Many important practical problems involve dependent variables that are not only functions of position but also functions of time. Well known examples are transient heat conduction in solids and solid state diffusion.

In this homework project you will create finite element models for two transient problems. In both cases, the goal is to obtain reliable approximations to the desired solution.

The first problem concerns the Jominy test used in the metallurgical industry to assess the hardenability of steels. A cylindrical sample of standardized dimensions is uniformly heated and then suddenly quenched from one end. The objective is to estimate the temperature and cooling rate as a function of distance from the quenched end.

The second problem is an analysis of the selective carburization process used to selectively enrich selected areas of the surface of a steel sample with carbon atoms in order to increase their hardness. Neighboring areas are masked to prevent the intake of carbon. The objective is to predict the penetration of carbon around the edge of the masked zone.

Use the information provided to construct the models paying particular attention to the sensitivity of the results to the time integration parameters. Ideally, model results should not only be independent of the size of the spatial mesh but also of the time step used in the calculation. Do your best to verify and validate your calculations in order to produce reliable results.