

**Tutorial series # 4 : Conductors in equilibrium** ————— *Avril 2024*

**Exercice 1 :** Let's suppose we want to make a flat capacitor with a capacitance of 1F using square plates, separated by 1 mm. What surface area should be used for each plate?

*Ans. :  $C = \epsilon_0 A/d \implies A = Cd/\epsilon_0$ , which gives a surface area of  $1.1 \times 10^8 \text{m}^2$ , i.e. plates with sides exceeding 10 km! In the past, it was common practice to ask a student to go to the laboratory storeroom and ask for a 1 F parallel-plate capacitor, until the storeroom attendants got tired of the joke.*

**Exercice 2 :** The capacitance of a parallel-plate capacitor is 2 pF. If the area of each plate is 2.4 cm<sup>2</sup>, what is the plate separation?

*Ans. :  $C = \epsilon_0 A/d \implies d = \epsilon_0 A/C$ , we find  $d = 1.1 \text{mm}$ .*

**Exercice 3 :** In the combination of figure 1 below, the subscripted numbers indicate the value of the capacitances in  $\mu\text{F}$ , e.g.  $C_5 = 5 \mu\text{F}$ . a) Determine the capacitance  $C_{\text{eq}}$  of the equivalent capacitor. b) Find the charge and the potential difference for each capacitor and the energy of the assembly when a potential difference of 120 V is applied between A and B.

*Ans. : a)  $C_{\text{eq}} = 10 \mu\text{F}$ ; b)  $Q_1 = 80 \mu\text{C}$ ,  $Q_2 = 160 \mu\text{C}$ ,  $Q_3 = 240 \mu\text{C}$  and  $V_1 = V_2 = V_3 = 80\text{V}$ ;  $Q_4 = 320 \mu\text{C}$ ,  $Q_5 = 400 \mu\text{C}$ ,  $Q_{18} = 720 \mu\text{C}$  and  $V_4 = V_5 = 80\text{V}$ ,  $V_{18} = 40\text{V}$ ; The energy of the assembly is  $U = C_{\text{eq}}V^2/2 = 7.2 \times 10^{-2}\text{J}$ .*

**Exercice 4 :** The equivalent capacitance of the combination in Figure 3 below is  $C_{\text{eq}} = 2,5 \mu\text{F}$ . 1) Find the value of  $C_4$  knowing that  $C_1 = C_2 = 2 \mu\text{F}$  and  $C_3 = 4 \mu\text{F}$ . 2) Find the charge of  $C_4$ , the ddp between its terminals and the energy it stores when a ddp  $V_a - V_b = 20 \text{V}$  is applied between a and b.

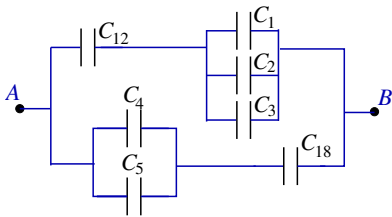


Figure 1

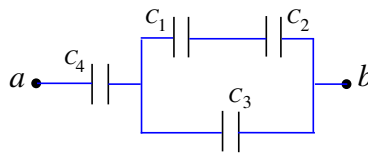


Figure 3

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