KOM
COURSE
FILE

K S INSTITUTE OF TECHNOLOGY BANGALORE

DEPARTMENT OF MECHANICAL ENGINEERING

Contents

KS INSTITUTE OF TECHNOLOGY, BANGALORE-109

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE FILE

NAME OF THE STAFF	:	L.NIRMALA
SUBJECT CODE/NAME	:	17ME42/KINEMATICS OF MACHINERY
SEMESTER/YEAR	:	IV/II
ACADEMIC YEAR	:	2018-2019
BRANCH	:	MECHANICAL

COURSE INCHARGE

HOD

Head of the Department
Dept. of Mechanical Engg.
K.S. Institute of Technology
Bengaluru - 560 109.

K. S. INSTITUTE OF TECHNOLOGY

#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru-5600109

Vision and Mission

Vision of the Institute

To impart quality technical education with ethical values employable skills and research excellence

Mission of the Institute

- To attract and retain highly qualified, experienced & committed faculty.
- To create relevant infrastructure
- Network with industry & premier institutions to encourage emergence of new ideas by providing research & development facilities to strive for academic excellence
- To inculcate the professional & ethical values among young students with employable skills & knowledge acquired in transform the society

DEPARTMENT OF MECHANICAL ENGINEERING

Vision of the Department

To groom the incumbent to be able to compete with the best in the Mechanical Engineering profession and to get recognized by peers as one of the best learning centers

Mission of the Department

- To impart sound fundamentals in mechanical engineering
- To expose students to new frontiers
- To achieve engineering excellence through experiential learning and team work.

K. S. INSTITUTE OF TECHNOLOGY

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DEPARTMENT OF MECHANICALENGINEERING

PEO'S, PSO'S and PO'S

a. PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)

- PEO1: To produce graduates who would have developed a strong background in basic science and mathematics and ability to use these tools in Mechanical Engineering.
- PEO2: To prepare graduates who have the ability to demonstrate technical competence in their fields of Mechanical Engineering and develop solutions to the problems.
- PEO3: To equip graduates to function effectively in a multi-disciplinary environment individually, within a global, societal, and environmental context.

b. PROGRAM SPECIFIC OUTCOMES (PSO's)

It is expected that a student in mechanical engineering will possess an:

PSO1: Ability to apply concept of mechanical engineering to design a system, a component or a process/system to address a real world challenges.

PSO2: Ability to develop effective communication, team work, entrepreneurial and computational skills.

c. PROGRAM OUTCOMES (PO's)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineeringfundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complexengineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems anddesign 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.

4. **Conduct investigations of complex problems**: Use research-based knowledge and researchmethods including design of experiments, analysis and interpretation of data, and

synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modernengineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assesssocietal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutionsin societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader indiverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineeringcommunity 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.

11. **Project management and finance**: Demonstrate knowledge and understanding of theengineering 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.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage inindependent and life-long learning in the broadest context of technological change.

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DEPARTMENT OF MECHANICALENGINEERING

CO-PO-PSO Mapping

Course Outcomes

Student will be able to

CO1: Understanding the basic terminology of planar mechanisms and their motion study	Understand (K2)
CO2:Model displacement diagrams for followers with various types of motions and Cam profile drawing for various followers	Apply (K3)
CO3: Evaluating the transmission of power by application of various gears and gear trains.	Analyze (K4)
CO4: Constructing velocity and acceleration diagrams for planar mechanisms by Graphical method	Analyze (K4)
CO5: Inspect velocity and acceleration of planar mechanisms by complex algebra method and kinematic synthesis of four bar and slider crank kinematic chain	Analyze (K4)

17 ME52 CO	PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS O1	PS O2
CO1	K3	1	-											2	2
CO2	K3	3	1											2	2
CO3	K3	3	2											2	1
CO4	K4	3	2											2	1
CO5	K4	3	2											2	1
Total		2.6	1.74											2	1.4

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Bengaluru - 560 109.

KSIT

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#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru-5600109
DEPARTMENT OF MECHANICALENGINEERING

4.STUDENTSDETAILS -IV SEM (A-SECTION)

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DEPARTMENT OF MECHANICAL ENGINEERING

CALENDER OF EVENTS

INSTITUTE

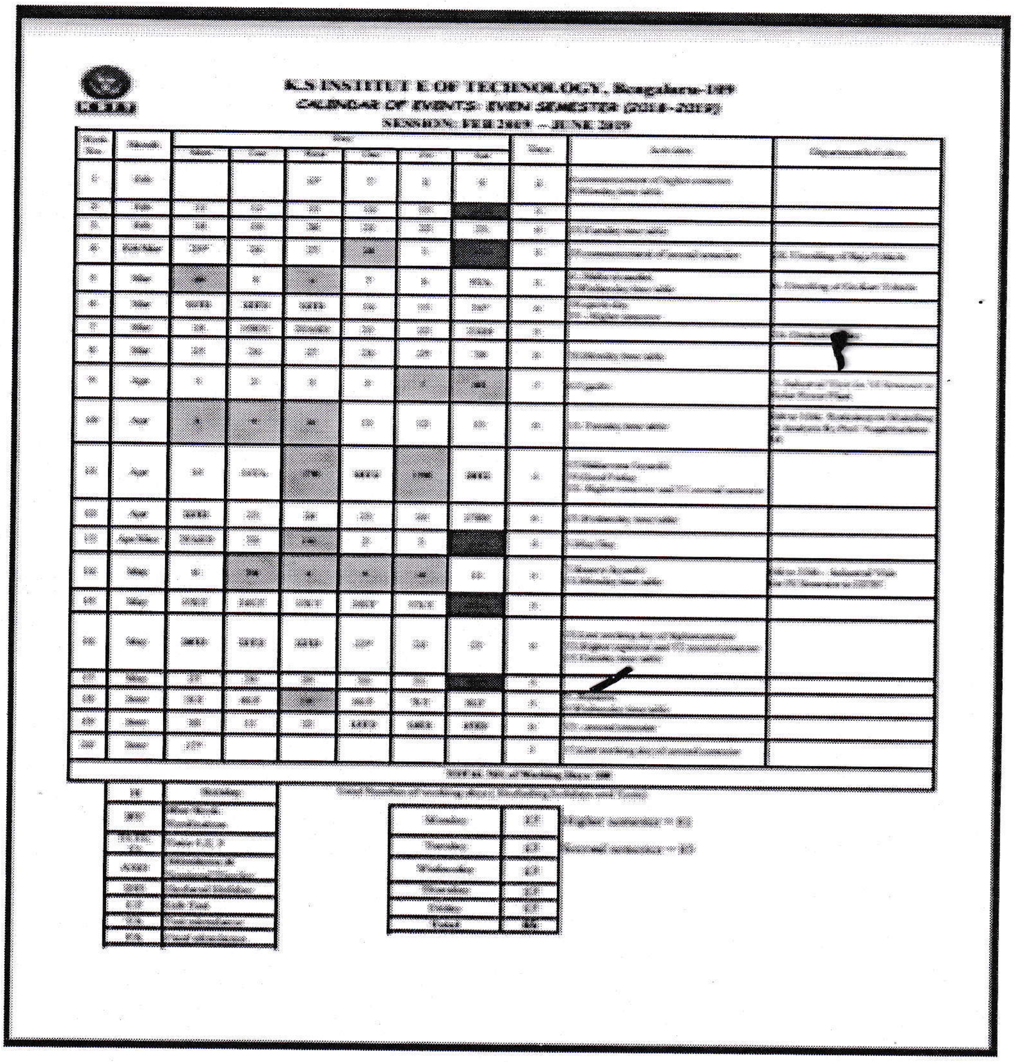
K.S INSTITUTE OF TECHNOLOGY, Bengaluru-109

CALENDAR OF EVENTS: EVEN SEMESTER (2018-2019)

SESSION: FEB 2019 – JUNE 2019

PRINCIPAL
K.S. INSTITUTE OF TECHNOLOGY
BENGALURU - 560 109

DEPARTMENT



K.S INSTITUTE OF TECHNOLOGY, Bengaluru-109
CALENDAR OF EVENTS: EVEN SEMESTER (2018-2019)
SESSION: FEB 2019 – JUNE 2019

Head of the Department
Dept. of Mechanical Engg.
K.S. Institute of Technology
Bengaluru - 560 109.

CLASS TIME TABLE

K[illegible] INSTITUTE OF TECHNOLOGY, BENGA[illegible]RU - 560109
DEPARTMENT OF MECHANICAL ENGI[illegible]EERING
IV SEMESTER TIME TABLE FOR THE YEAR [illegible] SEMESTER

W.E.F: 06/02/2019
Section : IV A

Class Teacher : Mr.Pruthviraj B S
Class Room : NB LH 101

PERIOD	1	2	10:20 - 10:35	3	4	12:25 - 1:30	5	6	7
TIME/DAY	8:30 - 9:25	9:25 - 10:20		10:35 - 11:30	11:30 - 12:25		1:30 - 2:25	2:25 - 3:20	3:20 - 4:15
MON	MM&M LAB(A1) - Mrs. Sreenadha N M/C SHOP (A2) - Mr. Naresha K				KANNADA		PROGRAMMING CLASS		
TUE	MATHS VK/PJ	MM&M BKR	TEA BREAK	KOM LN	FM PBS	LUNCH BREAK	MM&M LAB(A2) - Mr. Bharath Kumar K R M/C SHOP (A1) - Mr. Harish U		
WED	MM&M KMM	MATHS VK/PJ		ATD KP	ATD KP		FM PBS	FM PBS	MTO Dr. AJS
THU	ATD KP	ATD KP		FM PBS	MATHS VK/PJ		KOM LN	MTO Dr. AJS	MM&M KMM
FRI	KOM LN	KOM LN		MTO Dr. AJS	MM&M BKR		MATHS VK/PJ	MTO Dr. AJS	FM PBS
SAT									

Subject Code	Subject Name	Faculty Name
17MAT41	Engineering Mathematics - IV	Mrs.P.Jayashree/Mr.Venkataramana
17ME42	Kinematics of Machines	Mrs. Nirmala .L
17ME43	Applied Thermodynamics	Mr.K.Prasad
17ME44	Fluid Mechanics	Mr.Pruthviraj B S
17ME45B	Machine Tools and Operations	Dr.Aajay Kumar B S
17ME46B	Mech Measurements and Metrology	Mr. Bharath Kumar K R/ Mr. Kaushik M M
17MEL47B	Mech Measurements and Metrology Lab	Mrs. Sreenadha N (A1) /Mr. Bharath Kumar K R (A2)
17MEL48B	Machine Shop Lab	Mr. Harish U (A1) / Mr.Naresh.K (A2)
17KKM49	Kannada Manasu	Mr. Trimurthy
17KKK49	Kannada kali	Note: Kannada (NK) From 12.25pm to 1.15pm every Monday

TIME TABLE CO-ORDINATOR

HEAD OF THE DEPARTMENT
Head of the Department
Dept. of Mechanical Engg.
K.S. Institute of Technology
Bengaluru - 560 109

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BENGALURU - 560 109

5.INDIVIDUAL TIME TABLE

PERIOD	1	2	10:20 - 10.35	3	4	12:25 - 1:30	5	6	7
TIME/ DAY	8:30 - 9:25	9:25 - 10:20		10:35 - 11:30	11:30 - 12:25		1:30 - 2:25	2:25 - 3:20	3:20 - 4:15
MON			TEA BREAK			LUNCH TIME			KOM
									IV A
TUE				KOM					
				IV A					
WED									
THU							KOM		
							IV A		
FRI	KOM	KOM							
	IV A	IV A							

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KINEMATICS OF MACHINES

B.E, IV Semester, Mechanical Engineering

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17ME42	CIE Marks	40
Number of Lecture Hours/Week	04	SEE Marks	60
Total Number of Lecture Hours	50(10 Hours per Module)	Exam Hours	03

Credits – 04

Course Objectives:

1. **Familiarize with mechanisms and motion analysis of mechanisms.**
2. **Understand methods of mechanism motion analysis and their characteristics.**
3. **Analyse motion of planar mechanisms, gears, gear trains and cams.**

Module - 1

Introduction: Definitions: Link, kinematic pairs,kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classifiction of pairs based on type of relative motion,Grubler's criterion, mobility of mechanism, Groshoff's criteria, inversions of Grashoff's chain.

Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Oldham's coupling, Straight line motion mechanisms, Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms:Geneva wheel mechanism, Ratchet and Pawl mechanism,toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism.

Module - 2

Velocity and Acceleration Analysis of Mechanisms (Graphical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.

Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem, Determination of linear and angular velocity using instantaneous center method.

Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.

Module - 3

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.

Freudenstein's equation for four bar mechanism and slider crank mechanism. **Function Generation** for four bar mechanism.

Module - 4

Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference,condition and expressions for minimum number of teeth to avoid interference.

Gear Trains: Simple gear trains, compound gear trains.

Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains.

Module - 5

Cams: Types of cams, types of followers. displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, Uniform Acceleration, Retardation and Cycloidal motion.

Cam profiles: disc cam with reciprocating followers such as knife-edge, roller and flat-face followers, inline and offset.

Analysis of Cams: Analysis of arc cam with flat faced follower.

Course outcomes:

1. **Identify mechanisms with basic understanding of motion.**
2. **Comprehend motion analysis of planar mechanisms, gears, gear trains and cams.**
3. **Carry out motion analysis of planar mechanisms, gears, gear trains and cams.**

TEXT BOOKS:

1. Rattan S.S, Theory of Machines,Tata McGraw-Hill Publishing Company Ltd., New Delhi, 4th Edition, 2014.
2. Ambekar A. G., Mechanism and Machine Theory, PHI, 2009.

REFERENCE BOOKS

Michael M Stanisic, Mechanisms and Machines-Kinematics, Dynamics and Synthesis, Cengage Learning, 2016.

2. Sadhu Singh, **Theory of Machines,** Pearson Education (Singapore)Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006.

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DEPARTMENT OF MECHANICAL ENGINEERING

7. COURSE PLAN

Academic Year	2018-2019					
Batch	2017-2021					
Year/Semester/section	II/IV/A					
Course Component	Professional core					
Subject Code-Title	17ME42-Kinematics of Machinery					
No. of Students						
Schedule	L	4	T	-		
Name of the Instructor	Mrs. Nirmala.L				Dept	ME

K S INSTITUTE OF TECHNOLOGY, BENGALURU-109

DEPARTMENT OF MECHANICAL ENGINEERING

LESSON PLAN FOR THE ACADEMIC YEAR OF 2018-2019

SUBJECT : KINEMATICS OF MACHINERY

SUBJECT CODE : 17ME42

FACULTY :NIRMALA.L **SEMESTER/SECTION : 4th 'A '** **W.E.F : 06/02/2019**

Course Objectives:

1. Familiarize with mechanisms and motion analysis of mechanisms.
2. Understand methods of mechanism motion analysis and their characteristics.
3. Analyse motion of planar mechanisms, gears, gear trains and cams

Course Outcomes

CO1: Understanding the basic terminology of planar mechanisms and their motion study

CO2:Model displacement diagrams for followers with various types of motions and Cam profile drawing for various followers

CO3: Evaluating the transmission of power by application of various gears and gear trains.

CO4: Constructing velocity and acceleration diagrams for planar mechanisms by Graphical method

CO5: Inspect velocity and acceleration of planar mechanisms by complex algebra method and kinematic synthesis of four bar and slider crank kinematic chain

COURSE CONTENTS :

PERIOD	MODULE	TOPICS	DATE	CO	K-LEVEL

12

1	1	Introduction: Definitions: Link, kinematic pairs, kinematic chain, mechanism, structure.	07-02-2019	CO 1	Understand (K2)
2	1	Degrees of freedom, Classification links, Classifiction of pairs based on type of relative motion	08-02-2019	CO 1	Understand (K2)
3	1	Grubler's criterion, mobility of mechanism, Groshoff's criteria, inversions of Grashoff's chain.	09-02-2019	CO 1	Understand (K2)
4	1	Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism.	11-02-2019	CO 1	Understand (K2)
5	1	Oldham's coupling, Straight line motion mechanisms, Peaucellier's mechanism and Robert's mechanism.	12-02-2019	CO 1	Understand (K2)
6	1	Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism,	14-02-2019	CO 1	Understand (K2)
7	1	pantograph, condition for correct steering, Ackerman steering gear mechanism.	15-02-2019	CO 1	Understand (K2)
8	1	Numericals on mobility of mechanism	18-02-2019	CO 1	Understand (K2)
9	1	Numericals on grashoff's chain	19-02-2019	CO 1	Understand (K2)
10	2	Cams: Types of cams, types of followers. and Cam profiles	21-02-2019	CO 2	Apply (K3)
11	2	Displacement, velocity and acceleration curves for uniform velocity,	22-02-2019	CO 2	Apply (K3)
12	2	Simple Harmonic Motion, Uniform Acceleration, Retardation	25-02-2019	CO 2	Apply (K3)
13	2	Cycloidal motion.	26-02-2019	CO 2	Apply (K3)
14	2	Disc cam with reciprocating followers such as knife-edge	28-02-2019	CO 2	Apply (K3)
15	2	Disc cam with reciprocating followers roller and flat-face followers, inline and offset.	01-03-2019	CO 2	Apply (K3)
16	2	Numericals on knife edge follower with UV,SHM	02-03-2019	CO 2	Apply (K3)
17	2	Numericals on roller follower with UV, UARM	05-03-2019	CO 2	Apply (K3)
18	2	Numericals flat faced follower with cycloidal motion	07-03-2019	CO 2	Apply (K3)
19	3	Spur Gears: Gear terminology	08-03-2019	C03	Analyze (K4)
20	3	Law of gearing	09-03-2019	C03	Analyze (K4)
22	3	Expression for Path of Contact and arc of contact	14-03-2019	CO 3	Analyze (K4)
23	3	Contact ratio of spur gear	15-03-2019	CO 3	Analyze (K4)
24	3	Numericals to determine length of path of contact	16-03-2019	CO 3	Analyze (K4)
25	3	Numericals to determine arc of contact	18-03-2019	CO 3	Analyze (K4)
26	3	Nuericals to determine contact ratio	19-03-2019	CO 3	Analyze (K4)
27	3	Numericals on interference between gears	21-03-2019	CO 3	Analyze (K4)
28	3	Numericals on interference between gears	22-03-2019	CO 3	Analyze (K4)
29	3	Numericals on interference between gears	23-03-2019	CO	Analyze (K4)

				3	
30	3	Interference in involute gears, methods of avoiding interference,	25-03-2019	CO 3	Analyze (K4)
31	3	condition and expressions for minimum number of teeth to avoid interference.	26-03-2019	CO 3	Analyze (K4)
32	3	Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains	28-03-2019	CO 3	Analyze (K4)
33	3	Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains,	29-03-2019	CO 3	Analyze (K4)
34	3	torque calculation in epicyclic gear trains.	30-03-2019	CO 3	Analyze (K4)
35	3	Numericals on gear trains	01-04-2019	CO 3	Analyze (K4)
36	3	Numericals on gear trains	02-04-2019	CO 3	Analyze (K4)
37	3	Numericals on gear trains	04-04-2019	CO 3	Analyze (K4)
38	3	Numericals on gear trains	08-04-2019	CO 3	Analyze (K4)
40	4	Velocity and Acceleration Analysis of Mechanisms (Graphical Method)	09-04-2019	CO 4	Analyze (K4)
41	4	Velocity and acceleration analysis of four bar mechanism	11-04-2019	CO 4	Analyze (K4)
42	4	slider crank mechanism.	12-04-2019	CO 4	Analyze (K4)
43	4	Mechanism illustrating Corioli's component of acceleration.	13-04-2019	CO 4	Analyze (K4)
44	4	Angular velocity and angular acceleration of links, velocity of rubbing	15-04-2019	CO 4	Analyze (K4)
45	4	Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's theorem	16-04-2019	CO 4	Analyze (K4)
46	4	Determination of linear and angular velocity using instantaneous center method.	23-04-2019	CO 4	Analyze (K4)
47	4	Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.	25-04-2019	CO 4	Analyze (K4)
48	4	Determination of linear and angular velocity of four bar mechanism	26-04-2019	CO 4	Analyze (K4)
49	4	Determination of linear and angular velocity of slider crank mechanism	27-04-2019	CO 4	Analyze (K4)
50	4	Determination of velocity acceleration of four bar mechanism	29-04-2019	CO 4	Analyze (K4)
51	4	Determination of velocity acceleration of slider crank mechanism	30-04-2019	CO 4	Analyze (K4)
52	4	Numericals	02-05-2019	CO 4	Analyze (K4)
53	4	Numericals	03-05-2019	CO 4	Analyze (K4)
54	4	Numericals	06-05-2019	CO 4	Analyze (K4)
55	4	Numericals	14-05-2019	CO 4	Analyze (K4)
56	4	Numericals	16-05-2019	CO 4	Analyze (K4)
57	4	Numericals	21-05-2019	CO 4	Analyze (K4)

58	5	Velocity and acceleration analysis of four bar mechanism,	23-05-2019	CO 5	Analyze (K4)
59	5	slider crank mechanism using complex algebra method.	24-05-2019	CO 5	Analyze (K4)
60	5	Freudenstein's equation for four bar mechanism and slider crank mechanism.	25-05-2019	CO 5	Analyze (K4)
61	5	Function Generation for four bar mechanism.	27-05-2019	CO 5	Analyze (K4)
62	5	Numericals on analysis of four bar mechanism by complex method	28-05-2019	CO 5	Analyze (K4)
63	5	Numericals on analysis of slider crank mechanism by complex method	30-05-2019	CO 5	Analyze (K4)
64	5	Numericals on function generation of four bar mechansm	31-05-2019	CO 5	Analyze (K4)
REFERNCE BOOKS	1. Theory of Machines, Sadhu Singh, Pearson Education, 2nd Edition. 2007. 2. Theory of Machines, Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009. 3. Mechanism and Machine Theory, A. G. Ambekar PHI, 2007				

SIGNATURE OF THE FACULTY

SIGNATURE OF THE HOD

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DEARTMENT OF MECHANICAL ENGINEERING

TEACHING AND LEARNING

PEDAGOGY REPORT

Academic Year	2018-19
Name of the Faculty	Mrs.Nirmala L
Course Name /Code	KINEMATICS OF MACHINERY/17ME42
Semester/Section	IV/A
Activity Name	Integrate new forms of technology
Topic Covered	Animations and videos of various mechanisms, Kinematic analysis
Objectives/Goals	• To review student's factual and conceptual knowledge of various mechanisms and relationship between input motion and output motion in any mechanism. • To adoptnew method of interaction of student activities. • To effectively motivate and share the latest technologies toall the students. • To engage the students in a positive learning environment.
Tools Used	Visual and observational media: videos, animations, physical models and simulations through sources like YouTube.

Appropriate Method/Instructional materials/Exam Questions

- Study of mechanisms is one of the first applied sciences, so use of physical models for demonstration of mechanism plays a vital role.
- Enhancing the conceptual knowledge of the students to maintain curiosity and interest as the chief motivative forces behind the learning. Sustained interest leads students to set themselves realistic standards of achievement and develop a mechanism for real time challenges.

