(c) Analyze the differences between planar and cylindrical geometries in gas-filled detectors, particularly in terms of their electric field configurations and their effects on time resolution and energy resolution. (6)

5. (a) Describe the construction and working of a photomultiplier tube (PMT). What factors influence the time response and resolution of a PMT? (9)

(b) Compare NaI(Tl) and plastic scintillators based on: speed of response, light output, linearity, high-energy gamma efficiency, and cost. (5)

(c) Describe the operating principle of a Charge Coupled Device (CCD) for radiation detection. (4)

6. (a) Differentiate between the NIM, ECL, and TTL standards in electronic instrumentation. (6)

(b) Draw a block diagram of a modern electronic signal processing chain used in radiation detection and label each component briefly. (6)

(c) Discuss the applications of detectors in medical physics and imaging, providing a specific example to illustrate their use. (6)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 5134 **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) What is the primary mechanism by which heavy charged particles lose energy when passing through matter?

(b) What is bremsstrahlung, and when is it significant?

(c) Differentiate between the intrinsic and extrinsic efficiency of a detector.

(d) What is the significance of depletion depth in semiconductor detectors?

(e) Why are semiconductor detectors preferred over gas detectors for high-resolution spectroscopy?

(f) What does VME stand for in detector electronics? Discuss its advantages in large-scale experiments?

(g) What is shot noise, and what is its origin in radiation detectors?

2. (a) Describe the three primary processes by which gamma rays interact with matter. Compare their relative dominance at different energy ranges. (6)

(b) What is neutron moderation? How does neutron energy influence interaction types? (6)

(c) Consider a 100 GeV proton cyclotron. If the guide field is 10 kG, what is the radius of curvature of the machine needed to contain the full energy protons? (6)

3. (a) Define and differentiate between differential pulse height spectra and integral pulse height spectra. Using the same horizontal scale, sketch both the differential and integral pulse height spectra for a set of radiation pulses, all having a uniform amplitude of 1 V. (6)

(b) What is energy resolution in a radiation detector, and why is it better to have a lower percentage energy resolution for accurate energy measurements? What factors can affect the energy resolution of a detector?

A NaI(Tl) scintillation detector is used to measure a 1 MeV gamma-ray source, and the observed Full Width at Half Maximum (FWHM) of the energy peak is 80 keV. Calculate the energy resolution of the detector in percentage terms. (8)

(c) A radiation detector collects a charge equal to that carried by 10^6 electrons on a capacitance of 100 pF. Calculate the amplitude of the voltage pulse generated. ($e = 1.602 \times 10^{-19}$C). (4)

4. (a) Explain the construction, working, and applications of a Geiger-Müller counter. (6)

(b) What is the fundamental principle behind the operation of bubble and cloud chambers for particle detection? (6)