B.Tech.
THIRD SEMESTER EXAMINATION 2015-16
EOE036
NUCLEAR SCIENCE

Time: 3 hours   Max Mark: 100

Note

- Attempt all questions.
- Marks and number of question to attempt from the section is mentioned before each section.
- Assume missing data suitably .Illustrate the answer with suitable sketch.

1. **Attempt any FOUR parts of the following:**   [4x5]
   a. Draw and explain the graph for the binding energy per nucleon against the mass number.
   b. What do you mean by quadrupole moment ? What is the significance of existence of quadrupole moment of nucleus?
   c. Explain the concept of parity of nuclear physics.
   d. If an electron is confined within a nucleus whose diameter is 10^{-14} m, estimate its minimum kinetic energy and the coulomb energy. Also prove that electrons are not the nuclear binding blocks.
   e. Electrons of kinetic energy 500 MeV are scattered from a target of nuclei into a diffraction pattern that has minima with an average separation of $\theta = 30^0$. Find the charge distribution radius r' of the target nuclei.

2. **Attempt any FOUR parts of the following**   [4x5]
   a. What are magic numbers? How magic numbers and energy levels were predicted by singl particle shell model?
   b. Discuss the main features of collective model for atomic nucleus. How does the collective help in understanding the phenomenon of nuclear fission.
   c. Comparison liquid drop and shell model of nuclei.
   d. Discuss semi empirical mass formula explaining meaning of each term in itand stste its limitations.
   e. Using the single particle shell model to predict the ground state angular momenta and parities of (i) $_{13}Al^{27}$ (ii) $_{16}S^{23}$ (iii) $_{8}C^{12}$

3. **Attempt any FOUR parts of the following**   [4x5]
   a. Explain the difference between compound nucleus and direct reaction mechanism.
   b. Define threshold energy of a nuclear reaction. State the conservation laws that can be applied to a nuclear reaction and derive an expression for the Q- value.
   c. Calculate the Q- value of the following nuclear reaction.

   d. What do you mean by prompt and delayed neutrons?
   e. A deuterium reaction that occurs in experimental fusion reactor is
      $$_{1}H^{2} + {}_{1}H^{2} \rightarrow {}_{1}H^{3} + {}_{1}H^{1} + Q \text{ and then it follows}$$
      $$_{1}H^{3} + {}_{1}H^{2} \rightarrow {}_{2}He^{4} + {}_{0}n^{1} + Q2$$
      (i)   Calculate the percentage of the rest mass of deuteron released as energy.
      (ii)   Calculate U^{235} fision with deuteron fusion as a source of energy release..
      Given
      $_{1}H^{2} = 2.014740u.$ $_{1}H^{3} = 3.017005u.$ $_{1}H^{1} = 1.008145u.$ $_{0}n^{1} = 1.008986u.$
      $_{2}He^{4} = 4.003179u.$ $_{92}U^{235} = 235.1175u.$

4. **Attempt any FOUR parts of the following**   [4x5]
   a. Calculate the weight in grams of one curie of RaB (pb^{214}) from its half life of 26.8 minutes.
   b. Discuss Gamow's theory of alpha decay. How far does this explain the Geiger- Nuttall law?
   c. Discuss interaction of Gamma rays with matter.
   d. Give the construction and working of Aston mass spectrograph.
   e. Describe the working of a cyclotron and explain how their limitations have been overcome in a synchro- cyclotron.

5. **Attempt any ONE parts of the following**   [1x10]

   a. Describe the construction and working of a self quenching Geiger- Muller counter.

   OR

   b. Give in brief the mode of operation of a scintillation counter and describe how it may be used to study nuclear reaction.

6. **Attempt any ONE parts of the following**   [1x10]

   a. What do you mean by radioactive tracers? Explain their use in material science and agriculture.

   OR

   b. Give a brief account of discovering of positron. Explain the mechanism of emission of positron from a radio-active substance.