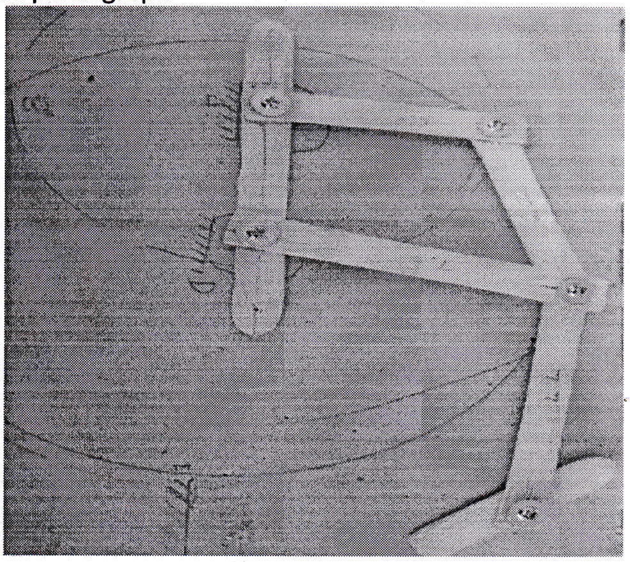
Relevant PO's	PO2,PO9
Significance of Results/Outcomes	• The activity tested the students understanding of various mechanisms used in daily life and assisted them in cognitive development, ensuring that they advance their understanding of concepts to higher levels. • Students not only expanded their knowledge base, but also understood how to use that knowledge in authentic and relevant real-world scenarios and contexts, as well as connect concepts from lessons with situations in their own lives.
Reflective Critique	• Student's awareness in participation of other modes of learning is enhanced. • The students' understanding and knowledge is reviewed. 60 % of the students could join in the platform and actively participated

	and benefited. • Need to focus on other set of students.

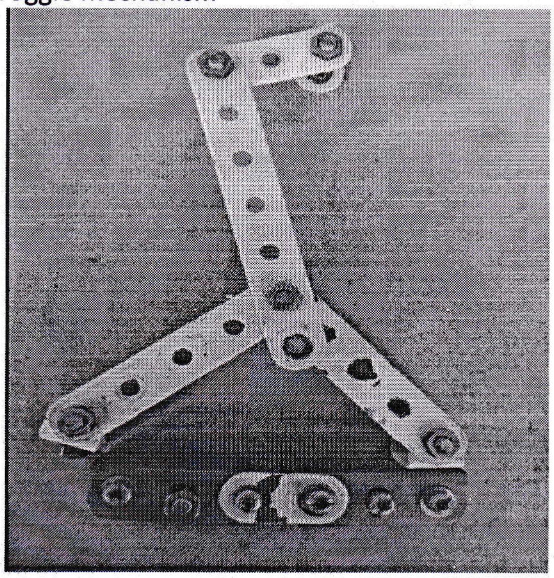
Proofs (Photographs/Videos/Reports/Charts/Models)

An Illustration of Visual and observational media in kinematics of machinery

Prototype working model of pantograph



Prototype working model of Toggle mechanism



https://drive.google.com/drive/folders/1Czrq8FwUqcPmuY-767acLvT41gkCxhdZ

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#14, Raghuvanahalli, Kanakapura Main Road, Bengaluru-5600109

DEPARTMENT OF MECHANICALENGINEERING

8. ASSIGNMENT QUESTIONS

Assignment No: 1 **Total marks:20**

Sl.No	Assignment Questions	K Level	CO	Marks
1)	**Explain** i) kinematic pair ii)mechanism iii)structure iv)inversion v) degree of freedom vi)binary joints and binary link vii) self-closed pair & force closed pair viii)lower pair & turning pair.	UNDERSTANDING	CO1	2
2)	**Classify** and explain kinematic pairs based on type of relative motion.	UNDERSTANDING	CO1	2
3)	The link lengths of quadric cycle chain, taken in order are 10cm, 40cm, 30cm and 25cm. **Infer** all the inversions of the given chain and classify them.	UNDERSTANDING	CO1	2
4)	Name an exact straight line motion mechanism having only turning pairs. **Draw** neat proportionate sketch of the same. State geometric relationships among its links. Indicate the point tracing straight line and prove that the point can trace straight line.	UNDERSTANDING	CO1	2
5)	**Draw** a neat proportionate sketch of whit worth quick return mechanism and crank slotted lever mechanisms. Indicate clearly the positions of drive crank corresponding to the extreme positions of shaper tool	UNDERSTANDING	CO1	2
6)	**Construct the cam profile** for -follower type = Knife edged, in-line; lift = 50mm; base circle radius = 50mm; out stroke with SHM, for 60^0 cam rotation; dwell for 45^0 cam rotation; return stroke with SHM, for 90^0 cam rotation; dwell for the remaining period. **Solve** max. velocity and acceleration during out stroke and return stroke if the cam rotates at 1000 rpm in clockwise direction.	APPLYING	CO2	2
7)	**Construct the cam profile** for the same operating conditions of problem (1), with the follower offset by 10 mm to the left of cam centre.	APPLYING	CO2	2
8)	**Construct the cam profile for following conditions**:Follower type = roller follower, in-line; lift = 25mm; base circle radius = 20mm; roller radius = 5mm; out stroke with UARM, for 120^0 cam rotation; dwell for 60^0 cam rotation; return stroke with UARM, for 90^0 cam rotation; dwell for the remaining period. Determine max. Velocity and acceleration during out stroke and return stroke if the cam rotates at 1200 rpm in clockwise direction.	APPLYING	CO2	2
9)	**Construct the cam profile for following conditions**: Follower type = knife edged follower, in line; follower rises by 24mm with SHM in 1/4 rotation, dwells for 1/8 rotation and then raises again by 24mm with UARM in 1/4 rotation and dwells for 1/16 rotation before returning with SHM. Base circle radius = 30mm	APPLYING	CO2	2
10)	A push rod of valve of an IC engine ascends with UARM, along a path inclined to the vertical at 60^0. The same descends with SHM. The base circle diameter of the cam is 50mm and the push rod has a roller of 60mm diameter, fitted to its end. The axis of the roller and the cam fall on the same vertical line. The stroke of the follower is 20mm. The angle of action for the outstroke and the return stroke is 60^0 each, interposed by a dwell period of 60^0. **Construct the profile of the cam.**	APPLYING	CO2	2

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I SESSIONAL TEST QUESTION PAPER 2018 – 19 ODD SEMESTER

SET-A

USN | | | | | | | | | |

Degree	: B.E	**Semester**	: III
Branch	: Mechanical Engineering	**Subject Code**	: 17ME42
Subject Title	: KINEMATICS OF MACHINERY	**Date**	:
Duration	: 90 Minutes	**Max Marks**	: 30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	CO mapping	K-level
	PART-A			
1(a)	**Explain** i) kinematic pair ii)mechanism iii)structure iv)inversion v) degree of freedom	5	CO1	Understanding K1
(b)	**Classify** and explain kinematic pairs based on type of relative motion.	5	CO1	Understanding K1
(c)	**Construct the cam profile for** -follower type = Knife edged, in-line; lift = 50mm; base circle radius = 50mm; out stroke with SHM, for 60^0 cam rotation; dwell for 45^0 cam rotation; return stroke with SHM, for 90^0 cam rotation; dwell for the remaining period. **Solve** max. velocity and acceleration during out stroke and return stroke if the cam rotates at 1000 rpm in clockwise direction.	5	CO2	Applying K3
	OR			
2(a)	Name an exact straight line motion mechanism having only turning pairs. **Draw** neat proportionate sketch of the same. State geometric relationships among its links. Indicate the point tracing straight line and prove that the point can trace straight line.	5	CO1	Understanding K1
(b)	The link lengths of quadric cycle chain, taken in order are 10cm, 40cm, 30cm and 25cm. **Infer** all the inversions of the given chain and classify them.	5	CO1	Understanding K1
(c)	**Construct the cam profile for following conditions:**Follower type = roller follower, in-line; lift = 25mm; base circle radius = 20mm; roller radius = 5mm; out stroke with UARM, for 120^0 cam rotation; dwell for 60^0 cam rotation; return stroke with UARM, for 90^0 cam rotation; dwell for the remaining period. Determine max. Velocity and acceleration during out stroke and return stroke if the cam rotates at 1200 rpm in clockwise direction.	5	CO2	Applying K3
	PART-B			

3(a)	Draw a neat proportionate sketch of whit worth quick return mechanism and **explain** briefly, Indicate clearly the positions of drive crank corresponding to the extreme positions of shaper tool	5	CO1	**Understanding K1**
(b)	Interpret the expression for necessary condition of correct steering	5	CO1	**Understanding K1**
(c)	**Construct the cam profile** for following conditions: Follower type = roller follower, in-line; lift = 25mm; base circle radius = 20mm; roller radius = 5mm; out stroke with UARM, for 120^0 cam rotation; dwell for 60^0 cam rotation; return stroke with UARM, for 90^0 cam rotation; dwell for the remaining period.	5	CO2	**Applying K3**
	OR			
4(a)	State and **Explain** the suitable mechanism which can be used in forming machines/sheet metal punching	5	CO1	**Understanding K1**
(b)	**Explain** the Pantograph mechanism, with a neat sketch. State its application	5	CO1	**Understanding K1**
(c)	**Construct the cam profile** to give the following motion to a knife edged follower:- i) Outstroke during 60° of cam rotation. ii) Dwell for the next 30° of cam rotation iii) Return stroke during next 60° of cam rotation iv) Dwell for the remaining 210° of cam rotation The stroke of the follower is 40mm and the minimum radius of the cam is 50mm. The follower moves with uniform velocity during both the outstroke and return strokes. **Construct cam** profile when the axis of the follower is offset by 20mm from the axis of the cam shaft.	5	CO2	**Applying K3**

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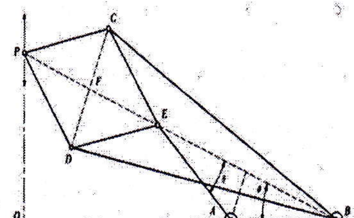
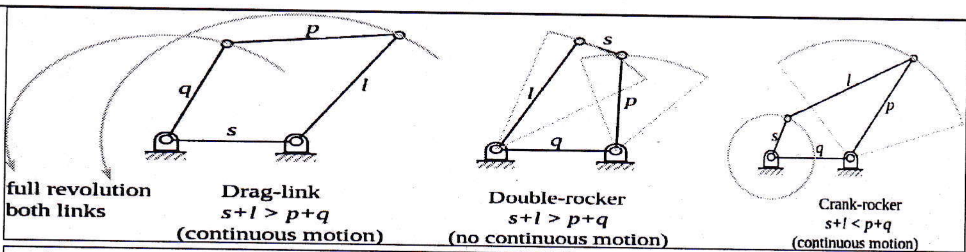
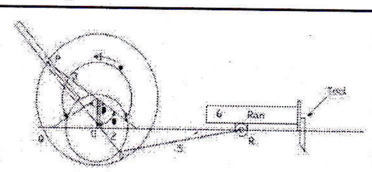
I SESSIONAL TEST QUESTION PAPER SCHEME 2018 – 19 ODD SEMESTER

SET-A

Semester : III
Subject Code : 17ME42
Subject Title : KINEMATICS OF MACHINERY
Duration : 90 Minutes

Note: Answer ONE full question from each part.

1(a)	Kinematic Pair - Two links or elements of a machine when in contact with each other, paid to form a pair. relative motion between them is completely or successfuly constrained (i.e. in a definite direction) the pair is called Kinematic pair. When one of the links of a kinematic chain is fixed, the chain is known as mechanism. Mechanism with four links – simple mechanism - - - - more than four – compound " When a mechanism is required to transmit power, it becomes machines. Inversion of Mechanism Like fourbar mechanism, The method of obtaining different mechanisms by fixing different links in a kinematic chain, is known as IOM. Degree of freedom (Movability) of the mechanism Each carries 1 Mark	5

(b)	<u>classification of Kinematic Pairs</u> (According to the type of relative motion between the elements) (a) <u>Sliding Pair</u> - when two elements of a pair are connected in such a way that one can only slide relative to the other. reciprocating steam engine. Tail stock on lathe bed. (b) <u>Turning Pair</u> - one can only turn or revolve about a fixed axis of another link. cycle wheel turning over their axle. (c) <u>Rolling Pair</u> - one roll over another fixed link. ball and roller bearing. (d) <u>Screw Pair</u> - one element can turn about the other by screw threads. lead screw of lathe. (e) <u>Spherical pair</u> - one element (with spherical shape) turns or swivels about other fixed element. ball socket joint.	5
(c)	Displacement diagram-2Marks Cam profile-3Marks	5
2(a)	 1 Mark In triangles BFC and PFC, $BC^2 = FB^2 + FC^2$ and $PC^2 = PF^2 + FC^2$ $\therefore BC^2 - PC^2 = FB^2 - PF^2 = (FB + PF)(FB - PF) = BP \times BE$ 4 Marks	5
(b)	 Each carries 1 marks and 2Marks for caluclation	5
(c)	Displacement diagram-2Marks Cam profile-3Marks.	5
3(a)	 sketch-2Marks Explanation-3Marks	5
(b)	**Condition for Correct steering:**The steering gear mechanism is used to change the direction of two or more of the wheel axle's with reference to the chassis, so as to move the automobile in the desired path. The steering is done by front wheels and back wheels remain straight and do not turn. The condition for correct steering is that all the four	5

wheels must rotate about the same instantaneous centre which lies on the axis of the back wheels. Let the axis of the inner wheels makes a larger angle θ than the angle φ subtended by the axis of outer wheel. Let

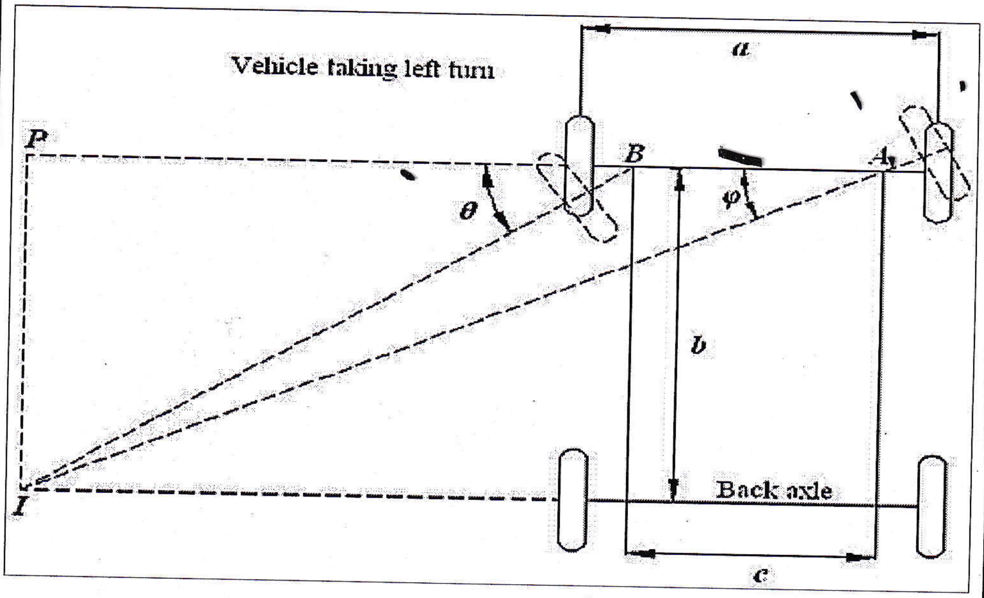
a=wheeltrack, b=wheelbase, c= distance between the pivots A and B of the front axle

FromtriangleIBP =

$$\cot\theta = \frac{BP}{IP}$$

FromtriangleIAP

$$\cot\phi = \frac{AP}{IP} = \frac{AB+BP}{IP} = \frac{AB}{IP} + \frac{BP}{IP} = \frac{c}{b} + \cot\theta$$



$$\cot\phi - \cot\theta = \frac{c}{b}$$

This is the fundamental equation for correct steering

sketch-2 Marks

Explanation-3Marks

(c) Displacement diagram-2Marks

Cam profile-3Marks — **5**

4(a) A toggle mechanism is used to generate a large force over a small distance

At right a toggle mechanism is [illegible] an application for crushing rocks

Another application would be for clamping something:

sketch-2Marks

Explaination-3marks — **5**

(b)	A **pantograph** is a **mechanical linkage** connected in a manner based on **parallelograms** so that the movement of one pen, in tracing an image, produces identical movements in a second pen. If a line drawing is traced by the first point, an identical, enlarged, or miniaturized copy will be drawn by a pen fixed to the other. sketch-2Marks Explaination-3Marks	5
(c)	. Displacement diagram-2Marks Cam profile-3Marks	5

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DEPARTMENT OF MECHANICAL ENGINEERING

	IV Semester	IA1 Marks	Academic year:2018-19		
Student Details	KINEMATICS OF MACHINERY				
Sl No	USN	Student Name	IA-1 MARKS	CO1	CO2
			30MARKS	20MARKS	10MARKS
1	1KS17ME001	ABBAS RAZIN	10	10	0
2	1KS17ME003	ABHILASH K S	14	12	2
4	1KS17ME099	ADITHYA R BHAT	13	8	5
5	1KS17ME006	AKASH K L	22	20	2
6	1KS17ME007	ANANDU K SANIL	8	8	0
7	1KS17ME008	ANIRUDH BHARADHWAJ K	10	10	0
8	1KS17ME009	ANIRUDH M V	6	5	1
9	1KS17ME011	ARJUN PRASAD	9	4	5
10	1KS17ME012	ASHUTOSH VILAS JAIN	10	10	0
11	1KS17ME013	ASIF K	7	7	0
12	1KS17ME014	BHARATH KUMAR G	20	15	5
13	1KS17ME016	CHETHAN N	28	20	8
14	1KS17ME017	CHIRANJEEVI U	13	10	3
15	1KS17ME018	DARSHAN B S	9	8	1
16	1KS17ME019	DARSHAN GOWDA S	30	20	10
17	1KS17ME020	DARSHAN V	8	5	3
18	1KS17ME021	DHEERAJ PASUPULETI	12	12	0
19	1KS17ME022	DILEEP S K	21	15	6
20	1KS17ME023	ESHWAR A N	12	12	0
21	1KS17ME024	GANAPATI MANJUNATH HE	16	11	5
22	1KS17ME025	GANESHKUMAR NARAYAN	18	13	5
23	1KS17ME026	GIRIDHAR M P	2	2	0
25	1KS17ME028	IMPAL D RAJ	8	6	2
26	1KS17ME030	JEEVANKUMAR M A	11	6	5
27	1KS17ME031	JITHU MENON	15	15	0
28	1KS17ME032	K AASHISH BHARADWAJ	15	10	5
29	1KS17ME033	KARTHIK S DALABANJAN	13	13	0
30	1KS17ME034	KIRAN C	10	8	2
31	1KS17ME035	KIRAN R	15	10	5
32	1KS17ME036	KONDA ANIL KUMAR REDDY	10	5	5
33	1KS17ME037	KUNDAN B	0	0	0
34	1KS17ME038	KUSHAL RAO R	14	12	2
35	1KS17ME039	MANOJ H S	18	10	8
36	1KS17ME040	MANOJ M	23	15	8
37	1KS17ME041	MOHAMED FAUZAN S	14	8	6
38	1KS17ME042	MOHSIN SHAIKH	4	0	4
39	1KS17ME043	MOLAKALU PUNITH	0	0	0
40	1KS17ME044	NAGESH B U	8	8	0

	IV Semester	IA1 Marks	Academic year:2018-19		
Student Details	KINEMATICS OF MACHINERY				
Sl No	USN	Student Name	IA-1 MARKS	CO1	CO2
41	1KS17ME045	NISCHAL V CHADAGA	7	5	2
42	1KS17ME046	NITIN L	0	0	0
43	1KS17ME047	PARIKSHITA M S	13	10	3
44	1KS17ME048	PARIKSHITH K KASHYAP	25	18	7
45	1KS17ME049	PRABHUDEV C M	2	2	0
46	1KS17ME050	PRAKASH Y	12	12	0
47	1KS17ME051	PRAVEEN KUMAR V	30	20	10

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DEPARTMENT OF MECHANICAL ENGINEERING

ASSIGNMENT QUESTIONS

Academic Year	2018-19		
Batch	2017-21		
Year/Semester/section	III/IV/A		
Subject Code-Title	KINEMATICS OF MACHINERY		
Name of the Instructor	Mrs.Nirmala L	Dept	MECH

Assignment No: 2 **Total marks:15**

Sl. No	Assignment Questions	K Level	CO	Marks
1)	The following data relate to a cam profile in which the follower moves with UARM during ascent and descent. Minimum radius of cam =25mm, roller diameter=7.5mm,lift=28mm, offset of follower axis= 12mm towards right, angle of ascent= 60^0, angle of descent= 90^0, angle of dwell between ascent and descent =45^0, speed of the cam = 200 rpm. **Construct** the profile of the cam and determine the maximum velocity and uniform acceleration of the follower during the outstroke and the return stroke.	APPLYING(K3)	CO 2	1
2)	**Construct** the profile of a cam when a cam rotates at uniform speed of 300rpm operates a reciprocating follower through a roller 1.5cm diameter. The follower motion is defined as belowOutward stroke during 150^0 with UARM, dwell for next 30^0, return during next 120^0 with SHM, dwell for the remaining period, stroke of the follower is 3cm, minimum radius of the cam is 3cm.,follower axis passes through the cam axis.	APPLYING(K3)	CO 2	1
3)	**Construct** the profile of a cam to suit the following specifications: least radius of cam =25mm, diameter of the roller=16mm, angle of lift =60^0 with UARM, angle of descent= 90^0 with UARM, angle of dwell between ascent and descent =45^0, speed of cam =200 rpm clockwise. Also calculate max velocity and max acceleration during descent.	APPLYING(K3)	CO 2	1
4)	**Construct** the profile of a cam to give the following motion to the reciprocating follower with a flat face: follower to move outward through a distance of 20mm during 120^0 of cam rotation, follower to dwell for 30^0 of cam rotation, follower to return to its initial position during 120^0 of cam rotation, follower to dwell for the remaining 90^0 cam rotation, the minimum radius of cam is 25mm and the flat face of the follower is at right angle to the line of stroke of the follower. The outward and return stroke of the follower is to take place with SHM.	APPLYING(K3)	CO 2	1
5)	It is required to **construct** the profile of a cam to give the following motion to the follower: follower to move outwards through 31.4mm during 180^0 of cam rotation with cycloid motion, follower to return with cycloid motion during 180^0 of cam rotation. Determine the maximum velocity and acceleration of the follower during	APPLYING(K3)	CO 2	1

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	outstroke when the cam rotates at 2400 rpm clockwise. The base circle of the cam is 30mm diameter and the roller diameter of the follower is 10mm. the axis of the follower is offset by 7.5mm to the right.			
6)	State and **Derive** the law of gearing	APPLYING(K3)	CO 3	2
7)	Derive an expression for length of path of contact, length of arc of a contact and contact ratio for a pair of involute gears in contact	APPLYING(K3)	CO 3	2
8)	Derive an expression for minimum number of teeth on pinion to avoid interference.	APPLYING(k3)	CO 3	2
9)	Two involute gears of 20° pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5mm and the pitch line speed is 1.2m/s, assuming addendum as standard and equal to one module, **Evaluate** a. The angle turned through by pinion when one pair of teeth is in mesh. b. The maximum velocity of sliding	ANALYZING(K4)	CO 3	2
10)	A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12mm module and 10mm addendum. **Evaluate** the length of the path of contact, arc of contact and the contact ratio	ANALYZING(K4)	CO 3	2

