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DEPARTMENT OF SCIENCES III SEMESTER M.Sc. (PHYSICS) END SEMESTER REGULAR EXAMINATIONS, NOVEMBER & DECEMBER 2023 NUCLEAR PHYSICS - I [6003] (CHOICE BASED CREDIT SYSTEM - 2020)

Time: 3 Hours

Date: 07/12/2023

MAX. MARKS: 50

Note (i) Answer ALL questions

(ii) Draw diagrams, and write equations wherever necessary

Q. No.		Marks	CO	BL
1 (a)	Explain the necessary condition for having rotational excitation in a quantum system.	2	1	2
1 (b)	Write down the Hamiltonian of a vibrating nucleus. Explain various terms entering in the expression.	2	1	1
1 (c)	In figure 1 (on the next page), level scheme of a rotating nucleus is shown. Assuming that the rotational model is valid, calculate the excitation energy of states above 2 ⁺ level.	3	1	3
1 (d)	Assume there is a particle in the state $ nljK\rangle$ attached to a prolate core. Here, K is the projection of the angular momentum j on the symmetry axis. Explain, whether low K state or high K state is lower in energy.	3	1	4
2 (a)	What is a deformed shell model?	2	1	1
2 (b)	Write down the equation for nuclear surface	2	1	1
2 (c)	Show that quadrupole moment of an oblate deformed nucleus is always negative.	3	1	3
2 (d)	Show that $R_2(\pi)$ invariance of an axially symmetric nucleus with K=0 implies that total angular momentum can have either even or odd value.	3	1	3
3 (a)	Explain the three processes by which gamma-ray interacts with matter.	3	2	3
3 (b)	Explain the emission of secondary electrons in the photoelectric process.	3	2	3
3 (c)	To increase the photoelectric effect which of the material is more useful. Iodine or Carbon, Justify your answer.	2	2	2
3 (d)	Define absolute and intrinsic efficiency of a detector.	2	2	1

4 (a)	Explain the quenching process in an inorganic scintillator.		2	2	
4 (b)	Explain the mechanism of scintillation in organic and inorganic		2	2	
	scintillators.				
4 (c)	Draw a schematic figure of photomultiplier tube.	3	2	2	
5(a)	What is the electron transit time in a photomultiplier tube?	2	2	1	
5 (b)	Write down the relation between thickness of the depletion region of	3	2	3	
	the pn junction semiconductor, the reverse bias voltage applied across				
	the semiconductor and the concentration of impurity.				
	Explain with the help of this relation why the impurity concentration				
	should be low for this material to be used as detector.				
5 (c)	Draw the response of an intermediate size detector to a	5	2	2	
	monoenergetic gamma-ray source if all gamma-ray interaction				
	processes are taking place. Also explain all the features.				

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Fig. 1