ElCoM
ELECTRICAL COMPUTER MECHATRONICS

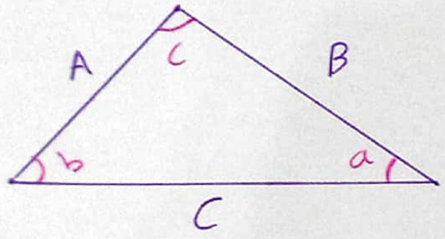
تلخيص

ميكانيكا هندسية

للطالب المبدع
محمود مجدلاني

إرادة - ثقة - تغيير

Chapter 2

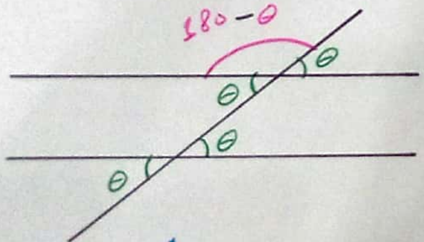


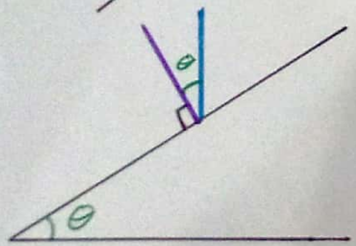
Cosine law

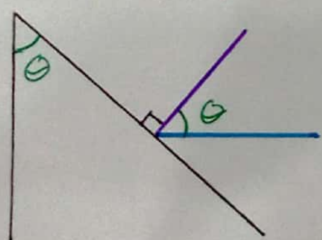
$$C = \sqrt{A^2 + B^2 - 2AB\cos c}$$

Sine law

$$\frac{A}{\sin(a)} = \frac{B}{\sin(b)} = \frac{C}{\sin(c)}$$







- $\cos\alpha = \frac{A_x}{|A|}$
- $\cos\beta = \frac{A_y}{|A|}$
- $\cos\gamma = \frac{A_z}{|A|}$

