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Subject Code

- Any - ▼

Chapter Name

- Any - ▼

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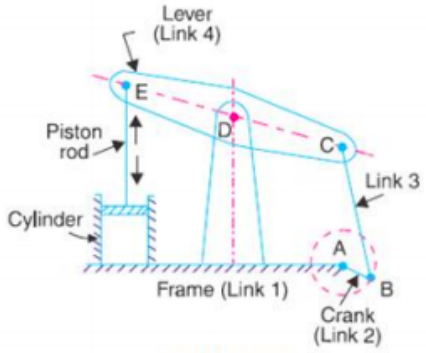
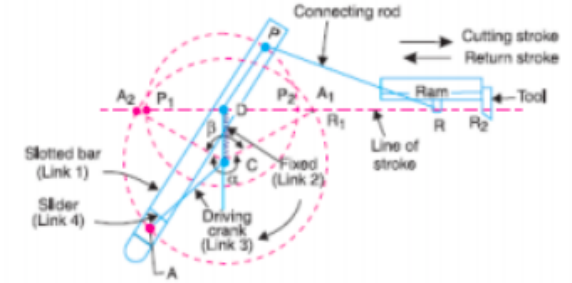
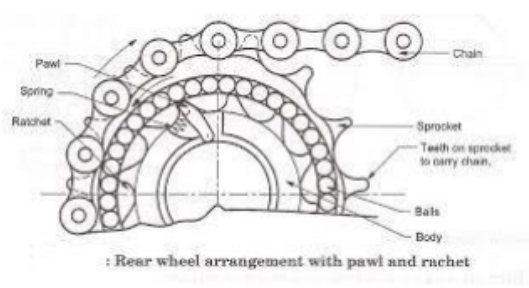
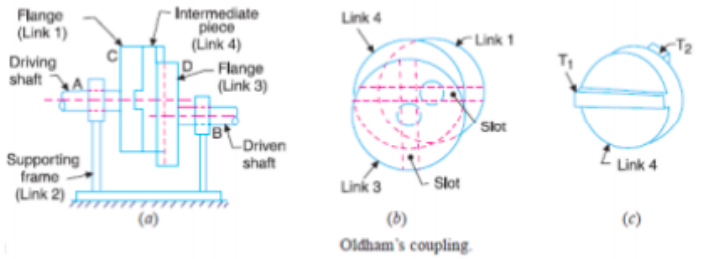
Que.No	Marks	
Q 1 a)	2	Question: **Define inversion with example.** Answer: When one of the links is fixed in a kinematic chain, it is called a mechanism. So we can obtain as many mechanisms as the number of links in a kinematic chain by fixing, in turn, different links in a kinematic chain. This method of obtaining different mechanisms by fixing different links in a kinematic chain is known as inversion of the mechanism. ----------
Q 1 b)	2	Question: **List the inversions for double slider crank mechanism.** Answer: **Inversions of Double Slider Crank Chain :** 1. Elliptical trammels. 2. Scotch yoke mechanism. 3. Oldham's coupling. ----------
Q 1 c)	2	Question: **Define sliding pair with example.** Answer: **Sliding pair :** When the two elements of a pair are connected in such a way that one can only slide relative to the other, the pair is known as a sliding pair. The piston and cylinder, cross-head and guides of a reciprocating steam engine, ram and its guides in shaper, tail stock on the lathe bed etc. are the examples of a sliding pair. A little consideration will show that a sliding pair has a completely constrained motion. ----------

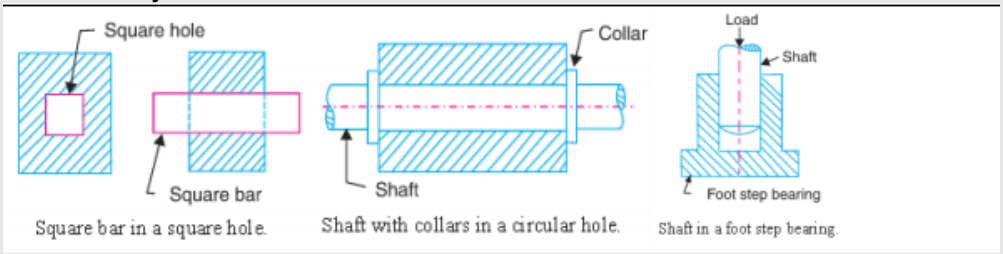
Que.No	Marks	
Q 2 a)	4	Question: **Draw a neat sketch and explain working of beam engine.** Answer: **Beam engine (crank and lever mechanism).** A part of the mechanism of a beam engine (also known as cranks and lever mechanism) which consists of four links is shown in Fig. In this mechanism, when the crank rotates about the fixed centre A, the lever oscillates about a fixed centre D. The end E of the lever CDE is connected to a piston rod which reciprocates due to the rotation of the crank. In other words, the purpose of this mechanism is to convert rotary motion into reciprocating motion.  Beam Engine ---
Q 3 a)	4	Question: **Differentiate between mechanism and machine.** Answer: | Sr. No.	Mechanism	Machine | |---|---|---| | 01 | Primary function is used to transmit or modify the motion. | Primary function is to obtain the mechanical advantage. | | 02 | It is not used to transmit the force. | It is used transmit the force. | | 03 | A mechanism is a single system to transfer the motion | A machine has one or more mechanism to perform the desired function. | | 04 | eg. In watch, energy stored on winding the spring is used to move hands An indicator is used to draw P-V diagram of engine | eg. Shaper receives mechanical power which is used to suitably convert to do work of cutting the metal. A hoist is machine to lift the loads. | ---

Que.No	Marks	
Q 3 b)	4	Question: **Explain the working of Whitworth quick return mechanism.** Answer: **Whitworth quick return motion mechanism.** This mechanism is mostly used in shaping and slotting machines. In this mechanism, the link *CD* (link 2) forming the turning pair is fixed, as shown in Fig. The link 2 corresponds to a crank in a reciprocating steam engine. The driving crank *CA* (link 3) rotates at a uniform angular speed. The slider (link 4) attached to the crank pin at *A* slides along the slotted bar *PA* (link 1) which oscillates at a pivoted point *D*. The connecting rod *PR* carries the ram at *R* to which a cutting tool is fixed. The motion of the tool is constrained along the line *RD* produced, *i.e.* along a line passing through *D* and perpendicular to *CD*.  When the driving crank *CA* moves from the position *CA*1 to *CA*2 (or the link *DP* from the position *DP*1 to *DP*2) through an angle α in the clockwise direction, the tool moves from the left hand end of its stroke to the right hand end through a distance 2 *PD*. Now when the driving crank moves from the position *CA*2 to *CA*1 (or the link *DP* from *DP*2 to *DP*1) through an angle β in the clockwise direction, the tool moves back from right hand end of its stroke to the left hand end. A little consideration will show that the time taken during the left to right movement of the ram (*i.e.* during forward or cutting stroke) will be equal to the time taken by the driving crank to move from *CA*1 to *CA*2. Similarly, the time taken during the right to left movement of the ram (or during the idle or return stroke) will be equal to the time taken by the driving crank to move from *CA*2 to *CA*1. Since the crank link *CA* rotates at uniform angular velocity therefore time taken during the cutting stroke (or forward stroke) is more than the time taken during the return stroke. In other words, the mean speed of the ram during cutting stroke is less than the mean speed during the return stroke. The ratio between the time taken during the cutting and return strokes is given by $\frac{\text{Time of cutting stroke}}{\text{Time of return stroke}} = \frac{\alpha}{\beta} = \frac{\alpha}{360^\circ - \alpha}$ or $\frac{360^\circ - \beta}{\beta}$ ----------

