii) maximum acceleration and retardation of the valve. [8M]

UNIT-V

9 a) Derive an expression for the minimum number of teeth required on the pinion in order to avoid interference in involute gear teeth when it meshes with wheel. [7M]

b) An epicyclic gear train for an electric motor is shown in the fig: 9. 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 the speed of the output shaft. If the motor is transmitting 1.5 kW, find the torque required to fix the annulus A. [7M]

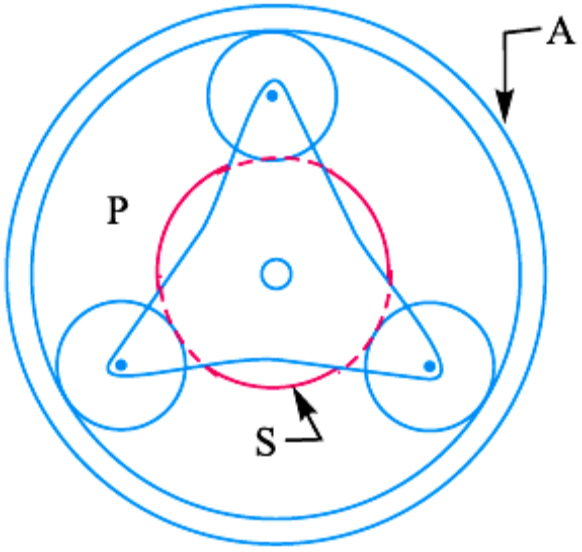

Fig: 9

OR

10 a) A spiral wheel reduction gear, of ratio 3 to 2, is to be used on a machine, with the angle between theshafts 80°. The approximate centre distance between the shafts is 125 mm. The normal pitch of theteeth is 10 mm and the wheel diameters are equal. Find the number of teeth on each wheel, pitch circlediameters and spiral angles. Find the efficiency of the drive if the friction angle is 5°. [7M]

b) Explain briefly the differences between simple, compound, and epicyclic gear trains. What are the special advantages of epicyclic gear trains? [7M]

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UNIT-I

1 a) Sketch slider crank chain and its various inversions, stating actual machines in which these are used inpractice. [7M]

b) In a Whitworth quick return motion mechanism, as shown in the fig: 1, the distance between the fixed centers is 50 mm and the length of the driving crank is 75 mm. The length of the slotted lever is 150 mm and the length of the connecting rod is 135 mm. Find the ratio of the time of cutting stroke to the time of return stroke and also the effective stroke. [7M]

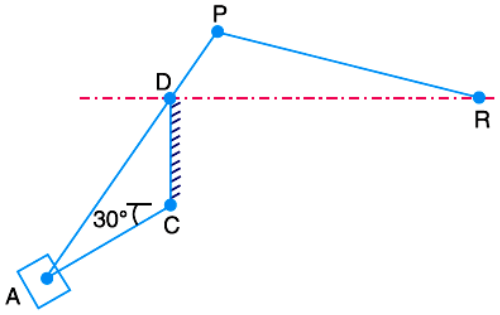

Fig: 1

OR

2 a) Identify the kinematic chains to which the following mechanisms belong and explain them with neat sketch:
i) Steam engine mechanism ii) Beam engine iii) Whitworth quick return motion mechanism and iv) Elliptical trammels. [8M]

b) Define kinematic pair. Explain different kinds of kinematic pairs giving example for each one of them. [6M]
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UNIT-II

3 a) Fig: 3 shows the link GAB which oscillates on a fixed centre at A and the link FD on a fixed centre at F. The link AB is equal to AC and DB, BE, EC and CD are equal in length. [8M]

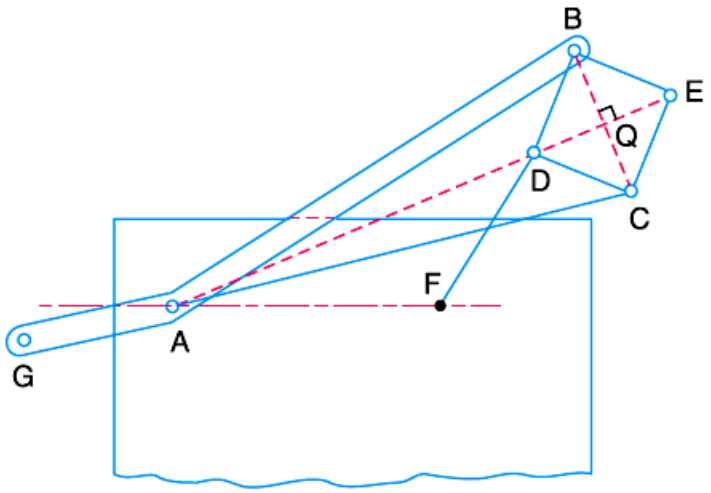

Fig: 3

(i) Find the length of AF and the position of centre F so that the point E may move in a straight line.

