

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 1 - Fundamentals of Kinematics and Mechanisms

SUBJECT: THEORY OF MACHINES I (202048)

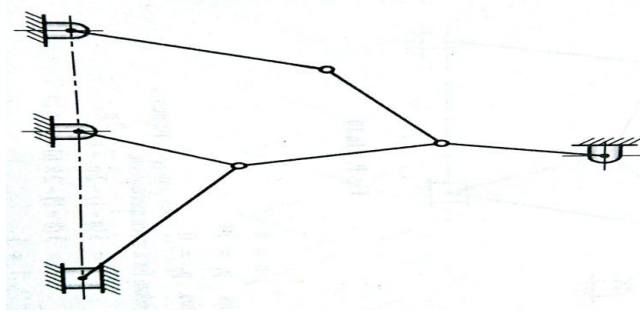
COURSE : SE (2015 Pattern)

THEORY QUESTIONS

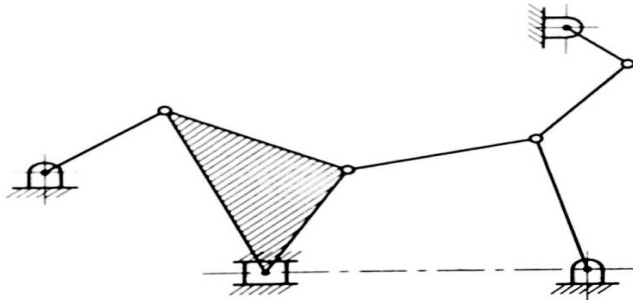
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| Q.1 | Explain the term kinematic link. Give the classification of kinematic link | 6 |
| Q.2 | Explain the term kinematic pair. Give the classification of kinematic pairs based on various criterion. | 6 |
| Q.3 | What is an inversion of a kinematic chain? Explain any two inversions of a single slider-crank chain with practical applications | 6 |
| Q.4 | What is a mechanism? Giving example, differentiate between a machine and a mechanism. | 6 |
| Q.5 | What is a machine? Giving example differentiate between a machine and a structure. | 6 |
| Q.6 | Write notes on complete and incomplete constraints in lower and higher pairs, illustrating your answer with neat sketches. | 6 |
| Q.7 | Explain the terms : 1. Lower pair, 2. Higher pair, 3. Kinematic chain, and 4. Inversion. | 6 |
| Q.8 | What is Grashof's law. | 6 |
| Q.9 | Write a short note on Gnome engine. | 4 |
| Q.10 | What is the significance of degrees of freedom? | 4 |
| Q.11 | What is Kutzbach mobility criterion. | 4 |
| Q.12 | What is equivalent linkage of mechanisms. | 4 |
| Q.13 | Explain Grubler's criterion for determining degree of freedom for mechanisms. | 6 |
| Q.14 | Sketch and explain the various inversions of a slider crank chain and four bar chain mechanism. | 6 |
| Q.15 | Sketch and describe the working of two different types of quick return mechanisms. Give examples of their applications. | 6 |
| Q.16 | Derive an expression for the ratio of times taken in forward and return stroke for one of these mechanisms. | 6 |
| Q.17 | Sketch and explain any two inversions of a double slider crank chain. | 6 |
| Q.18 | Identify the kinematic chains to which the following mechanisms belong :
a. Steam engine mechanism
b. Beam engine
c. Whitworth quick return motion mechanism
d. Elliptical trammel | 6 |
| Q.19 | Explain with a neat sketch 'Geneve Mechanism' | 6 |
| Q.20 | Explain with a neat sketch 'Swinging and rocking Mechanism' | 6 |
| Q.21 | What is pantograph. | 4 |
| Q.22 | What are the different types of straight and exact line generating mechanisms. | 6 |
| Q.23 | State and explain the condition for correct steering. | 6 |
| Q.24 | Name and explain the two main types of steering gear mechanisms used in automobiles. | 6 |
| Q.25 | Differentiate between Ackermann and Davis steering gear mechanisms. | 6 |
| Q.26 | What is the condition of correct steering? Explain the construction and working of Davis steering Gear Mechanism with the help of neat sketch | 6 |
| Q.27 | What is meant by a 'steering gear mechanism'? Why is it necessary? Why are steering gear mechanism seen in four-wheelers? Explain. | 6 |

