This question paper contains 3 printed pages.]

3436   **A**

M. Tech./IV Sem.

NUCLEAR SCIENCE AND TECHNOLOGY
Paper NST–624—Nuclear Power Engineering

Time : 3 Hours   *Maximum Marks :* 70

(Write your Roll No. on the top immediately

on receipt of this question paper.)

Question No. **1** *is compulsory and carries 25 marks.*

Rest all questions carry **15** *marks each.*

Attempt ***four*** *questions in all.*

1.   Write short notes on the following :   25

   (a) Energy is released in fusion of lighter nucleii and energy is also
        released when a very heavy nucleus undergoes fission. Explain
        with the help of finding energy the distribution curve.

   (b) India's 2nd stage of nuclear power program will utilize fast
        reactors run with plutonium obtained from 1st stage.

   (c) Thermal flux flattening (radially) for a cylindrical power reactor
        is essential and is achieved by different means.

(d) Attenuation coefficient and build-up factor are used for design of shield against gamma radiation.

(e) Emergency preparedness plans around a nuclear power plant.

2. In a bare cylindrical reactor, the central fuel consists of a single solid cylindrical fuel rod of UO_2 having rod diameter of 12 mm and a clad thickness of 0.4 mm. At the central position of the channel, the heat generation rate in the fuel is 5.6×10^5 kW/m^3 and clad outer surface temperature is 330°C. The thermal conductivity of fuel material is 2.6 w/m.k. and that of clad material is 16.5 w/m.k.

   (a) Calculate the fuel centre temperature at the central position of the channel.   6

   (b) Derive the expressions used with necessary assumptions.   9

3. (a) Explain xenon poisoning and xenon over-ride for an operating reactor.   9

   (b) Draw an outline of a BWR containment structure showing the two volume approach of a containment system.   6

4. (a) Explain the problems associated with thorium as a nuclear fuel element.   5

   (b) Explain the significance of $\int K \, dT$ with reference to nuclear fuel element design.   5

(c) Explain with reference the use of free-standing and collapsible design of clad for fuel material for power reactors.   5

5. (a) Calculate the doubling time of fissile material for a FBR using Pu–239 as fuel. Consider a breeding ratio of 1.15, discharged fuel cooling period of 6 months and fuel reprocessing and fabrication time of 1 year.   9

   (b) The imported PWRs and BWRs do not have any place in India's 3 stage nuclear power program. But why still it is being done ?   6

6. (a) Explain the working principle of a PWR with a diagram. Level the main components in the diagram.   10

   (b) When starting a fresh reactor or a reactor after a long shutdown, need of neutron source arises. What are the neutron sources available ? Explain with nuclear equations.   5