Course Incharge

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II SESSIONAL TEST QUESTION PAPER 2018 – 19 EVEN SEMESTER

SET – A

USN | | | | | | | | | | |

Degree	: B.E	Semester :	IV
Branch	: Mechanical Engineering	Course Code :	17ME42
Course Title	: KINEMATICS OF MACHINERY	Date :	16-04-2019
Duration	: 90 Minutes	Max Marks :	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks	CO mapping	K-Level
	PART-A			
1(a)	It is required to **construct** the profile of a cam to give the following motion to the follower: follower to move outwards through 31.4mm during 180^0 of cam rotation with cycloid motion, follower to return with cycloid motion during 180^0 of cam rotation. Determine the maximum velocity and acceleration of the follower during outstroke when the cam rotates at 2400 rpm clockwise. The base circle of the cam is 30mm diameter and the roller diameter of the follower is 10mm. the axis of the follower is offset by 7.5mm to the right.	5	CO2	APPLYING K3
(b)	State and **Derive** the law of gearing	5	CO3	APPLYING K3
(c)	**Distinguish** between cycloid profile and involute profile of gear tooth	5	CO3	ANALYZING K4
	OR			
2(a)	**Construct** the profile of a cam when a cam rotates at uniform speed of 300rpm operates a reciprocating follower through a roller 1.5cm diameter. The follower motion is defined as below Outward stroke during 150^0 with UARM, dwell for next 30^0, return during next 120^0 with SHM, dwell for the remaining period, stroke of the follower is 3cm, minimum radius of the cam is 3cm.,follower axis passes through the cam axis	5	CO2	APPLYING K3
(b)	A pair of gears, having 40 and 20 teeth respectively, are rotating in mesh, the speed of the smaller being 2000 r.p.m. **Determine** the velocity of sliding between the gear teeth faces at the point of engagement, at the pitch point, and at the point of disengagement if the smaller gear is the driver. Assume that the gear teeth are 20° involute form, addendum length is 5 mm and the module is 5 mm. Also find the angle through which the pinion turns while any pairs of teeth are in contact.	5	CO3	APPLYING K3
(c)	**Establish** an expression for length of path of contact	5	CO3	
	PART-B			
3(a)	The following data relate to a cam profile in which the follower moves with UARM during ascent and descent. Minimum radius of cam =25mm, roller	5	CO2	

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	diameter=7.5mm,lift=28mm, offset of follower axis= 12mm towards right, angle of ascent= 60^0, angle of descent= 90^0, angle of dwell between ascent and descent $=45^0$, speed of the cam = 200 rpm. **Construct** the profile of the cam and determine the maximum velocity and uniform acceleration of the follower during the outstroke and the return stroke			
(b)	A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12mm module and 10mm addendum. **Evaluate** the length of the path of contact, arc of contact and the contact ratio	**5**	**CO3**	
(c)	Derive an expression for minimum number of teeth on GEAR WHEEL to avoid interference.	**5**	**CO3**	
	OR			
4(a)	**Construct** the profile of a cam to give the following motion to the reciprocating follower with a flat face: follower to move outward through a distance of 20mm during 120^0 of cam rotation, follower to dwell for 30^0 of cam rotation, follower to return to its initial position during 120^0 of cam rotation, follower to dwell for the remaining 90^0 cam rotation, the minimum radius of cam is 25mm and the flat face of the follower is at right angle to the line of stroke of the follower. The outward and return stroke of the follower is to take place with SHM.	**5**	**CO2**	
(b)	Explain the methods of avoiding interference in gears	**5**	**CO3**	
(c)	Two involute gears of 20° pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5mm and the pitch line speed is 1.2m/s, assuming addendum as standard and equal to one module, **Evaluate** a. The angle turned through by pinion when one pair of teeth is in mesh. b. The maximum velocity of sliding	**5**	**CO3**	

Signature of Course incharge

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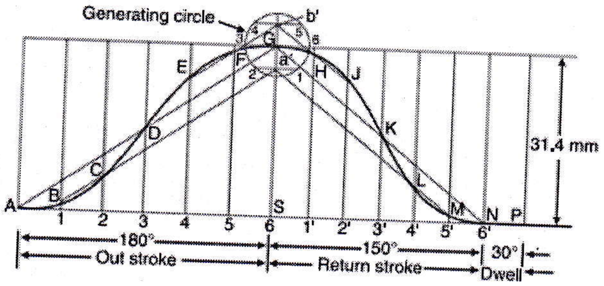
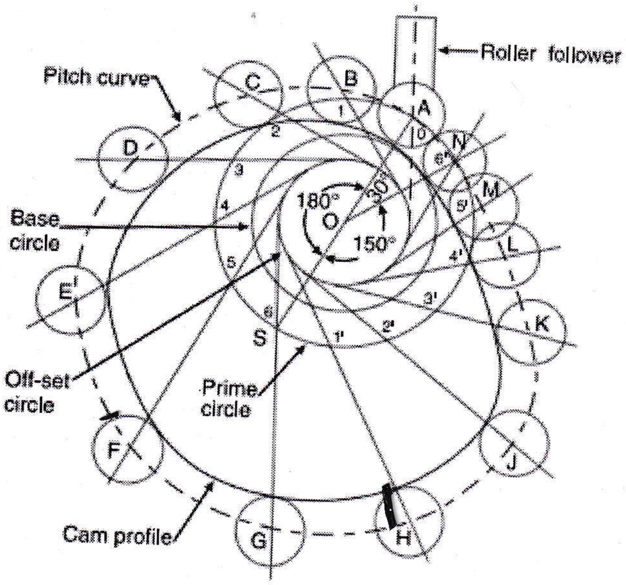
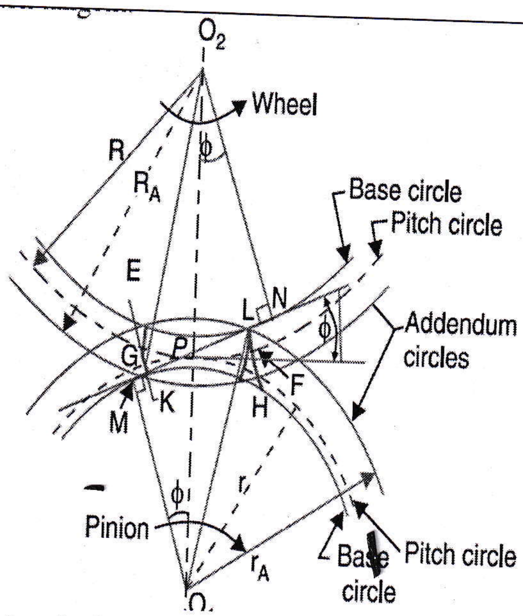
II SESSIONAL TEST SCHEME 2018 – 19 EVEN SEMESTER

Semester : IV
Course Code : 17ME42
Course Title : KINEMATICS OF MACHINERY
Max Marks : 30

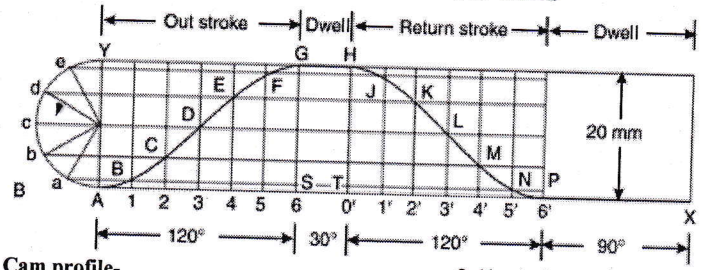
Q No.	Question	Marks
1(a)	**Given** Roller follower Angle of ascent=180^0(cycloidal motion) Angle of descent=180^0(cycloidal motion) list=31.4mm N=2400 rpm Base circle radius= 30mm r= Stroke/2 π = 31.4 /2 π = r = 5 mm Offset=7.5mm right Roller radius=5mm **Displacement diagram- 2 Marks**  **Cam profile- 2 Marks**	5

	 **Max velocity – $2\omega s/\Theta_o$ 0.5 Marks** **Maximum acceleration- $2\pi\omega^2 s / \Theta_0^2$ 0.5 Marks**	
(b)	**Definition of law of gearing -1 Mark** **Sketch- 2Marks** **Derivation- 2 Marks**	**5**
(c)	Difference between cycloid profile and involute profile of gear tooth **five differences- 5Marks**	**5**
2(a)	**Given** N= 300rpm Roller= 1.5cm diameter. Outward stroke during 150^0 with UARM, dwell for next 30^0, Return during next 120^0 with SHM, Dwell for the remaining period, Stroke of the follower is 3cm, minimum radius of the cam is 3cm., **Displacement diagram- 2 ½ Marks** **Cam profile- 2 ½ Marks**	**5**
(b)	Given : T = 40 ; t = 20 ; N 1 = 2000 r.p.m. ; _ = 20° ; addendum = 5 mm ; m = 5 mm ***Velocity of sliding at the point of engagement=3975mm/s-2 Marks*** ***Velocity of sliding at the pitch point=0*** ***Velocity of sliding at the point of disengagement=3614mm/s- 2Marks*** ***Angle through which the pinion turns=29.45^0- 11Mark***	**5**
(c)	Length of path of contact	**5**

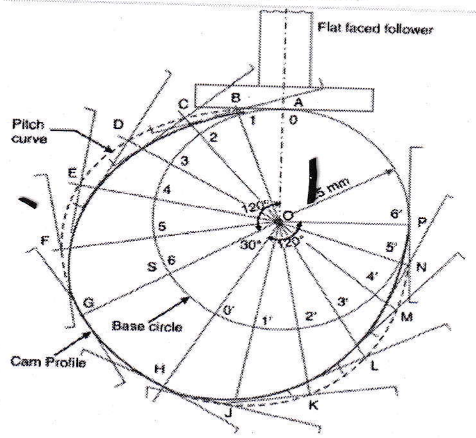
	 **Sketch-** **Derivation-** Length of the path of contact= **2 Marks** $= \sqrt{(R_A)^2 - R^2 \cos^2 \phi} + \sqrt{(r_A)^2 - r^2 \cos^2 \phi} - (R + r)\sin \phi$ **3 Marks**	
3(a)	**Given** Minimum radius of cam =25mm, roller diameter=15mm, lift=28mm, offset of follower axis= 12mm towards right, angle of ascent= 60^0, UARM angle of descent= 90^0, UARM angle of dwell between ascent and descent =45^0, Speed of the cam = 200 rpm. **Displacement diagram- 2 Marks** **Cam profile- 2 Marks** **maximum velocity- $2\omega s/\Theta_0$** **maximum acceleration -$4\omega^2 s / \Theta_0^2$ 1Mark**	5
(b)	t=30 teeth T=80 teeth. Pressure angle=20°, m=12mm module and addendum=10mm. **length of the path of contact= 52.3mm 2 Marks** **arc of contact =55.66mm 2Marks** **contact ratio= 1.51Marks**	5
(c)	**Minimum number of teeth on pinion Sketch- 2 ½ Marks** $T = \frac{2 A_W}{\sqrt{1 + \frac{t}{T}\left(\frac{t}{T} + 2\right)\sin^2 \phi} - 1}$ **derivation.- 2 ½ Marks**	5
4(a)	Given flat face: follower s= 20mm angle of ascent =120^0 of cam rotation, SHM	5

follower to dwell for 30^0 of cam rotation
angle of descent $=120^0$ SHM
follower to dwell for the remaining 90^0 cam rotation,
the minimum radius of cam is 25mm

Displacement diagram- **2 ½ marks**



Cam profile- **2 ½ marks**



(b)

Methods of avoiding interference in gears

1. By increasing pressure angle
2. By increasing no of teeth
3. By Decreasing addendum of gear

5

(c)

Given
Pressure angle= 20° are in mesh. The number of teeth on pinion is t=20 and the Gear ratio is 2.
Module is 5mm
pitch line speed is 1.2m/s, assuming
addendum =equal to one module,

c. **The angle turned through by pinion when one pair of teeth is in mesh – 29.45^0 -2 ½ Marks**

d. **The maximum velocity of sliding- 455.4mm/s** **2 ½ Marks**

5

Signature of Course incharge

Signature of HOD/ME

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K S INSTITUTE OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING

IV Semester IA2 Marks Academic year:2018-19

KINEMATICS OF MACHINERY

Student Details			IA-2		
Sl No	USN	Student Name	IA-2	CO2	CO3
			30	10	20
1	1KS17ME001	ABBAS RAZIN	10		10
2	1KS17ME003	ABHILASH K S	15	5	10
4	1KS17ME099	ADITHYA R BHAT	17	5	12
5	1KS17ME006	AKASH K L	23	3	20
6	1KS17ME007	ANANDU K SANIL	11		11
7	1KS17ME008	ANIRUDH BHARADHWAJ K	19	2	17
8	1KS17ME009	ANIRUDH M V	17		17
9	1KS17ME011	ARJUN PRASAD	16	5	11
10	1KS17ME012	ASHUTOSH VILAS JAIN	17	2	15
11	1KS17ME013	ASIF K	17	2	15
12	1KS17ME014	BHARATH KUMAR G	27	7	20
13	1KS17ME016	CHETHAN N	25	5	20
14	1KS17ME017	CHIRANJEEVI U	15		15
15	1KS17ME018	DARSHAN B S	17		17
16	1KS17ME019	DARSHAN GOWDA S	30	10	20
17	1KS17ME020	DARSHAN V	9		9
18	1KS17ME021	DHEERAJ PASUPULETI	15		15
19	1KS17ME022	DILEEP S K	21	3	18
20	1KS17ME023	ESHWAR A N	16		16
21	1KS17ME024	GANAPATI MANJUNATH HEGDE	30	10	20
22	1KS17ME025	GANESHKUMAR NARAYAN HEGDE	30	10	20
23	1KS17ME026	GIRIDHAR M P	12	4	8
24	1KS16ME018	HARIPRASAD	15	10	5
25	1KS17ME028	IMPAL D RAJ	18	3	15
26	1KS17ME030	JEEVANKUMAR M A	10		10
27	1KS17ME031	JITHU MENON	21	5	16
28	1KS17ME032	K AASHISH BHARADWAJ	22	2	20
29	1KS17ME033	KARTHIK S DALABANJAN	20		20
30	1KS17ME034	KIRAN C	20	5	15
31	1KS17ME035	KIRAN R	15	10	5
32	1KS17ME036	KONDA ANIL KUMAR REDDY	15	5	10
33	1KS17ME037	KUNDAN B	2		2
34	1KS17ME038	KUSHAL RAO R	22	2	20
35	1KS17ME039	MANOJ H S	22	5	17
36	1KS17ME040	MANOJ M	17	5	12
37	1KS17ME041	MOHAMED FAUZAN S	24	7	17
38	1KS17ME042	MOHSIN SHAIKH	15		15
39	1KS17ME043	MOLAKALU PUNITH	25	5	20

Student Details			IA-2		
Sl No	USN	Student Name	IA-2	CO2	CO3
			30	10	20
40	1KS17ME044	NAGESH B U	20	5	15
41	1KS17ME045	NISCHAL V CHADAGA	13	4	9
42	1KS17ME046	NITIN L	14	5	9
43	1KS17ME047	PARIKSHITA M S	4		4
44	1KS17ME048	PARIKSHITH K KASHYAP	18	2	16
45	1KS17ME049	PRABHUDEV C M	9		9
46	1KS17ME050	PRAKASH Y	12	7	5
47	1KS17ME051	PRAVEEN KUMAR V	25	5	20

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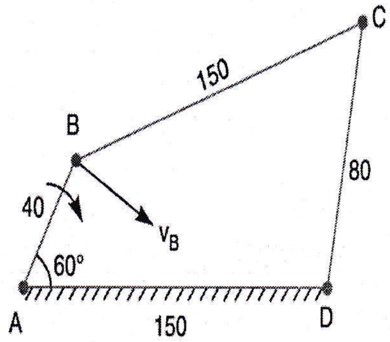
KSIT Bangalore

DEPARTMENT OF MECHANICAL ENGINEERING

ASSIGNMENT QUESTIONS

Academic Year	2018-19		
Batch	2017-21		
Year/Semester/section	III/IV/A		
Subject Code-Title	KINEMATICS OF MACHINERY		
Name of the Instructor	Mrs Nirmala L	Dept	MECH

Assignment No: 3 **Total marks:15**

Sl.No	Assignment Questions	K Level	CO	Marks
11)	In a four bar chain ABCD, AD is fixed and is 150 mm long. The crank AB is 40 mm long and rotates at 120 r.p.m. clockwise, while the link CD = 80 mm oscillates about D. BC and AD are of equal length. Inspect the angular velocity of link CD when angle BAD = 60°. 	Analyzing (K4)	CO 4	2
12)	The crank of a slider crank mechanism rotates clockwise at a constant speed of 300 r.p.m. The crank is 150 mm and the connecting rod is 600 mm long. Examine :1. Linearvelocity and acceleration of the midpoint of the connecting rod, and 2. angular velocity and angular acceleration of the connecting rod, at a crank angle of 45° from inner dead centre position.	Analyzing (K4)	CO 4	2
13)	In the mechanism shown in Fig, the slider C ismoving to the right with a velocity of 1 m/s and an acceleration of 2.5 m/s2. The dimensions of various links are AB = 3 m inclined at 45° with the vertical and BC = 1.5 m inclined at 45° with the horizontal. Examine: 1. The magnitude of vertical and horizontal component of the acceleration of the point B, and 2. the angular acceleration of the links AB and BC.	Analyzing (K4)	CO 4	2

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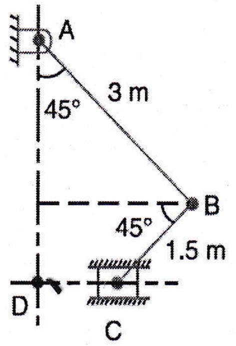
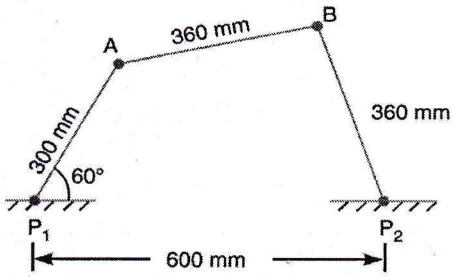
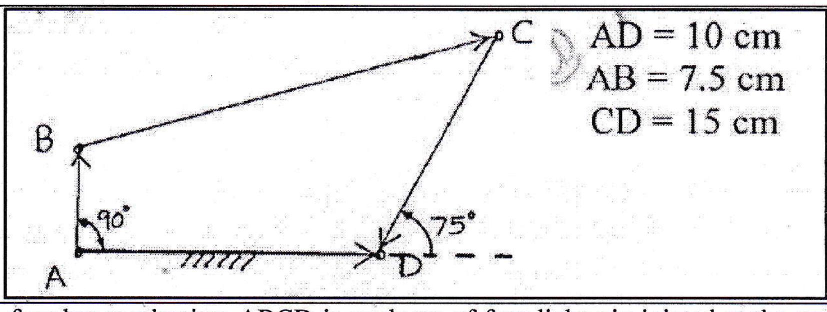
				
14)	The dimensions and configuration of the four bar mechanism, shown in are as follows: The angle AP1P2= 60°. The crank P1A has an angular velocity of 10 rad/s and an angular acceleration of 30 rad/s2, both clockwise. Inspect the angular velocities and angular accelerations of P2B, and AB and the velocity and acceleration of the joint B.P1A = 300 mm; P2B = 360 mm; AB = 360mm, and P1P2 = 600 mm. 	Analyzing (K4)	CO 4	2
15)	Inspect equation for Coriolis component of acceleration, with the help of appropriate sketches.	Analyzing (K4)	CO5	2
16)	Examine and Develop Freudenstein's equation for a four bar chain mechanism and slider crank mechanism	Analyzing (K4)	CO 5	2
17)	In slider crank mechanism, the crank radius is 100mm and length of connecting rod is 500mm. the crank is rotating in CCW direction at an angular velocity of 15 rad/sec and the angular acceleration of 115rad/sec. Inspect the acceleration of piston and the angular acceleration of connecting rod when the crank is at 60^0 from IDC	Analyzing (K4)	CO 5	2
18)	The four bar mechanism ABCD is shown in fig which is driven by link 2 at ω2=45rad/s, CCW. Examine the angular velocities of links3 and 4 by using complex number method AB=100mm, CD=300mm, AD=250mm	Analyzing(K4)	CO 5	2
19)	In four bar mechanism shown in figure, link AB rotates uniformly at 2rad/sec in clockwise. Using complex algebra write loop closure equation for this. Examine magnitude and direction of angular velocity and angular acceleration of links BC and CD using vector algebra. Also state whether magnitudes of angular velocities of these links tend to increase or decrease at that instant.	Analyzing (K4)	CO 5	2

				
20)	A four bar mechanism ABCD is made up of four links pin jointed at the ends. AD is the fixed link of 600mm. Links AB, BC and CD are 300mm, 360mm and 360mm respectively. At certain instant link AB makes 600 with AD. If the link AB rotates at an angular velocity of 10rad/sec and an angular acceleration of 30rad/sec2, both clockwise, Inspect for the angular velocity and angular acceleration of link BC and CD by using complex algebra method.	Analyzing (K4)	CO 5	2

Course Incharge

HOD/ME

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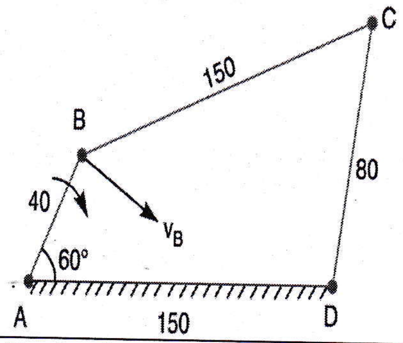
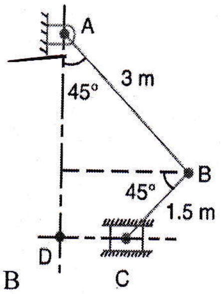
K.S. INSTITUTE OF TECHNOLOGY, BANGALORE - 560109
III SESSIONAL TEST QUESTION PAPER 2018 – 19 EVEN SEMESTER

SET – A

Degree	: **B.E**	**USN**	
Branch	: **Mechanical Engineering**	**Semester**	: **III**
Course Title	: **KINEMATICS OF MACHINERY**	**Course Code**	: **17ME 42**
Duration	: **90 Minutes**	**Date**	: **20/05/2019**
		Max Marks	: **30**

Note: Answer ONE full question from each part.

