Notes for the FEM class on 30/9/2021

Prof. Amar started with an explanation of why it helps to consider 3D objects such as a rod as a 1D object for the purpose of modeling to understand certain processes/phenomenon. He started with the specific PDE formula used (`Eq.1 on slide 7`), as a mathematical model, to understand the displacement of particles at various points in a rod when the rod is subjected to certain kinds of forces. This formula, he explained, is in strong-form, has a second-order derivative term, and hence, requires a quadratic polynomial function to accurately represent it whenever such representation exists. He then explained that an approximate (linear in this case) function is used to represent the PDE formula. He then derived the formulation for this approximate function, also called the weak-form equation, for the 1D problem using FEM employing Galerkin approach / weighted residuals.

In the general formula that Prof. Amar derived, he explained what each term intuitively meant: Stiffness matrix, body force vector, boundary condition coefficients.

Then, he took the example of 1D rod fixed at one end and subjected to body and axial forces. Examples of body forces are gravitational, electromagnetic etc. He considered the rod as a single element with the two endpoints serving as nodes. He explained how when given two points, one can fit/approximate a linear function connecting the points. He then went on to explain the origin of the weight functions associated with the two nodes of the rod element. Further, he also mentioned what Galerkin suggested: choose the weight functions appearing in the weak-form equation as the same as ones derived for the nodes.

So, the weak-form formula was rewritten for every element substituting for the weight functions to yield Stiffness matrix, body force vector, and boundary condition coefficients.

Note: If you understand FEM by this time, then it is because of the excellent guest lecture by Prof. Amar Gaonkar. If you don't understand it, it is probably because of the poor notes written by me.