1. In a critical reactor, the effective multiplication factor is
   [a] slightly greater than unity
   [b] equal to unity
   [c] slightly less than unity
   [d] equal to zero

2. Doppler broadening is caused by
   [a] increase in temperature of the fuel
   [b] decrease in temperature of the fuel
   [c] is independent of temperature of the fuel
   [d]decrease in temperature of the moderator

3. Resonance escape probability in a heterogeneous system is
   [a] equal to that of homogeneous system for the same fuel/moderator composition
   [b] greater than that of homogeneous system for the same fuel/moderator composition
   [c] less than that of homogeneous system for the same fuel/moderator composition
   [d] independent of fuel/moderator composition

4. The amount of total energy released in a nuclear fission is about 200 MeV, out of which most of the energy is carried by
   [a] Prompt neutrons [b] Fission products
   [c] prompt gammas [d] Neutrinos

5. In a nuclear fission, most of the prompt neutrons are emitted with kinetic energy approximately equal to

   [a] 0.0625 eV [b] 1 eV [c] 1 keV [d] 1 MeV

6. If 'Σ_a' is the macroscopic absorption cross section and 'Φ' is the flux, then reaction rate is

   [a] $\Phi \Sigma_a$ [b] $1/(\Phi \Sigma_a)^2$ [c] $1/\Phi \Sigma_a$ [d] $(\Phi \Sigma_a)^2$

7. Main source of thermal neutrons in a reactor core is:

   [a] Fissile material [b] Moderator

   [c] Fertile material [d] Absorber

8. By integrating which of the following variables in neutron transport equation, one obtains the diffusion equation:

   [a] Angular, Ω [b] Energy, E

   [c] time, t [d] Space, r

9. In a chain reaction system, if infinite multiplication factor, k_∞, is 1.005, the neutron density increases 10 times in approximately

   [a] 46 generations [b] 6 generations

   [c] 462 generations [d] 1460 generations

10. With the decrease in the size of the reactor system, the non-leakage probability:

[a] decreases [b] increases

[c] remains constant [d] depends on k-eff

11. The amount of total energy released in a nuclear fission is about 200 MeV, out of which most of the energy is carried by

[a] Prompt neutrons [b] Fission products

[c] prompt gammas [d] Neutrinos

12. Which of the following moderator material has largest migration area/length:

[a] D_2O [b] H_2O [c] Beryllium [d] Graphite

13. In a nuclear fission, most of the prompt neutrons are emitted with kinetic energy approximately equal to

[a] 0.0625 eV [b] 1 eV [c] 1 keV [d] 1 MeV

14. If 'Σ_a' is the macroscopic absorption cross section and 'Φ' is the flux, then reaction rate is

[a] $\Phi \Sigma_a$ [b] $1/(\Phi \Sigma_a)^2$ [c] $1/\Phi \Sigma_a$ [d] $(\Phi \Sigma_a)^2$

15. Main source of thermal neutrons in a reactor core is:

[a] Fissile material [b] Moderator

[c] Fertile material [d] Absorber

16. By integrating which of the following variables in neutron transport equation, one obtains the diffusion equation:

[a] Angular, Ω [b] Energy, E

[c] time, t [d] Space, r

17. In a chain reaction system, if infinite multiplication factor, k_∞, is 1.005, the neutron density increases 10 times in approximately

[a] 46 generations [b] 6 generations

[c] 462 generations [d] 1460 generations

18. With the decrease in the size of the reactor system, the non-leakage probability:

[a] decreases [b] increases

[c] remains constant [d] depends on k-eff

19. . Define quantities 'η' and 'ν'. If the macroscopic absorption and fission cross section are defines as Σ_a and Σ_f respectively, what is the relation between 'η' and 'ν'.

20. . Various mechanisms by which neutrons can be gained or lost from an arbitrary volume, in the neutron transport formulation.

