

# Indian Institute of Technology Delhi

## Centre for Energy Studies

### ESL 744: PLASMAS FOR ENERGY AND ENVIRONMENT

Major Examinations  
Duration: 60+10 minutes

Marks: 20  
27 August 2020

**NOTE:** The students should keep their video and audio on throughout the examination (1 hrs and 10 minutes). The students must not contact with each other. If the transcript will be found same for multiple students, all will get zero marks. Within the examination time, the students have to send their scanned transcript to [satyananda@ces.iitd.ac.in](mailto:satyananda@ces.iitd.ac.in) and [rams@ces.iitd.ac.in](mailto:rams@ces.iitd.ac.in). During the examination, the students must not refer the books or internet or any kind of unfair practices. Before examination, please check your audio and video.

***Any assumption made should be clearly mentioned and intermediate steps in derivations should be clearly shown. Answer all questions in the same copy.***

#### SECTION – A

1. A particle (charge  $q_1$ ) with velocity  $v_1$  and mass  $m_1$  is deflected by another particle (charge  $q_2$ ) with velocity  $v_2$  and mass  $m_2$ . Derive a relation for the scattering cross-section of the particle; for
  - i. a single collision resulting in a deflection of the particle greater than  $90^\circ$
  - ii. Multiple collisions resulting in a deflection of the particle greater than  $90^\circ$Compare these two cross-sections for two plasma systems, one with temperature 4.4 keV and density  $10^{20} \text{ m}^{-3}$  and another with 1 eV and  $10^{16} \text{ m}^{-3}$  respectively. [5]

#### SECTION – B

2. Explain concept of cell migration. What is the possible mechanism? How plasma treatment can affect the cell migration? [1+2+2]
3. Explain different kind of plasma etching processes. [5]
4. Explain the importance of cathode and cathode layer in arc discharges. [5]

#### Given the following constants:

Avagadro's number,  $N_A = 0.6022 \times 10^{24} / \text{mol}$

Boltzmann constant,  $k_B = 1.38 \times 10^{-23} \text{ J/}^\circ\text{K}$

Electron charge,  $q = 1.602 \times 10^{-19} \text{ C}$

Electron rest mass,  $m_e = 9.109 \times 10^{-31} \text{ kg} = 0.00549 \text{ amu}$

Proton rest mass,  $m_p = 1.672 \times 10^{-27} \text{ kg} = 1.007276 \text{ amu}$

Neutron rest mass,  $m_n = 1.675 \times 10^{-27} \text{ kg} = 1.008665 \text{ amu}$

Speed of light,  $c = 3 \times 10^8 \text{ m/s}$

1 eV =  $1.602 \times 10^{-19} \text{ J} = 11604 \text{ K}$

1 amu =  $1.660531 \times 10^{-27} \text{ kg}$

Permittivity of free space =  $8.8542 \times 10^{-12} \text{ F/m}$

Permeability of free space =  $4 \times 10^{-7} \text{ H/m}$

Atomic weight of  $^1_1\text{H} = 1.007825 \text{ amu}$

Atomic weight of  $^2_1\text{H} = 2.014102 \text{ amu}$

Atomic weight of  $^3_1\text{H} = 3.016046 \text{ amu}$