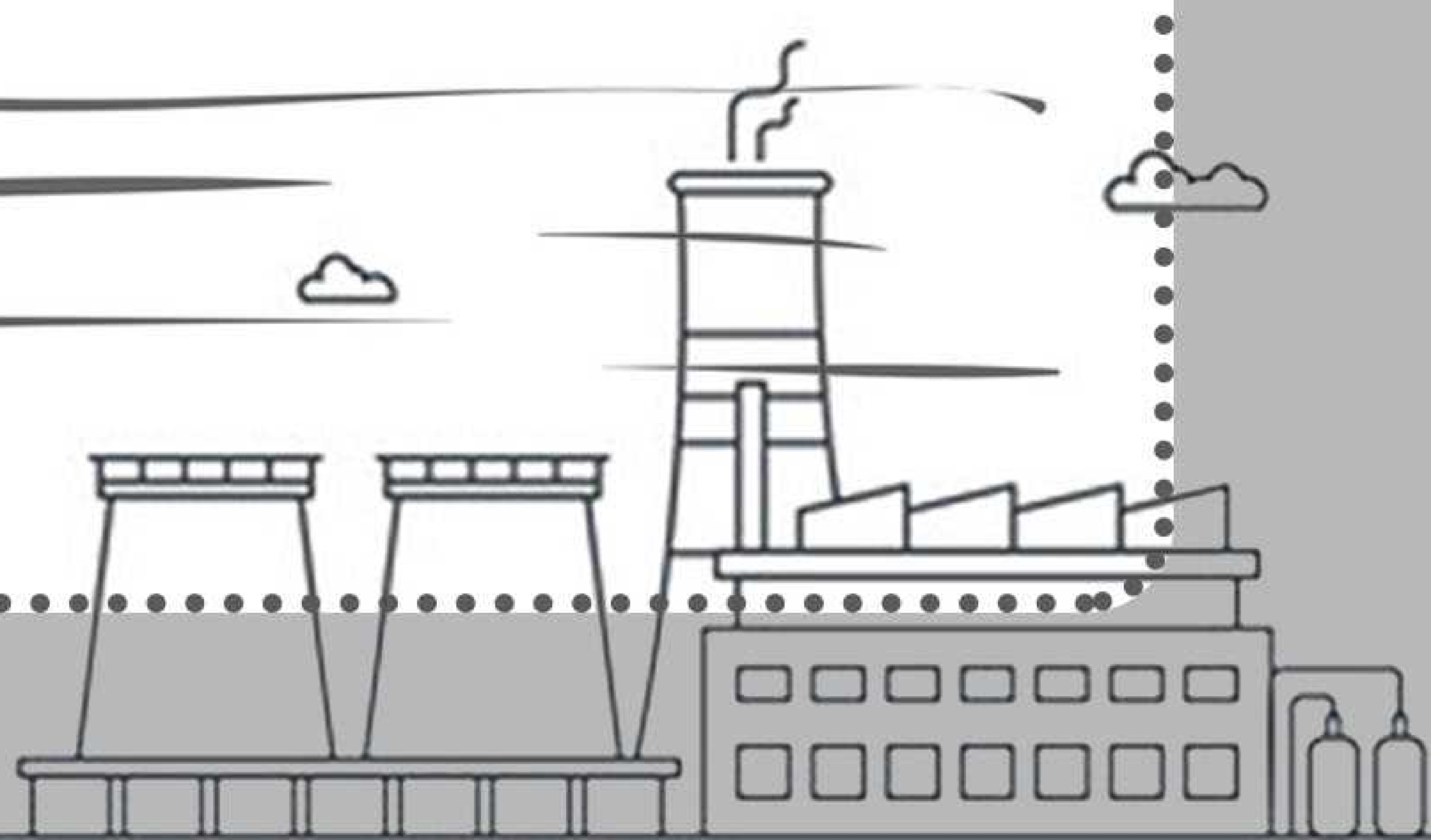
WEEKLY NOTEBOOK

Design

second semester

2021



改善 KAIZEN TEAM

Engineering design

Process

1. define the problem
2. Identify constraints
3. Brainstorming
4. select the best solution
5. PrototType your solution (3D printing)
6. testing and evaluation
7. تحسين Iterate to improve your prototype
8. Comunicate your solution

Engineering design

- CAD Industrial/product — empathy — توافق مع الزبون
- Manufacturing — تختار process الافضل — science
- Machine element (CAD)
- Materials

Yield Factor of safty

$\sigma_{working} = \frac{\sigma_{yield}}{n}$ → factor of safty [1.2 - 4]

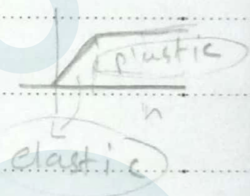
There will always be uncertainties when determining exactly how a material will behaves

$n = \frac{Property}{\sigma_{working}} = \frac{S}{\sigma_w} = \frac{\sigma_y}{\sigma_v}$

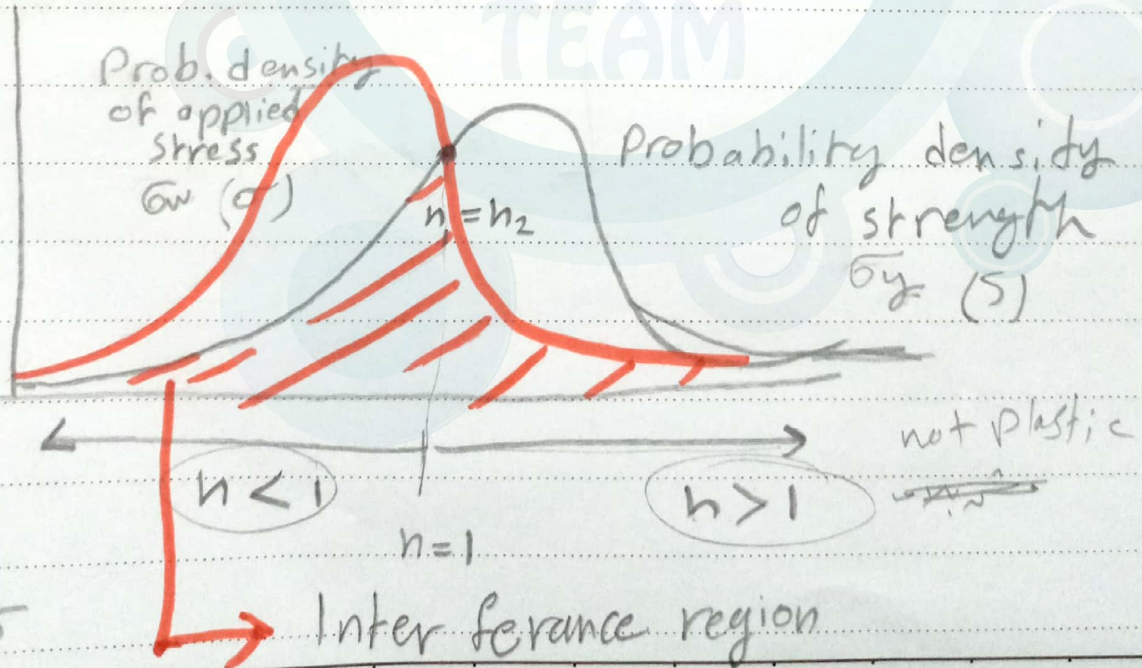
$\sigma_{working} = \sigma_{yield}$ يصير plastic deformation

σ_{yield} ⇒ it has variation

plastic deformation حتى نحمي المواد من ⇐ $n > 1$

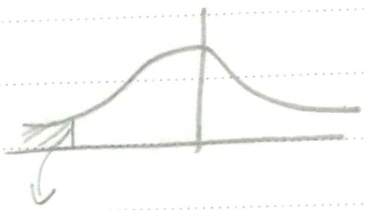


$n = \frac{\sigma_y}{\sigma_w}$



margin
$R = S - \sigma$

margin $Q = \underset{\text{yeild}}{S} - \underset{\text{stress}}{\sigma}$



$$\boxed{Z = \frac{Q - \mu_Q}{\sigma_Q}}$$

$$Z\Big|_{Q=0} = -\frac{\mu_Q}{\sigma_Q}$$

If the distributions for both the stress and the strength both follow a normal distribution then the relecibility (R) of a component can be determined by the following equation

$$R = 1 - P(Z_o)$$

prob. of servizer

prob. of failure

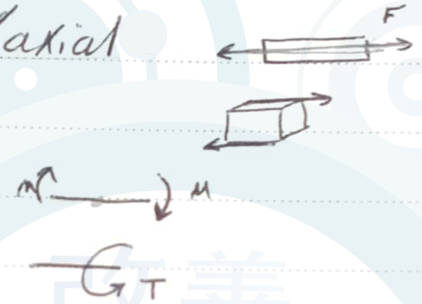
$$Z_o = -\frac{\mu_s - \mu_\sigma}{\sqrt{\sigma_s^2 + \sigma_\sigma^2}}$$