21. The migration length is a measure of the net vector distance travelled by

(a) a thermal neutron before getting absorbed

(b) a fission neutron before getting absorbed
(c) a fission neutron before leaking out
(d) a thermal neutron before leaking out

22. Fick's law is not valid
(i) far away from the boundaries
(ii) when the neutron flux strongly varies with distance
(iii) for a uniform medium
(iv) near strong absorbers

23. The flux at a distance r from a point source of neutrons in an infinite medium is given by

(a) $\phi(r) = \frac{S}{4\pi D}\frac{e^{-r}}{r}$ (b) $\phi(r) = \frac{4S}{\pi D}e^{-r/L}$

(c) $\phi(r) = \frac{1}{4\pi D}\frac{e^{-r}}{L}$ (d) $\phi(r) = \frac{D}{4\pi S}\frac{e^{-L}}{r}$

24. Linear extrapolation distance is the distance over which
(a) thermal absorption goes to zero
(b) neutron diffusion coefficient becomes zero
(c) neutron flux goes to zero
(d) derivative of neutron flux becomes zero

25. In a certain critical reactor having a geometrical buckling B^2, if M^2 is doubled, then k_∞ should be
(a) $k'_\infty = k_\infty$
(b) $k'_\infty = 2k_\infty$
(c) $k'_\infty = 2\,k_\infty + 1$
(d) $k'_\infty = 2\,k_\infty - 1$

26. As the neutron loses energy while slowing down
(a) the average logarithmic decrement increases
(b) the average logarithmic decrement decreases
(c) the neutron lethargy increases
(d) the neutron lethargy decreases

27. The diffusion area termed as L^2 for thermal neutrons
(a) is inversely proportional to the diffusion coefficient
(b) directly proportional to the macroscopic absorption cross section
(c) inversely proportional to the absorption mean free path
(d) directly proportional to the absorption mean free path

28. The average logrithmic energy decrement ξ for isotropic scattering
(a) independent of initial energy
(b) dependent on initial energy
(c) dependent on scattering angle
(d) independent of the scattering angle

29. Identify the critical relation for diffusion of two group of neutrons in a multiplying medium for a bare reactor

(a) $k_\infty = 1 + L^2 B_g^{\,2} + \tau$

(b) $k_{eff} = \dfrac{k_\infty}{(1 + L^2 B_g^{\,2})(1 + \tau B_g^{\,2})}$

(c) $k_{eff} = \dfrac{k_\infty}{(1 + L^2 B_g^{\,2})\tau}$

(d) $k_{eff} = \dfrac{\tau B_g^{\,2}}{(1 + L^2 B_g^{\,2})}$

30. The unit of fermi age τ is

(a) sec (b) sec^{-1} (c) cm^2 (d) cm^{-2}

51. A nuclide is said to be fertile if
   a) It can be fissioned.
   b) It can be fissioned with fast neutrons.
   c) It can be converted to fissile species.
   d) It can be fissioned by neutrons of any energy.

52. Resonance escape probability is the probability
   a) that a neutron is captured in the resonance.
   b) that a neutron escapes the resonance.
   c) that a neutron undergoes fission.
   d) that a neutron leaks out while slowing down.

53. Delayed neutrons are the ones
   a) which are produced by fission products.
   b) which are produced due to (n,γ) reaction with fission products.
   c) which are produced during fission.
   d) which are produced neutron sources in the reactor.

54. The unit of J, current density are
   a) neutrons/m.
   b) neutrons/sec.
   c) neutrons/sq. m/sec.
   d) neutrons/m/sec.

55. Fast reactor is one where
   a) the fission occur at a fast rate.
   b) most of the fissions are caused by fast neutrons.
   c) the heat is transferred to the coolant at a fast rate.
   d) the fission neutrons are born with fast energies.

56. If a U^{235} nucleus is split into its constituent neutrons and protons
   a) then 2500 MeV energy is released.
   b) then 2500 MeV has to be supplied.
   c) then 200 MeV is released.
   d) then 200 MeV has to be supplied.

57. Migration length is a measure of
   a) the distance travelled by a thermal neutron before getting absorbed.
   b) distance travelled by a fission neutron before getting absorbed.
   c) distance travelled by a fission neutron before leaking out.
   d) the distance travelled by a thermal neutron before leaking out.

58. A good moderator is one
   a) which has a small scattering cross section.
   b) which has a small diffusion length.
   c) which has a high absorption cross section.
   d) which has a small ξ value.

59. As a size of the reactor increases the leakage
   a) increases.
   b) decreases.
   c) does not change.
   d) can not be predicted.

60. The number of collisions required to a neutron for a hydrogen atom to slow down to thermal energy (0.025 ev) from 2 Mev is
   a) 18.
   b) 55.
   c) 200.
   d) 150.

