Bachelor or Master Thesis
Material Modelling for Simulation of Cyclic Plasticity in Metallic Components under Thermal and Mechanical Loads

Background
For an accurate estimation of the fatigue performance of metallic joints, both initial residual stress field and its variation under load is decisive. Residual stresses are elastic stresses in the material which are induced because of inhomogeneous plastic deformation during thermal and mechanical processes. These stresses could in potentially decrease the strength of the components in service life. According to the complexity of the thermal processes e.g. laser welding or inductive heat treatment, it is not so easy to predict the induced residual stresses as a consequence of cyclic plasticity during the process. In this regard, numerical approaches could be implemented as an advanced predictive tool for accurately determining the residual stresses. Here the use of a correct temperature dependent material hardening/softening model is of paramount importance.

Your tasks
In order to capture the cyclic mechanical response of high strength steel undergoing a thermomechanical process, appropriate strain controlled cyclic mechanical tests will be performed in this study. The first task here is to find an appropriate material hardening model (isotropic, kinematic or mixed hardening) to describe the material response based on the experiments. The next step is to use this model for predicting the residual field in thermally processed metallic components and to assess the fatigue life in service.

Requirements
For working on this project good knowledge of mechanics of materials and Finite Element Analysis would be required.

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Figure. Material characterization under cyclic thermomechanical loading (top), Stress-Strain hysteresis (middle), Finite Element Modeling of Welding Residual Stresses in a tubular joint (bottom).