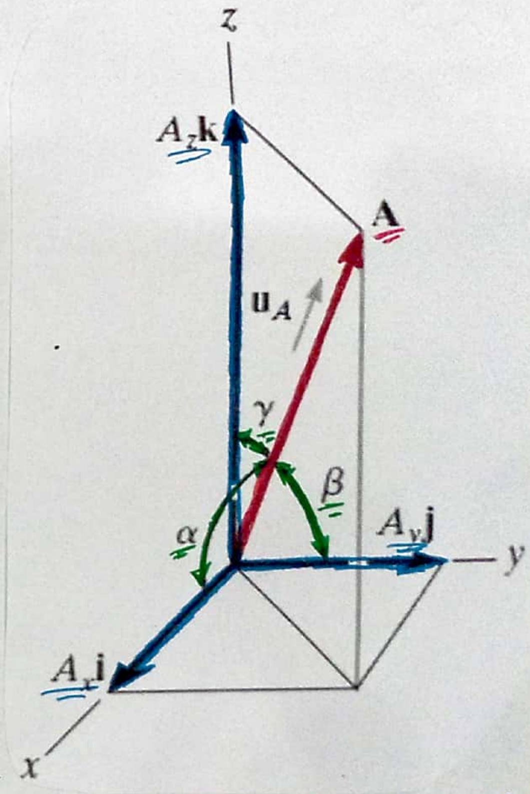
unit vector

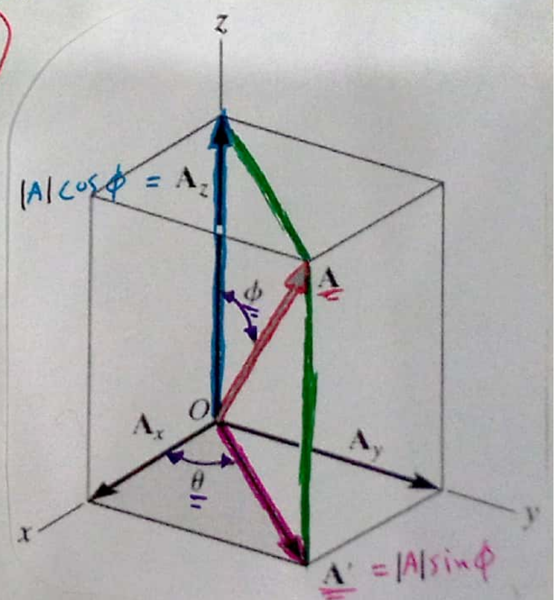
u_A:
- $\frac{\vec{A}}{|A|} \rightarrow \frac{A_x}{|A|}\hat{i} + \frac{A_y}{|A|}\hat{j} + \frac{A_z}{|A|}\hat{k}$
- $\cos\alpha\,\hat{i} + \cos\beta\,\hat{j} + \cos\gamma\,\hat{k}$

$\vec{A}$:
- $|A|\,u_A$
- $A\cos\alpha\,\hat{i} + A\cos\beta\,\hat{j} + A\cos\gamma\,\hat{k}$
- $A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

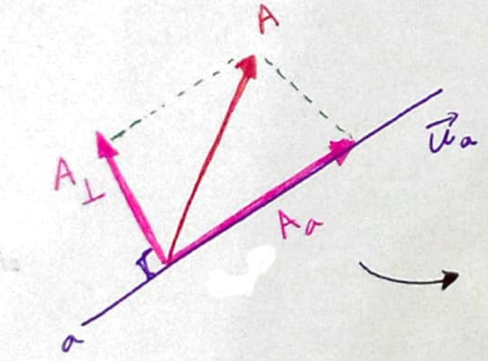
♦ $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

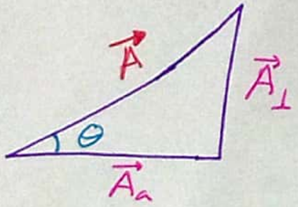
$A' = |A|\sin\phi$
- $A_x = A'\cos\theta$
- $A_y = A'\sin\theta$





Chapter 2



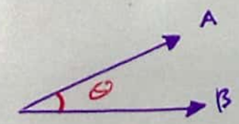


- A_a → $A \cos\theta$
  → $\vec{A} \cdot \vec{u}$

- $|A_\perp| = \sqrt{A^2 - A_a^2}$
  $\vec{A}_\perp = \vec{A} - \vec{A}_a$

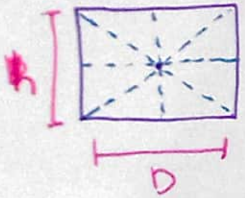
- $\theta = \cos^{-1}\left(\frac{A_a}{A}\right)$

