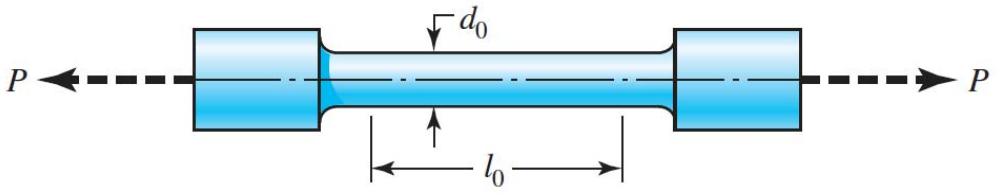
دانشگاه سمنان، دانشکده مکانیک

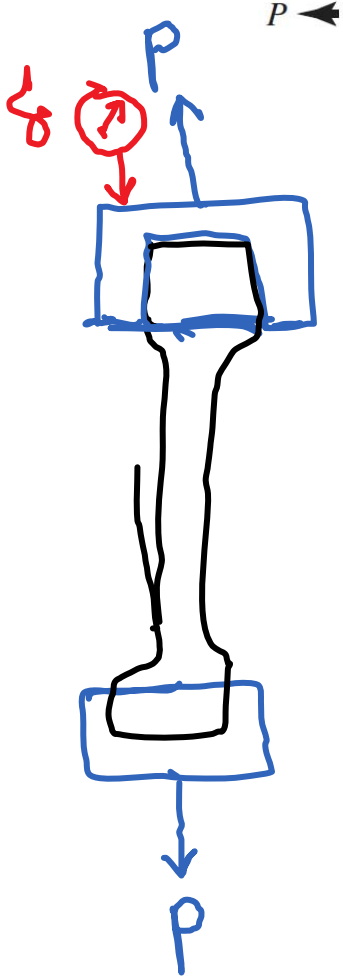
طراحی اجزاء ۱

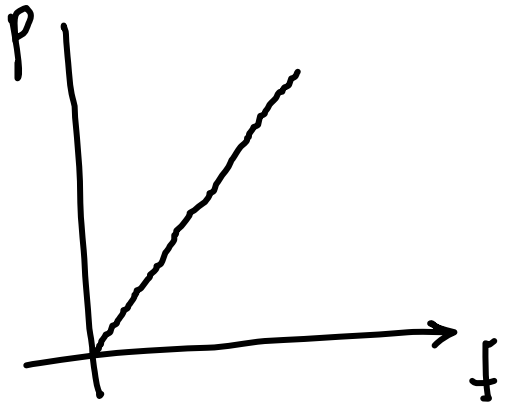
فصل دوم: مواد

مدرس: دکتر نیکوبین

رابطه بین تنش و کرنش از آزمایش کشش







