Exercise # 1

A thin plate is initially at a uniform temperature of 200 oC at t = 0. Also, at t=0 sec, Ta = 200 oC and Tb = 200 oC at both ends of the plate. Neglect energy generation in the plate. The other sides in the y and z axes are perfectly insulated. The data are:

- L= 0.012 m, k= 10 W/m*K, h= 50 W/m2*K and ρC =10X106 J/m3*K
- T∞ = Tsur =20 oC

- Only face "b" (see Figure) is exposed to both radiation & convection
- Determine the following :
  - Known the values
  - Provide appropriate assumptions to analyze this problem
  - Calculate criterion Δt
  - Transient temperature distribution (T1, T2 & T3) of the slab at t = 10, 15 and 20 sec via the explicit finite volume method in conjunction with a suitable time step size to calculate

Hint: at t = 0

$$T_P^0 = T_1^0 = T_2^0 = T_3^0 = 200^0 C$$

At each node on each CV

Criteria for Δt

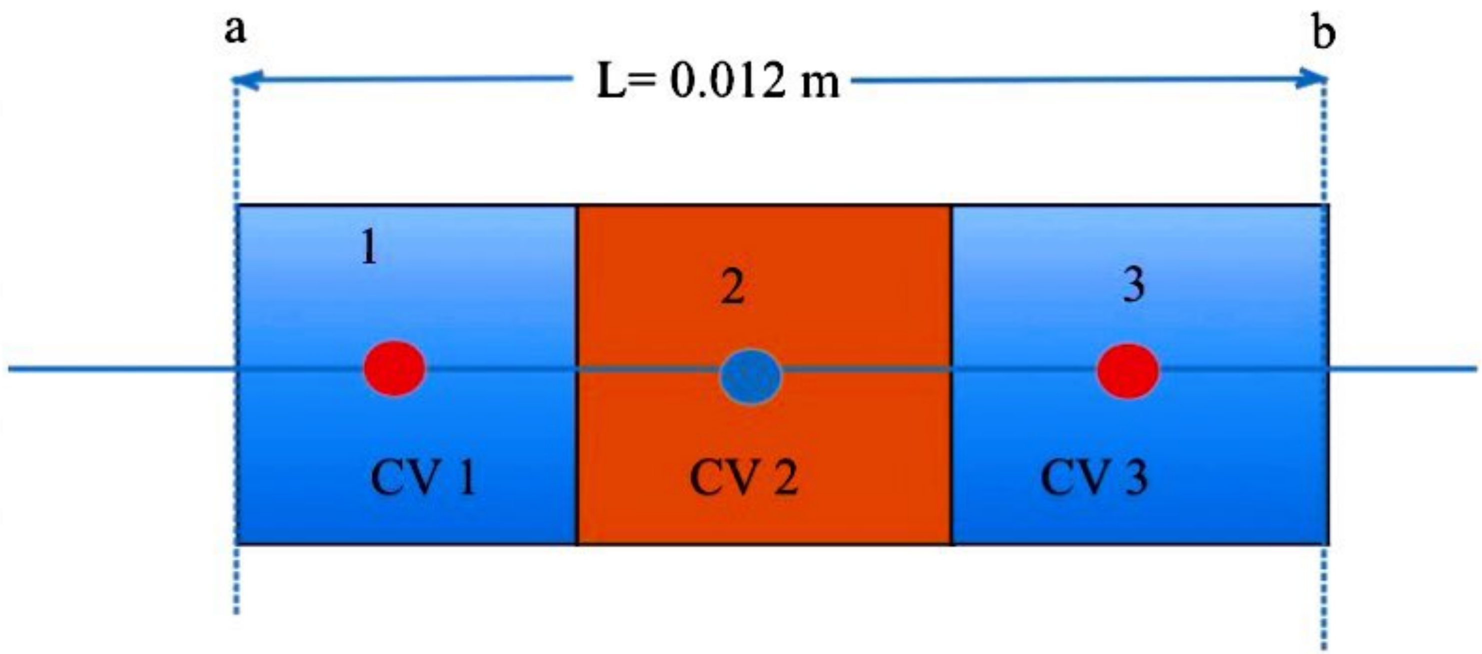
$$\Delta t < \frac{\rho C \Delta x^{(2)}}{2k}$$