Ch3 Principal Stresses

$\sigma = \frac{F_1}{A}$ normal stress

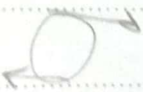
$\tau = \frac{F_2}{A}$ shear stress

Forces
- Normal / axial
- Shear
- Bending
- Torsion



$\sigma = \frac{F}{A}$

* الإشارات بتعبر عن الاتجاه

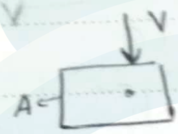


shear and bending moments in Beams

load acting transversely to the longitudinal axis the loads create shear forces and bending moments

مهم نعرف الإتجاهات

$$\tau_{avg} = \frac{V}{A}$$



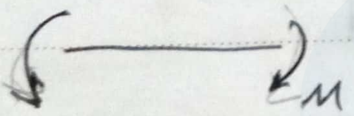
$$M = \underline{r} \times F = i \times j = K$$

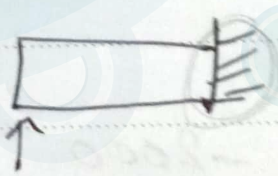
Pure Bending & **Non uiform Bending**

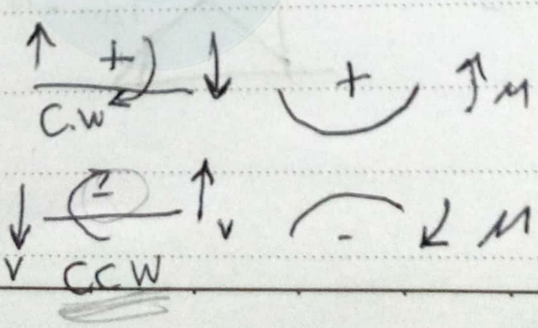
shear force (V) = 0 | $V \neq 0$

moment → normal stress | moment → normal stress

| shear → shear stress





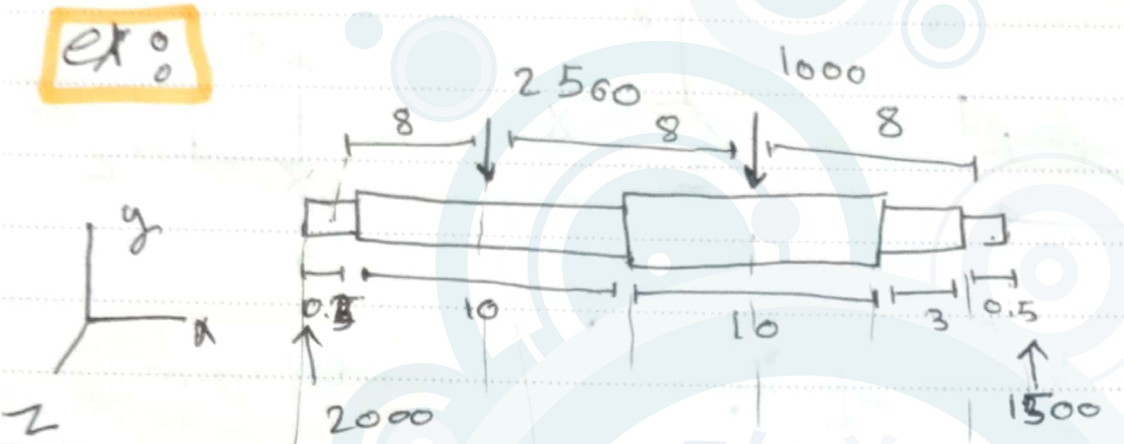


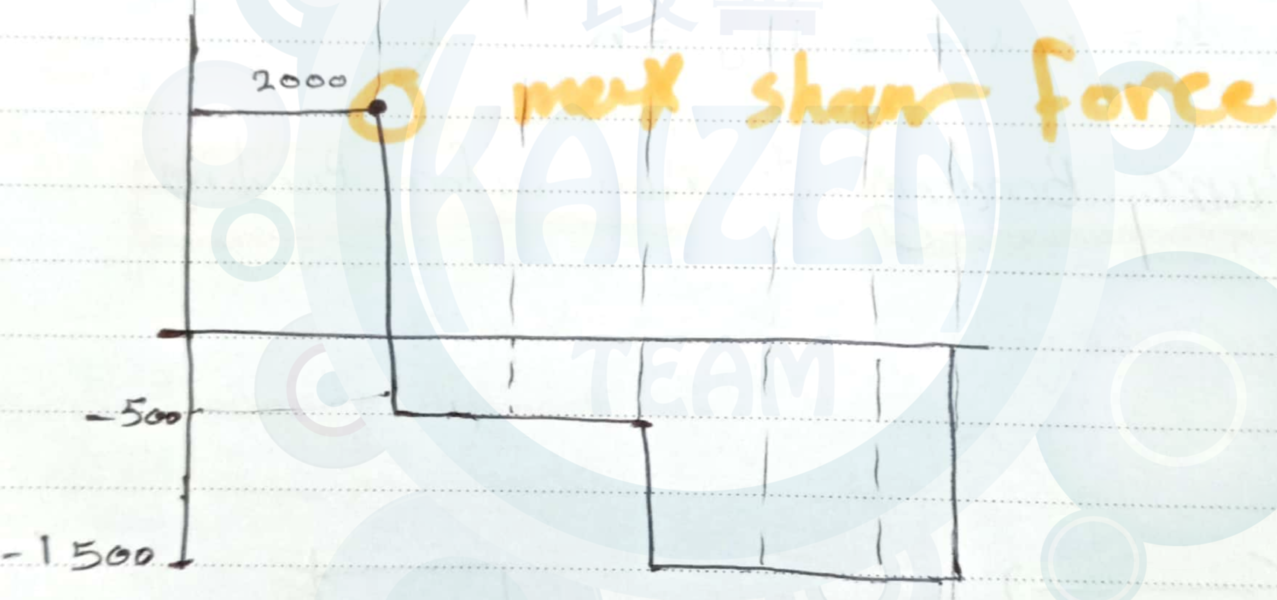
shear force and bending moment are related by the equation

$$V = \frac{dM}{dx}$$

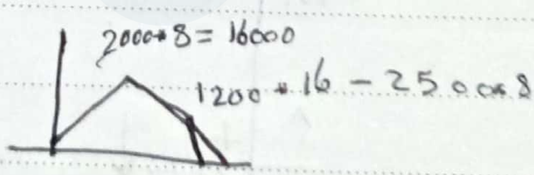
shear is the slope of moment diagram

ex:





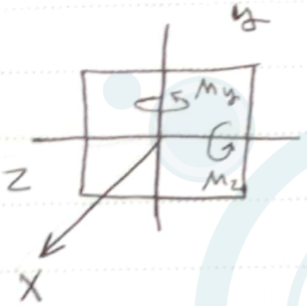
$$\tau_{xy} = \frac{-2000}{\frac{\pi}{4}(1)^2} =$$



(Internal forces) stresses on the cross section of the bending member

Internal force → Shearing force V → shearing stress V

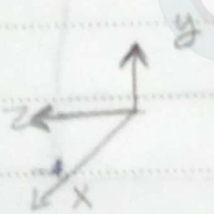
→ Bending moment M → Normal stress σ



(3-10) Normal stress for beams

$$\sigma_{xx} = \frac{-M_z y}{I_z}$$

الـيل موجب
الـسم سالب

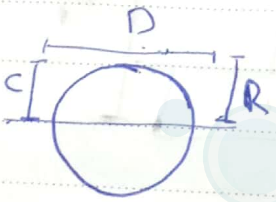


Centroid and moment of Inertia

Centroid $(\bar{x}, \bar{y})$

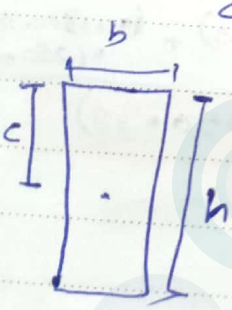
$$\bar{x} = \frac{\Sigma \bar{X} A}{\Sigma A}$$

