Engy-4350: Nuclear Reactor Engineering Spring 2019 UMass Lowell; Prof. V. F. de Almeida
19Apr19

Midterm Exam 19 Apr 2019

Name:

Guidance:

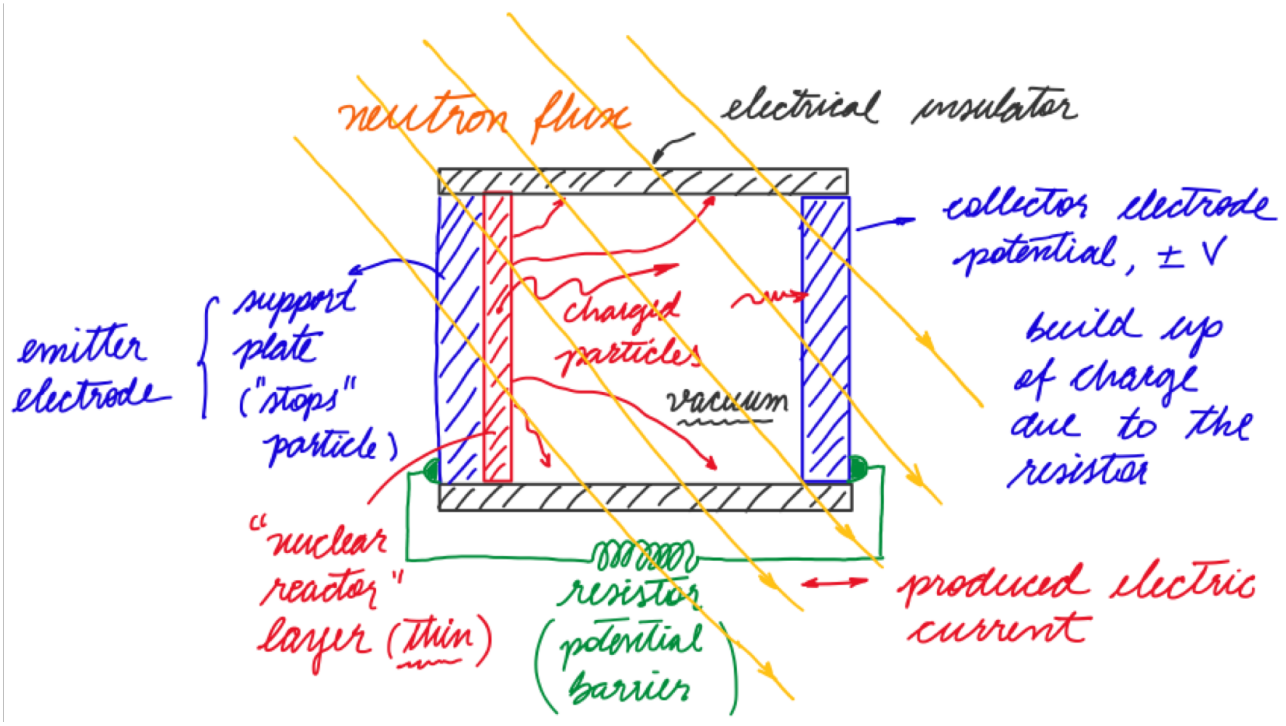
- This is an open-book, open-note, **individual** exam.
- No discussion with anyone is allowed.
- You may use online documents and course notes.
- Make sure to answer the questions asked.
- Show your **invidual** work and be crystal clear.

Rubric Panel

Show No.	Now Showing (2:00-3:15pm)	Value	Score
1	Nuclear Eureka	100	

Show Problem 1 (100 pts)

Consider a **fission-electric cell**, constructed with a thin layer of ^{235}U, pure metal (mass density 19.1 g/cm^3), as shown in the diagram below. The cell is inserted in a nuclear reactor with a constant thermal neutron flux where: $\varphi = 10^{14}\ \frac{\text{neutrons}}{\text{cm}^2\ \text{s}}$. The area of the ^{235}U layer facing the inside of the cell is constant, that is to say, only the thickness of the layer changes during irradiation. An electric current runs on the external circuit and it will be too small to measure after enough time has elapsed.



The **purity** of ^{235}U in the fission layer is of great interest for the operation of the cell. Therefore assessing the purity of the layer stated by the supplier is needed. **Use "nuclear" data from the NNDC or any other of the nuclear data sites referred to in course notes.** Assume the data is for temperature of 20 C. Address the following:

1. Everything remaining the same, the longevity of the electric current is greater the higher the purity of ^{235}U is. Explain this.
2. Identify a physical quantity that will determine the purity of ^{235}U in the fission layer while operating the cell under normal conditions.
3. Derive a formula for the time-dependent variation of this purity-like quantity relative to its initial value.
4. Using the data given, evaluate the previously derived time-dependent formula at the long-time limit ($t \rightarrow \infty$).
5. How soon can a measurement of this quantity be made to evaluate the purity of the fission layer if the measurement is only reliable for a 1% variation?

1.1: Everything remaining the same, the longevity of the electric current is greater the higher the purity of ^{235}U is. Explain this.

In [ ]:

1.2: Identify a physical quantity that will determine the purity of ^{235}U in the fission layer while operating the cell under normal conditions.

In [ ]:

1.3: Derive a formula for the time-dependent variation of this purity-like quantity relative to its initial value.

In [ ]:

1.4: Using the data given, evaluate the previously derived time-dependent formula at the long-time limit ($t \rightarrow \infty$).

In [ ]:

1.5: How soon can a measurement of this quantity be made to evaluate the purity of the fission layer if the measurement is only reliable for a 1% variation?

In [ ]: