JEPPIAAR ENGINEERING COLLEGE

DEPARTMENT OF MECHANICAL ENGINEERING

ME6401-KINEMATICS OF MACHINERY

II YEAR/ IV SEMESTER

QUESTION BANK

Vision of Institution

To build Jeppiaar Engineering College as an institution of academic excellence in technological and management education to become a world class university.

Mission of Institution

- To excel in teaching and learning, research and innovation by promoting the principles of scientific analysis and creative thinking.
- To participate in the production, development and dissemination of knowledge and interact with national and international communities.
- To equip students with values, ethics and life skills needed to enrich their lives and enable them to meaningfully contribute to the progress of society.
- To prepare students for higher studies and lifelong learning, enrich them with the practical and entrepreneurial skills necessary to excel as future professionals and contribute to Nation's economy.

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

JEPPIAAR ENGINEERING COLLEGE

DEPARTMENT OF MECHANICAL ENGINEERING

Vision of the Department

To create excellent professionals in the field of Mechanical Engineering and to uplift the quality of technical education on par with the International Standards.

Department Mission

1. To reinforce the fundamentals of Science and Mathematics to Mechanical Engineering**and critically and relatively investigate co**mplex mechanical systems and processes.
2. To engage in the **production, expansion and practice** of advanced engineering applications through knowledge sharing activities by interacting with global communities and industries.
3. To**equip** students with **engineering ethics, professional roles, corporate social responsibility** and life skills and**apply**them for the betterment of society.
4. To promote higher studies and lifelong learning and entrepreneurial skills and **develop**excellent professionals for empowering nation's economy.

PEO's

1. To **enrich** the technical knowledge of design, manufacturing and management of mechanical systems and **develop creative and analytical thinking** in research.
2. To **relate, strengthen and develop** the theoretical knowledge of the Mechanical Engineering by exhibiting various concepts applied through diverse industrial exposures and experts' guidance.
3. **Facilitate** the students to communicate effectively on complex social, professional and engineering activities with strict adherence to ethical principles.
4. **Create awareness for independent and life long learning and develop the ability to keep abreast of modern trends and adopt them for personal technological growth of the nation.**

PSO's

1. To understand the basic concept of various mechanical engineering field such as design, manufacturing, thermal and industrial engineering.
2. To apply the knowledge in advanced mechanical system and processes by using design and analysis techniques.
3. To develop student's professional skills to meet the industry requirements and entrepreneurial skills for improving nation's economy stronger.

ME6401-KINEMATICS OF MACHINERY

COURSE OUTCOMES

C211.1	Explain the concept and application of linkages in the assembly of a machine
C211.2	Inspect the assembly with respect to the displacement, velocity and acceleration at any point in a link.
C211.3	Extend the motion of specified set of linkages and cam mechanisms for specified output motions
C211.4	Demonstrate the basic concepts of toothed gearing and kinetics of gear trains
C211.5	Outline the effects of friction in motion transmission and in machine components

ME6401 KINEMATICS OF MACHINERY L T P C

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OBJECTIVES:

- To understand the basic components and layout of linkages in the assembly of a system/ machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage Mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

UNIT I BASICS OF MECHANISMS 9

Classification of mechanisms–Basic kinematic concepts and definitions–Degree of freedom,Mobility–Kutzbach criterion, Gruebler's criterion–Grashof's Law–Kinematic inversions of four-bar chain and slider crank chains–Limit positions–Mechanical advantage–Transmission Angle–Description of some common mechanisms–Quick return mechanisms, Straight line generators, Universal Joint–rocker mechanisms.

UNIT II KINEMATICS OF LINKAGE MECHANISMS 9

Displacement, velocity and acceleration analysis of simple mechanisms–Graphical method–Velocity and acceleration polygons–Velocity analysis using instantaneous centres–kinematic analysis of simple mechanisms–Coincident points–Coriolis component of Acceleration–Introduction to linkage synthesis problem

UNIT III KINEMATICS OF CAM MECHANISMS 9

Classification of cams and followers–Terminology and definitions–Displacement diagrams–Uniform velocity, parabolic, simple harmonic and cycloidal motions–Derivatives of follower motions–Layout of plate cam profiles–Specified contour cams–Circular arc and tangent cams–Pressure angle and undercutting–sizing of cams.

UNIT IV GEARS AND GEAR TRAINS 9

Law of toothed gearing–Involutes and cycloidal tooth profiles–Spur Gear terminology and definitions–Gear tooth action–contact ratio–Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only].Gear trains–Speed ratio, train value–Parallel axis gear trains–Epicyclic Gear Trains.

UNIT V FRICTION IN MACHINE ELEMENTS 9

Surface contacts–Sliding and Rolling friction–Friction drives–Friction in screw threads–Bearings and lubrication–Friction clutches–Belt and rope drives–Friction in brakes-Band and Block brakes.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students can able to apply fundamentals of mechanism for the design of new mechanisms and analyse them for optimum design.

TEXT BOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 3rd Edition, Oxford University Press, 2009.
2. Rattan, S.S, "Theory of Machines", 3rd Edition, Tata McGraw- Hill, 2009.

REFERENCES:

1. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors,2005.
2. Cleghorn. W. L, "Mechanisms of Machines", Oxford University Press, 2005
3. Robert L. Norton,"Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
4. Allen S. Hall Jr., "Kinematics and Linkage Design", Prentice Hall, 1961
5. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", Affiliated East-West Pvt.Ltd., New Delhi, 1988.
6. Rao.J.S. and Dukkipati.R.V."Mechanisms and Machine Theory", Wiley-Eastern Ltd.,New Delhi, 1992.
7. John Hannah and Stephens R.C.,"Mechanics of Machines", Viva Low-Prices Student Edition,1999
8. Ramamurthi. V,"Mechanics of Machines", Narosa Publishing House, 2002.
9. Khurmi, R.S.,"Theory of Machines",14th Edition, S Chand Publications, 2005
10. Sadhu Sigh : Theory of Machines, "Kinematics of Machine", Third Edition, Pearson Education,2012

JEPPIAAR ENGINEERING COLLEGE

Jeppiaar Nagar, Rajiv Gandhi Salai – 600 119

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

IV SEMESTER
ME6401 – Kinematics of Machinery
Regulation – 2013

JEPPIAAR ENGINEERING COLLEGE

Jeppiaar Nagar, Rajiv Gandhi Salai – 600 119

DEPARTMENT OF MECHANICAL ENGINEERING

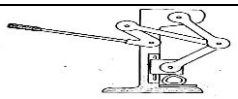
QUESTION BANK

SUBJECT : ME6401 – Kinematics of Machinery

YEAR /SEM: II /IV

UNIT 1 BASICS OF MECHANISMS				
Classification of mechanisms–Basic kinematic concepts and definitions–Degree of freedom,Mobility–Kutzbach criterion, Gruebler's criterion–Grashof's Law–Kinematic inversions of four-bar chain and slider crank chains–Limit positions–Mechanical advantage–Transmission Angle–Description of some common mechanisms–Quick return mechanisms, Straight line generators, Universal Joint–rocker mechanisms.				
PART-A				
CO Mapping: C211.1				
Q.No	**Questions**	**BT Level**	**Competence**	**PO**
1	Define kinematic link.	BTL-1	Remembering	P01
2	Differentiate between a machine and a structure.	BTL-2	Understanding	P01,P02,P012
3	Classify the constrained motion	BTL-2	Understanding	P01,P02
4	Define kinematic pair	BTL-1	Remembering	P01
5	Define kinematic chain	BTL-1	Remembering	P01
6	Define degree of freedom of a mechanism	BTL-1	Remembering	P01,P02
7	State Grubler's criterion for planar mechanisms	BTL-1	Remembering	P01,P02
8	State Grubler's criterion of spatial mechanisms	BTL-1	Remembering	P01,P02
9	What is the significance of Grashof's law for a four bar mechanism?	BTL-1	Remembering	P01,P02
10	List any four inversion of a single slider chain	BTL-1	Remembering	P01,P02,P03,P12
11	Define sliding connectors	BTL-1	Remembering	P01
12	Define mechanical advantages of a mechanism.	BTL-1	Remembering	P01,P012
13	Define transmission angle of a four bar mechanism what are the worst value of transmission angle?	BTL-1	Remembering	P01,P02
14	Show the indicate the transmission angle of a four bar mechanism.	BTL-2	Understanding	P01,P02,P03
15	What is the use of offset slider – crank mechanism?	BTL-1	Remembering	P01,P02,P03
16	List out the application of straight line motion mechanisms	BTL-1	Remembering	P01,P02
17	What is the condition of correct steering of an automobile?	BTL-1	Remembering	P01,P02
18	What are indexing mechanisms?	BTL-1	Remembering	P01,P02
19	What is low degree of complexity?	BTL-1	Remembering	P01
20	Determine the number of freedom of the mechanism shown in the figure below.	BTL-5	Evaluating	P01,P02,P03
21	What is the significance of degrees of freedom of a kinematic chain when it functions as a mechanism? Given examples.	BTL-1	Remembering	P01,P02
22	Differentiate between rigid and resistant bodies.	BTL-2	Understanding	P01,P02,P012

23	The ratio between the width of the front axle and that of wheel base of a steering mechanism is 0.44.At the instant when the front inner wheel is turned by 18 degree, what should be the angle turned by the outer front wheel for perfect steering?	BTL-1	Remembering	P01,P02
24	State any four types of kinematic pairs according to the types of relative motion between them.	BTL-1	Remembering	P01,P02
25	Identify the possible motion and name of the following combinations.	BTL-3	Applying	P01,P02
26	State at least one similarly and difference between a helical pair and cylindrical pair.	BTL-1	Remembering	P01,P02
27	Give the DOF for a shaft in a circular in a circular hole.	BTL-3	Applying	P01,P02,P03
28	What is Kutzbach criterion for planner mechanism?	BTL-1	Remembering	P01, P02
29	List a four – bar mechanism and show that if has one DOF.	BTL-1	Remembering	P01,P02,P03
30	What do you meant by inversion of mechanism?	BTL-1	Remembering	P01,P08,P10,P11, P12
	PART-B&C			
1	What is known as kinematic inversion? Sketch and explain the various inversions of a slider crank chain, also starting the actual machines in which these are used in practice.	BTL-1	Remembering	P01,P02,P03,P08, P10,P11,P12
2	Explain why two Hooke's joints are used to transmit motion from the engine to the differential of an automobile. Two shafts are connected by a universal joint. The driving shaft rotates at a uniform speed of 1200 r.p.m. Determine the greatest permissible angle between the shaft axes so that the total fluctuation of speed does not exceed 100 r.p.m. Also calculate the maximum and minimum speeds of the driven shaft.	BTL-2	Understanding	P01,P02,P03,P06, P12
3	Explain the working of two different types of quick return mechanisms. Derive an expression for the ratio of time taken in forward and return stroke for one of these mechanisms.	BTL-2	Understanding	P01,P02,P03,P11, P12
4	Label and explain any three kinematic inversion of four-bar chain	BTL-1	Remembering	P01,P02,P03
5	Explain the inversions of four bar chain with examples	BTL-2	Understanding	P01,P02,P03,P10, P12
6	Label and explain the following.(i)Elliptical trammel (ii)Scotch yoke mechanism.	BTL-1	Remembering	P01,P02,P03,P12
7	Explain different types of constrained motion with suitable example	BTL-2	Understanding	P01,P02,P06
8	Explain the working of peaucellier mechanism and offset slider mechanism	BTL-2	Understanding	P01,P02,P03
9	Explain mechanical advantage and transmission angle related to four bar mechanism.	BTL-2	Understanding	P01,P02,P03,P12
10	Figure shows a mechanical press used to exert large forces to insert a small part into a larger one. Draw a kinematic diagram, using the end of the handle as a point of interest. Also compute the degrees of	BTL-1	Remembering	P01,P02,P03,P06, P09,P11,P12

	freedom. 			