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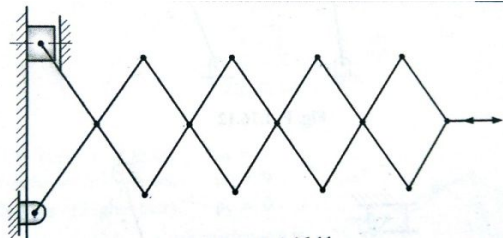
- Q.28 Below Fig. shows schematic of a mechanism. Redraw the free-hand sketch on the answer book. Find out the total number of a kinematic links and number of kinematic pairs. Hence find out the degree of freedom for the mechanism. 10



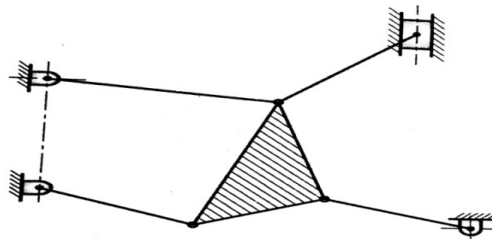
- Q.29 Below Fig. shows schematic of a mechanism. Redraw the free-hand sketch on the answer book. Find out the total number of a kinematic links and number of kinematic pairs. Hence find out the degree of freedom for the mechanism. 10



- Q.30 Calculate the degree of freedom of the following mechanism, as shown in Fig, 10

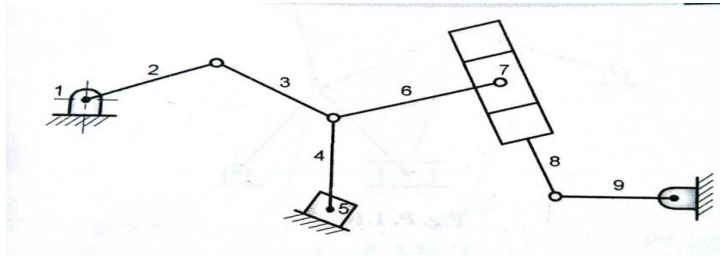


- Q.31 Fig.shows schematic of a mechanism. Redraw the free-hand sketch on the answer book. Find out the total number of a kinematic links and number of kinematic pairs. Hence find out the degree of freedom for the mechanism. 10



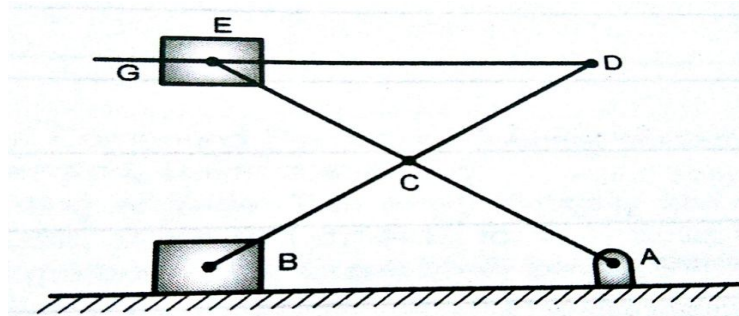
Q.32 calculate the degree of freedom of the following mechanism, shown in Fig.

10



Q.33 A car using Ackermans steering gear has a wheel base of 2.8 m and a track of 1.5m. The track rod is 1.1 m and the track arm is 0.15 m. the distance between the pivots of stub axle is 1.2 m. find the radius of inner wheels for correct steering. 10

Q.34 For the mechanism shown in Fig. Find (i) No. of binary links (ii) No. of binary joints (iii) No. of lower pairs. (iv) Degree of freedom. 10



DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 2 - Static and Dynamics Force Analysis

SUBJECT: THEORY OF MACHINES I (202048)

COURSE : SE (2015 Pattern)

THEORY QUESTIONS

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| Q.1 | Explain D'Alembert's principle | 6 |
| Q.2 | What is friction circle and friction axis. Explain its application for a linkage. | 6 |
| Q.3 | Explain what is mean by Dynamical equivalence of two system masses. For a connecting rod of an I.C. engine having mass 'm' and radius of gyration 'k', obtain a two mass dynamically | 4 |
| Q.4 | Explain analytical method for inertia forces in IC engine mechanism. | 4 |
| Q.5 | Explain the important and use of turning moment diagram of reciprocating engines. | 5 |
| Q.6 | What is meant by 'Correction Couple' ? When do we need to consider it ? | 4 |
| Q.7 | Define turning moment diagram. Explain the method of drawing (T ₀) diagram for a single cylinder, double acting reciprocating steam engine. | 5 |
| Q.8 | Compare compound pendulum method and bifilar suspension method of finding moment of inertia of flat like body. | 5 |
| Q.9 | Explain trifilar suspension method. | 5 |
| Q.10 | State and explain with fig. conditions for dynamically equivalent system. | 5 |
| Q.11 | Explain correction couple. When do we consider it? | 5 |
| Q.12 | Derive relation for piston effort or axial force acting on piston. | 5 |
| Q.13 | Explain types of friction and laws of dry friction. | 5 |
| Q.14 | Explain friction circle and friction axis. | 5 |
| Q.15 | Explain how to find values of correction couple. | 5 |
| Q.16 | Explain how to determine position of m ₂ dynamically equivalent system of two masses by graphical method. | 5 |