Find values at of Tp at Δt= 5, 10 & 15 sec at each control volume

Exercise # 2

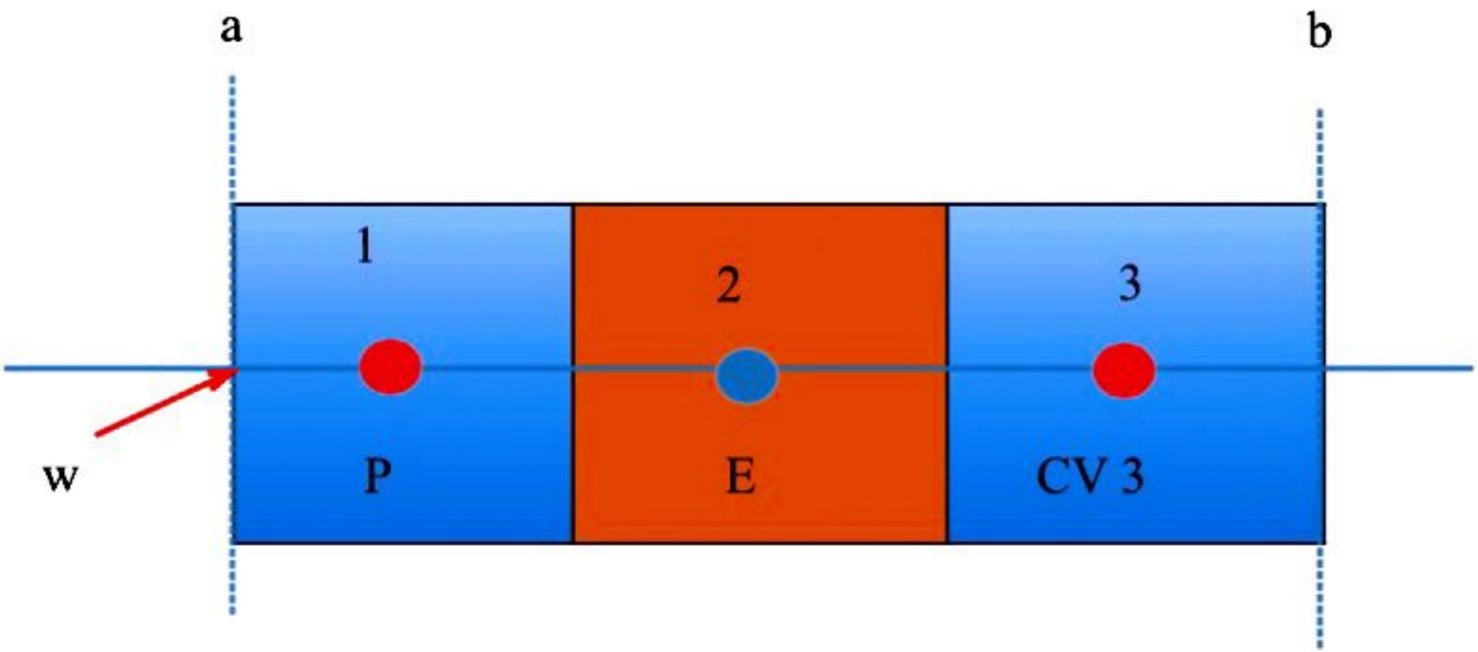
Repeat Problem # 2 but consider a uniform energy generation (S_bar) = 5 W/m3 on the thin plate

Problem # 1 & 2 (Figure)



Tsur=T∞ = 20 oC, h= 50 W/m2*K, ε=1

CV1 (Figure)

