Subject : Theory of Machine	**موضوع : نظرية المكائن**
Weekly Hours : Theoretical: 2	**الساعات الأسبوعية: نظري:2**
Tutorial: 1	**منافشة: 1**
Experimental : 1	**عملي:1**
Units: 5	**الوحدات:5**

week	Contents	المحتويات	الأسبوع
1 + 2	**1-Velocity diagrams** 1.1 introduction 1.2 linear velocity 1.3 Angular velocity 1.4 Velocities of points on a rolling body	مخططات السرعة	1-2
3+4+5	**2-Acceleration diagrams** 2.1 Introduction 2.2 Linear Acceleration 2.3 Angular Acceleration 2.4 Equivalent Linkages 2.5 Carioles Acceleration	مخططات التعجيل	5+4+3
6+7+8	**3-Cams and followers** 3.1 Introduction 3.2 Cam and followers types 3.3 Displacement Diagrams 3.4 Types of motion 3.5 Construction of cam profile	الحدبات والتوابع	8+7+6
9.	**4-Gears** 4.1 Introduction 4.2 Gear Requirements 4.3 Classification of Gears 4.4 Terms and Definitions 4.5 Basic relation ships 4.6 Contact Ratio	التروس	.9
10+11+12	**5 - Gear trains** 5.1 Introduction 5.2 Types of Gear Trains 5.3 Simple Train of Wheels 5.4 Compound Train of wheels 5.5 Reversed Gear Train 5.6 Epicycles Gear Train 5.7 Compound Epicycles Gear Train 5.8 Torques in Epicycle Gear Train	المسلسلات الترسية	11+10 12+
13+14	**6 – Inertia Force in Machines** 6.1 Introduction 6.2 Inertia force and inertia torque		14+13
15+16	**7 - Flywheel** 7.1 Introduction 7.2 Mass of Flywheel	الحذافة	16+15

	7.3 Flywheel for an internal combustion engine		
17+18	**8 - Friction clutches** 8.1 Introduction 8.2 Disc or plate clutches 8.2 Cone clutches 8.3 Centrifugal clutches	القوا بض الاحتكاكية	18+17
19+20	**9 - Friction belts** 9.1 Introduction 9.2 Types of belts 9.3 Determination of flat belt characteristics 9.4 Determination of V- belt characteristics 9.5 Rope Drive	السيور الاحتكاكية	20+19
21+22	**10 - Balancing of rotating masses** 10.1 Introduction 10.2 Single Rotating mass 10.3 Several Rotating masses in single transverse plane 10.4 Several Rotating masses in several transverse planes	موازنة الكتل الدوارة	22+21
23+24	**11 - Balancing of reciprocating masses** 11.1 Introduction 11.2 Balancing of Four – bar Linkage 11.3 Balancing of Sliber – Crank mechanism 11.4 Multi cylinder in line engine	موازنة الكتل الترددية	24+23
25+26+27	**12- Speed governors** 12.1 Introduction 12.2 Types of Governors 12.3 Centrifugal Governors 12.4 Watt Governors 12.5 Porter Governors 12.6 Proell Governors	منظمات السرعة	27+25 26+
29+30+28	**13 - The gyroscope** 13.1 Introduction 13.2 Gyroscopic Couple	الجيروسكوب	29+28 30+

" Theory of Machine "

" Reference "

1- Mechanics of Machines /Textbook
by J. HANNAH & R.C. STEPHENS
ميكانيك الماكنات . جون هنا / الكتاب المنهجي

2- Theory of Machine
by Thomas Beven / الكتب المساعده

3- Theory of Machines
by P.L. BALLANEY / الكتب المساعده

4- Theory of Machines
by Anover / الكتب المساعده

Theory of Machine نظرية الآلات

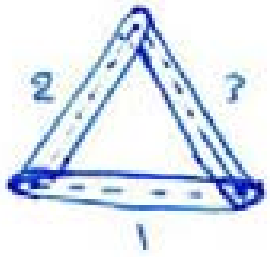
Theory of machine :- Comprises the study of the relative motion between the parts of amachine and the study of forces which act on those parts.

Link : Each part of amachine which has motion relative to some other part and it is consist of several part.

Machine :- An apparatus For appling Mechanical power, consisting of anumber of interrelated parts (links) each having adefinite Function.
[machine ⇒ recives energy and transForms it into useful work.]

structure :- is an assemblage of resistant bodies which are not kinematic links because there is no relative motion between the Links. There is only straining action due to Forces acting on them, for example Roof stussel

* every simple structure having three resistance bodies 1, 2 and 3



Kinematic pair :- A pair is a joint of two links that permits relative motion.

Kinematic chain :- is a combination of kinematic pairs in which each link Forms part of two pairs in which the relative motion is Completely Constrained.

A mechanisum with Four Links ⇒ [simple mechanism]

A mechanisum with more than Four Links ⇒ [compound mechanism]

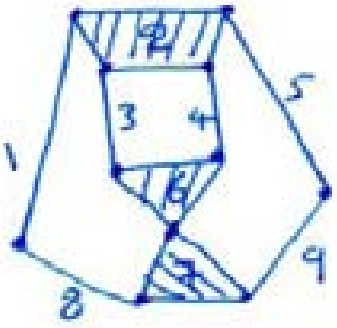
Link

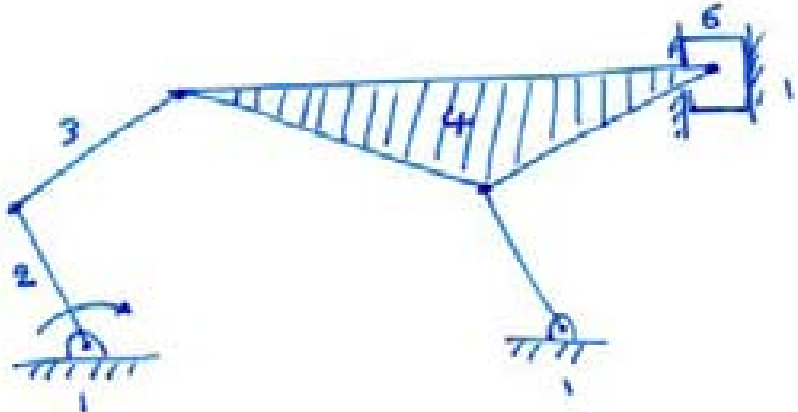
Binary Link

Ternary Link

quaternary Link

example :-





Velocity and acceleration in mechanisms

Velocity in mechanism

1- Relative velocity method

2- instantaneous centre method

Velocity digrams (relative velocity method) :-

Relative velocity of two Babies moving in straight lines :-

① The relative velocity of (A) to (B)

$$V_{AB} = V_A - V_B$$

$$\therefore \boxed{V_B = V_A + V_{AB}}$$

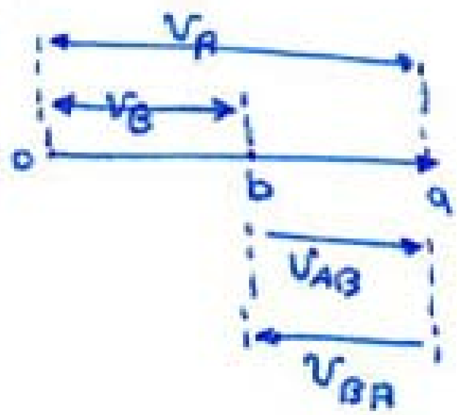
$$\overrightarrow{ba} = \overrightarrow{oa} - \overrightarrow{ob}$$

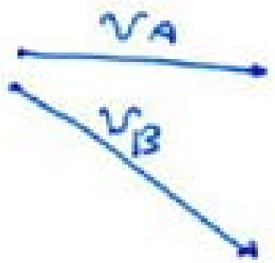
② The relative velocity of (B) with respect to (A