- $\theta = \cos^{-1}\left(\frac{A \cdot B}{|A||B|}\right)$



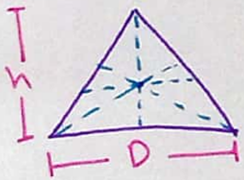
→ $0 \le \theta \le 180$

Chapter 9



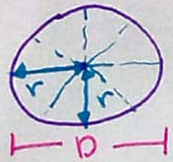
$\bar{x} = \frac{D}{2}$

$\bar{y} = \frac{h}{2}$

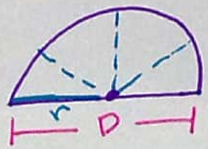


$\bar{x} = \frac{D}{2}$

$\bar{y} = \frac{h}{3}$

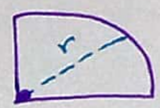


$\bar{x} = \bar{y} = r$



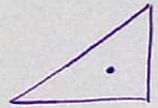
$\bar{x} = r$

$\bar{y} = \frac{4r}{3\pi}$



$\bar{x} = \frac{4r}{3\pi}$

$\bar{y} = \frac{4r}{3\pi}$



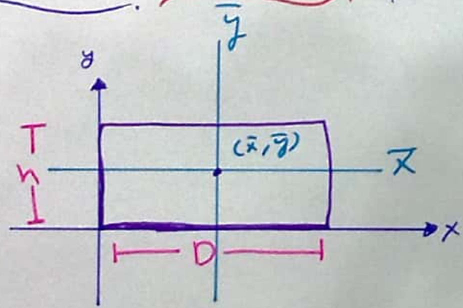
$\bar{x} = \frac{b}{3}$

$\bar{y} = \frac{h}{3}$

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

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

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



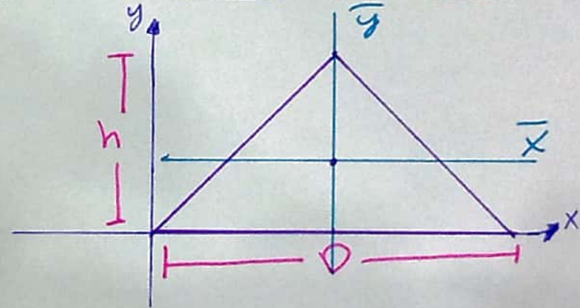
$I_{\bar{x}} = \frac{Dh^3}{12}$

$I_{\bar{y}} = \frac{hD^3}{12}$

centroidal axis

$I_x = \frac{Dh^3}{3}$

$I_y = \frac{hD^3}{3}$



$I_{\bar{x}} = \frac{Dh^3}{36}$

$I_{\bar{y}} = \frac{hD^3}{36}$

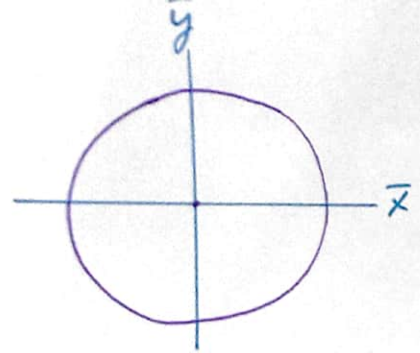
centroida axis

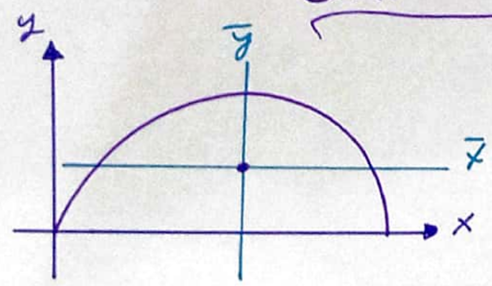
$I_x = \frac{Dh^3}{12}$

$I_y = \frac{hD^3}{12}$

- $I_x = I_{\bar{x}} + d^2 A$
- $I_y = I_{\bar{y}} + d^2 A$

Chapter 9+10





$$I_{\bar{x}} = I_{\bar{y}} = \frac{1}{4}\pi r^4$$

centroidal axis

$$I_{\bar{x}} = \frac{1}{8}\pi r^4$$

$$I_x = \frac{1}{8}\pi r^4 + \frac{8}{9\pi} r^4$$

chapter (1-5)

Normal stress

- $\sigma_z = \lim_{\Delta A \to 0} \frac{\Delta F_z}{\Delta A}$

Shear stress

- $\tau_{zx} = \lim_{\Delta A \to 0} \frac{\Delta F_x}{\Delta A}$
- $\tau_{zy} = \lim_{\Delta A \to 0} \frac{\Delta F_y}{\Delta A}$

Avg. Normal stress

- $\sigma = \frac{N_{max}}{A}$ [Pa]

Avg. shear stress

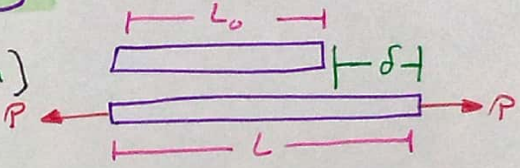
- $\tau_{avg} = \frac{V}{A}$ (Pa)

Factor of safety

- $F.S = \frac{F_{fail}}{F_{allow}} = \frac{\sigma_{fail}}{\sigma_{allow}} = \frac{\tau_{fail}}{\tau_{allow}}$

