# EE735_2023

# Assignment-4 (Part-A)

## Due date – will be announced on moodle

### Diffusion

**Problem 1: Consider a region of length 10μm from point A (x= 0μm) to point B (x= 10μm).**

**a) Time-Independent Part:**

$$D\frac{d^2n}{dx^2} = \frac{n}{\tau}$$

Consider diffusive transport of particles from point A to point B. The **concentration of particles at A is n=$10^{12}$** $cm^{-3}$, and at B is n=0 $cm^{-3}$. Assume $\tau$=$10^{-7}$ s. Find the particle profile from A to B. What is the particle flux from A to B?

In continuation, assume that the **boundary condition at B** is such that $J = kn$, where $J$ is the particle flux (outgoing), $k = 10^3\ cm/s$, and $n$ is the particle density. Again, find the particle profile from A to B and the particle flux at B. Explore the implications of this change in boundary conditions at B.

**Now consider the injection of particle flux/density in between point A to B.**

**b) In Continuation:**

Assume that **particle flux** is introduced midway at **x= ( 3 +0.5 * X)μm** {where, X= last digit of Roll No. from 0 to 9}at the **rate of $10^{13}$ $cm^{-2}$ /s.** Assume that the particle densities at points A and B are held constant at **n=0.** Assume **$\tau$ = $10^{-7}$ s**. Find the **particle profile** from A to B, and the flux at A and B. Also, compare with the analytical resulting the same plot **(use D = 0.1$cm^{-2}$/s).**

## c) Time-Dependent Part:

$$\frac{d^2n}{dx^2} = \frac{1}{D}\frac{dn}{dt}$$

Assume that particles are injected midway at **x=5µm** such that the density is (1+XX)***$10^6$cm$^{-3}$** {where, XX= last 2-digits of Roll No.} (i.e., the injection is a delta function in both space and time).Consider perfectly absorbing boundary conditions at **A** and **B,** at time **t = 0.**Using the formalism described in class, plot the **evolution of particle density** with time over the specified domain. Compare with analytical results. Explore the significance of the parameter$\sqrt{Dt}$. (Use **D = $10^{-4}$ cm$^2$ /s**)

Plot the evolution of particle density with both **(i) Implicit method, and (ii) Explicit method** with C<0.5 & C >0.5, where C =D*Δt/Δ$x^2$.

**Problem2:**

Consider a region of length 100um. Assume that the region is devoid of any particles at **time t=0**. Also assume perfectly absorbing boundary condition at **x=100µm**. Solve for the diffusion of particles from the **side x=0** as a function of time under the assumption that n**(x=0, t) =2000**. Plot the spatial and temporal evolution of the particle density profile. (Note that this scenario is very similar to doping of a semiconductor to form a PN junction diode). Compare the numerical solution with the analytical solution.

**Please note that, to avoid complexity, FOLLOW THESE:**

**Please send Assignment as a single folder.**

Save assignment file/folder: A4_RollNo_Name.

Save MATLAB files: 4_RollNo_Q1a.

Mention the axes names, title and legends properly for plots.