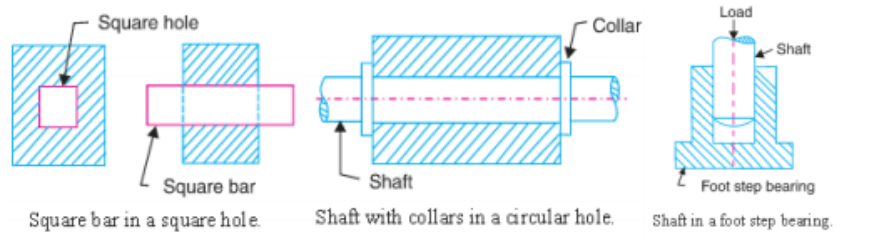
Que.No	Marks	
Q 4 a)	4	Question: **Explain the working of freewheel mechanism of bicycle with sketch.** Answer: A freewheel mechanism on a bicycle allows the rear wheel to turn faster than the pedals. If there is no freewheel on a bicycle, a simple ride could be exhausting, because one could never stop pumping the pedals. And going downhill would be downright dangerous, because the pedals would turn on their own, faster than one could keep up with them.  : Rear wheel arrangement with pawl and rachet Power Train of a bicycle: The power train of a simple bicycle consists of a pair of pedals, two sprockets and a chain. The pedals are affixed to one sprocket — the front sprocket, which is mounted to the bike below the seat. The second sprocket is connected to the hub of the rear wheel. The chain connects the two sprockets. When you turn the pedals, the front sprocket turns. The chain transfers that rotation to the rear sprocket, which turns the rear wheel, and the bicycle moves forward. The faster you turn the pedals, the faster the rear wheel goes, and the faster the bike goes. Coasting: At some point — when going downhill, for instance — speed is high enough so that the rear wheel is turning faster than the pedals. That's when coasting: we stop working the pedals and let the bike's momentum keep moving forward. It's the freewheel that makes this possible. On a bicycle, instead of being affixed to the wheel, the rear sprocket is mounted on a freewheel mechanism, which is either built into the hub of the wheel — a "freehub" — or attached to the hub, making it a true freewheel. Now when you have to move forward, the pawl acts like a hook and gets locked with the teeth - called ratchet and transmits the torque. The complete mechanism is called ratchet and pawl mechanism. But when you reverse pedal, it falls back and becomes "free". A spring prevents it from falling permanently. This is the reason why you hear the distinct "click-click" sound when you reverse pedal. Also, there are multiple "pawls" placed along the circumference too. ----------

Que.No	Marks	
Q 6 a)	4	Question: **Draw a neat sketch of Oldham's coupling and explain the working of it.** Answer:  Oldham's coupling. **Oldham's coupling.** An Oldham's coupling is used for connecting two parallel shafts whose axes are at a small distance apart. The shafts are coupled in such a way that if one shaft rotates, the other shaft also rotates at the same speed. This inversion is obtained by fixing the link 2, as shown in Fig. (a). The shafts to be connected have two flanges (link 1 and link 3) rigidly fastened at their ends by forging. The link 1 and link 3 form turning pairs with link 2. These flanges have diametrical slots cut in their inner faces, as shown in Fig. (b). the intermediate piece (link 4) which is a circular disc, have two tongues (i.e. diametrical projections) T1 and T2 on each face at right angles to each other, as shown in Fig. (c). The tongues on the link 4 closely fit into the slots in the two flanges (link 1 and link 3). The link 4 can slide or reciprocate in the slots in the flanges. When the driving shaft A is rotated, the flange C (link 1) causes the intermediate piece (link 4) to rotate at the same angle through which the flange has rotated, and it further rotates the flange D (link 3) at the same angle and thus the shaft B rotates. Hence links 1, 3 and 4 have the same angular velocity at every instant. A little consideration will show, that there is a sliding motion between the link 4 and each of the other links 1 and 3. **Fluctuations of energy:** The variations of energy above and below the mean resisting torque line are called fluctuations of energy. **Coefficient of fluctuation of energy**: It may be defined as the ratio of the maximum fluctuation of energy to the work done per cycle. Mathematically, **Coefficient of fluctuation of energy,** E = Maximum fluctuation of energy/Work done per cycle **Coefficient of fluctuation of speed:** The difference between the maximum and minimum speeds during a cycle is called the maximum fluctuation of speed. The ratio of the maximum fluctuation of speed to the mean speed is called the coefficient of fluctuation of speed. **Maximum fluctuation of energy**: ΔE = Maximum energy − Minimum energy = (E + a1) − (E + a1 − a2 + a3 − a4) = a2 − a3 + a4 ----------

Examination: 2017 WINTER

Que.No	Marks	
Q 1a)(a)	2	Question: **Pappu Define kinematic link and kinematic chain.** Answer: a) Kinematic link: Each part of a machine, which moves relative to some other part, is known as a kinematic link (or simply link) or element. Kinematic Chain: When the kinematic pairs are coupled in such a way that the last link is joined to the first link to transmit definite motion (i.e. completely or successfully constrained motion), it is called a kinematic chain.  ----------
Q 1a)(a)	2	Question: **Define kinematic link and kinematic chain.** Answer: a) Kinematic link: Each part of a machine, which moves relative to some other part, is known as a kinematic link (or simply link) or element. Kinematic Chain: When the kinematic pairs are coupled in such a way that the last link is joined to the first link to transmit definite motion (i.e. completely or successfully constrained motion), it is called a kinematic chain. ----------
Q 1a)(i)	2	Question: **(a) Define : (i) Spherical pair (ii) Higher pair** Answer: a) Single plate clutch b) Multi plate clutch c) Cone clutch d) Centrifugal clutch ii) Classification of follower: ----------
Q 1 b)	2	Question: **(b) Define : (i) Radial follower (ii) Off-set follower** Answer: 1. According to the surface in contact: Knife-edge follower Roller follower Flat faced or mushroom follower Spherical follower 2. According to the motion of the follower: Reciprocating or translating follower Oscillating or rotating follower 3. According to the path of motion of follower: Radial follower Off-set followe ----------

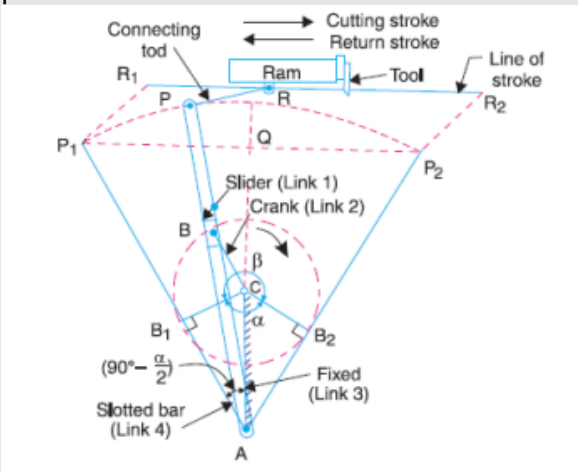
Que.No	Marks	
Q 1 b)	4	Question: **State any four types of friction clutch, along with its application each.** Answer: (Types of clutches: Two marks, applications Two marks) Types of clutches: a) Single plate clutch b) Multi plate clutch c) Cone clutch d) Centrifugal clutch Applications: a) Single plate clutch: Heavy vehicles, four-wheeler such as car, truck, bus b) Multi plate clutch: Two wheelers, mopeds, scooters, bikes c) Cone clutch: Machine tools, automobiles, press work d) Centrifugal clutch: mopeds, Luna ----------
Q 1 b)	4	Question: **Define slip and creep with reference to belt drive. Also state their effect on velocity ratio.** Answer: V- Belt drive – air compressor, machine tools (drilling machine) Flat belt drive - lathe headstock, floor mill, stone crusher unit Gear drive – gear box of vehicles, cement mixing unit, machine tools, I.C. Engine, differential of automobile, dial indicator Chain drive – Bicycle, cranes, Hoists, bikes ----------

