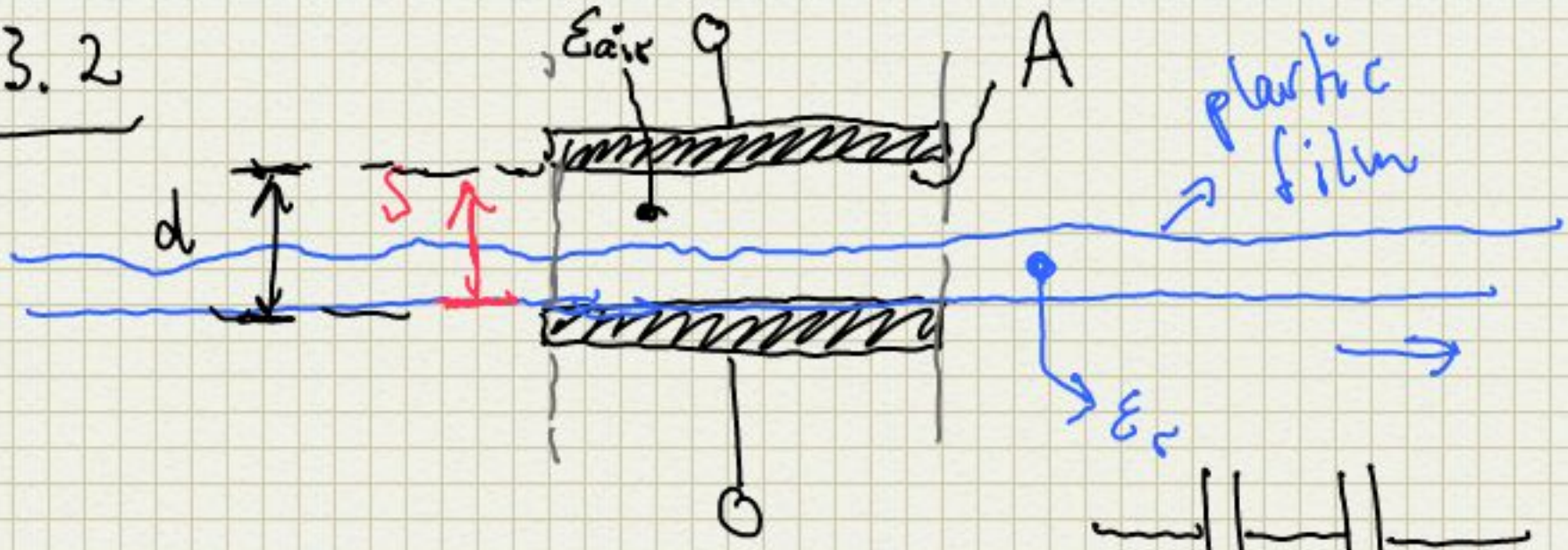
Ex 3.2



$$\frac{1}{C_{tot}} = \sum_{i=1}^{2} \frac{1}{C_i} = \frac{1}{C_1} + \frac{1}{C_2} \quad (1) \qquad C_1 \quad C_2$$

$$C_1 = \frac{\varepsilon_0 \varepsilon_{air} A}{d-s} \quad (2), \qquad C_2 = \frac{\varepsilon_0 \varepsilon_r A}{s} \quad (3)$$

(2) and (3) in (1)