Q No.	Question	Marks	CO mapping	K-Level
	PART-A			
1(a)	The dimensions and configuration of the four bar mechanism, shown in are as follows: P1A = 300 mm; P2B = 360 mm; AB = 360mm, and P1P2 =600 mm. The angle AP1P2= 60°. The crank P1A has an angular velocity of 10 rad/s and an angular acceleration of 30 rad/s2, both clockwise. **Caluclate** the angular velocities and angular accelerations of P2B, and AB and the velocity. 	5	CO4	Analyzing(K4)
(b)	For the above given figure in question 1(a) **Evaluate**acceleration of the joint B	5	CO4	Analyzing(K4)
(c)	**Establish** loop closure equation for a Slider crank mechanism.	5	CO5	Analyzing(K4
	OR			
2(a)	In the mechanism shown in Fig.the slider C is moving to the right with a velocity of 1 m/s and an acceleration of 2.5 m/s2. The dimensions of various links are AB = 3 m inclined at 45° with the vertical and BC = 1.5 m inclined at 45° with the horizontal. **Calculate: 1.** The magnitude of vertical and  horizontal component the acceleration of the point B	5	CO4	Analyzing(K4)
(b)	**For the above fig given in question2(a) calculate** the angular acceleration of the links AB and BC.	5	CO4	Analyzing(K4

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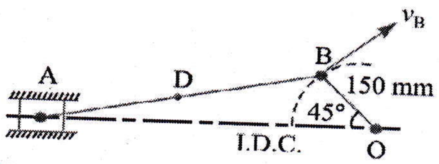
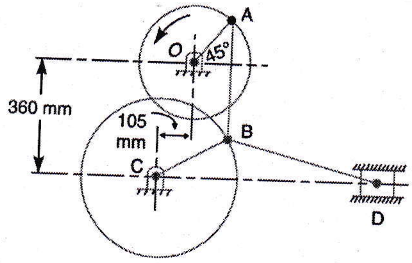
(c)	**Establish** loop closure equation for a four bar mechanism	5	CO5	Analyzing(K4
	PART-B			
3(a)	**Establish** equation for Coriolis component of acceleration, with the help of appropriate sketches	5	CO4	Analyzing(K4)
(b)	The crank of a slider crank mechanism rotates clockwise at a constant speed of 300 r.p.m. The crank is 150 mm and the connecting rod is 600 mm long. Determine: **1.** Linear velocity and acceleration of the midpoint of the connecting rod, and **2.** angular velocity and angular acceleration of the connecting rod, at a crank angle of 45° from inner dead centre position. 	5	CO4	Analyzing(K4)
(c)	The four bar mechanism ABCD is shown in fig which is driven by link 2 at ω2=45rad/s, CCW. **Evaluate** the angular velocities of links3 and 4 by using complex number method AB=100mm, CD=300mm, AD=250mm	5	CO5	Analyzing(K4)
	OR			
4(a)	In the toggle mechanism shown in Fig. 8.16, the slider D is constrained to move on a horizontal path. The crank OA is rotating in the counter-clockwise direction at a speed of 180 r.p.m. increasing at the rate of 50 rad/s2. The dimensions of the various links are as follows: OA = 180 mm ; CB = 240 mm ; AB = 360 mm ; and BD = 540 mm. For the given configuration, **Inspect1.** Velocity of slider D and angular velocity of BD, 	5	CO4	Analyzing(K4)
(b)	**For the above figure given in question 4(a) calculate** Acceleration of slider D and angular acceleration of BD.	5	CO4	Analyzing(K4)
(c)	In an engine mechanism, the length of the crank is 200mm. length of the connecting rod is 800mm. the crank is rotating with an angular velocity of 25m/sec and angular acceleration of 100 rad/sec ^{2} both clockwise. Crank is at 45^0 from IDC. **Inspect** from first principles only by loop closure method. a)velocity and acceleration of the piston b) angular velocity and angular acceleration of the connecting rod	5	CO5	Analyzing(K4)

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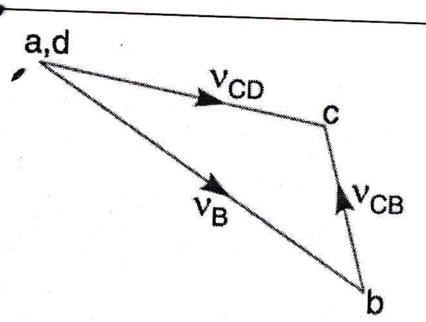
III SESSIONAL TEST QUESTION PAPER SCHEME
2018 – 19 EVEN SEMESTER

SET – A

Degree	:	B.E			
Branch	:	Mechanical Engineering	Semester	:	IV
Course Title	:	KINEMATICS OF MACHINERY			
Duration	:	90 Minutes	Max Marks	:	30

Note: Answer ONE full question from each part.

Q No.	Question	Marks
1(a)	 (*b*) Velocity diagram. **2.5 marks** $v_{BA} = v_B = \omega_{BA} \times AB = 12.568 \times 0.04 = 0.503$ m/s vector $ab = v_{BA} = v_B = 0.503$ m/s By measurement, we find that $v_{CD} = v_C =$ vector $dc = 0.385$ m/s We know that $CD = 80$ mm $= 0.08$ m ∴ Angular velocity of link *CD*, $\omega_{CD} = \frac{v_{CD}}{CD} = \frac{0.385}{0.08} = 4.8$ rad/s (clockwise about *D*) Ans. **2.5 marks**	5

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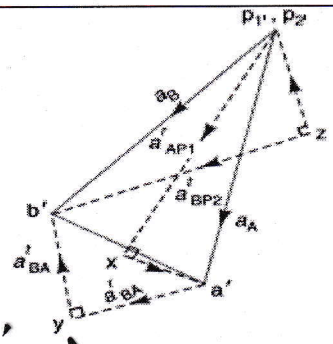
<table>
<tr>
<td>1(b)</td>
<td>


(c) Acceleration diagram **2.5 Marks**

$a_{BP2} = a_B$ = vector $p_2'b'$ = 29.6 m/s² Ans.

$$\alpha_{P2B} = \frac{a^t_{BP2}}{P_2B} = \frac{26.6}{0.36} = 73.8 \text{ rad/s}^2 \text{ (Anticlockwise) Ans.}$$

and angular acceleration of AB, $\alpha_{AB} = \frac{a^t_{BA}}{AB} = \frac{13.6}{0.36} = 37.8$ rad/s² (Anticlockwise) Ans.

2.5 Marks
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<td>1(c)</td>
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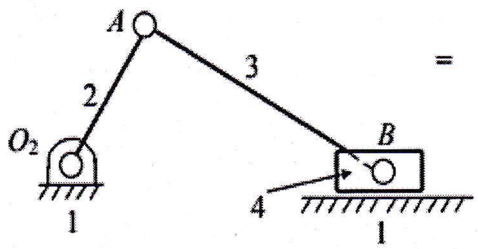

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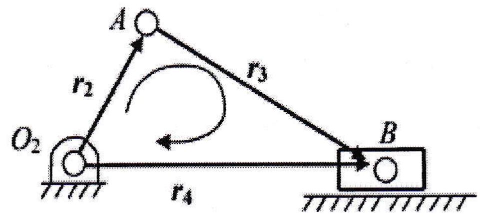

Slider-Crank Mechanism Vector Loop for Slider-Crank Mechanism
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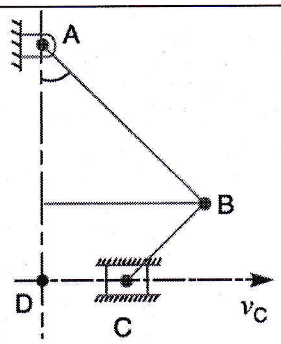
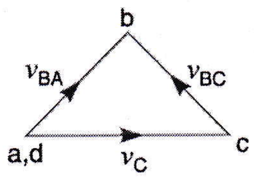
<tr>
<td>2(a)</td>
<td>


(a) Space diagram.



(b) Velocity diagram. **2.5 Marks**

v_{BA} = vector ab = 0.72 m/s

v_{BC} = vector cb = 0.72 m/s **2.5 Marks**
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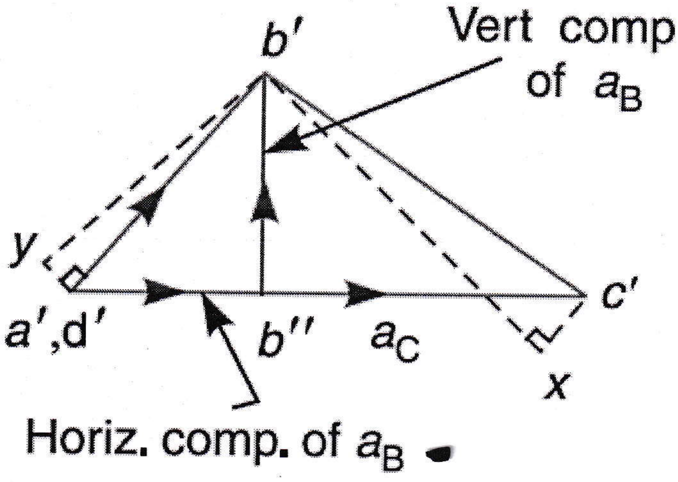


2(b)

(*c*) Acceleration diagram.

2.5 Marks — **5**

vector $b'b'' = 1.13\ \text{m/s}^2$ and vector $a'b'' = 0.9\ \text{m/s}^2$ **Ans.**

$$a^t_{BA} = \text{vector } yb' = 1.41\ \text{m/s}^2$$

$$a^t_{BC} = \text{vector } xb' = 1.94\ \text{m/s}^2$$

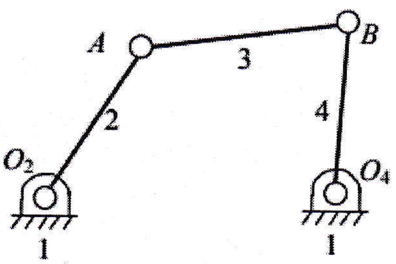
$$\alpha_{BC} = \frac{a^t_{BA}}{CB} = \frac{1.94}{1.5} = 1.3\ \text{rad/s}^2 \textbf{ Ans.}$$

$$\alpha_{AB} = \frac{a^t_{BA}}{AB} = \frac{1.41}{3} = 0.47\ \text{rad/s}^2 \textbf{ Ans.}$$

2.5 Marks

(c) — **5**

Develop loop closure equation for a four bar and Slider crank mechanism.



Four-Bar Linkage

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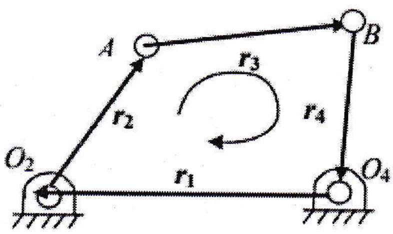
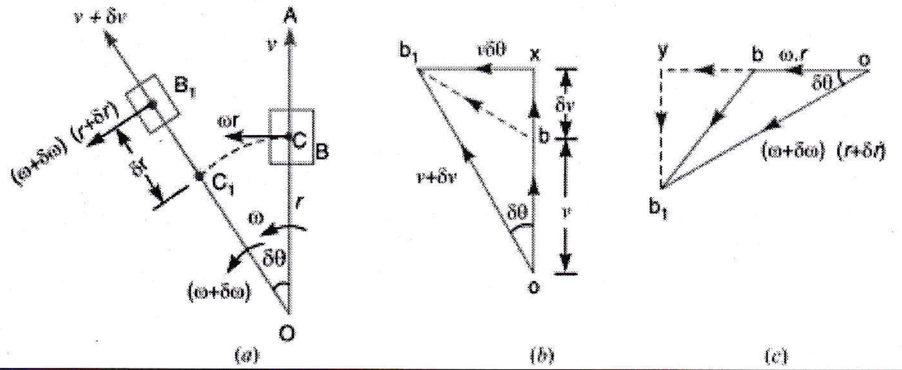
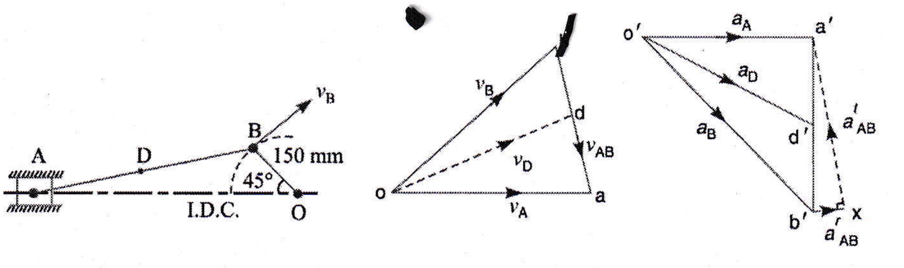
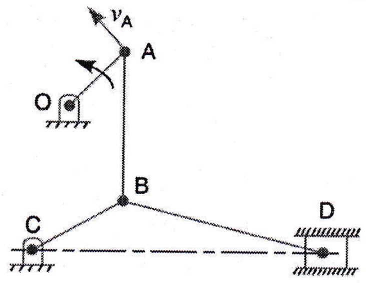
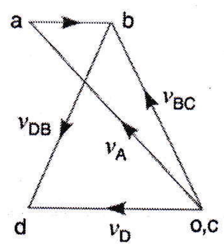
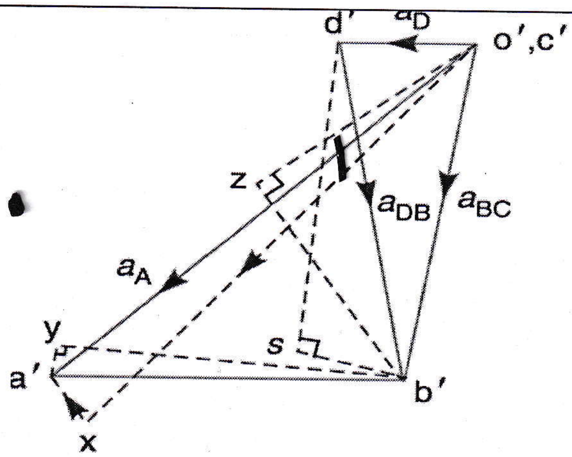


Vector Loop for Four-Bar Linkage

3(a)	Coriolis component of acceleration, with the help of appropriate sketches 	5
3(b)	 (*a*) Space diagram. (*b*) Velocity diagram. (*c*) Acceleration diagram. **2.5 Marks** $v_{BO} = v_B = \omega_{BO} \times OB = 31.42 \times 0.15 = 4.713$ m/s vector ob = $v_{BO} = v_B = 4.713$ m/s v_{AB} = vector $ba = 3.4$ m/s Velocity of A, v_A = vector $oa = 4$ m/s v_D = vector $od = 4.1$ m/s **Ans.** a_D = vector o' d' = 117 m/s2 Ans. $a^t_{AB} = 103$ m/s^2 $\alpha_{AB} = \frac{a^t_{AB}}{BA} = \frac{103}{0.6} = 171.67$ rad/s^2 (Clockwise about B) **Ans.** **2.5 Marks**	5
3(c)	$\Theta3 = 35.374^0$, r3=0.638m, ω3=7.5rad/sec, ω4=-18.313rad/sec,	5
4(a)	vAO = *v*A = _AO × *OA* = 18.85 × 0.18 = 3.4 m/s 2.5 Mraks	5

<table>
<tr><td></td><td>

(a) Space diagram.


(b) Velocity diagram. 2.5 Marks</td><td></td></tr>
<tr><td>4(b)</td><td>

(c) Acceleration diagram.</td><td>5</td></tr>
<tr><td>4(c)</td><td>Θ3= -10.18,Vc=4.17m/s,ω3=4.49rad/s^2,α3=126.59rad/s^2</td><td>5</td></tr>
</table>

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K S INSTITUTE OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING

IV Semeste IA3 Marks Academic year:2018-19

KINEMATICS OF MACHINERY

Student Details			IA-3		
Sl No	USN	Student Name	IA-3	CO4	CO5
			30	20	10
1	1KS17ME001	ABBAS RAZIN	25	15	10
2	1KS17ME003	ABHILASH K S	25	20	5
4	1KS17ME099	ADITHYA R BHAT	17	12	5
5	1KS17ME006	AKASH K L	23	13	10
6	1KS17ME007	ANANDU K SANIL	25	15	10
7	1KS17ME008	ANIRUDH BHARADHWAJ K	19	14	5
8	1KS17ME009	ANIRUDH M V	20	10	10
9	1KS17ME011	ARJUN PRASAD	22	17	5
10	1KS17ME012	ASHUTOSH VILAS JAIN	15	10	5
11	1KS17ME013	ASIF K	25	20	5
12	1KS17ME014	BHARATH KUMAR G	30	20	10
13	1KS17ME016	CHETHAN N	30	20	10
14	1KS17ME017	CHIRANJEEVI U	20	10	10
15	1KS17ME018	DARSHAN B S	25	20	5
16	1KS17ME019	DARSHAN GOWDA S	30	20	10
17	1KS17ME020	DARSHAN V	10	5	5
18	1KS17ME021	DHEERAJ PASUPULETI	17	17	-
19	1KS17ME022	DILEEP S K	30	20	10
20	1KS17ME023	ESHWAR A N	17	17	
21	1KS17ME024	GANAPATI MANJUNATH HEGDE	30	20	10
22	1KS17ME025	GANESHKUMAR NARAYAN HEGDE	30	20	10
23	1KS17ME026	GIRIDHAR M P	15	15	-
24	1KS16ME018	HARIPRASAD	30	20	10
25	1KS17ME028	IMPAL D RAJ	19	12	7
26	1KS17ME030	JEEVANKUMAR M A	15	5	10
27	1KS17ME031	JITHU MENON	25	20	5
28	1KS17ME032	K AASHISH BHARADWAJ	19	12	7
29	1KS17ME033	KARTHIK S DALABANJAN	30	20	10
30	1KS17ME034	KIRAN C	20	15	5
31	1KS17ME035	KIRAN R	30	20	10
32	1KS17ME036	KONDA ANIL KUMAR REDDY	30	20	10
33	1KS17ME037	KUNDAN B	2	2	-
34	1KS17ME038	KUSHAL RAO R	21	17	4
35	1KS17ME039	MANOJ H S	30	20	10
36	1KS17ME040	MANOJ M	20	10	10
37	1KS17ME041	MOHAMED FAUZAN S	10	10	-
38	1KS17ME042	MOHSIN SHAIKH	15	15	-
39	1KS17ME043	MOLAKALU PUNITH	30	20	10

Student Details			IA-3		
Sl No	USN	Student Name	IA-3	CO4	CO5
			30	20	10
40	1KS17ME044	NAGESH B U	20	15	5
41	1KS17ME[redacted]	NISCHAL V CHADAGA	15	5	10
42	1KS17ME046	NITIN L	7	5	2
43	1KS17ME047	PARIKSHITA M S	10	-	10
44	1KS17ME048	PARIKSHITH K KASHYAP	22	17	5
45	1KS17ME049	PRABHUDEV C M	10	5	5
46	1KS17ME050	PRAKASH Y	10	10	-
47	1KS17ME051	PRAVEEN KUMAR V	25	20	5

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11.Content Beyond syllabus

Academic Year	2018-2019		
Batch	2017-2021		
Year/Semester/secti	II/IV/A		
Subject Code-Title	17ME42A-KINEMATICS OF MACHINERY		
Name of the Instructor	Mrs. Nirmala.L	Dept	MECH

EXAMPLE PROBLEM 1.1

Figure 1.9 shows a shear that is used to cut and trim electronic circuit board laminates. Draw a kinematic diagram.

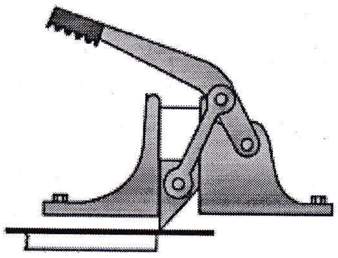


FIGURE 1.9 Shear press for Example Problem 1.1.

SOLUTION: 1. ***Identify the Frame***

The first step in constructing a kinematic diagram is to decide the part that will be designated as the frame. The motion of all other links will be determined relative to the frame. In some cases, its selection is obvious as the frame is firmly attached to the ground.

In this problem, the large base that is bolted to the table is designated as the frame. The motion of all other links is determined relative to the base. The base is numbered as link 1.

2. ***Identify All Other Links***

   Careful observation reveals three other moving parts:

   Link 2: Handle

   Link 3: Cutting blade

   Link 4: Bar that connects the cutter with the handle

3. ***Identify the Joints***

   Pin joints are used to connect link 1 to 2, link 2 to 3, and link 3 to 4. These joints are lettered *A* through *C*. In addition, the cutter slides up and down, along the base. This sliding joint connects link 4 to 1, and is lettered *D*.

4. ***Identify Any Points of Interest***

   Finally, the motion of the end of the handle is desired. This is designated as *point of interest X*.

5. ***Draw the Kinematic Diagram***

   The kinematic diagram is given in Figure 1.10.

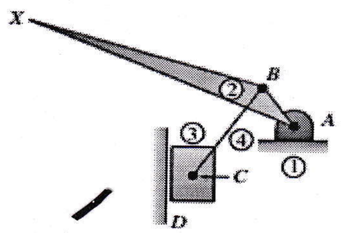


FIGURE 1.10 Kinematic diagram for Example Problem 1.1.

EXAMPLE PROBLEM 1.2

Figure 1.11 shows a pair of vise grips. Draw a kinematic diagram.

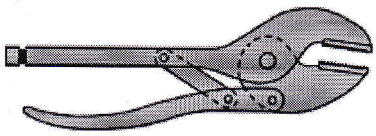


FIGURE 1.11 Vise grips for Example Problem 1.2.

SOLUTION:

1. ***Identify the Frame***

   The first step is to decide the part that will be designated as the frame. In this problem, no parts are attached to the ground. Therefore, the selection of the frame is rather arbitrary.

   The top handle is designated as the frame. The motion of all other links is determined relative to the top handle. The top handle is numbered as link 1.

2. ***Identify All Other Links***

   Careful observation reveals three other moving parts:

   Link 2: Bottom handle
   Link 3: Bottom jaw
   Link 4: Bar that connects the top and bottom handle

3. ***Identify the Joints***

   Four pin joints are used to connect these different links (link 1 to 2, 2 to 3, 3 to 4, and 4 to 1). These joints are lettered *A* through *D*.

4. ***Identify Any Points of Interest***

   The motion of the end of the bottom jaw is desired. This is designated as point of interest *X*. Finally, the motion of the end of the lower handle is also desired. This is designated as point of interest *Y*.

5. ***Draw the Kinematic Diagram***

   The kinematic diagram is given in Figure 1.12.

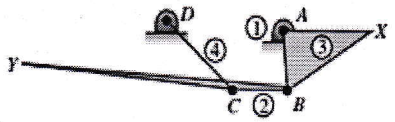


FIGURE 1.12 Kinematic diagram for Example Problem 1.2.

EXAMPLE PROBLEM 1.3

Figure 1.14 shows a toggle clamp. Draw a kinematic diagram, using the clamping jaw and the handle as points of interest. Also compute the degrees of freedom for the clamp.

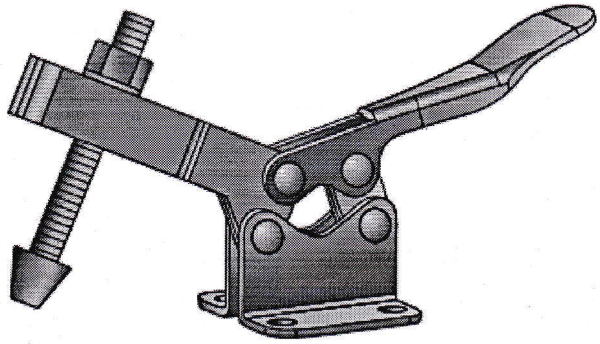


FIGURE 1.14 Toggle clamp for Example Problem 1.3.

SOLUTION:

1. ***Identify the Frame***

   The component that is bolted to the table is designated as the frame. The motion of all other links is determined relative to this frame. The frame is numbered as link 1.

2. ***Identify All Other Links***

   Careful observation reveals three other moving parts:

   Link 2: Handle
   Link 3: Arm that serves as the clamping jaw
   Link 4: Bar that connects the clamping arm and handle

3. ***Identify the Joints***

   Four pin joints are used to connect these different links (link 1 to 2, 2 to 3, 3 to 4, and 4 to 1). These joints are lettered *A* through *D*.

4. ***Identify Any Points of Interest***

   The motion of the clamping jaw is desired. This is designated as point of interest *X*. Finally, the motion of the end of the handle is also desired. This is designated as point of interest *Y*.

5. ***Draw the Kinematic Diagram***

   The kinematic diagram is detailed in Figure 1.15.

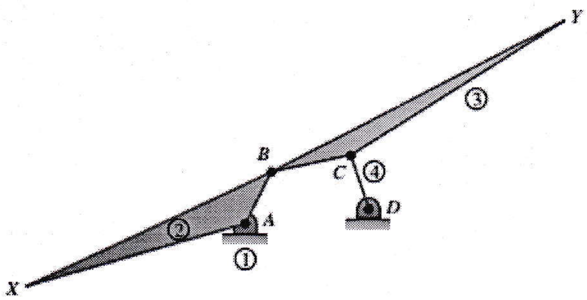


FIGURE 1.15 Kinematic diagram for Example Problem 1.3.