$$\bar{y} = \frac{\Sigma \bar{y} A}{\Sigma A}$$



$$\bar{I} = \frac{\pi D^4}{64} = \frac{\pi R^4}{4}$$

$$Z = \frac{\bar{I}}{c} = \frac{\pi D^3}{32} = \frac{\pi R^3}{4}$$

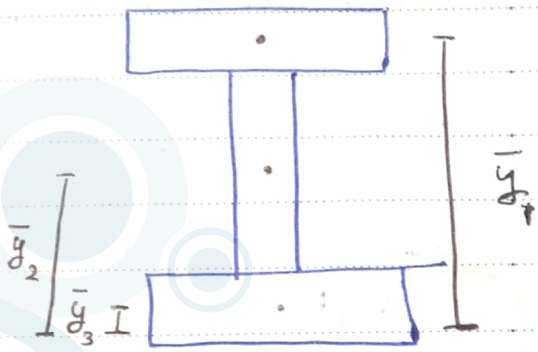


$$\bar{I} = \frac{b h^3}{12} \qquad Z = \frac{\bar{I}}{c} = \frac{b h^2}{6}$$

$$I = \bar{I} + A d^2$$

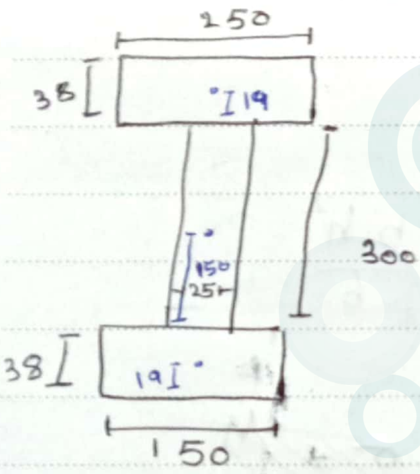
$$Z_1 > Z_2$$

$$\bar{y} = \frac{A_1\bar{y}_1 + A_2\bar{y}_2 + \cdots}{A_1 + A_2 + \cdots}$$



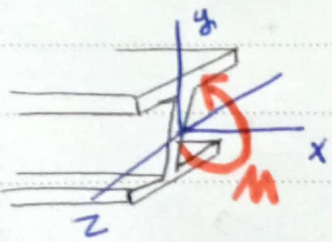
example

the beam is made from steel. Find the moment of inertia orround the z-axis



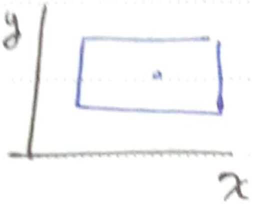
$$\bar{y} = \frac{19 \cdot (38 \cdot 150) + (150+38) \cdot (300 \cdot 25) + (19+300+38) \cdot (250 \cdot 38)}{(250 \cdot 38) + (25 \cdot 300) + (150 \cdot 38)}$$

$$= 216.29 \text{ mm}$$



Moment of inertia

$$I_x = \int_A y^2 \, dA$$



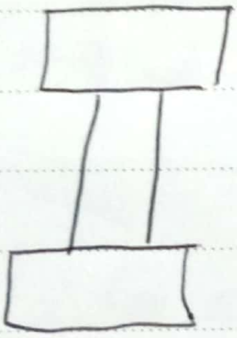
$$I_x = \int_A x^2 \, dA$$

when the axis is not throgh the centroid of an area we use the parallel axis theorem

$$I_x = \bar{I}_x + A\bar{y}^2$$

$\boxed{\text{example}}$

~~for~~



$$\bar{I}_1 = \frac{1}{12} \cdot 250 \cdot 38^3 = 1143166.667 \text{ mm}^4$$

$$A_1 = 250 * 38 = 9500 \text{ mm}^2$$

$$d_1 = |y_1 - \bar{y}| = \left|38 + 300 + \frac{38}{2} - 216.29\right| = 140.71$$

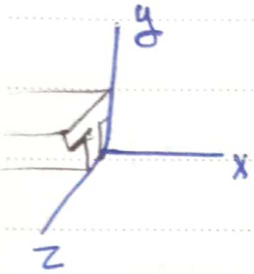
⋮

$$I_{tot} = \sum \bar{I} + A d^2$$

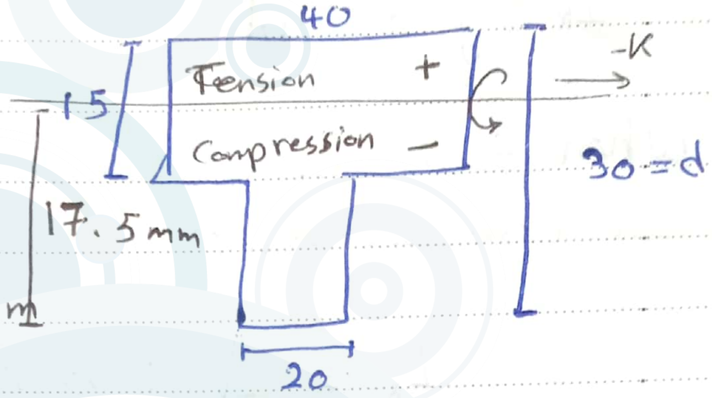
$$= 47403794.7 \text{ mm}^4$$

example

the beam is made of nylon with allowable stress of 24 MPa in tension, 30 MPa in compression
Determin largest M can be applied



$$\sigma_{xx} = \frac{-M_z \bar{y}}{I_z}$$



$I_z = 61870\ mm^4$

$\bar{y} = 17.5\ mm$

in compression $\sigma_{xx} = -30 \times 10^6 = \frac{M_z \times (-0.0175)}{61870 \times 10^{-12}}$

in Tension $\sigma = 24 \times 10^6 = -\frac{M_z \times (+0.0127)}{61870 \times 10^{-12}}$

-Z

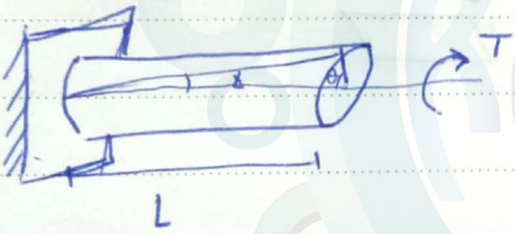
بلف مواليه

3-12 Torsion

torsion is the twisting of an object due to an applied torque

If γ is the shear strain θ is the angle of twist in length L

when a circular shaft is subjected to torque the shaft will be twisted and the angle of twist is found to be



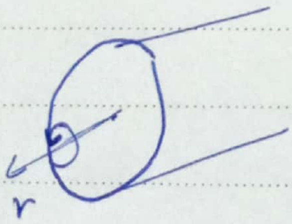
$$\theta = \frac{TL}{GJ}$$

T : torque L : Length

G : Modulus of rigidity is properity of material

J : Polar moment of inertia

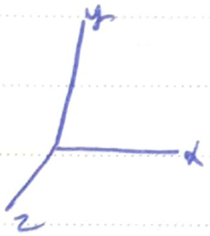
$$G = \frac{E}{2(1+\nu)}$$



$$T = r \times F$$

$$T = r \times F = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix}$$

$$= (r_y F_z - r_z F_y)\,i + (r_z F_x - r_x F_z)\,j + (r_x F_y - r_y F_x)\,k$$



$$i \times j = k$$
$$j \times k = i$$
$$k \times i = j$$

$$\tau = \frac{T\rho}{J} \qquad \tau_{max} = \frac{Tr}{J}$$

3-12 Torsion ⇒ shear stress

$$\boxed{\tau = \frac{T \cdot r}{J}}$$

r : distance from shaft axis to point interest

R : shaft Radius

D : shaft Diameter

$$J = \frac{\pi D^4}{32} = \frac{\pi . R^4}{2}$$ for solid circular

$$J = \frac{\pi (D_o^4 - D_i^4)}{32}$$ for hollow shafts

J = polar second moment of area

$$\tau_{max} = \frac{16 . T}{\pi D^3}$$ for solid circular shafts

$$\tau_{max} = \frac{16 . T . D_o}{\pi (D_o^4 - D_i^4)}$$ for ~~solid~~ hollow shafts

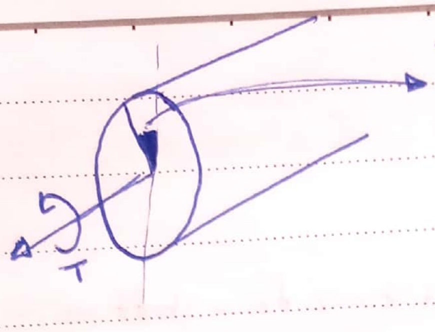
Torsion is the twisting of an object due to an applied torque.

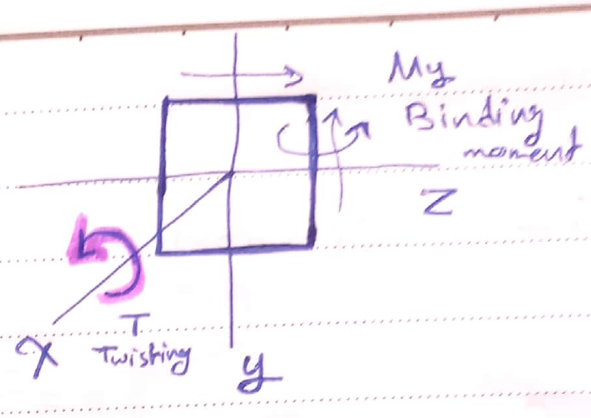
- we use Hook's law for a linear elastic material

+j

+Ty

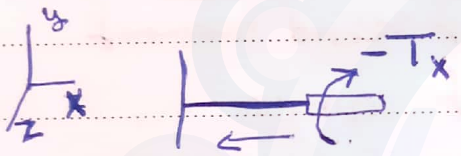
T+





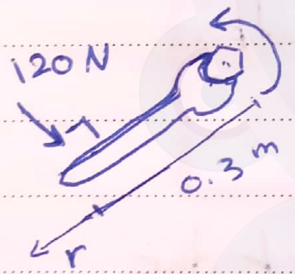
Twisting ⟹ يمشي على المحور العامودي
على Area