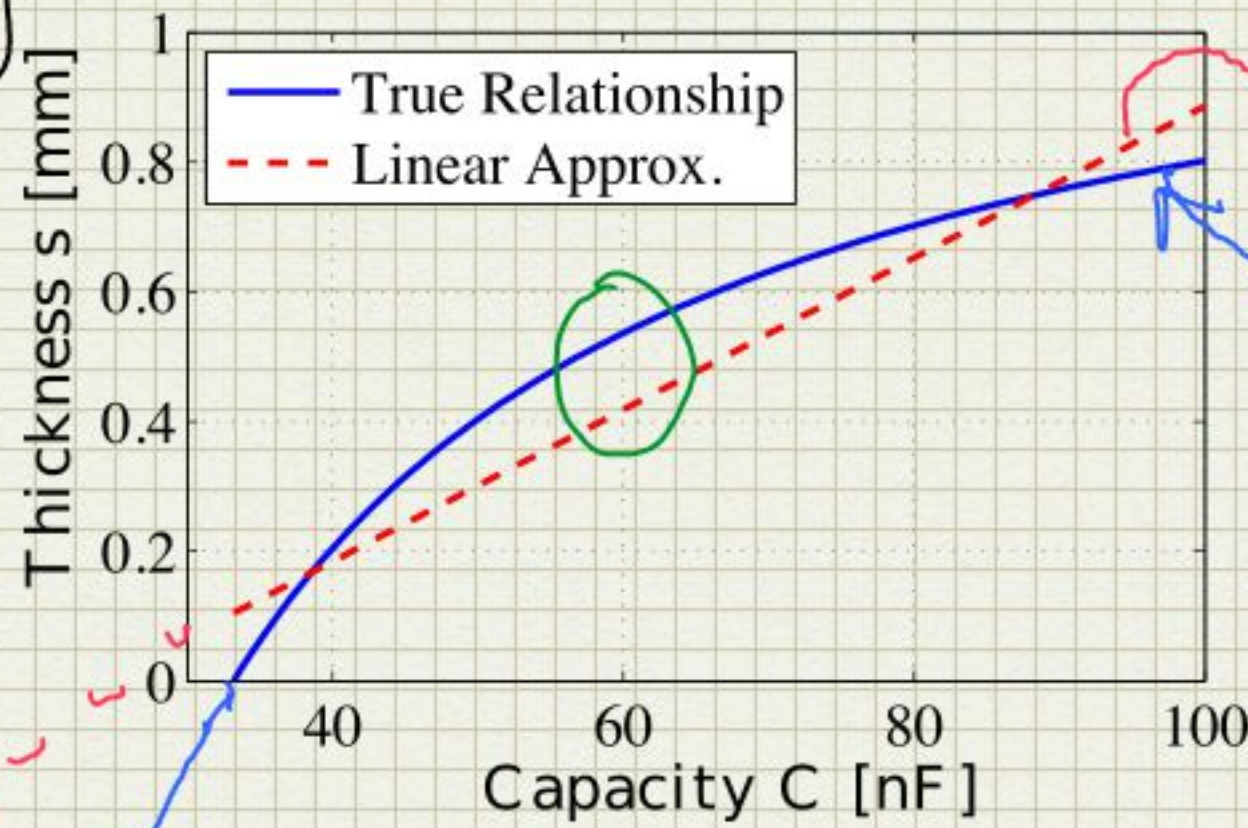
$$\frac{1}{C_{tot}} = \frac{d-s}{\varepsilon_0 \varepsilon_{air} A} + \frac{s}{\varepsilon_0 \varepsilon_r A}$$

$$\frac{1}{C_{tot}} = \frac{(d-s)\varepsilon_r + s\,\varepsilon_{air}}{\varepsilon_0 \varepsilon_{air} \varepsilon_r A} \quad | \cdot \text{Denominator}$$

$$\frac{\varepsilon_0 \varepsilon_{air} \varepsilon_r A}{C_{tot}} = d\varepsilon_r - s\varepsilon_r + s\varepsilon_{air} \quad | -d\varepsilon_r \;;\; :(\varepsilon_{air} - \varepsilon_r)$$

$$\frac{\varepsilon_0 \varepsilon_{air} \varepsilon_r A}{C_{tot}(\varepsilon_{air} - \varepsilon_r)} - \frac{d\varepsilon_r}{\varepsilon_{air} - \varepsilon_r} = s$$

b)



$g(C) = 11700C - 3 \cdot 10^{-4}\ m$

C [nF]	33,2	40	60	80	100
s [µm]	0	204	536	702	802

c) $E(C) = \underbrace{\frac{\varepsilon_r \varepsilon_0 \varepsilon_{air} A}{C(\varepsilon_{air} - \varepsilon_r)}}_{K_1} - \underbrace{\frac{d\varepsilon_r}{\varepsilon_{air} - \varepsilon_r}}_{K_2} - 11700C + 3 \cdot 10^{-4}$

$= \frac{K_1}{C} - K_2 - 11700C + 3 \cdot 10^{-4}$

Maximum error can occur in $[33,2; 100]$ nF

Lower boundary $E(C = 33.2\,nF) = -87.9\,\mu m$

Upper boundary $E(C = 100\,nF) = -68.3\,\mu m$

$$\frac{dE(C)}{dC} = -\frac{K_1}{C^2} - 11700 = E'(C)$$

$$E'(C) \stackrel{!}{=} 0 = -\frac{K_1}{C^2} - 11700$$

$$\Leftrightarrow \frac{K_1}{C^2} = -11700 \quad \Leftrightarrow C^2 = \frac{K_1}{-11700}$$

$$C = \sqrt{\frac{K_1}{-11700}} \Rightarrow C_{max} = 58.3\,nF$$

$$E(C_{max}) = 134.8\,\mu m \rightarrow \text{maximum error}$$

$$E_r = \frac{g(C_{max}) - s(C_{max})}{s(C_{max})}$$

$$= -0.26$$