EXAMPLE PROBLEM 1.4

Figure 1.16 shows a beverage can crusher used to reduce the size of cans for easier storage prior to recycling. Draw a kinematic diagram, using the end of the handle as a point of interest. Also compute the degrees of freedom for the device.

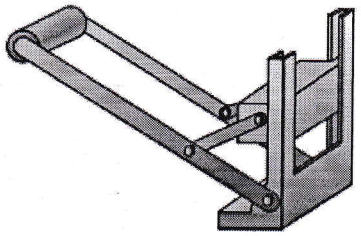


FIGURE 1.16 Can crusher for Example Problem 1.4.

SOLUTION:

1. ***Identify the Frame***

   The back portion of the device serves as a base and can be attached to a wall. This component is designated as the frame. The motion of all other links is determined relative to this frame. The frame is numbered as link 1.

2. ***Identify All Other Links***

   Careful observation shows a planar mechanism with three other moving parts:

   Link 2: Handle
   Link 3: Block that serves as the crushing surface
   Link 4: Bar that connects the crushing block and handle

3. ***Identify the Joints***

   Three pin joints are used to connect these different parts. One pin connects the handle to the base. This joint is labeled as *A*. A second pin is used to connect link 4 to the handle. This joint is labeled *B*. The third pin connects the crushing block and link 4. This joint is labeled *C*.

   The crushing block slides vertically during operation; therefore, a sliding joint connects the crushing block to the base. This joint is labeled *D*.

4. ***Identify Any Points of Interest***

   The motion of the handle end is desired. This is designated as point of interest *X*.

5. ***Draw the Kinematic Diagram***

   The kinematic diagram is given in Figure 1.17.

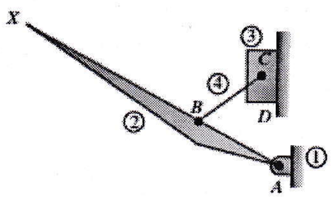


FIGURE 1.17 Kinematic diagram for Example Problem 1.4.

6. ***Calculate Mobility***

It was determined that there are four links in this mechanism. There are also three pin joints and one slider joint. Therefore,

$$n = 4,\ j_p = (3 \text{ pins} + 1 \text{ slider}) = 4,\ j_h = 0$$

and

$$M = 3(n - 1) - 2j_p - j_h = 3(4 - 1) - 2(4) - 0 = 1$$

With one degree of freedom, the can crusher mechanism is constrained. Moving only one link, the handle, precisely positions all other links and crushes a beverage can placed under the crushing block.

EXAMPLE PROBLEM 1.5

Figure 1.18 shows another device that can be used to shear material. Draw a kinematic diagram, using the end of the handle and the cutting edge as points of interest. Also, compute the degrees of freedom for the shear press.

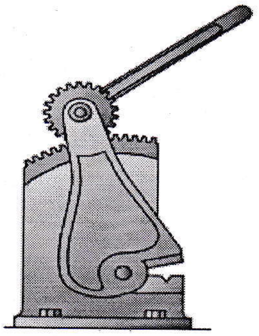


FIGURE 1.18 Shear press for Example Problem 1.5.

SOLUTION:

1. ***Identify the Frame***

   The base is bolted to a working surface and can be designated as the frame. The motion of all other links is determined relative to this frame. The frame is numbered as link 1.

2. ***Identify All Other Links***

   Careful observation reveals two other moving parts:

   Link 2: Gear/handle
   Link 3: Cutting lever

3. ***Identify the Joints***

   Two pin joints are used to connect these different parts. One pin connects the cutting lever to the frame. This joint is labeled as *A*. A second pin is used to connect the gear/handle to the cutting lever. This joint is labeled *B*.

   The gear/handle is also connected to the frame with a gear joint. This higher-order joint is labeled *C*.

4. ***Identify Any Points of Interest***

   The motion of the handle end is desired and is designated as point of interest *X*. The motion of the cutting surface is also desired and is designated as point of interest *Y*.

5. ***Draw the Kinematic Diagram***

   The kinematic diagram is given in Figure 1.19.

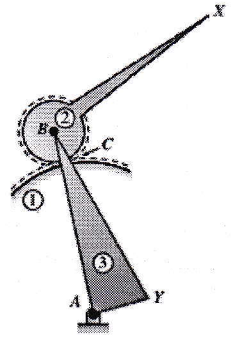


FIGURE 1.19 Kinematic diagram for Example Problem 1.5.

6. ***Calculate Mobility***

To calculate the mobility, it was determined that there are three links in this mechanism. There are also two pin joints and one gear joint. Therefore,

$$n = 3 \quad j_p = (2 \text{ pins}) = 2 \quad j_h = (1 \text{ gear connection}) = 1$$

and

$$M = 3(n - 1) - 2j_p - j_h = 3(3 - 1) - 2(2) - 1 = 1$$

With one degree of freedom, the shear press mechanism is constrained. Moving only one link, the handle, precisely positions all other links and brings the cutting edge onto the work piece.

EXAMPLE PROBLEM 1.6

Figure 1.21 shows an outrigger foot to stabilize a utility truck. Draw a kinematic diagram, using the bottom of the stabilizing foot as a point of interest. Also compute the degrees of freedom.

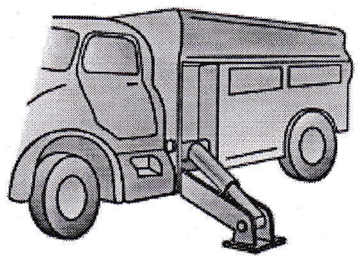


FIGURE 1.21 Outrigger for Example Problem 1.6.

SOLUTION:

1. ***Identify the Frame***

   During operation of the outriggers, the utility truck is stationary. Therefore, the truck is designated as the frame. The motion of all other links is determined relative to the truck. The frame is numbered as link 1.

2. ***Identify All Other Links***

   Careful observation reveals three other moving parts:

   Link 2: Outrigger leg
   Link 3: Cylinder
   Link 4: Piston/rod

3. ***Identify the Joints***

   Three pin joints are used to connect these different parts. One connects the outrigger leg with the truck frame. This is labeled as joint *A*. Another connects the outrigger leg with the cylinder rod and is labeled as joint *B*. The last pin joint connects the cylinder to the truck frame and is labeled as joint *C*.

   One sliding joint is present in the cylinder unit. This connects the piston/rod with the cylinder. It is labeled as joint *D*.

4. ***Identify Any Points of Interest***

   The stabilizer foot is part of link 2, and a point of interest located on the bottom of the foot is labeled as point of interest *X*.

5. ***Draw the Kinematic Diagram***

   The resulting kinematic diagram is given in Figure 1.22.

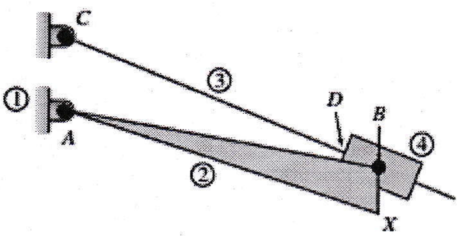


FIGURE 1.22 Kinematic diagram for Example Problem 1.6.

12.Question Bank for each module

Module-1

Introduction

1. Define Kinematic link. And write the types
2. Define Kinematic pair and write their types
3. Define Kinematic chain
4. Differentiate between structure and Machine
5. Differentiate between structure and Mechanism
6. Define mechanism When a linkage become mechanism
7. Write the types of constrained motion
8. Briefly explain the types of kinematic pair
9. Classify kinematic pairs based on nature of contact., Give example
10. Classify kinematic pair based on degrees of freedom
11. What are the types of constrained motions? And define their types
12. Difference between rotational and translation
13. Difference between rigid body and resistant body
14. Degree of freedom
15. Degree of freedom of Mechanism.
16. What is meant by spatial mechanism? And its Mobility
17. State the Grumblers' Criterion
18. Write Grashoff's law. What is kinematic inversion of mechanism.
19. Define double slider crank chain mechanism Name any two inversions of mechanism
20. What are the some important inversions of four chain mechanism
21. Explain Elliptical trammel and prove that it traces a path an elliptical path
22. Explain the inversions of four bar chain with examples

23. Describe with neat sketch, the mechanism obtained by the inversions of 4-bar chain
24. Explain the inversions of double slider crank chain with examples
25. Sketch and explain the Elliptical trammel and Scotch yoke mechanism.
26. With the help of a neat sketch explain the working of Oldham's coupling
27. Define single slider crank chain mechanism
28. Write the different slider crank inversion Mechanism
29. Sketch and explain the inversions of Single-slider crank chain
30. Sketch and describe the working of two different types of quick return mechanisms. Give examples of their applications. Derive an expression for the ratio of times taken in-forward and return s t r o k e for one of these mechanisms
31. Explain the working a quick return motion mechanism. Also derive an equation for the ratio of time taken for return stroke and forward strokes.
32. With the help of a neat sketch explain the working of Whitworth quick return mechanism
33. 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.
34. 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 120 mm. Find the inclination of the slotted bar with the vertical in the extreme position and the time ratio of cutting stroke to the return stroke. If the length of the slotted bar is 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
35. Explain ratchet pawl mechanism
36. Write short notes on toggle mechanism
37. Classification of mechanisms (Indexing Mechanism, Rocking Mechanism, Reciprocating Mechanism, Straight Line Mechanism)
38. 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 turns by 18 degree, what should be the angle be the angle turned by the outer front wheel for perfect steering?
39. What are straight-line mechanisms? Sketch the Peaucellier straight-line motion mechanism

EXAMPLES

(1) For the kinematic linkages shown in *Figure 1.1*, find the number of binary links (N_b), ternary links (N_t), other links (N_o), total links N, loops L, joints or pairs (P_1), and degree of freedom (F).

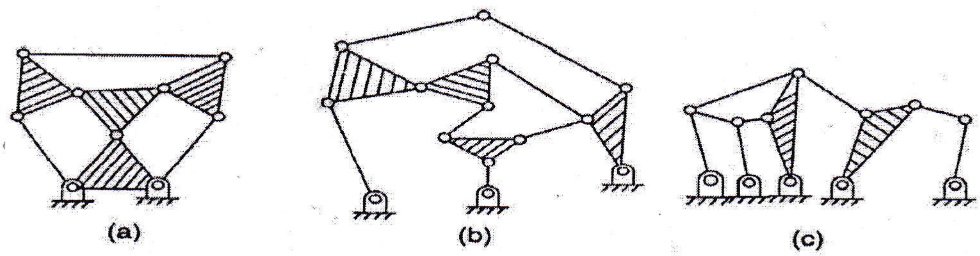


Figure 1.1

[(a) $N_b = 3;\ N_t = 4;\ N_o = 0; N = 7; L = 3;\ P_1 = 9; F = 0$

(b) $N_b = 7;\ N_t = 5;\ N_o = 0; N = 12; L = 4;\ P_1 = 15; F = 3$

(c) $N_b = 8;\ N_t = 2;\ N_o = 1; N = 11; L = 5;\ P_1 = 15; F = 0$]

MODULE-2
(VELOCITY AND ACCELERATION ANALYSIS BY GRAPHICAL METHOD, IC METHOD, KLEINS CONSTRUCTION)

Theory

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

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

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

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

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

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

---

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

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

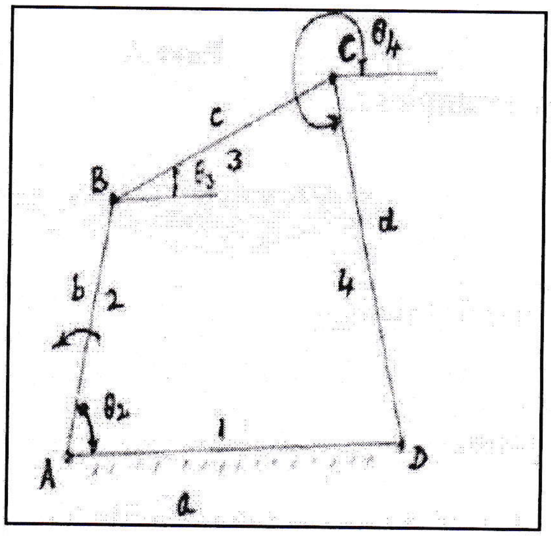
(9) What is Coriolis acceleration component? In which cases does it occur? How is it determined?

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

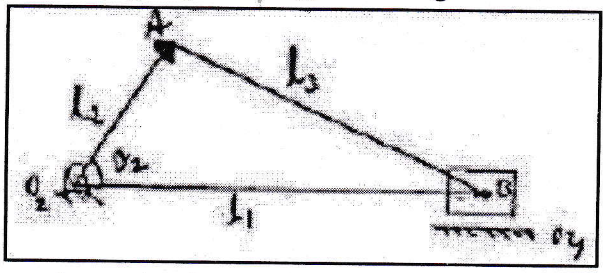
MODULE-3

(VELOCITY AND ACCELERATION ANALYSIS BY ANALYTICAL METHOD)

1. Obtain loop closure equation for a four bar mechanism.
2. Develop equation for angular velocity and angular acceleration of link 3 and 4 as shown in figure, using complex algebra method.



3. For an offset slider crank mechanism write loop closure equation and determine the expressions for
   i) Connecting rod angle and output displacement
   ii) Angular velocity of connecting rod
   iii) Angular acceleration of connecting rod.
4. Derive expression of displacement analysis of a four bar mechanism using complex algebra method
5. For the slider crank mechanism shown in figure, determine velocity and acceleration of piston and angular acceleration of connecting rod. Take crank length=50mm, connecting rod=200mm, crank speed=300rpm (constant), crank angle=30^0.



6. For an offset slider crank mechanism write loop closure equation and determine the expressions for

i) Connecting rod angle and output displacement

ii) Angular velocity of connecting rod

iii) Angular acceleration of connecting rod.

iv) Angular acceleration of piston

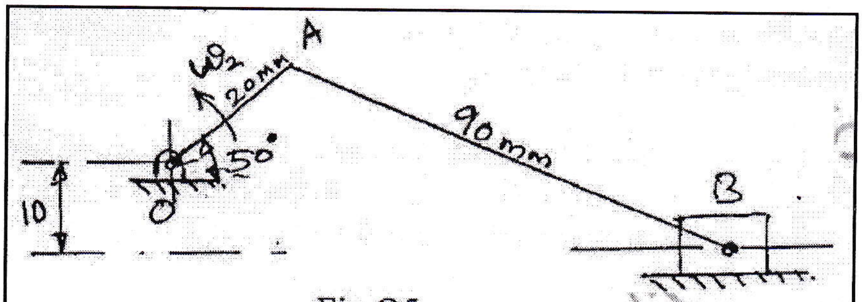
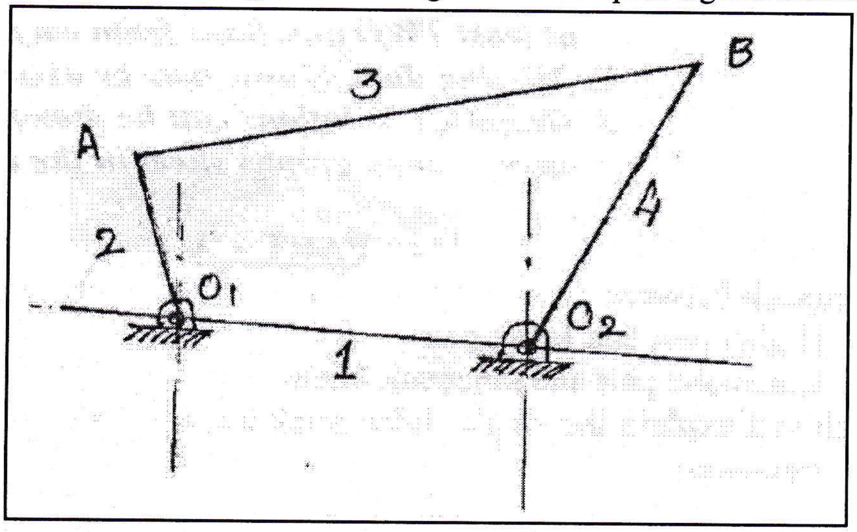


Fig.Q5

OA rotates with uniform angular velocity of 15 r/s.

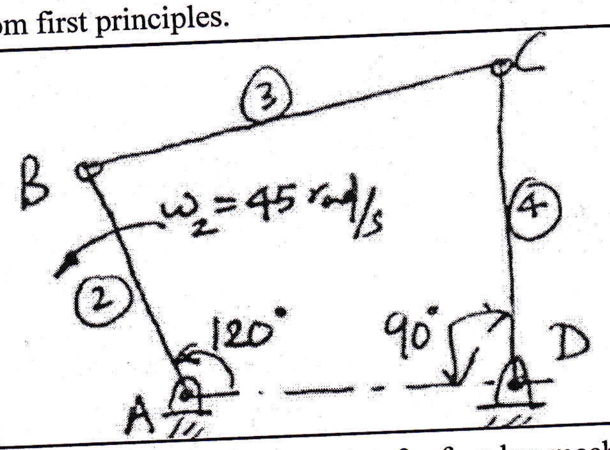
OA = 20 mm AB = 90 mm

7. Using complex algebra method, derive expressions for velocity and acceleration of piston and angular acceleration of connecting rod of a reciprocating engine mechanism. Use these expressions to find the above, Crank length is 50mm, Connecting rod is 200 mm, Crank angle is 30^0, the crank rotates at a constant speed of 3000rpm.
8. Develop an equation for the relationship between angular velocities of the input link and output link for a four bar linkage shown in figure. Use complex algebra method.



9. The crank and connecting rod of a engine are 0.3m and 1.5m long respectively. The crank rotates at 180rpm clockwise. Determine the velocity and acceleration of piston when the crank makes an angle of 40^0 from TDC. Also determine the position of crank for zero acceleration of the piston.
10. Explain the significance of loop closure equation with example.
11. The crank of an engine mechanism is 200mm long and the ratio of connecting rod length to crank radius is 4. Determine the acceleration of the piston when the crank has turned through 45^0 from IDC and rotating at a speed of 240 rpm CCW. Solve by using complex algebra method.

12. A four bar chain mechanism ABCD is as shown in figure. Find the angular velocity of link3 and link 4 by using complex algebra method, if W_2=45rad/sec, counter clock wise from first principles.



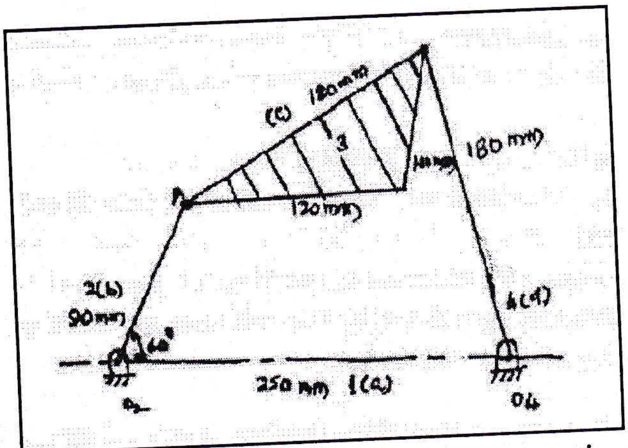
AB = 100 mm
BC = r_3.
CD = 300 mm
AD = 250 mm

Fig.Q5

13. Obtain Freudenstein's equation for four bar mechanism.

14. The crank of a reciprocating engine is 90mm long, the connecting rod is 360mm long, and crank rotates at 150rpm clockwise. Find the velocity and acceleration of piston, and the angular velocity and angular acceleration of connecting rod when the crank makes an angle 30^0 with IDC. Solve the problem using complex algebra method.

15. A four bar mechanism is as shown in figure. Crank O_2A rotates at 100rpm clockwise and an angular acceleration of 12 rad/sec^2 clockwise at an instant when crank makes an angle of 60^0 with horizontal. Determine angular velocity and angular acceleration of link 3 and 4 by Raven's method. Also find velocity and acceleration of point C by assuming AC is parallel to O_2O_4.



16. In a reciprocating engine length of crank is 250mm and connecting rod length 1000mm. The crank rotates at a uniform speed of 300rpm clock wise, crank is at 30^0 with IDC. Determine,
   i) Velocity of piston and angular velocity of connecting rod
   ii) Acceleration of piston and angular acceleration of connecting rod using complex algebra method.

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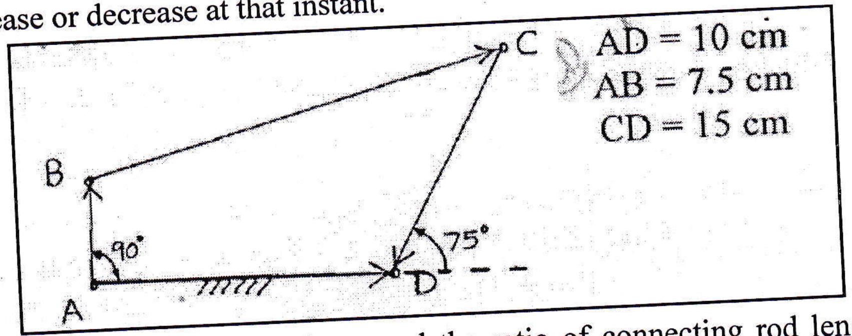
17. In four bar mechanism shown in figure, link AB rotates uniformly at 2rad/sec in clockwise. Using complex algebra write loop closure equation for this. Determine magnitude and direction of angular velocity and angular acceleration of links BC and CD using vector algebra. Also state whether magnitudes of angular velocities of these links tend to increase or decrease at that instant.



18. The crank of an engine is 20cm long, and the ratio of connecting rod length to crank length is 4. Determine the acceleration of the piston when the crank has turned through 45^0 from the IDC and moving towards the other center at 240rpm counter clock wise direction. Solve by using Complex algebra method.

19. The slider crank of an internal combustion engine has a crank of 150mm length and connecting rod of 600mm long. The crank rotates at a constant speed of 300rpm CCW. Determine the position, velocity and acceleration of slider when the crank angle is 45^0 from the IDC. Solve by using complex algebra method.

20. A four bar mechanism ABCD is made up of four links pin jointed at the ends. Ad is the fixed link of 600mm. Links AB, BC and CD are 300mm, 360mm and 360mm respectively. At certain instant link AB makes 60^0 with AD. If the link AB rotates at an angular velocity of 10rad/sec and an angular acceleration of 30rad/sec^2, both clockwise, determine the angular velocity and angular acceleration of link BC and CD by using complex algebra method.

21. The slider crank of an internal combustion engine mechanism includes crank of 50mm and connecting rod of 200 mm long respectively. The crank speed of the engine is constant at 300rpm. Determine the acceleration of the mass center of the connecting rod by using complex algebra method, when the crank angle is 30^0. The mass center is located at 50mm from the crank pin.

MODULE-4
SPUR GEARS AND GEAR TRAINS

22. What is Interference and mention the methods to avoid it.

23. Derive equation for length of path of contact and length of arc of contact & contact ratio for a pair of Involute gears in contact.

24. State and prove Law of gearing.

25. Compare Cycloidal and involute gear toot profile.

26. A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gear is involute with 20^0 pressure angle, 12mm module and 10mm addendum. Find the length of path of contact and length of arc of contact.

27. Two gears in mesh have 28 & 45 teeth respectively and standard addendum of one module. The module and pressure angle are 6mm & 20^0 respectively. Determine

    i) Contact ratio
    ii) Angle turned by pinion & gear when one pair in contact
    iii) The ratio of sliding to rolling velocity when the tip of tooth on the larger wheel is just making contact, is leaving contact with its mating tooth, is at the pitch point.

28. Two gear wheels mesh externally and are to give a velocity ratio of 3:1. The teeth are of Involute form module=6mm, addendum=one module, pressure angle=20^0. The pinion rotates at 90rpm. Determine

    i) Minimum number of teeth on each wheel to avoid interference
    ii) The number of pair of teeth in contact.
    iii) Length of path of contact
    iv) Maximum velocity of sliding between teeth.