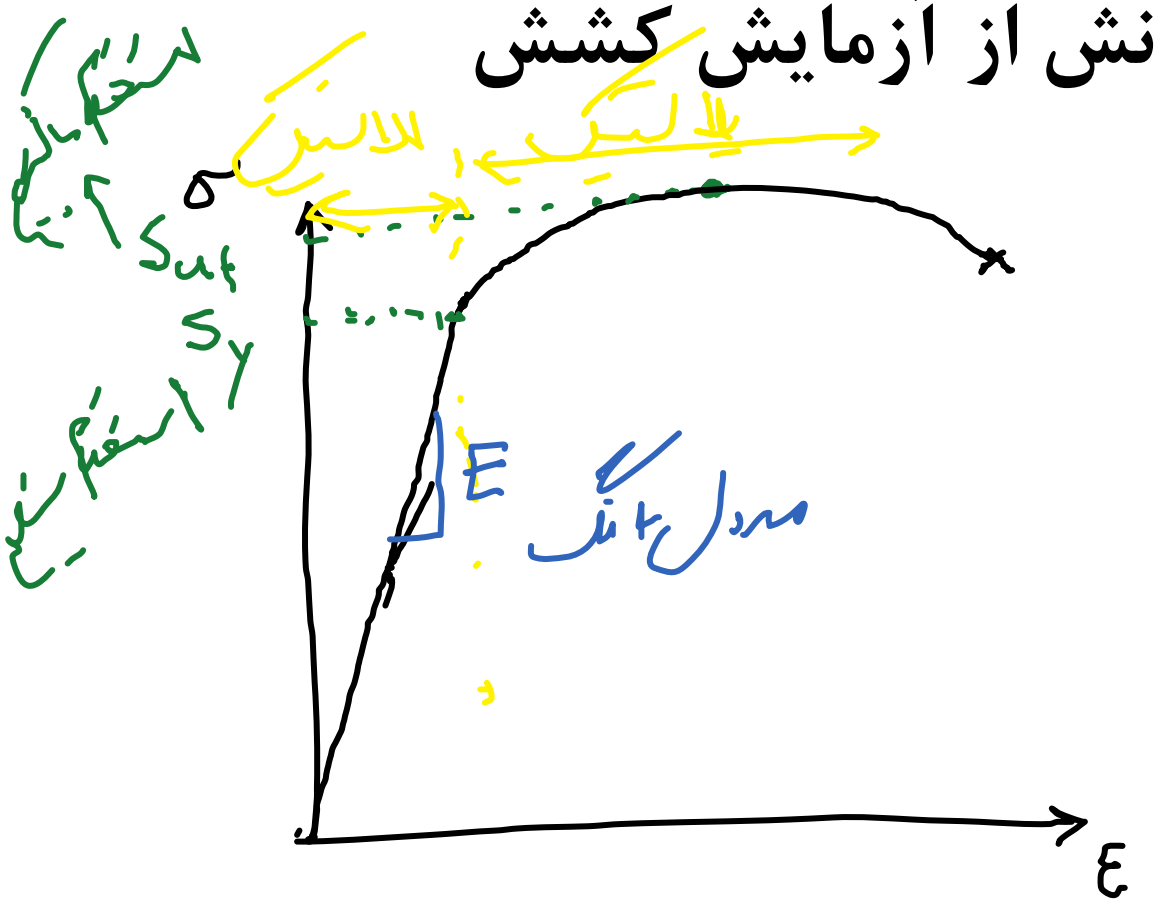
$$A = \frac{\pi d_0^2}{4}$$

$$\sigma = \frac{P}{A_0} \quad \frac{N}{m^2} \quad (Pa)$$

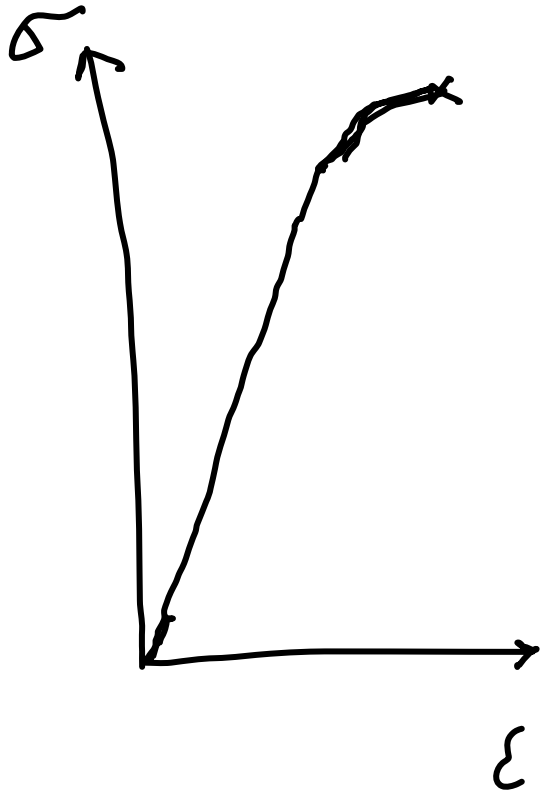
$$l_0 \longrightarrow l_0 + \Delta l \qquad \varepsilon = \frac{\Delta l}{l_0}$$