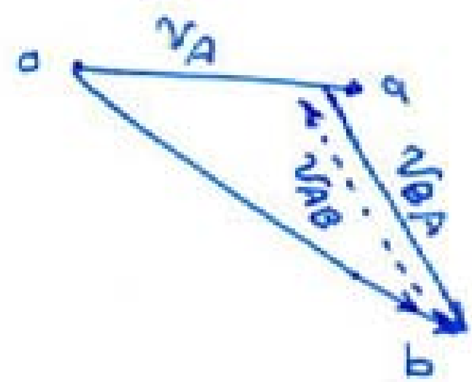
$$V_{BA} = V_B - V_A$$

$$\overrightarrow{ab} = \overrightarrow{ob} - \overrightarrow{oa}$$

$$\boxed{V_A = V_B + V_{BA}}$$







$\therefore$

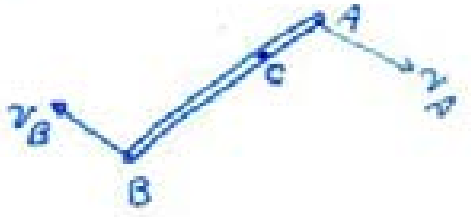
$$v_{AB} = - v_{BA}$$

$$\overrightarrow{ba} = - \overrightarrow{ab}$$

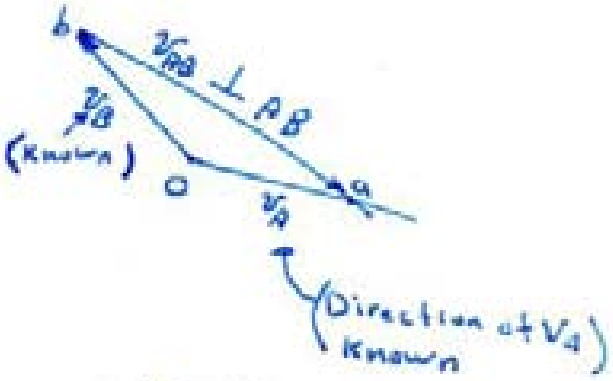
Velocity digram of point on link

Relative velocity method of obtaining velocities is the most useful method. students should use a Compass, protractor and triangles to possess the necessary drawing skills

To explain the method, Considering Link (AB) in Figure below, the velocity of (B) and its direction is Known, and the direction of (A) is Known only. A velocity digram is Constructed as follows:-



1- Locate the origin (o) (lower. case letter), which represents a fixed point. All vectors originating at (o) represent absolute velocities. [Choose asutable sacle For velocity polxgon].



A Vel. digram

2- The Known absolute velocity (V_B) is drawn From (o)

3- The direction of absolute velocity (V_A) is drawn through (o)

4- The relative velocity V_{AB} is drawn From (b) to be ⊥ to the line Connecting and intersect with V_A

given point (a). This established the magnitudes of v_A and v_{AB}.

5- The velocity of any point (C) on BA may be obtained by : $v = r.\omega$

$$\frac{v_{BC}}{v_{BA}} = \frac{BC.\omega}{BA.\omega}$$

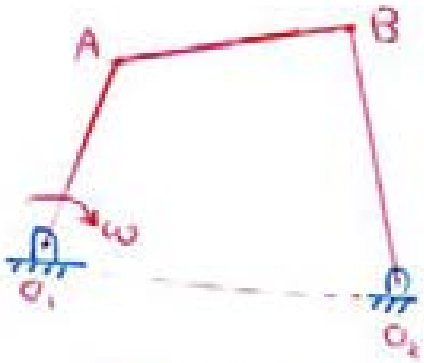
any point on BA have same(ω) (rad/sec)

$$\frac{v_{BC}}{v_{BA}} = \frac{BC}{BA} \Longrightarrow v_{BC} \text{ m/sec}$$

Application

Four-Bar Mechanism :-

1- Drawing space digram of Mechanism with asutabile scale with Higher-Case letter