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| Q.17 | A connecting rod with mass 3.5 kg oscillates 50 times in one minute when suspended from small end. Find its mass moment of inertia about an axis passing through its C.G which is located at 350mm from small end. | 10 |
| Q.18 | The following data is related to connecting rod of reciprocating engine. Mass=40kg,distance between bearing center=800mm,big end bearing diameter=80mm, small end bearing diameter=60mm,Timeof oscillation when suspended from small end 1.75sec and from big end is 1.6sec. Find M.I about axis passing through ass centre and dynamically equivalent system of two masses, one located at small end center. | 10 |
| Q.19 | Find the dynamically equivalent system of two masses for a connecting rod when one –third of the mass is located at small end. Center of mass is at two-third length from the small end and its M.I is $(1/20) mL^2$. | 12 |
| Q.20 | The connecting rod of engine has length of 220mm between centers and has a mass of 2kg. If C.G is at 150mm from the small end center and the M.I of 0.02kg-m^2 about its C.G. Find two mass dynamically equivalent system when one mass is located at the small end center. | 10 |

- Q.21 In a slider crank mechanism crank is 150 mm and length of connecting rod is 600 mm. The mass of reciprocating parts is 6 kg. The mass of connecting rod is 1.5 kg. The CG of connecting rod is 200 mm from big end centre and mass moment of inertia of the connecting rod is about the mass centre is 0.0048 kg m^2 . Determine by graphically the torque on crank shaft to overcome the inertia of moving parts. 10
- Q.22 The connecting rod of an engine has a length equal to 220 mm between centers and has a mass equal to 2 kg. Its centre of gravity is at 150 mm from the small end centre and the moment of inertia of 0.02 kg-m² about its centre of gravity. Find : 10
- (I) the two mass dynamically equivalent system when one mass is located at the small end centre.
- (ii) the correction couple, if two masses are placed at the two ends and the angular acceleration of the connecting rod is 20,000 rad/s anticlockwise.
- Q.23 A high speed vertical engine has a connecting rod length five times the crank which is 60 mm. Its mass is 3 kg and has a C.G. 200 mm from the small end bearing. When suspended in a small end bearing, it makes 50 oscillations in 52 seconds. The reciprocating parts have a mass of 1.5 kg. Determine the torque exerted on the crankshaft due to inertia of the moving parts when the crank makes an angle of 135° with TDC, and speed of rotation is 1200 rpm. 10
- Q.24 Find the torque required to overcome inertia of moving parts when crank is at 60 with IDC and crank rotates at 700 rpm. 4
- Q.25 The following data relate to a connecting rod of a reciprocating engine : 10
- Mass = 55 kg
Distance between bearing centers = 850 mm
Diameter of small end bearing = 75 mm
Diameter of big end bearing = 100 mm
Time of oscillation when the connecting rod is suspended from small end 1.83 seconds. Time of oscillation when the connecting rod is suspended from big end = 1.68 second. Determine :
1. The radius of gyration of the rod about an axis passing through the centre of gravity and perpendicular to the plane of oscillation;
 2. The moment of inertia of the rod about the same axis; and
 3. The dynamically equivalent system for the connecting rod constituted of two masses, one of which is situated at the small end.
- Q.26 The piston diameter of an internal combustion engine is 125 mm and the stroke is 220 mm. The connecting rod is 4.5 times the crank length and has a mass of 50 kg. The mass of the reciprocating parts is 30 kg. The centre of mass of connecting rod is 170 mm from the crank pin centre and the radius of gyration about an axis through the centre of mass is 148 mm. The engine runs at 320 rpm. Find the magnitude and the direction of the inertia force and the corresponding torque on the crankshaft when the angle turned by the crank is 140° from the inner dead centre. 10
- Q.27 The following data relate to a horizontal reciprocating engine : 10
- Mass of the reciprocating parts = 120 kg
Crank length = 90 mm Engine speed = 600 rpm
Connecting rod data :
Mass = 90 kg
Length between centers = 450 mm
Distance of centers of mass from big end centre = 180 mm.
Radius of gyration about an axis through centre of mass = 150 mm.