29. Two mating gears have 20 & 40 teeth respectively of module 10mm & 20^0 pressure angles. The addendum of 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, length of path of contact, arc of contact, contact ratio.

30. Two 20^0 Involute spur gears in mesh externally & give velocity ratio of 3. Module is 3mm & addendum equal to 1.1 module. If the pinion rotates at 120rpm determine.

    i) Minimum number of teeth on each wheel to avoid interference
    ii) The number of pairs of teeth in contact.

31. A pinion having 20 teeth of Involute form, 20^0 pressure angle and 6mm module drives the gear having 40 teeth. If addendum equal to 1 module, find

    a) Addendum & pitch circle radius of the two gears.
    b) Length of path of approach
    c) Length of path of contact
    d) Length of arc of contact.

32. The following data relate to pair of Involute spur gears in mesh. Module=6mm, Number of teeth on wheel=49, Number of teeth on pinion=17, Addendum of pinion and gear wheel in terms of module=1. Find the number of pair of teeth in contact.

33. Two gear wheels mesh externally & are to give a velocity ratio of 3. The teeth are of Involute form of module 6mm and standard addendum one module. Pressure angle=18^0, pinion rotates at 90rpm, find

    a) Number of teeth on each wheel so that interference is just avoided

b) Length of path of contact

c) Maximum velocity of sliding between teeth

d) Number of pair of teeth in contact.

34. A pair of spur gear has 16 teeth and 18 teeth, a module of 12.5mm, an addendum of 12.5mm and a pressure angle of 14.5^0. Prove that the gears have interference. Determine the minimum number of teeth and the velocity ratio to avoid interference.

35. Pair of gears having 40 & 30 teeth respectively is of 25 degree Involute form. Addendum=5mm, module=2.5mm. If the small wheel is the driver and rotate at 1500 rpm, find the velocity of sliding at the point of engagement, at pitch point and at the point of disengagement, length of path of contact, length of arc of contact.

36. Two mating gears with module 6mm have 20 and 50 teeth respectively of pressure angle 20^0 and addendum 6mm. Determine the number of pair of teeth in contact.

37. A pair of gear has 16 teeth and 18 teeth, a module 21.5mm, addendum 12.5mm and a pressure angle14.5^0. Prove that gears have interference. Determine the minimum number of teeth and velocity ratio to avoid interference.

38. The number of teeth on each of the two equal spur gears in mesh is 40. The teeth have 20^0 involute profiles and the module is 6mm. If the length of arc of contact is 1.75 times the circular pitch, find the addendum.

39. Two 20^0 involute spur gear have a module of 10mm and addendum of 1module. The number of teeth on pinion is 13 and on spur gear is 52. Does interference occurs? If it occurs to what value the pressure angle is change to eliminate interference?

40. A pinion of 32 involute teeth and 4mm module drives a rack. The pressure angle is 20^0. The addendum of both pinion and rack is same. Determine the maximum permissible value of addendum to avoid interference. Also find the number of pair of teeth in contact.

41. Two gear wheels mesh externally and are to give a velocity ratio of 3. The teeth are of Involute form module=6mm, addendum=one module, pressure angle=20^0. The pinion rotates at 400rpm. Determine

i) Minimum number of teeth on each wheel to avoid interference

ii) The number of pair of teeth in contact.

iii) Length of path of contact, arc of contact and contact ratio

iv) Maximum velocity of sliding between teeth.

42. Two spur gear wheels have 23 and 57 teeth. The profile of the gear is involute with pressure angle 20^0, module is 8mm and addendum equals to one module. Calculate the length of path of contact and arc of contact.

43. Explain Epicyclic gear train with neat figure.

44. Explain with neat sketch the sun & planet wheel.

45. Explain compound and reverted gear train.

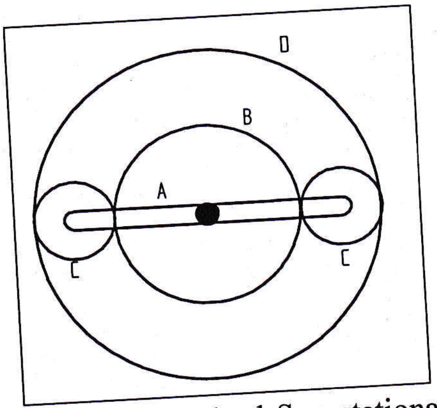
46. Explain different types of gear train with neat sketch.

47. Sketch and explain Simple gear train and Epicyclic gear train.

48. Explain with a neat sketch classification of gear trains.

49. Explain with a sketch differential mechanism of an automobile.

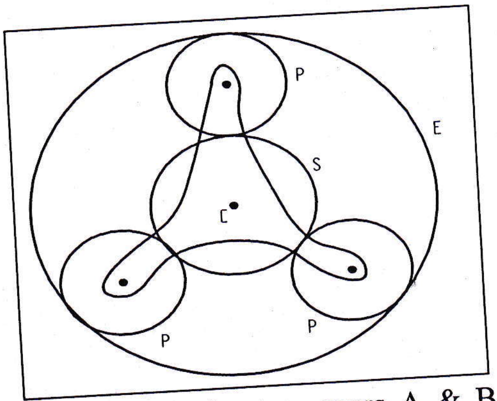
50. Figure shows Epicyclic gear train where the arm A the driver and annular gear D is the follower. The wheel D has 112 teeth and B has 48 teeth. B runs freely on pin P and D is separately driven. The arm A runs at 100 rpm and wheel D at 50rpm in same direction, find the speed of wheel **B** and C.



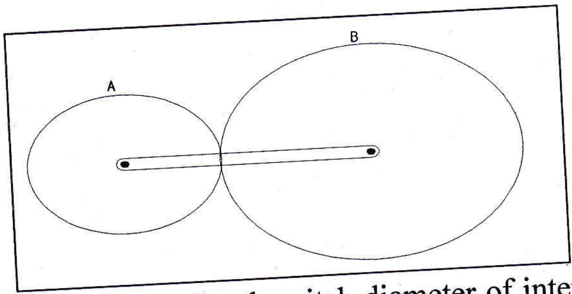
51. An Epicyclic gear train consist of a sun wheel S, a stationary internal gear E and three identical planet wheels P carried on a star shaped planet carrier C. The size of different toothed wheels is such that the planet carrier C rotates one revolution for every 5 revolutions of the sun wheel S. The minimum number of teeth on any wheel is 16, the driving torque on the sun wheel is 100N-m, Determine

a) Number of teeth on different wheels of the train

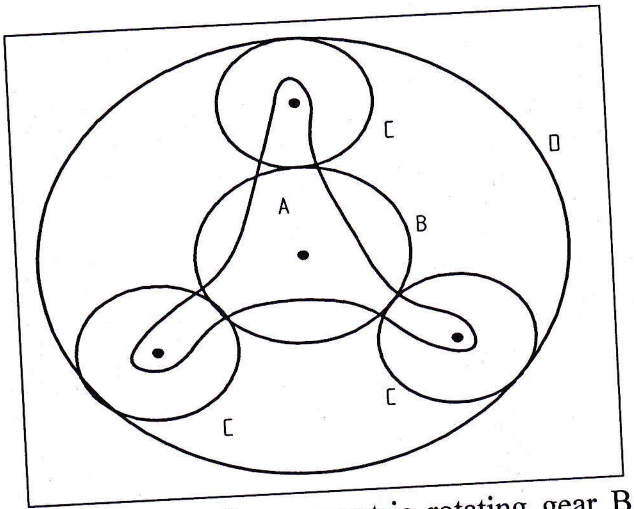
b) Torque necessary to keep the internal gear stationary.



52. In an Epicyclic gear train, an arm carries two gears A & B having 36 and 45 teeth, respectively. If the arm rotates at 150rpm in the anti-clock wise direction about the center of gear A which is fixed, determine the speed of gear B, if the gear A instead of being fixed, makes 300rpm clock wise direction.



53. In an Epicyclic gear train shown in fig. the pitch diameter of internally toothed wheel D is to be nearly as possible 228mm and the module 4mm. When the ring is stationary, the spider A which carries three planet wheels C of equal size is to make one revolution for every five revolutions of the driving spindle carrying sun wheel B. Determine the number of teeth for all wheels and exact pitch circle diameter of the ring D using tabular method. If the torque of 30 Nm is applied on sun wheel B, What torque will be required to keep the ring stationary?



54. A fixed annular gear A and a smaller concentric rotating gear B are connected by a compound gears C & D. The gear C meshes with gear A & D with B. The compound gears revolved in a pin on the arm R, which revolves about the axis of A & B. The numbers of teeth on gear A, B & D are 150, 40, and 100. Determine the number of teeth on gear C, if the gears A & C have twice the module of gears B & D. How many revolutions will B make for one revolution of arm R.?

55. In an Epicyclic gear train, the internal gears A, B & compound gears C-D rotates independently about a common axis O. The gears E & F rotates on a pin fixed to the arm G which turns independently about axis O. E gears with A & C, F gears with B & D. All gears have same module. The number of teeth on gears C, D, E & F is 28, 26, 18 & 18 respectively.

a) Sketch the arrangement
b) If G makes 100 rpm clock wise and gear A is fixed find speed of gear B
c) If G makes 100 rpm clock wise and gear A makes 10 rpm CCW. Find speed of B.

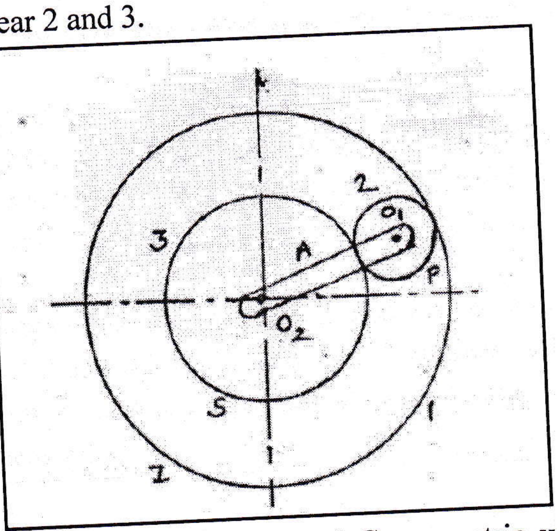
d) Number of teeth on A and B

e) If arm (g) makes 200rpm clockwise and gear A is fixed, find speed of gear B

f) If arms (g) make 100rpm clockwise and gear A makes 50 rpm CCW, find the speed of gear B.

56. In an Epicyclic gear train of sun and planet type, the pitch circle diameter of the Annular wheel (A) is 425mm and the module is 5mm. When the annular wheel is stationary, the spider which carries 3 planet gears (P) of equal size has to make one revolution for every 6 revolutions of the driving spindle carrying Sun wheel (S). Determine the number of teeth on all the wheels.

57. An epicyclic gear train consist of three gears 1, 2, and 3 as shown in figure. The internal gear 1 has 72 teeth, gear 3 has 32 teeth. The gear 2 meshes with gear 1 and 3 and is carried on Arm A which rotates about center O_2 at 20 rpm. If the gear 1 is fixed, determine the speed of gear 2 and 3.



58. An epicyclic gear train has fixed annular wheel C concentric with wheel A. A planet wheel B gears with A and C and can rotate freely on pin carried by arm D which rotates about an axis coaxial with that of A and C. If T_1 and T_2 are the number of teeth on A and C respectively, show that ratio of speeds of D to A is

$$\frac{T_1}{T_1 + T_2}$$

59. An epicyclic gear train has fixed annular wheel C concentric with wheel A. A planet wheel B gears with A and C and can rotate freely on pin carried by arm D which rotates about an axis coaxial with that of A and C. If T_1 and T_2 are the number of teeth on A and C respectively, if T_1 and T_2 are the number of teeth on gears A and C respectively, show that ratio of speeds of D to A is

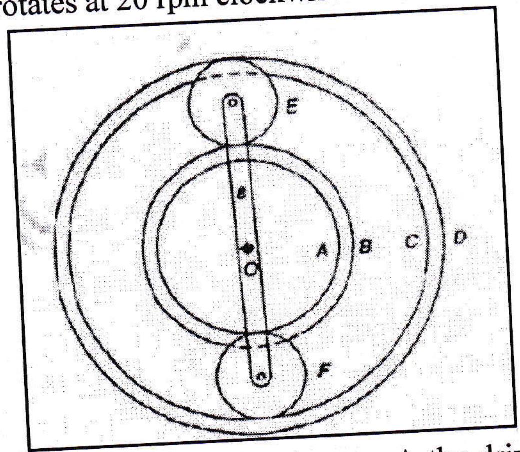
$$\frac{T_1}{T_1 + T_2}$$

If the least number of teeth on any wheel is 18 and $T_1+T_2=120$, find the greatest and least speeds of D when wheel A rotates at 500rpm.

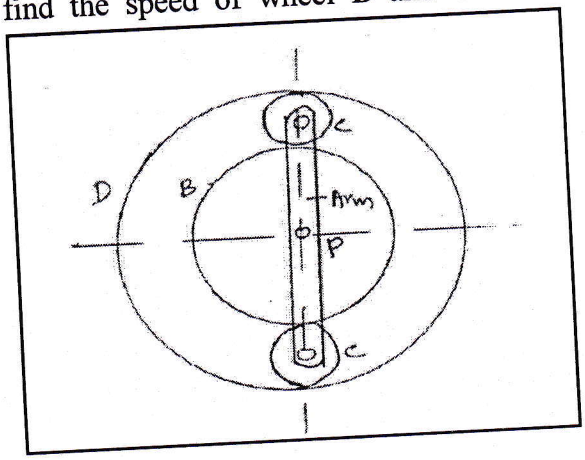
60. In an Epicyclic gear trains shown if figure, the compound wheels A and B as well as internal wheels C and D rotate independently about axis O. The wheels E and F rotate on the pins fixed to arm A. All the wheels are of same module. The number of teeth on wheels are T_A=52, T_B=56, T_E=T_F=36. Determine the speed of C if,

i) The wheel D is fixed and arm A rotates at 200 rpm in clockwise

ii) The wheel D rotates at 20 rpm clockwise and arm A rotates at 200rpm clockwise.



61. Figure shows Epicyclic gear train where the arm A the driver and annular gear D is the follower. The wheel D has 112 teeth and B has 48 teeth. B runs freely on pin P and D is separately driven. The arm A runs at 100 rpm and wheel D at 50rpm in same direction, find the speed of wheel **B** and C and find the torque on B if A receives 7.5KW.



62. An internal wheel with 80 teeth is keyed to shaft F. A fixed internal wheel with 82 teeth is concentric with B. A compound wheels D and E gears with two internal wheels, gear D has 28 teeth and meshes with gear C, while the gear B meshes with Gear B. The compound wheels revolve freely on a pin which projects from a disc keyed to shaft co-axial with shaft F. If all the wheels have same pitch and Gear A makes 600rpm, what is the speed of F.

MODULE-5

ANALYSIS OF CAMS AND CAM PROFILE DIAGRAMS

1. A cam rotating at uniform speed of 300rpm operates a reciprocating follower through a roller of 1.5cm diameter. The follower motion is defined as below:
   i) Outward during 150° with UARM.
   ii) Dwell for next 30°
   iii) Return during next 120° with SHM
   iv) Remaining dwell period

   Stroke of the follower is 3cm. Minimum radius of cam is 3cm. Draw the cam profile when the follower axis is offset to the left by 1cm and determine maximum velocity and maximum acceleration during outstroke.
2. Draw neat sketch for each of the following:
   i) Plate or disc cam with a translating follower,
   ii) Wedge cam with translating follower.
   iii) Cylindrical cam with translating follower.
3. Draw the profile of a cam operating a knife-edge follower having a lift of 30mm. The cam raises the follower with SHM for 150° of the rotation followed by a period of dwell for 60°. Followed by a dwell period. The cam rotates in an anticlockwise sense at a uniform velocity f 120 rpm and has a least radius of 25mm. what will be the maximum velocity and acceleration of the follower during the lift.
4. Draw the profile of a cam operating a roller reciprocating follower and with following data: minimum radius of cam = 25mm, lift =30mm, roller diameter = 15mm.The cam lifts the follower for 120° with SHM followed by a dwell period of 30°. Then the follower lowers down during 150° of cam rotation with uniform acceleration and deceleration followed by dwell period. If the cam rotates at uniform speed of 150 rpm, calculate maximum velocity and acceleration of the follower during the decent period.
5. Draw the cam profile for the following details:
   Minimum radius of cam = 30mm, Roller follower with roller = 10mm radium,
   Axis of the roller is along the straight line with the axis of the cam shaft.
   θ_{rise}= 90° lift=30mm, UARM
   θ_{dwell} = 30° in lifted position
   θ_{return}= 120° SHM
   θ_{dwell} for remaining position of the cam rotation
6. Draw the profile of a cam operating a roller follower with following data.
   Minimum radius of cam = 25m,
   Lift of follower= 30m,
   Roller diameter = 15mm
   Angle of decent with UARM = 150°
   Angle of ascent with 5 rpm = 120°

Dwell between ascent and descent = 30°
If cam rotates at a uniform speed of 150 rpm, calculate the maximum velocity and acceleration of the follower during the descent period.

7. The following data relate to a cam profile in which the follower moves with UARM during ascent and descent.
   Minimum radius of the cam = 25mm,
   Roller diameter = 8mm,
   Lift = 30mm,
   Offset of follower axis = 10mm towards right,
   Angle of ascent = 60°,
   Angle of descent = 90°
   Angle of dwell between ascent and descent = 45°,
   Speed of the cam = 200 rpm .Draw the profile of the cam.
8. The following data relate to cam profile in which the roller follower moves with SHM during ascent and uniform acceleration and retardation motion during descent.
   Minimum radius of cam = 30mm,
   Roller radius = 8mm,
   Lift = 28mm,
   Offset of the follower axis = 12mm towards right,
   Angle of ascent = 90°,
   Angle of Descent=60^0
   Angle of dwell between ascent and descent = 45°,
   Speed of cam = 200 rpm.
   Draw the profile of cam and determine the maximum velocity and acceleration during outstroke and return stroke.
9. Draw the profile of a cam operating a roller reciprocating follower and with the following data: Minimum radius of cam = 25mm, lift = 30mm, Roller diameter =15mm, the cam lift the follower for 120° with SHM followed by a dwell period of 30°, then the follower lowers down during 150° of the cam rotation with UARM followed by a dwell period. The cam rotates at a uniform speed of 150 rpm (CW direction). The axis of the follower passes through the axis of the cam shaft. Calculate the maximum velocity and acceleration of the follower during the descent period.
10. A cam rotating clockwise at uniform speed of 300 rpm operates a reciprocating follower through a roller 10mm diameter. The follower motion is defined below.
    i) Follower to move outwards during 120° of the cam rotation with UARM
    ii) Follower to move dwell in the lifted position for next 30° of the cam rotation.
    iii) Follower to return to its starting position during 120° of cam rotation with SHM.
    iv) Follower to dwell for the next of the cam rotation.
    The stroke of the follower is 30mm. the minimum radius of the cam is 20mm. draw the profile of the cam when line of stroke of the follower is offset 10mm from the axis of the

cam shaft. Find the maximum velocity and acceleration during its outward stroke and inward stroke.

11. The following data relate to a cam profile in which, the roller follower moves with Uniform acceleration and retardation motion during ascent and descent.
    Minimum Radius of cam = 25mm.
    Roller radius = 8mm,
    Lift = 32mm,
    Offset of follower axis =12mm towards right,
    Angle of ascent = 60°,
    Angle of descent = 90°,
    Angle of dwell between ascent and descent = 45°,
    Speed of cam = 20 rpm clockwise.
    Draw the profile of cam.
12. Sketch the following
    i) Disc cam with translating follower
    ii) Wedge cam with translating follower
    iii) Cylindrical cam with oscillating follower.
13. Draw the profile of cam operating a knife edge follower a lift of 30mm. The cam raises the follower with simple harmonic motion for 150° of the rotation, followed by a Period of dwell for 60°. The follower descends for the next 100° rotation of the cam with uniform velocity, again followed by a dwell period. The cam rotates at a uniform speed of 120 rpm and has a least radius of 20mm. what will be the maximum velocity and acceleration of the follower during the lift and the return.
14. Construct the profile of a cam to suit the following specifications:
    Cam shaft diameter = 40mm
    Least radius of cam=25mm
    Diameter of roller = 25mm
    Angle of lift = 120°
    Angle of fall = 150°
    Lift of the follower = 40mm
    Numbers of pauses are two of equal interval between motions. During the lift the motion is SHM. During the fall motion is UARM. The speed of cam shaft is uniform. The line of stroke is center of the cam.
13. Draw the cam profile for the following data for a roller follower-Offset=10mm towards right of cam Centre, roller radius=10mm, minimum radius of the cam= 20mm, max displacement of the follower= 24mm , out stroke angle= 90^0 of cam rotation with UARM, acceleration being half of the retardation. Dwell at the elevated position = 30^0 of cam rotation return stroke =90^0 of cam rotation with modified uniform velocity. After the return stroke cam dwells for the remaining period. Determine the maximum velocity and acceleration during out stroke only. Speed of cam is 600 rpm in CW
14. Draw the cam profile for the following data for a roller follower-Offset=10mm towards right of cam Centre, roller radius=10mm, minimum radius of the cam= 20mm, max

displacement of the follower= 24mm, out stroke angle= 90^0 of cam rotation with UARM, acceleration being half of the retardation. Dwell at the elevated position = 30^0 of cam rotation, return stroke =90^0 of cam rotation with modified uniform velocity. After the return stroke cam dwells for the remaining period. Determine the maximum velocity and acceleration during out stroke only. Speed of cam is 600 rpm in CW

15. Draw the cam profile for following conditions:
    Follower type = Knife edged, in-line; lift = 50mm; base circle radius = 50mm; out stroke with SHM, for 60^0 cam rotation; dwell for 45^0 cam rotation; return stroke with SHM, for 90^0 cam rotation; dwell for the remaining period. Determine max. Velocity and acceleration during out stroke and return stroke if the cam rotates at 1000 rpm in clockwise direction.
16. Draw the cam profile for following conditions:
    Follower type = roller follower, in-line; lift = 25mm; base circle radius = 20mm; roller radius = 5mm; out stroke with UARM, for 120^0 cam rotation; dwell for 60^0 cam rotation; return stroke with UARM, for 90^0 cam rotation; dwell for the remaining period. Determine max. Velocity and acceleration during out stroke and return stroke if the cam rotates at 1200 rpm in clockwise direction.
17. Draw the cam profile for following conditions:
    Follower type = roller follower, off set to the right of cam axis by 18mm; lift = 35mm; base circle radius = 50mm; roller radius = 14mm; out stroke with SHM in 0.05sec; dwell for 0.0125sec; return stroke with UARM, during 0.125sec; dwell for the remaining period. During return stroke, acceleration is 3/5 times retardation. Determine max. Velocity and acceleration during out stroke and return stroke if the cam rotates at 240 rpm.
18. Draw the cam profile for following conditions:
    Follower type = knife edged follower, in line; lift = 30mm; base circle radius = 20mm; out stroke with uniform velocity in 120^0 of cam rotation; dwell for 60^0; return stroke with uniform velocity, during 90^0 of cam rotation; dwell for the remaining period.
19. Draw the cam profile for following conditions:
    Follower type = knife edged follower, in line; follower rises by 24mm with SHM in 1/4 rotation, dwells for 1/8 rotation and then raises again by 24mm with UARM in 1/4 rotation and dwells for 1/16 rotation before returning with SHM. Base circle radius = 30mm.
20. Draw the cam profile for following conditions:
    Follower type = flat faced follower, in line; follower rises by 20mm with SHM in 120^0 of cam rotation, dwells for 30^0 of cam rotation; returns with SHM in 120^0 of cam rotation and dwells during the remaining period. Base circle radius = 25mm.
21. Draw the cam profile for following conditions:
    Follower type = roller follower, in line; roller dia. = 5mm; follower rises by 25mm with SHM in 180^0 of cam rotation, falls by half the distance instantaneously; returns with Uniform velocity in 180^0 of cam rotation. Base circle radius = 20m.
22. Draw the cam profile for following conditions:

Follower type = roller follower, off-set to the right by 5mm; lift = 30mm; base circle radius = 25mm; roller radius = 5mm; out stroke with SHM, for 120^0 cam rotation; dwell for 60^0 cam rotation; return stroke during 120^0 cam rotation; first half of return stroke with Uniform velocity and second half with UARM; dwell for the remaining period.