بی بعد

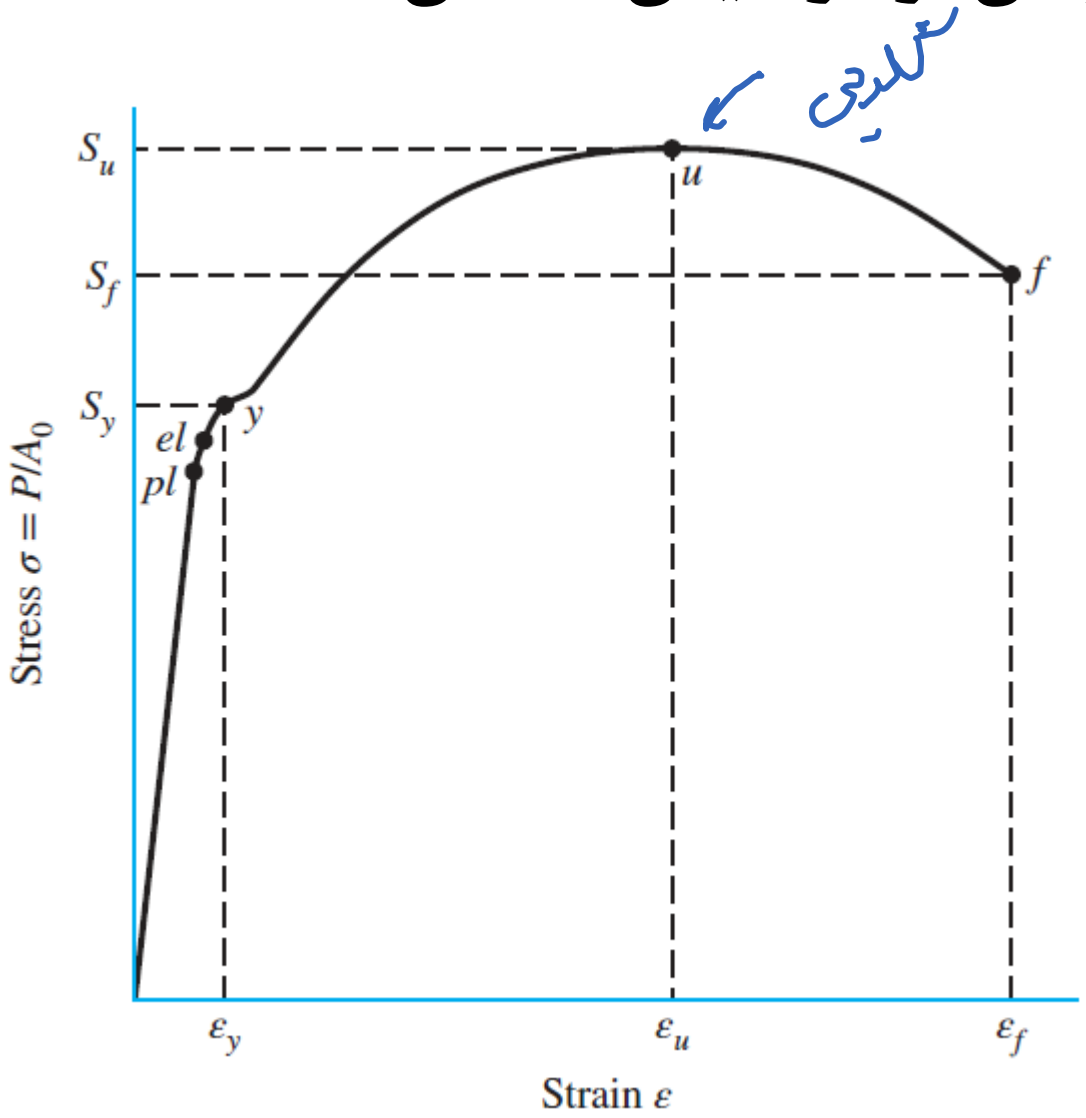
رابطه بین تنش و کرنش از آزمایش کشش



$\sigma = E\varepsilon$

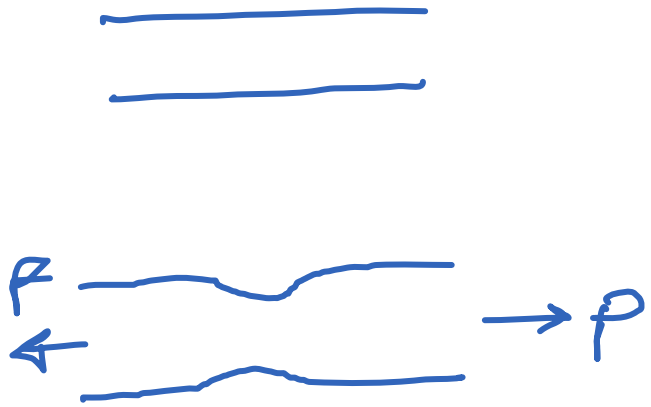


رابطه بین تنش و کرنش از آزمایش کشش



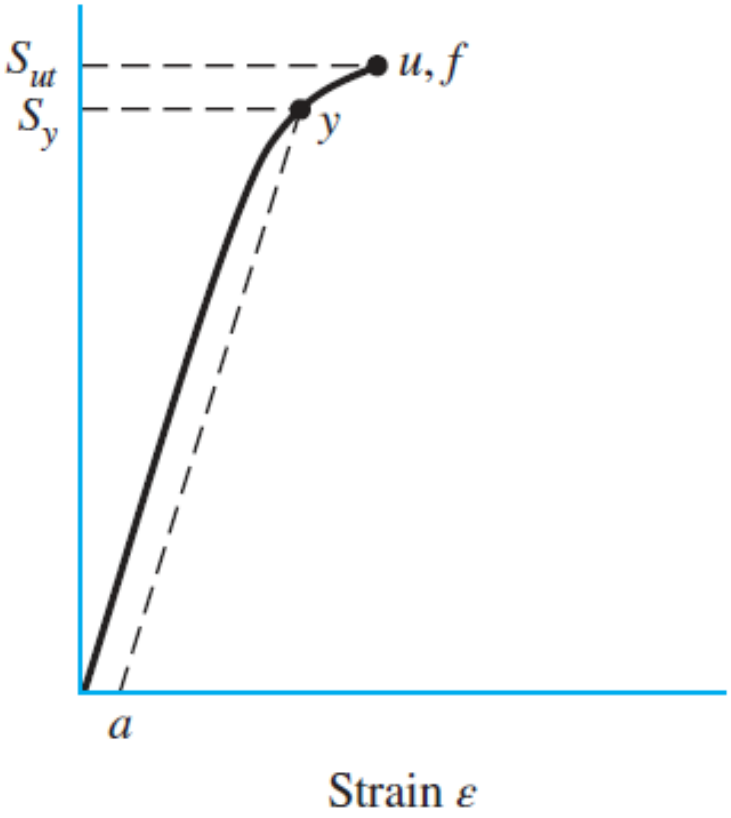
مواد نرم

Yeild point



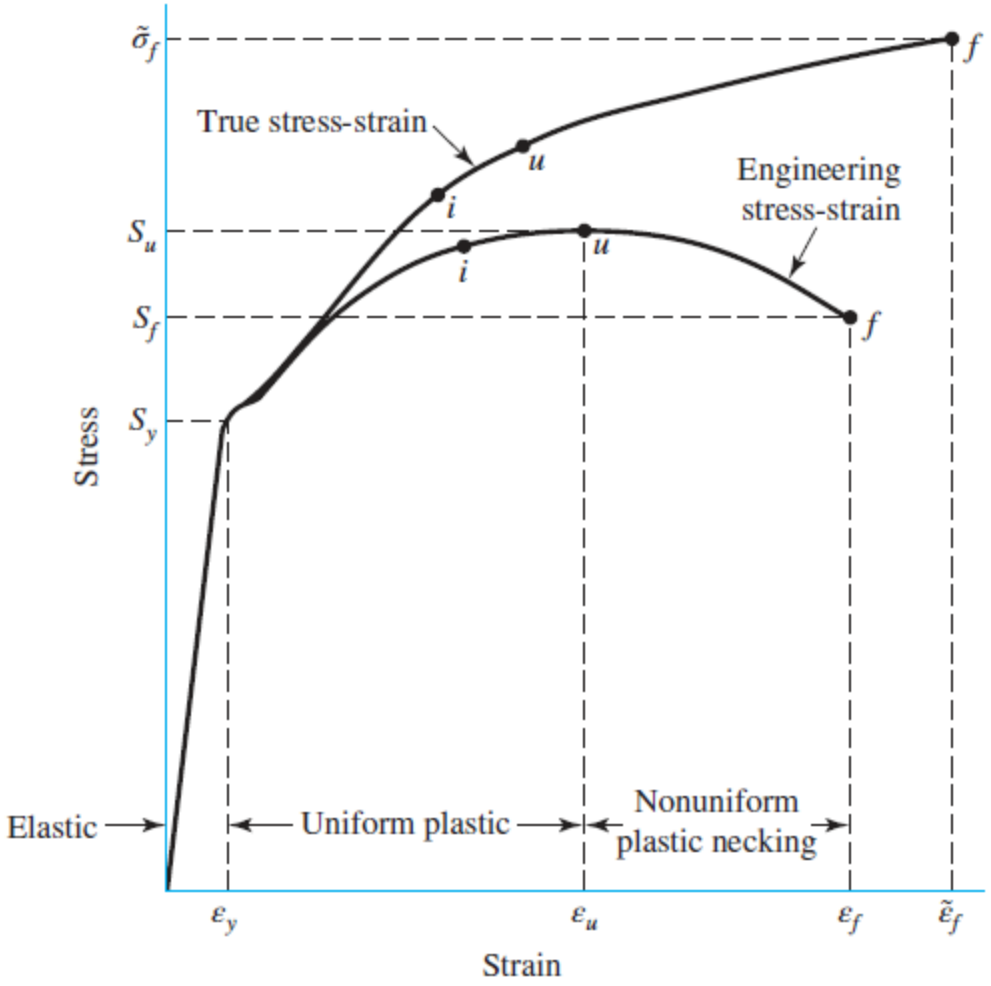
