Roll No: ----------

UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2018

Program: MTech Nuclear Science and Technology | **Semester – II**
Subject (Course): Nuclear Reactor Physics and Nuclear Reactor Theory | **Max. Marks : 100**
Course Code : NSAT 7004 | **Duration : 3 Hrs**
No. of page/s : 2

Section A

Answer all the 5 questions. Each question carries 4 marks

1. What is the difference between moderating power or slowing down power and moderating ratio and which is more important for a nuclear reactor moderator

2. For fissionable materials in reactors, ν(nu) and η(eta) represents what quantities and write the relation between them

3. What is the physical meaning of the thermal diffusion length and fast diffusion length?

4. The reactivity of the reactor is 0.001 and the fuel is ^{235}U. What is the reactivity in dollars and in cents?. The value of β for ^{235}U is 0.0065

5. What are nuclear reactor control materials and reactor poisons and explain their role briefly

Section B

Answer all the 4 questions. Each question carries 10 marks

6. Explain the concept of compound nucleus and nuclear resonances cross section

or

The absorption cross sections of ^{235}U and 238U at 0.0253 eV are 680.8 b and 2.70 b, respectively. Calculate Σa for natural uranium at this energy

7. Derive the four and six factor formulas and explain the differences between them

8. Define slowing down density and slowing down time and derive the corresponding equations in terms of neutron lethargy

9. Define thermal diffusion length and derive equation for the case of a fuel-moderator mixture

Section C

Answer both the questions. Each question carries 20 marks

10. Derive the kinetic energy loss of a neutron in an elastic head on collision and the average energy loss in each collision through conservation of energy and momentum

or

Prove that a thermal neutron with approximately zero energy cannot cause fission in ^{238}U nucleus having a fission barrier of 6.6 MeV. Use the following data: mass of ^{238}U and neutron are 238.05078826 and 1.0086644 amu respectively

11. Delayed neutrons play a dominant role in the fission chain reaction control. Prove that through the time dependent equations reactor operation would become impossible with only prompt neutrons

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Section A

Answer all the 5 questions. Each question carries 4 marks

1. Define the following terms: i) Neutron flux and ii) Radiative capture
2. Define induced fission and spontaneous fission and give one example for each of these reactions
3. What is the average slowing down logarithmic decrement (what does it mean, what is it describing)?
4. What is the cause of the neutron diffusion in a reactor assembly?. What effect does the presence of the fuel have on the diffusion of neutrons (scattering and absorption)
5. Describe the reactivity effects of fuel depletion in a thermal nuclear reactor

Section B

Answer all 4 questions. Each question carries 10 marks

6. Draw the graph of fission yield for thermal, fast and high energy 235U fissions and explain how the energy released in fission is distributed among the resultant fragments and radiations
7. Derive the neutron diffusion equation in two energy groups

Or

Calculate L, thermal diffusion length of a moderator for thermal neutrons in graphite using these values $\sigma_a = 3.2$ mb, $\sigma_s = 4.8$ mb and $\rho = 1.62$ gm/ cm^3

8. Write down the wave equation and the solution for neutron flux (ϕ) for the following nuclear reactor shapes: i) a rectangular parallelepiped, ii) a sphere and iii) a cylinder

9. Derive the In-hour equation

. Section C

Answer both the questions. Each question carries 20 marks

10. Derive the thermal neutron diffusion equation

or

Calculate the thermal diffusion time for graphite. The microscopic absorption cross section of graphite and density are 0.003 barns and 1.62 gm/cm^3 respectively. The average thermal neutron speed is 2200 meter/ second.

11. Derive Fermi age equation in the case of fast neutron diffusion

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