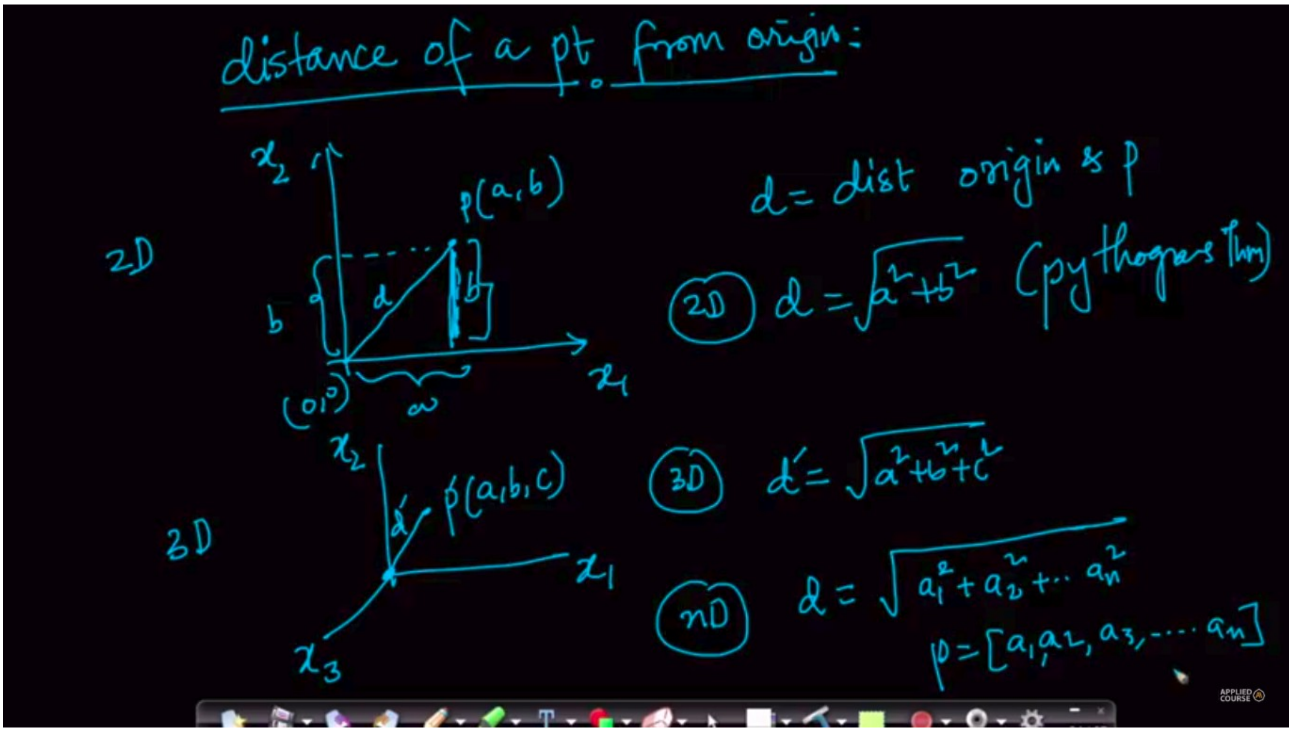
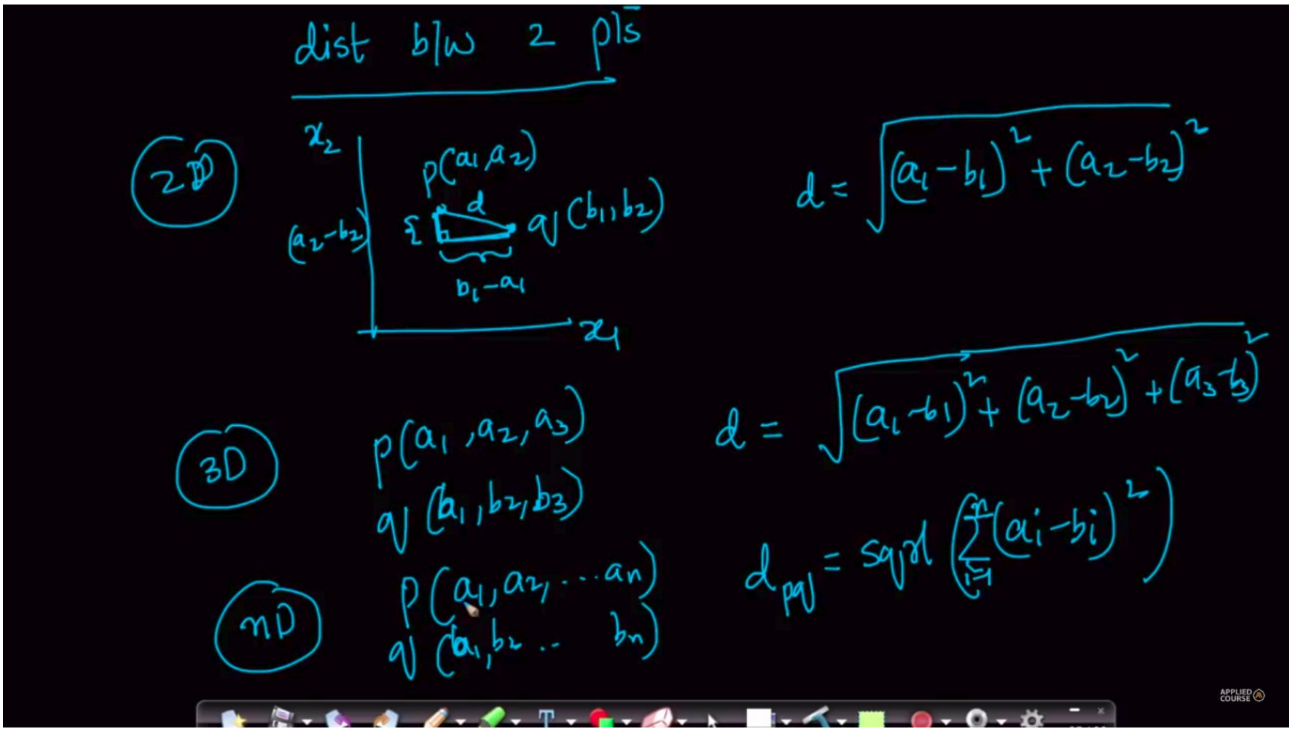

distance of a pt. from origin:
d = dist origin & p
2D
p(a,b)
(0,0)
2D d = √(a²+b²) (pythogoras thm)
3D
p(a,b,c)
3D d′ = √(a²+b²+c²)
nD d = √(a₁²+a₂²+.. aₙ²)
p = [a₁,a₂, a₃,.... aₙ]


dist b/w 2 pts
2D
p(a₁,a₂)
q(b₁,b₂)
(a₂-b₂)
b₁-a₁
d = √((a₁-b₁)² + (a₂-b₂)²)
3D
p(a₁,a₂,a₃)
q(b₁,b₂,b₃)
d = √((a₁-b₁)² + (a₂-b₂)² + (a₃-b₃)²)
nD
p(a₁,a₂,...aₙ)
q(b₁,b₂ .. bₙ)
d_pq = sqrt(Σ (aᵢ-bᵢ)²)

✓ row vector: $A = \begin{array}{c} \begin{matrix} 1 & 2 & 3 & \cdots & n \end{matrix} \\ [a_1, a_2, a_3, \ldots, a_n] \end{array}$ $(1 \times n)$

$\uparrow$ rows, $\uparrow$ columns

✓ column vector

$$b = \begin{array}{c|c} & 1 \\ \begin{matrix} 1 \\ 2 \\ \vdots \\ n \end{matrix} & \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_n \end{bmatrix} \end{array}_{n \times 1}$$

$n \times 1$: $\uparrow$ rows, columns

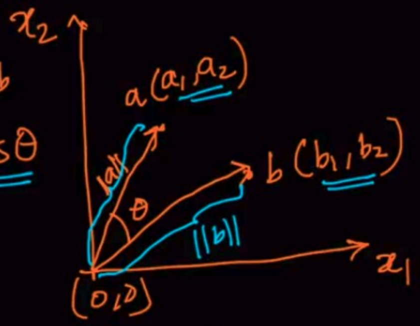
$b_{n\times 1}$ $\quad$ $A_{1\times n}$

$A_{m\times n} \rightarrow$ double array of arrays

$$\begin{array}{c|c} & \begin{matrix} 1 & 2 & 3 & \cdots & n \end{matrix} \\ \begin{matrix} 1 \\ 2 \\ \vdots \end{matrix} & \begin{bmatrix} & & & & \\ & & & & \end{bmatrix} \end{array}$$

Addition:

a : $[a_1]$



$a \cdot b$ len. of b

$= \|a\| \, \|b\| \cos\theta$

$\downarrow$

length of a

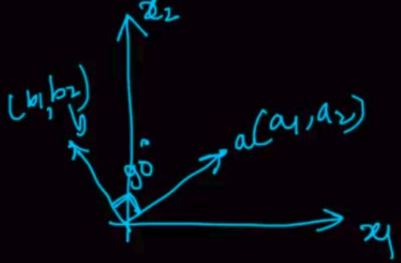
= dist of a from origin

$\|a\|$ = len. of vec.