رابطه بین تنش و کرنش از آزمایش کشش

مواد ترد



$\alpha = 0.2\% \Rightarrow 0.002$

رابطه بین تنش و کرنش از آزمایش کشش



تنش کرنش حقیقی

مهندسی

$$\sigma = \frac{P}{A_0}$$

$$\tilde{\sigma} = \frac{P}{A}$$

$$\varepsilon = \frac{\Delta L}{L_0}$$

رابطه بین تنش و کرنش از آزمایش کشش

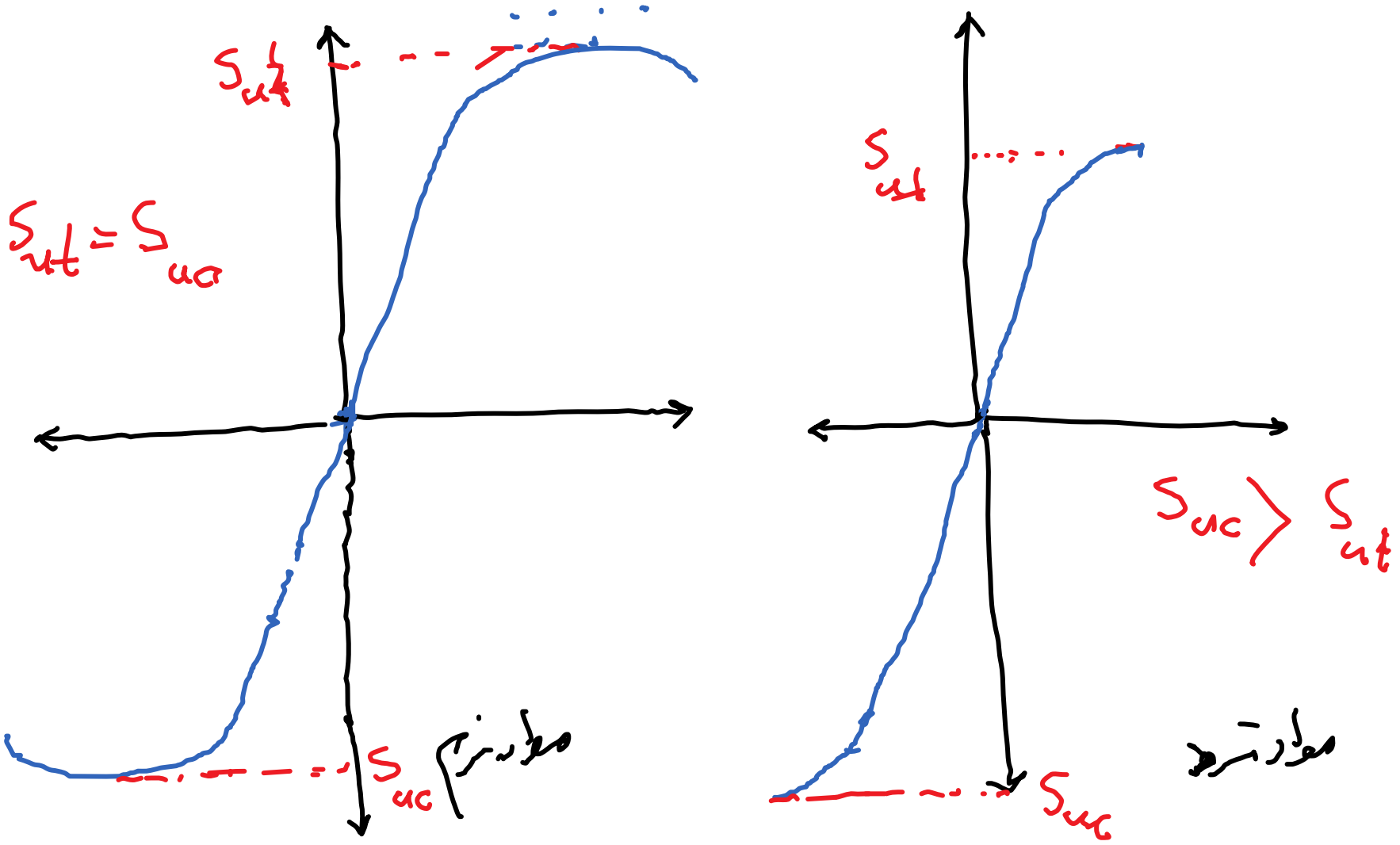
مهندسی

$$\begin{cases} \sigma = \dfrac{P}{A_0} \\ \varepsilon = \dfrac{\Delta l}{l_0} \end{cases}$$

حقیقی

$$\begin{cases} \tilde{\sigma} = \dfrac{P}{A} \\ \tilde{\varepsilon} = \sum \dfrac{\Delta l_i}{l_i} = \sum \dfrac{\Delta l_i}{l_0 + \Delta l_i} = \int \dfrac{dL}{L} = \ln \dfrac{l}{l_0} \end{cases}$$