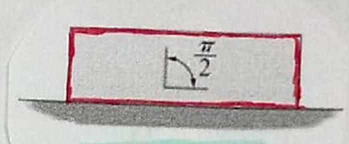
Avg. Normal strain

- $\varepsilon_{avg} = \frac{L_{new} - L_{old}}{L_{old}}$ [m/m]

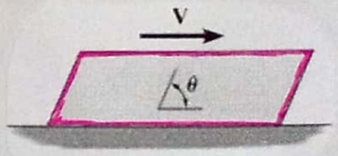


shear strain

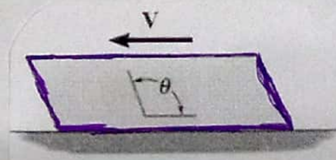
- $\gamma = \frac{\pi}{2} - \theta$



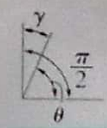
Undeformed body



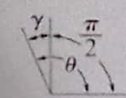
Deformed body



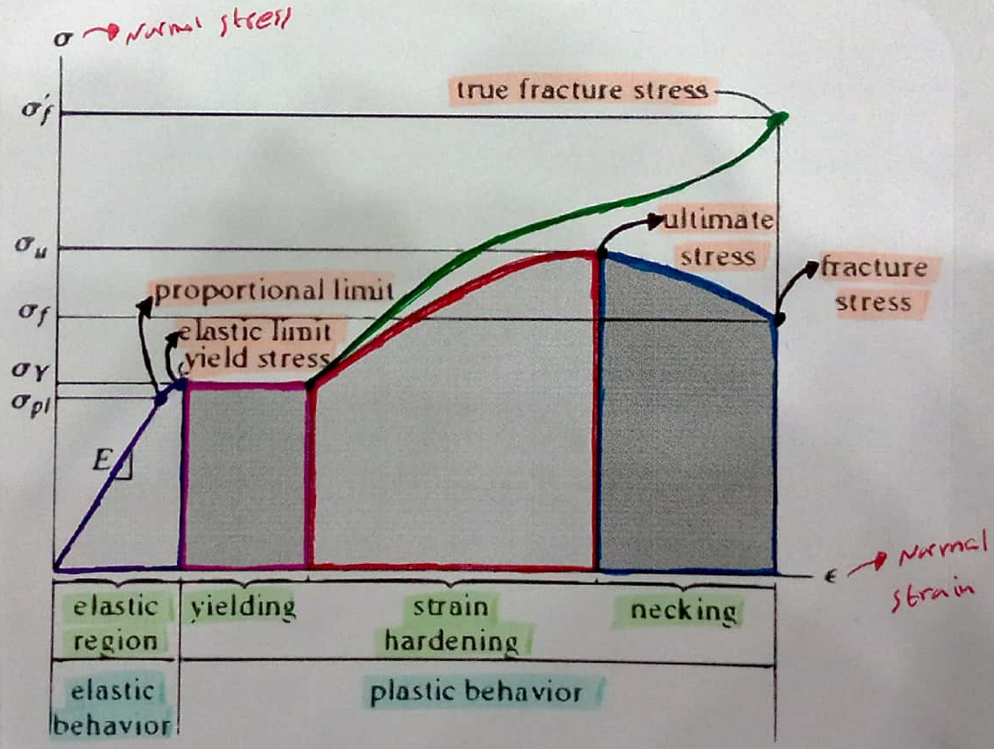
Deformed body



Positive shear strain γ



Negative shear strain γ



Conventional and true stress–strain diagram for ductile material (steel) (not to scale)

Conventional Stress-Strain Diagram

◆ $\sigma = \dfrac{P}{A_0}$ ← بحكي عن القوة من العرضية لما يكون بال yielding, ultimate, ...

