

**INDIAN INSTITUTE OF TECHNOLOGY  
KHARAGPUR**

Sub. Name : Nuclear Geophysics                      Sub. No. : EX41004      Total Time: 2 hours  
Spring (Mid) Semester 2009-2010                      M.Sc. Fourth Year (Exploration Geophysics)  
Department of Geology & Geophysics                      No. of Students : 14      Total Marks : 80  
Instructions: Attempt all the questions. Draw suitable figures as required.

- Q1(a). Enumerate the essential aspects of the 'Applied Voltage' versus 'Output Pulse-height characteristics' for Ionization detectors. Give the circuit diagram for the Ionization chambers and Proportional counters. Give the relative merits and de-merits of the Geiger Muller detectors, Scintillation detectors and the Semiconductor devices.
- (b). Estimate the actual rate of decay for a radionuclide, for a detection coefficient of 15% and a counting rate of  $5 \times 10^{10}$  counts per second, respectively.
- (c). How long it will take for a sample of radium to decrease to 10% of its initial value, if its half-life is 22 years?

(10+5+5=20)

- Q2(a). Explain the essential concept of scintillation counting and the basic concept of the 'radiometric phosphors'. Explain the overall concept with the help of a suitable schematic/diagram.

- (b) Prove that the activity of 1 gram of radium is  $3.7 \times 10^{10}$  disintegrations per second. What is the significance of the result so obtained. Use the half-life for the radiogenic daughter as 1620 years.

(10+5+5=20)

- Q3(a). Enumerate the essential aspects of the individual components of the 'Nuclear Electronics' routinely used for radiometric prospecting and assaying. Why are 'multi-channel analysers better than single channel analysers?
- (b). Enumerate the essential features of P-I-N detectors. Why are HPGe detectors preferred over Ge(Li) detectors specially for radiometric prospecting?
- (c) Alpha particle with energy of 7 Mev passes through an ionization chamber completely losing its energy. Assuming that 35 ev of energy is required to produce one ion pair, estimate the number of ion pairs formed.

(10+5+5=20)

- Q4(a). Obtain the number of radiogenic daughters produced due to a nuclear decay based on the 'Rutherford Soddy's' relationship. Explain the geophysical significance of the following for a given radionuclide :

(i) Decay constant, (ii) Half-life and (iii) Mean-life.

- (b). Calculate the activity of  $^{40}\text{K}$  in a 75 Kg. rock sample, assuming that about 0.35% of its bulk weight comprises of potassium and the isotopic abundance of the radiogenic potassium is 119 ppm, respectively.
- (c) Explain the concept of a 'Four channel analyser' using suitable equations. How is the same utilized for radiometric assaying for 'field surveys'.

(8+5+7=20)