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO. 3 - Friction Clutches, Brakes & Dynamometers

SUBJECT: THEORY OF MACHINES I (202048)

COURSE : SE (2015 Pattern)

THEORY QUESTIONS

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| Q.1 | Derive an expression for frictional torque of a collar thrust bearing assuming uniform pressure and uniform wear theory. | 10 |
| Q.2 | State various types of clutches and explain the construction and working of multiplate clutch with fig. | 6 |
| Q.3 | State advantages & disadvantages of the positive clutch. | 4 |
| Q.4 | State advantages & disadvantages of the friction clutches | 4 |
| Q.5 | Justify the statement ' Though cone clutches provide high frictional torque yet they have become obsolete'. | 5 |
| Q.6 | Draw a neat sketch of centrifugal clutch give two practical applications. | 4 |
| Q.7 | Derive the expression for torque transmitting capacity of centrifugal clutch. | 5 |
| Q.8 | State general requirement of good braking system. | 5 |
| Q.9 | Explain with figure working of single block shoe brake and band brake. | 5 |
| Q.10 | Explain self locking and self energizing brakes. | 5 |
| Q.11 | Explain with figure working of differential band brake. | 5 |
| Q.12 | Derive the expression for tension ratio in case of band and block brake. | 5 |
| Q.13 | Explain with figure working of internal expanding shoe brake and give its applications. | 5 |
| Q.14 | Define dynamometer and state its applications. | 5 |
| Q.15 | Explain with figure working of rope brake dynamometer. | 5 |
| Q.16 | Explain belt transmission dynamometer. | 5 |
| Q.17 | Explain with figure principle and working of Belvis-Gibson torsion dynamometer. | 5 |

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| Q.18 | A shaft has a number of collar integral with it. the outer and inner diameters of collar are 400mm and 250mm respectively. If intensity of pressure is 0.35MN/m^2 and its COF is 0.05. Find power absorbed in overcoming friction when shaft runs at 105 rpm with axial load | 10 |
| Q.19 | A conical pivot supports the load of 20KN. The intensity of pressure is 0.5MN/m^2 . Find diameter of bearing surface and cone angle, if the face width is 0.75 times the diameter. If the shaft runs at 120 rpm and COF is 0.06. Find power lost in friction. | 10 |
| Q.20 | A single plate clutch transmits 25KW at 900rpm. The max intensity of pressure is 85KN/m^2 . The outer diameter of plate is 360 mm with both sides effective and COF is 0.25. Find inner diameter of plate. | |
| Q.21 | A centrifugal clutch transmits 25KW power at 900rpm. The speed at which engagement begins is 70% of running speed. The inner radius of drum is 15 cm and the radial distance of center of gravity of shoe from axis of rotation of spider in engaged position is 12cm. Determine mass of each shoe. Take no. of shoe is four and COF is 0.25 and pressure intensity is 0.1N/mm^2 . | 10 |

- Q.22 A band and block brake having 12 blocks, each of which subtends angle of 16° at center is applied to a rotating drum of diameter 600mm. The blocks are 75mm thick. The drum and flywheel mounted on same shaft have mass of 1800kg and combined radius of gyration is 600mm. The two ends of band are attached to pins on opposite sides of the brake fulcrum at distance of 40mm and 150mm from fulcrum. If the force of 250N applied at the distance of 900mm from fulcrum. Find a) Max braking torque. b) Angular retardation of drum. c) Time taken by system to be stationary from rated speed of 300rpm. Take COF as 0.3. 10
- Q.23 A torsion dynamometer is fitted on turbine shaft to measure the angle of twist. The shaft twist 1.6° for length of 8m at 600 rpm. The diameter of shaft is 250mm. Find the power transmitted by the turbine. Take $G=80\text{Gpa}$. 10
- Q.24 A centrifugal clutch transmits 15KW power at 900rpm. The shoes are four in numbers and engages with the drum at 75% of running speed of input shaft. The inner radius of drum is 15cm and the radial distance of centre of gravity of shoes from centre of rotation of spider in engaged position is 12 cm. Take coefficient of friction as 0.25 and maximum permissible pressure intensity as 0.1 N/mm^2 . Determine i) Mass of each shoe. ii) Size of the shoes if angle subtended by the shoes at the centre of the spider is 60° . 10

