Nuclear Materials Oral Exam **Spring 2015** **Second question**

(1) Start by drawing as much of the Fe-C phase diagram (vertical axis: temperature, horizontal axis: composition) as you can remember. Label the different regions. Which are comprised of single phases, and which are two-phase mixtures?

(2) What should be the dislocation slip systems (in Miller indices) in each phase? What are the "spatial" degrees of freedom required to specify a grain boundary, and a phase boundary?

(3) What is the martensite phase, and martensitic transformation? Explain the difference between strength, ductility and toughness. Describe the different phases of steel in terms of these quantities.

(4) Suppose we have a two-phase steel with ferrites and martensites inside, and it receives long-term irradiation in service in a fission reactor. Outline the atomistic and mesoscopic processes that can happen in the steel.

(5) For the irradiated steel in (4), explain the consequences of irradiation, if any, on:

a. physical dimensions,

b. mechanical properties, and

c. corrosion kinetics.

(6) Based on your answers above, which crystal structure do you think is most suitable for use in: (a) light water reactors (LWRs), and (b) fast reactors. Why? (hint: consider the dose received by the structures in LWRs and fast reactors).