Bending moment ⟹ يمر على الاطراف



حسب قاعدة اليد اليمنى

example :-



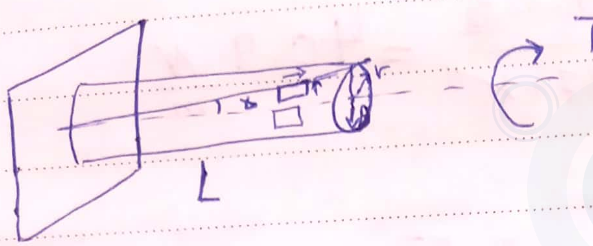
$T = r \times F$ = ~~0.6 * 12~~

$T = 0.3 * 120 * \sin 90 = 36$ CCW

$-T_x$

If the angle is 115 instead 90

$-T_x = 120 * 0.3 * \sin 115 = 32.63$ Nm ↶



$$\gamma = \frac{\rho\,\theta}{L}$$

γ : shear strain

the maximum shear strain occurs at the outer surface when $\rho = r$

$$\gamma_{max} = \frac{r\,\theta}{L}$$

عالسطح بكونه shear stress اعلى إشي

$$\gamma = \frac{\rho\,\theta}{L} \qquad \tau = \frac{T\rho}{J} \qquad \tau_{max} = \frac{Tr}{J}$$

example :-

what is the max. diameter of solid shaft which will not twist more than 3° in length of 6 m when subjected to a torque of 12 Kn-m. what is the max. shear stress induced in the shaft. Use G = 82 GPa.

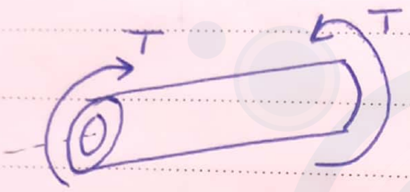
$$\theta = \frac{TL}{GJ} \Rightarrow 3 * \frac{\pi}{180} = \frac{12 * 6000 * 10^6}{82 * 10^3 \; J} \Rightarrow J = 16.77 * 10^6$$

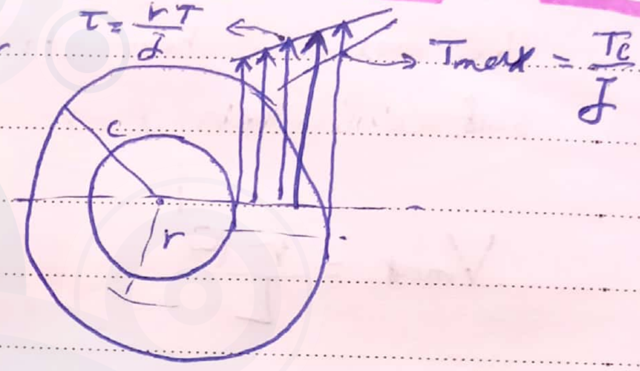
$$J = \frac{\pi D^4}{32} \Rightarrow 16.77 * 10^6 = \frac{\pi D^4}{32}$$

$$D_{max} = 114.32 \text{ mm}$$

$$\tau_{max} = \frac{Tr}{J} = \frac{12*10^{6} * 14.32}{2 * 16.77 * 10^{6}} = 40.9 \frac{N}{m}$$

Hollow cylinder



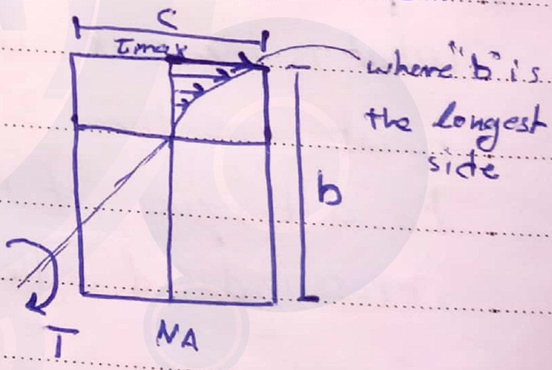


stress distrib. $J = \frac{\pi}{32}(D^4 - d^4)$

for rectangular cross-section, the max. shear stress is found as:

$$\tau_{max} = \frac{T}{abc^2} = \frac{T}{bc^2}\left(3 + \frac{1.8}{b/c}\right)$$

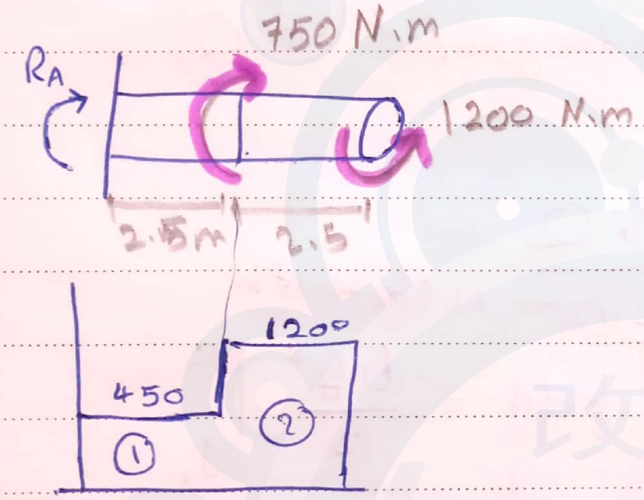
$$\frac{\theta}{L} = \frac{T}{\beta d b^3 G}$$



where "b" is longest side

example

a solid steel shaft is loaded using $G = 83$ GPa determain the required diameter of the shaft if the $\tau_{max} = 60$ MPa , $\theta_{max} = 4$ deg.



For part 1

$$\tau_{max} = \frac{T \, D/2}{\frac{\pi D^4}{32}}$$

$$60 = \frac{450 * 32}{\pi * 2 * D^3}$$

$$D = 33.678 \text{ mm}$$

$R_A = 750 - 1200 = -450$ N.m

نفس كامل حل السؤال

$$\theta = \frac{TL}{GJ}$$

$$4 * \frac{\pi}{180} = \frac{32(450 * 2.5 + 1200 * 2.5)}{\pi D^4 (83000)}$$

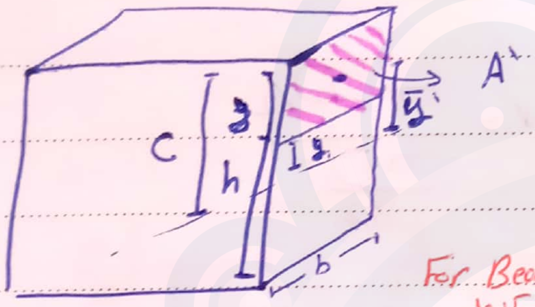
$= 51.89$ mm

↳ we use largest diameter

3-11 shear stresses for Beams in Bending

$$\tau = \frac{V}{Ib}\int_{y_1}^{c} y\,dA$$

the integral is the first moment of the area A' with respect to the neutral axis, this integral is usually designated as Q



$$\tau = \frac{VQ}{Ib}$$ b → is the width

For Beam
لكل

$$Q = \int_{y_1}^{c} y\,\underset{b}{dA} = \frac{by^2}{2}\Big|_{y_1}^{c}$$

ما تنسوهاش

$$\boxed{Q = \bar{y}A}$$

$\boxed{by = \text{Area}}$ نعوض

shearing stress dist. in typical cross section

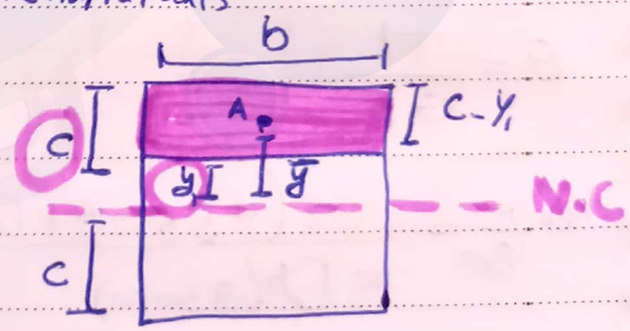
shear stress at any point y_1 from the nutral axis

$$\tau = \frac{V}{2I}\left[c^2 - y_1^2\right]$$

c → بعد طرف المساحة عند N.C

y_1 → ~~بعد~~ ~~N.C~~

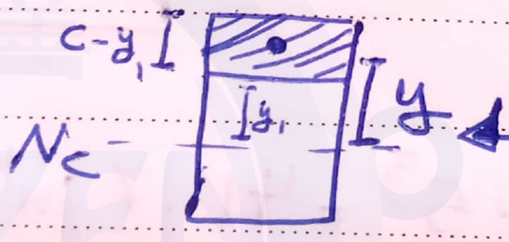
→ بعد المساحة عند N.C



$\boxed{\tau_{max}}$ at N.C and zero at both the top and bottom surface

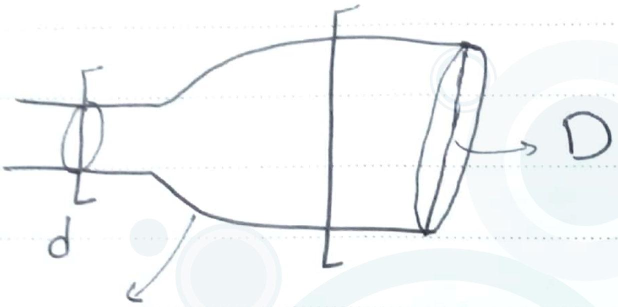
$$\tau_{max} = \frac{3V}{2A}$$

$$Q_{NA} = \bar{y}A_1 = \underbrace{\left(y_1 + (c-y_1)/2\right)}_{\bar{y}} * \underbrace{\left(b*(c-y_1)\right)}_{A}$$