(ii) If the point E is required to move in a circle passing through centre A, what will be the path of point D?

b) Describe the Watt's parallel mechanism for straight line motion and derive the condition under which the straight line is traced. [6M]

OR

4 a) In a Davis steering gear, the distance between the pivots of the front axle is 1 metre and the wheel base is 2.5 metres. Find the inclination of the track arm to the longitudinal axis of the car, when it is moving along a straight path. [7M]

b) A circle has OR as its diameter and a point Q lies on its circumference. Another point P lies on the line OQ produced. If OQ turns about O as centre and the product OQ × OP remains constant, show that the point P moves along a straight line perpendicular to the diameter OR. [7M]

UNIT-III

5 a) In a four bar chain ABCD, link AD is fixed and the crank AB rotates at 10 radians per second clockwise. Lengths of the links are AB = 60 mm; BC = CD = 70 mm; DA = 120 mm. When angle DAB = 60° and both B and C lie on the same side of AD, find i) angular velocities (magnitude and direction) of BC and CD; and ii) angular acceleration of BC and CD. [9M]

b) Explain, with the help of a neat sketch, the space centrode and body centrode. [5M]

OR

6 a) What is the difference between ideal mechanical advantage and actual mechanical advantage? [4M]

b) In the toggle mechanism, as shown in the fig: 6, D is constrained to move on a horizontal path. The dimensions of various links are: AB = 200 mm; BC = 300 mm; OC = 150 mm; and BD = 450 mm. [10M]

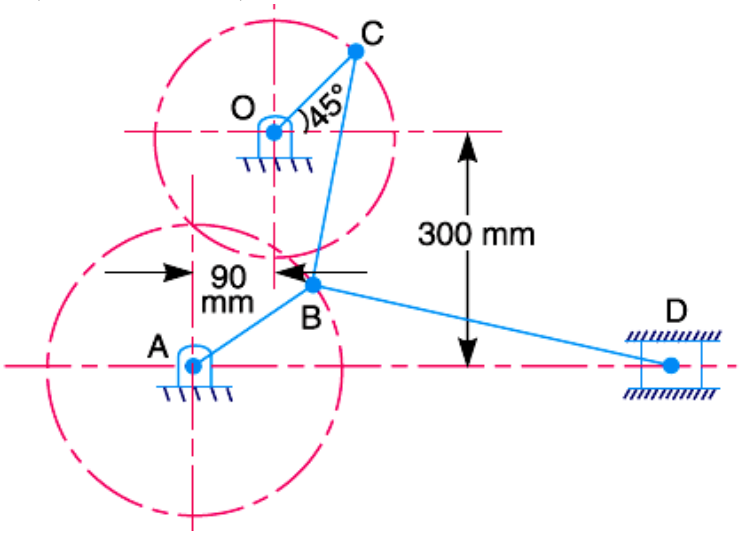

Fig: 6

The crank OC is rotating in a counter clockwise direction at a speed of 180 r.p.m., increasing at the rate of 50 rad/s^2. Find, for the given configuration i) velocity and acceleration of D, and ii) angular velocity and angular acceleration of BD.

UNIT-IV

7 a) The following particulars relate to a symmetrical circular cam operating a flat-faced follower: [7M]
Least radius = 25 mm; nose radius = 8 mm, lift of the valve = 10 mm, angle of action of cam =120°, cam shaft speed = 1000 r.p.m. Determine the flank radius and the maximum velocity, acceleration and retardation of the follower. If the mass of the follower and valve with which it is in contact is 4 kg, find the minimum force to be exerted by the spring to overcome inertia of the valve parts.

b) It is stated that the speed at which a belt or rope should be run to transmit maximum power is that at which the maximum allowable tension is three times the centrifugal tension in the belt or rope at that speed. Prove the statement. [7M]

OR

8 a) Explain with sketches the different types of cams and followers.Why a roller follower is preferred to that of a knife-edged follower? [6M]

b) The reduction of speed from 360 r.p.m. to 120 r.p.m. is desired by the use of chain drive. The driving sprocket has 10 teeth. Find the number of teeth on the driven sprocket. If the pitch radius of the driven sprocket is 250 mm and the centre to centre distance between the two sprockets is 400 mm, find the pitch and length of the chain. [8M]

UNIT-V

9 a) How the velocity ratio of epicyclic gear train is obtained by tabular method? [6M]

b) Two spur gears of 24 teeth and 36 teeth of 8 mm module and 20° pressure angle are in mesh. Addendum of each gear is 7.5 mm. The teeth are of involute form. Determine: i) the angle through which thepinion turns while any pair of teeth are in contact, and ii) the velocity of sliding between the teeth when the contact on the pinion is at a radius of 102 mm. The speed of the pinion is 450 r.p.m. [8M]

OR

10 a) Derive an expression for the length of the arc of contact in a pair of meshed spur gears. [7M]

b) An epicyclic gear train, as shown in the fig: 10 consists of two sunwheels A and D with 28 and 24teeth respectively, engaged with a compound planet wheels B and C with 22 and 26 teeth. The sunwheel D is keyed to the driven shaft and the sunwheel A is a fixed wheel co-axial with the driven shaft. The planet wheels are carried on an arm E from the driving shaft which is co-axial with the driven shaft. Find the velocity ratio of gear train. If 0.75 kW is transmitted and input speed being 100 r.p.m., determine the torque required to hold the sunwheel A. [7M]

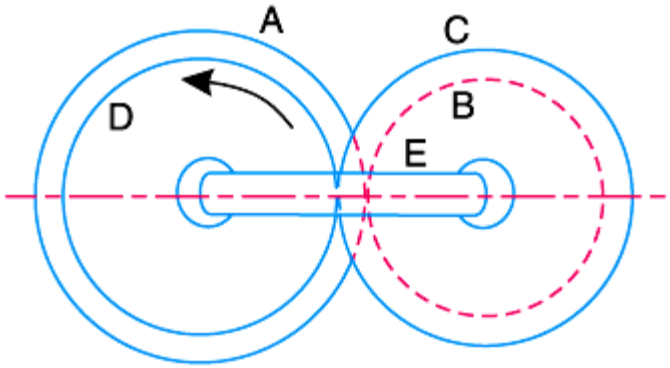

Fig: 10