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO.4 - Kinematic Analysis of Mechanisms (Analytical Methodes)

SUBJECT: THEORY OF MACHINES I (202048)

COURSE : SE (2015 Pattern)

THEORY QUESTIONS

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| Q.1 | Explain Hooke's joint and state its applications. | 4 |
| Q.2 | Write short note on double Hooke's joint. | 4 |
| Q.3 | Derive the relation between input and output speed of Hooke's joint. | 4 |
| Q.4 | Write short note on complex algebra method. | 4 |
| Q.5 | Write short note on vector algebra method. | 6 |
| Q.6 | Explain method of loop closure equation. | 6 |
| Q.7 | Derive an expression for calculating velocity and acceleration of piston of IC engine mechanism when crank is rotating with uniform angular velocity. | 6 |
| Q.8 | Derive an expression for calculating velocity and acceleration of piston of IC engine mechanism when crank is rotating with non-uniform angular velocity. | 6 |
| Q.9 | Derive an expression for calculating angular velocity and angular acceleration of connecting rod of IC engine mechanism when crank is rotating with uniform angular velocity. | 6 |
| Q.10 | Derive an expression for calculating angular velocity and angular acceleration of connecting rod of IC engine mechanism when crank is rotating with non-uniform angular velocity. | 6 |
| Q.11 | Derive an equation for angular acceleration of driven shaft in case of Hooke's joint. | 4 |
| Q.12 | Derive an equation for maximum fluctuation of speed of driven shaft in case of Hooke's joint. | 6 |

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| Q.13 | The stroke of steam engine is 15cm and connecting rod is 30 cm in length. Determine the velocity and acceleration of the piston,also find angular velocity and angular acceleration of connecting rod when the crank has rotated 45 degrees from IDC position and rotates at 600 rpm. | 10 |
| Q.14 | The stroke of steam engine is 40 and connecting rod is 75 cm in length. Determine the velocity and acceleration of the piston,also find angular velocity and angular acceleration of connecting rod when the crank is 60 degrees from IDC position and angular velocity of crank is 20 rad/s and increasing at the rate of 15 rad/s ² . | 10 |
| Q.15 | In an IC engine mechanism the stroke of piston is 400 mm and $n=4.5$. The crank rotates uniformly at 600 rpm in clockwise direction. Find velocity and acceleration of piston when crank is approaching IDC and connecting rod is perpendicular to crank. | 10 |
| Q.16 | In an IC engine mechanism, lengths of crank and connecting rod are 3cm and 15 cm respectively.The crank rotates at 600 rpm clockwise. Find maximum slider velocity & corresponding crank position also find acceleration of the slider in its extreme position. | 10 |
| Q.17 | Two shafts A and B are connected by Hooke's joint and have their axes inclined at 20 degree. Find the max acceleration of shaft B and angular position of shaft A when speed of shaft A is 1000 rpm uniform. | 10 |

- Q.18 A universal joint is used to connect two shafts whose axes are inclined at 18 degrees. Find the angle turned by the driving shaft when. a) velocity ratio is maximum, minimum and unity b) Retardation of driven shaft is maximum. Draw the polar diagram representing the angular velocities of driving and driven shaft indicating above all the calculated values. 10
- Q.19 A universal joint is used to connect two shafts together. The input shaft rotates at uniform speed of 1200 rpm. Find the greatest permissible angle between the shaft axes so that the total fluctuation of speed may not exceed 200 rpm. Also find the maximum speed of driven shaft. 10
- Q.20 Draw a polar velocity diagram of Hooke joint and mark all its salient features of the diagram for the driving shaft speed of 400 rpm having shaft angle of 18 degrees. What is the average speed of the driven shaft. 10

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO.5 - Vel. & Accl. Analysis of simple Mechanisms (Graphical Method I)

SUBJECT: THEORY OF MACHINES I (202048)

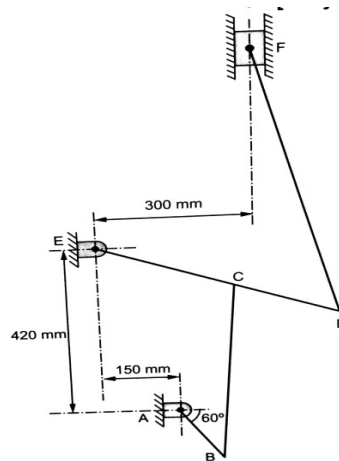
COURSE : SE (2015 Pattern)