$$Q_{NA} = \frac{c^2 b}{2} - \frac{b y_1^2}{2}$$

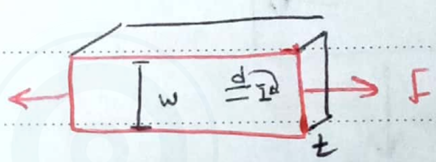
/ /



$\boxed{\text{stress}}$ أكبر هون

$$\sigma_{max} = K_t \, \sigma_o$$

$$\tau_{max} = K_{ts} \, \tau_o$$



لازم نعرف نوع load والشكل
or geomtric

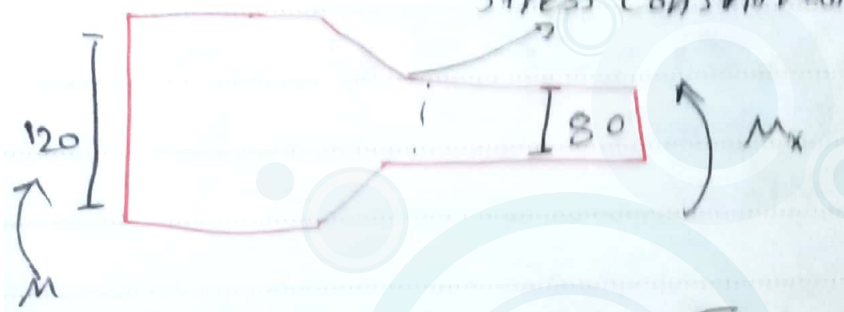
① $\sigma_o = \dfrac{F}{A}$

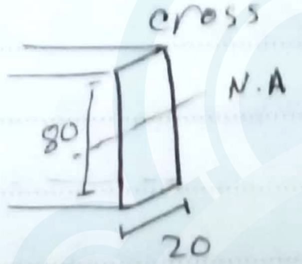
② $A = (w - d)t$

③ $\sigma_{max} = K_G \, \sigma_o$

/ /

example





$$\sigma_{av} = \frac{MC}{I}$$

$$= \frac{5 \times 10^5 \times 0.04}{I}$$

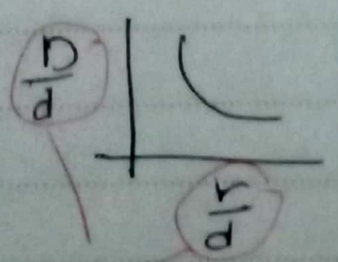
$$I = \frac{1}{12} \times 0.02 \times 0.08^3 = \boxed{}$$

$$\sigma_{max} = K \ \sigma_{av}$$

$$= 1.45 \times$$

$$= 340 \text{ MPa}$$

K منه الرسمة
في الكتاب
ص ١ شكل



بيوم
هد ول القيمتين

المسوحة ضوئيا بـ CamScanner

Example

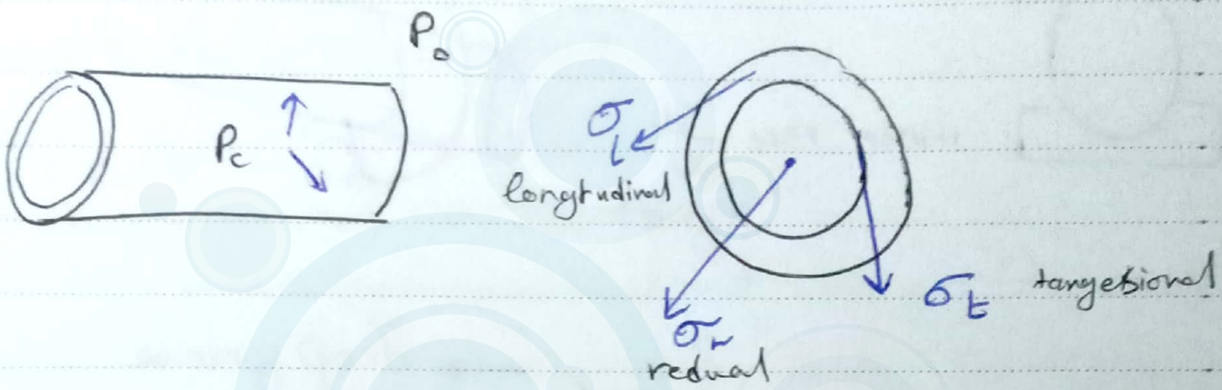
سؤال أهملنا في shear

$$\sigma_x = \frac{My}{I} = 22.8\ MPa$$

$$\sigma_x = 1.7 * 22.8$$
$$= 38.76\ MPa$$

$$\tau_{max} = K_{ts} \times \tau = 1.35 * 0.39 = 0.51\ MPa$$

3-14 stresses in Pressurized cylinders



$\sigma_t = \sigma_1 \Rightarrow$ maximum

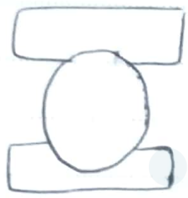
$\sigma_r = \sigma_3 \Rightarrow$ minimum

$\sigma_L = \sigma_2$

$$\tau_{max} = \frac{1}{2}(\sigma_t - \sigma_r)$$

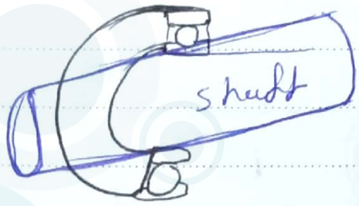
باقي الشرح واضح في السلايد

Ch11: Rolling Contact Bearing

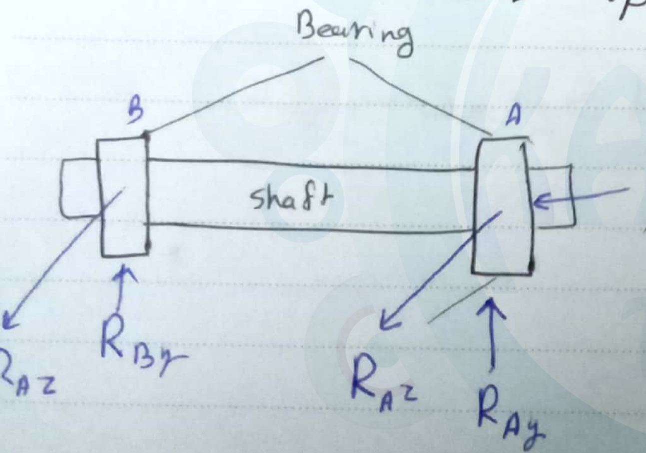


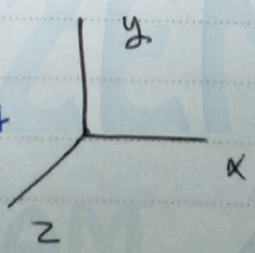
outer race ثابت

inner race بلف مع Shaft



Types of bearing
- ball
  - → deep groove
  - → angular contact
  - → ~~force~~ تتحمل أقل
- cyliendrical
- Tapered — thrust تتحمل force

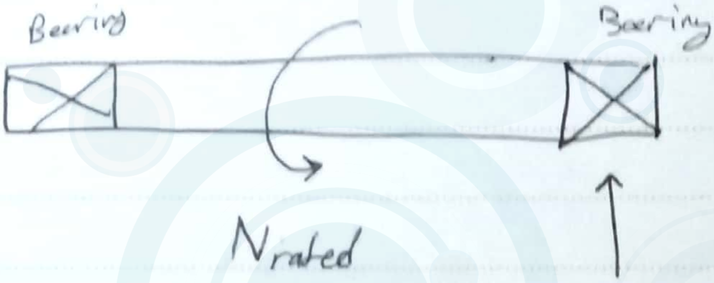




angular contact for misse allimant

3) كيف نعمل selection للـ bearing ؟!

