M.Sc. Examination, 2018
Semester – III
Physics
Course: MPC-354
(Nuclear Physics-I)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer ***any four*** of the following questions.

1 (a) Given a graph of the gas amplification curve for an ion chamber, identify the different regions of the curve and characterize the detectors operated in each of the useful regions of the curve.

(b) A particle is passing through a cylindrical proportional counter, operating under certain voltage and with a given size of wire. How would you proceed to calculate expected voltage signal as a function of time ?

(c) A paralyzable detector system has a dead time of 1.5 microseconds. If a counting rate of 100 kHz is recorded, find the two possible values for the true interaction rate ? [4+4+2]

2 (a) Describe the working principle of a GM counter with special reference to the following points:
construction, quenching, characteristics, efficiency and dead time ?

(b) Why does the pulse height from a GM counter continue to increase with applied voltage even after a full discharge is obtained ?

(c) An end-window type GM counter with the window area of 1 cm^2, placed 5 cm from the point radioactive source (activity 10^5 disintegration per second), detects all the beta particles entering into it. Assuming that only 10% of the beta particles could pass through the window, find the resolving time of the counter if the measured counting rate is 30 Hz. [4+2+4]

3 (a) Draw a diagram to explain how the voltage is multiplied in Cockcroft-Walton voltage generator.

(b) Explain how an ion source produces a negative ion beam ?

(c) Design and sketch a plan for an experiment where you need a negative ^{16}O beam of 65 MeV laboratory energy. What type of accelerator you will choose for this measurement ? [4+2+4]

4 (a) Write down the working principle of a van de Graaff accelerator and explain its construction with a schematic diagram.

(b) How a tandem accelerator works ?

(c) How the terminal potential is raised with the help of a charging belt in a tandem accelerator ? [5+3+2]

5 (a) If the energy resolution of a particular NaI(Tl) scintillation detector is 7% for ^{137}Cs gamma rays (0.662 MeV), estimate its energy resolution for the 1.28 MeV gamma rays from ^{22}Na.

(b) In what way a scintillation detector is superior to a gas detector ?

(c) Calculate the scintillation efficiency of anthracene if 1 MeV of particle energy loss creates 20300 photons with average wavelength of 447 nm.

(d) The gain per dynode of a 10-stage PM tube varies as $V^{0.6}$ where V is the interdynode voltage. If the tube is operated at an overall voltage of 1kV, how much voltage fluctuation can be tolerated if the gain is not to change by more than 1% ? [3+1+3+3]

P.T.O.

6 (a) What is the principal advantage of bipolar shaped pulses over monopolar shaped pulses ?

(b) What are the different NIM logic levels used in nuclear electronics ?

(c) A step voltage of 1V amplitude is applied to the input of a CR-RC differentiator-integrator network with equal time constants. What is the amplitude of the shaped pulse ?

(d) Sketch a configuration of two integral discriminators and an anti-coincidence unit that will perform the function of a single-channel analyzer.

(e) A Wilkinson-type ADC has a conversion gain of 2048 channels and a maximum conversion time of 25 microseconds. At what frequency must the oscillator operate ?

[1+1+2+4+2]