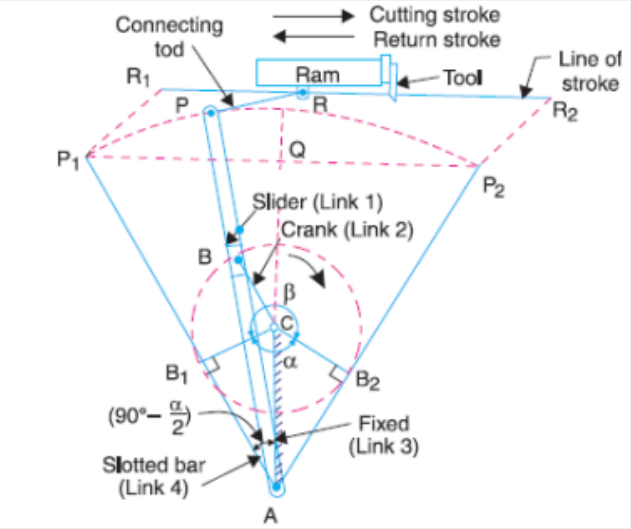
Que.No	Marks	
Q 1b)(a)	4	Question: **Define completely constrained motion and successfully constrained motion with neat sketch. State one example of each.** Answer: a) 1. Completely constrained motion: When the motion between a pair is limited to a definite direction irrespective of the direction of force applied, then the motion is said to be a completely constrained motion. For example, the piston and cylinder (in a steam engine) form a pair and the motion of the piston is limited to a definite direction (i.e.it will only reciprocate) relative to the cylinder irrespective of the direction of motion of the crank. Examples: 1. The motion of a square bar in a square hole 2. the motion of a shaft with collars at each end in a circular hole, 2. Successfully constrained motion: When the motion between the elements, forming a pair, is such that the constrained motion is not completed by itself, but by some other means, then the motion is said to be successfully constrained motion. Consider a shaft in a foot-step bearing as shown in Fig. The shaft may rotate in a bearing or it may move upwards. This is a case of incompletely con-strained motion. But if the load is placed on the shaft to prevent axial upward movement of the shaft, then the motion of the pair is said to be successfully constrained motion. Examples:1. The motion of an I.C. engine valve (these are kept on their seat by a spring) 2. The piston reciprocating inside an engine cylinder 3. Shaft in a foot step bearing  ----------
Q 1 c)	2	Question: **What do you mean by crowning of pulleys in flat belt drive ? State its use.** Answer: 1. As no slip takes place, hence, perfect velocity ratio is obtained (Positive drive). 2. Chain drive gives high transmission efficiency (up to 98 %). 3. Chain drive may be used when the distance between the shafts is less. 4. Chain is made up of metal which would occupy less space as compared with belt or rope drive. 5. Ability to transmit power to several shafts by one chain. 6. Load on the shaft is less and long life. ----------

Que.No	Marks	
Q 1 d)	2	Question: **Define initial tension in belt drive & state its effect.** Answer: 1. Manufacturing cost of chains is relatively high 2. The chain drive needs accurate mounting and careful maintenance 3. High velocity fluctuations especially when unduly stretched 4. Chain operations are noisy as compared to belts. ----------
Q 1 e)	2	Question: **Define fluctuation of speed and fluctuation of energy in case of flywheel.** Answer: Fluctuation of speed: It is the difference between the maximum and minimum speed of Flywheel. Fluctuation of speed = (N1 – N2) rpm N1 – maximum speed, N2 -- minimum speed Fluctuation of energy: It is the difference between the maximum and minimum energy of Flywheel. Maximum energy of Flywheel I ω1 2 Minimum energy of Flywheel = I ω2 2 Fluctuation of energy = I (ω1 2 - ω2 2) in N-m or J I – moment of inertia of flywheel = mk2 where, m – mass of the flywheel, kg and k - radius of gyration of flywheel, m2 ω1 – Maximum Angular velocity, rad/sec ω2 – Minimum Angular velocity, rad/sec ----------
Q 1 f)	2	Question: **Define the sensitivity in relation to governer. State its significance.** Answer: The function of governor is to regulate the mean speed of the engine, when there are variations in the load. Governor automatically adjusts and controls the supply of fuel / working fluid to the engine with the varying load conditions and keeps the mean speed within the certain desired limits. e.g. When the load on an engine increases, its speed decreases, therefore it becomes necessary to increase the supply of fuel or working fluid. The configuration of the governor changes and valve is moved to increase the supply of working fluid. Conversely, when the load on the engine ----------

Que.No	Marks	
Q 1 h)	2	Question: **State the adverse effect of imbalance of rotating elements of machine.** Answer: The process of providing the second mass in order to counter act the effect of the centrifugal force of the disturbing mass is called balancing. In order to prevent the bad effect of centrifugal force of disturbing mass, another mass (balancing) is attached to the opposite side of the shaft at such a position, so as to balance the effect of centrifugal force of disturbing mass. This is done in such a way that the centrifugal forces of both the masses are made equal and opposite. Methods of balancing: Balancing of rotating masses 1) Balancing of a single rotating mass by a single rotating mass in the same plane 2) Balancing of a single rotating mass by two masses rotating in the different planes * Disturbing mass lies in a plane between the planes of balancing masses * Disturbing mass lies in a plane on one end of the planes of balancing masses 3) Balancing of different masses rotating in the same plane 4) Balancing of different masses rotating in the different planes Balancing of reciprocating masses ----------
Q 2 a)	4	Question: **Differentiate between machine and structure.** Answer: Sl. No Machine Structure 1 All parts / links have relative motion No relative motion between the links 2 It transforms the available energy into some useful work No energy transformations 3 The kinematic link of a machine may transmit both power and The member of the structure transmit forces only ----------

Que.No	Marks	
Q 2 a)	4	Question: **What is a machine ? Differentiate between a machine and a structure.** Answer: Sl. No Machine Structure 1 All parts / links have relative motion No relative motion between the links 2 It transforms the available energy into some useful work No energy transformations 3 The kinematic link of a machine may transmit both power and motion The member of the structure transmit forces only 4 Examples: I.C. Engine, Machine tools, steam engine, type writer, etc. Example: Truss of roof, frame of machine, truss of bridge 5 Studied under 'Dynamics' Studied under 'Statics' ----------

Que.No	Marks	
Q 2 b)	4	Question: **Explain with the neat sketch working of crank and slotted lever quick return mechanism.** Answer: Crank and slotted lever quick return motion mechanism: This mechanism is mostly used in shaping machines, slotting machines and in rotary internal combustion engines. In this mechanism, the link AC (i.e. link 3) forming the turning pair is fixed, as shown in fig. The link 3 corresponds to the connecting rod of a reciprocating steam engine. The driving crank CB revolves with uniform angular speed about the fixed centre C. A sliding block attached to the crank pin at B slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A. A short link PR transmits the motion from AP to the ram which carries the tool and reciprocates along the line of stroke R1R2. The line of stroke of the ram (i.e. R1R2) is perpendicular to AC produced  In the extreme positions, AP1 and AP2 are tangential to the circle and the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position CB1 to CB2 (or through an angle β) in the clockwise direction. The return stroke occurs when the crank rotates from the position CB2 to CB1 (or through angle α) in the clockwise direction. Since the crank has uniform angular speed, $\frac{\text{Time of cutting stroke}}{\text{Time of return stroke}} = \frac{\beta}{\alpha} = \frac{\beta}{360^\circ - \beta}$ or $\frac{360^\circ - \alpha}{\alpha}$ ----------