UNIT II KINEMATICS OF LINKAGE MECHANISMS				
Displacement, velocity and acceleration analysis of simple mechanisms–Graphical method–Velocity and acceleration polygons–Velocity analysis using instantaneous centres–kinematic analysis of simple mechanisms–Coincident points–Coriolis component of Acceleration–Introduction to linkage synthesis problem.				
PART-A				
CO Mapping: C211.2				
Q.No	**Questions**	**BT Level**	**Competence**	**PO**
1	Distinguish between rotation and translation?	BTL-4	Analyzing	P01,P02,P03
2	How to represent the direction of velocity of any point on a link with respect to another point on the same link?	BTL-1	Remembering	P01,P02,P03
3	What is a configuration diagram/ what is use?	BTL-1	Remembering	P01,P02,P03, P09,P11,P12
4	How the direction of the angular velocity is found out during velocity analysis of a mechanism by graphical method?	BTL-1	Remembering	P01,P02,P03, P09,P11,P12
5	What is Coriolis component of acceleration?	BTL-1	Remembering	P01,P02,P03, P12
6	Name two mechanisms: one where Coriolis acceleration is countered and another where Coriolis acceleration is not encountered?	BTL-1	Remembering	P01,P02,P03, P12
7	State the condition for a link to experience Coriolis acceleration (or for what kind of relative motion, the Coriolis component of acceleration occurs?	BTL-1	Remembering	P01,P02,P03,P12
8	Show the relation to find the magnitude of Coriolis components of acceleration?	BTL-1	Remembering	P01,P02,P12
9	A slide, sliding at 100 mm/s on link, which is rotating at 60rpm.Is subjected to Coriolis acceleration. Find its magnitude?	BTL-1	Remembering	P01,P02,P03
10	How direction of Coriolis component of acceleration is determined?	BTL-1	Remembering	P01,P02
11	What is meant by the virtual centre on instantaneous centre?	BTL-1	Remembering	P01,P02,P03, P11,P12
12	Solve the equation to determine the number of instantaneous centers of a mechanism?	BTL-3	Applying	P01,P02,P03, P11,P12
13	State the relationship between crank angle ϕ of single slider crank mechanism	BTL-1	Remembering	P01,P02,P03,
14	What do you mean by coupler curve?	BTL-	Remembering	P01,P02,P03 ,P12

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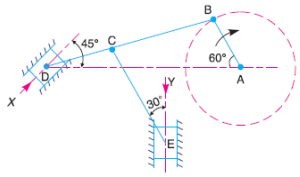
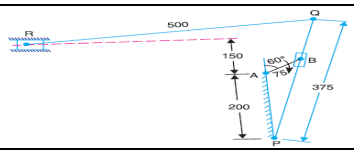
15	Explain how the acceleration of a point on a link (whose direction is known) is obtained when the acceleration of some other point on the same link is give in magnitude and direction	BTL-2	Understanding	P01,P02,P08
16	Explain how the coriolis component of acceleration arises when a point is rotating about some other fixed point and at the same time its distance from the fixed point varies.	BTL-2	Understanding	P01,P02,P03
17	What is the need of finding acceleration of linkage in a mechanism	BTL-1	Remembering	P01,P02,P03 ,P12
18	Name any two mechanism having coriolis component	BTL-1	Remembering	P01,P02,P03,P12
19	A four-bar mechanism has couples pin center at A and B, and fixed pivot center at Ao and B. show the two vector equation involving the output velocity vector of B	BTL-2	Understanding	P01,P02,P03,P12
20	Explain normal component of acceleration?	BTL-2	Understanding	P01,P02,P03 P09,P11,P12
21	Distinguish normal component of a acceleration and tangential component of acceleration	BTL-1	Remembering	P01,P02,P03 P11,P12
22	What type of link will have only centripetal component of acceleration and what types of link will have only linear acceleration?	BTL-1	Remembering	P01,P02,P03 P11,P12
23	State coriolis law	BTL-1	Remembering	P01,P02,P03, P11,P12
24	When coriolis component of acceleration occurs?	BTL-1	Remembering	P01,P02,P03,P12
25	In a revolving stage with a speed of 3 rpm,a person is walking with a speed of 0.5m/s along a radial path ,determine the magnitude of the coriolis component of acceleration in this motion.	BTL-5	Evaluating	P01,P02,P03
26	How many instantaneous are in a single slider crank mechanism?	BTL-1	Remembering	P01,P02,P03,P12
27	What are the types of instantaneous centers?	BTL-1	Remembering	P01,P02,P03, P12
28	What do you mean by couples curve?	BTL-1	Remembering	P01,P02,P03, P12
29	State the frouden stein's equation for a four bar mechanism	BTL-1	Remembering	P01,P02,P03, P12
30	State and prove Kennedy's three centre theorem	BTL-1	Remembering	P01,P02,P03 ,P12
PART-B&C				
1	The dimensions of the mechanism, as shown in Figure are as follows :AB = 0.45 m; BD = 1.5 m : BC = CE = 0.9 m.The crank AB turns uniformly at 180 r.p.m. in the clockwise direction and the blocks at D and E are working in frictionless guides. Draw the velocity diagram for the mechanism and find the	BTL-5	Evaluating	P01,P02,P03,P06, P09,P11,P12

	velocities of the sliders D and E in their guides. Also determine the turning moment at A if a force of 500 N acts on D in the direction of arrow X and a force of 750 N acts on E in the direction of arrow Y. 			
2	In a slider crank mechanism, the length of crank OB and connecting rod AB are 125 mm and 500 mm respectively. The centre of gravity G of the connecting rod is 275 mm from the slider A. The crank speed is 600 r.p.m. clockwise. When the crank has turned 45° from the inner dead centre position, determine: 1. velocity of the slider A, 2. velocity of the point G, and 3. angular velocity of the connecting rod AB.	BTL-5	Evaluating	P01,P02,P03,P12
3	By analytical method, derive the velocity and acceleration for the reciprocating steam engine mechanism			P01,P02,P03, P12
4	The following data refer to the dimensions of the links of a four - bar mechanism: AB = 50mm; BC = 66mm; CD = 56mm and AD (fixed link) = 100mm. at the instant when DAB = 60°, the link AB has an angular velocity of 10.5 rad/s in the counter clockwise direction. Determine the velocity of point C, velocity of point E on the link BC while BE = 40 mm and the angular velocities of the links BC and CD. Also sketch the mechanism and indicate the data.	BTL-5	Evaluating	P01,P02,P03,P06, P09,P11,P12
5	A four bar chain is represented by a quadrilateral ABCD in which AD is fixed and is 0.6 m long. The crank AB = 0.3 m long rotates in a clockwise direction at 10 rad/s and with an angular acceleration of 30 rad/s^2, both clockwise. The crank drives the link CD (=0.36 m) by means of the connecting link BC (=0.36 m). The angle BAD = 60°. Using graphical method, determine the angular velocities and angular accelerations of CD and BC.	BTL-5	Evaluating	P01,P02,P03,P12
6	The driving crank AB of the quick-return mechanism, as shown in Figure,revolves at a uniform speed of 200 r.p.m. Find the velocity and acceleration of the tool-box R, in the position shown, when the crank makes an angle of 60° with the vertical line of centres PA. What is the acceleration of sliding of the block at B along the slotted lever PQ?	BTL-1	Remembering	P01,P02,P03,P12

				
7	The mechanism as following dimensions OA=200 mm , AB=1.5 m, BC=600mm , CD = 500 mm ,BE=400 mm.Locate the instantaneous centres.If the crank OA rotates uniformly at 120 rpm. Clockwise, find (i) velocity of D and (ii) the angular velocity of the link AB and CD.	BTL-1	Remembering	P01,P02,P03,P12
8	In a mechanism , the various dimensions areOC=125mm,CP=500mmPA=125mm,AQ=250mm and QE=125mm.The slider P translates along and axis which is 25mm vertically below point O.The crank OC rotates uniformly at 120 r.p.m in the anticlockwise direction. The bell crank lever AQE rocks about fixed centre Q. Draw the velocity diagram and calculate the absolute velocity of point E of the lever.	BTL-1	Remembering	P01,P02,P03,P12
9	In a crank and slotted lever quick return motion mechanism, the distance between the fixed centers is 240 mm and the length of the driving crank is 120mm. Determine the inclination of the slotted bar with the vertical in the extreme position and the time ratio. If the length of the slotted bar is 450 mm, find the length of the stroke if the line of stroke passes through the extreme positions of the free end of the lever.	BTL-1	Remembering	P01,P02,P03,P10,P12
10	An engine mechanism have the crank CB=200 mm and the connecting rod BA= 600 mm. In the position, the crankshaft has a speed of 50 rad/s and an angular acceleration of 800 rad/s^2.Find (i) angular velocity of AB (ii) angular acceleration of AB	BTL-1	Remembering	P01,P02,P03,P12
11	Locate all the instantaneous centres of the slider crank mechanism. The length of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s find (i) Velocity of the slider A, and (ii) Angular velocity of the connecting rod AB.	BTL-1	Remembering	P01,P02,P03,P12

UNIT III KINEMATICS OF CAM MECHANISMS				
Classification of cams and followers–Terminology and definitions–Displacement diagrams–Uniform velocity, parabolic, simple harmonic and cycloidal motions–Derivatives of follower motions–Layout of plate cam profiles–Specified contour cams–Circular arc and tangent cams–Pressure angle and undercutting–sizing of cams.				
PART-A				
CO Mapping: C211.3				
Q.No	**Questions**	**BT Level**	**Competence**	**PO**
1	What is the classification of cam based on physical shape?	BTL-1	Remembering	P01,P02,P012
2	Why is a roller follower preferred to knife-edge follower?	BTL-1	Remembering	P01,P02
3	Why sometimes the axes of translating roller follower in cam. Follower mechanisms are offset from the axis of rotation of cam?	BTL-1	Remembering	P01,P02,P03
4	Define pressure angle of a cam mechanism?	BTL-1	Remembering	P01
5	What is the significance of pressure angle in cam?	BTL-1	Remembering	P01,P02
6	Define dwell period or angle of dwell?	BTL-1	Remembering	P01,P02
7	What are the different types of motion with which a follower can move?	BTL-1	Remembering	P01,P02
8	State the equation to determine the maximum velocity and the maximum acceleration when the follower has Simple harmonic motion?	BTL-1	Remembering	P01,P02
9	State the expressions for maximum velocity and acceleration of a follower moves with cycloidal motion	BTL-1	Remembering	P01,P02,P03,P12
10	What is the follower motion used for high speed cams?	BTL-1	Remembering	P01,P02,P012
11	What is the follower motion used for high speed cams? Why?	BTL-1	Remembering	P01,P02
12	Name the types of cams with specified.	BTL-1	Remembering	P01
13	Define tangent cam.	BTL-1	Remembering	P01
14	State the advantages of tangent cam and sketch it.	BTL-1	Remembering	P01,P02
15	What do you mean by under cutting in cams?	BTL-1	Remembering	P01,P02
16	State the basic requirement for high speed cam.	BTL-4	Analyzing	P01,P02
17	Which of the displacement diagrams in respect of follower motion should be chosen for buffer dynamic performance of a cam-follower mechanism?	BTL-1	Remembering	P01,P02
18	Write the procedure to draw the cam profile. Draw a base circle with minimum radius of the cam (rb=25mm) with O as centre.	BTL-2	Understanding	P01,P02,P03,P12
19	State the advantage of cam mechanisms over linkage mechanisms.	BTL-1	Remembering	P01
20	List any four types of cam followers?	BTL-4	Analyzing	P01,P06,P012
21	Why is a roller follower preferred to knife-edge follower?	BTL-1	Remembering	P01,P02

