Basics of Finite Element Analysis – Part II

Prof. Nachiketa Tiwari
Department of Mechanical Engineering
Indian Institute of Technology, Kanpur

Lecture – 01
Overview of the Course

Hello. Welcome to this MOOCs on Basics of Finite Element Part II. This is a MOOC course, it is an online course and in this course each week we will be having assignments, and at the end of the course we will be also conducting an examination and both these assignment as well as the examination they will be objective in nature. So, most likely they will be multiple choices of questions and both of the assignment as well as in the final exam.

But that does not mean that detailed understanding and working of whatever I will be talking about and teaching in this course will not be required for you to do good in assignment as well as the examination. Because the questions will be drafted in such a way that you will have to work through the entire procedure, and then come off with some answer and it is the answer which will be objective in nature. But to get the correct answer you will be required to go through a series of steps and observe and use whatever I teach in this course.

Now, this course is 8 weeks long. Each week we will have 6 lectures, each lectures being some in like 20 to 25 may be 30 minutes. So, from Monday till Saturday we will be having these lectures and close to the end of the week. You will also be getting an assignment and they are dead line for assignments, so please make sure that you stick to those this deadlines, it will make our job easier.

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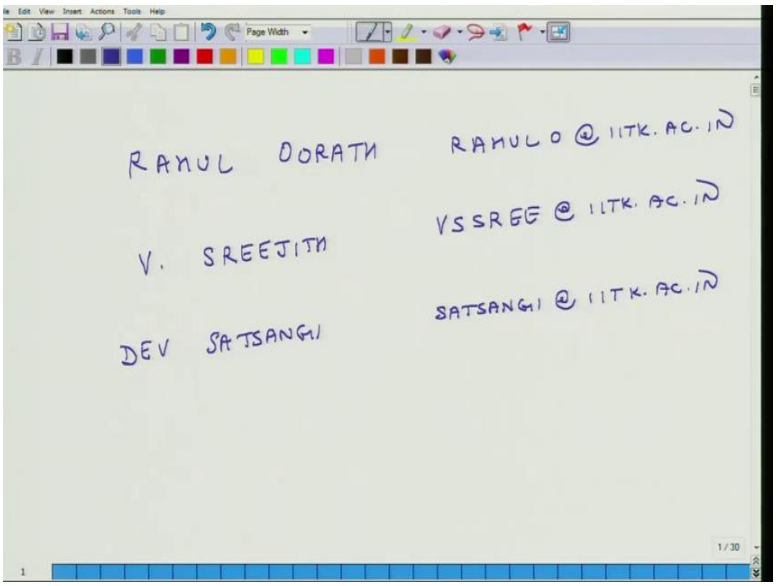

In this particular course there are three teaching assistants. So, I will write down their names. The teaching assistants are; Rahul Oorath and his email id is RAHUL O @ IITK.AC.IN. Then there is another teaching assistant, so these gentlemen will be helping me in conduction of this course. So, the second assistant is V. Sreejith, and his email id is VSSREE @ IITK.AC.IN. And the third teaching assistant is Dev Satsangi, and his email id is SATSANGI @ IITK.AC.IN. If you have any questions or doubts, you can directly communicate with these people or you can also post them online on the forum so that others can also know what doubts you have and will try to respond to those questions soon as possible.

So, that is about the overall logistics of this course. Now what is this course all about? In the last semester we had thought basics of finite element method part one and in that what we have done was we have deal with several the concepts. We started with solving and developing finite element equations for 1 D problems and different types of 1 D problem, heat conduction problems, a bar and tension beams. And we also did time dependent problem, so if you have a bar and it mean pulled and pushed. So, it is a time dependent problems, so we solved develop finite element method formulation for time dependent problem, and also for Eigen problem.

And in the first part the whole part is oriented in such way that person with any background or let us say with the reasonable background in mathematics or engineering

even if he or she is at second year on his curriculum, he or she could take this course with sufficient is and do well in this examination.

So, this particular course Basics of Finite Element Method Part II is essentially a continuation of that course. So, we will be starting from there we left in that particular course. So, that is how we are going to start and what is it that we are going to cover in this course.