$\|a\| = \sqrt{a_1^2 + a_2^2}$

$$a \cdot b = a_1 b_1 + a_2 b_2 = \|a\| \, \|b\| \cos\theta$$

$$✓ \ \theta = \cos^{-1}\left\{\frac{a_1 b_1 + a_2 b_2}{\|a\| \, \|b\|}\right\}$$



$$a \cdot b = \|a\| \, \|b\| \underbrace{\cos 90^\circ}_{0}$$

$$a \cdot b = 0$$

nD

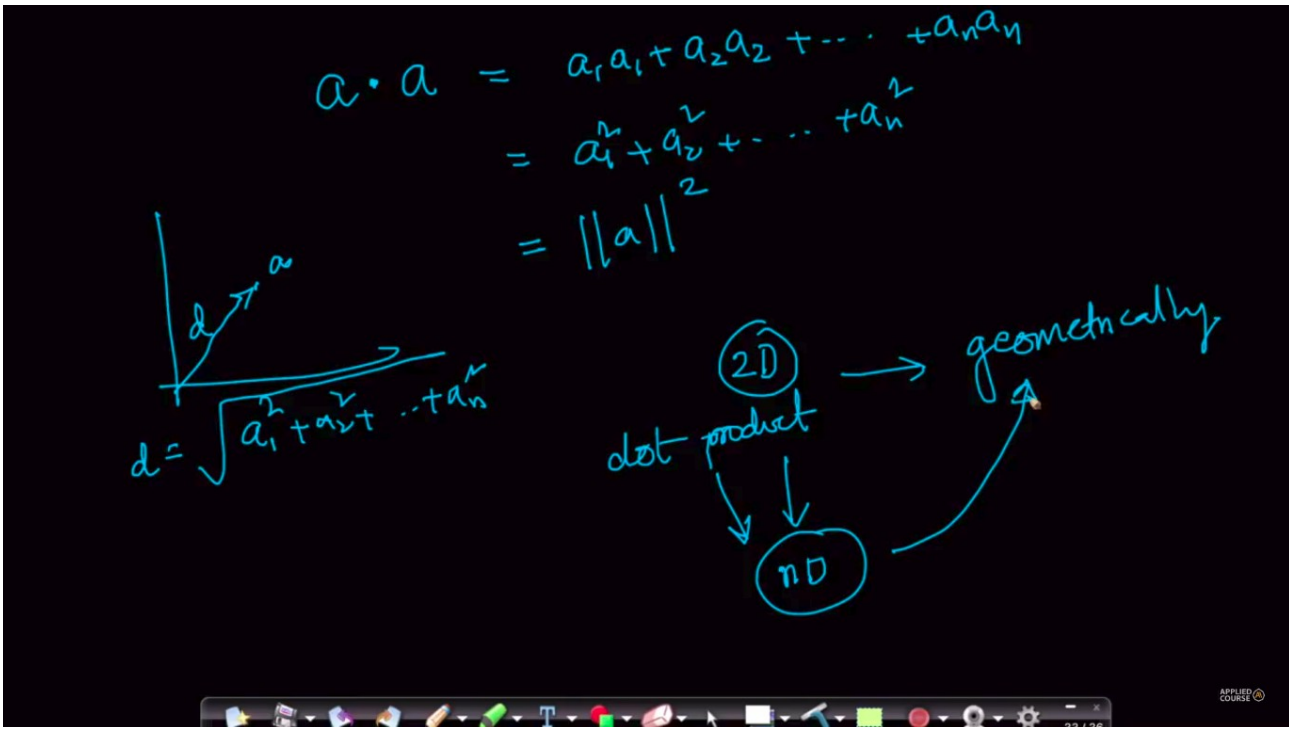
✓ $a = [a_1, a_2, \ldots a_n]$

✓ $b = [b_1, b_2, \ldots b_n]$

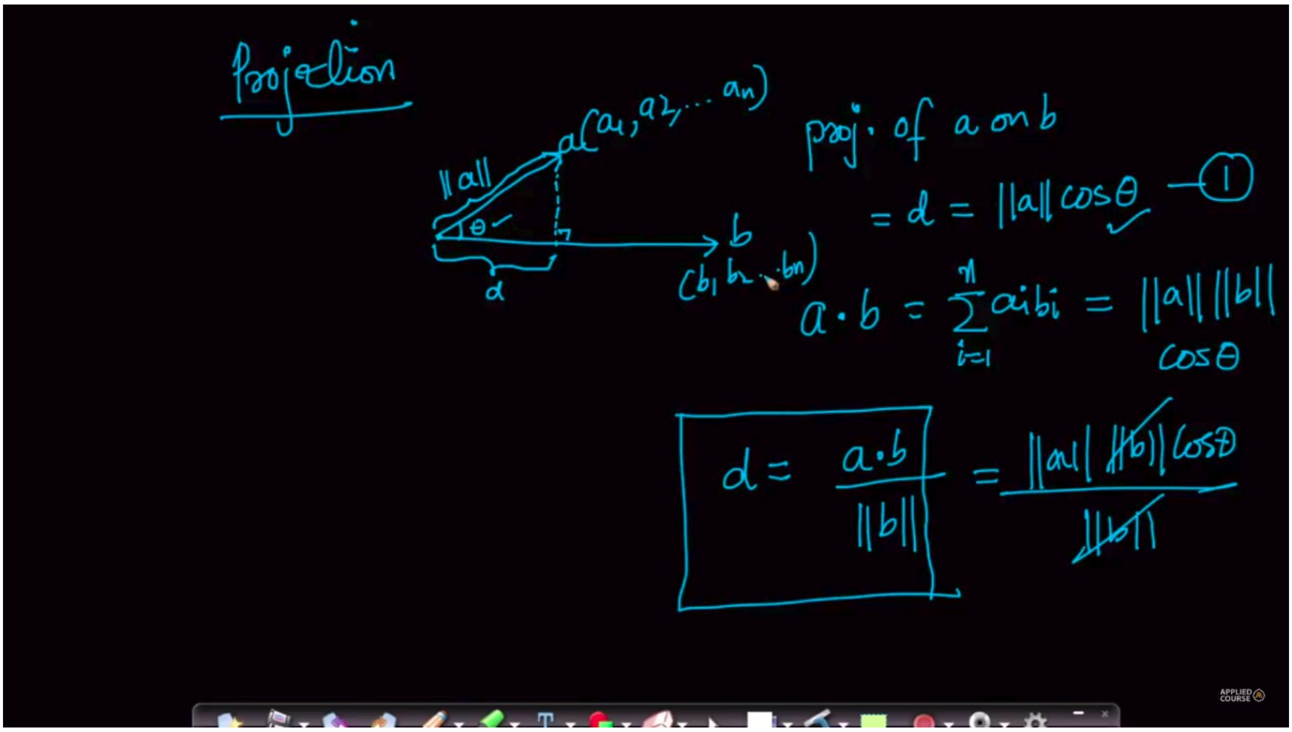
$$a \cdot b = \|a\| \, \|b\| \cos\theta$$

$$\theta_{ab} = \cos^{-1}\left(\frac{\sum_{i=1}^{n} a_i b_i}{\|a\| \, \|b\|}\right)$$