Que.No	Marks	
Q 2 b)	4	Question: **Describe with neat sketch the working of scotch yoke mechanism.** Answer: Crank and slotted lever quick return motion mechanism. This mechanism is mostly used in shaping machines, slotting machines and in rotary internal combustion engines. In this mechanism, the link AC (i.e. link 3) forming the turning pair is fixed, as shown in fig. The link 3 corresponds to the connecting rod of a reciprocating steam engine. The driving crank CB revolves with uniform angular speed about the fixed centre C. A sliding block attached to the crank pin at B slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A. A short link PR transmits the motion from AP to the ram which carries the tool and reciprocates along the line of stroke R1R2. The line of stroke of the ram (i.e. R1R2) is perpendicular to AC produced  In the extreme positions, AP1 and AP2 are tangential to the circle and the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position CB1 to CB2 (or through an angle β) in the clockwise direction. The return stroke occurs when the crank rotates from the position $CB2$ to $CB1$ (or through angle α) in the clockwise direction. Since the crank has uniform angular speed, therefore, $\frac{\text{Time of cutting stroke}}{\text{Time of return stroke}} = \frac{\beta}{\alpha} = \frac{\beta}{360° - \beta}$ or $\frac{360° - \alpha}{\alpha}$ Since the tool travels a distance of $R_1 R_2$ during cutting and return stroke, therefore travel of the tool or length of stroke $= R_1R_2 = P_1P_2 = 2P_1Q = 2AP_1 \sin \angle P_1 AQ$ $= 2AP_1 \sin\left(90° - \frac{\alpha}{2}\right) = 2AP \cos \frac{\alpha}{2}$ ..... $(\because AP_1 = AP)$ $= 2AP \times \frac{CB_1}{AC}$ ... $\left(\because \cos \frac{\alpha}{2} = \frac{CB_1}{AC}\right)$ $= 2AP \times \frac{CB}{AC}$ ... $(\because CB_1 = CB)$ ----------

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Q 2 c)	4	Question: **Explain the inter-relation between linear and angular velocity, linear and angular acceleration with suitable example.** Answer: Velocity of piston, $V_p = \omega r \left(\sin\theta + \frac{\sin 2\theta}{2n} \right)$ State all the terms: ω = angular velocity of the crank, rad/sec n = Ratio of length of connecting rod to the radius of crank = **l / r** (Obliquity of connecting rod) θ = Angle made by the crank with Inner Dead Centre (IDC) r = radius of crank, l = length of connecting rod Acceleration of piston, $A_p = \omega^2 r \left\{ \cos\theta + \frac{\cos 2\theta}{n} \right\}$ Angular velocity of connecting rod $= \frac{\omega \cos\theta}{(n^2 - \sin^2\theta)^{1/2}}$ Angular acceleration of connecting rod, $\alpha_{cr} = -\omega^2 \frac{\sin\theta\,(n^2-1)}{[n^2-\sin^2\theta]^{3/2}}$ ----------

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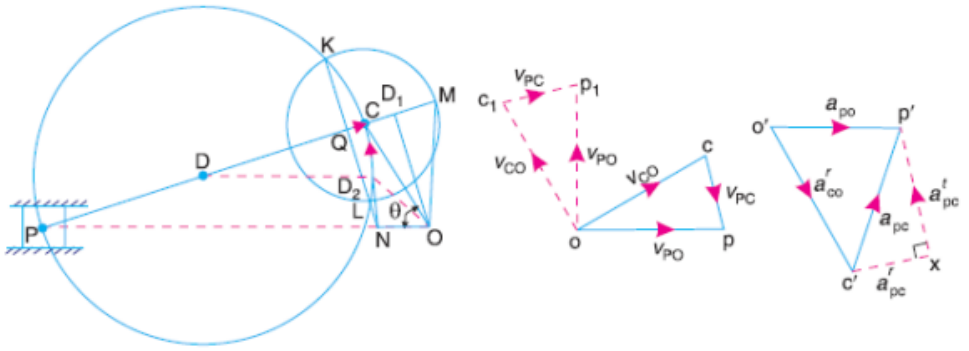
Q 2 d)	4	Question: **Explain the Klein's construction to determine velocity and acceleration of a link in an I.C. engine mechanism.** Answer: Let OC be the crank and PC the connecting rod of a reciprocating steam engine, as shown in Fig. Let the crank makes an angle θ with the line of stroke PO and rotates with uniform angular velocity ω rad/s in a clockwise direction. The Klien's velocity and acceleration diagrams are drawn as discussed below:



(*a*) Klien's acceleration diagram. (*b*) Velocity diagram. (*c*) Acceleration diagram.

Klien's construction

as shown in Fig. If this triangle is revolved through 90°, it will be a triangle oc_1p_1, in which oc_1 represents v_{CO} (*i.e.* velocity of *C* with respect to *O* or velocity of crank pin *C*) and is paralel to *OC*,

op_1 represents v_{PO} (*i.e.* velocity of *P* with respect to *O* or velocity of cross-head or piston *P*) and is perpendicular to *OP*, and

c_1p_1 represents v_{PC} (*i.e.* velocity of *P* with respect to *C*) and is parallel to *CP*.

the triangles oc_1p_1 and *OCM* are similar. Therefore,

$$\frac{oc_1}{OC} = \frac{op_1}{OM} = \frac{c_1p_1}{CM} = \omega \text{ (a constant)}$$

or

$$\frac{v_{CO}}{OC} = \frac{v_{PO}}{OM} = \frac{v_{PC}}{CM} = \omega$$

$$\therefore \quad v_{CO} = \omega \times OC \; ; \; v_{PO} = \omega \times OM, \text{ and } v_{PC} = \omega \times CM$$

Thus, we see that by drawing the Klien's velocity diagram, the velocities of various points may be obtained without drawing a separate velocity diagram.

Klien's acceleration diagram

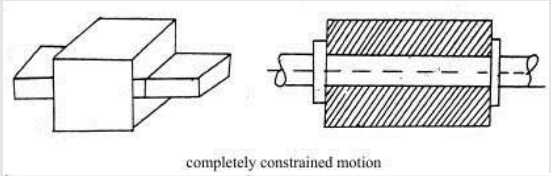
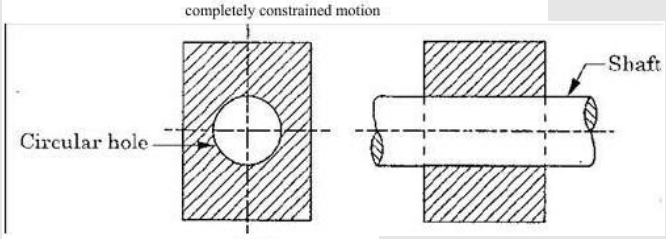
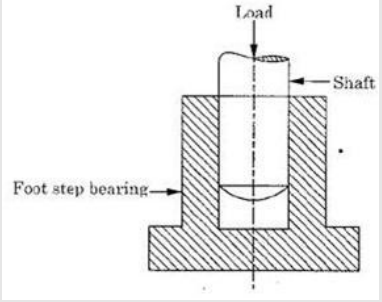
The Klien's acceleration dia- gram is drawn as discussed below:

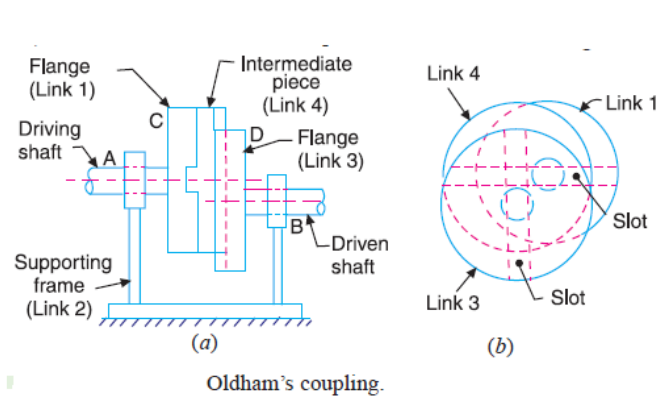
1. First of all, draw a circle with *C* as centre and *CM* as radius.
2. Draw another circle with *PC* as diameter. Let this circle intersect the previous circle at *K* and *L*.
3. Join *KL* and produce it to intersect *PO* at *N*. Let *KL* intersect *PC* at *Q*. This forms the quadrilateral *CQNO*, which is known as *Klien's acceleration diagram*.

