b) $\|x_i - u_j\|_2^2$ $\qquad u_j = \frac{1}{n_j}\sum_i^n \phi(x_i)$ mean of $\phi(x_i)$

$$\|\phi(x_i) - u_j\|_2^2 = (\phi(x_i) - u_j)^T(\phi(x_i) - u_j)$$
$$= \phi(x_i)^T\phi(x_i) - 2\phi(x_i)^T u_j + u_j^T u_j$$

$$u_j^T u_j = \frac{1}{n^2}\sum_{i=1}^{d}\phi(x_i)\cdot\sum_{i=1}^{d}\phi(x_i)$$
$$= \frac{1}{n^2}\phi(x_i)^T\phi(x_i)$$

$$\phi(x_i)\phi(x_i) - \frac{2}{n_j}\sum_{j=C_j}^{n}\phi(x_i)^T\phi(x_j) + \frac{1}{n_j^2}\sum_{\substack{j\in C_j\\ m\in C_j}}^{n}\phi(x_j)^T\phi(x_m)$$
$$= (x_i^T x_i + 1)^2 - \frac{2}{n_j}\sum_{j=1}^{n}(x_i^T x_j + 1)^2 + \frac{1}{n_j^2}\sum_{j\in C_j, m\in C_j}^{n}(x_j^T x_m + 1)^2$$

x_i = single data point
x_j = point in cluster j
x_m = another point in cluster j

c) convergence_threshold = 1
Initialize centroid of cluster.

for i in range (0, npoints):
  for j in range (0, k): # k= number of clusters.
    Compute the distance
    $$d = (1 + x_i x_i)^2 - \frac{2}{n_j}\sum_{m\in C_j}^{n_j}(1 + x_i x_m)^2 + \frac{1}{n_j^2}\sum_{\substack{m\in C_j\\ k\in C_j}}^{n_j}(1 + x_m x_k)^2$$
    x_m and x_k is point from cluster j
  end
end

Keep running and find min distance,
Save cluster label to value

if (|u_{new} - u_{prev}| < convergence_threshold) Check convergence
  done
else
  converged == false return to for loop!

d) Since ϕ maping is quadratic, decision surface should be a curve.