ME 756 – Numerical Modeling of Manufacturing Processes

Sample Problems (Casting) - Transient heat conduction

1. A flat plate cast of size 0.3 m (length) x 0.1 m (width) x 0.2 m (height) is solidifying from the pouring temperature to the room temperature. It is required to know the solidification time for the cast when the material is low-carbon steel and aluminium alloy. The initial pouring temperature for a steel cast is 1900 K and that for an aluminium cast is 1200 K. Consider their respective solidification temperatures as 1700 K and 1000 K. Considering temperature invariant thermo-physical properties of the cast material and convective heat loss from all the six surfaces, set up and solve this problem using a simple three-dimensional element [either a four node tetrahedron element or an eight node brick element.] in any finite element method based analysis software. Choose the required properties and convective heat transfer coefficient from standard books / references.

1. Set up the same problem for a cast of cylindrical shape with its radius = height = 0.12 m, and likewise for a cast of spherical shape with its radius = 0.11 m. With all the conditions, material properties and boundary conditions remaining the same, see how much time would these shapes take to solidify for both steel and aluminum.