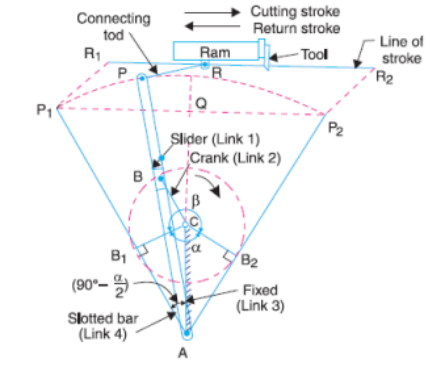
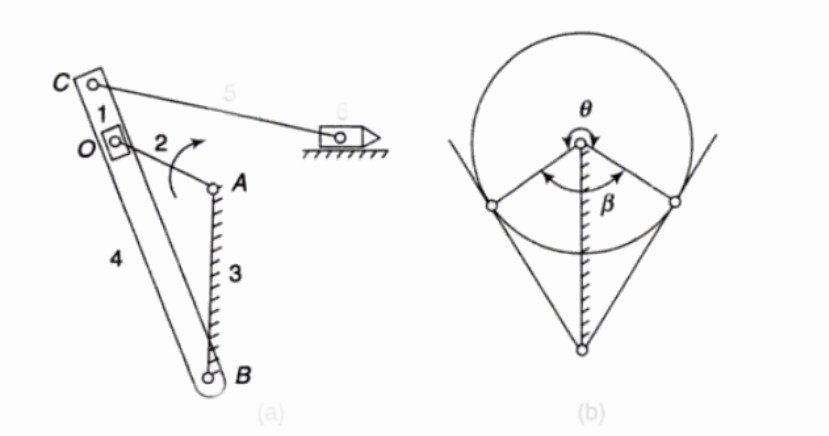
Acceleration of piston, $\alpha_p = \omega^2$ ON

Que.No	Marks	
Q 2 e)	4	Question: **Draw the labelled displacement, velocity and acceleration diagrams for a follower when it moves with simple harmonic motion.** Answer: Roller follower is preferred over knife edge follower Knife-edge of the follower will cause the wear of the cam. Higher load on the small contact area the follower likely to cause wear at the tip of Knifeedge due to more stresses. Knife-edge follower practically not feasible for higher torque / load applications. More friction due to sliding motion of the knife-edge follower and hence, more maintenance. Roller follower on the other hand produces smooth operation with less wear and tear of both cam and follower. Pure rotational motion of roller follower causes less friction and less loss of power. Considerable side thrust exists between knife-edge follower and the guide. ----------
Q 2 f)	4	Question: **A pulley rotating at 50 m/s transmits 40 kW. The safe pull in belt is 400 N/cm width of belt. The angle of lap is 170º. If coefficient of friction is 0.24, find required width of belt.** Answer: Data: Initial tension, To = 2000 N, coefficient of friction, μ = 0.3, Angle of lap, θ = 1500 = 1500 x Π / 180 = 2.618 rad, Smaller pulley radius, R = 200 mm, hence, D = 400 mm, Speed of smaller pulley, N = 500 r.p.m. We know that the velocity of the belt, v = Π = Π = 10.47 m/sec (01 mark) Let T1 = Tension in the belt on the tight side, N Let T2 = Tension in the belt on the slack side, N We know that, T0 = Hence, 2000 = (T1 + T2) / 2 Thus, (T1 + T2) = 4000 N ..... (1) We also know that, = therefore, = or = 2.2 ..... (2) From equations 1 and 2, T1 = 2750 N and T2 = 1250 N (02 marks) Power transmitted by belt, P = [T1 - T2] v = [2750 - 1250] 10.47 = 15700 watts = 15.7 kW ----------
Q 4 b)	4	Question: **Justify that slider crank mechanism is a modification of the basic four bar mechanism with neat sketch.** Answer: Justification for a single slider crank mechanism is a modification of four bar chain mechanism is as given below. 1) Single slider mechanism has four kinematic links – crank, connecting rod, frame and slider and four bar mechanism has crank, coupler, frame and a follower. 2) A follower in four bar mechanism is replaced by a slider. 3) A four bar mechanism has 4 turning pairs and single slider crank mechanism has also four pairs, but one of the turning pairs is replaced by a sliding pairs. 4) A four bar mechanism rotary motion of the crank into oscillating motion of the follower whereas in single slider motion is converted in sliding motion of the piston ----------

Examination: 2016 SUMMER

Que.No	Marks	
Q 1a)(i)	2	Question: **Enlist the types of constrained motion. Draw a label sketch of any one** Answer: Types of constrained motion: (i)Completely constrained motion. (ii)Incompletely constrained motion. (iii)Successfully constrained motion.  completely constrained motion   ----------

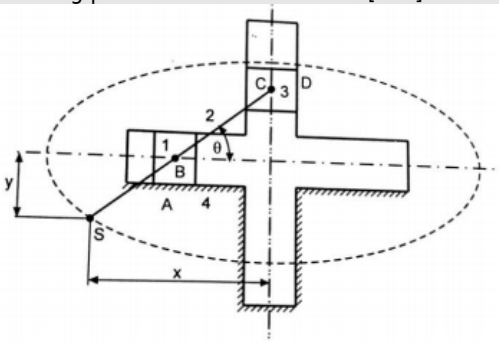
Que.No	Marks	
Q 1b)(i)	4	Question: **State inversions of double slider crank chain. Explain Oldham's coupling with neat sketch** Answer: Inversions of double slider crank chain: i.Scotch Yoke mechanism. ii.Oldham's coupling. iii. Elliptical trammel. Oldham's coupling: An Oldham's coupling is used for connecting two parallel shafts whose axes are at a small distance apart. The shafts are coupled in such a way that if one shaft rotates, the other shaft also rotates at the same speed. This inversion is obtained by fixing the link 2, as shown in Fig. The shafts to be connected have two flanges (link 1 and link 3) rigidly fastened at their ends by forging. The link 1 and link 3 form turning pairs with link 2. These flanges have diametrical slots cut in their inner faces, as shown in Fig. The intermediate piece (link 4) which is a circular disc, have two tongues (i.e. diametrical projections) T1 and T2 on each face at right angles to each other. The tongues on the link 4 closely fit into the slots in the two flanges (link 1 and link 3). The link 4 can slide or reciprocate in the slots in the flanges.  Oldham's coupling. When the driving shaft A is rotated, the flange C (link 1) causes the intermediate piece (link 4) to rotate at the same angle through\ which the flange has rotated, and it further rotates the flange D (link 3) at the same angle and thus the shaft B rotates. Hence links 1, 3 and 4 have the same angular velocity at every instant. A little consideration will show that there is a sliding motion between the link 4 and each of the other links 1 and 3. ----------

Que.No	Marks	
Q 2 a)	4	Question: **Draw a labeled sketch of quick return mechanism of shaper and explain its working?** Answer: **Quick return mechanism** Quick return mechanism : Crank and slotted lever quick return motion mechanism. This quick return mechanism is mostly used in shaping machines, slotting machines and in rotary internal combustion engines. In this quick return mechanism, the link AC (i.e. link 3) forming the turning pair is fixed, as shown in fig. The link 3 corresponds to the connecting rod of a reciprocating steam engine. The driving crank CB revolves with uniform angular speed about the fixed centre C. A sliding block attached to the crank pin at B slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A. A short link PR transmits the motion from AP to the ram which carries the tool and reciprocates along the line of stroke R1R2. The line of stroke of the ram (i.e. R1R2) is perpendicular to AC produced.  n the extreme positions, AP1 and AP2 are tangential to the circle and the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position CB1 to CB2 (or through an angle β) in the clockwise direction. The return stroke occurs when the crank rotates from the position CB2 to CB1 (or through angle α) in the clockwise direction. Since the crank has uniform angular speed, therefore, $\frac{\text{Time of cutting stroke}}{\text{Time of return stroke}} = \frac{\beta}{\alpha} = \frac{\beta}{360°-\beta}$ or $\frac{360°-\alpha}{\alpha}$ Since the tool travels a distance of $R_1 R_2$ during cutting and return stroke, therefore travel of the tool or length of stroke $= R_1R_2 = P_1P_2 = 2P_1Q = 2AP_1 \sin \angle P_1AQ$ $= 2AP_1 \sin\left(90° - \frac{\alpha}{2}\right) = 2AP \cos\frac{\alpha}{2}$ ..... $(\because AP_1 = AP)$ $= 2AP \times \frac{CB_1}{AC}$ ... $\left(\because \cos\frac{\alpha}{2} = \frac{CB_1}{AC}\right)$ $= 2AP \times \frac{CB}{AC}$ ... $(\because CB_1 = CB)$ --- **Quick return mechanism Alternate answer :**  **Links -** 1.Slider 2. Crank 3.Frame 4.Slotted Lever ---