رابطه بین تنش و کرنش از آزمایش کشش



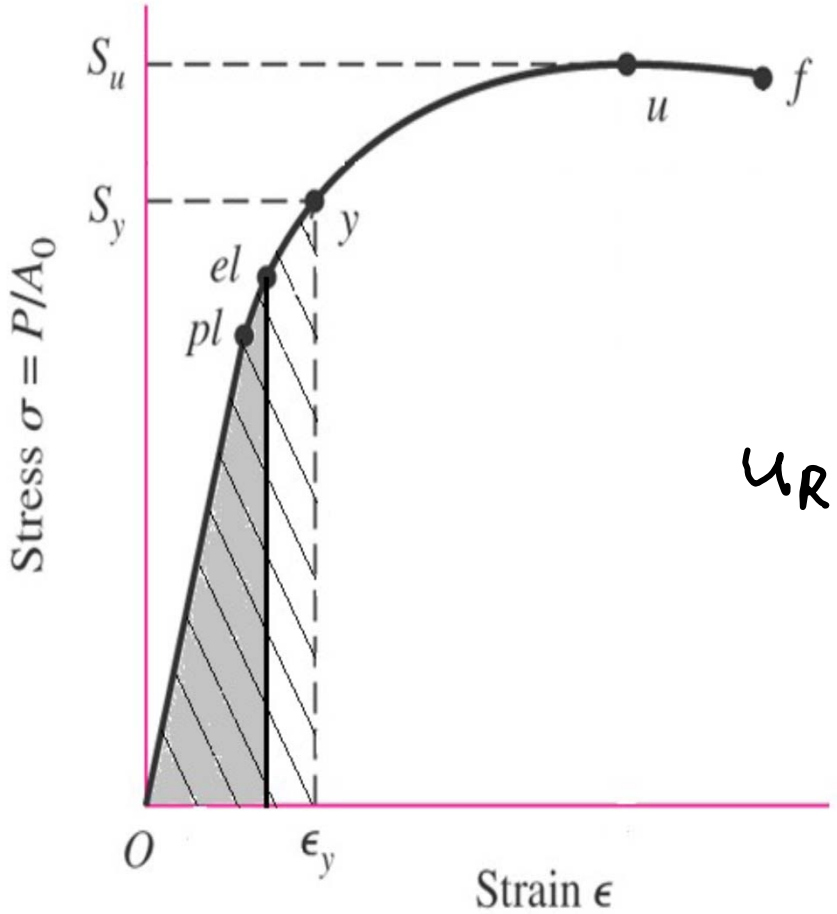
Resilience

جهندگی

$E_{\text{فولاد}} = 210\ GPa$

$E_{Al} = 70\ GPa$

ظرفیت ماده برای جذب انرژی در ناحیه خطی



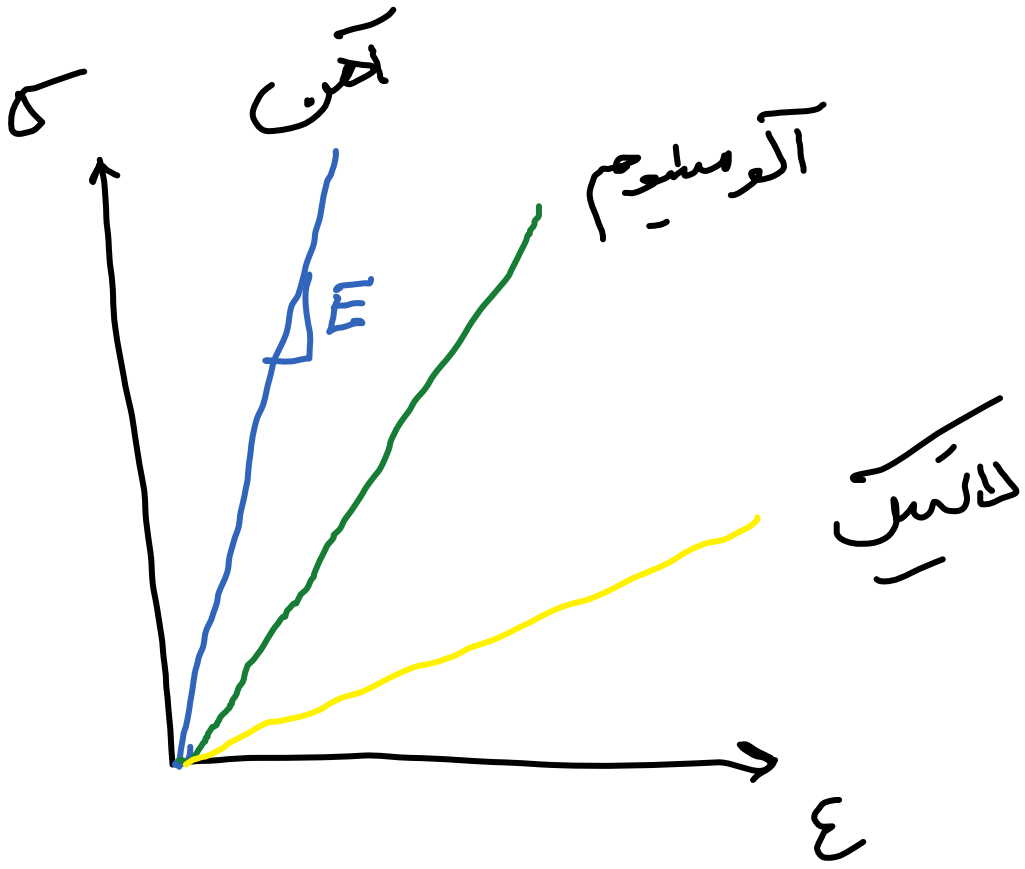
$$u_R \cong \int_0^{\varepsilon_y} \sigma \, d\varepsilon \qquad \sigma = E\varepsilon$$

$$u_R = \frac{1}{2} S_y \varepsilon_y = \frac{1}{2} S_y \left(\frac{S_y}{E}\right)$$

