

ME664 Fundamentals of Casting and Solidification

Credits: 3L-0T-0P-0A (9 Credits)

Objectives:

The objective of this course is to underline fundamentals of the casting process in order to predict and control casting defects such as segregation, shrinkage, mold filling and other heat transfer related defects. These defects are solely dependent upon the solidification transport phenomena (heat, mass, solute transport and fluid dynamics) taking place during the casting process. This course would provide students education and training in the analytical and the mathematical understanding of the solidification principles involved in the casting. This would enable them to develop a feel about how to better design the casting processes and their control. On one hand the fundamentals of the transport phenomena will be explained, and on the other hand the same will be illustrated with some case studies of actual industrial applications (directional solidification processes (e.g., crystal growth, semiconductor casting), welding, additive manufacturing involving laser electron beam, surface and coatings technology).

Course contents:

Introduction to manufacturing involving solidification of liquid materials.

Casting: Casting solidification, introduction to fluid flow, microstructure in casting.

Solidification transport phenomena: Mathematical treatment of solidification transport phenomena (mass and heat transfer, fluid dynamics, mushy zone).

Defects: Casting defects (compositional, microstructural, mold filling, shrinkage and other flow and heat transfer related defects), cause and remedies; Understanding the role of transport phenomena in the formation of these defects.

Case studies of some selected casting processes.

Casting design by controlling the accompanied heat transfer, fluid flow and solidification.

Welding, Joining, Surface coating and Additive manufacturing processes: Brief Introduction and modeling overview.

More applications of melting/solidification principles in manufacturing, energy and others.

References:

- Solidification Processing, M C Fleming, McGraw Hill.
- Science and Engineering of Casting Solidification, D M Stefanescu, 2nd ed.
- Fundamentals of Modern Manufacturing, M P Groover.
- Principles of metal casting, R W Heine, C R Loper and Rosenthal, Tata McGraw Hill, New Delhi.
- Casting, J Campbell, Butterworth-Heinemann.
- Manufacturing Engineering and Technology, S Kalpakjian.