$$a \cdot b = \sum_{i=1}^{n} a_i b_i = 0 \Rightarrow a \perp b$$



Projection and Unit Vector



- Consdering case of n-dimentional

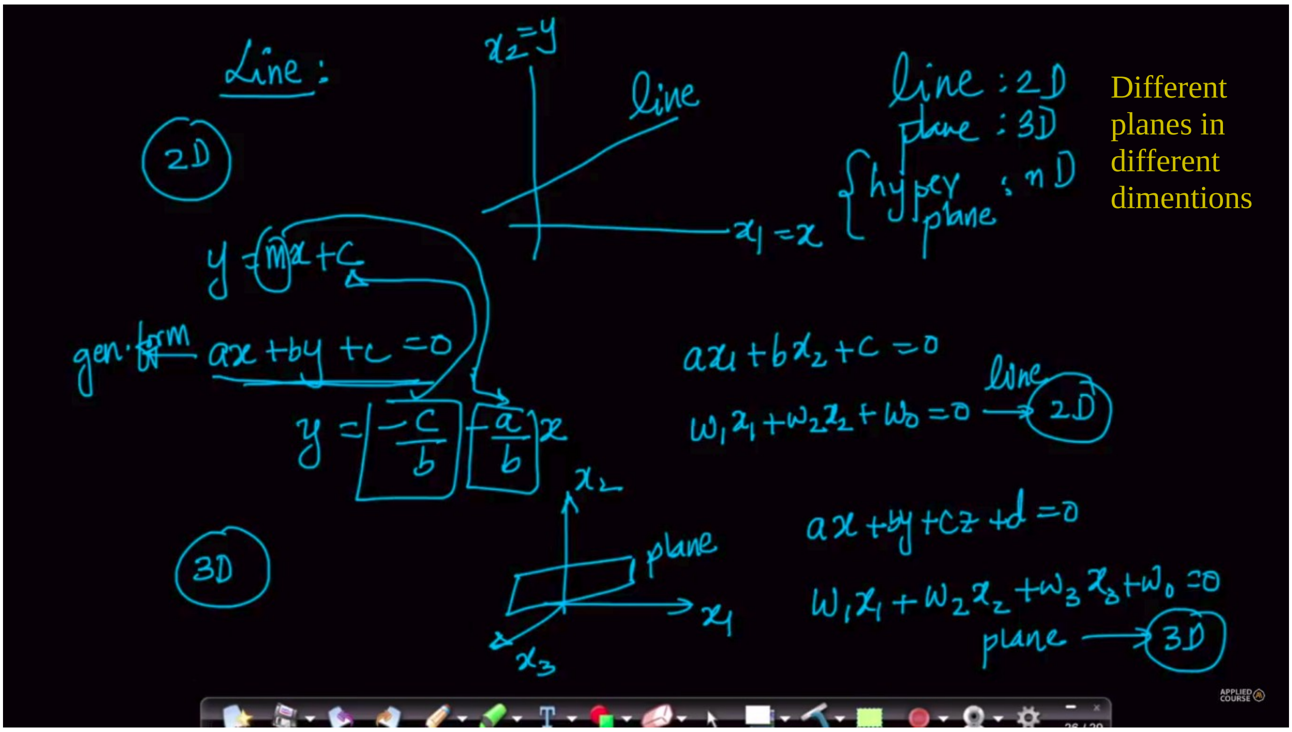
unit vector

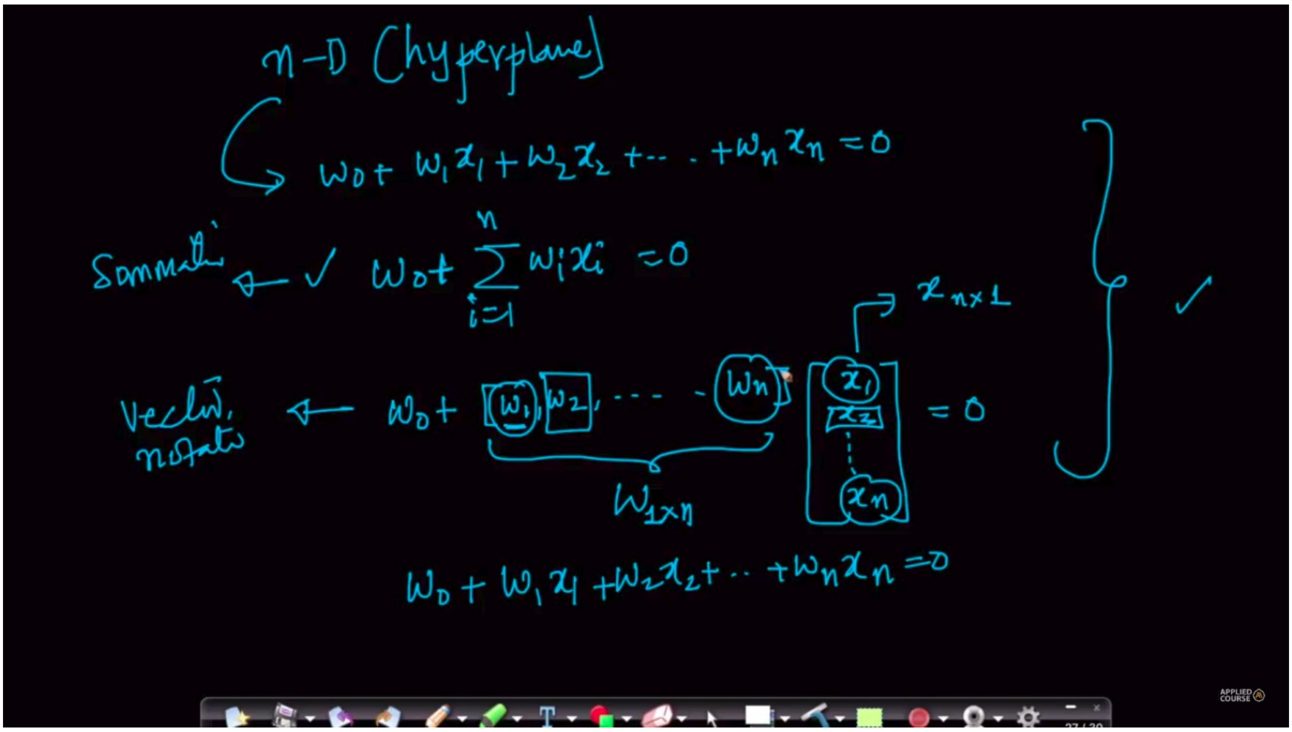
$$\hat{a} = \frac{a}{\|a\|}$$

① $\hat{a}$ same direction as a

② $\|\hat{a}\| = 1$

- Equation of a line (2-D), Plane(3-D) and Hyperplane (n-D), Plane Passing through origin, Normal to a Plane

