Question 1 :

$$\text{mean}(C_j) = \frac{1}{|C_j|} \times \sum_{x \in C_j} x$$

$$\text{cost}(C_1, C_2, \dots, C_k; z_1, z_2, \dots, z_k) = \sum_{j=1}^{k} \sum_{x \in C_j} \|x - z_j\|^2$$

$$= \sum_{j=1}^{k} \sum_{x \in C_j} \left(\|x - \text{mean}(C_j) + \text{mean}(C_j) - z_j\|^2\right) =$$

$$\sum_{j=1}^{k} \sum_{x \in C_j} \left(\underbrace{(x - \text{mean}(C_j))}_{a} + \underbrace{(\text{mean}(C_j) - z_j)}_{b} \right)^2$$

$$= \sum \sum (x - \text{mean}(C_j))^2 + 2 \sum \sum (x - \text{mean}(C_j))(\text{mean}(C_j) - z_j) + \sum \sum (\text{mean}(C_j) - z_j)^2$$

$$= \sum_{j=1}^{k} \sum_{x \in C_j} (x - \text{mean}(C_j))^2 + \sum_{j=1}^{k} \sum_{x \in C_j} (\text{mean}(C_j) - z_j)^2$$

$$= \text{cost}(C_j; \text{mean}(C_j)) + \sum_{j=1}^{k} \sum_{x \in C_j} (\text{mean}(C_j) - z_j)^2$$