

Fusion Reactor Engineering 1 (459.760)

Final Examination

20 June, 2011

1. (1) (10 points) Describe the four procedures of the sawtooth activity in terms of the kinetic profiles as well as the magnetic field structure by the Kadomtsev model.
(2) (10 points) Discuss the shortcomings of the Kadomtsev model in explaining experimental results.
2. (5 points) Why is the fishbone activity crucial in fusion reactors?
3. (10 points) How are neoclassical tearing modes triggered and developed?
4. (1) (10 points) Describe the cycle of the edge localised mode (ELM).
(2) (5 points) How to control the ELMs?
5. (20 points) Derive the following condition for trapping particles in a tokamak
$$v_{\parallel}^2 \leq 2\epsilon v_{\perp}^2$$
6. (10 points) Describe the principle of the bootstrap current.
7. Evaluate the statements: O if correct, X otherwise.
 - (1) (5 points) Negative ion beams have advantages with respect to the beam energy, however they are difficult to produce at the ion source.
 - (2) (5 points) It seems unlikely that tokamaks that would lead to practical reactors can be heated to thermonuclear temperatures by Ohmic heating mainly because the plasma resistivity increases as the plasma temperature increases.
 - (3) (5 points) The magnetic boundary between confined plasma and edge/divertor plasma is separatrix which is called as last closed flux surface.
 - (4) (5 points) The physical sputtering becomes important for carbon at low energies below 100 eV.

"Because you have so little faith. I tell you the truth, if you have faith as small as a mustard seed, you can say to this mountain, 'Move from here to there' and it will move. Nothing will be impossible for you." (Matthew 17:20)