THEORY QUESTIONS

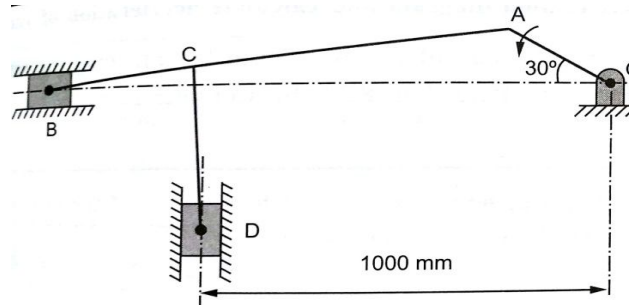
- Q.1 With the help of supporting sketch, explain the concept of 'Velocity Image Principle'. 4
- Q.2 Explain Acceleration Image Principle. 4
- Q.3 Explain the relative velocity and acceleration method of two bodies moving in straight line. 4
- Q.4 Explain the velocity diagram of a rigid link. 4
- Q.5 Explain the rubbing velocity at a pin joint. 4
- Q.6 What is instantaneous centre of rotation ? Explain various types of instantaneous centres of rotation with suitable example. 4
- Q.7 With the help of supporting sketch, explain the concept of 'Body centrode and space centrode'. 6
- Q.8 State and explain " Kennedy's Theorem " of three centres inline. 4
- Q.9 Explain the following terms i) Instantaneous centre of rotation, ii) Space centrode, iii) Body centrode. 6

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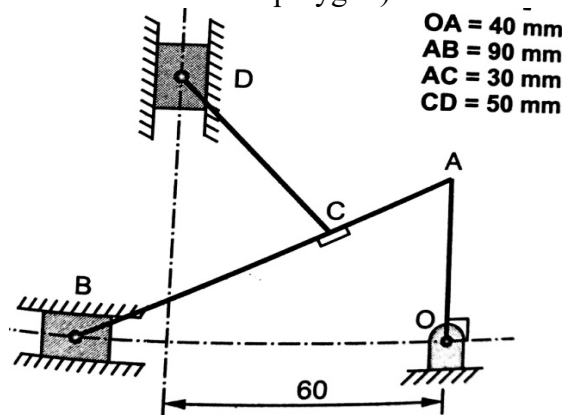
- Q.10 For the mechanism as shown in fig. the crank AB rotates at 180 rpm uniformly in clockwise direction. The dimensions of various links are as follows. AB=150 mm, BC = 450 mm, CE = 240 mm, CD = 210 mm, DF = 660 mm. Find acceleration of slider acceleration of link DF. 12



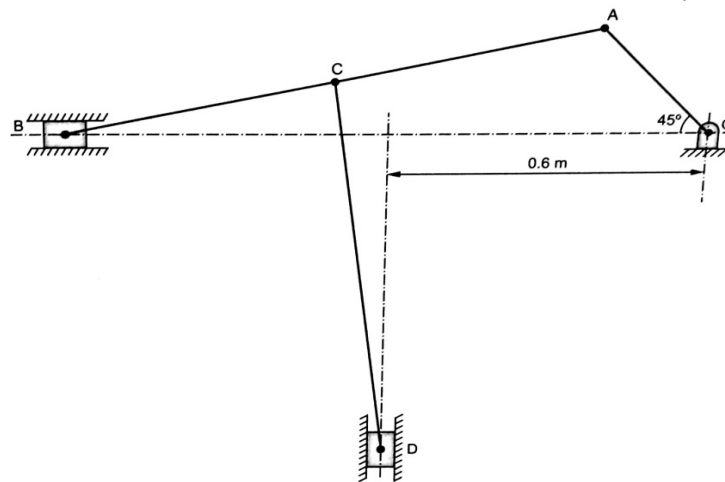
- Q.11 Crank OA of a compound slider crank mechanism, as shown in fig. rotates at 20 r.p.m. Anticlockwise and gives motion to sliding blocks B & D. The dimensions of various links are OA = 300 mm, AB = 1200 mm, BC = 450 mm and CD = 450 mm. Determine the linear acceleration of block D. 10