$$\Rightarrow u_R \cong \frac{1}{2} \frac{S_y^2}{E}$$

stiff

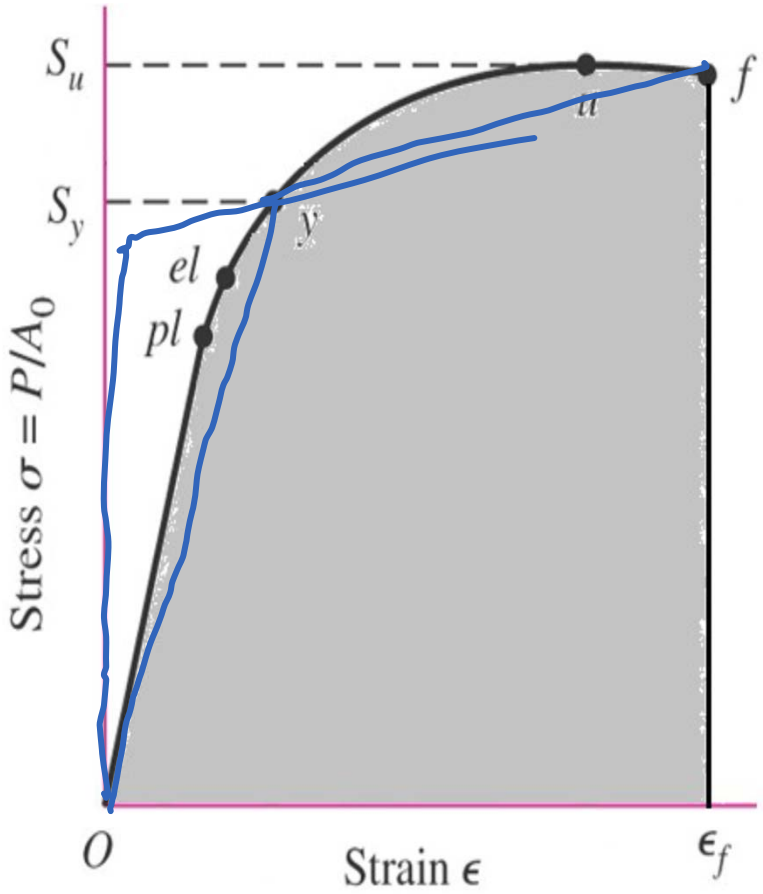
Resilience جهندگی



Toughness

چقرمگی

ظرفیت کل ماده برای جذب انرژی

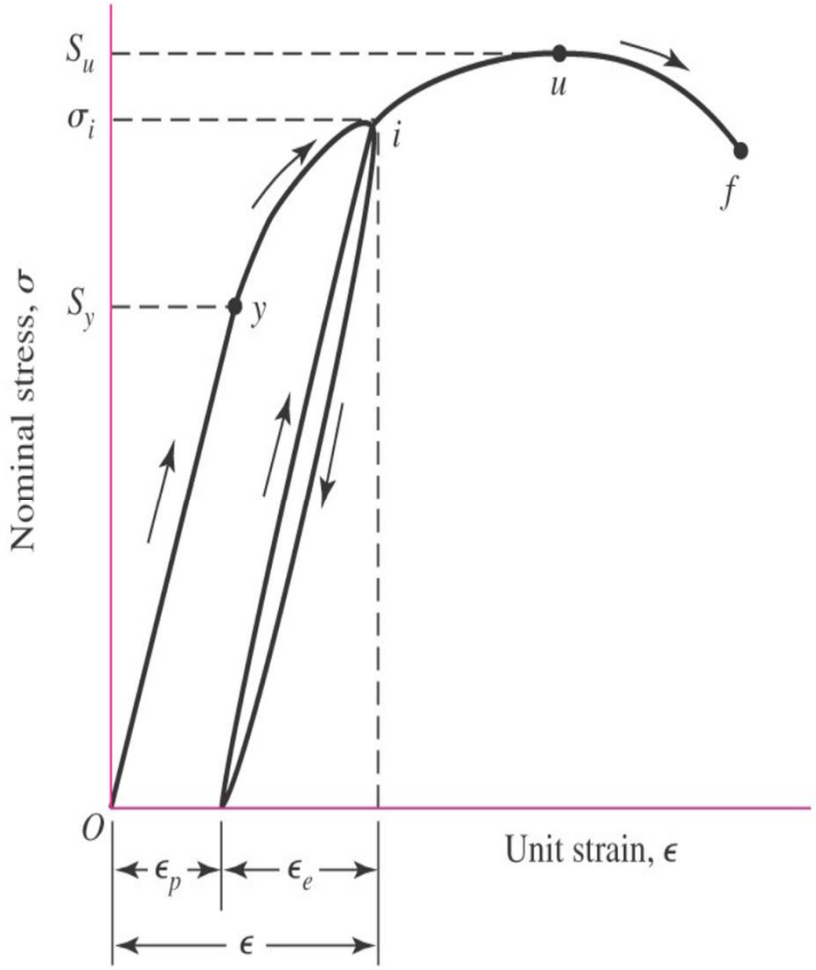


$$u_T = \int_0^{\epsilon_f} \sigma \, d\epsilon$$

$$u_T \cong \left(\frac{S_y + S_u}{2} \right) \epsilon_f$$

Cold work

کار سرد



سخت کاری کرنشی

ماده ترد ترمی شود

Hardness سختی

مقاومت ماده در برابر نفوذ یک ابزار نقطه ای

Two most common hardness-measuring systems

- Rockwell
  - A, B, and C scales
  - Specified indenters and loads for each scale
  - Hardness numbers are relative
- Brinell
  - Hardness number H_B is the applied load divided by the spherical surface area of the indentation

Hardness

سختی

فولادها

$$S_u = \begin{cases} 0.5\,H_B & \text{kpsi} \\ 3.4\,H_B & \text{MPa} \end{cases}$$

چدن

$$S_u = \begin{cases} 0.23\,H_B - 12.5\ \text{kpsi} \\ 1.58\,H_B - 86\ \text{MPa} \end{cases}$$