61. If $B_g^2 >> B_m^2$ then
   a) the system is over sized.
   b) the system is critical.
   c) the system is supercritical.
   d) the system is subcritical.

62. If the enrichment of the fuel is increased, then one can say that
   a) **f** decreases.
   b) η increases.
   c) **p** increases.
   d) non leakage probability increases.

63. The diffusion theory is not valid for a
   a) homogeneous medium.
   b) far away from the boundaries.
   c) heterogeneous medium.
   d) near strong absorber.

(I). Write short note on following-
(II). Microscopic and macroscopic cross section
(III). Delayed neutrons in fission and their significance.
(IV). Average logarithmic energy decrement.
(V). Four factor formula.

69. Answer the following:

(i) Calculate η and α for thermal neutron fission of U^{233} and P^{239} from the following quantities;

	U^{233}	Pu^{239}
σ_a	**580 b**	**1010 b**
σ_f	**530 b**	**740 b**

v	2.492	2.871

70. Diffusion theory is not valid
(a) for a homogeneous system
(b) far away from the boundaries
(c) when there are no neutron sources
(d) near strong absorbers

71. If ξ of Oxygen is 0.158, the number of collisions required for a neutron to slow dwon from 2 MeV to 0.025 eV upon scattering is around

(a) 18 (b) 115 (c) 151 (d) 221

72. The average logrithmic energy decrement ξ for isotropic scattering
(a) independent of initial energy (b) dependent on initial energy

(c) dependent on scattering angle (d) independent of the scattering angle

73. The unit of fermi age τ is
(a) sec (b) sec^{-1} (c) cm^{-2} (d) cm^{2}

74. . A thermal reactor is one in which

(a) fission neutrons are generated with thermal energies

(b) most of fissions are caused by thermal neutrons

(c) fission reactions take place at a slow rate

(d) neutrons are slowed down to thermal energies

75. In an critical reactor, the multiplication factor

(a) slightly greater than unity

(b) equal to unity

(c) slightly less than unity

(d) equal to zero

76. The average energy of fission neutrons is

(a) 0.025 ev

(b) 2 Kev

(c) 2 Mev

(d) 200 Mev

77. Pu-239 is produced by

(a)□□-decay of U239

(b) capture of neutron in U-238

(c)□□-decay of Pu-238

(d)□□-decay of Np-239

79. If U^{235} nucleus is split into 92 protons and 143 neutrons then (assuming the Binding Energy per nucleon in this nucleus to be 7.6 MeV) about

a) 200 MeV energy will be released.
b) 1800 MeV energy will be released.
c) 200 MeV energy will be required.
d) 1800 MeV energy will be required.

80. The neutron capture cross section below the resonance energy is proportional to

a) 1/E b) 1/√E c) √E d) E

81. Most of the fission energy is taken away by

a) fast fission neutrons b) γ-rays c) fission fragments d) neutrinos

82. U^{235} is fissile nucleus because

a) it releases about 200 MeV of energy after fission.
b) it undergoes fission by neutrons of any energy.
c) it is present only about 0.71% in natural uranium.
d) its binding energy is very small.\

83. If temperature of the moderating medium is increased three times from 20 to 60 °C, the speed of the thermal neutrons in this medium will increase by a factor of

a) 3 b) 1.3 c) √3 d) 1.14

84. An average lethargy gain of a neutron per scattering collision

a) is same for collisions with any nucleus.
b) does not depend upon the initial energy of the neutron.
c) is higher for collisions with light mass nuclei.
d) increases with neutron energy.

85. Average number of collisions required to slow down a neutron from 2 MeV to 1 eV energy is

a) higher for heavy water medium than light water medium.
b) higher for light water medium than heavy water medium.
c) independent of the medium.

86. In a single elastic collision with a stationary nucleus, the kinetic energy of a neutron (in lab. System) can become zero if mass of the nucleus as compared to neutron mass is

a) infinitely large b) infinitely small c) same d) anything

87. In a thermal reactor the fission neutrons loose energy mainly by

a) inelastic scattering with light nuclei.
b) elastic scattering with light nuclei.
c) inelastic scattering with heavy nuclei.
d) elastic scattering with heavy nuclei.