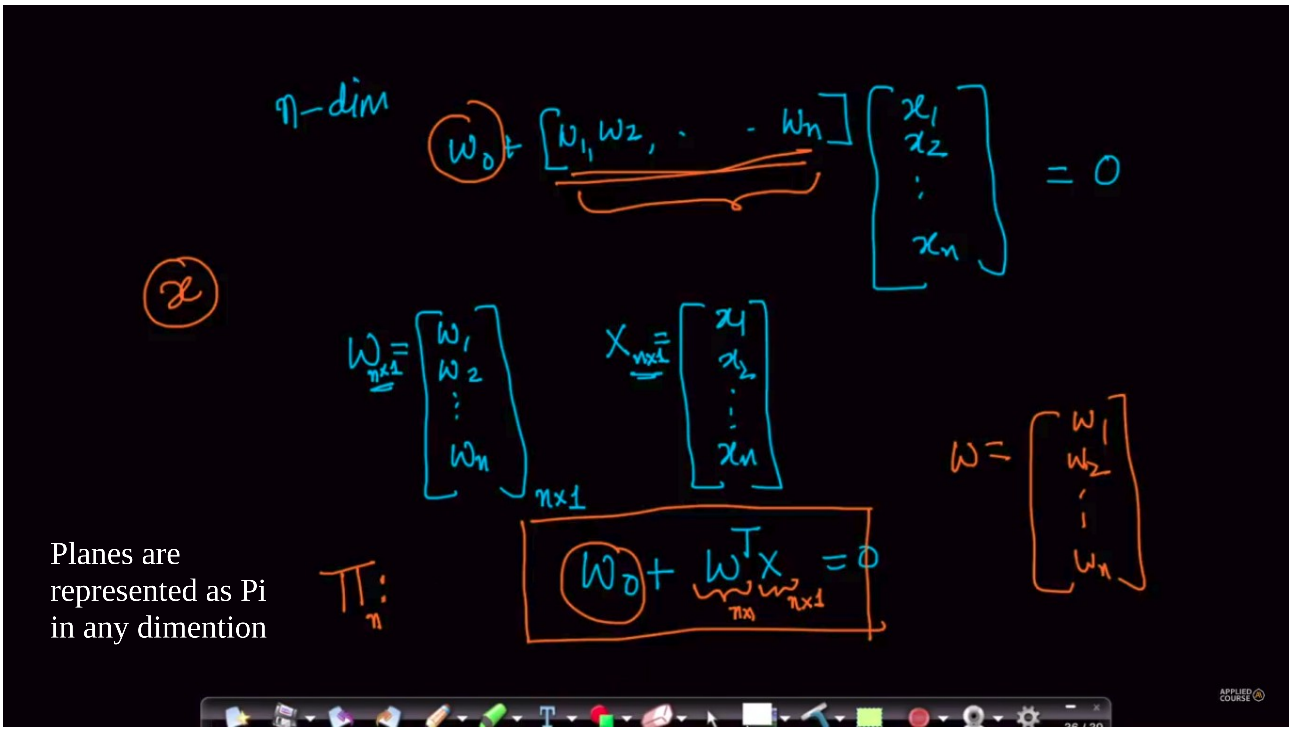


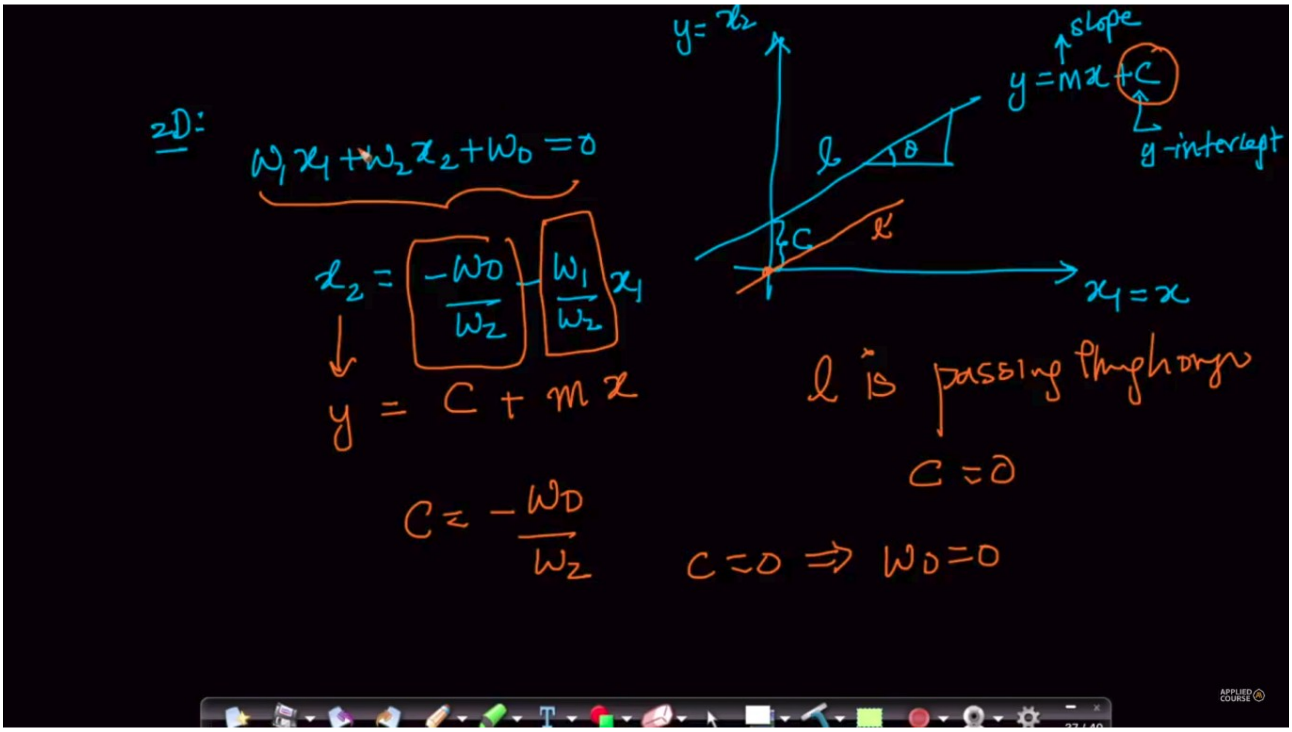


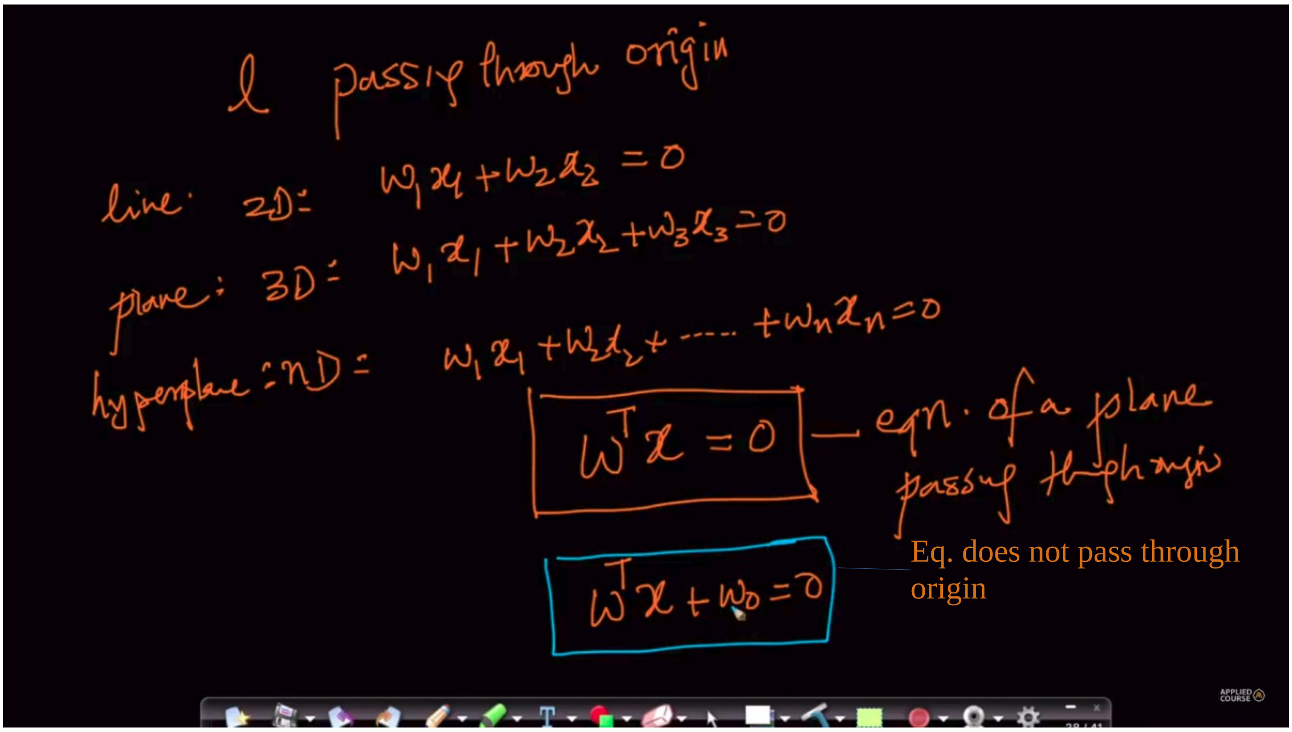
Hyper plane representation

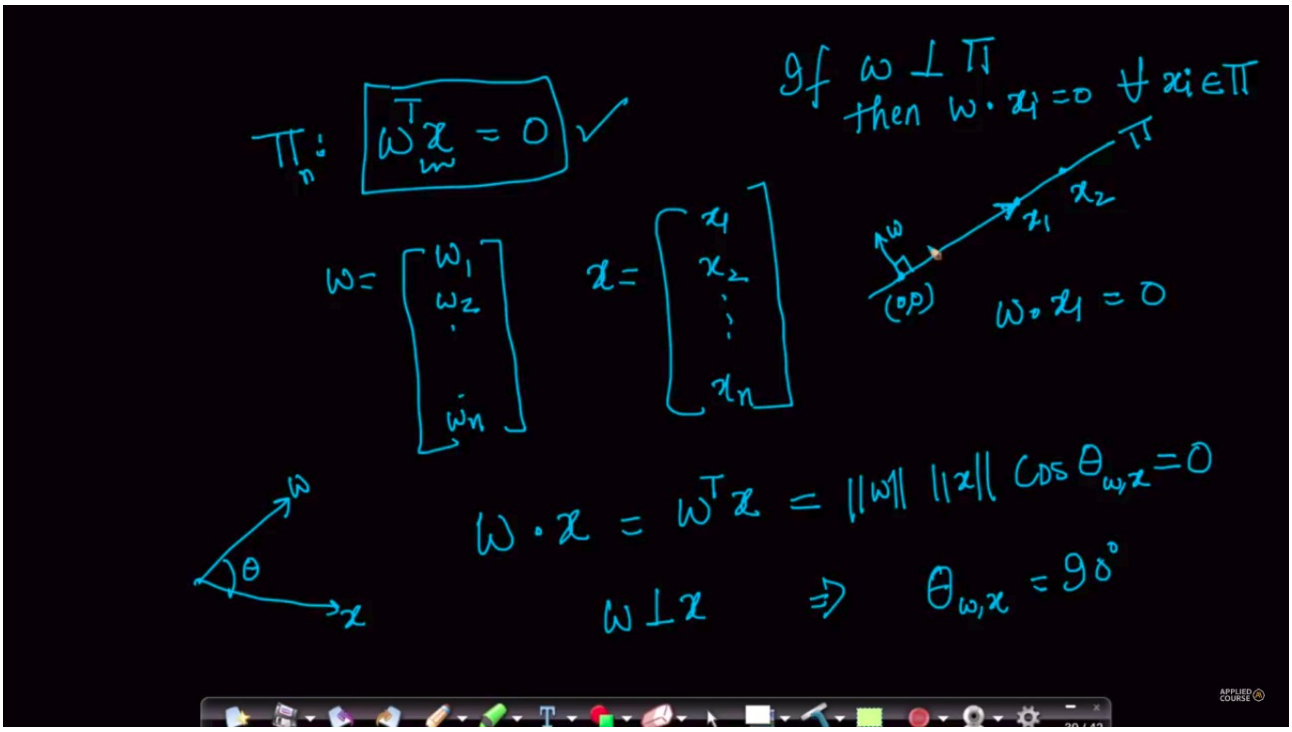
Note:

By default any vector is Column Vector.

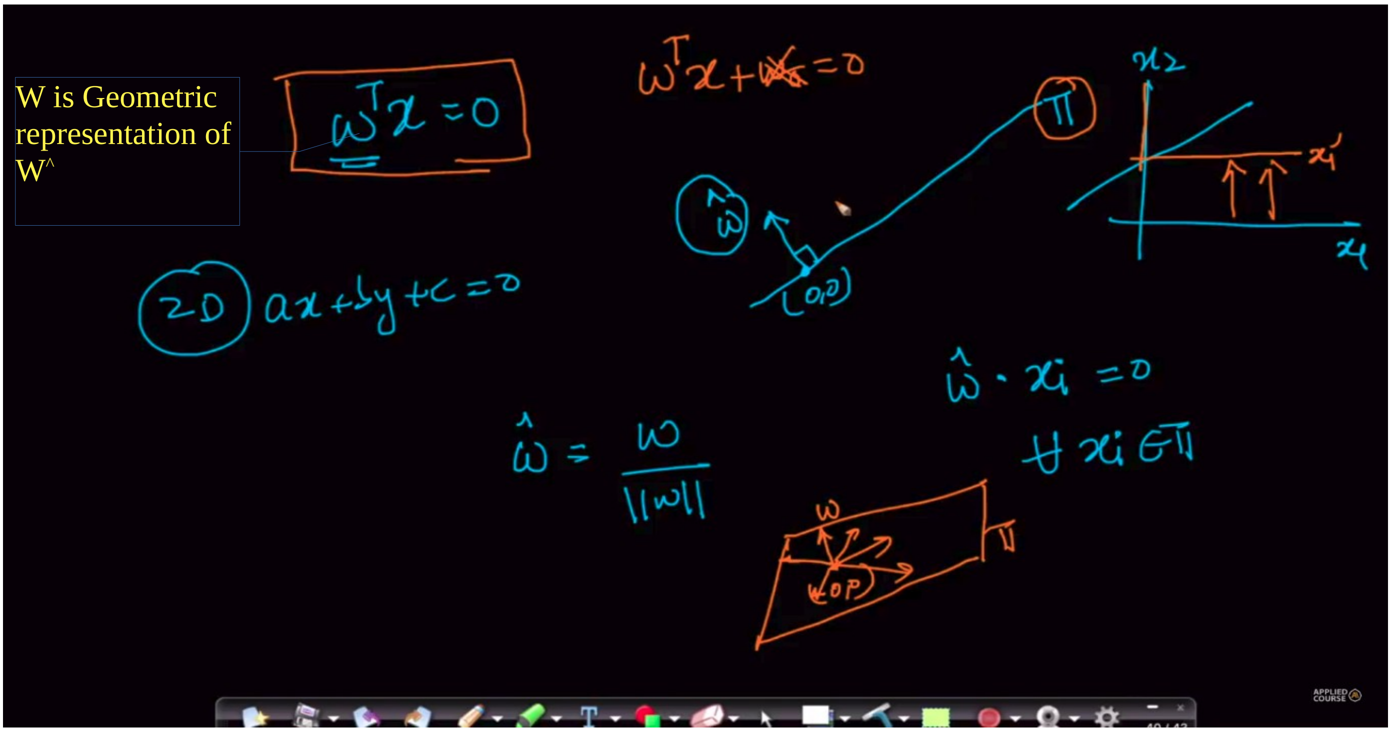

n-dim
w0 + [w1, w2, . . wn] [x1 x2 : xn] = 0
W = [w1 w2 : wn] n×1
X = [x1 x2 : xn] n×1
W = [w1 w2 : wn]
π_n :
W0 + W^T X = 0
Planes are represented as Pi in any dimention


2D:
w1x1 + w2x2 + w0 = 0
x2 = -w0/w2 - w1/w2 x1
y = c + m x
c = -w0/w2
y = x2
slope
y = mx + c
y-intercept
x1 = x
l is passing through origin
c = 0
c = 0 ⇒ w0 = 0

