Numerical Modelling of Metal Forming Processes: Formability and Damage

1. Overview

The finite element method is the most widespread numerical technique to simulate and analyse complex industrial metal forming processes. In contrast to the active role performed by the manufacturing research groups during the pioneering developments of finite element computer programs that were produced during the 1980's and 1990's, current practice indicates a total or near-total engagement of the majority of these groups on applications rather than on developments. A critical gap was formed between the developers of computer programs and users having the know-how on metal forming technology. This course is concerned with this gap and was designed with the purpose of providing industrial and academic users of computer programs a basic overview of the finite element method applied to metal forming. The goal is to provide users with a good understanding of the basic theoretical and numerical ingredients behind the development of computer programs, namely to obtain a better knowledge on the different sources of non-linearity, on different available constitutive equations, friction models, damage criteria and formability limits, among other subjects. All this accounts for the overall aim and objective of users being able to understand the differences between different available formulations, to recognize their pitfalls, to identify the possible sources of errors and to understand the routes for validating results from numerical simulations.

2. **Objectives of the Course**

The course is concerned with the gap between developers of the finite element computer programs and the users having the know-how on material forming technologies. The course was designed with the following objectives:

- to refresh fundamentals of solid mechanics, plasticity theory, formability, damage and friction;
- to provide a bridge between analytical and numerical modelling of metal forming processes;
- to provide participants with a better understanding on the fundamental ingredients that are necessary to develop and properly utilize computer programs based on the finite element method;
- to discuss computer implementation of a wide range of theoretical and numerical subjects related to mesh generation, contact algorithms, friction, constitutive equations, solution procedures and parallelization, among others;
- to draw from the fundamentals of finite element formulations to aspects of accuracy, reliability and validity of numerical modeling.

.**Modules**	**Numerical Modelling of Metal Forming Processes: Formability and Damage : December 2 – December 13, 2019**
You Should Attend If…	• You work on metal forming, fatigue and fracture or similar non-linear problems involving plasticity (Industrial R & Ds, academic institutions, Govt institutions) • You use and / or write FEM codes in plasticity related field • You perform numerical simulations / studies involving metal forming & plasticity • You are a student wanting to learn use of FEM to solve plasticity based problems
Fees	The participation fees for taking the course is as follows: **Participants from abroad : Rs. 60000** **Industry : Rs. 50000** **Academic Institutions / Government organisations : Rs. 40000** **Full time Students : Rs. 30000** The above fee includes all instructional materials, refreshments during breaks in the programme, and 24 hours free internet facility. Lodging and Boarding are NOT included in the fees. The participants are requested to bring their own laptops. *On-Campus accommodation will not be available for outstation participants.* **A certificate of participation will be issued to those participants who register as above.**

The Faculty

Prof. Paulo A. F. Martins

Department of Mechanical Engineering, Instituto Superior Técnico, University of Lisbon, Portugal.

Prof. Martins obtained a PhD in mechanical engineering from Instituto Superior Técnico, Portugal in 1991 and the degree of doctor technices honoris causa from the Technical University of Denmark in 2018. His research interests are focused in metal forming and joining technologies and he is co-author of six books, several international patents and 400 papers in international journals and conferences.

Prof. Prashant P. Date

Department of Mechanical Engineering IIT Bombay

Prof. Date's research interests lie in manufacturing processes, especially bulk metal forming and sheet metal working processes; sustainable manufacturing, Light weighting and manufacturing process design.

Detailed Coverage:

Deformation. Measures of strain and strain rate
Stress. Measures of stress
Yield Criteria. Anisotropy. Constitutive Equations
Formability. Ductile Damage. Fracture Toughness
Material and Friction Characterization
Overview of Analytical and Numerical Simulation of Metal Forming Processes
Finite Element Simulation of Metal Forming Processes – Users' Perspective.
Overview of Formulations. Accuracy, Reliability and Validity
Finite Element Flow Formulation
Fundamentals and Discretization by Finite Elements
Computer Implementation – Non-Linearity, Contact, Friction
Thermo-Electro-Mechanical Coupling.
Analogy with Fluid Dynamics

Understanding the Source Code of a FE Computer Program based on The FE Flow Formulation
Meshing and Remeshing
Understanding the Source Code of a Mapped Meshing Computer Program

FE Dynamic Formulation Computer Implementation

Finite Element Solid Formulation. Modelling of Springback

Above topics with Finite Element Dynamic Formulation.

Training Sessions with a Commercial Finite Element Computer Program for Metal Forming

Team Work on Application Problem