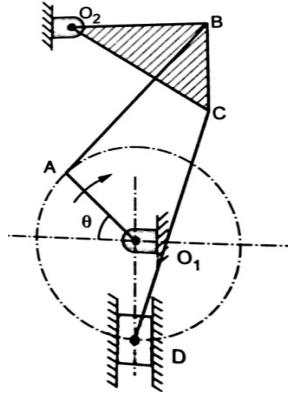
- Q.12 Fig. shows the mechanism in which crank OA is rotating anticlockwise at 20 rad/s. At the instant shown, find out the velocity and acceleration of slider B & D as well as the angular acceleration of link AB using relative method. (Use scale 1mm = 10 mm/s for the velocity polygon and 1mm = 200 mm/s² for acceleration polygon). 12



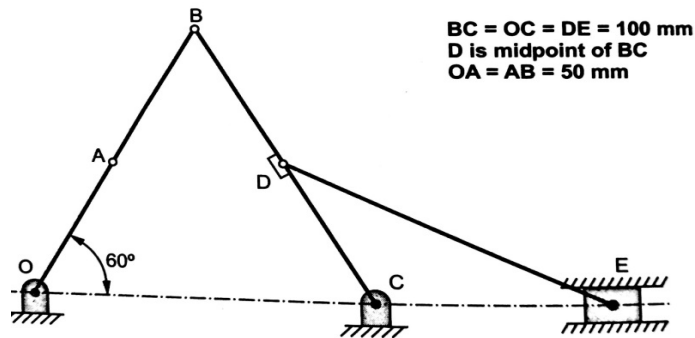
- Q.13 The length of various links of a mechanism as shown in fig. are OA = 0.3m, AB = 1m, CD = 0.8m, and AC = CB. Determine for the given configuration, i) Velocity of slider D, ii) Velocity of slider B, iii) Angular velocity of CD, iv) Angular velocity of AB. If OA rotates at 60 r.p.m. clockwise use instantaneous centre method. Also find absolute velocity of point C. 12



- Q.14 Fig. shows a sewing machine needle box mechanism O_1ABO_2CD in which different dimensions are as follows. Crank $O_1A = 16$ mm; crank angle with horizontal $\angle\theta = 45^\circ$; vertical distance between O_1 and $O_2 = 40$ mm; Horizontal distance between O_1 and $O_2 = 13$ mm. $O_2B = 23$ mm; $BC = 16$ mm; $AB = 35$ mm; $CD = 40$ mm; $\angle O_2BC = 90^\circ$. D lies vertically below O_1 when crank O_1A rotates at 400 rpm. Find the velocity of needle D for the given configuration by instantaneous centre method.



- Q.15 Fig. shows a mechanism in which crank OA is rotating clockwise at 240 rpm. At the instant shown. Locate all ICRs for the mechanism and find out the velocity of slider E as well as the angular velocity of link BC using ICR method.



DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

UNIT NO.6 - Vel. & Accl. Analysis of Mechanisms (Graphical Method II)

SUBJECT: THEORY OF MACHINES I (202048)

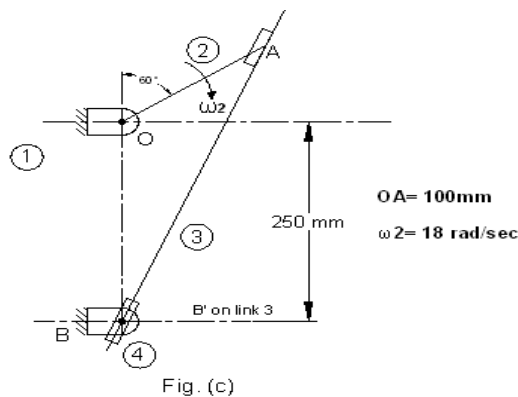
COURSE : SE (2015 Pattern)

THEORY QUESTIONS

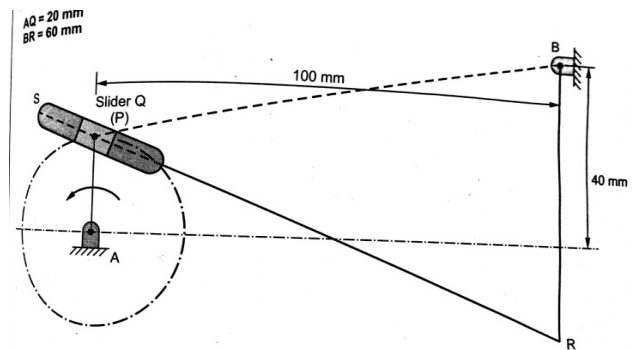
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| Q.1 What is mean by coriolis component of acceleration? In which mechanism it will exist? | 4 |
| Q.2 Explain the method of finding the direction of coriolis component of acceleration. | 4 |
| Q.3 Derive the equation for magnitude of coriolis component of acceleration. | 4 |
| Q.4 Explain Klein's construction for slider crank mechanism when the crank rotates with uniform angular velocity | 6 |
| Q.5 Explain Klein's construction for slider crank mechanism when the crank rotates with non-uniform angular velocity | 6 |