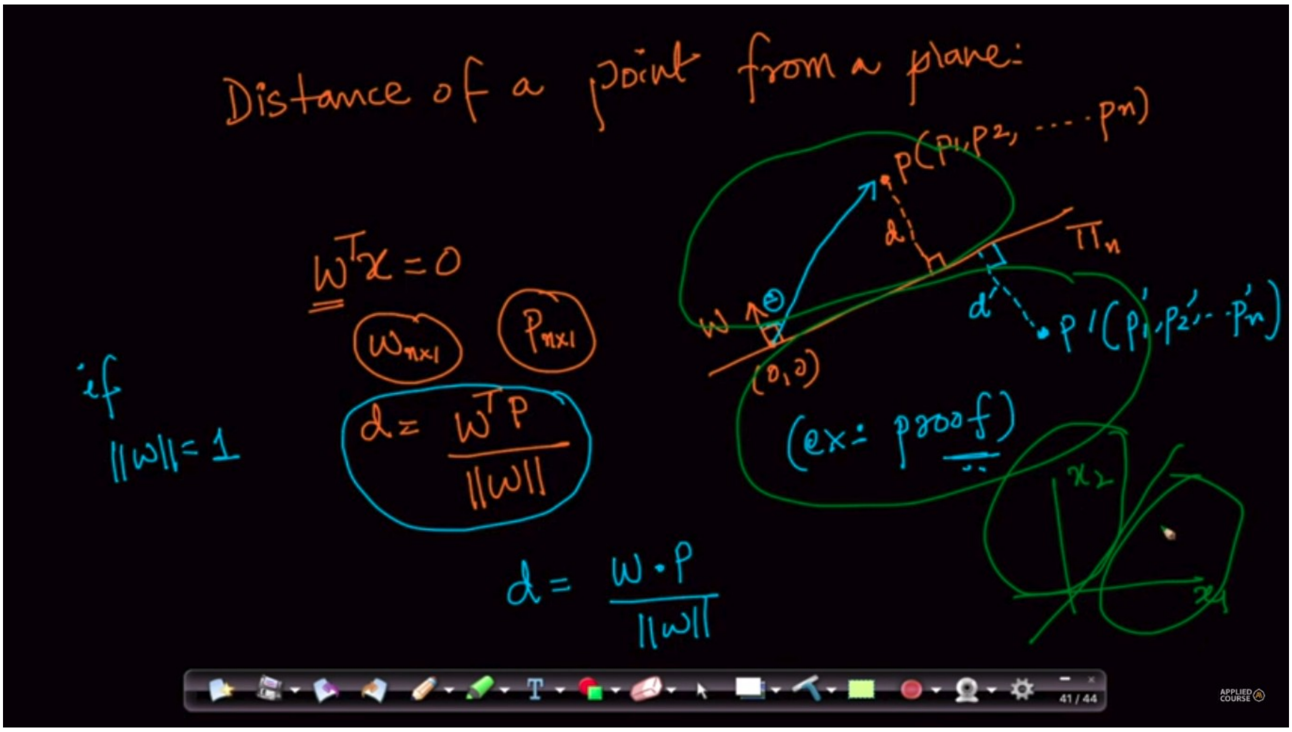




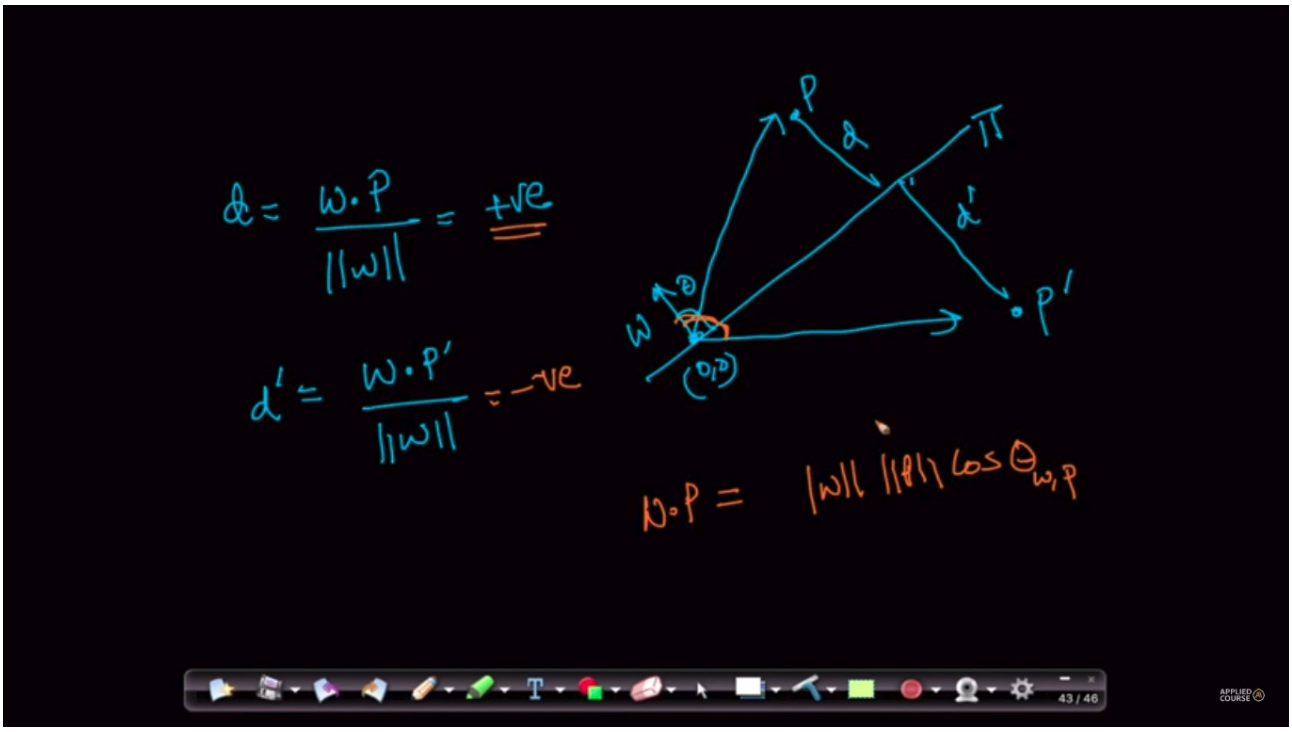
Note: Normally we assume our planes passing through origin