22	State at least one advantage and one disadvantage of flat-faced follower over roller follower in a cam mechanisms.	BTL-1	Remembering	P01,P02,P012
23	Define pitch circle of the cam?	BTL-1	Remembering	P01,P02
24	What is the radial distance between the prime circle and base circle for a cam with knife-edge follower?	BTL-1	Remembering	P01
25	What is a circular arc cam?	BTL-1	Remembering	P01
26	State the basic requirements for high speed cams.	BTL-1	Remembering	P01,P02
27	List the various methods to eliminate under cutting.	BTL-4	Analyzing	P01,P02
28	What do you mean by specified contours?	BTL-1	Remembering	P01,P02
29	Why cams with specified contours are used?	BTL-1	Remembering	P01,P02
30	Classify followers according to the motion of the follower.	BTL-2	Understanding	P01,P02,P03,P12
31	What is a cam?	BTL-1	Remembering	P01
PART-B&C				
1	The following particulars relate to a symmetrical circular cam operating a flat faced follower : Least radius = 16 mm, nose radius = 3.2 mm, distance between cam shaft centre and nose centre = 25 mm, angle of action of cam = 150°, and cam shaft speed = 600 r.p.m. Assuming that there is no dwell between ascent or descent, determine the lift of the valve, the flank radius and the acceleration and retardation of the follower at a point where circular nose merges into circular flank.	BTL-4	Analyzing	P01,P02,P03,P06, P09,P11,P12
2	A cam rotating clockwise at a uniform speed of 200 r.p.m. is required to move an offset roller follower with a uniform and equal acceleration and retardation on both the outward and return strokes. The angle of ascent, the angle of dwell (between ascent and descent) and the angle of descent is 120°, 60° and 90° respectively. The follower dwells for the rest of cam rotation. The least radius of the cam is 50 mm, the lift of the follower is 25 mm and the diameter of the roller is 10 mm. The line of stroke of the follower is offset by 20 mm from the axis of the cam. Draw the cam profile and find the maximum velocity and acceleration of the follower during the outstroke.	BTL-4	Analyzing	P01,P02,P03,P10,P12
3	A cam is designed for a knife edge follower with following data: i. Cam lift = 40 mm during 90° of cam rotation with SHM ii. Dwell for the next 30°	BTL-4	Analyzing	P01,P02,P03,P06, P09,P11,P12

	iii. During the next 60° of cam rotation the follower returns to original position with SHM iv. Dwell for the remaining 180° Draw the profile of the cam when the line of stroke is offset 20 mm from the axis of the cam shaft.			
4	In a cam with translating roller follower, the follower axis is offset to the right of cam hinge by 12 mm. the roller radius is 10 mm and the cam rotates in the counter clock-wise direction. Layout the rise portion of the cam profile to meet the following specifications: Rise takes place during 180° of cam rotation of which for the first 90° the rise is with constant acceleration and the rest is with constant retardation. Take seven station points only. The lift of the cam is 30 mm and the least radius of the cam is 25 mm	BTL-4	Analyzing	P01,P02,P03,P06,P09
5	A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described below : 1. To raise the valve through 50 mm during 120° rotation of the cam; 2. To keep the valve fully raised through next 30°; 3. To lower the valve during next 60°; and 4. To keep the valve closed during rest of the revolution i.e. 150°; The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm. Draw the profile of the cam when **(a)** the line of stroke of the valve rod passes through the axis of the cam shaft, and **(b)** the line of the stroke is offset 15 mm from the axis of the cam shaft. The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 100 r.p.m. Draw the displacement, the velocity and the acceleration diagrams for one complete revolution of the cam.	BTL-5	Evaluating	P01,P02,P03,P06, P09,P11,P12
6	A circular cam operating a flat faced follower has a least diameter of 40 mm. The lift is 12 mm and angle of action is 160°. The speed of rotation is 500 rpm. If the period of acceleration of the follower is 60% of the retardation during the lift, determine the following:	BTL-5	Evaluating	P01,P02,P03,P06,P12

	(i)The principal dimensions of the cam (ii)The acceleration the main points. Also determine the maximum acceleration and deceleration during the lift. With the help of a neatly drawn sketch of a spur gear, explain elaborately the nomenclature of gears			
7	Draw a cam profile to drive an oscillating roller follower to the specification given below.(i) Follower to move outwards through an angular displacement of 20°c during the first 120 rotation of the cam.(ii) Follower to return to its initial position during next 120 degree rotation of the cam. (iii) the follower to dwell during the next 120 degree f the cam rotation. distance between the pivot centre and roller centre = 120 mm and distance between the pivot centre and cam axis = 130 mm,minimum radius of the cam = 40 mm, radius of roller=10 mm, inward and outward strokes take place with simple harmonic motion.	BTL-4	Analyzing	P01,P02,P03,P12
8	The following particulars relate to a symmentrical a circular cam operating a flat faced follower has a least diameter of 25 mm, nose radius = 8 mm, lift of the valve is 10 mm, Angle of action of cam =120 degree. Cam shaft speed = 1000 rpm. Determine the flank radius and maximum velocity, acceleration and retardation of the follower. Draw profile of the cam.	BTL-5	Evaluating	P01,P02,P03,P06, P09,P11,P12
9	Draw the profile of a cam operating a knife edge follower having a life of 30 mm. The cam raises the follower with SHM for 150 degree of the rotation followed by a period of dwell for 60 degree. The follower descends for the next 100 degree rotation of the cam with uniform velocity, again followed by a dwell period. The cam rotates at a uniform velocity of 120 rpm and has a least radius of 20 mm. What will be the maximum velocity and acceleration of the follower during the life and the return?	BTL-4	Analyzing	P01,P02,P03,P12
10	In a symmetrical tangent cam operating a roller follower, the least radius of the cam is 30 mm and roller radius is 17.5 mm. The angle of ascent is 75 degree and the total lift is 17.5 mm. The speed of the cam shaft is 600 r.p.m.	BTL-4	Analyzing	P01,P02,P03,P12

	Calculate: (i) The principal dimensions of the cam; (ii) the accelerations of the follower at the beginning of the life, where straight flank merges into the circular nose and at the apex of the circular nose; (iii) Draw the profile of the cam. Assume that there is no dwell between ascent and descent**.**			
11	A cam is to be used for a platform that will repeatedly lift boxes from a lower conveyor. This machine is plot a displacement diagram and determine the required speed of the cam when the follower motion sequences is as follows: (i)Rise 40 mm in 1.2 s (ii) Dwell for 0.3 s (iii) Fall 20 mm in 0.9 s (iv) Dwell 0.6 s (v) Fall 20 mm in 0.9 s**.**	BTL-5	Evaluating	P01,P02,P03,P12

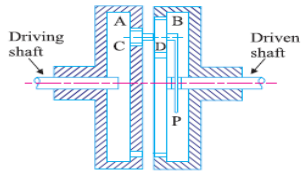
UNIT IV GEARS AND GEAR TRAINS

Law of toothed gearing–Involutes and cycloidal tooth profiles–Spur Gear terminology and definitions–Gear tooth action–contact ratio–Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only].Gear trains–Speed ratio, train value–Parallel axis gear trains–Epicyclic Gear Trains.

PART-A

CO Mapping: C211.4

Q.No	Questions	BT Level	Competence	PO
1	Define (a) Normal Pitch and (b) axial Pitch relating to helical gears.	BTL-1	Remembering	P01,P02,P012
2	What is a worm gear drive?	BTL-1	Remembering	P01,P02
3	Define the following terms used in gears? (a) Pressure angle (b) Module	BTL-1	Remembering	P01,P02,P03
4	Define the term “arc of contact” in gears?	BTL-1	Remembering	P01
5	State the law of gearing?	BTL-1	Remembering	P01,P02
6	Define the terms velocity ratio and the sliding velocity in a spur gear pair?	BTL-1	Remembering	P01,P02
7	Name the curves for use as gear profile which satisfies the law of gearing?	BTL-1	Remembering	P01,P02
8	What is the significance of contact ratio in gears?	BTL-1	Remembering	P01,P02
9	Explain the term interference as applied to gears?	BTL-1	Remembering	P01,P02,P012
10	Define undercutting in gears?	BTL-1	Remembering	P01,P02
11	Explain any two methods of reducing or eliminating interference in gears?	BTL-2	Understanding	P01,P02
12	What are the roles of idles in gears train?	BTL-1	Remembering	P01,P02,P03
13	What are the applications of reversed gear trains?	BTL-1	Remembering	P01
14	What is meant by an Epicyclic gear train? Give a practical example	BTL-1	Remembering	P01,P02
15	Explain briefly the use of differential in an automobile.	BTL-2	Understanding	P01,P02,P012

16	What are the advantages of epicyclic gear train?	BTL-1	Remembering	P01,P02
17	What is the degree of freedom for a differential mechanism?	BTL-1	Remembering	P01,P02,P03
18	What is the necessity of a differential used in an automobile?	BTL-1	Remembering	P01,P02,P03,P12
19	What is the role of idlers in a gear train?	BTL-1	Remembering	P01,P02
20	Write short notes on differentials	BTL-2	Understanding	P01,P02
21	List down the common forms of teeth	BTL-4	Analyzing	P01,P02
22	What is gear ratio?	BTL-1	Remembering	P01,P02,P10,P012
23	What are the methods to avoid interference and undercutting?	BTL-1	Remembering	P01,P02
24	What are the types of standard tooth profile?	BTL-1	Remembering	P01,P02,P03
25	What are the types of gears?	BTL-1	Remembering	P01,P02,P03,P12
26	Define Addendum:	BTL-1	Remembering	P01,P02
27	Define Deddendum?	BTL-1	Remembering	P01,P02
28	What is mean by backlash?	BTL-1	Remembering	P01,P02
29	What are the methods to obtain velocity ratio of epicyclic gear train?	BTL-1	Remembering	P01,P02,P012
30	What is reverted gear train?	BTL-1	Remembering	P01,P02
PART-B&C				
1	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: 1. The angle through which the pinion turns while any pair of teeth are in contact and 2. 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.	BTL-5	Evaluating	P01,P02,P03,P06, P09,P11,P12
2	An epicyclic train is shown in Fig. 13.42. Internal gear *A* is keyed to the driving shaft and has 30 teeth. Compound wheel *C* and *D* of 20 and 22 teeth respectively are free to rotate on the pin fixed to the arm *P* which is rigidly connected to the driven shaft. Internal gear *B* which has 32 teeth is fixed. If the driving shaft runs at 60 r.p.m. clockwise, determine the speed of the driven shaft. What is the direction of rotation of driven shaft with reference to driving shaft? 	BTL-5	Evaluating	P01,P02,P03,P12
3	Two gear wheels mesh externally and are to give a velocity ratio of 3 to 1. The teeth are of involute form; module = 6 mm, addendum = one module, pressure angle = 20°. The pinion rotates at 90 r.p.m. Determine: 1. The number of teeth on the pinion to avoid interference on it and the corresponding number	BTL-5	Evaluating	P01,P02,P03,P12

	of teeth on the wheel, 2. The length of path and arc of contact, 3. The number of pairs of teeth in contact, and 4. The maximum velocity of sliding.			
4	With the help of a neatly drawn sketch of a gear, explain elaborately the nomenclature of gears.	BTL-2	Understanding	P01,P02,P03,P12
5	Two unequal gears of involute profile are to give required gear ratio. Derive an expression for the minimum number of teeth required for the pinion in order to avoid interference	BTL-3	Applying	P01,P02,P03,P12
6	A reverted compound gear train is used as back gear of a lathe. It is required to give a reduction from cone – pulley speed to spindle speed of approximately 9 to 1. The module of the teeth on the high-speed pair is 4 mm and of those on low-speed pair is 5 mm. the centre distance is 180 mm. determine the number of teeth on each of the four wheels, if the pinions are to have as nearly as possible equal numbers of teeth. Also sketch a line diagram and show the gear train.	BTL-5	Evaluating	P01,P02,P03,P12
7	Prove max length of arc of contact between a pair of gear tooth to avoid interference is $(r+R)\tan\varphi$.	BTL-5	Evaluating	P01,P02,P03
8	Two mating gears have 20 and 40 involutes teeth of module 10 mm and 20 degree pressure angle. The addendum on each wheel is to be made of such a length that the line of contact on each side of the pitch point has half the maximum possible length. Determine the addendum height of each gear wheel, length of path of contact.	BTL-5	Evaluating	P01,P02,P03
9	A compound epicyclic gear A,D,E are free to rotate on axis P. The compound gear B and C rotate together on the axis Q at the end of arm F. All gear have equal pitch. The number of external teeth on gears A,B and C are 18,45 and 21 respectively. The gears D & E are annular gears. The gear A rotates at 100 rpm in anticlockwise direction and gear D rotates at 450 rpm clockwise. Find the speed and direction of the arm and the gear E.	BTL-1	Remembering	P01,P02,P03,P12
10	Derive an expression for minimum number of teeth on the wheel in order to avoid interference.	BTL-3	Applying	P01,P02,P03,P06, P09,P11,P12
11	The following data relate to a pair of 20 degree involute gears in mesh: Module = 6 mm, Number of teeth on pinion = 17, Number of teeth on gear=49; Addenda on pinion and gear wheel = 1 module. Find (i) The number of pairs of teeth in contact (ii) The angle turned through by the pinion and the gear wheel when one pair of teeth is in	BTL-1	Remembering	P01,P02,P03,P12

	contact, and (iii) The ratio of sliding to rolling motion when the tip of a tooth on the larger wheel (1) is just making contact, (2) is just leaving contact with its mating tooth, and (3) is at the pitch point.			
12	An epicyclic gear consist of three gears. A,B and C . The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with booth A and C and is carried on an arm EF which rotates about the centre of A at 18 r.p.m. If the gear A is fixed, determine the speed of gears B and C	BTL-5	Evaluating	P01,P02,P03,P12