Que.No	Marks	
Q 2 b)	4	Question: **What are the types of kinematic pair ? Give its examples.** Answer:

Types of Kinematic Pairs.	Examples
A. According to nature of relative motion	
i. Sliding pair.	Piston and cylinder, Tail stock on the lathe bed etc.
ii. Turning pair.	A shaft with collars at both ends fitted into a circular hole, Cycle wheels turning over their axles etc.
iii. Rolling pair.	Ball and roller bearing.
iv. Screw pair.	A lead screw of a lathe with nut, Bolt with a nut etc.
v. Spherical pair	The ball and socket joint, attachment of car mirror, pen stand etc.
B. According to nature of contact	
i. Lower Pair.	All sliding pairs, turning pairs and screw pairs forms lower pair.
ii. Higher pair	A pair of friction discs, toothed gearing, belt and rope drives, ball and roller bearings, cam and followers are examples of higher pairs.
C. According to nature of mechanical arrangement	
i. Closed pair or self closed pair.	The lower pairs are self closed pairs.
ii. Open or force close pair.	Cam and follower.

Q 4 b)	4	Question: **Justify with neat sketch elliptical trammel as an inversion of double slider crank chain.** Answer: **Elliptical trammel :** Since Elliptical trammel consist of two turning pairs and two sliding pairs, it is inversion of double slider crank chain. This instrument is used for drawing ellipses. This inversion is obtained by fixing a slotted plate (link 4) as shown in fig. It has got two right angled grooves cut into it. 1-2 is turning pair 2-3 is turning pair 1-4 is sliding pair 3-4 is sliding pair..... [2 M]



As the crank BC is rotated, any point on crank except midpoint of BC and point B and C will trace the ellipse. Midpoint of BC will trace a circle. The points B and C will move in straight line along the slot. .....[2M]

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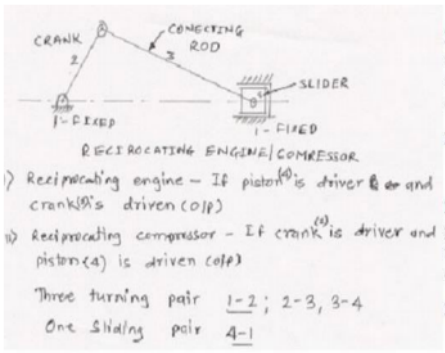
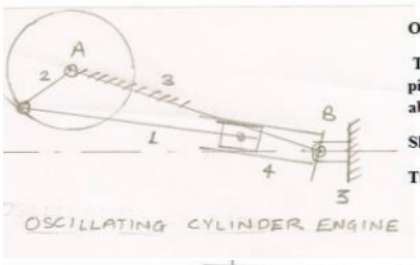
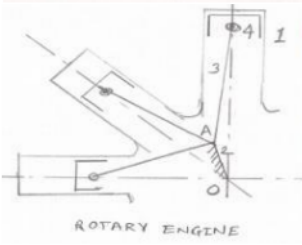
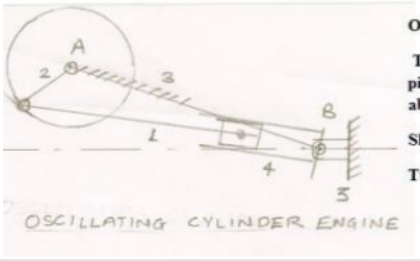
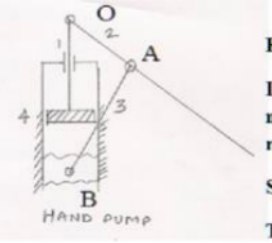
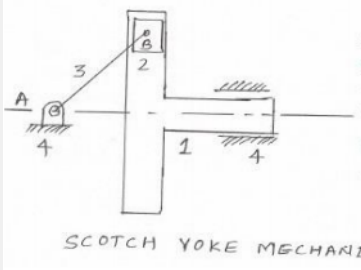
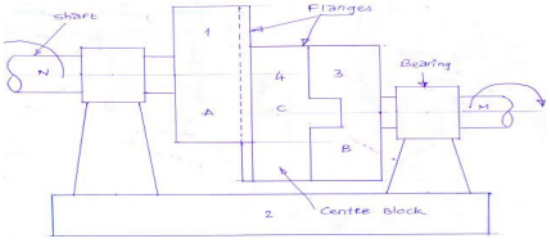
Que.No	Marks	
Q 1a)(i)	2	Question: **Define Kinematic link with one example.** Answer: **Kinematic link --**Each part of a machine, which moves relative to some other part, is known as a 'kinematic link (or simply link) or element. Example – any one Example of machine element, (e.g. shaft, spindle, gear, crank, belt, pulley, key etc.) ----------
Q 1a)(ii)	2	Question: **Name different mechanisms generated from a single slider crank chain.** Answer: Different mechanism generated by single slider crank chain mechanism. a) Reciprocating engine, Reciprocating compressor b) Whitworth quick return mechanism, Rotary engine, c) Slotted crank mechanism, Oscillatory engine d) Hand pump, pendulum pump or Bull engine ----------

Que.No	Marks	
Q 1b)(i)	4	Question: **State any four inversions of single slider crane chain. Describe any one with neat sketch.** Answer: **1.**Reciprocating engine, Reciprocating compressor; **2.** Whitworth quick return mechanism, Rotary engine, **3.**Slotted crank mechanism, Oscillatory engine. **4.**Hand pump, pendulum pump. **1.Reciprocating engine**, Reciprocating compressor link 1 is fixed  **Reciprocating engine** – In reciprocating engine piston/ slider (link 4) reciprocates in cylinder (fixed link 1) forming sliding pair. The connecting rod (fixed link 3)oscillates and crank rotates about fixed link 1. **Here input is from slider or piston (link 4)** **Reciprocating compressor** – In reciprocating compressor, piston/ slider (link 4) reciprocates in cylinder (fixed link 1) forming sliding pair. The connecting rod (fixed link 3) oscillates and crank rotates about fixed link 1. **Here input is from crank (link 2).** **2.Whitworth quick return mechanism, Rotary engine** link 2 is fixed,  **Oscillating cylinder engine** **The crank (link 2) rotates; the piston is connected to piston rod (link1) reciprocates and cylinder oscillates about fixed link 3.** **Sliding pair 1-4,** **Turning pair 1-2 , 2-3, 3-4**  **Rotary engine** **Crank link is fixed (link 2), slider (link 4) is mounted in cylinder, all sliders are connected by connecting rod (link 3). The complete assembly of cylinders and crankcase rotates about center o.** **Sliding pair 1-4,** **Turning pair 3-4, 2-3, 1-2** **3.- Oscillatory engine. Slotted crank mechanism**. link 3 is fixed  **Oscillating cylinder engine** **The crank (link 2) rotates; the piston is connected to piston rod (link1) reciprocates and cylinder oscillates about fixed link 3.** **Sliding pair 1-4,** **Turning pair 1-2 , 2-3, 3-4** **4. Hand pump, pendulum pump.** link 4 is fixed  **Hand pump** **Link 3 can oscillates about fixed point B on link 4, this makes end A of link 2 to oscillates about B and end O to reciprocates along the axis of the fixed link 4** **Sliding pair 1-4,** **Turning pair 1-2 , 2-3, 3-4** ----------