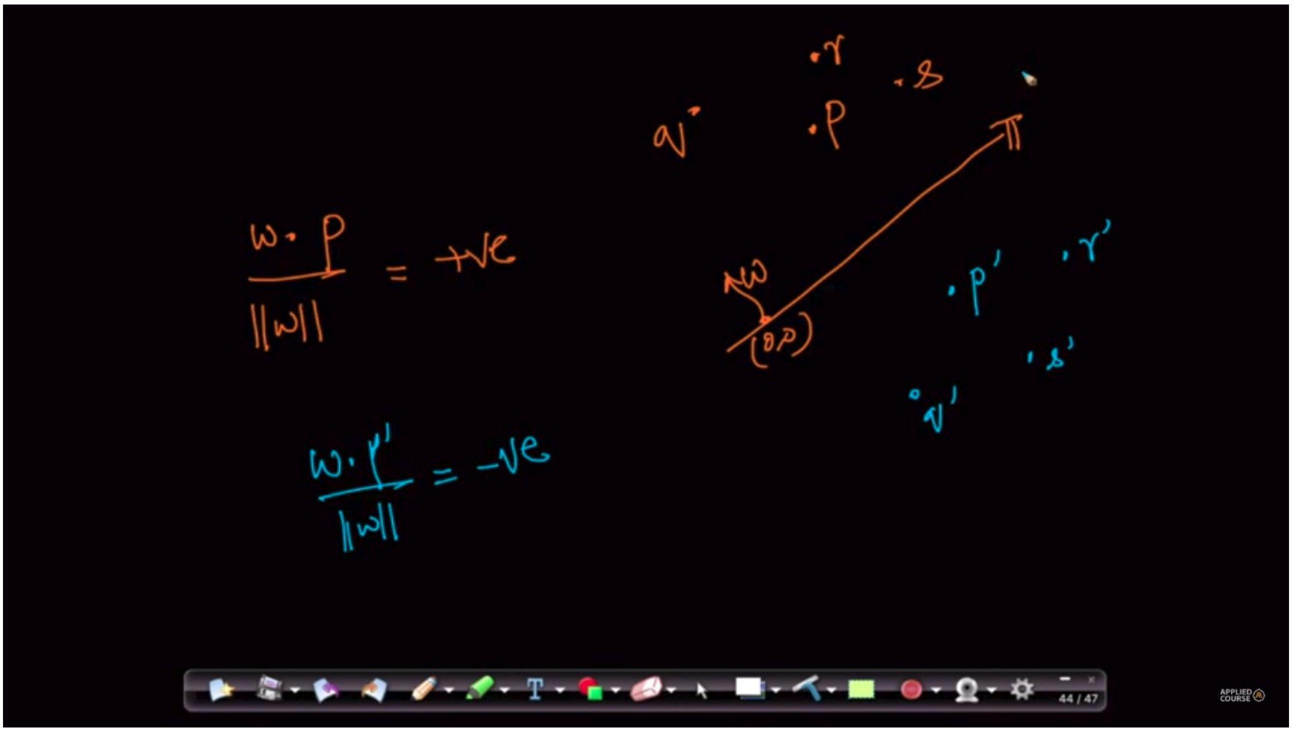


Distance of a point from a Plane/Hyperplane, Half-Spaces

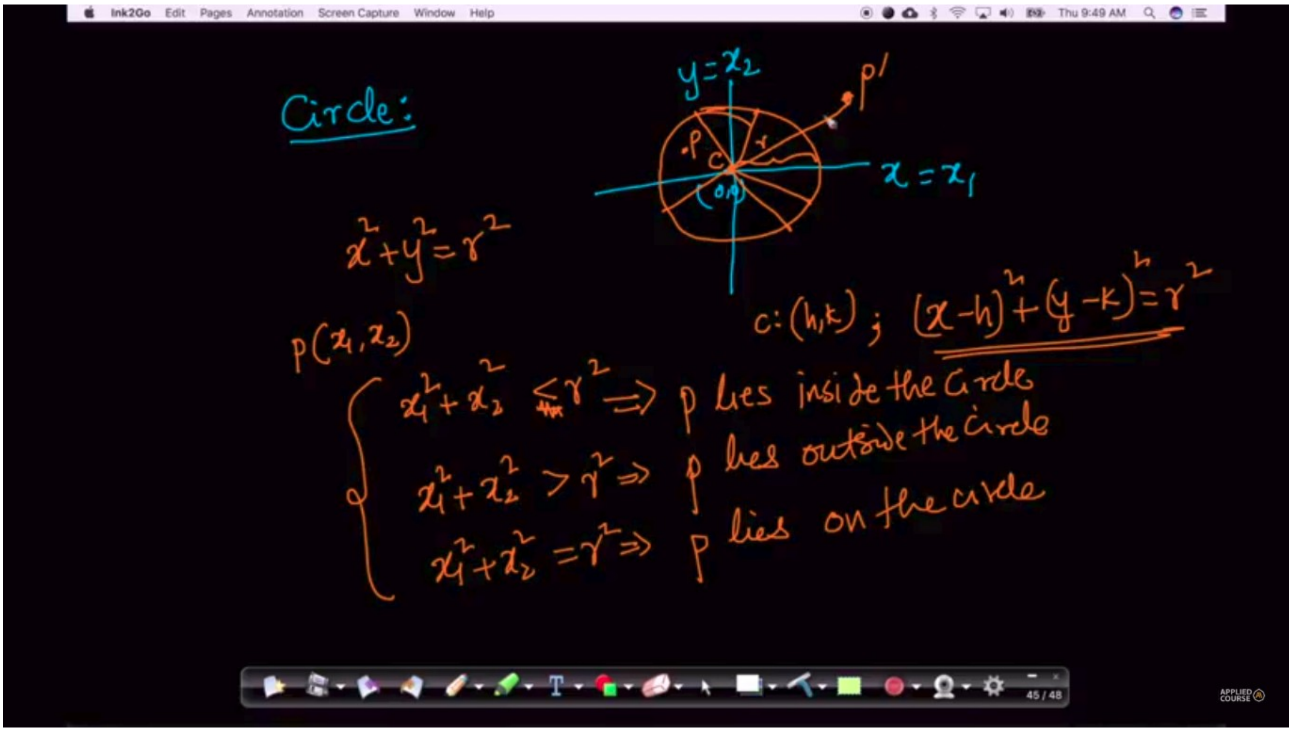


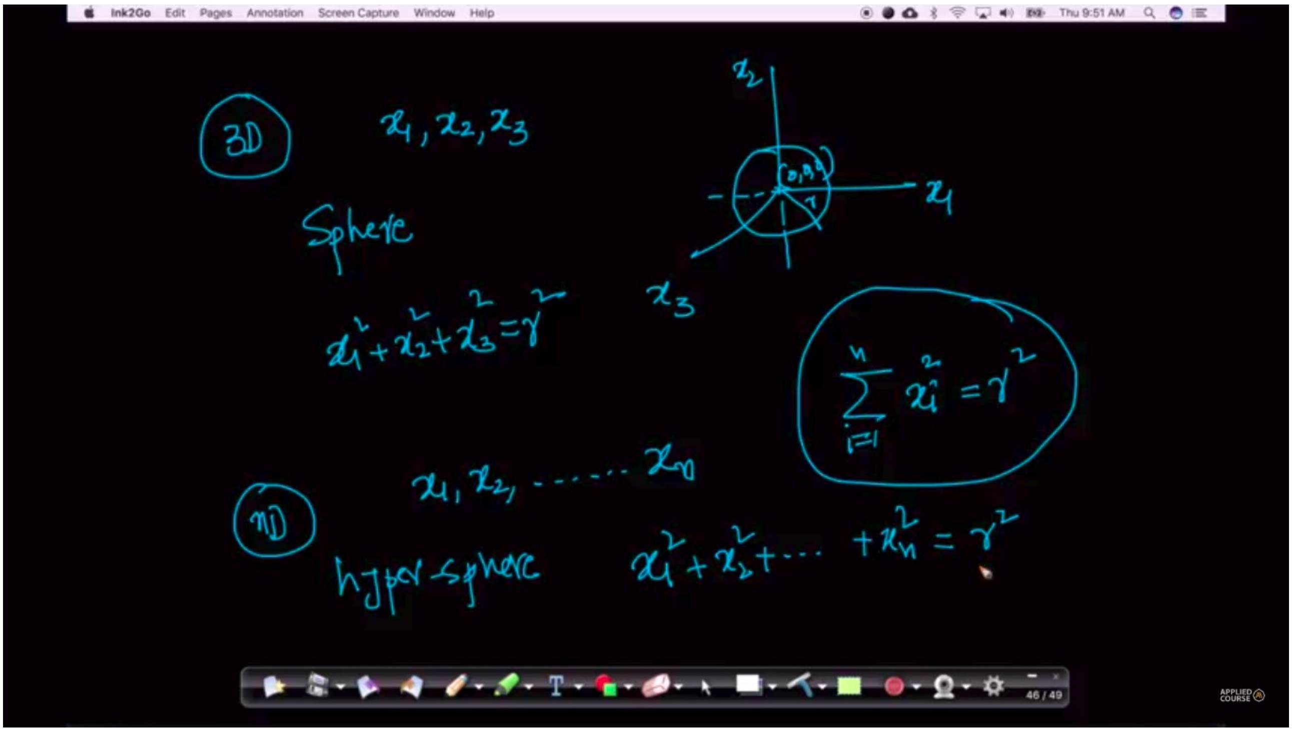
- Line separates 2D into half spaces n 3D divides plane into half spaces.
- Both distances will be in opposite direction


d = w·P / ||w|| = +ve
d' = w·p' / ||w|| = -ve
W·P = ||w|| ||P|| cos θ_{w,P}
P
d
π
d'
p'
w
θ
(0,0)
43 / 46
APPLIED COURSE