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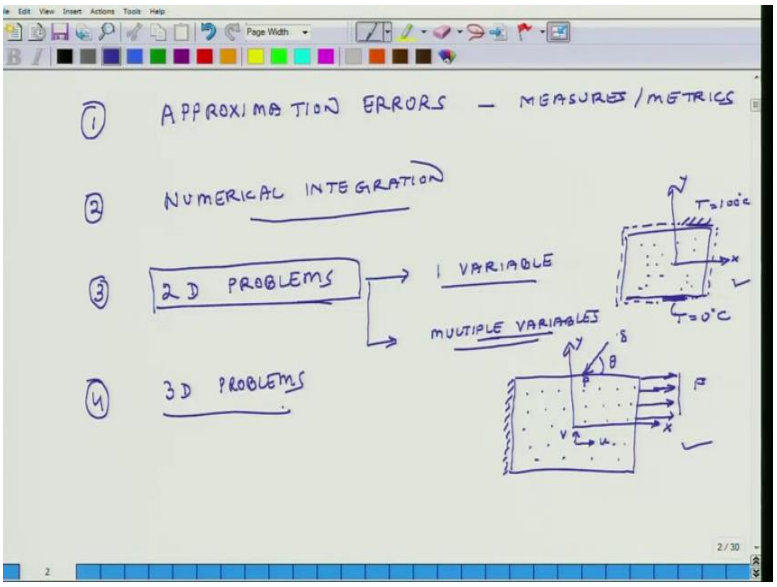

So, the first topic we are going to cover in this course is that when you do a finite element analysis you have to make a lot of approximation, as to how displacement various across the domain or temperature various in the domain and so on and so forth. So, because of these approximations your finite elements solution is somewhat difference then the exact solutions, so there is an error, so we will discuss approximation errors. And then how do the measure these errors and quantify them, so their measures or metrics.

The second thing we will talk about is numerical integration. So, what we learnt in last course part one was that we develop residues related to partial differential equations and we integrate these residue over the domain of the element, and then equate this value to 0 and the way we integrated in the previous class is that we have function and then we just use that function and use our understanding of integration to integrate analytically. But when we implement this thing on computers it is probably easier and faster to do these

types of integration numerically. So, we will learn some tricks as to how numerical integration of functions could be conducted and that is actually used in a lot of finite element programs.

Then the third thing, we will do is 2 D problems. Now these 2 D problems are in a way fundamentally different then 1 D problem in terms of how we assemble element level metrics and also how we impose boundary conditions. So, moving from 1 D assembly process to 2 D assembly process it revise a little bit of conceptual expansion, so we will do this 2 D problems and once we are familiar with how 2 D problems assembly of element level equations is conducted and how are the boundary conditions applied, then moving to 2 D to 3 D is pretty much mechanical. The same idea can be use for assembly to solve 3 D problems.

And in 3 D problems we will address two types of problems. One is one variable problem. For example, you can have a plate it and let us say here in part of this plate I am terms temperature let us say is equal to 100 degree centigrade and in another part of the plate in this zone let us say I am specifying temperature is equal to 0 degree centigrade. And all other surfaces of the problem, outside surfaces or edges of the problem I can assume that they are insulated and I am interested in finding temperatures at all these individual points in the plate.

So, here I have 2 Dimension; one is the x dimension and other one is the y dimension, but the variable in this problem is new one which is temperature. So, this is the 2 dimensional problems which involve one variable which is temperature. We will start our 2 D problems by solving those problems which involve only one variable.

Then once we have learned that then we will move to 2 D problems with multiple variables. An example of this multiple variable problem could be again, a plate and let us say now here instead of temperature I am interested in finding displacements. So, let us say I m on this plate part of the edge I am pulling and I am applying a force F suppose, and let us say this edge is rigidly clammed, and it could be another thing that here at this particular point P I am applying a displacement not normal to the edge, but at some angle.

So, I am applying some displacement let us say, delta at an angle theta and here the question is that if this is the situation of the plate, so here again this is the 2 D problem

because it has 2 Dimension x and y and what I am interested in finding out that at all these inter in points inside the problems or inside the domain, I am interested in finding the displacement. Let us say I am interested in finding displacement in x direction let us call it u, and here in the y direction it is v. In this case the problem is 2 Dimension in nature, but it is having not one variable but two variables u and v. So, this is a 2 D problem with multiple variables.

So, we will solve one variable problem and we will solve a multiple variable problem in this case. This is about the 2 D problems that we will be covering. And then we will briefly cover 3 D problems. So, where will the object in considerations we will have all 3 dimensions and there could be multiple single variable like in case of thermal study or there could be several variables. For instance, in cases of deflections we may bond to and find out all 3 deflections u v and w.

So, this is what we plan to do in this course and this completes the discussion for today's lecture. What we will do in the remaining part of this week is that is in the next 5 lectures is a quick overview of all the staff which we did in the earlier course which is Basics of Finite Element Part I. With this we close the discussion for today and I look forward to meeting you tomorrow at the same time.

Thank you very much, bye.