Normal, Engineering strain

◆ $\epsilon_{Long} = \dfrac{\delta}{L_0}$

Hook's law

◆ $\sigma = E\,\epsilon_{Long/PL}$ $\qquad E = \dfrac{\Delta\sigma}{\Delta\epsilon}$

E → Modulus of elasticity, Young modulus

◆ $\tau = G\,\gamma$

G → shear modulus of elasticity, modulus of rigidity

◆ $G = \dfrac{\tau_{PL}}{\gamma_{PL}}$ ⟹ في حال أعطاني السحة ⟹

↓ Pa

◆ $G = \dfrac{E}{2(1+V)}$

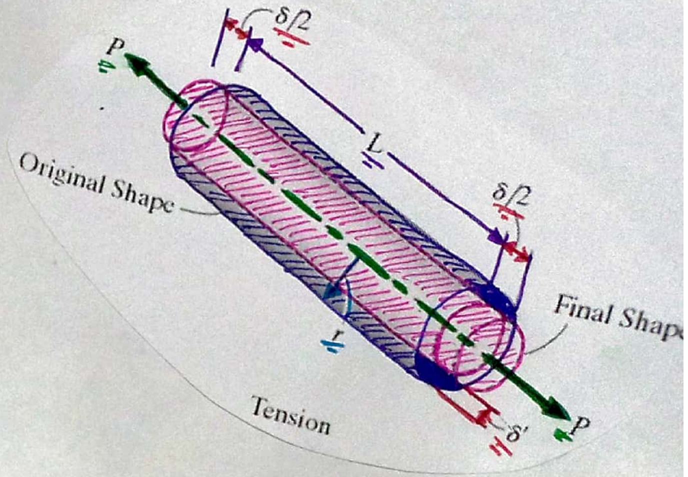
↓ Pa

Poisson's ratio

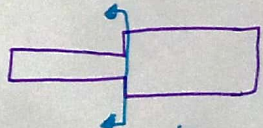
* $V = -\dfrac{\epsilon_{lat}}{\epsilon_{Long}}$

→ $\epsilon_{Long} = \dfrac{\delta}{L}$

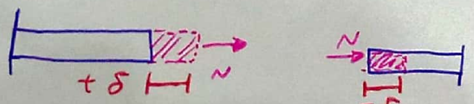
→ $\epsilon_{lat} = \dfrac{\delta'}{r}$



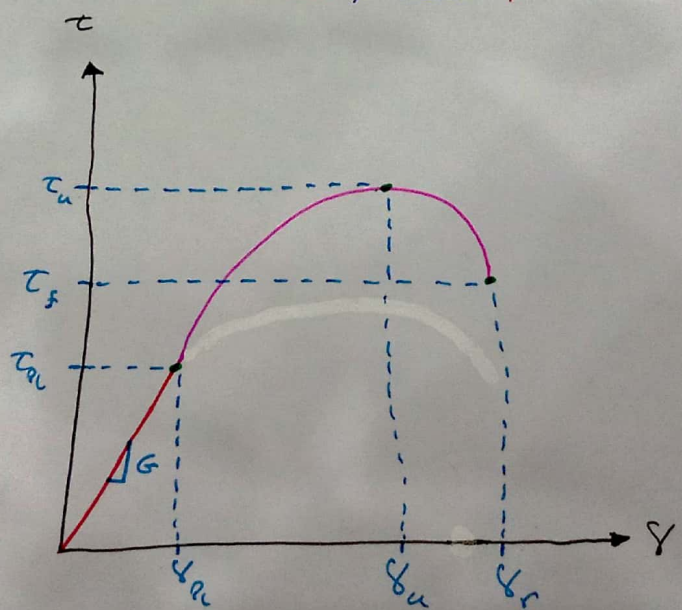
* $\delta = \sum \dfrac{NL}{AE}$

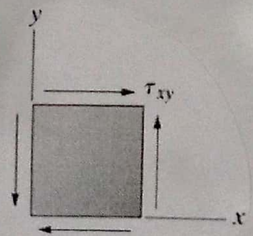


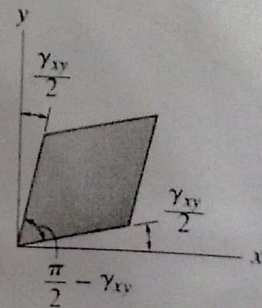
لأنه تغيرت المساحة



* yielding = E = σ_y







Chapter (1-5)