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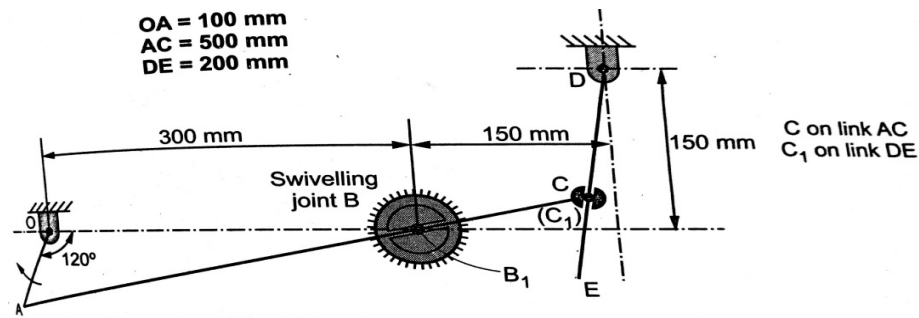
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| Q.6 For the mechanism as shown in below fig. Find the acceleration of slider B. Angular velocity of OA is 18 rad/sec. as shown. | 10 |
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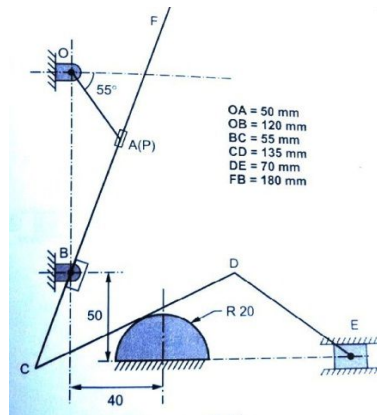
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| Q.7 For the mechanism as shown in below fig link AQ rotates at 20 rad/s anticlockwise. Find a) angular velocity of link BRS, b) angular acceleration of link BRS. | 10 |
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- Q.8 For the mechanism as shown in below fig crank OA rotates at 200 rpm. Rod AC slides in swivelling pin at B. The end C of rod AC slides on a swinging link DE. Find angular velocity and angular acceleration of link DE. 10



- Q.9 Below fig. shows a mechanism in which crank OA is rotating anticlockwise at 20 rad/s. Link CD is in the form of rod sliding tangentially on an inverted and grounded semi-cylinder as shown, find out the linear velocity of slider E using graphical method of velocity polygon at the instant shown. 10



- Q.10 The crank of an engine is 180 mm long and the ratio of connecting rod length to crank radius is 4. Determine the acceleration of the piston, the acceleration of a point X on the connecting rod (located at 1/4th distance from big end) when the crank is turned through 400 from the IDC position, and the instantaneous speed of rotation of the crank is 300 rpm clockwise and is increasing at the rate of 120 rad/sec². Use Klien's construction. 10
- Q.11 In the slider crank mechanism having a crank length 20 cm and obliquity ratio of 4. The crank is rotating uniformly clockwise. The angular acceleration of connecting rod is 50 rad/s² when the crank is perpendicular to the line of stroke. Determine using Klein's construction, a) Linear velocity and acceleration of the slider. b) angular velocity of the connecting rod. 10
- Q.12 The crank an I.C engine is 200 mm long and the obliquity ratio is 4. Determine the acceleration of piston, angular acceleration of connecting rod, when is turned through 45° from i.d.c position and instantaneous speed of rotation of crank is 240 rpm clockwise and increasing at the rate of 100 rad/s². 10

- Q.13 The crank and connecting rod of a reciprocating engine are 200 mm and 700 mm respectively. 10
The crank is in clockwise direction at 120 rad/s. Find with the help of Klein's construction:
a) Velocity and acceleration of the piston, b) Velocity and acceleration of the mid point of the connecting rod, and c) Angular velocity and angular acceleration of the connecting rod, at the instant when the crank is at 30° to I.D.C.