Que.No	Marks	
Q 2 a)	4	Question: **Explain a scotch yoke mechanism with a neat sketch.** Answer: **Explanation of scotch yoke mechanism with neat sketch**  **In scotch yoke mechanism slide block of first inversion is fixed. End B of crank (link 3) rotates about center A. Link 1 reciprocates in horizontal direction.** **Sliding pair –two --- 1-4, 2-1** **Turning pair – two---- 2-3, 3-4** ----------
Q 2 b)	4	Question: **What is machine ? Differentiate between a machine and a structure.** Answer: Machine definition --A device which transforms available energy into useful work is called as machine Difference of machine and structure **Machine** / **Structure** Machine transform available energy into useful work / Structure dose not transform energy in to the useful work The link of m/c made transmit both power relative motion and forces. / The members of structure transmit forces only. M/c can have one or more mechanism. / It does not have mechanism. e.g. Drilling machine; Lathe machine etc. / e.g. Machine frames, Bridge etc. ----------
Q 4 b)	4	Question: **Describe with neat sketch the working of Oldham's coupling.** Answer:  Oldham's coupling is used for connecting too parallel shafts whose axis are a small distance a part the shafts are coupled in such a way that if one shaft rotates the other shaft also rotate at same speed. This mechanism is obtained by fixing link 2 which is shown in fig. The shafts to be connected have two flanges namely link 1 and links 3 are rigidly fasten at their end by pair with link2. The link 4 is a single part but acting in two ways so link 4 form two sliding pair. When the driving shaft N rotates the flange 'A' causes the intermediate piece (Centre Block) to rotate at same angle through which flange has rotate and it further rotate the flange B (link 3) at same angle and thus shaft M rotates. ----------

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<table>
<tr><th>Que.No</th><th>Marks</th><th></th></tr>
<tr><td>Q 1a)(a)</td><td>2</td><td>Question:
Define kinematic link and kinematic chain.

Answer:
Each part of a machine, which moves relative to some other part, is known as a kinematic link.
When the kinematic pairs are coupled in such a way that the last link is joined to the first link to transmit definite motion (i.e. completely or successfully constrained motion), it is called a kinematic chain.
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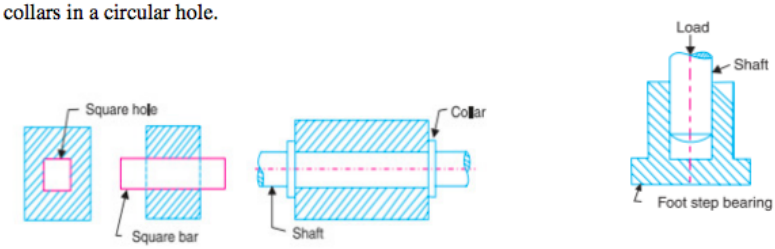
<tr><td>Q 1b)(a)</td><td>4</td><td>Question:
Define completely constrained motion and successfully constrained motion with neat sketch. State one example of each.

Answer:
Completely constrained motion. When the motion between a pair is limited to a definite direction irrespective of the direction of force applied, then the motion is said to be a completely constrained motion. For example, the piston and cylinder (in a steam engine) form a pair and the motion of the piston is limited to a definite direction (i.e. it will only reciprocate) relative to the cylinder irrespective of the direction of motion of the crank, e.g. Square bar in a square hole. & Shaft with collars in a circular hole.
 

Completely constrained motion. Successfully constrained motion

Successfully constrained motion. When the motion between the elements, forming a pair, is such that the constrained motion is not completed by itself, but by some other means, then the motion is said to be successfully constrained motion. Consider a shaft in a foot-step bearing as shown in Fig. The shaft may rotate in a bearing or it may move upwards. This is a case of incompletely constrained motion. But if the load is placed on the shaft to prevent axial upward movement of the shaft, then the motion of the pair is said to be successfully constrained motion. The motion of an I.C. engine valve (these are kept on their seat by a spring) and the piston reciprocating inside an engine cylinder are also the examples of successfully constrained motion.
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<tr><td>Q 2 a)</td><td>4</td><td>Question:
Differentiate machine and structure on any four points.

Answer:
<table>
<tr><th>Sr. No.</th><th>Machine</th><th>Structure</th></tr>
<tr><td>1</td><td>Relative motion exist between its parts</td><td>No relative motion exists between its members.</td></tr>
<tr><td>2</td><td>Links are meant to transmit motion and forces which are dynamic (both static and kinetic)</td><td>Members are meant for carrying loads or subjected to forces having straining actions</td></tr>
<tr><td>3</td><td>Machines serve to modify and transmit mechanical work.</td><td>Structure serves to modify and transmit forces only.</td></tr>
<tr><td>4</td><td>Example: shaper, lathe , screw jack etc</td><td>Examples: roof trusses, bridges, buildings, machine frames etc.</td></tr>
</table>
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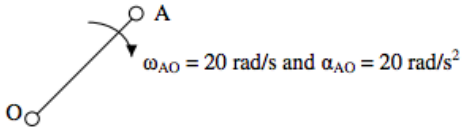
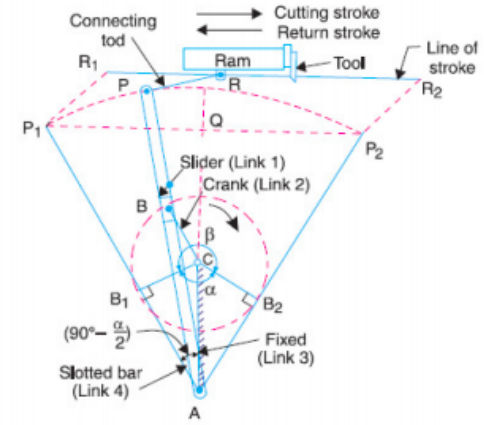
</table>

Que.No	Marks	
Q 3 f)	4	Question: **Crank OA of a mechanism is hinged at 'O' and rotates at an angular velocity of 20 rad/sec. and angular acceleration of 25 rad/sec2 . If crank OA is 50 mm long determine linear velocity, centripetal acceleration and tangential acceleration of a point A.** Answer:  Angular velocity ω_{AO} = 20 rad /sec, α_{AO} = 20 rad /s^2 , OA = 50 mm Linear velocity $V_{AO} = \omega_{AO}$ x OA =20 x 50 /1000 = 1 m/s Centripetal acceleration = $a^r_{AO} = a_B = \omega^2_{AO}$ x OA = 20 x 20 x 0.05 =20 m/s^2 Tangential acceleration = $\alpha^t_{OA} = a^t_{AO}$ / OA a^t_{AO} = OA x α^t_{OA} = 0.05 x 20 = 1 rad / s^2 ----------

Que.No	Marks	
Q 4 b)	4	Question: **Explain with the diagram working of crank and slotted lever quick return mechanism.** Answer: **Crank and slotted lever quick return motion mechanism:** This mechanism is mostly used in shaping machines, slotting machines and in rotary internal combustion engines. In this mechanism, the link AC (i.e. link 3) forming the turning pair is fixed, as shown in fig. The link 3 corresponds to the connecting rod of a reciprocating steam engine. The driving crank CB revolves with uniform angular speed about the fixed centre C. A sliding block attached to the crank pin at B slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A. A short link PR transmits the motion from AP to the ram which carries the tool and reciprocates along the line of stroke R1R2. The line of stroke of the ram (i.e. R1R2) is perpendicular to AC produced.  In the extreme positions, $AP1$ and $AP2$ are tangential to the circle and the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position $CB1$ to $CB2$ (or through an angle β) in the clockwise direction. The return stroke occurs when the crank rotates from the position $CB2$ to $CB1$ (or through angle α) in the clockwise direction. Since the crank has uniform angular speed, therefore, $$\frac{\text{Time of cutting stroke}}{\text{Time of return stroke}} = \frac{\beta}{\alpha} = \frac{\beta}{360° - \beta} \quad \text{or} \quad \frac{360° - \alpha}{\alpha}$$ Since the tool travels a distance of $R_1 R_2$ during cutting and return stroke, therefore travel of the tool or length of stroke $$= R_1R_2 = P_1P_2 = 2P_1Q = 2AP_1 \sin \angle P_1AQ$$ $$= 2AP_1 \sin\left(90° - \frac{\alpha}{2}\right) = 2AP \cos\frac{\alpha}{2} \quad \ldots (\because AP_1 = AP)$$ $$= 2AP \times \frac{CB_1}{AC} \quad \ldots \left(\because \cos\frac{\alpha}{2} = \frac{CB_1}{AC}\right)$$ $$= 2AP \times \frac{CB}{AC} \quad \ldots (\because CB_1 = CB)$$ ----------

