

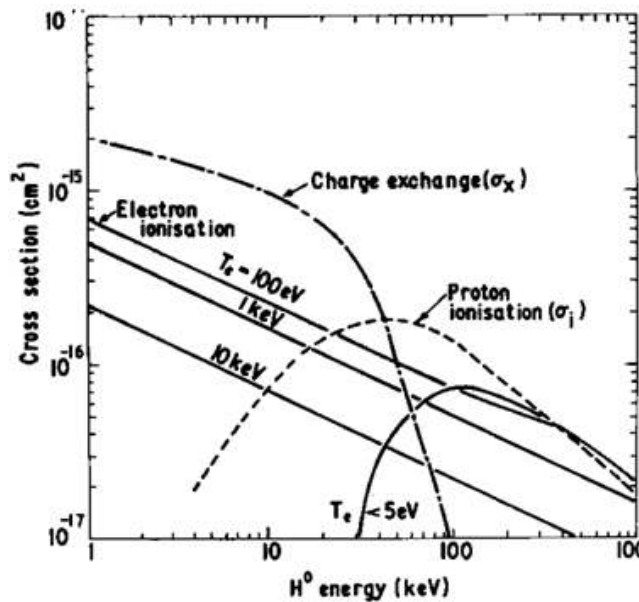
**Fusion Reactor Engineering 1 (459.760)**  
**Final Examination**  
**17 June, 2009**

1. (15 points) Answer the following questions.

- (1) How one can describe the plasma configuration in a tokamak?
- (2) Explain the concept of beta in the economic point of view.
- (3) Explain the concept of the energy confinement time

2. (10 points) Explain why Ohmic heating is not relevant to commercial fusion reactors.

3. (20 points) Find the path length of neutral beam injection with the beam energy of 70 keV where the beam intensity  $I_0$  is reduced to  $(1/e)I_0$ , assuming that the plasma density and the electron temperature are  $10^{20} \text{ m}^{-3}$  and 1 keV.



4. (10 points) What are the two driving mechanisms of electron cyclotron current in tokamaks?

5. (20 points) Explain startup of a tokamak in terms of stray field, field null, loop voltage, Townsend avalanche, role of ECH, breakdown, D<sub>α</sub> signal and field index.

6. (1) (10 points) What are the limitations of H-modes in view of stability and steady state operation of tokamaks?
- (2) (10 points) Do we have any alternatives to overcome those drawbacks?
- (3) (5 points) If the alternatives have another problems to solve, explain.

한 학기 동안 모두들 수고 많으셨습니다.  
좋은 결과 얻으시길 바랍니다.

"So we fix our eyes not on what is seen, but on what is unseen. For what is seen is temporary, but what is unseen is eternal." (2 Corinthians 4:18)