

## UNENE UN901 - 2007 - Assignment 2

1. Explain how energy can be obtained from fission and fusion using the diagram of binding energy per nucleon vs. mass number.
2. Explain the function of the moderator in a fission reactor. How does this relate to the nuclear properties of  $^{235}\text{U}$  and  $^{238}\text{U}$ ?
3. Why are light elements better moderators than heavy elements?
4. Compare heavy and light water as moderators.
5. Why is zirconium a good material for reactor core components?
6. What are the desirable characteristics of the pressure boundary in a power reactor? Explain how these are achieved in CANDU and a PWR.
7. What are the desirable features of a fuel material in a power reactor. Give four examples of fuel materials.
8. Compare the key features of three power reactor designs.
9. Explain the concept of grouping and separation in designing a safe reactor system.
10. What is the CANDU approach to safety?
11. What is "displacement" damage? In what units is it quantified? Explain these units.
12. What are a displacement cascade and a thermal spike? What happens during the thermal spike phase of a displacement cascade and what defects remain after the thermal spike?
13. What are the typical effects of displacement damage on the properties of structural reactor materials?
14. Explain irradiation hardening qualitatively and quantitatively in terms of dislocation bowing and obstacle spacing.
15. Explain the effect of irradiation on the ductility of a metal with reference to the yield strength, the work hardening rate, and the onset of plastic instability.
16. Why do the microstructure and microchemistry of a material vary during irradiation and what are the stages of this evolution?
17. Describe the stages of development of microstructure and microchemistry in annealed Zircoloy-2 during irradiation at about 300°C.
18. Give a brief description of swelling of fast reactor steels during irradiations. What microstructural features are involved? What is believed to be the driving force for swelling?
19. Describe microstructural evidence for the DAD model obtained in the high-voltage electron microscope.
20. Describe the CEG (climb-enabled glide) and ED (elasto-diffusion) theories of irradiation creep.
21. A material has an initial dislocation density,  $\rho$ , of  $1 \times 10^{13} \text{ m}^{-2}$ , a shear modulus,  $G$ , of 30 GPa, and a Burgers vector of  $3 \times 10^{-10} \text{ m}$ . Assume that the strength of the material depends only on the dislocation density and the obstacle spacing due to radiation. Plot a true-stress/true-strain curve for the material to 30% strain assuming that the dislocation density increases linearly with strain by  $1 \times 10^{13} \text{ m}^{-2}$  for each 1% strain. Now assume that the initial material is irradiated, and that the spacing,  $l$ , of the irradiation induced obstacle is  $1.73 \times 10^{-7} \text{ m}$ . Plot the true-stress/true-strain curve for the irradiated material assuming the same relationship between strain and dislocation density.