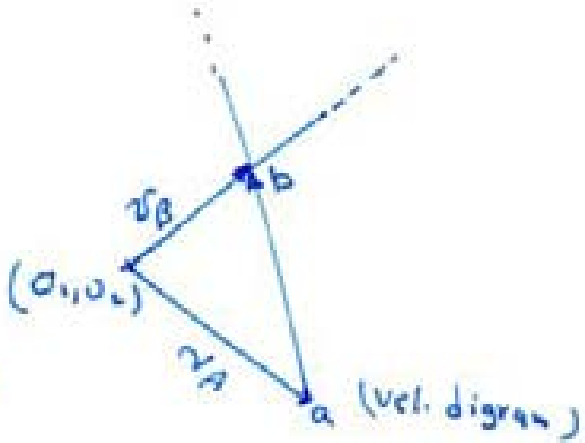


(space digram)

2- Taking asutabile scale to drawing velocity digram (with lower-case letter).

$v_A = O_1A \cdot \omega \Longrightarrow$ scale

3- Taking O_1 and O_2 the origin which represent a fixed point from it absolute velocities are drawn



4- Drawing the known absolute velocity $v_A \perp O_1A$ From (O_1)

note

C.C.W
Counter-clockwise

C.W
Clockwise

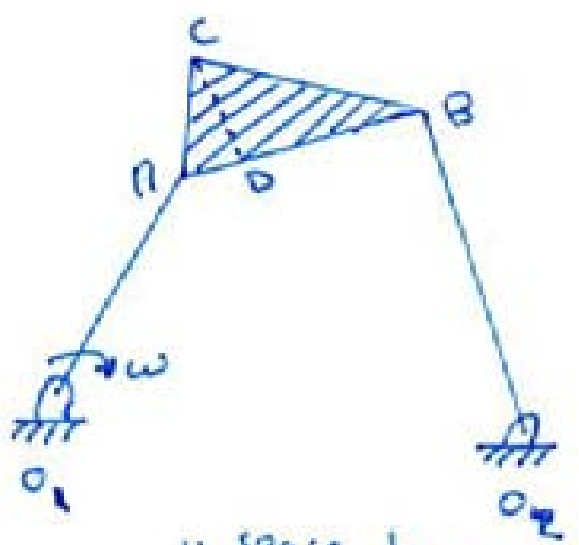
5- The direction of absolute velocity (v_B) drawn through (O_2) $v_B \perp O_2B$

6- The relative velocity v_{AB} is drawn From(A) to be $\perp$ to line (AB) and intersect with v_B given point(b) This estabilised the magnitudes of v_B and v_{AB}

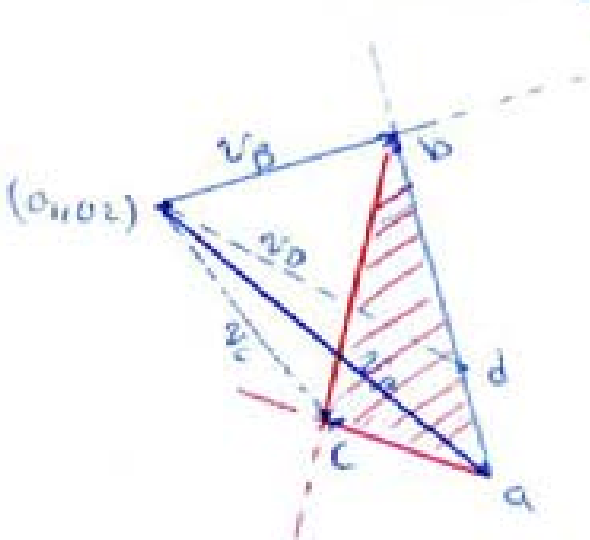
Mechanism with plates

As in Four Bar mechanism
From (1-6) parts take place

7- From point (a) draw line ⊥ AC
From point (b) draw line ⊥ BC
intersection of these two
line give (c)
than ⟹ v_B, v_{AB}, v_c are
given