88. Unit of neutron current density and neutron flux are

a) neutrons/cm^3/sec

b) neutrons/cm^2/sec

c) neutrons.cm^2/sec

d) neutrons.cm^3/sec

89. In elastic scattering collisions the kinetic energy of the neutron can be changed by a very small amount if

a) the target nucleus is a proton

b) the target nucleus is deuterium

c) the target nucleus is uranium

d) carbon

90. Homogenization of fuel and moderator thoroughly leads to

a) an increase in fast fission factor

b) an increase in the number of neutrons produced per neutron absorbed in the fuel

c) an increased thermal utilization factor

d) an increase in the resonance escape probability

80. In the following materials, diffusion length is the highest in

a) Light water

b) Heavy water

c) Graphite

d)Beryllium

91. Heavy water is a better moderator than H_2O because of its

a) large α

b) large Σ_s

c) Higher moderating ratio

d)Higher slowing down power

92. Lethargy is the highest for

a) Fission neutrons

b) Delayed neutrons

c) Thermal neutrons

d) Can't say

1. Choose the correct answer **[10 x 2 = 20]**

(i) Actual mass of element is

(a) always greater than the sum of mass of constituent nucleons

(b) always equal to the sum of mass of constituent nucleons

(c) always less than the sum of mass of constituent nucleons

(d) independent of mass of constituent nucleons

(ii) As the size of a reactor increases, the neutron leakage

(e) increases

(f) decreases

(g) does not change

(h) cannot be predicted

(iii) A good moderator is one

(a) which has a small scattering cross section

(b) which has a small diffusion length
(c) which has a high absorption cross section
(d) which has a high moderating ratio

(iv) The average logarithmic energy decrement ξ for isotropic scattering
(a) independent of initial energy

(b) dependent on initial energy

(c) dependent on scattering angle

(d) independent of the scattering angle

(v) In an critical reactor, the multiplication factor

(a) slightly greater than unity

(b) equal to unity

(c) slightly less than unity

(d) equal to zero

(vi) The average energy of fission neutrons is

(a) 0.025 ev

(b) 2 Kev

(c) 2 Mev

(d) 200 Mev

(vii) U^{235} is fissile nucleus because
(a) it releases about 200 MeV of energy after fission.
(b) it undergoes fission by neutrons of any energy.
(c) it is present only about 0.71% in natural uranium.
(d) its binding energy is very small.

(viii) The fuel material that contributes to a major part in resonance capture of neutrons that are being slowed down is

(a) Th-232

(b) U-233

(c) U-235

(d) U-238

(ix)For a super-critical reactor which of the following is correct?

(a) $B_m^2 > B_g^2$

(b) $B_m^2 < B_g^2$

(c) $B_m^2 = B_g^2$

(d) None of the above

(x) When U-235 enrichment in the fuel is increased, the factor that is primarily affected is

(a) η

(b) ε

(c) p

(d) f

2. State whether 'TRUE' or 'FALSE' **[15 x 1 = 15]**

(a) For a given lattice as the radius of the fuel rod pitch increases, f increases.

(b) U-233 is a fertile isotope.

(c) Light water has a larger Moderating Ratio than heavy water.

(e) The resonance escape probability of a homogenous system is less than that of a heterogeneous system.

(f) Nuclear Forces are long range repulsive force.

(g) Energy release in the fission reaction is around 200 MeV.

(h) Activity of the radioactive nuclide increases exponentially with time.

(i) In a nuclear fission maximum energy is carried away by neutrons.

(j) The unit of macroscopic cross section is barn.

(k) When geometric buckling is less than material buckling, the reactor is supercritical.

(l) The smaller the mass number of scattering nucleus, the smaller is the average logarithmic energy decrement.

(m) Heat production in a nuclear reactor stops immediately as soon as reactor is shutdown.

(n) Infinite multiplication factor increases as the size of the system increases.

(o) A reactor is CRITICAL if K-eff = 1.

(p) Presence of neutron reflector decreases the size of active core.

