MATHEMATICAL MODELING OF MANUFACTURING PROCESSES

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INTENDED AUDIENCE : Bachelor/Master/PhD students having backgrund in Mechanical/Material Science/Metallurgical engineering/Production Engineering/Manufacturing Technology.

COURSE OUTLINE :
The understanding of the basic mechanism such as heat and mass transport with associated fluid flow including metallurgical transformation, distortion and residual stress generation in different manufacturing processes is the focus of this course. Understanding the complex interaction not only helps to develop mathematical model, it makes the foundation for analysis, numerical simulation at different scale and experimentation for different types of manufacturing processes. The development of computational models for a manufacturing process relies on mathematical expression of the governing mechanism. It helps to design relevant experiments and drives to find the data to be obtained. Mutual understanding between analytical/numerical and experimental results leads to better insight of the basic manufacturing processes that impact on the improvement of existing process and directs for the development of new process. However, this course is completely different from statistical or data driven modeling approach. This course emphasized on the understanding of the most general to advanced manufacturing processes based on scientific principle. The complex mechanism is presented in a simplified way to understand the subject at elementary level. The broad impact is that the students will be able to develop physics based computational model of manufacturing process using standard commercial package (However, this course does not intend to cover the learning of the commercial software).

ABOUT INSTRUCTOR :
Prof. Swarup Bag , The broad area of instructor is teaching and research interest of materials and manufacturing processes through computational models using finite element method and experiments. The instructor completed his Ph.D on “Development of bi-directional heat transfer and fluid flow model for reliable design of GTA and laser welding processes” from Indian Institute of Technology Bombay. Later he has worked at the Center for Material Forming (CEMEF), MINES Paris Tech, France in Metallurgy, Structure and Rheology (MSR) group. Soon after post-doctoral research experience, he joined in the Department of Mechanical Engineering, Indian Institute of Technology Guwahati as a faculty member. His primary area of research is fundamental process modeling of welding and joining technologies, optimization of manufacturing processes and recrystallization in metal forming processes. Dr. Bag has published about 56 journal papers, 45 Conference papers, and 18 book chapters related to welding and joining processes. He is the author of the book ‘Computational models for GTA and laser welding processes’ and recipient of ‘Royal Arc Award 2009’ from Indian Institute of Welding for the best PhD thesis in welding. The instructor is involved in teaching the subjects like ‘Physics of Manufacturing Processes’, ‘Engineering Materials’, ‘Advanced Welding Processes’, ‘Mechanical Behavior of Materials’, ‘Solidification Processes’ and ‘Manufacturing Technology’ at IIT Guwahati. The subjects broadly covers the fundamentals of manufacturing processes, mechanical metallurgy, theory of plasticity, heat transfer in manufacturing processes, crystallography, dislocation mechanism, phase transformation and solidification.

COURSE PLAN :

Week 1: Introduction to Manufacturing processes
Week 2: Physics of manufacturing processes
Week 3: Conventional machining
Week 4: Non-conventional machining
Week 5: Metal forming
Week 6: Welding
Week 7: Welding
Week 8: Casting and powder metallurgy
Week 9: Coating and additive manufacturing
Week 10: Heat treatment
Week 11: Micro/nano scale manufacturing
Week 12: Processing of non-metallic materials