Unit – V FRICTION				
Surface contacts–Sliding and Rolling friction–Friction drives–Friction in screw threads–Bearings and lubrication–Friction clutches–Belt and rope drives–Friction in brakes-Band and Block brakes.				
PART-A				
CO Mapping: C211.5				
Q.No	**Questions**	**BT Level**	**Competence**	**PO**
1	What are the type of friction?	BTL-1	Remembering	P01,P02,P012
2	What is role friction in screw jack?	BTL-1	Remembering	P01,P02
3	Why shall self-locking screw have lesser efficiency?	BTL-1	Remembering	P01,P02,P03
4	List down the laws of friction	BTL-4	Analyzing	P01,P02,P03,P12
5	Define anti friction bearing	BTL-1	Remembering	P01,P02
6	Differentiate between multi plate clutch &core clutch	BTL-4	Analyzing	P01,P02
7	Differentiate between self-locking & over howling of screw	BTL-4	Analyzing	P01,P02
8	What is limiting angle of friction?	BTL-1	Remembering	P01,P02,P012
9	What is the difference between sliding friction & rolling friction?	BTL-1	Remembering	P01,P02
10	What are advantage & disadvantage of V-Belt drive?	BTL-1	Remembering	P01,P02,P10,P012
11	Distinguish between open & cross belt drive in term of its application.	BTL-4	Analyzing	P01,P02
12	Define Velocity Ratio.	BTL-1	Remembering	P01,P02,P03
13	What is self-energizing brake?	BTL-1	Remembering	P01,P02,P012
14	What is meant by self-locking brake?	BTL-1	Remembering	P01,P02
15	What is the max efficiency of screw jack?	BTL-1	Remembering	P01,P02,P03
16	Obtain an expression for length of an open belt drive	BTL-5	Evaluating	P01,P02,P03,P12
17	Define helix angle.	BTL-1	Remembering	P01,P02
18	What are the functions of clutch?	BTL-1	Remembering	P01,P02
19	Give expression for torque transmitting capacity for multi plate clutch by uniform pressure theory	BTL-2	Understanding	P01,P02

	and uniform wear theory			
20	What are the types of belts?	BTL-1	Remembering	P01,P02,P012
21	What is meant by angle of contact?	BTL-1	Remembering	P01,P02
22	What is the disadvantage of v-belt drive over flat belt?	BTL-1	Remembering	P01,P02,P03
23	What is the condition for transmission of maximum power in belt drive?	BTL-1	Remembering	P01,P02,P012
24	What is the brake?	BTL-1	Remembering	P01,P02
25	What are the types of brake?	BTL-1	Remembering	P01,P02,P03
26	Define bearing?	BTL-1	Remembering	P01,P02,P03,P12
27	Give any two functions of bearing.	BTL-2	Understanding	P01,P02
28	What are the types of bearing?	BTL-1	Remembering	P01,P02
29	What is expression for ratio of driving tension for rope drive?	BTL-1	Remembering	P01,P02
30	What is Antifriction bearing**?**	BTL-1	Remembering	P01,P02,P012
31	What kind of friction acts between the tyre and road in an automobile?	BTL-1	Remembering	P01,P02
32	State the functional difference between a clutch and a brake	BTL-1	Remembering	P01,P02,P03
	PART-B&C			
1	Two pulleys, one 450 mm diameter and the other 200 mm diameter are on parallel shafts 1.95 m apart and are connected by a crossed belt. Find the length of the belt required and the angle of contact between the belt and each pulley. What power can be transmitted by the belt when the larger pulley rotates at 200 rev/min, if the maximum permissible tension in the belt is 1 kN, and the coefficient of friction between the belt and pulley is 0.25?	BTL-1	Remembering	P01,P02,P03,P06, P09,P11,P12
2	The power transmitted between two shafts 3.5 metres apart by a cross belt drive round the two pulleys 600 mm and 300 mm in diameters, is 6 kW. The speed of the larger pulley (driver) is 220 r.p.m. The permissible load on the belt is 25 N/mm width of the belt which is 5 mm thick. The coefficient of friction between the smaller pulley surface and the belt is 0.35. Determine: 1. Necessary length of the belt 2. Width of the belt and 3. Necessary initial tension in the belt.	BTL-5	Evaluating	P01,P02,P03,P06, P09,P11,P12
3	A multi-plate clutch has three pairs of contact surfaces. The outer and inner radii of the contact surfaces are 100 mm and 50 mm respectively. The maximum axial spring force is limited to 1 kN. If the coefficient of friction is 0.35 and assuming uniform wear, find the power transmitted by the clutch at 1500 r.p.m.	BTL-1	Remembering	P01,P02,P03,P12
4	A single plate clutch, with both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of	BTL-5	Evaluating	P01,P02,P03,P12

	pressure at any point in the contact surface is not to exceed 0.1 N/mm2. If the coefficient of friction is 0.3, determine the power transmitted by a clutch at a speed 2500 r.p.m.			
5	A single dry plate clutch transmits 7.5 kW at 900 r.p.m. The axial pressure is limited to 0.07 N/mm2. If the coefficient of friction is 0.25, find 1. Mean radius and face width of the friction lining assuming the ratio of the mean radius to the face width as 4, and 2. Outer and inner radii of the clutch plate.	BTL-1	Remembering	P01,P02,P03,P12
6	A load of 10 kN is raised by means of a screw jack, having a square threaded screw of 12 mm pitch and of mean diameter 50 mm. If a force of 100 N is applied at the end of a lever to raise the load, what should be the length of the lever used? Take coefficient of friction = 0.15. What is the mechanical advantage obtained? State whether the screw is self locking.	BTL-1	Remembering	P01,P02,P03,P06, P09,P11,P12
7	The mean diameter of the screw jack having pitch of 10 mm is 50 mm. A load of 20 KN is lifted through a distance of 170 mm. Find the work done in lifting the load and efficiency of the screw jack when (i) the load rotates with the screw and (ii) the load rests on the loose head which does not rotates with the screw. The external and internal diameters of the bearing surface of the loose head are 60 mm and 10mm respectively. The coefficient of friction for the screw as well as the bearing surface may be taken as 0.08	BTL-1	Remembering	P01,P02,P03,P12
8	A leather faced conical clutch has a cone angle of 30 degree. If the intensity of pressure between the contact surfaces is limited to 0.35 N/mm2 and the breadth of the conical surface is not exceed of one-third of the mean radius. Determine the dimensions of the contact surfaces to transmit 22.5 KW at 2000 rpm. Assume uniform wear rate and take coefficient of friction as 0.15	BTL-5	Evaluating	P01,P02,P03,P12
9	A compressor, requiring 90KW to operate at 250rpm. The drive is by V-belts from an electric motor running at 750 rpm. The diameter of the pulley on the compressor shaft must not be greater than 1 meter while the center distance between the pulleys is limited to 1.75m. The belt speed should not exceed 1600 m/min. Determine the number of V belt required to transmit the	BTL-5	Evaluating	P01,P02,P03,P12

	power if each belt has a cross sectional area of 375 mm2, density 1000 kg/m3 and an allowable tensile stress of 2.5 Mpa. The groove angle of the pulley is 35 degree. The coefficient of friction between the belt and the pulley is 0.25. Also calculate the length of each belt.			
10	The following data relate to a screw jack: Pitch of the threaded screw= 8 mm. Diameter of the threaded screw = 40 mm. Coefficient of friction between screw and nut =0.1 Load =20 KN. Assuming that the load rotates with the screw, determine the (i) Ratio of torques required to raise and lower the load (ii) Efficiency of the machine**.**	BTL-5	Evaluating	P01,P02,P03,P12
11	A single plate clutch transmits 25 kw at 900 rpm. The maximum pressure intensity between the plates is 85 KN/m2. The outer diameter of the plate is 360 mm. Both the sides of the plate are effective and the coefficient of friction is 0.25. Determine the (i) Inner radius of the plate. (ii) Axial force to engage the clutch.	BTL-5	Evaluating	P01,P02,P03,P06, P09,P11,P12

UNIT I BASICS OF MECHANISMS

Classification of mechanisms–Basic kinematic concepts and definitions–Degree of freedom,Mobility–Kutzbach criterion, Gruebler's criterion–Grashof's Law–Kinematic inversions of four-barchain and slider crank chains–Limit positions–Mechanical advantage–Transmission Angle–Description of some common mechanisms–Quick return mechanisms, Straight line generators,Universal Joint–rocker mechanisms.

PART-A

1. Define kinematic link. **(A.U., NOV/DEC 2011)**

A kinematic link, also known as an element, is defined as a single part of a machine which has motion relative to some other part of the machine.

2. Differentiate between a machine and a structure. **(A.U., NOV 2002, MAY 2005, DEC 2010,** JUN 2013&2014)

Machine:

i. Relative motion exits between its parts.
ii. It transforms available energy into useful work

Structure:

i. No relative motion exists between its members.
ii. It does not convert the available energy into work.

3. Classify the constrained motion**.(A.U, JUN 2014)**

There are three types of constrained motions they are

i. Completely constrained motion
ii. Incompletely constrained motion
iii. successfully constrained motion

4. Define kinematic pair. **(A.U,DEC 2006, MAY 2010,JUN2013)**

When any two links are connected in such a way that their relative motion is completely or successfully constrained, they form a kinematic pair.

5. Define kinematic chain. **(A.U,DEC 2005, MAY 2010)**

A kinematic chain is defined as the combination of kinematic pairs in which each link forms a part of two kinematic pairs and relative motion between the links is either completely constrained or successfully constrained.

6. Define degree of freedom of a mechanism. **(A.U.,DEC 2007, MAY 2010)**

The degree of freedom of a mechanism is the number of independent parameters required to specify the location of every link with the mechanism.

7. State Grubler's criterion for planar mechanisms. **(A.U.,DEC 2005, MAY 2005, DEC 2008, DEC 2011)**

Grubler's criterion for planar mechanisms given by $3n-2l-4=0$

Where, n= number of links, and

l= number of lower pairs.

8. State Grubler's criterion of spatial mechanisms. **(A.U.,DEC 2009)**

Grubler's criterion for spatial mechanisms is given by $6n-5p_1-7=0$

Where, n= number of links, and

p_1= number of pairs having 1 DOF.

9. What is the significance of Grashof's law for a four bar mechanism? **(A.U,DEC 2011)**

For four bar chain grashof's law is used to test whether any of the links in the chain can be a crank.

10. Given any four inversion of a single slider chain. **(A.U.,JUN2009)**

i. Internal combustion engine.
ii. Reciprocation quick return mechanism.
iii. Whitworth quick return mechanism.
iv. Pendulum pump.

11. Define sliding connectors.

Sliding connectors are used when one slider is to drive another slider. Usually the two sliders operate in the same plane but in different directions.

12. Define mechanical advantages of a mechanism. **(A.U.,DEC 2008,2009)**

The mechanical advantage of a mechanism is defined as the ratio of the output torque exerted by the drive link to the required input torque at the driver link.

13. Define transmission angle of a four bar mechanism what are the worst value of transmission angle?**(A.U.,DEC 2003,2011, JUN 2012,Dec 2016,May 2017)**

The able between the coupler link and the driven link is known as transmission angle. The worst value of transmission angle is less than 45^0.

14. Sketch and indicate the transmission angle of a four bar mechanism. **(A.U, MAY2010,Dec 2016)**

Link AB=driver
Link BC=coupler
Link CD=driven
Link AD=frame=transmission angle

15. What is the use of offset slider – crank mechanism? **(A.U.,NOV/DEC 2011)**

The offset slider crank mechanisms is essentially used as a quick return mechanism in which return stroke is executed quickly as compared to the working stroke.

16. List out the application of straight line motion mechanisms. **(A.U., MAY 2010)**

i. Used to machine straight and flat surface.
ii. Used in self-recording instruments in indicator mechanism.
iv. Used in a mechanism used for advancing film of a movie camera.

17. What is the condition of correct steering of an automobile? **(A.U.,JUN 2012)**

The condition of correct steering is that the relative motion between the wheels and the road surface should be that of pure rolling while taking a turn avoiding any lateral slip.

18. What are indexing mechanisms? **(A.U.,DEC 2012)**

Indexing mechanism is generally used to convert a rotary or oscillating motion of a series of step movements of the output link or shaft.

19. What is low degree of complexity? **(A.U.,DEC 2013)**

In a complex mechanism, if only one radius of path curvature of one motion transfer point is not known, such a mechanism is called a mechanism with low degree of complexity.