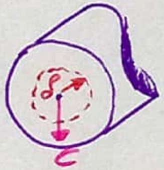
Torsion formula

$$\tau_{max} = \frac{T}{J} c$$

N-m

$$\tau = \frac{T}{J} \rho$$

Polar moment of inertia



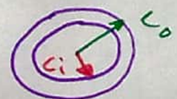
$$\gamma = \left(\frac{\rho}{c}\right) \gamma_{max}$$

$$\tau = \left(\frac{\rho}{c}\right) \tau_{max}$$

Polar Moment of inertia

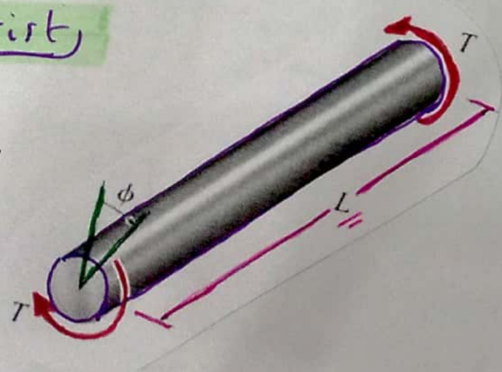
$$J_s = \pi/2 \; c^4 \quad m^4$$

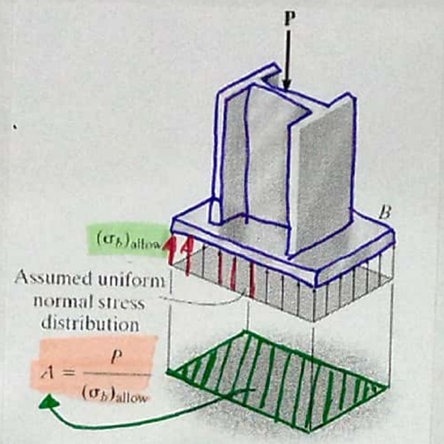
$$J_t = \pi/2 \; (c_o^4 - c_i^4)$$



Angle of twist

$$\phi = \sum \frac{TL}{JG}$$



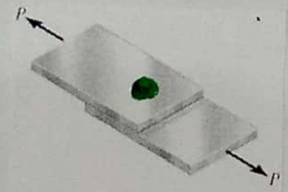


The area of the column base plate B is determined from the allowable bearing stress for the concrete.

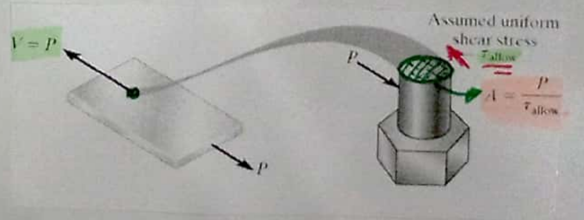
$$A = \frac{P}{(\sigma_b)_{allow}}$$

The embedded length l of this rod in concrete can be determined using the allowable shear stress of the bonding glue.

$$L = \frac{P}{\pi d \; \tau_{allow}}$$



The area of the bolt for this lap joint is determined from the shear stress, which is largest between the plates.



$$A = \frac{P}{\tau_{allow}}$$

Chapter(6+7)

fluxer formula

$$\sigma_{max} = \frac{Mc}{I}$$

Normal stress at any distance

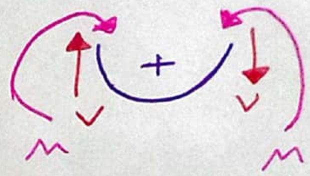
$$\sigma = -\frac{My}{I}$$

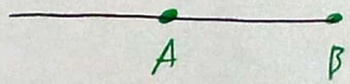
* Note

- $-\sigma$ → combrifion
- $+\sigma$ → Tension

Shear formula

$$\tau = \frac{VQ}{It}$$





A → إذا كانت ال M
مع عقارب الساعة ↻
فتحتها ⊕

B → وعكس فتحتها ⊖