a space digram



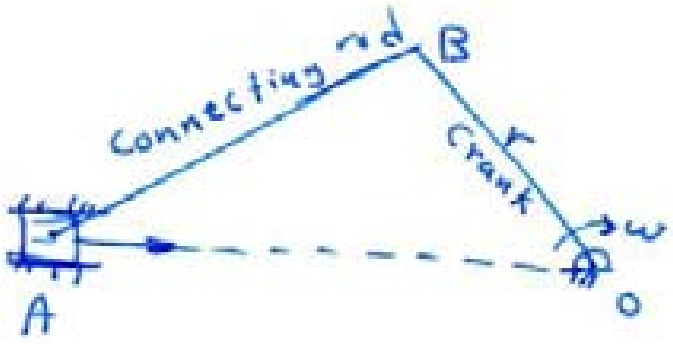
a vel. digram

Slider Crank Mechanism :-

$v_B = \omega r$

1- Space digram

2- Velocity digram

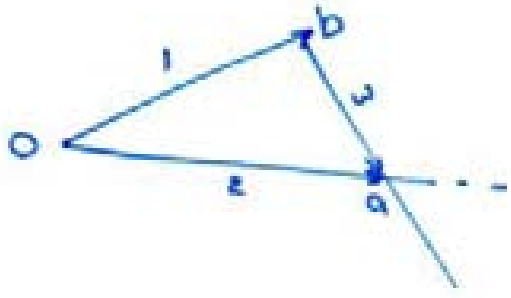


Piston

1- Draw vector $\vec{ob} \perp OB = v_B$ From Fixed point (o) (Known)

2- Draw vector $\vec{oA}$ // Piston (A) with known direction only

3- Draw vector A to B From point (b) $\vec{ab} \perp AB$ with known direction only



4- intersection of these two line give point (a)

than $\Rightarrow$ v_A is given

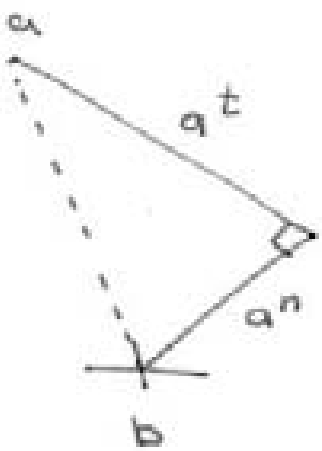
acceleration digrm

1- tangantial component a_t

$a_b^t = r \cdot \alpha$ $\perp r$

2- radial component a_n

$a_b^n = r \cdot \omega^2$ $\parallel r$



* note a^n is drawn First than a^t

$a^t \perp a^n$

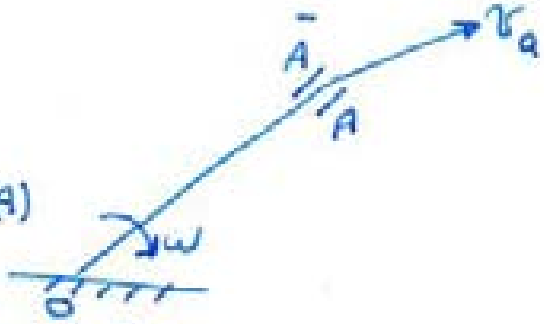
velocity and acceleration of block sliding on a rotating Link

when a point in one body moves along path of second body which rotating then it has velocity and tangential component of acceleratio of point known as (a^c) Coriolis acceleration

$$a^c = 2\omega v \perp r$$

Velocity digram

* IF [$\bar{A}$] is the point on the Link coincident with the block(A)

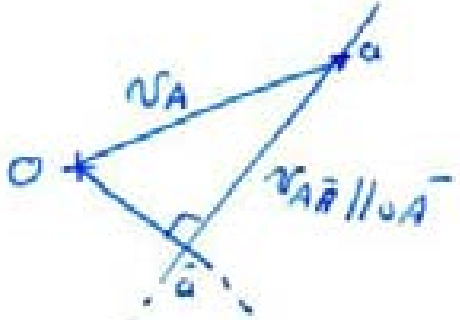


1- The velocity of $\bar{A}$ relative to (o) $\perp o\bar{A}$

2- The velocity of A relative to ($\bar{A}$) // $o\bar{A}$

3- The intersection of them gives point $\bar{a}$

The relative velocity of sliding A to $\bar{A}$ is given by $\vec{\bar{a}a}$



Direction of Coriolis acceleration