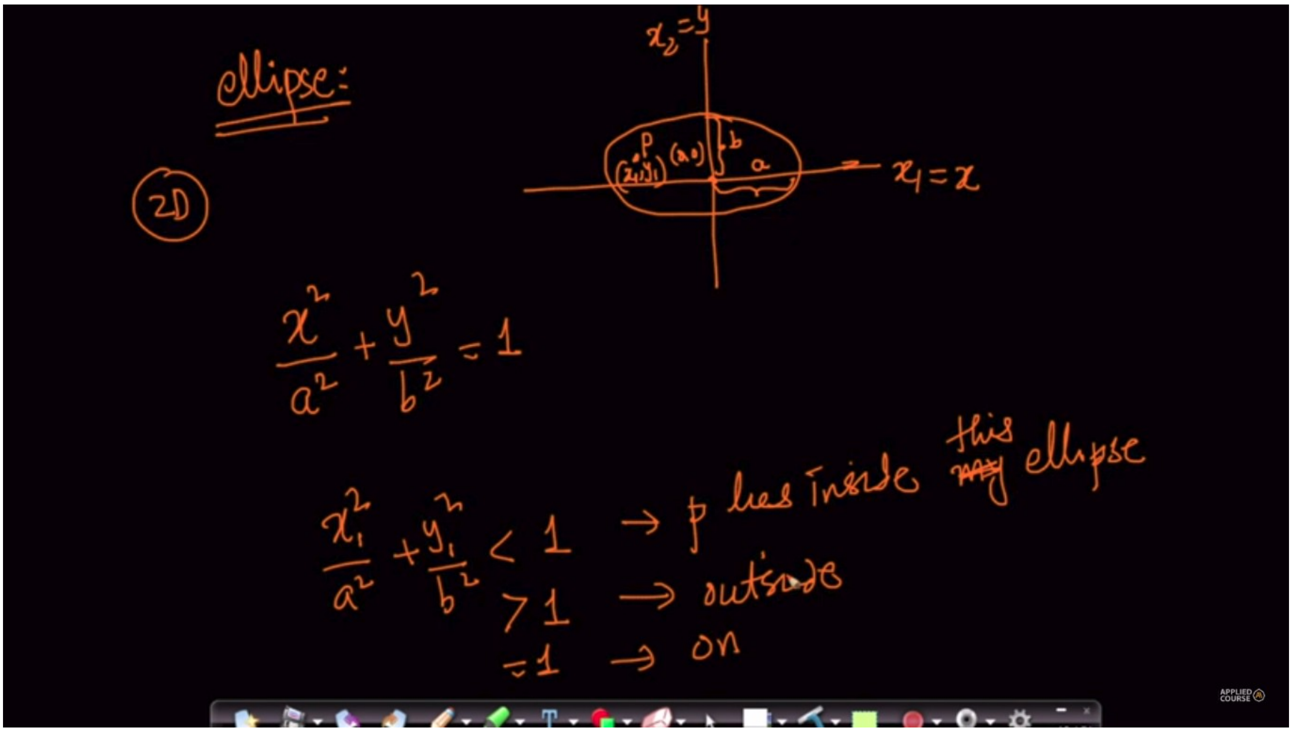

w·p / ||w|| = +ve
w·p' / ||w|| = -ve
r
s
q
p
π
w
(0,0)
p'
r'
s'
q'
44 / 47
APPLIED COURSE

Equation of a Circle (2-D), Sphere (3-D) and Hypersphere (n-D)



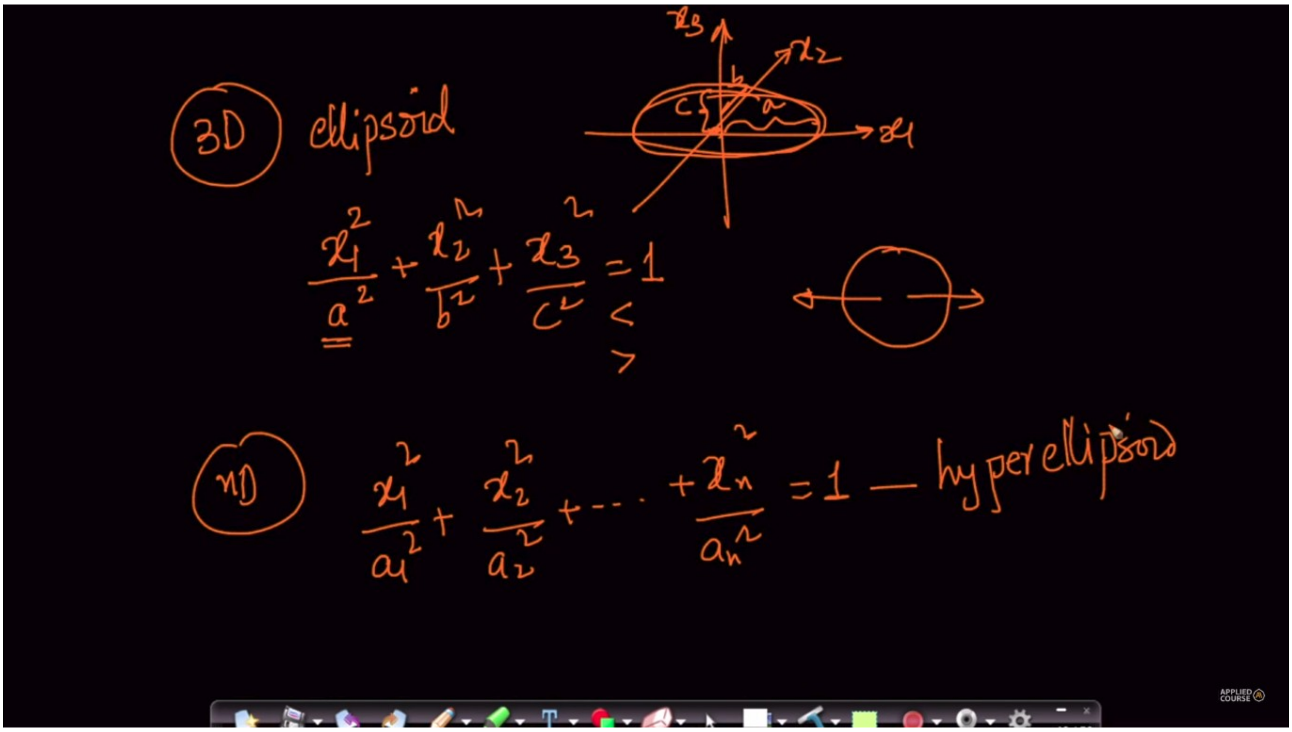


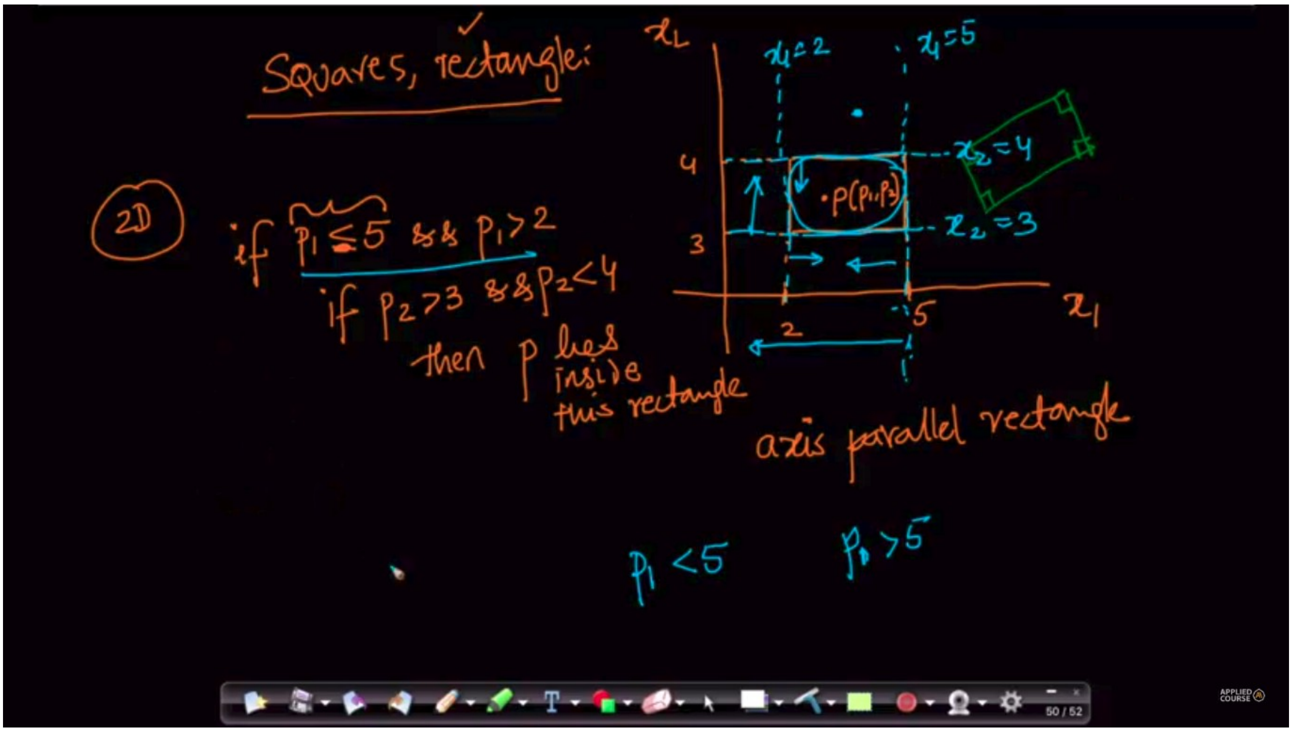
Equation of ellipse , ellipsoid and Hyperellipsiod



2D – ellipse

3D – ellipsoid





Hyper Cube,Hyper Cuboid