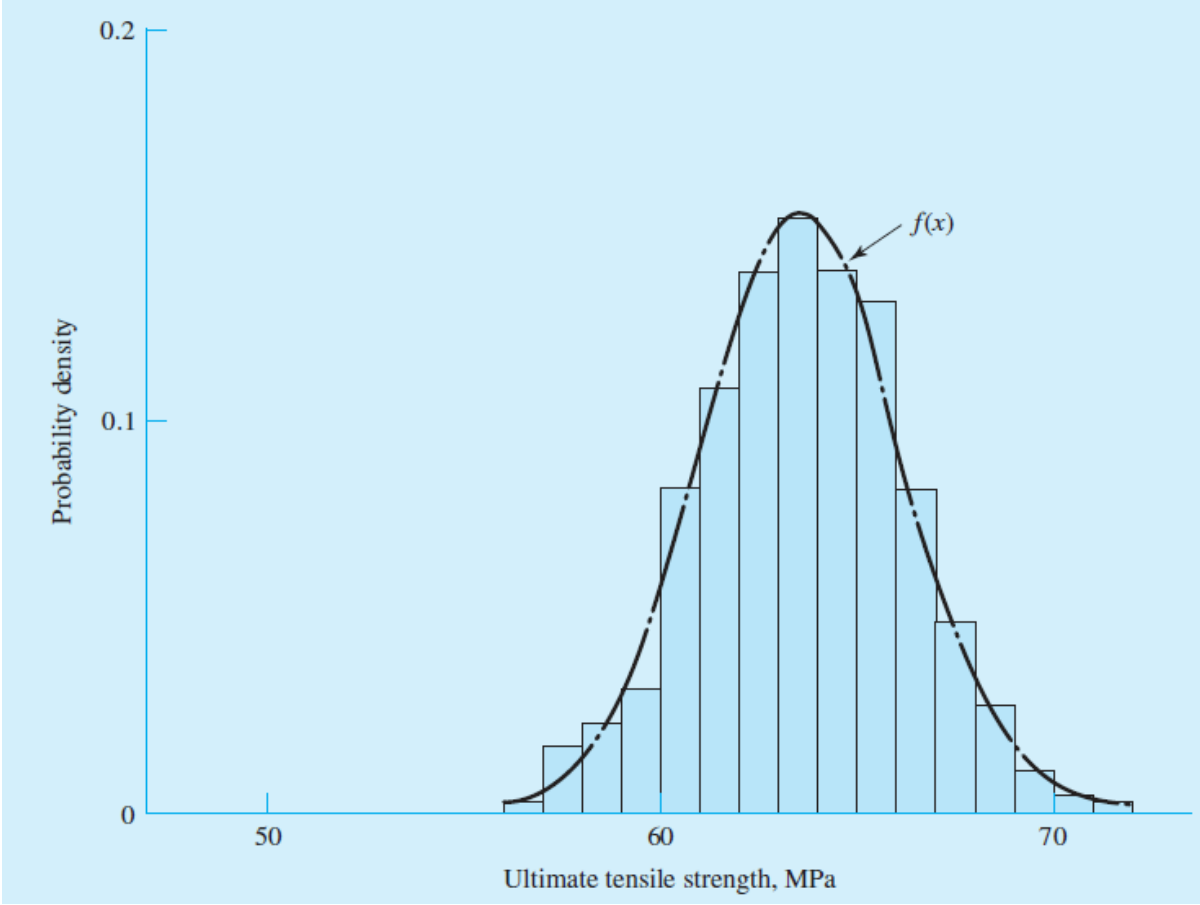
ماهیت آماری خواص مواد

EXAMPLE 2–1

One thousand specimens of 1020 steel were tested to rupture, and the ultimate tensile strengths were reported as follows:

Range midpoint S_{ut} (MPa)	56.5	57.5	58.5	59.5	60.5	61.5	62.5	63.5	64.5	65.5	66.5	67.5	68.5	69.5	70.5	71.5
Frequency, f_i	2	18	23	31	83	109	138	151	139	130	82	49	28	11	4	2

ماهیت آماری خواص مواد



سیستمهای نام گذاری مواد

- Society of Automotive Engineers (SAE)
- American Iron and Steel Institute (AISI)
- Unified Numbering System (UNS)
- American Society for Testing and Materials (ASTM) for cast irons

- UNS system established by SAE in 1975
- Letter prefix followed by 5 digit number
- Letter prefix designates material class
  - G – carbon and alloy steel
  - A – Aluminum alloy
  - C – Copper-based alloy
  - S – Stainless or corrosion-resistant steel

سیستمهای نام گذاری مواد

- For steel, letter prefix is G
- First two numbers indicate composition, excluding carbon content

G10	Plain carbon	G46	Nickel-molybdenum
G11	Free-cutting carbon steel with more sulfur or phosphorus	G48	Nickel-molybdenum
		G50	Chromium
G13	Manganese	G51	Chromium
G23	Nickel	G52	Chromium
G25	Nickel	G61	Chromium-vanadium
G31	Nickel-chromium	G86	Chromium-nickel-molybdenum
G33	Nickel-chromium	G87	Chromium-nickel-molybdenum
G40	Molybdenum	G92	Manganese-silicon
G41	Chromium-molybdenum	G94	Nickel-chromium-molybdenum
G43	Nickel-chromium-molybdenum		

- Second pair of numbers indicates carbon content in hundredths of a percent by weight
- Fifth number is used for special situations
- Example: G52986 is chromium alloy with 0.98% carbon