BARC Training School -PHYSICS
OCES-2012 (56TH Batch)
REACTOR PHYSICS

Time-2hrs **Total Marks – 60**

[10X2] = 20 marks

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    [a] slightly greater than unity
    [b] equal to unity
    [c] slightly less than unity
    [d] equal to zero

32. Doppler broadening is caused by
    [a] increase in temperature of the fuel
    [b] decrease in temperature of the fuel
    [c] is independent of temperature of the fuel
    [d]decrease in temperature of the moderator

33. Resonance escape probability in a heterogeneous system is
    [a] equal to that of homogeneous system for the same fuel/moderator composition
    [b] greater than that of homogeneous system for the same fuel/moderator composition
    [c] less than that of homogeneous system for the same fuel/moderator composition
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34. The amount of total energy released in a nuclear fission is about 200 MeV, out of which most of the energy is carried by
    [a] Prompt neutrons [b] Fission products
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35. In a nuclear fission, most of the prompt neutrons are emitted with kinetic energy approximately equal to

[a] 0.0625 eV [b] 1 eV [c] 1 keV [d] 1 MeV

36. If 'Σ_a' is the macroscopic absorption cross section and 'Φ' is the flux, then reaction rate is

[a] $\Phi \Sigma_a$ [b] $1/(\Phi \Sigma_a)^2$ [c] $1/ \Phi \Sigma_a$ [d] $(\Phi \Sigma_a)^2$

37. Main source of thermal neutrons in a reactor core is:

[a] Fissile material [b] Moderator

[c] Fertile material [d] Absorber

38. By integrating which of the following variables in neutron transport equation, one obtains the diffusion equation:

[a] Angular, Ω [b] Energy, E

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39. In a chain reaction system, if infinite multiplication factor, k_∞, is 1.005, the neutron density increases 10 times in approximately

[a] 46 generations [b] 6 generations

[c] 462 generations [d] 1460 generations

40. With the decrease in the size of the reactor system, the non-leakage probability:

[a] decreases [b] increases

[c] remains constant [d] depends on k-eff

1. Derive the semi empirical mass formula
2. Explain the neutron life cycle.
3. Calculate the BE/A for U-235, U-238

   Given: mass of proton – 1.007825 amu, mass of neutron – 1.008665 amu, 1amu = 931 Mev
4. Nat U is a homogenous mixture of 99.28 wt% of U-238 (σ_b=2.7 b) and 0.72 wt% U-235 (σ_b=681 b). The density of nat. U is 19.0x10E03 kg/m^3. Determine the total macro-scopic and micro-scopic absorption cross section of this material

5. The micro-scopic cross sections for the capture of (slow neutrons) at 0.025 eV by hydrogen is 0.33 barns and for oxygen is 2x10e-04 barns. Calculate the macro-scopic x sec of H_2O molecule for thermal neutrons.

6. Explain the terms involved four factor formulas. How does the expression change if leakage on neutrons is considered? Explain the following terms: critical, super critical and sub critical state.

7. How four factor changes by fuel lumping?

8. Explain the terms: neutron flux, neutron current, reaction rate, diffusion length, logarithmic energy decrement

9. Write down the steady state neutron diffusion equation in multiplying medium and explain the various terms. What are the assumptions used in the derivation of diffusion theory. State Fick's law of diffusion.

10. a) Derive the relationship between the kinetic energy of an elastically scattered neutron and its initial kinetic energy.

b) Explain the conditions for maximum and minimum energy loss of neutron in an elastic collision.

c) Calculate the average number of collisions needed to reduce the fission neutron energy from 2MeV to 0.025 ev in the Be moderator. ξ for Be =0.209.

11. Explain various mechanisms by which neutrons can be gained or lost from an arbitrary volume, in the neutron transport formulation.

---BEST OF LUCK---

(a) Describe the total binding energy of a nucleus using Liquid Drop Model. Explain the nuclear fission on the basis of Liquid Drop Model. Determine the binding per nucleon in a) Sn_{50}^{120} for which M=119.9022 amu b) U_{92}^{235} for which M=235.0439 amu, m_p=1.007825 amu, m_n=1.008665 amu.

(b) Explain macro scopic and micro scopic cross sections. Natural Uranium contains 99.28 wt% of U-238 (σ_{ab} = 2.8 barns) and 0.72 wt% of U-235 (σ_{ab} = 700 barns). The density of Natural U metal is 19.0 x 10^3 kg/m^3. Determine the total microscopic and macroscopic cross section of this material.

(c) What is four factor formula? Define the Neutron Cycle based on four factors. Explain the behavior of each component of four factors for the increasing pitch in a heterogeneous system.

(d) Describe various mechanisms by which neutrons can be gained or lost from an arbitrary volume, in the neutron transport formulation. Define material bucking and geometrical buckling.