23. A push rod of valve of an IC engine ascends with UARM, along a path inclined to the vertical at 60^0. The same descends with SHM. The base circle diameter of the cam is 50mm and the push rod has a roller of 60mm diameter, fitted to its end. The axis of the roller and the cam fall on the same vertical line. The stroke of the follower is 20mm. The angle of action for the outstroke and the return stroke is 60^0 each, interposed by a dwell period of 60^0. Draw the profile of the cam.

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CBCS SCHEME

USN | | | | | | | | | | | **15ME42**

Fourth Semester B.E. Degree Examination, Dec.2018/Jan.2019
Kinematics of Machines

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Explain with neat sketch the mechanism required to convert rotary motion to reciprocating motion [which should have only one turning pair] **(08 Marks)**

b. State and explain the suitable mechanism which can be used in Forming machines/sheet metal punching. **(08 Marks)**

OR

2 a. Some of the 4 bar linkages are shown in Fig Q2(a) where the number indicate the respective link in Lengths in 'cm'. Identify the nature of each mechanism whether

(i) double crank

(ii) crank rocker

(iii) Double Rocker. Give Reason in brief **(12 Marks)**

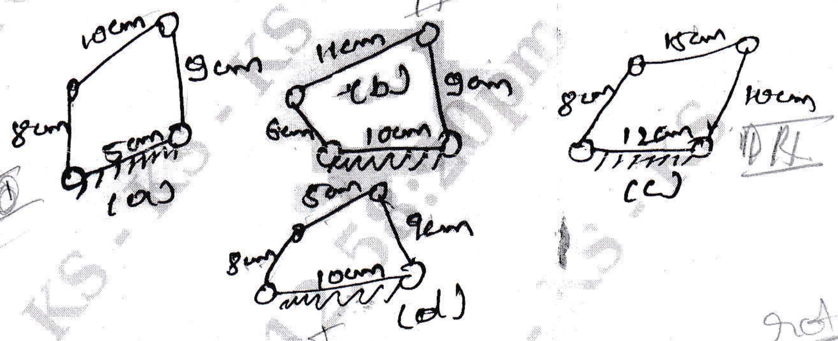


Fig Q2(a)

b. Differentiate between

i) Machine and mechanism

ii) Binary joints and binary links **(04 Marks)**

Module-2

3 In the mechanism shown in Fig Q3 crank 2 rotates out 300 rpm. Find the acceleration of point C in magnitude, direction and sense. Find also the angular acceleration of link 3.

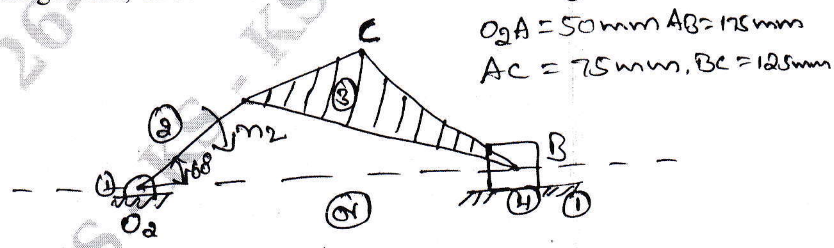


Fig Q3 **(16 Marks)**

OR

4 A pin jointed 4 bar mechanism ABCD show Fig Q4. Link AB = 150mm, BC = 180mm, CD = 180mm and fixed link AD = 300mm. Link AB makes 60° with link AD, and rotates uniformly at 100 rpm. Locate all the instantaneous centres and find the angular velocity of link BC and linear velocity of link CD.

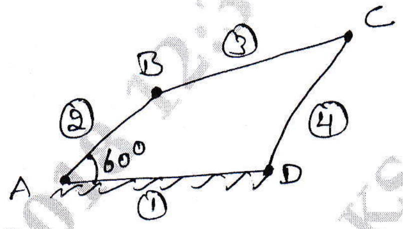


Fig Q4 **(16 Marks)**

Module-3

5 Develop an equation for the relationship between the Angular velocities of the input crank and output crank of 4 bar linkage shown in Fig Q5. Using loop closure equation.

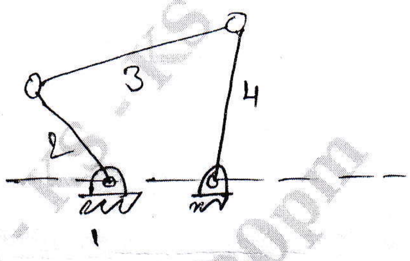


Fig Q5 **(16 Marks)**

OR

6 Design a four bar mechanism when the motions of the input and output links are governed by a function $y = 2x^2$ and x various 2 to 4 with an interval of 1. Assume θ to vary from 40° to 120° and ϕ from 60° to 132°. **(16 Marks)**

Module-4

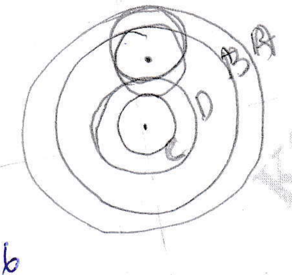
7 a. A pair of gears 40 and 30 teeth respectively are of 25°involute form. Addendum = 5mm, Module = 2.5mm. If the smaller wheel is the driver and rotate at 1500rpm, find the velocity of sliding at the point of engagement, out pitch point and the point of disengagement, length of path of contact and length of Arc of contact. **(10 Marks)**

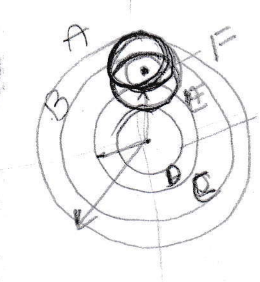
b. Explain minimum of teeth an a Gear to avoid interference and minimum number of teeth on a pinion to avoid interference. **(06 Marks)**

OR

8 In an epicyclic gear train, the internal wheels A, B and compound wheel C and D rotate independently about the axis 'O'. The wheels E and F rotate on a pin fixed to the Arm G. E gears with A and C, and F gears with B and D. All the wheels have same pitch and the number of teeth on E and F are 18, C = 28, D = 26

i) Sketch the arrangement
ii) Find the number of teeth on A and B
iii) If the Arm G makes 15rpm CW and A is fixed, find speed of B
iv) If the Arm G makes 150rpm CW and wheel A makes 15rpm CCW, find speed of B. **(16 Marks)**





28

$T_E = 18$

$F_F = 18$

$T_D = 26$

$T_C = 28$

$T_A = T_C + 2T_F$

76

Module-5

9 A cam rotating clockwise at uniform, speed of 300 rpm operates a reciprocating follower through a roller 1.5cm diameter. The follower motion is defined as below

i) Outward during 150° with U.AR.M
ii) Dwell for next 30°
iii) Return during next 120° with SHM
iv) Dwell for the remaining period

Stroke of the follower is 3 cm. Minimum radius of the cam is 3 cm. Draw the cam profile, Follower axis passes through the cam axis. **(16 Marks)**

OR

10 A symmetrical tangent cam operating a roller follower has the following particulars Radius of base circle of cam = 40mm, Roller radius = 20mm, Angle of ascent = 75°, total lift = 20mm, N = 300rpm. Determine :

a. Principle Dimensions of the cam
b. The equation of the displacement curve when follower is in contact with straight flank.
c. Acceleration of the follower, when it is in contact with the straight flank where it merges into circular nose. **(16 Marks)**

* * * * *

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USN

Fourth Semester B.E. Degree Examination, Dec.2013/Jan.2014

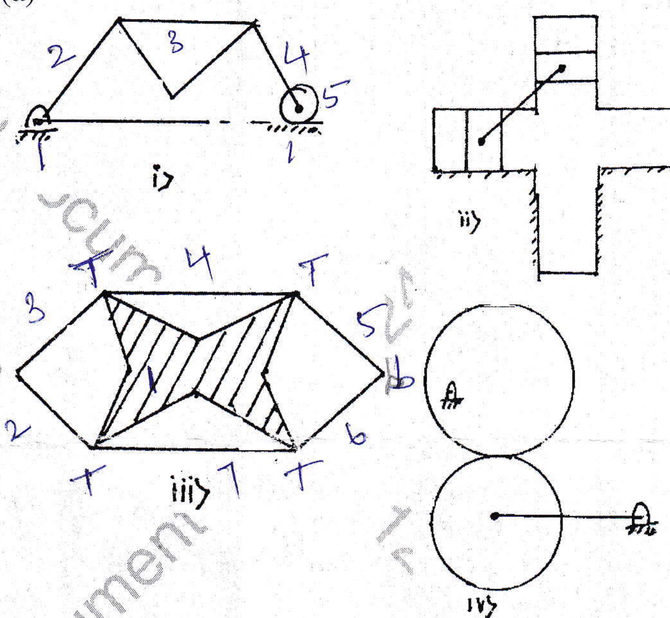
Kinematics of Machines

Time: 3 hrs. Max. Marks:100

Note:1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Graphical solution may be obtained either on graph or on answer sheet.***

PART – A

1 a. Define degrees of freedom. Find the degrees of freedom for the following mechanism as shown in Fig.Q1 (a) **(10 Marks)**



b. Define the following terms with examples:
i) Kinematic pair ii) Mechanism iii) Structure iv) Inversion **(10 Marks)**

2 a. Describe with neat sketch two inversion of double slider-crank chain mechanism. **(10 Marks)**

b. Derive an expression for necessary condition of correct steering and explain Ackermann steering gear with neat sketch. **(10 Marks)**

3 A four bar mechanism shown in Fig. Q3 crank BC rotates with an angular velocity of 100 rad/sec and an angular acceleration of 4400 rad/sec^2 at the instant when the crank makes an angle 53° to the horizontal. Draw the acceleration polygon and determine the linear acceleration of points E and the angular acceleration of link 3. **(20 Marks)**

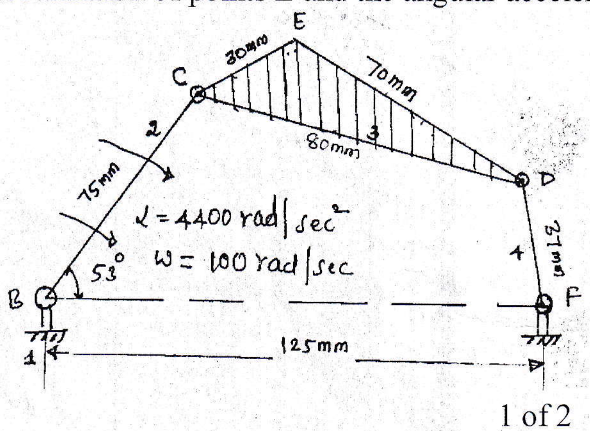


Fig. Q3

4 a. Write a note on Kennedy's theorem. **(05 Marks)**

b. List the properties of instantaneous centre of rotation. **(05 Marks)**

c. In a slider crank mechanism shown in Fig. Q4 (c) the crank OA = 300 mm and connecting rod AB = 1200 mm the crank OA is turned 30° from inner dead centre. Locate all the instantaneous centres. If the crank rotates at 15 rad/sec clockwise, find i) velocity of slider B and ii) Angular velocity of connecting rod AB. **(10 Marks)**

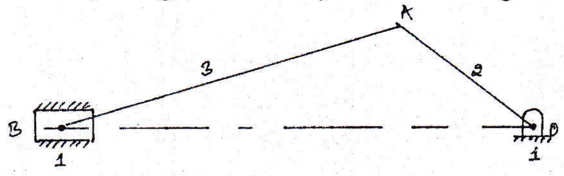


Fig. Q4 (c)

PART – B

5 a. Derive an expression for displacement analysis of a 4 bar mechanism using complex algebra method. **(10 Marks)**

b. For a single slider mechanism, of Fig. Q5 (b) determine the velocity and acceleration of piston, angular acceleration of connecting rod. Take crank length = 50 mm, connecting rod = 200 mm, Crank speed = 300 rpm (constant), Crank angle 30°. **(10 Marks)**

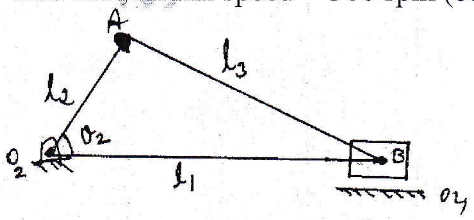


Fig. Q5 (b)

6 a. Derive an equation to determine length of arc of contact for mating of 2 spur gear. **(08 Marks)**

b. Two gear wheel mesh externally and are to give a velocity ratio of 3. The teeth are of involute form of module 6 mm and standard addendum one module. Pressure angle = 18°. Pinion rotates at 90 rpm. Find

i) Number of teeth on each wheel so that interference is just avoided.
ii) Length of path of contact.
iii) Maximum velocity of sliding between teeth.
iv) Number of pairs of teeth in contact. **(12 Marks)**

7 a. Explain with neat sketch classification of gear trains. **(06 Marks)**

b. In an epicyclic gear train, the internal wheels A, B and the compound wheel C and D rotate independently about the axis 'O'. The wheel E and F rotate on a pin fixed to the arm G. E gear with A and C, and F gears with B and D. All the wheels have same pitch and the number of teeth on E and F are 18, C and D are 28, 26 respectively.

i) Sketch the arrangement.
ii) Number of teeth on A and B.
iii) If arm (G) makes 200 rpm clockwise and gear A is fixed, find speed of gear B
iv) If arm (G) makes 100 rpm clockwise and gear A make 50 rpm CCW, find the speed of gear B. **(14 Marks)**

8 A cam rotating at uniform speed of 300 rpm operates a reciprocating follower through a roller 1.5 cm diameter. The follower motion is defined as below:

i) Outward during 150° with UARM.
ii) Dwell for next 30°
iii) Return during next 120° with SHM.
iv) Remaining dwell period.

Stroke of the follower is 3 cm. Minimum radius of cam is 3 cm. Draw the cam profile when the follower axis is offset to the left by 1 cm and determine maximum velocity and maximum acceleration during outstroke. **(20 Marks)**

* * * * *

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K. S. INSTITUTE OF TECHNOLOGY

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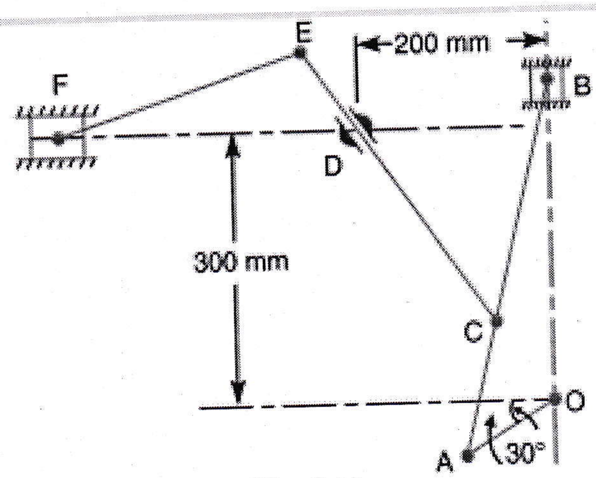
DEPARTMENT OF MECHANICALENGINEERING

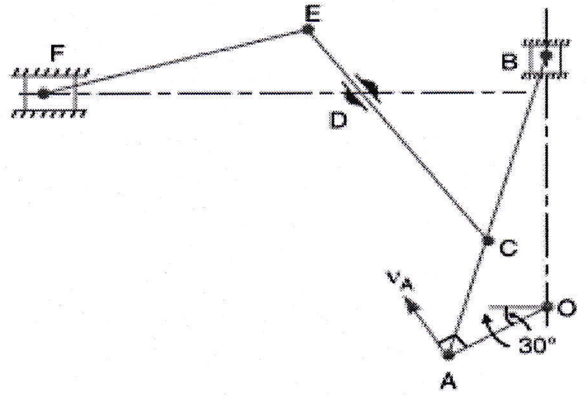
14.Unit Wise challenging questions for toppers with reference

1. In a mechanism shown in Fig. 7.13, the crank OA is 100 mm long and rotates clockwise about O at 120 r.p.m. The connecting rod AB is 400 mm long.At a point C on AB, 150 mm from A, the rod CE 350 mm long is attached. This rod CE slides in a slot in a trunnion at D. The end E is connected by a link EF, 300 mm long to the horizontally moving slider F. For the mechanism in the position shown,
   find 1. velocity of F, 2. velocity of sliding of CE in the trunnion, and 3. angular velocity of CE.

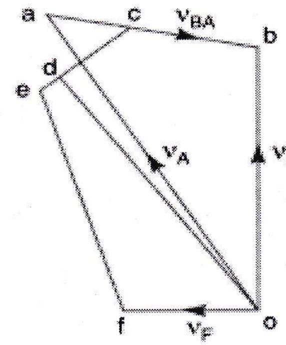


Solution: Given :v_{AO} = 120 r.p.m. or $\omega_{AO} = 2\pi \times 120/60 = 4\pi$ rad/s Since the length of crank OA = 100 mm = 0.1 m, therefore velocity of A with respect to O or velocity of A (because O is a fixed point), $v_{AO} = v_A = \omega_{AO} \times OA = 4\pi \times 0.1 = 1.26$ m/s . . . (Perpendicular to AO)

1. Velocity of F: First of all draw the space diagram, to some suitable scale, as shown in Fig. 7.14 (a). Now the velocity diagram, as shown in Fig. 7.14 (b), is drawn as discussed below :



(a) Space diagram.



(b) Velocity diagram.

1. Draw vector oa perpendicular to AO, to some suitable scale, to represent the velocity of A with respect to O or simply velocity of A (i.e. v_{AO} or v_A), such that vector oa = v_{AO}= v_A = 1.26 m/s 2.

2. From point a, draw vector ab perpendicular to A B to represent the velocity of B with respect to A i.e. v_{BA}, and from point o draw vector ob parallel to the motion of B (which moves along BO only) to represent the velocity of B i.e. vB . The vectors ab and ob intersect at b.

3. Since the point C lies on A B, therefore divide vector ab at c in the same ratio as C divides A B in the space diagram. In other words, ac/ab = AC/AB

4. From point c, draw vector cd perpendicular to CD to represent the velocity of D with respect to C i.e. v_{DC}, and from point o draw vector od parallel to the motion of CD, which moves along CD only, to represent the velocity of D, i.e. vD.

5. Since the point E lies on CD produced, therefore divide vector cd at e in the same ratio as E divides CD in the space diagram. In other words, cd/ce = CD/CE

6. From point e, draw vector ef perpendicular to EF to represent the velocity of F with respect to E i.e. v_{FE}, and from point o draw vector of parallel to the motion of F, which is along FD to represent the velocity of F i.e. v_F.

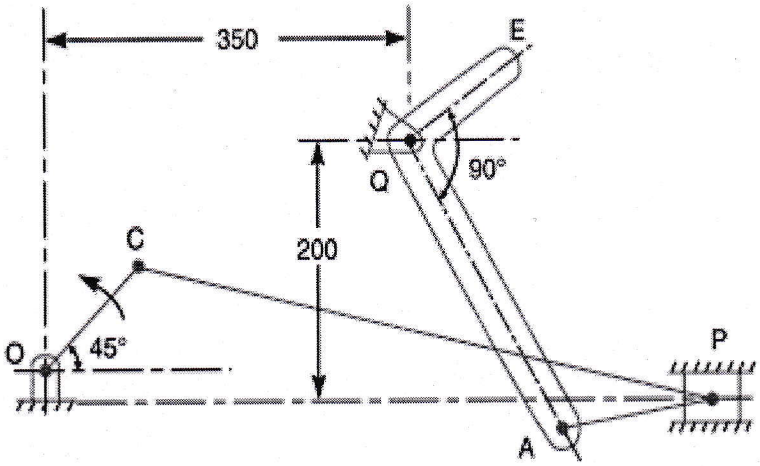
By measurement,

we find that velocity of F, v_F = vector of = 0.53 m/s Ans.

2. Velocity of sliding of CE in the trunnionSince velocity of sliding of CE in the trunnion is the velocity of D, therefore velocity of sliding of CE in the trunnion = vector od = 1.08 m/s Ans.

3. Angular velocity of CE By measurement, we find that linear velocity of C with respect to E, v_{CE} = vector ec = 0.44 m/s Since the length CE = 350 mm = 0.35 m, therefore angular velocity of CE, CE CE 0.44 0.35 v CE ω= = = 1.26 rad/s (Clockwise about E) Ans.

2. CP = 500 mm ; PA = 125 mm ; AQ = 250 mm and QE = 125 mm. Fig. 7.15. All dimensions in mm. The slider P translates along an axis which is 25 mm vertically below point O. The crank OC rotates uniformly at 120 r.p.m. in the anti-clockwise 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.



Solution. Given :

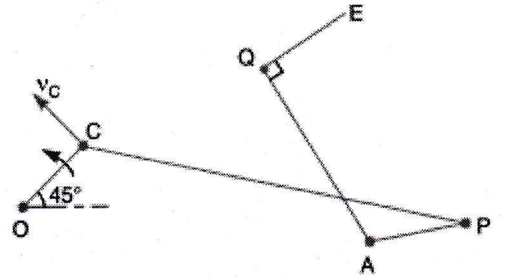
N_{CO} = 120 r.p.m. or $\omega_{CO} = 2\pi \times 120/60 = 12.57$ rad/s ;

OC = 125 mm = 0.125 m

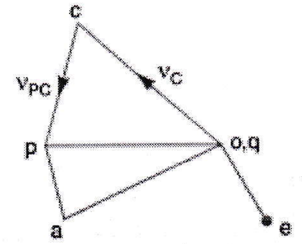
We know that linear velocity of C with respect to O or velocity of C, (because O is as fixed point)

$v_{CO} = v_C = \omega_{CO} \times OC = 12.57 \times 0.125 = 1.57$ m/s First of all, draw the space diagram, as shown in Fig. 7.16 (a), to some suitable scale.

1. Since the points O and Q are fixed, therefore these points are taken as one point in the velocity diagram. From point o, draw vector oc perpendicular to OC, to some suitable scale, to represent the velocity of C with respect to O or velocity of C, such that vector oc = $v_{CO} = v_C$ = 1.57 m/



(a) Space diagram.



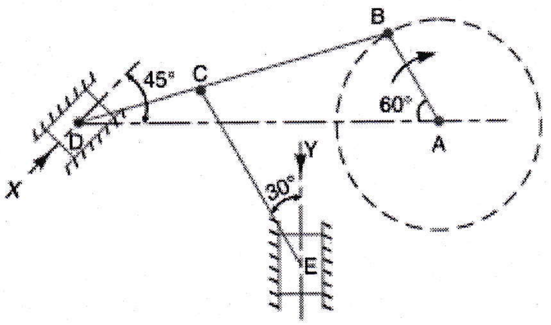
(b) Velocity diagram.