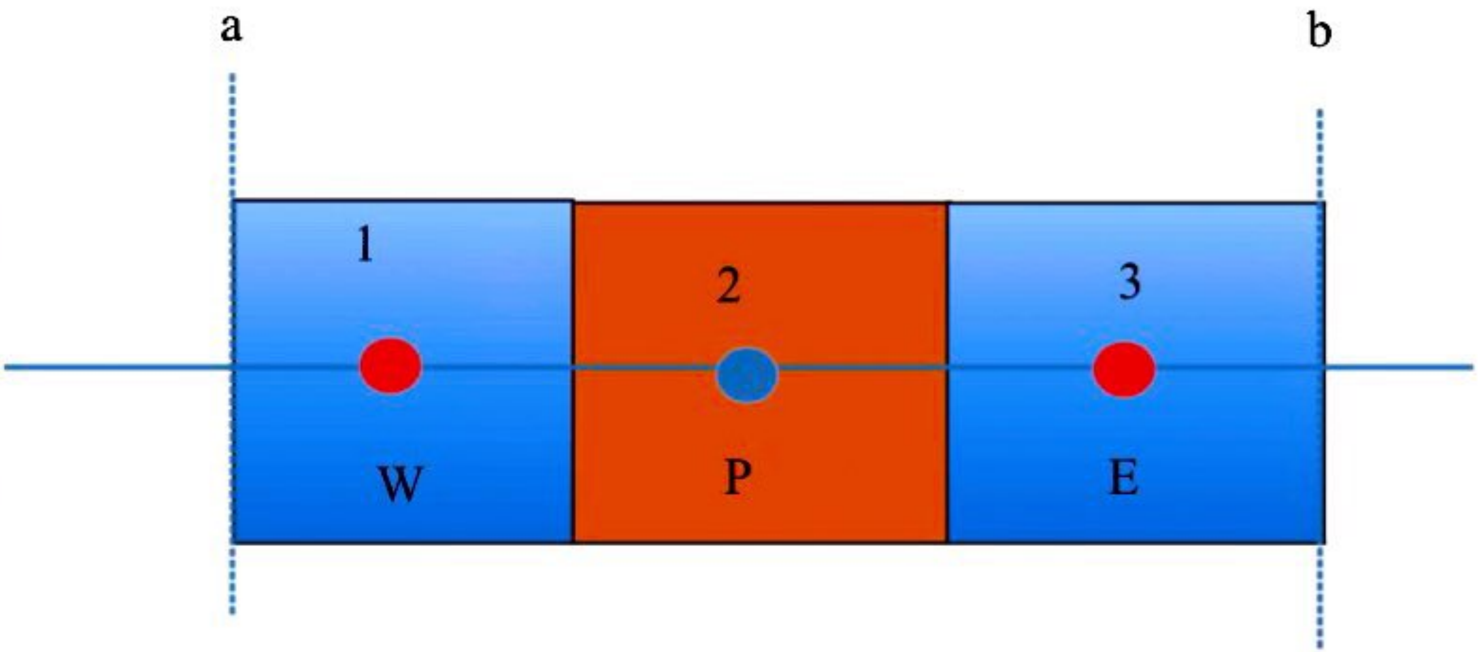


Tsur=T∞ = 20 oC, h= 50 W/m2*K, ε=1

Use this to calculate Tp = f(t) for CV1

$$T_P = T_P^0 + \frac{\Delta t}{\rho C \Delta x}\left[\bar{S}\Delta x + \frac{k}{\Delta x}\left(T_E^0 - 3T_P^0 + 2T_w^0\right)\right]$$

CV2 (Figure)

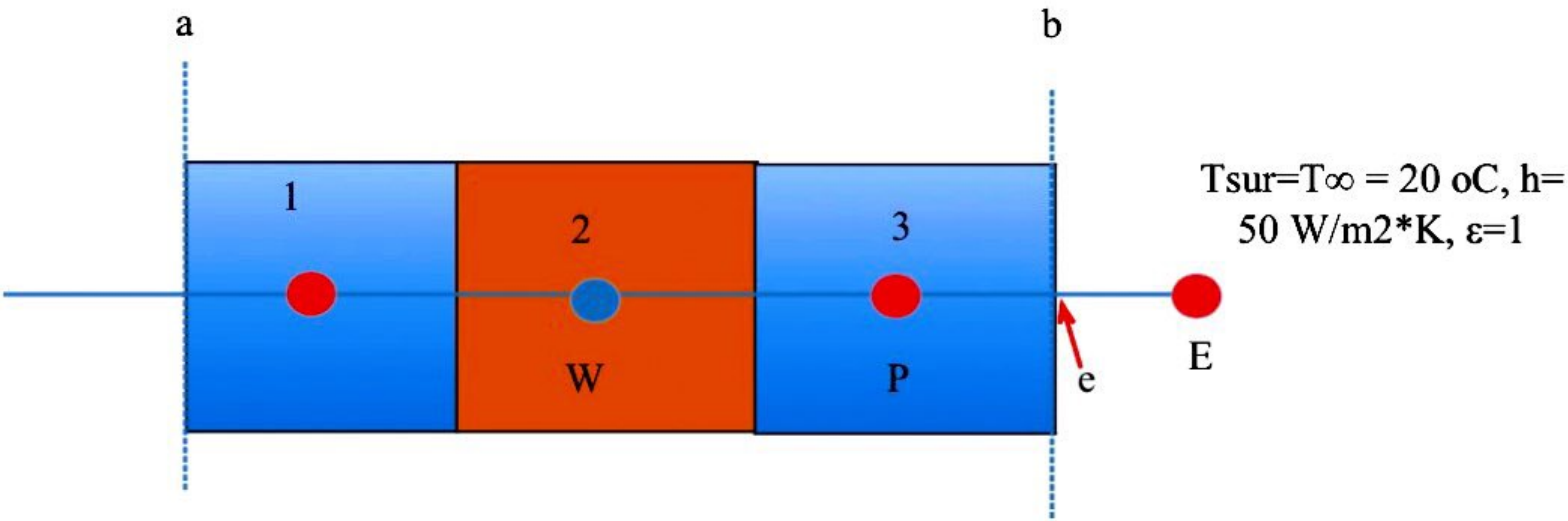


Tsur=T∞ = 20 oC, h= 50 W/m2*K, ε=1

Use this to calculate Tp = f(t) for CV2

$$T_P = T_P^0 + \frac{\Delta t}{\rho C \Delta x}\left[\bar{S}\Delta x + \frac{k}{\Delta x}\left(T_E^0 - 2T_P^0 + T_W^0\right)\right]$$

CV3 (Figure)



Use this to calculate Tp = f(t) for CV3

$$T_P = T_P^0 + \frac{\Delta t}{\rho C \Delta x}\left[\bar{S}\Delta x + \frac{k}{\Delta x}\left(2T_E^0 - 3T_P^0 + T_W^0\right) - h\left(T_P^0 - T_\infty\right) - \sigma\varepsilon\left(T_P^{0,4} - T_{surr}^4\right)\right]$$