20. Determine the number of freedom of the mechanism shown in the figure below. (A.U., MAY 2015)

Soln;

Number of links, n=14

Number of binary joints,j=18

Number of lower pairs, l=j=18

Number of higher pairs , h=1

DOF=3(n-1)-2l-h=2

21. What is the significance of degrees of freedom of a kinematic chain when it functions as a mechanism? Given examples.**(A.U., MAY2015)**

The degree of freedom, also as mobility of freedom, refers to the number of inputs required to produce the constrained motion of the mechanism.

22. Differentiate between rigid and resistant bodies. **(A.U.,DEC 2014,Dec 2016)**

Rigid body means a body with no deformation when the required force is transmitted. A body is said to be resistant if it is capable of transmitting the required force with negligible deformation.

23. The ratio between the width of the front axle and that of wheel base of a steering mechanism is 0.44.At the instant when the front inner wheel is turned by 18 degree, what should be the angle turned by the outer front wheel for perfect steering? **(A.U.,DEC 2014)**

24. State any four types of kinematic pairs according to the types of relative motion between them.(May 2017).

i. Sliding pair
ii. Cylindrical pair
iii. Turing pair
iv. Spherical pair
v. . Screen pair

25. Identify the possible motion and name of the following combinations.

i. Members of a scissor
ii. A two plug inserted in a two pin socket

26. State at least one similarly and difference between a helical pair and cylindrical pair.

Similarity: Both are lower pair

Difference: Helical pair has an degree of freedom where as the cylindrical pair has 2 degree of freedom

27. Give the DOF for a shaft in a circular in a circular hole.

Since a circular shaft moving in a circular hole in both rotation and sliding it has 2 degree of freedom.

28. What is Kutzbach criterion for planner mechanism? **(A.U.,MAY2007)**

DOF=3(n-1)-2l-h

N=No. of links

l=No. of lower pairs

l=No. of higher pairs

29. Draw a four – bar mechanism and show that if has one DOF.**(A.U.,MAY 2006)**

Where,

n=4,l=4, h=0

DOF = 3(n-1)-2l-h= 3(4-1)-2*4-0= 1

30. What do you meant by inversion of mechanism?**(A.U.,MAY2006)**

The process of obtaining different mechanisms by fixing different links in a kinematic chain.

PART – B & C

1. What is known as kinematic inversion? Sketch and explain the various inversions of a slider crank chain, also starting the actual machines in which these are used in practice. **[May 2015,2017]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R and Shigley, J.E., Page No: 39 - 42

2. Explain why two Hooke's joints are used to transmit motion from the engine to the differential of an automobile. Two shafts are connected by a universal joint. The driving shaft rotates at a uniform speed of 1200 r.p.m. Determine the greatest permissible angle between the shaft axes so that the total fluctuation of speed does not exceed 100 r.p.m. Also calculate the maximum and minimum speeds of the driven shaft. **[May 2015]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No: 42-43

3. Explain the working of two different types of quick return mechanisms. Derive an expression for the ratio of time taken in forward and return stroke for one of these mechanisms. **[May 2015]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No: 18 – 20

4. Sketch and explain any three kinematic inversion of four-bar chain. **[May 2015]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No: 50 – 51.

5. Explain the inversions of four bar chain with examples. **[May 2015]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:27 – 29.

6. Sketch and explain the following:
   i. Elliptical trammel
   ii. Scotch yoke mechanism. **[May 2015]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No: 133 - 134

7. Explain different types of constrained motion with suitable example **(Dec 2016)**

Refer: "Theory of Machines" by Rattan, S.S Page No: 15 – 16

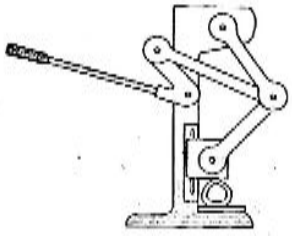
8. Describe the working of peaucellier mechanism and offset slider mechanism. **(Dec 2016)**

Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:25 - 26.

9. Explain mechanical advantage and transmission angle related to four bar mechanism. **(May 2017)**

Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:130 – 133.

10. Figure shows a mechanical press used to exert large forces to insert a small part into a larger one. Draw a kinematic diagram, using the end of the handle as a point of interest. Also compute the degrees of freedom.**(May 2017)**



Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:42 – 44.

UNIT IIKINEMATIC ANALYSIS

Displacement, velocity and acceleration analysis of simple mechanisms–Graphical method–Velocityand acceleration polygons–Velocity analysis using instantaneous centres–kinematic analysis ofsimple mechanisms–Coincident points–Coriolis component of Acceleration–Introduction to linkagesynthesis problem.

PART-A

1. Difference between rotation and translation? **(Dec 2013)**

   Translation – A state of motion of body for which the displacement difference between any two points is zero.

   Rotation – A state of motion of body for which the displacement difference points of the body are equal.

2. How to represent the direction of velocity of any point on a link with respect to another point on the same link?

   The direction of linear velocity of any point or a link with respect to another point on the same link is perpendicular to the line joining the points.

3. What is a configuration diagram/ what is use? **(May, Dec 2012)**

   Configuration diagram is a line sketch of a given mechanism drawn to a suitable scale.

   The configuration diagram forms the basis for the construction of

4. How the direction of the angular velocity is found out during velocity analysis of a mechanism by graphical method? **(May 2010)**

   By using right hand screw rule.

5. What is Coriolis component of acceleration? **(Dec 2009, 10, 11)**

   Coriolis component of acceleration occurs when a point on one link is sliding along another rotating link, such as in quick return mechanism.

6. Name two mechanisms: one where Coriolis acceleration is countered and another where Coriolis acceleration is not encountered? **(May 2010)**

   In the mechanism such as crank and slotted lever mechanism, whit worth quick return mechanism and oscillating cylinder mechanism, Coriolis acceleration is encountered.

   In the mechanism such as four bar chain, slider- crank mechanism and toggle mechanism, Coriolis is not encountered.

7. State the condition for a link to experience Coriolis acceleration (or for what kind of relative motion, the Coriolis component of acceleration occurs? **(Dec 2011)**

The Coriolis acceleration occurs when a point or one link is sliding along another rotating link, such as in quick return mechanism.

8. Give the relation to find the magnitude of Coriolis components of acceleration? May 2014,2008

$A^c = 2v^s \times$ angular velocity

Where, V^s = velocity of sliding

9. A slide, sliding at 100 mm/s on link, which is rotating at 60rpm.Is subjected to Coriolis acceleration. Find its magnitude? (May 2010)

Coriolis acceleration, $A^c = 2v^s \times$ angular velocity

$= 2*0.1*6.28$

$= 1.256\ m/s^2$

10. How direction of Coriolis component of acceleration is determined? **(June 2009)**

The direction of Coriolis component is the direction of relative velocity for the two coincident point rotated at 90* in the direction of angular velocity of rotate of link..

11. What is meant by the virtual centre on instantaneous centre? **(Dec 2002, Dec 2003,Dec 2009, June 2014)**

The combination motion of rotating and translation of the link may be assumed to be a motion of pure rotation about some centre known as virtual centre or instantaneous centre.

.

12. Write the equation to determine the number of instantaneous centers of a mechanism? **(Dec 2013,June 2007,June 2013,Dec 2013)**

Number of instantaneous centre,

N= n (n-1) / 2

Where, n=number of links.

13. State the relationship between crank angle ϕof single slider crank mechanism.**(Dec 2011)**

sinϴ = (r/l) sin ϴ = sin ϴ /n.

14. What do you mean by coupler curve? **(June 2007)**

When the linkage is put into motion, any point attached to the plane of coupler generates some path/curve with respect to frame link. This path or curve is called couple curve.

15. 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 give in magnitude and direction**. (May 2013, Dec 2016**)

From any arbitrary point b draw vector b'x such that b'x'= in the direction parallel to BA to represent the radial component of B with respect to A.

16. Explain how the coriolis component of acceleration arises when a point is rotating about some other fixed point and at the same time its distance from the fixed point varies. **(AU, May 2015)**

The coriolis component of acceleration happens only when a point known as coincident point, on one link is sliding along another rotating link. In other words whenever coincident points exist in a mechanism we have to consider coriolis component of acceleration.

17. What is the need of finding acceleration of linkage in a mechanism

Since the dynamic forces are function of accelerations of various links become very important in the design of any mechanism.

18. Name any two mechanism having coriolis component

(i)Crank and slotted lever mechanism.

(ii)Whit worth quick-return mechanism.

20. A for-bar mechanism has couples pin center at A and B, and fixed pivot center at Ao and B. write the two vector equation involing the output velocity vector of B. may 2006

$V_{ba} = W_{ba} . BA$

$V_b Bo = W_b Bo . B_{Bo}$

$V_b bo = Va + V_{ba}$

21. Explain normal component of acceleration? **(Dec 2006)**

Normal or radial component of acceleration is perpendicular to the velocity velocity to the particle at the given instant. The magnitude is given by

$$a_{rBA} = \acute{\omega}^2 * AB = v^2_{BA}/AB$$

22. Distinguish normal component of a acceleration and tangential component of acceleration. May 2003

Normal:-

$a_{rlink} * \acute{\omega}^2$*length of the link.

Tangential :

a_{rlink} *length of the link.

23. What type of link will have only centripetal component of acceleration and what types of link will have only linear acceleration? **(May 2005)**

The link which rotates at a constant velocity will only centripetal radial component of acceleration.

The link which moves in a linear direction will have only linear tangential component of acceleration.

24. State coriolis law **(Dec 2006)**

Whenever a point on one link is sliding along another rotating link, then the total acceleration will have one additional acceleration component known as coriolis component.

25. When coriolis component of acceleration occurs? **(Dec 2004)**

Coriolis component of acceleration occurs when a point on one link is sliding along another rotating link such as in quick-return mechanism.

26. In a revolving stage with a speed of 3 rpm,a person is walking with a speed of 0.5m/s along a radial path,determine the magnitude of the coriolis component of acceleration in this motion. **(Dec 2003)**

Coriolis acceleration

$= 2v^s \times$ angular velocity

$= 2 * 0.5 * 0.314$

$= 0.314\ m/s^2$

27. How many instantaneous are in a single slider crank mechanism? **(June 2006)**

In a single slider crank mechanism, there are four links.

No. of instantaneous centre ,

$N = n(n-1/2)$

$= 4(4-1/2)$

$= 6$

28. What are the types of instantaneous centers? **(May 2005,May 2017)**

1. Fixed 2. Permanent 3.neither neither fixed nor permanent

29. What do you mean by couples curve? (May 2007)

When the linkage is put in to motion, any point attached to the plane of

couples generates some path /curve with respect to frame link. This path or curve is called couples curve.

30. State the frouden stein's equation for a four bar mechanism

$K1\cos\theta + k2\cos\theta + k3 = \cos(\theta-\phi)$

Where $k1 = (d/d1)$ $k2 = (-d/c)$,and $k3 = a-b+c+d / (2ac)$

a, b, c, d are magnitude of four links

31. State and prove Kennedy's three center theorem **(Dec 2016)**

Statement: If three bodies have motion relative to each other, their instantaneouscentres should lie in a straight line.

Proof:Consider a three link mechanism with link 1 being fixed link 2 rotating about

I12and link 3 rotating about I13. Hence, I12and I13 are the instantaneous centres for link 2 and link 3. Let us assume that instantaneous center of link 2 and 3 be at point A i.e. I23. Point A is a coincident point on link 2 and link 3.

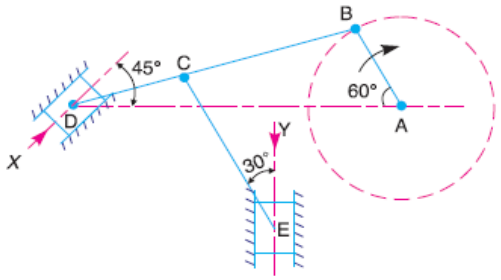
PART – B & C

1. The dimensions of the mechanism, as shown in Fig. 7.30, are as follows :

AB = 0.45 m; BD = 1.5 m: BC = CE = 0.9 m.