From point c, draw vector cp perpendicular to CP to represent the velocity of P with respect to C (i.e. v_{PC}) and from point o, draw vector op parallel to the path of motion of slider P (which is horizontal) to represent the velocity of P (i.e. v_P). The vectors cp and op intersect at p.

3. From point p, draw vector pa perpendicular to PA to represent the velocity of A with respect to P (i.e. v_{AP}) and from point q, draw vector qa perpendicular to QA to represent the velocity of A (i.e. v_A). The vectors pa and qa intersect at a.

4. Now draw vector qe perpendicular to vector qa in such a way that QE/QA = qe/qaBy measurement, we find that the velocity of point E, v_E = vector oe = 0.7 m/s Ans

3. The dimensions of the mechanism, as shown in Fig. are as follows : AB = 0.45 m; BD = 1.5 m : BC = CE = 0.9 m.



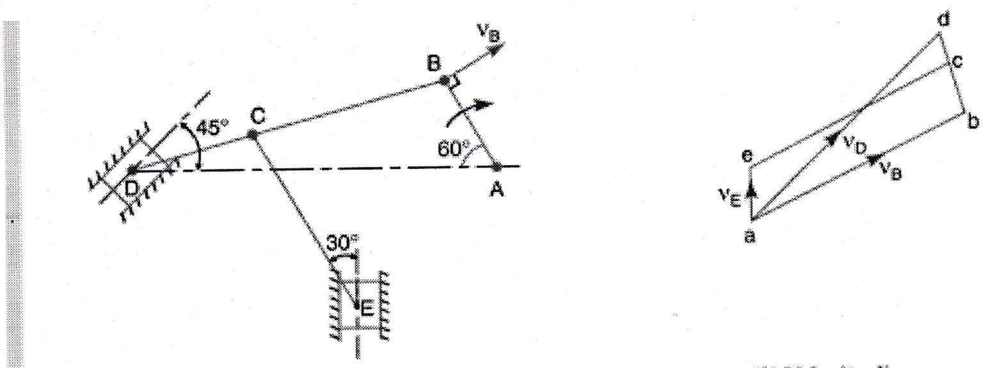
The crank A B turns uniformly at 180 r.p.m. in the clockwise direction and the blocks at D and E are working in frictionless guides. Draw the velocity diagram for the mechanism and find the velocities of the sliders D and E in their guides. Also determine the turning moment at A if a force of 500 N acts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

Solution. Given : $N_{BA} = 180$ r.p.m. or $\omega_{BA} = 2\,\pi \times 180/60 = 18.85$ rad/s

Since A B = 0.45 m, therefore velocity of B with respect to A or velocity of B (because A is a fixed point),

$v_{BA} = v_B = \omega_{BA} \times AB = 18.85 \times 0.45 = 8.5$ m/s . . . (Perpendicular to A B)

Velocities of the sliders D and E First of all draw the space diagram, to some suitable scale, as shown in Fig. 7.31 (a). Now the velocity diagram, as shown in Fig. 7.31 (b), is drawn as discussed below :



(*a*) Space diagram. (*b*) Velocity diagram.

1. Draw vector ab perpendicular to A B, to some suitable scale, to represent the velocity of B with respect to A or simply velocity of B (i.e. v_{BA} or v_B), such that vector ab = $v_{BA} = v_B = 8.5$ m/s

2. From point b, draw vector bd perpendicular to BD to represent the velocity of D with respect to B (i.e. v_{DB}) and from point a draw vector ad parallel to the motion of D to represent the velocity of D (v_D). The vectors bd and ad intersect at d.

3. Since the point C lies on BD, therefore divide vector bd at c in the same ratio as C divides BD in the space diagram. In other words, bc/bd = BC/BD

4. Now from point c, draw vector ce perpendicular to CE to represent the velocity of E with respect to C (i.e. vEC) and from point a draw vector ae parallel to the path of E to represent the velocity of E (i.e. vE). The vectors ce and ae intersect at e.

By measurement,

we find that Velocity of slider D, v_D = vector ad = 9.5 m/s Ans.

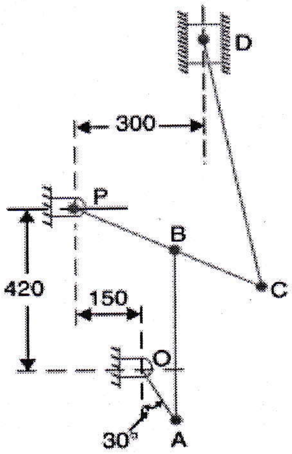
Velocity of slider E, v_E = vector ae = 1.7 m/s Ans.

Turning moment at A Let T_A = Turning moment at A (or at the crank-shaft).

We know that force at D, FD = 500 N . . . (Given) and Force at E, FE = 750 N . . . (Given) ∴ Power input = FD $\times v_D$ − FE $\times v_E$ . . . (– ve sign indicates that FE opposes the motion) = 500 × 9.5 – 750 × 1.7 = 3475 N-m/s

Power output = TA.ω_{BA} = T_A × 18.85 TA N-m/s Neglecting losses, power input is equal to power output. ∴ 3475 = 18.85 T_A or T_A = 184.3 N-m Ans.

4. Find out the acceleration of the slider D and the angular acceleration of link CD for the engine mechanism shown in Fig. 8.14. The crank OA rotates uniformly at 180 r.p.m. in clockwise direction. The various lengths are: OA = 150 mm ; AB = 450 mm; PB = 240 mm ; BC = 210 mm ; CD = 660 mm.



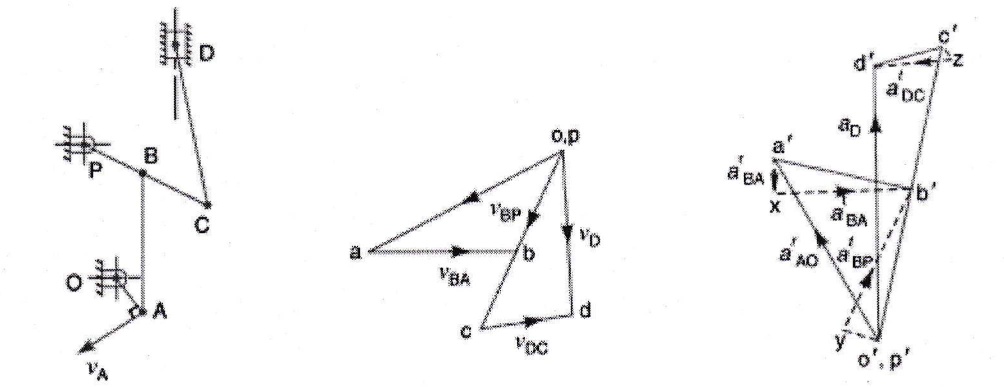
All dimensions in mm.

Solution. Given: N_{AO} = 180 r.p.m., or $\omega_{AO} = 2\pi \times 180/60$ = 18.85 rad/s ; OA = 150 mm = 0.15 m ; A B = 450 mm = 0.45 m ; PB = 240 mm = 0.24 m ; CD = 660 mm = 0.66 m

We know that velocity of A with respect to O or velocity of A,

$v_{AO} = v_A = \omega_{AO} \times OA = 18.85 \times 0.15 = 2.83$ m/s ...(Perpendicular to OA)

First of all draw the space diagram, to some suitable scale, as shown in Fig. 8.15 (a). Now the velocity diagram, as shown in Fig. 8.15 (b), is drawn as discussed below:



(a) Space diagram. (b) Velocity diagram. (c) Acceleration diagram.

1. Since O and P are fixed points, therefore these points lie at one place in the velocity diagram. Draw vector oa perpendicular to OA, to some suitable scale, to represent the velocity of A with respect to O or velocity of A (i.e. v_{AO} or v_A), such that vector oa = $v_{AO} = v_A = 2.83$ m/s

2. Since the point B moves with respect to A and also with respect to P, therefore draw vector ab perpendicular to A B to represent the velocity of B with respect to A i.e. v_{BA} ,and from point p draw vector pb perpendicular to PB to represent the velocity of B with respect to P or velocity of B (i.e. vBP or vB). The vectors ab and pb intersect at b.

3. Since the point C lies on PB produced, therefore divide vector pb at c in the same ratio as C divides PB in the space diagram. In other words, pb/pc = PB/PC

4. From point c, draw vector cd perpendicular to CD to represent the velocity of D with respect to C and from point o draw vector od parallel to the path of motion of the slider D (which is vertical), to represent the velocity of D, i.e. vD.

By measurement, we find that velocity of the slider D, v_D = vector od = 2.36 m/s Velocity of D with respect to C, v_{DC} = vector cd = 1.2 m/s

Velocity of B with respect to A,

v_{BA} = vector ab = 1.8 m/s

and velocity of B with respect to P, v_{BP} = vector pb = 1.5 m/s

Acceleration of the slider D

We know that radial component of the acceleration of A with respect to O or acceleration of A,

$$a^r_{AO} = a_A = \omega^2_{AO} \times AO = (18.85)^2 \times 0.15 = 53.3 \text{ m/s}^2$$

Radial component of the acceleration of B with respect to A,

$$a^r_{BA} = \frac{v^2_{BA}}{AB} = \frac{(1.8)^2}{0.45} = 7.2 \text{ m/s}^2$$

Radial component of the acceleration of B with respect to P,

$$a^r_{BP} = \frac{v^2_{BP}}{PB} = \frac{(1.5)^2}{0.24} = 9.4 \text{ m/s}^2$$

Radial component of the acceleration of D with respect to C,

$$a^r_{DC} = \frac{v^2_{DC}}{CD} = \frac{(1.2)^2}{0.66} = 2.2 \text{ m/s}^2$$

Now the acceleration diagram, as shown in Fig. 8.15 (c), is drawn as discussed below:

1. Since O and P are fixed points, therefore these points lie at one place in the acceleration diagram. Draw vector o' a' parallel to OA, to some suitable scale, to represent the radial component of the acceleration of A with respect to O or the acceleration of A (i.e. AO r a or aA),

2. From point a', draw vector a' x parallel to A B to represent the radial component of the acceleration of B with respect to A (i.e. BA r a), such that 2 vector 7.2 m/s

3. From point x, draw vector xb' perpendicular to the vector a'x or AB to represent the tangential component of the acceleration of B with respect to A i.e. BA ta whose magnitude is yet unknown.

4. Now from point p', draw vector p' y parallel to PB to represent the radial component of the acceleration of B with respect to P (i.e. BP r a), such that 2 vector 9.4 m/s

5. From point y, draw vector yb' perpendicular to vector b'y or PB to represent the tangential component of the acceleration of B, i.e. BP ta .

The vectors xb' and yb' intersect at b'. Join p' b'. The vector p' b' represents the acceleration of B, i.e. aB

6. Since the point C lies on PB produced, therefore divide vector $p'b'$ at c' in the same ratio as C divides PB in the space diagram. In other words, $p'b'/p'c' = PB/PC$

7. From point c', draw vector $c'z$ parallel to CD to represent the radial component of the acceleration of D with respect to C *i.e.* a^r_{DC}, such that

$$\text{vector } c'z = a^r_{DC} = 2.2 \text{ m/s}^2$$

8. From point z, draw vector zd' perpendicular to vector $c'z$ or CD to represent the tangential component of the acceleration of D with respect to C *i.e.* a^t_{DC}, whose magnitude is yet unknown.

9. From point o', draw vector $o'd'$ parallel to the path of motion of D (which is vertical) to represent the acceleration of D, *i.e.* a_D. The vectors zd' and $o'd'$ intersect at d'. Join $c'd'$.

By measurement, we find that acceleration of D,

$$a_D = \text{vector } o'd' = 69.6 \text{ m/s}^2 \textbf{ Ans.}$$

Angular acceleration of CD

From acceleration diagram, we find that tangential component of the acceleration of D with respect to C,

$$a^t_{DC} = \text{vector } zd' = 17.4 \text{ m/s}^2 \quad \text{...(By measurement)}$$

We know that angular acceleration of CD,

$$\alpha_{CD} = \frac{a^t_{DC}}{CD} = \frac{17.4}{0.66} = 26.3 \text{ rad/s}^2 \text{ (Anticlockwise) } \textbf{Ans.}$$

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K S INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

YEAR / SEMESTER		II / IV
COURSE TITLE		KINEMATICS OF MACHINERY
COURSE CODE		17ME42
ACADEMIC YEAR		2018-19 EVEN Sem

Significance	For Direct attainment , 50% of CIE and 50% of
60% and above students should have scored >= 60% of Total marks	For indirect attainment, Course end survey is considered.
55% to 59% of students should have scored >= 60% of Total marks	CO attainment is 90%of direct attainment + 10% of Indirect atttainment.
50% to 54% of students should have scored >= 60% of Total marks	PO attainment = CO-PO mapping strength/3 * CO attainment .

Student Details			IA-1			ASSIGNMENT 1			IA-2			ASSIGNMENT 2			IA-3			ASSIGNMENT 3			MARKS	
Sl No	USN	Student Name	IA-1	CO1	CO2	A1	CO1	CO2	IA-2	CO2	CO3	A2	CO2	CO3	IA-3	CO4	CO5	A3	CO4	CO5	IA	SEE
			30	20	10	15	10	5	30	10	20	15	5	10	30	20	10	15	7	8	40	60
1	1KS17ME001	ABBAS RAZIN	10	10		15	10	3	10		10	15	5	10	25	15	10	15	7	8	24	28
2	1KS17ME003	ABHILASH K S	14	12	2	15	10	3	15	5	10	15	5	10	25	20	5	15	7	8	34	33
4	1KS17ME099	ADITHYA R BHAT	13	8	5	15	10	3	17	5	12	15	5	10	17	12	5	15	7	8	34	42
5	1KS17ME006	AKASH K L	22	20	2	15	10	3	23	3	20	15	5	10	23	13	10	15	7	8	33	35
6	1KS17ME007	ANANDU K SANIL	8	8		15	10	3	11		11	15	5	10	25	15	10	15	7	8	25	21
7	1KS17ME008	BHARADHWAJ K	10	10		15	10	3	19	2	17	15	5	10	19	14	5	15	7	8	26	32
8	1KS17ME009	ANIRUDH M V	6	5	1	15	10	3	17		17	15	5	10	20	10	10	15	7	8	27	27
9	1KS17ME011	ARJUN PRASAD	9	4	5	15	10	3	16	5	11	15	5	10	22	17	5	15	7	8	26	15
10	1KS17ME012	ASHUTOSH VILAS JAIN	10	10		15	10	3	17	2	15	15	5	10	15	10	5	15	7	8	32	27
11	1KS17ME013	ASIF K	7	7		15	10	3	17	2	15	15	5	10	25	20	5	15	7	8	34	35
12	1KS17ME014	BHARATH KUMAR G	20	15	5	15	10	3	27	7	20	15	5	10	30	20	10	15	7	8	38	30
13	1KS17ME016	CHETHAN N	28	20	8	15	10	3	25	5	20	15	5	10	30	20	10	15	7	8	40	27
14	1KS17ME017	CHIRANJEEVI U	13	10	3	15	10	3	15		15	15	5	10	20	10	10	15	7	8	26	8
15	1KS17ME018	DARSHAN B S	9	8	1	15	10	3	17		17	15	5	10	25	20	5	15	7	8	29	32
16	1KS17ME019	DARSHAN GOWDA S	30	20	10	15	10	3	30	10	20	15	5	10	30	20	10	15	7	8	40	46

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Student Details			IA-1			ASSIGNMENT 1			IA-2			ASSIGNMENT 2			IA-3			ASSIGNMENT 3			MARKS	
Sl No	USN	Student Name	IA-1	CO1	CO2	A1	CO1	CO2	IA-2	CO2	CO3	A2	CO2	CO3	IA-3	CO4	CO5	A3	CO4	CO5	IA	SEE
			30	20	10	15	10	5	30	10	20	15	5	10	30	20	10	15	7	8	40	60
17	1KS17ME020	DARSHAN V	8	5	3	15	10	3	9		9	15	5	10	10	5	5	15	7	8	19	30
18	1KS17ME021	DHEERAJ PASUPULETI	12	12		15	10	3	15		15	15	5	10	17	17	-	15	7	8	31	28
19	1KS17ME022	DILEEP S K	21	15	6	15	10	3	21	3	18	15	5	10	30	20	10	15	7	8	34	27
20	1KS17ME023	ESHWAR A N	12	12		15	10	3	16		16	15	5	10	17	17		15	7	8	25	28
21	1KS17ME024	GANAPATI MANJUNATH HEGDE	16	11	5	15	10	3	30	10	20	15	5	10	30	20	10	15	7	8	36	24
22	1KS17ME025	GANESHKUMAR NARAYAN HEGDE	18	13	5	15	10	3	30	10	20	15	5	10	30	20	10	15	7	8	36	41
23	1KS17ME026	GIRIDHAR M P	2	2		15	10	3	12	4	8	15	5	10	15	15	-	15	7	8	20	8
24	1KS16ME018	HARIPRASAD	AB			15	10	3	15	10	5	15	5	10	30	20	10	15	7	8	30	21
25	1KS17ME028	IMPAL D RAJ	8	6	2	15	10	3	18	3	15	15	5	10	19	12	7	15	7	8	27	27
26	1KS17ME030	JEEVANKUMAR M A	11	6	5	15	10	3	10		10	15	5	10	15	5	10	15	7	8	26	22
27	1KS17ME031	JITHU MENON	15	15		15	10	3	21	5	16	15	5	10	25	20	5	15	7	8	34	42
28	1KS17ME032	K AASHISH BHARADWAJ	15	10	5	15	10	3	22	2	20	15	5	10	19	12	7	15	7	8	29	21
29	1KS17ME033	KARTHIK S DALABANJAN	13	13		15	10	3	20		20	15	5	10	30	20	10	15	7	8	31	38
30	1KS17ME034	KIRAN C	10	8	2	15	10	3	20	5	15	15	5	10	20	15	5	15	7	8	34	39
31	1KS17ME035	KIRAN R	15	10	5	15	10	3	15	10	5	15	5	10	30	20	10	15	7	8	30	31
32	1KS17ME036	KONDA ANIL KUMAR REDDY	10	5	5	15	10	3	15	5	10	15	5	10	30	20	10	15	7	8	29	27
33	1KS17ME037	KUNDAN B	AB			15	10	3	2		2	15	5	10	2	2	-	15	7	8	21	32
34	1KS17ME038	KUSHAL RAO R	14	12	2	15	10	3	22	2	20	15	5	10	21	17	4	15	7	8	32	38
35	1KS17ME039	MANOJ H S	18	10	8	15	10	3	22	5	17	15	5	10	30	20	10	15	7	8	34	36
36	1KS17ME040	MANOJ M	23	15	8	15	10	3	17	5	12	15	5	10	20	10	10	15	7	8	30	43
37	1KS17ME041	MOHAMED FAUZAN S	14	8	6	15	10	3	24	7	17	15	5	10	10	10	-	15	7	8	28	32
38	1KS17ME042	MOHSIN SHAIKH	4		4	15	10	3	15		15	15	5	10	15	15	-	15	7	8	28	32
39	1KS17ME043	MOLAKALU PUNITH	AB			15	10	3	25	5	20	15	5	10	30	20	10	15	7	8	39	26
40	1KS17ME044	NAGESH B U	8	8		15	10	3	20	5	15	15	5	10	20	15	5	15	7	8	30	28
41	1KS17ME045	NISCHAL V CHADAGA	7	5	2	15	10	3	13	4	9	15	5	10	15	5	10	15	7	8	22	27
42	1KS17ME046	NITIN L	AB			15	10	3	14	5	9	15	5	10	7	5	2	15	7	8	24	33
43	1KS17ME047	PARIKSHITA M S	13	10	3	15	10	3	4		4	15	5	10	10	-	10	15	7	8	21	32
44	1KS17ME048	PARIKSHITH K KASHYAP	25	18	7	15	10	3	18	2	16	15	5	10	22	17	5	15	7	8	34	21
45	1KS17ME049	PRABHUDEV C M	2	2		15	10	3	9		9	15	5	10	10	5	5	15	7	8	25	23

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Student Details			IA-1			ASSIGNMENT 1			IA-2			ASSIGNMENT 2			IA-3			ASSIGNMENT 3			MARKS	
Sl No	USN	Student Name	IA-1	CO1	CO2	A1	CO1	CO2	IA-2	CO2	CO3	A2	CO2	CO3	IA-3	CO4	CO5	A3	CO4	CO5	IA	SEE
			30	20	10	15	10	5	30	10	20	15	5	10	30	20	10	15	7	8	40	60
46	1KS17ME050	PRAKASH Y	12	12		15	10	3	12	7	5	15	5	10	10	10	-	15	7	8	23	17
47	1KS17ME051	PRAVEEN KUMAR V	30	20	10	15	10	3	25	5	20	15	5	10	25	20	5	15	7	8	38	41
	60% of Maximum marks (X)			12	6		6	3		6	12		3	6		12	6		4.2	4.8		36
	No. of students above X			5	9		46	46		9	31		46	46		34	24		46	46		9
	Total number of students (Y)			41	30		46	46		33	46		46	46		45	40		46	46		46
	CO Percentage			12.20	30		100	100		27.27	67.3913043		100	100		75.56	60.00		100	100		19.5652174
				CO1	CO2		CO1	CO2		CO2	CO3		CO2	CO3		CO4	CO5		CO4	CO5		
	LEVEL			0	0		3	3		0	3		3	3		3	3		3	3		0

CO	CIE	SEE	DIRECT ATTAINMENT		ATTAINMENT	COURSE EXIT SURVEY	INDIRECT ATTAINMENT	TOTAL ATTAINMENT	attainment in %
CO1	56.10	19.57	37.8		0	60.00	3	0.30	40.0482503
CO2	64.32	19.57	41.9		0	60.00	3	0.30	43.7475296
CO3	83.70	19.57	51.6		1	60.00	3	1.20	52.4673913
CO4	87.78	19.57	53.7		1	60.00	3	1.20	54.3043478
CO5	80.00	19.57	49.8		0	60.00	3	0.30	50.8043478
							AVERAGE	0.66	

weightage of Cos	IA1	A1	IA2	A2	IA3	A3
CO1	20	10	-	-	-	-
CO2	10	5	10	5	-	-
CO3	-	-	20	10	-	-
CO4	-	-	-	-	20	7
CO5	-	-	-	-	10	8
TOTAL	30	15	30	15	30	15

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Co-Po Mapping Table														
CO'S	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PSO2
17ME42.1	1	-	-	-	-	-	-	-	-	-	-	-	2	2
17ME42.2	3	1	-	-	-	-	-	-	-	-	-	-	2	2
17ME42.3	3	2	-	-	-	-	-	-	-	-	-	-	2	1
17ME42.4	3	2	-	-	-	-	-	-	-	-	-	-	2	1
17ME42.5	3	2	-	-	-	-	-	-	-	-	-	-	2	1
Total	2.6	1.75	-	-	-	-	-	-	-	-	-	-	2	1.4

PO Attainment

	CO Attainment	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PS02
CO1	**0.30**	0.10	-	-	-	-	-	-	-	-	-	-	-	0.20	0.20
CO2	**0.30**	0.30	0.10	-	-	-	-	-	-	-	-	-	-	0.20	0.20
CO3	**1.20**	1.20	0.80	-	-	-	-	-	-	-	-	-	-	0.80	0.40
CO4	**1.20**	1.20	0.80	-	-	-	-	-	-	-	-	-	-	0.80	0.40
CO5	**0.30**	0.30	0.20	-	-	-	-	-	-	-	-	-	-	0.20	0.10
Average		0.62	0.48	-	-	-	-	-	-	-	-	-	-	0.44	0.26
LEVEL		1.00	1.00	-	-	-	-	-	-	-	-	-	-	1.00	1.00

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