Design Consideration

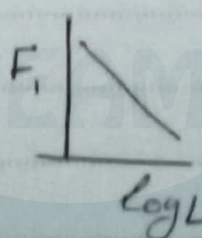


C_{10}: rated load   load بركب المهندس
12.7 KN

L_{10}: rated life   Faliur ويستنى لحد ما يصير

10^6 rev. $\Rightarrow$ $R_r = 90\%$

11.3 - Rated Reliability



$$F_1 L_1^{1/a} = F_2 L_2^{1/a}$$

a : حسب نوع Bearing

$R = R_r = 90\%$ بنستخدم هاي العلاقة

reliability المطلوبة

11-5 load life Reliability Trade-off

$\boxed{R_d \neq 90}$

لكل الحالات يلي فيها $R \neq 90$

$$\boxed{C_{10} = a_f F_D \left[\frac{X_D}{X_o + (\theta - X_o)(\ln 1/R_D)^{1/b}} \right]^{1/a}}$$

a_f → application Factor

إذا ما اعطاني في السؤال بتكون = 1

R_D → desiard reliability

$$X_D = \frac{L_D}{L_R}$$

L_D ⇒ desired life

example

desired life = 5000 hr

= 1725 rpm

$R_D = 0.99$

$F_D = 400$

Find Deep groove

$$X_D = \frac{L_D}{L_R}$$

L_D بحولها revelutions

$$= \frac{5000 * 1725 * 60}{10^6}$$

F_R ⇒ على القانون ⇒ $F_R = 23.7 \text{ KN}$

من الجدول ⇒ $C_{10} = 14.3$

we have two bearing on the shaft

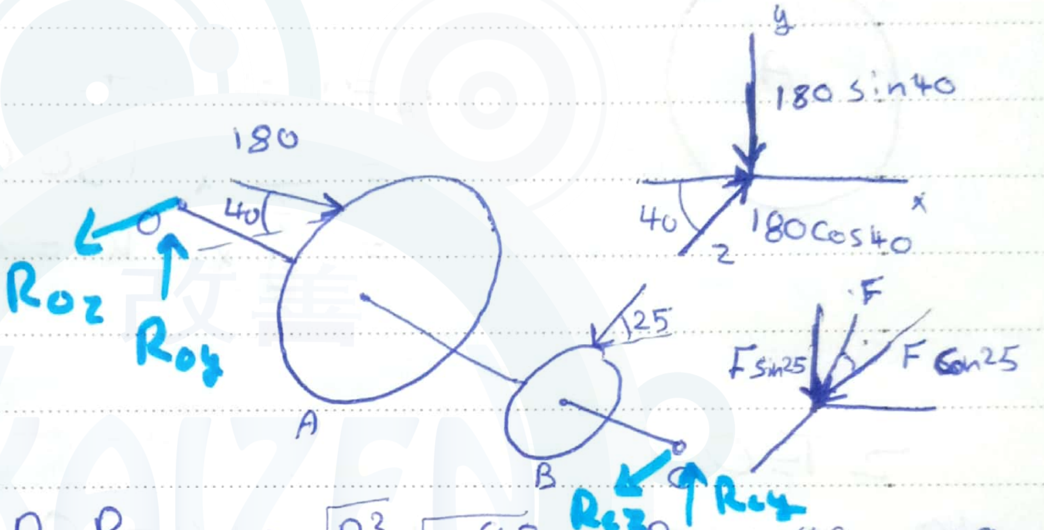
$R_{sys} = R_A \cdot R_B$

$R_A = R_B$

~~$R_{sys} = \sqrt{R}$~~

$R_{sys} = R^2$

إذا اكانو ٣ أو أكثر بنحط
$R^3 \ldots$



Q_2 :

$L_D = 50$

$a_f = 1.2$

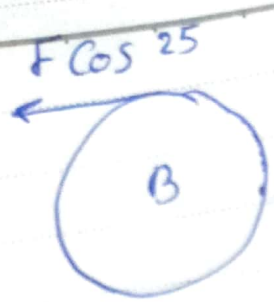
400 rev/min

$R = 0.98 = R_o R_c \Rightarrow \sqrt{R^2} = \sqrt{0.98}$ $R = 0.99 \neq 0.90$

$\boxed{\sum T = 0 \quad \sum M = 0 \quad \sum F = 0}$ in equ.

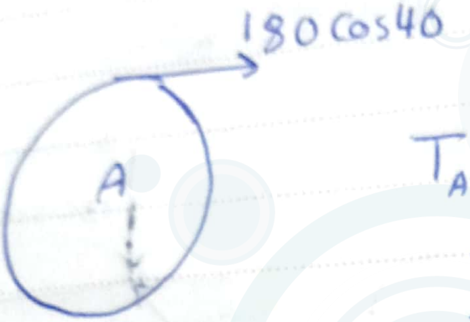
بنطلع reaction عند O ، C واكبر reaction بنوخذه

$\Rightarrow$



$$\Sigma T = 0$$

$$T_B = r \times F.\cos(25)$$
$$= \frac{10}{2} * F\cos 25$$
$$= \hat{j} \times \hat{k} \Rightarrow +\hat{i}$$



$$T_A = r \times 180\cos 40$$
$$= \frac{20}{2} \times 180\cos 40$$
$$= \hat{j} \times -\hat{k} = -\hat{i}$$

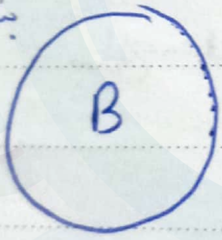
$$\Sigma T = 0$$

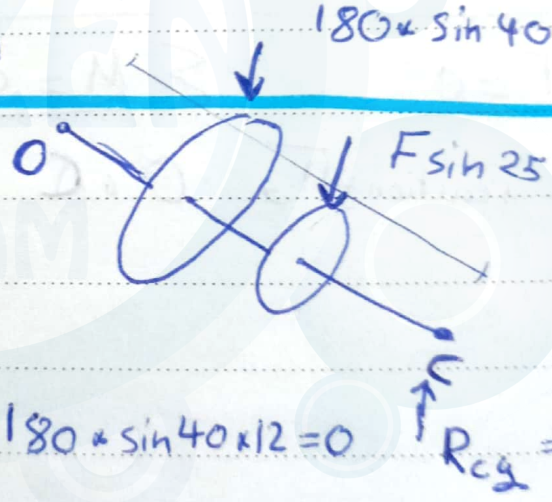
$$\frac{10}{2} * F\cos 25 - \frac{20}{2} * 180\cos 40 = 0$$

$$\boxed{F = 304.28}$$

بندور ع F باتجاه y

$$\Sigma M_{Oz} = 0$$





$$\hat{i} \times \hat{j} = -\hat{k}$$

$$+36 * R_{cy} - 26 * F\sin 45 - 180 * \sin 40 \times 12 = 0 \Rightarrow \hat{i} \times \hat{j} = \hat{k}$$

M

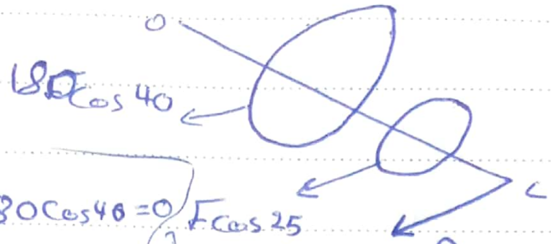
$$R_{cy} = 131.4$$

$$\Sigma F_y = 0$$

$$R_{cy} - F\sin 25 - 180\sin 40 + R_{oy} = 0$$

$$R_{oy} = 112.86$$

$\sum M_o^y$



$-36\, R_{cz} - 26 \times F \cos 25 - 180 \cos 40 = 0$

$\hat{i} \times k = -j \qquad R_{cz} \quad \hat{j} \times k = -\hat{j}$

$R_{cz} = 153.2$

$\sum F_z = 0$

$R_{oz} = \cancel{153.2}\ 15.136$

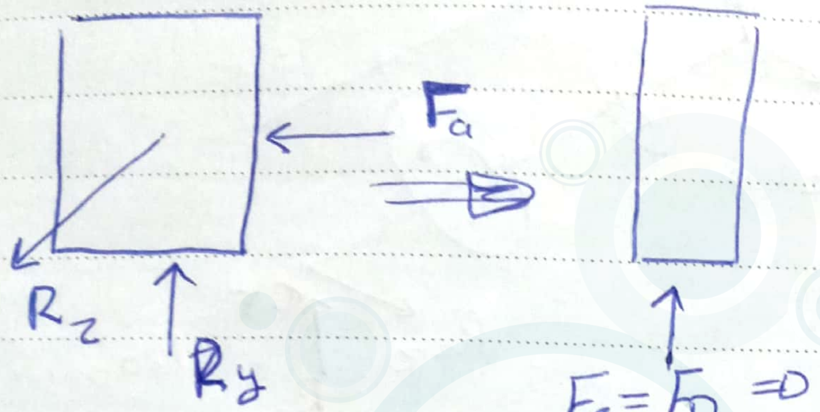
$R_o = \sqrt{R_{oz} + R_{oy}} = 114$

$R_c = \sqrt{153.2^2 + 131.4^2} = 201.8 \Leftarrow$ اعلى قيمة بستخدمها

$$C_{10} = a_f F_D \left[\frac{X_D}{x_o + (\theta - x_o)(\ln 1/R_D)^{1/b}} \right]^{1/a}$$