(e) Explain the desirable properties of fuel, clad, moderator and coolant. Define slowing down power and moderating ratio. Calculate the number of collisions required for a neutron colliding with oxygen to slow down from 2 MeV to 0.025 eV. ξ of Oxygen is 0.158.

3. Choose the correct answer **[10 x 2 = 20]**

(v) Actual mass of element is
(a) always greater than the sum of mass of constituent nucleons
(b) always equal to the sum of mass of constituent nucleons
(c) always less than the sum of mass of constituent nucleons
(d) independent of mass of constituent nucleons

(vi) As the size of a reactor increases, the neutron leakage
(i) increases
(j) decreases
(k) does not change
(l) cannot be predicted

(vii) A good moderator is one

(e) which has a small scattering cross section
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(g) which has a high absorption cross section
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(a) independent of initial energy

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(v) In an critical reactor, the multiplication factor

(a) slightly greater than unity

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(a) 0.025 ev

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(xii) The fuel material that contributes to a major part in resonance capture of neutrons that are being slowed down is

(e) Th-232
(f) U-233
(g) U-235
(h) U-238

(xiii) For a super-critical reactor which of the following is correct?
(e) $B_m^2 > B_g^2$
(f) $B_m^2 < B_g^2$
(g) $B_m^2 = B_g^2$
(h) None of the above

(xiv) When U-235 enrichment in the fuel is increased, the factor that is primarily affected is
(e) η
(f) ε
(g) p
(h) f

4. State whether 'TRUE' or 'FALSE' **[15 x 1 = 15]**

(a) For a given lattice as the radius of the fuel rod pitch increases, f increases.

(b) U-233 is a fertile isotope.

(c) Light water has a larger Moderating Ratio than heavy water.

(e) The resonance escape probability of a homogenous system is less than that of a heterogeneous system.

(f) Nuclear Forces are long range repulsive force.

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(q) Activity of the radioactive nuclide increases exponentially with time.

(r) In a nuclear fission maximum energy is carried away by neutrons.

(s) The unit of macroscopic cross section is barn.

(t) When geometric buckling is less than material buckling, the reactor is supercritical.

(u) The smaller the mass number of scattering nucleus, the smaller is the average logarithmic energy decrement.

(v) Heat production in a nuclear reactor stops immediately as soon as reactor is shutdown.

(w) Infinite multiplication factor increases as the size of the system increases.

(x) A reactor is CRITICAL if K-eff = 1.

(y) Presence of neutron reflector decreases the size of active core.

5. Answer any FOUR of the following questions. [4 x 10 = 40]

(a) Describe the total binding energy of a nucleus using Liquid Drop Model. Explain the nuclear fission on the basis of Liquid Drop Model. Determine the binding per nucleon in a) Sn_{50}^{120} for which M=119.9022 amu b) U_{92}^{235} for which M=235.0439 amu, m_p=1.007825 amu, m_n=1.008665 amu.

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(h) Explain the desirable properties of fuel, clad, moderator and coolant. Define slowing down power and moderating ratio. Calculate the number of collisions required for a neutron colliding with oxygen to slow down from 2 MeV to 0.025 eV. ξ of Oxygen is 0.158.

1. **Define fissile, fissionable and fertile materials with examples.**
2. **What are the different ways of neutron interaction with matter?**
3. **Define the term moderating ratio.**
4. **What are the desirable properties of the fuel?**
5. **What are the desirable properties of the moderator?**
6. **Explain Neutron Cycle.**
7. **Explain the Binding Energy Curve.**
8. **Define the infinite multiplication factor and the effective multiplication factor of the medium.**
9. **Define Critical, Sub critical and super critical state of the reactor.**
10. **Explain critical energy with respect to the nuclear fission.**
11. **Explain the term Migration Length.**

50 Explain the following
(i) Diffusion length
(ii) Geometrical buckling

64. **Explain how the four factors η,ε, p and f change for homogenous and heterogeneous reactors ?**

65. **Define the terms fissile, fertile and fissionable materials giving examples. Write the nuclear reactions leading to the production of fissile plutonium and uranium.**

66. **Write a note on two types of neutron sources with their possible role in the reactor operation.**

67. **Explain the terms involved four factor formula. How does the expression change if leakage on neutrons is considered.**

68. **What is the basic purpose of reflector?**