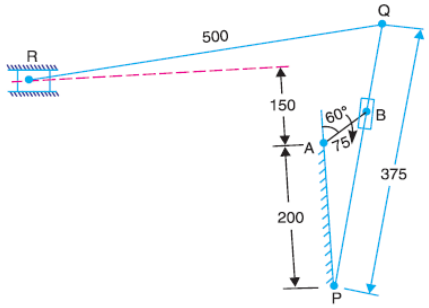
The crank AB turns uniformly at 180 r.p.m. in the clockwise direction and the blocks at D and E are working in frictionless guides. Draw the velocity diagram for the mechanism and find the velocities of the sliders D and E in their guides. Also determine the turning moment at A if a force of 500 N acts on D in the direction of arrow X and a force of 750 N acts on E in the direction of arrow Y.

[May 2015]



Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:62 –64.

2. In a slider crank mechanism, the length of crank OB and connecting rod AB are 125 mm and 500 mm respectively. The centre of gravity G of the connecting rod is 275 mm from the slider A. The crank speed is 600 r.p.m. clockwise. When the crank has turned 45° from the inner dead centre position, determine: 1. velocity of the slider A, 2. velocity of

the point G, and 3. angular velocity of the connecting rod AB. **[May 2014]** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:78.*
3. By analytical method, derive the velocity and acceleration for the reciprocating steam engine mechanism. **[May 2014]** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:82 – 84.*
4. The following data refer to the dimensions of the links of a four - bar mechanism: AB = 50mm; BC = 66mm; CD = 56mm and AD (fixed link) = 100mm. at the instant when DAB = 60°, the link AB has an angular velocity of 10.5 rad/s in the counter clockwise direction. Determine the velocity of point C, velocity of point E on the link BC while BE = 40 mm and the angular velocities of the links BC and CD. Also sketch the mechanism and indicate the data. *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:78.*
5. A four bar chain is represented by a quadrilateral ABCD in which AD is fixed and is 0.6 m long. The crank AB = 0.3 m long rotates in a clockwise direction at 10 rad/s and with an angular acceleration of 30 rad/s^2, both clockwise. The crank drives the link CD (=0.36 m) by means of the connecting link BC (=0.36 m). The angle BAD = 60°. Using graphical method, determine the angular velocities and angular accelerations of CD and BC.**[May 2012]** **Uicker,** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:106 – 108.*
6. The driving crank AB of the quick-return mechanism, as shown in Fig. 8.30, revolves at a uniform speed of 200 r.p.m. Find the velocity and acceleration of the tool-box R, in the position shown, when the crank makes an angle of 60° with the vertical line of centres PA. What is the acceleration of sliding of the block at B along the slotted lever PQ?**[May 2009]**    *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:78.*
7. The mechanism as following dimensions OA=200 mm, AB=1.5 m, BC=600mm, CD = 500 mm, BE=400 mm.Locate the instantaneous centres.If the crank OA rotates uniformly at 120 rpm. Clockwise, find (i) velocity of D and (ii) the angular velocity of the link AB and CD. **(Dec 2016)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:78.*

8.	In a mechanism, the various dimensions are OC=125mm, CP=500mmPA=125mm,AQ=250mm and QE=125mm.The slider P translates along and axis which is 25mm vertically below point O.The crank OC rotates uniformly at 120 r.p.m in the anticlockwise direction. The bell crank lever AQE rocks about fixed centre Q. Draw the velocity diagram and calculate the absolute velocity of point E of the lever. **(Dec 2016)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:78.*
9.	In a crank and slotted lever quick return motion mechanism, the distance between the fixed centers is 240 mm and the length of the driving crank is 120mm. Determine the inclination of the slotted bar with the vertical in the extreme position and the time ratio. If the length of the slotted bar is 450 mm, find the length of the stroke if the line of stroke passes through the extreme positions of the free end of the lever. **(Dec 2016)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:94 – 96.*
10.	An engine mechanism have the crank CB=200 mm and the connecting rod BA= 600 mm. In the position, the crankshaft has a speed of 50 rad/s and an angular acceleration of 800 rad/s^2.Find (i) angular velocity of AB (ii) angular acceleration of AB **(May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:192.*
11.	Locate all the instantaneous centres of the slider crank mechanism. The length of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s find (i) Velocity of the slider A, and (ii) Angular velocity of the connecting rod AB. **(May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:193.*

UNIT - III KINEMATICS OF CAM MECHANISMS

Classification of cams and followers–Terminology and definitions–Displacement diagrams–Uniformvelocity, parabolic, simple harmonic andcycloidal motions–Derivatives of follower motions–Layoutof plate cam profiles–Specified contour cams–Circular arc and tangent cams–Pressure angle andundercutting–sizing of cams.

1. What is the classification of cam based on physical shape? **(MAY-2013, Dec 2016)**
   1.Radial 2.Cylindrical 3.Wedge
   4.Globoidal 5.Conical 6.End

2. Why is a roller follower preferred to knife-edge follower? **(DEC-2009)**
   In roller follower, the wear rate is considerably reduced because of rollingmotion between contacting surfaces.

3. Why sometimes the axes of translating roller follower in cam. Follower mechanisms are offset from the axis of rotation of cam? **(DEC-2012)**
   An offset is usually provided on a side so as to decrease pressure angle at the Point of maximum velocity during out stroke is order to reduce the side thrust in guides of follower.

4. Define pressure angle of a cam mechanism? **(DEC-2011 & 2013)**
   Pressure angle is the angle between the line of action of the follower and corresponding normal to the pitch curve through trace point.

5. What is the significance of pressure angle in cam? **(JUNE-2009 & 2012)**
   The pressure angle is very important in cam design as it measures the effectiveness of cam to transfer driving force to the follower.

6. Define dwell period or angle of dwell? **(JUNE -2013)**
   The period during which the follower remains at rest

7. What are the different types of motion with which a follower can move? **(MAY-2010, 2014,2017)**
   1. Uniform velocity motion.
   2. Simple harmonic motion.
   3. Uniform acceleration & retardation motion.
   4. Cycloidal motion.

8. State the equation to determine the maximum velocity and the maximum acceleration when the follower has Simple harmonic motion?
   (MAY -2010)
   $(v_O)_{min} = \pi L\omega /2\theta_o$ $(ao)_{min} = \pi^2 L\omega^2/2\theta_o$
   $(v_O)_{max} = \pi L\omega /2\theta_r$ $(ao)_{max} = \pi^2 L\omega^2/2\theta_o$

9. State the expressions for maximum velocity and acceleration of a follower moves with cycloidal motion. (DEC-2012)

$(v_O)_{min} = \pi L\omega / 2\theta_o$ $(ao)_{min} = 2\pi L\omega^2 / 2\theta_o^2$

$(v_O)_{max} = \pi L\omega / 2\theta_r$ $(ao)_{max} = 2\pi L\omega^2 / 2\theta_o^2$

10. What is the follower motion used for high speed cams? Why?**(JUNE 2009, 2012)**

The cams with cycloidal motion for follower are recommended for higher speeds. Because the acceleration curves is

11. What is the follower motion used for high speed cams? Why? **(JUNE 2009, 2012)**

The cams with cycloidal motion for follower are recommended for higher speeds. Because the acceleration curves is continuous and the value of jerk is not infinite anywhere.

12. Name the types of cams with specified. **(MAY 2010)**

1. Tangent cam
2. Circular cam

13. Define tangent cam. **(JUNE 2014)**

When the flanks of the cam are straight and tangential to the base circle and nose circle the cam is known as tangent cam.

14. State the advantages of tangent cam and sketch it. **(DEC 2011)**

The tangent cams are usually symmetrical about the centre line of cam shaft. The tangent cams with roller followers are used for operating inlet and exhaust valves of IC engines.

15. What do you mean by under cutting in cams?**(A.U., MAY 2003, JUNE 2006, DEC 2009, DEC 2010)**

If the curvature of the pitch curve is too sharp, then the part of the cam shape would be lost and thereafter the intended cam motion would not be achieved, such a cam is said to be undercut.

16. State the basic requirement for high speed cam. **(A.U., DEC 2006, JUNE 2007)**

For any high speed cam application it is extremely important that not only the displacement and velocity curves but also the acceleration curve be made continuous for

the entire motion cycle. No discontinuities should be allowed at the boundaries of different sections of the cam.

17. Which of the displacement diagrams in respect of follower motion should bechosen for buffer dynamic performance of a cam-follower mechanism? **(A.U., MAY-2015)**

Cycloidal follower motion.

18. Write the procedure to draw the cam profile. Draw a base circle with minimum radius of the cam (rb=25mm) with O as centre. **(A.U., DEC 2013)**

Draw another circle, called prime circle, with same centre with radius equal to minimum radius of the cam plus roller radius.

19. State the advantage of cam mechanisms over linkage mechanisms. **(A.U., MAY 2003)**

The cam mechanisms are preferred over linkage mechanisms in applications that require complex or irregular motion and work function requirements.

20. List any four types of cam followers? **(A.U., NOV/DEC 2004)**

1. Knife edge follower.

2. Roller follower.

3. Flat-faced (or mushroom follower)and

4. Spherical–faced follower.

21. Why is a roller follower preferred to knife-edge follower?**(A.U.,NOV/DEC-2006, DEC 2009)**

In roller follower, the wear rate is considerably reduced because of rolling motion between contacting surfaces.

22. State at least one advantage and one disadvantage of flat-faced follower over roller follower in a cam mechanisms. **(A.U., JUNE 2006)**

ADVANTAGE:

The thrust at the bearings is less as compared roller followers.

DISADVANTAGE:

It causes high surfaces stresses.

23. Define pitch circle of the cam? **(A.U., MAY 2008)**

The locus or path of the tracing point is known as the pitch curve.

24. What is the radial distance between the prime circle and base circle for a cam with knife-edge follower? **(A.U., JUNE 2007)**

The smallest circle drawn tangent to the pitch curve is known as the prime circle. The radial distance between the prime circle and base circle for a cam with knife-edge follower is zero.

25. What is a circular arc cam? **(A.U., DEC 2007)**

When the flanks of the cam connecting the base circle and nose arc of convex circular arcs, then the cam is known as circular arc cam.

26. State the basic requirements for high speed cams. **(A.U., DEC 2006, JUNE 2007,May 2017)**

For any high speed cam application it is extremely important that not only the displacement and velocity curves but also the acceleration curve be made continuous for the entire motion cycle. No discontinuities should be allowed at the boundaries of different sections of the cam.

27. List the various methods to eliminate under cutting. **(A.U., MAY 2002)**

By decreasing the desired follower lift.

By increasing the cam rotation angle.

By increasing the cam size.

28. What do you mean by specified contours? **(A.U., MAY 2004)**

In actual practice, in order to achieve case of manufacturing and cheaper cost of production of cams, the cams with specified contours.

29. Why cams with specified contours are used? **(A.U., Dec 2004)**

The specified contours are used because of the case of availability and its less cost. It is also known for its production.

30. Classify followers according to the motion of the follower. **(A.U., Dec 2005)**

1. Reciprocating follower.

2. Oscillating follower.

31.What is a cam? **(A.U., DEC 2006)**

A cam is a rotating mechanical member used for transmitting desired motion to a follower by direct contact.

PART-B

1. The following particulars relate to a symmetrical circular cam operating a flat faced follower:
Least radius = 16 mm, nose radius = 3.2 mm, distance between cam shaft centre and nose centre = 25 mm, angle of action of cam = 150°, and cam shaft speed = 600 r.p.m. Assuming that there is no dwell between ascent or descent, determine the lift of the valve, the flank radius and the acceleration and retardation of the follower at a point where circular nose merges into circular flank.**[May 2015]**

Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley,

J.E., Page No:216 – 217.

2. A cam rotating clockwise at a uniform speed of 200 r.p.m. is required to move an offset roller follower with a uniform and equal acceleration and retardation on both the outward and return strokes. The angle of ascent, the angle of dwell (between ascent and descent) and the angle of descent is 120°, 60° and 90° respectively. The follower dwells for the rest of cam rotation. The least radius of the cam is 50 mm, the lift of the follower is 25 mm and the diameter of the roller is 10 mm. The line of stroke of the follower is offset by 20 mm from the axis of the cam. Draw the cam profile and find the maximum velocity and acceleration of the follower during the outstroke. **[May 2015]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:220.

3. A cam is designed for a knife edge follower with following data:

   v. Cam lift = 40 mm during 90° of cam rotation with SHM

   vi. Dwell for the next 30°

   vii. During the next 60° of cam rotation the follower returns to original position with SHM

   viii. Dwell for the remaining 180°

   Draw the profile of the cam when the line of stroke is offset 20 mm from the axis of the cam shaft. **[May 2014]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:224.