$$X_D = \frac{5000 \times 400 \times 60}{10^6} = 1200$$

11-6 Combined Radial and Thrust loading



$F_e = F_D$

equivalent desiard

لـ اذا كان outer ring ⇐ stationary و كان inner ring ⇐ rotating

يكون $V = 1$

لـ اذا كان outer ring ⇐ rotating و كان inner ring ⇐ stationary

يكون $V = 1.2$

$$\frac{F_a}{V F_r} \leq e \qquad X_1 = 1, \; Y_1 = 0$$

thrust ~~xxx~~ has no effect

example

$L_D = 10 * 1200$

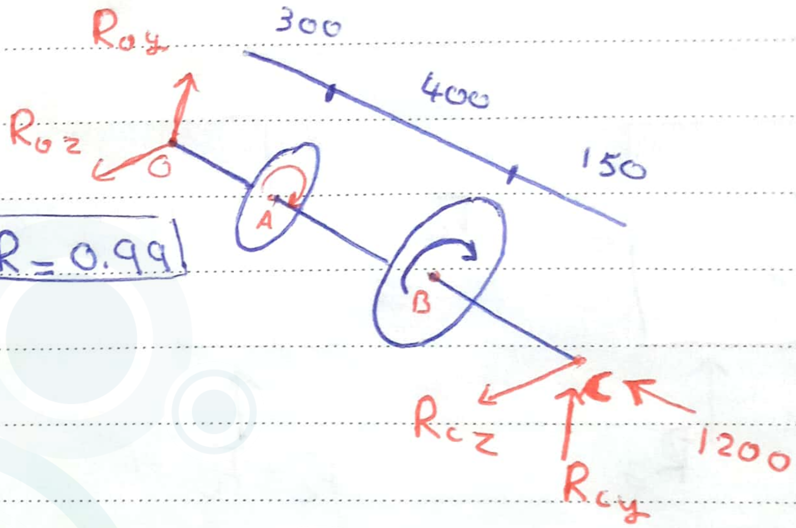
$R_D = 0.98$

$R_A R_B = R^2 = 0.98 \Rightarrow \boxed{R = 0.99}$

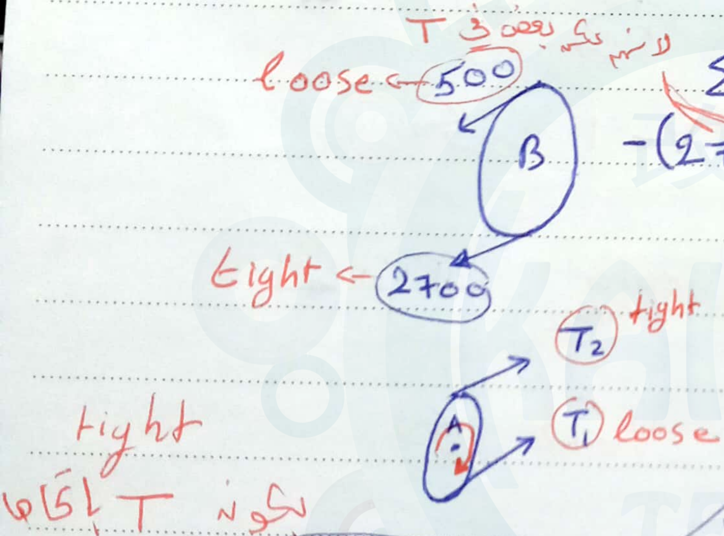
$b = 1.483$

$x_o = 0.2$

$\theta = 4.439 + 0.2$



$$\boxed{\Sigma T = 0 \quad \Sigma F = 0 \quad \Sigma M = 0}$$



$\Sigma T = 0$

$-(2700 - 500) * \frac{300}{2} + (T_1 - T_2) * \frac{250}{2} = 0$

$T_1 = 310.6\,N$

$T_2 = 46.6$

$T_2 = 0.15 T_1$

نعوض

نفس السلايد باقي الحل

بوخذ هاي

$\boxed{R_{oy} = 2918.97\,N}$

$R_c = 1958.4\,N$

$C \Rightarrow$ unknown $\Rightarrow$ assume $Y_2 = 1.63$

$X = 1$

$a = 3$

$\boxed{V = 1}$ إذا ما ذكر في السؤال بنوخذ

$\underline{F_e} = 3052.8\ N$

منه القانون

$\underline{C_{10}} = 44.52 \xRightarrow{\text{جدول}}$ Angular Contact $= 46.2$

منه القانون

سؤال جديد

$\frac{F_o}{C_o} = \frac{1.2}{28.5} = 0.0421 \xRightarrow{\text{منه الجدول}} e = 0.24 \Rightarrow Y_2$ منه الجدول

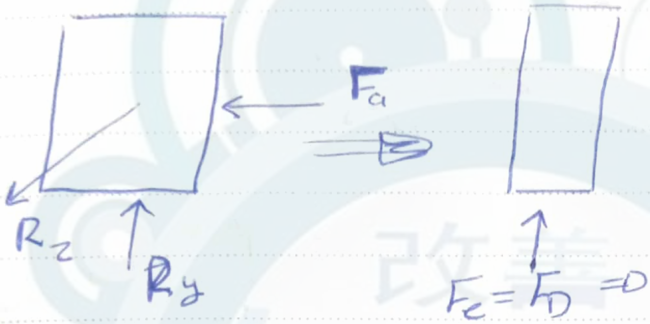
$F_a/(V F_r) = 1200/1 * 1958.4 = 0.61 > 0.24$

$F_e = \cancel{337}.68$ بنحسب مرة ثانية على القانون

$C_{10} = 48.35\ KN \xRightarrow{\text{منه الجدول}} 55.9$

وبنعيد لما يتساووا القيم C_o

11-6 Combined Radial and Thrust loading



$F_e = F_D = 0$

equivelnt desiord

لـ اذا كان outer ring ← stationary و كان inner ring ← rotating

يكون $V = 1$

لـ اذا كان outer ring ← rotating و كان inner ring ← stationary

تكون $V = 1.2$

$$\frac{F_a}{V F_r} \le e \qquad X_1 = 1 , \; Y_1 = 0$$

thrust ~~load~~ has no effect

example

$L_D = 10 * 1200$

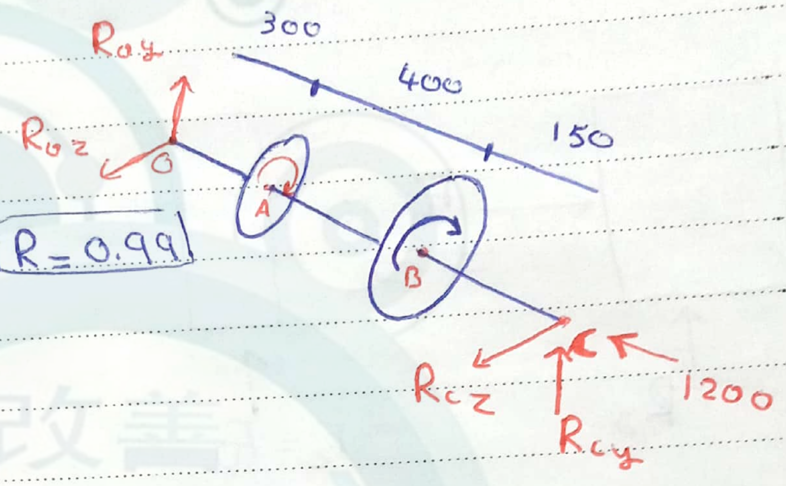
$R_D = 0.98$

$R_A R_B = R^2 = 0.98 \Rightarrow \boxed{R = 0.99}$

$b = 1.483$

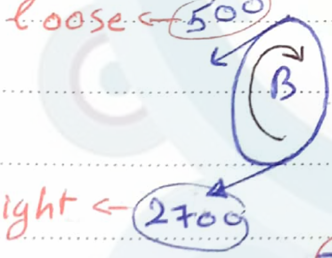
$x_0 = 0.2$

$\theta = 4.439 + 0.2$



$$\boxed{\sum T = 0 \qquad \sum F = 0 \qquad \sum M = 0}$$

T لانهم عكس بعض

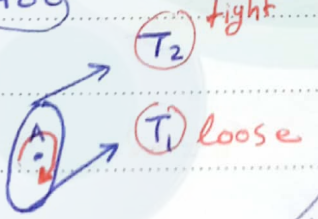


$\sum T = 0$

$-(2700 - 500) * \frac{300}{2} + (T_1 - T_2) * \frac{250}{2} = 0$

$T_1 = 310.6\ N$

$T_2 = 46.6$



tight

تكون T إيجابا

$\boxed{T_2 = 0.15 T_1}$ نعوض

نفس السلايد باقي الحل

نوجد هاي $\boxed{R_{oy} = 2918.97\ N}$

$R_c = 1958.4\ N$

$C \Rightarrow$ unknown $\Rightarrow$ assume $y_2 = 1.63$

$x = 1$

$a = 3$

$\boxed{V = 1}$ بداخل في الدوال بنوضح

$Fe = 3052.8\ N$

من القانون

$C_{10} = 44.52 \xrightarrow{\text{جدول}}$ Angular Contact $= 46.2$

من القانون

سؤال جديد

$\frac{F_o}{C_o} = \frac{1.2}{28.5} = 0.0421 \xrightarrow{\text{من الجدول}} e = 0.24 \xrightarrow{\text{من الجدول}} y_2 = 1.85$

