(b) Discuss the role of polyatomic and electronegative gases in the operation of gaseous detectors. (4)

(c) Describe the working principle of bolometric detectors. (4)

5. (a) What are scintillation detectors? Compare and contrast organic and inorganic scintillators. (6)

(b) Explain how a semiconductor detector works. Also, describe the main features of silicon and germanium detectors. (6)

(c) Describe the methods for detecting slow and fast neutrons. (6)

6. (a) Differentiate between analog and digital signal processing in radiation detection. What are the advantages of digital signal processing? (6)

(b) Explain the roles of preamplifiers, amplifiers, and ADCs in detector systems. (6)

(c) A hospital uses a gamma camera for thyroid imaging. If the images appear blurred, what detector-related issues could be responsible? How can they be resolved? (6)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4823 **J**

Unique Paper Code : 2224002009

Name of the Paper : Physics of Detectors

Name of the Course : **B.Sc. Hons. - (Physics)_NEP: UGCF-2022**

Semester : IV / VI (GE Paper)

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions in total.
3. Question No. **1** which is compulsory.
4. **All** questions carry equal marks.
5. Use of a Non-programmable calculator is allowed.

1. Answer any **six** of the following : (6×3=18)

(a) Which type of shielding material is most effective for high-energy electrons, and why?

(b) What is the threshold energy for pair production to occur, and what are the resulting particles?

(c) What is the Fano factor, and what information does it provide about a detector's performance?

(d) What advantage does a multi-wire proportional counter (MWPC) have over a simple Geiger-Muller counter?

(e) Why are activators like thallium (Tl) added to inorganic scintillators (e.g., NaI)?

(f) State the logic voltage levels for NIM, TTL, and ECL standards in nuclear instrumentation?

(g) Give two applications of radiation detectors in medical physics.

2. (a) Derive the expression of specific energy loss (Bethe-Block formula) for heavy charged particles in the detector material. (10)

(b) What is Cerenkov radiation? What are the conditions necessary for its occurrence. (4)

(c) Calculate the energy of a 1 MeV gamma-ray photon after Compton Scattering through 90°. (4)

3. (a) Describe and compare the pulse mode and current mode of detector operation. (6)

(b) What is dead time in a radiation detector, and calculate its value (assuming no background radiation) if the detector records 10,000 counts/sec with one source and 19,000 counts/sec when an identical second source is added beside the first. (6)

(c) What is pulse height spectrum? Using the same horizontal scale, sketch both the differential and integral pulse height spectra for a set of radiation pulses uniformly distributed in amplitude between 0 and 1 V. (6)

4. (a) Plot the characteristic curve illustrating the relationship between the number of collected ions and the applied bias voltage in a gas-filled detector. On the graph, clearly label and describe the distinct operational regions, including the ionization region, proportional region, limited proportional region, Geiger-Muller region, and discharge region. For each region, explain the underlying physical processes governing detector operation and discuss their significance in the context of radiation detection and measurement. (10)