4. In a cam with translating roller follower, the follower axis is offset to the right of cam hinge by 12 mm. the roller radius is 10 mm and the cam rotates in the counter clock-wise direction. Layout the rise portion of the cam profile to meet the following specifications: Rise takes place during 180° of cam rotation of which for the first 90° the rise is with constant acceleration and the rest is with constant retardation. Take seven station points only. The lift of the cam is 30 mm and the least radius of the cam is 25 mm. **[May 2014]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:230 – 231.

5. A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described below :
   1. To raise the valve through 50 mm during 120° rotation of the cam;

   2. To keep the valve fully raised through next 30°;

   3. To lower the valve during next 60°; and

4. To keep the valve closed during rest of the revolution i.e. 150°;

The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm.

Draw the profile of the cam when **(a)** the line of stroke of the valve rod passes through the axis of the cam shaft, and **(b)** the line of the stroke is offset 15 mm from the axis of the cam shaft.

The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 100 r.p.m.

Draw the displacement, the velocity and the acceleration diagrams for one complete revolution of the cam. **[May 2014]**

Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:235 – 236.

6. A circular cam operating a flat faced follower has a least diameter of 40 mm. The lift is 12 mm and angle of action is 160°. The speed of rotation is 500 rpm. If the period of acceleration of the follower is 60% of the retardation during the lift, determine the following:

   i. The principal dimensions of the cam

   ii. The acceleration the main points.

   Also determine the maximum acceleration and deceleration during the lift.

   With the help of a neatly drawn sketch of a spur gear, explain elaborately the nomenclature of gears. **[May 2014]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:241 – 242.

7. Draw a cam profile to drive an oscillating roller follower to the specification given below.(i) Follower to move outwards through an angular displacement of 20°c during the first 120 rotation of the cam.

   (ii) Follower to return to its initial position during next 120 degree rotation of the cam. (iii) the follower to dwell during the next 120 degree f the cam rotation. Distance between the pivot centre and roller centre = 120 mm and distance between the pivot centre and cam axis = 130 mm,minimum radius of the cam = 40 mm, radius of roller=10 mm, inward and outward strokes take place with simple harmonic motion. (**Dec 2016**)

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:245 – 246.

8.	The following particulars relate to a symmetricala circular cam operating a flat faced follower has a least diameter of 25 mm, nose radius = 8 mm, lift of the valve is 10 mm, Angle of action of cam =120 degree. Cam shaft speed = 1000 rpm. Determine the flank radius and maximum velocity, acceleration and retardation of the follower. Draw profile of the cam. **(Dec 2016)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:251 – 252.*
9.	Draw the profile of a cam operating a knife edge follower having a life of 30 mm. The cam raises the follower with SHM for 150 degree of the rotation followed by a period of dwell for 60 degree. The follower descends for the next 100 degree rotation of the cam with uniform velocity, again followed by a dwell period. The cam rotates at a uniform velocity of 120 rpm and has a least radius of 20 mm. What will be the maximum velocity and acceleration of the follower during the life and the return? **(May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:255 – 256.*
10.	In a symmetrical tangent cam operating a roller follower, the least radius of the cam is 30 mm and roller radius is 17.5 mm. The angle of ascent is 75 degree and the total lift is 17.5 mm. The speed of the cam shaft is 600 r.p.m. Calculate: (i) The principal dimensions of the cam; (ii) the accelerations of the follower at the beginning of the life, where straight flank merges into the circular nose and at the apex of the circular nose; (iii) Draw the profile of the cam. Assume that there is no dwell between ascent and descent**.(May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:262.*
11.	A cam is to be used for a platform that will repeatedly lift boxes from a lower conveyor. This machine is plot a displacement diagram and determine the required speed of the cam when the follower motion sequences is as follows: (i)Rise 40 mm in 1.2 s (ii) Dwell for 0.3 s (iii) Fall 20 mm in 0.9 s (iv) Dwell 0.6 s (v) Fall 20 mm in 0.9 s**. (May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:262.*

UNIT-IV GEARS AND GEAR TRAINS

Law of toothed gearing–Involutes and cycloidal tooth profiles–Spur Gear terminology and definitions–Gear tooth action–contact ratio–Interference and undercutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only].Gear trains–Speed ratio, train value–Parallel axis gear trains–Epicyclic Gear Trains.

1. Define (a) Normal Pitch and (b) axial Pitch relating to helical gears. **(May 2010)**

Normal pitch

Distance between similar faces or adjacent teeth along a helix on the pitch cylinder normal to the teeth.

Axial pitch

Distance measured parallel to the axis between similar faces of adjacent teeth

2. What is a worm gear drive? **(May 2010)**

A worm gear drive is used to transmit power from one shaft to another which arenon-intersecting and their axes are normally right angles to each other

3. Define the following terms used in gears? **(May 2010, 2011)**

(a) Pressure angle (b) Module

(i) Pressure angle:

Angle between the common normal to the two gears teeth at the point of contact and the common tangent at the pitch point.

(ii) Module the ratio of pitch circle diameter to the number of teeth on the gears

4. Define the term "arc of contact" in gears? **(Dec 2016)**

The arc of contact is the path traced by a point on the pitch circle from the beginning to the end of engagement of the two meshing teeth

5. State the law of gearing? **(May 2013,2014,2017)**

The law of gearing states that for maintaining constant velocity to ratio between two meshing point of the gears the common normal of the tooth profiles at all contact points with in mesh must always pass through a fixed point on the lines of centers.

6. Define the terms velocity ratio and the sliding velocity in a spur gear pair? **(Dec 2013, May2014)**

Velocity ratio:The ratio of speed of driving gear to the speed of the driven gear.

Sliding velocity:The velocity of one tooth relative to its mating tooth along the common tangent at the point of contact.

7. Name the curves for use as gear profile which satisfies the law of gearing? **(May 2010,2013)**

1.Involutes curve

2.Cycloidal Curve

8. What is the significance of contact ratio in gears? **(Dec 2010)**

The greater contact ratio values result in smoother action because another gear tooth shares the load for a longer duration during the engaging / disengaging process.

9. Explain the term interference as applied to gears? **(May 2008,Dec 2016)**

The phenomenon when the tip of the tooth will dig out or interfere with the flank portion of the tooth portion of the mating gear.

10. Define undercutting in gears? **(May 2008,Dec 2016)**

When the tip of the gear tooth undercuts the root of the mating gear tooth some portion of the flank will be removed. This process of removal of material due to interference phenomenon is called undercutting.

11. Explain any two methods of reducing or eliminating interference in gears? **(May 2014)**

- By modifying addendum of gear tooth.
- By increasing the pressure angle.
- By modifying tooth profile or profile shifting
- By increasing the centers distances.

12. What the roles are of idles in gears train? **(May 2010, 2012)**

- To change the direction of the driven gear without changing its angular velocity
- To bridge the gap between first and last gears when the center distance is large.

13. What are the applications of reversed gear trains? **(Dec 2012)**

The reverted gear trains are used in automobile gear boxes, lather back gear, clocks etc.

14. What is meant by an Epicyclic gear train? Give a practical example. **(Dec 2011)**

When the axes of rotation of one or more gears are allowed to rotate about another axis, then the gear train is known as Epicyclic gear train. Ex: Automobile Differentials, M/C tools

15. Explain briefly the use of differential in an automobile. **(Dec 2011)**

- Transmit motion from engine to reach wheels
- Rotate the rear wheels at different speeds while the automobile is taking a turn

16. What are the advantages of epicyclic gear train?

The advantage of epicyclic gear trains over simple or compound gear trains is that it can achieve high speed reduction wit in a very limited space.

17. What is the degree of freedom for a differential mechanism?

The degree of freedom for a differential mechanism is 2.

18. What is the necessity of a differential used in an automobile?

- To compensate the difference in distance that the outer wheel travels while the vehicle is taking a turn.
- To avoid skidding.

19. What is the role of idlers in a gear train?
- Idlers are used to connect the gears where large center distance is required.
- Idlers are used to obtain the desired motion of the driven gear.

20. Write short notes on differentials:
It is the application of an epicyclic gear train with bevel gears. The function of the differential gear is to transmit the motion from engine to gear wheels.

21. List down the common forms of teeth:
- Cycloidal profile teeth.
- Involute profile teeth.

22. What is gear ratio?
It is the ratio of pinion speed to the gear speed.

$$G = np/ng.$$

23. What are the methods to avoid interference and undercutting?
- Modified involute profile tooth.
- Modified addendum of gear and pinion.
- Increase in center distance.

24. What are the types of standard tooth profile?
1. 14.5^0composite system.
2. 14.5^0 full depth involute system.
    - 20^0 full depth involute system.
    - 20^0 stab involute system.

25. What are the types of gears?(**May 2017**)
1. Parallel shaft axes gears.
2. Intersecting shaft axes gears.
3. Non-Intersecting and perpendicular shaft.
4. Non-Intersecting and non-perpendicular shaft gears.

26. Define Addendum:
It is the radial distance of gear tooth from the pitch circle to the top of the gear tooth.

27. Define Deddendum?
The radial distance of gear tooth from the pitch circle to the bottom of the gear tooth.

28. What is mean by backlash?
It is defined as the difference between the tooth space and the tooth thickness which is measured along the pitch circle. Theoretically it should be zero but practically some backlash must be allowed to prevent jamming of the teeth due to tooth errors.

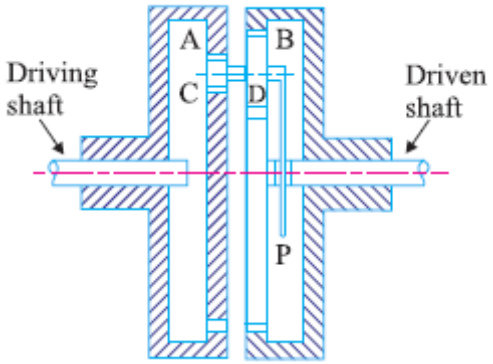
29. What are the methods to obtain velocity ratio of epicyclic gear train?
1. Tabulated method.
2. Algebraic method.

30. What is reverted gear train?
If the axis of the first driver and last driver of the follower gear are coaxial or co-incident, then it is called as reverted gear train.

PART- B

1. 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: 1. The angle through which the pinion turns while any pair of teeth are in contact and 2. 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. **[May 2015]**
   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:273 – 274.

2. An epicyclic train is shown in Fig. 13.42. Internal gear *A* is keyed to the driving shaft and has 30 teeth. Compound wheel *C* and *D* of 20 and 22 teeth respectively are free to rotate on the pin fixed to the arm *P* which is rigidly connected to the driven shaft. Internal gear *B* which has 32 teeth is fixed. If the driving shaft runs at 60 r.p.m. clockwise, determine the speed of the driven shaft. What is the direction of rotation of driven shaft with reference to driving shaft? **[May 2015]**
   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:330.



3. Two gear wheels mesh externally and are to give a velocity ratio of 3 to 1.
   The teeth are of involute form; module = 6 mm, addendum = one module, pressure angle = 20°. The pinion rotates at 90 r.p.m. Determine:

   1. The number of teeth on the pinion to avoid interference on it and the corresponding number of teeth on the wheel,
   2. The length of path and arc of contact,
   3. The number of pairs of teeth in contact, and
   4. The maximum velocity of sliding. **[May 2013]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:301 – 302.