$F_a/(V\,F_r) = 1200/1 \cdot 1958.4 = 0.61 > 0.24$

$Fe = 3317.68$ بنحسبه مرة ثانية على القانون

$C_{10} = 48.35\ KN \xrightarrow{\text{من الجدول}} 55.9$

وبنعوض فاينساوي القيم C_o

$C \Rightarrow$ unknown $\Rightarrow$ assume $y_2 = 1.63$
$x = 1$
$a = 3$

$\boxed{V = 1}$ إذا ما ذكر في السؤال بنوخذ

$\underline{Fe} = 3052.8\ N$
منه القانون

$\underline{C_{10}} = 44.52 \xrightarrow{\text{جدول}}$ Angular Contact $= 46.2$
منه القانون

سؤال جديد

$\frac{Fo}{C_o} = \frac{1.2}{28.5} = 0.0421 \xrightarrow{\text{منه الجدول}} e = 0.24 \xrightarrow{\text{منه الجدول}} y_2 = 1.8$

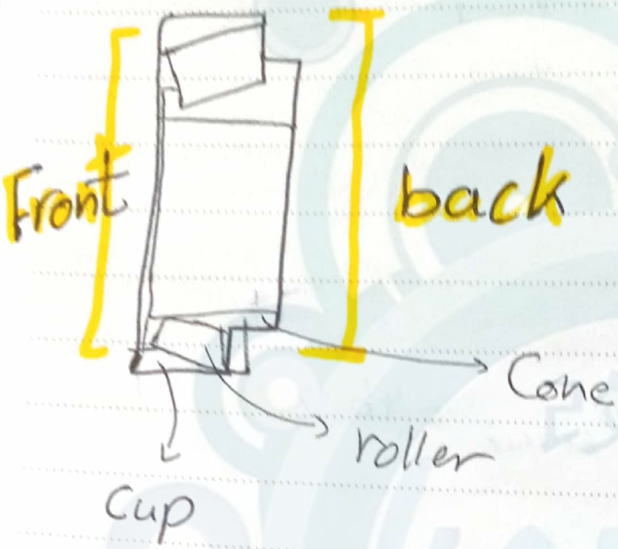
$Fa/(V\,Fr) = 1200/1 * 1958.4 = 0.61 > 0.24$

$Fe = 3\cancel{3}\cancel{7}.68$ بنحسبوه تانية على القانون

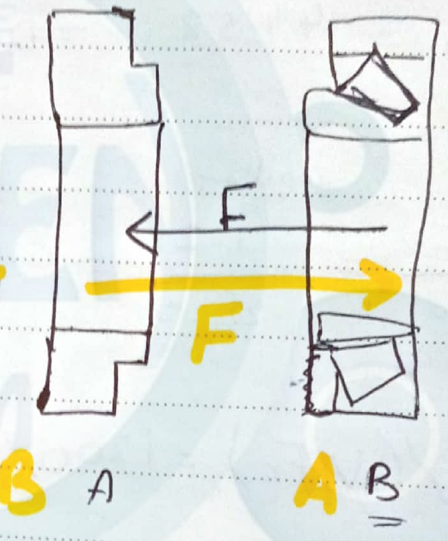
$C_{10} = 48.35\ KN \xrightarrow{\text{منه الجدول}} 55.9$

وبنعرف كم ما بتساووا القيم C_o

Tapered roller bearings

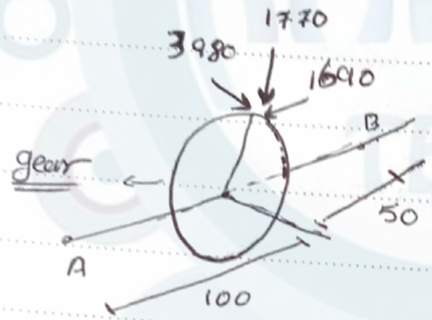


Face to Face (indirect)
back to back (direct)
Face to back عادي



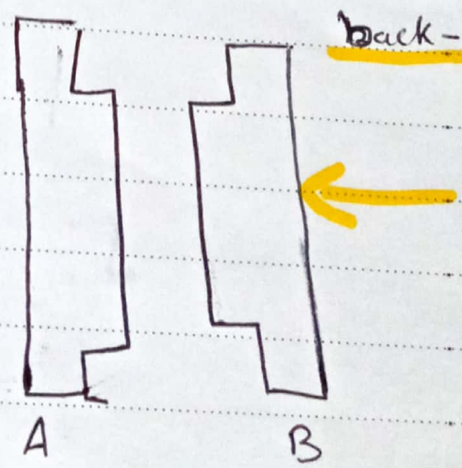
لأنو بدي مد Face الاول للثاني
سميناه A, B
اذا كان العكس بنعكس الاحرف

example



3980 Tangintional
1770 radial
1690 thrust force external

back - back



$\sum M = 0$ عند A, B نطلع reaction.

$F_{rB} = 2170\ N$

$F_{rB} = 2654\ N$

تابع

$K_A = K_B = 1.5$

$F_{oA} = \frac{0.47 F_{rA}}{K_A} = 680$

$F_{oB} = \frac{0.47 F_{rB}}{K_B} + 1690 = 2522$

$F_{iA} \le F_{iB} + F_{oe}$ ✓ $\xRightarrow{\text{نوخذ هاي المعادلة}}$ $F_{eA} = 0.4 F_{rA} + K_A \left(\frac{0.47 F_{rB} + F_{oe}}{K_B} \right)$

$F_{eB} = F_{rB}$

$F_{eA} = 4651$

$F_{eB} = F_{rB} = 2654$

هاي أكبر فبنستخدمها لحساب C_{10}

$C_{10} = 11486 N \xRightarrow[\text{radial في}]{\text{Table في}}$ Cone 15101 Cup 15243

بنعيد باستخدام $K = 1.67$

$F_{oA} = 611$

$F_{oB} = 2437$ ← هاي أكبر تحقق الشرط الاول

$F_{eA} = 4938 N$ → $C_{10} = 6554 N$

$F_{eB} = 2654 N$

Tab.1 في

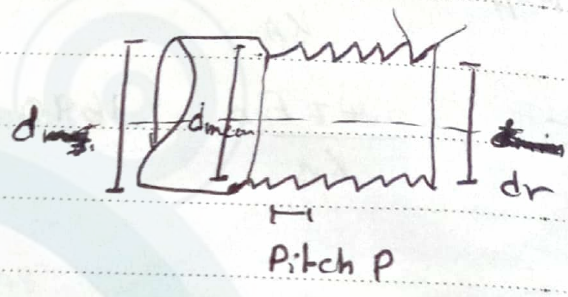
cone 15101

Cup 15243

Ch8

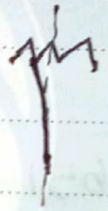
$\boxed{8\text{-}1}$ Thread standards and def.

Thread angle $2\alpha = 60°$



mean diameter $= \dfrac{d + d_r}{2}$

double thread $L = 2p$
~~triable~~ thread $L = 3p$

right hand إذا كانت ميلان الأسنان للشمال بكون 
left hand " للمين " " " "

Standardization

UNR MJ

radius لتقليل ~~[illegible]~~

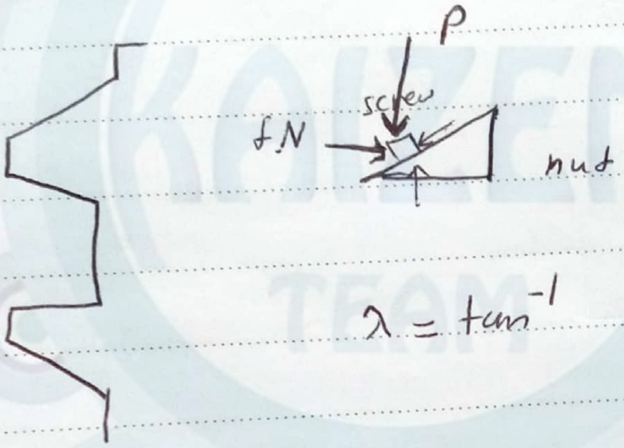
pitch in UNF ~~is~~ less than UNC

Power screw

we have tow conditions :-

→ nut fixed , screw move
→ " move , " fixed

load analysis For seyuor



$\lambda = \tan^{-1}$

Raising اعلى load بتنزله ~~screw~~ screw

lowering ~~lowering~~ اقل load بتنزله screw

$P_R > P_L$

$T_L > 0$ حتى نقدر ندفع الجسم لاعلى معطيا إياه