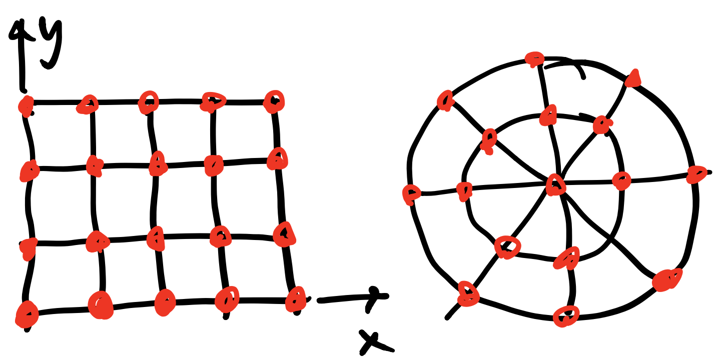
Computational Electromagnetics (CEM)

Solve Maxwell's equations (PDE) by numerical methods.

Three main methods:

① Finite differences (FD)
Unknown function (field) evaluated/defined on a set of grid points, typically arranged along constant coordinate lines.

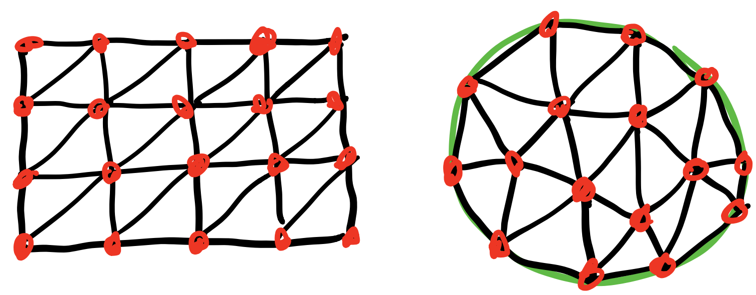
structured grids



② Finite-element method (FEM)

Unknown function (field) expanded as a sum of basis functions on a region subdivided into cells.

unstructured meshes



③ Method of Moments (MoM)

Apply the FEM to an integral equation. Expand unknown source distribution in terms of basis functions and express the fields using the Green's function.

Hand-in assignment #1

Consider the integral

$$\int_a^b f(x)\,dx$$

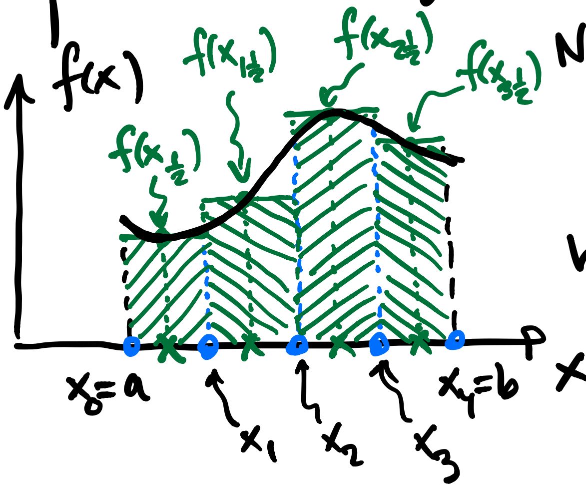
If $f(x)$ has a primitive function, the analytically calculated value is denoted by I_0. An example

$$f(x) = cx^2$$

$$\Rightarrow \int_a^b f(x)\,dx = \int_a^b cx^2\,dx$$

$$= c\left[\frac{x^3}{3}\right]_a^b = \frac{c}{3}\left(b^3 - a^3\right) = I_0$$

Midpoint integration



N = number of subintervals (= 4 in this ex.)

h = width of (all) subinter.

$$= \frac{b-a}{N}$$

$x_i = a + ih$ with $i = 0, 1, \ldots, N$ (or $i = \frac{1}{2}, 1\frac{1}{2}, \ldots, N - \frac{1}{2}$ for midp.)

$$I_0 = \int_a^b f(x)\,dx \simeq$$

$$\simeq \sum_{i=0}^{N-1} f(x_{i+1/2})\,h$$

$$= I_{midp}(h)$$

$$e(h) = \left| I_{midp}(h) - I_0 \right|$$

absolute error