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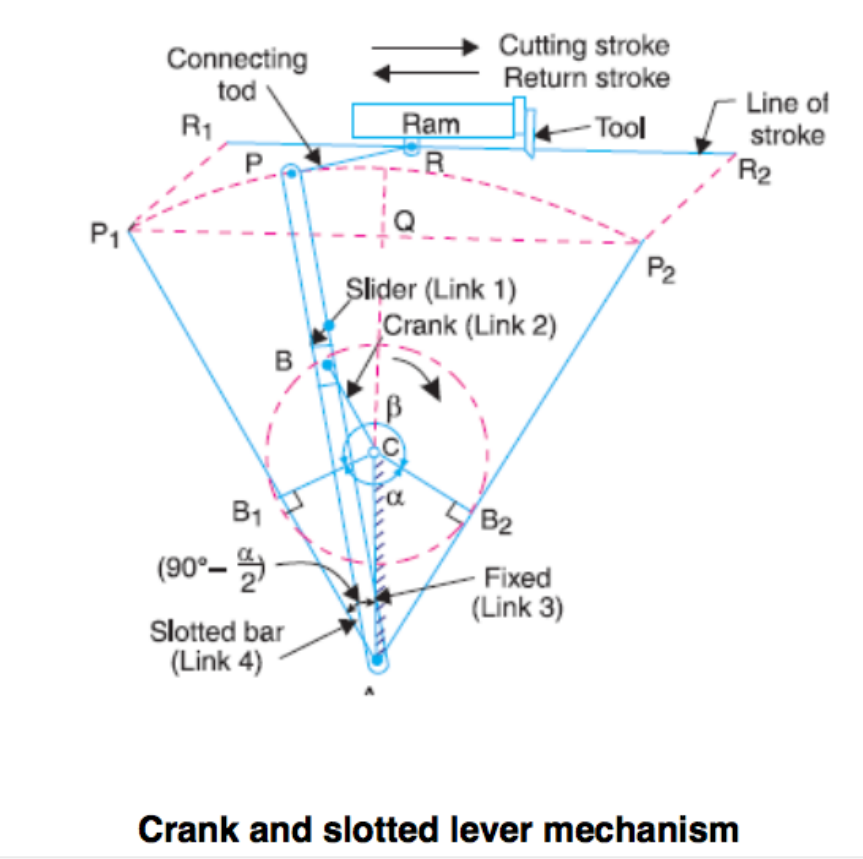
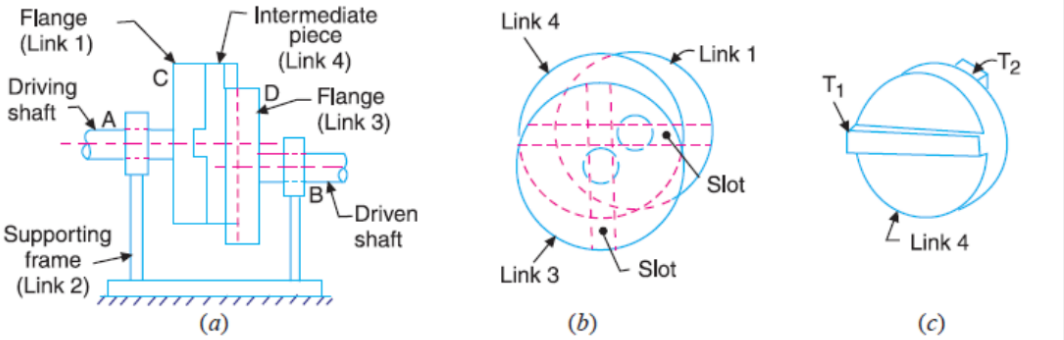
Que.No	Marks	
Q 1a)(i)	2	Question: **Define - 1. Mechanism 2.Inversion** Answer: 1. Mechanism : When one of the links of a kinematic chain is fixed, the chain is known as mechanism. 2. Inversion of mechanism The method of obtaining different mechanisms by fixing different links in a kinematic chain, is known as inversion of the mechanism. So we can obtain as many mechanisms as the number of links in a kinematic chain by fixing, in turn, different links in a kinematic chain. ----------
Q 1b)(i)	2	Question: **Draw neat labeled sketch of crank and slotted lever mechanism. Label all parts.** Answer:  **Crank and slotted lever mechanism** ----------

Que.No	Marks	
Q 2 a)	4	Question: **State and explain various types of constrained motions with suitable examples.** Answer: **Types of Constrained Motions :** Following are the three types of constrained motions: **1. Completely constrained motion:** When the motion between a pair is limited to a definite direction irrespective of the direction of force applied, then the motion is said to be a completely constrained motion. For example, the piston and cylinder (in a steam engine) form a pair and the motion of the piston is limited to a definite direction (i.e. it will only reciprocate) relative to the cylinder irrespective of the direction of motion of the crank. **2. Incompletely constrained motion:** When the motion between a pair can take place in more than one direction, then the motion is called an incompletely constrained motion. The change in the direction of impressed force may alter the direction of relative motion between the pair. A circular bar or shaft in a circular hole is an example of an incompletely constrained motion as it may either rotate or slide in a hole. These both motions have no relationship with the other. **3. Successfully constrained motion:** When the motion between the elements, forming a pair, is such that the constrained motion is not completed by itself, but by some other means, then the motion is said to be successfully constrained motion. Consider a shaft in a foot-step bearing. The shaft may rotate in a bearing or it may move upwards. This is a case of incompletely constrained motion. But if the load is placed on the shaft to prevent axial upward movement of the shaft, then the motion of the pair is said to be successfully constrained motion. ----------
Q 2 b)	4	Question: **Draw the neat labeled sketch of Oldham's coupling. State its applications.** Answer: **Applications:** An Oldham's coupling is used for connecting two parallel shafts whose axes are at a small distance apart. Used to transmit motion and power.  **Oldham's coupling.** ----------

Que.No	Marks	
Q 4 b)	4	Question: **State the meaning of sliding pair, turning pair, rolling pair and spherical pair with one example each.** Answer: *Sliding pair.* When the two elements of a pair are connected in such a way that one can only slide relative to the other, the pair is known as a sliding pair. The piston and cylinder, cross-head and guides of a reciprocating steam engine, ram and its guides in shaper, tail stock on the lathe bed etc. are the examples of a sliding pair. A little consideration will show, that a sliding pair has a completely constrained motion. *Turning pair.* When the two elements of a pair are connected in such a way that one can only turn or revolve about a fixed axis of another link, the pair is known as turning pair. A shaft with collars at both ends fitted into a circular hole, the crankshaft in a journal bearing in an engine, lathe spindle supported in head stock, cycle wheels turning over their axles etc. are the examples of a turning pair. A turning pair also has a completely constrained motion. *Rolling pair.* When the two elements of a pair are connected in such a way that one rolls over another fixed link, the pair is known as rolling pair. Ball and roller bearings are examples of rolling pair. *Spherical pair.* When the two elements of a pair are connected in such a way that one element (with spherical shape) turns or swivels about the other fixed element, the pair formed is called a spherical pair. The ball and socket joint, attachment of a car mirror, pen stand etc., are the examples of a spherical pair. ----------