4. With the help of a neatly drawn sketch of a gear, explain elaborately the nomenclature of gears. **[May 2013]**
   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley,

J.E., Page No:294.
5. Two unequal gears of involute profile are to give required gear ratio. Derive an expression for the minimum number of teeth required for the pinion in order to avoid interference. **[May 2012]** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:294.*
6. A reverted compound gear train is used as back gear of a lathe. It is required to give a reduction from cone – pulley speed to spindle speed of approximately 9 to 1. The module of the teeth on the high-speed pair is 4 mm and of those on low-speed pair is 5 mm. the centre distance is 180 mm. determine the number of teeth on each of the four wheels, if the pinions are to have as nearly as possible equal numbers of teeth. Also sketch a line diagram and show the gear train. **[May 2012]** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:329.*
7. Prove max length of arc of contact between a pair of gear tooth to avoid interference is $(r+ R)\tan \varphi$. **(Dec 2016)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:294.*
8. Two mating gears have 20 and 40 involutes teeth of module 10 mm and 20 degree pressure angle. The addendum on each wheel is to be made of such alength thatthe line of contact on each side of the pitch point has half the maximum possible length. Determine the addendum height of each gear wheel, length of path of contact. **(Dec 2016)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:294.*
9. A compound epicyclic gear A,D,E are free to rotate on axis P. The compound gear B and C rotate together on the axis Q at the end of arm F. All gear have equal pitch. The number of external teeth on gears A,B and C are 18,45 and 21 respectively. The gears D & E are annular gears. The gear A rotates at 100 rpm in anticlockwise direction and gear D rotates at 450 rpm clockwise. Find the speed and direction of the arm and the gear E. **(Dec 2016)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:294.*
10. Derive an expression for minimum number of teeth on the wheel in order to avoid interference.(**Dec 2016**) *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:294.*
11. The following data relate to a pair of 20 degree involute gears in mesh: Module = 6 mm, Number of teeth on pinion = 17, Number of teeth on gear=49; Addenda on pinion and gear wheel = 1 module. Find (i) The number of pairs of teeth in contact (ii) The angle turned through by the pinion and the gear wheel when one pair of teeth is in contact, and (iii) The ratio of

sliding to rolling motion when the tip of a tooth on the larger wheel (1) is just making contact, (2) is just leaving contact with its mating tooth, and (3) is at the pitch point. **(May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:285 – 286.*
12. An epicyclic gear consist of three gears. A,B and C . The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with booth A and C and is carried on an arm EF which rotates about the centre of A at 18r.p.m. If the gear A is fixed, determine the speed of gears B and C **(May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:294.*

UNIT-V FRICTION

Surface contacts–Sliding and Rolling friction–Friction drives–Friction in screw threads–Bearings and lubrication–Friction clutches–Belt and rope drives–Friction in brakes-Band and Block brakes.

1. What are the types of friction? **(Nov/Dec 2013)**

   According to the nature of surface

   a) Static friction b) Dynamic friction

   According to the condition of surface

   a) Dry friction b) Greasy friction c) Film friction

2. What is role friction in screw jack? **(Nov/Dec 2010)**

   The role friction in screw jack is to be avoiding the descending of load under its own weight or friction is necessary for the self-locking condition of the screw.

3. Why shall self-locking screw have lesser efficiency? **(Nov/Dec 2012)**
   - The self-locking screw requires friction in between the thread surface of screw &nut
   - Thus it requires more effort to lift the body
   - For this reason the self-locking have lesser efficiency.

4. List down the laws of friction **(April/May 2013)**
   1. The force of friction **α** to normal reaction between the surface in contact & always opposes the relative motion between them.
   2. The force friction is independent of the load.
   3. The force of friction depends on the nature of materials of the contacting surface.

5. Define anti friction bearing **(Nov/Dec 2013)**

   It is define as a type of bearing using rolling motion to support a load & reduce friction

6. Differentiate between multi plate clutch &core clutch **(Nov/Dec 2013)**

   Multi plate clutch is an extension of single plate clutch and works on the same principle that of single plate clutch.

   In cone clutch working principle is same that of single plate clutch accept that contact surface are conical in cone clutch.

7. Differentiate between self-locking & over howling of screw **(May 2012)**

S. No	Self-Locking	Over Howling
1	Condition for self-locking **Φ>α**	**Φ<α**

	2	Due to self-locking the load will be held in position without any external brake	Due to over howling load continuous to descend under its own weight unless external brake is applied
	3	Used in screw jack	Used in fly press

8. What is limiting angle of friction? **(Nov/Dec 2011)**
   It is defined as the angle between the resultant of force (R) of friction (FF) and normal reaction (RN) makes with the direction of normal reaction (RN)Φ=Tan^-1 (FF/RN).

9. What is the difference between sliding friction & rolling friction? **(May 2011)**
   Sliding friction: If two surface having sliding motion with respect to each other the friction between is known as sliding friction. Ex: Nuts & Bolts

   Rolling Friction: If two surface have rolling motion with respect to each other the friction between them is known as rolling friction. Ex: Ball & Rolling Bearing.

10. What are advantage & disadvantage of V-Belt drive? **(May 2011)**
    Advantage

    - It have higher power transmitting capacity
    - It can be used for high speed reduction ratio

    Disadvantage

    - They are complex to design & manufacture
    - It have lower efficiency

11. Distinguish between open & cross belt drive in term of its application. **(April /May 2013)**
    Open belt drive is used when both the driving & driven shaft are arranged in parallel in same direction

    Cross belt drive is used when both the driving & driven shaft are arranged in parallel in opposite direction.

12. Define Velocity Ratio. **(May 2014)**
    Velocity ratio = (speed of driven pulley/speed of driving pulley).

13. What is self-energizing brake? **(April/May 2011,Dec 2016)**
    In single block brake when the moments of actuating force and frictional force in same direction the frictional force assist the actuating force.

14. What is meant by self-locking brake? **(Nov /Dec 2012,Dec 2016)**
    When no effort is required to apply the brake & brake is applied on its own.

15. What is the max efficiency of screw jack?

ήmax=1-sinǿ/1+sinǿ
16. Obtain an expression for length of an open belt drive. $L=d/2(\pi-2\alpha)+d/2(\pi+2\alpha)+2C\cos\alpha$
17. Define helix angle. It is defined as angle made by helix of the thread with a plane perpendicular to the axis of the screw.
18. What are the functions of clutch? When clutch is engaged the clutch transmit maximum power from engine crank shaft of gear box input shaft When clutch is engaged, the clutches accommodates for minor slippages and hence provide smooth drive transmission without jerks.
19. Give expression for torque transmitting capacity for multi plate clutch by uniform pressure theory and uniform wear theory i) uniform pressure theory $T=n*2/3\mu w(R1^3-R2^3/R1^2-R2^2)$ ii)uniform wear theory $T=n*1/2\mu w(R1+R2)$
20. What are the types of belts? 1. Flat belt 2.v-belt 3.circular belt 4.timming belt
21. What is meant by angle of contact? It is the angle made by a common normal drawn to the tangent line at the point of engagement and at the point of disengagement of belt on a pulley as its center.
22. What is the disadvantage of v-belt drive over flat belt? **(Dec 2016)** • V-belt cannot be used has larger distance • It's not as durable as flat belt • It's a costlier system
23. What is the condition for transmission of maximum power in belt drive? Power transmitted shall be a maximum. When the centrifugal tension is one-third of the belt together when belt runs at velocity of $V_B=\sqrt{TI/3T_m}$
24. What is the brake? It is a device with the help of which artificial fractional resistance is applied to a moving machine member in order to stop or returned the motion of body.
25. What are the types of brake? • Block or shoe brake. • Band & block. • Band brake. • Drum & shoe. • Disk brake.
26. Define bearing? It is a machine element which supports another moving machine elements called as

journal.

27. Give any two functions of bearing.
    - It provides the support to the shaft or axe & holds them in correct position.
    - It facilitates free rotation of the shaft or axle with rim amount of friction.

28. What are the types of bearing?
    1. Sliding contact bearing.
    2. Rolling contact bearing.

29. What is expression for ratio of driving tension for rope drive?
    T1/T2= e^(μθ/sinβ)

30. What is Antifriction bearing**?**
    - In rolling contact bearing, the between the bearing surface is rolling instead of sliding as in case of sliding center.
    - Main advantage of rolling contact bearing over a sliding contact bearing is that, it has low staring friction. Due to this property, these bearing are also called antifriction bearing.

31. What kind of friction acts between the tyre and road in an automobile? **(May 2017)**
    It is because the patch of rubber that is actually touching the road is not moving with respect to the road. It is static (for a very brief period every revolution).
    As the patch flattens out on the road, there is a tiny bit of relative motion, which is part of that rolling friction, but the whole patch is not sliding, so it's not kinetic friction (unless you have slammed on the brakes and the wheels are screeching or you are cornering so hard the tires are slipping).

32. State the functional difference between a clutch and a brake.**(May 2017)**
    Brake and clutch are the two different components used in automotive. These two elements serve two different purposes. Though their functions are entirely different, both are needed for the smooth running of a automotive vehicle.

PART-B

1. Two pulleys, one 450 mm diameter and the other 200 mm diameter are on parallel shafts 1.95 m apart and are connected by a crossed belt. Find the length of the belt required and the angle of contact between the belt and each pulley.
   What power can be transmitted by the belt when the larger pulley rotates at 200 rev/min, if the maximum permissible tension in the belt is 1 kN, and the coefficient of friction between the belt and pulley is 0.25? **[May 2015]**

   Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:445 – 446.

2. The power transmitted between two shafts 3.5 metres apart by a cross belt drive round the two pulleys 600 mm and 300 mm in diameters, is 6 kW. The speed of the larger pulley (driver) is 220 r.p.m. The permissible load on the belt is 25 N/mm width of the belt which is 5 mm thick. The coefficient of friction between the smaller pulley surface and the belt is 0.35.
   Determine:

   1. Necessary length of the belt

2. Width of the belt and

3. Necessary initial tension in the belt. **[May 2015]**

Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:440 – 442.

3. A multi-plate clutch has three pairs of contact surfaces. The outer and inner radii of the contact surfaces are 100 mm and 50 mm respectively. The maximum axial spring force is limited to 1 kN. If the coefficient of friction is 0.35 and assuming uniform wear, find the power transmitted by the clutch at 1500 r.p.m. **[May 2014]**
Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:444 – 445.

4. A single plate clutch, with both sides effective, has outer and inner diameters 300 mm and 200 mm respectively. The maximum intensity of pressure at any point in the contact surface is not to exceed 0.1 N/mm2. If the coefficient of friction is 0.3, determine the power transmitted by a clutch at a speed 2500 r.p.m. **[May 2014]**
Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:459 – 460.

5. A single dry plate clutch transmits 7.5 kW at 900 r.p.m. The axial pressure is limited to 0.07 N/mm2. If the coefficient of friction is 0.25, find 1. Mean radius and face width of the friction lining assuming the ratio of the mean radius to the face width as 4, and 2. Outer and inner radii of the clutch plate. **[May 2013]**
Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:449 – 451.

6. A load of 10 kN is raised by means of a screw jack, having a square threaded screw of 12 mm pitch and of mean diameter 50 mm. If a force of 100 N is applied at the end of a lever to raise the load, what should be the length of the lever used? Take coefficient of friction = 0.15. What is the mechanical advantage obtained? State whether the screw is self-locking. **[May 2013]**
Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:453 – 455.

7. The mean diameter of the screw jack having pitch of 10 mm is 50 mm. A load of 20 KN is lifted through a distance of 170 mm. Find the work done in lifting the load and efficiency of the screw jack when (i) the load rotates with the screw and (ii) the load rests on the loose head which does not rotates with the screw. The external and internal diameters of the bearing surface of the loose head are 60 mm and 10mm respectively. The coefficient of friction for the screw as well as the bearing surface may be taken as 0.08 **(Dec 2016)**
Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:456.

8. A leather faced conical clutch has a cone angle of 30 degree. If the intensity of pressure between the contact surfaces is limited to 0.35 N/mm2 and the breadth of the conical surface is not exceed of one-third of the mean radius. Determine the dimensions of the contact surfaces to transmit 22.5 KW at 2000 rpm. Assume uniform wear rate and take

coefficient of friction as 0.15**.(Dec 2016**) *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:458 – 460.*
9. A compressor, requiring 90KW to operate at 250rpm. The drive is by V-belts from an electric motor running at 750 rpm. The diameter of the pulley on the compressor shaft must not be greater than 1 meter while the center distance between the pulleys is limited to 1.75m. The belt speed should not exceed 1600 m/min. Determine the number of V belt required to transmit the power if each belt has a cross sectional area of 375 mm2, density 1000 kg/m3 and an allowable tensile stress of 2.5 Mpa. The groove angle of the pulley is 35 degree. The coefficient of friction between the belt and the pulley is 0.25. Also calculate the length of each belt. **(Dec 2016)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:461 – 462.*
10. The following data relate to a screw jack: Pitch of the threaded screw= 8 mm. Diameter of the threaded screw = 40 mm. Coefficient of friction between screw and nut =0.1 Load =20 KN. Assuming that the load rotates with the screw, determine the (i) Ratio of torques required to raise and lower the load (ii) Efficiency of the machine**.** **(May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:465.*
11. A single plate clutch transmits 25 kw at 900 rpm. The maximum pressure intensity between the plates is 85 KN/m2. The outer diameter of the plate is 360 mm. Both the sides of the plate are effective and the coefficient of friction is 0.25. Determine the (i) Inner radius of the plate. (ii) Axial force to engage the clutch. **(May 2017)** *Refer: "Theory of Machines and Mechanisms" by Uicker, J.J., Pennock G.R andShigley, J.E., Page No:465.*