FACULTY OF MEDICAL SCIENCES
UNIVERSITY OF DELHI
दिल्ली विश्वविद्यालय

MINUTES

A meeting of the Committee of Courses and Studies (CCS) of the Department of Radiology, **was** held on **Wednesday, the 18th December, 2024 at 2.00 p.m.** in the Committee Room, 7th Floor, Faculty of Medical Sciences, V.P.C.I. Building, University of Delhi – 110007.

The names of the members who have attended the meeting are annexed (F/A).

At the outset, the CCS recalled its decision in the meeting held on 06.03.2024 in which the revised proposal alongwith Course Curriculum, Scheme of Examination, duration of Course, eligibility criteria and other requirements for starting of B.Sc. (Nuclear Medicine Technology) was considered and after due deliberations it was decided that the proposed course curriculum for starting of 3 years B.Sc. (Nuclear Medicine Technology) Course under the Department of Radiology is required more deliberation to finalize the Course Curriculum.

The CCS considered the revised Ordinance alongwith Course Curriculum, Scheme of Examination, duration of Course, eligibility criteria and other requirements for starting of 3 years B.Sc. (Nuclear Medicine Technology) Course in the Department of Nuclear Medicine at Army Hospital (R & R) w.e.f. 2025-2026 and approved the same. It was resolved that it may be placed in the meeting of Faculty of Medical Sciences for further consideration and approval.

The meeting ended with a vote of thanks to the Chair.

18.12.24

(Prof. R.S. Solanki)
Chairperson

ORDINANCE OF

B.Sc. (NUCLEAR MEDICINE TECHNOLOGY)

UNDER

FACULTY OF MEDICAL SCIENCES

UNIVERSITY OF DELHI

DELHI-110007

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

(Aneesh Mohanan)
Col
Sr Advsr (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

देबराज सेन/Debraj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

SCOPE OF THE COURSE

1. Nuclear medicine is a branch of medicine that incorporates diagnostic and therapeutic services using radiopharmaceuticals. Small amounts of radioactivity are used to get insights into the function of various organs of human body. Imaging equipments are used to produce images of internally administered radiopharmaceutical that localise to various parts of the body. Measuring the function of organs is especially possible with nuclear medicine techniques. Relatively larger amounts of radioactivity can be used to treat various intractable disease conditions including some advanced cancers.

2. The field of nuclear medicine exemplifies one of the most noble and responsible uses of radioactivity to decrease the malady of people who suffer from disease. Nuclear medicine professionals work as a team and function in a co-ordinated manner to achieve productive results. Technologists form an integral and indispensable part of the team and work in union alongside nuclear medicine physicians, staff nurses and physicists.

3. A nuclear medicine technologist works for the well-being of patients and is expected to take utmost care in administering radioactivity for diagnostic and therapeutic purposes. She / He conducts prescribed patient studies adhering to laid protocol /guidelines and at the same taking into consideration patient's comfort and wishes. She/ He has good communication skill and works in harmony with the rest of the nuclear medicine team including physicians to bring about finest outcome. It is the duty and responsibility of a nuclear medicine technologist to judiciously and carefully handle radioactivity and to comply with radiation protection regulations laid down by AERB from time to time.

4. A nuclear medicine technologist should update his knowledge with the current trends in the field and radiation protection regulations amended from time to time. The Society of Nuclear medicine and molecular imaging (SNMMI) has outlined the principles of nuclear medicine Technologist code of ethics approved on June 7, 2013:

a) ***Principle 1*** The nuclear medicine technologist will provide services with compassion and respect for the dignity of the individual and with the intent to provide the highest quality of patient care.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

b) ***Principle 2*** The nuclear medicine technologist will provide care without discrimination regarding the nature of the illness or disease, gender, race, religion, sexual preference, or socioeconomic status of the patient.

c) ***Principle 3*** The nuclear medicine technologist will maintain strict patient confidentiality in accordance with state and federal regulations.

d) ***Principle 4*** The nuclear medicine technologist will comply with the laws, regulations, and policies governing the practice of nuclear medicine.

e) ***Principle 5*** The nuclear medicine technologist will continually strive to improve his or her knowledge and technical skills.

f) ***Principle 6*** The nuclear medicine technologist will not engage in fraud, deception, or criminal activities.

g) ***Principle 7*** The nuclear medicine technologist will be an advocate for his or her profession.

COURSE OBJECTIVES

B. Sc. (Nuclear Medicine Technology) is a three years undergraduate course that prepares students through an interdisciplinary curriculum that includes preclinical subjects, radiopharmacy, radiation safety and instrumentation. The aim of the course is to impart appropriate knowledge and skills to work closely with nuclear medicine physicians and participate in the daily operation of the nuclear medicine department. The aims of the undergraduate nuclear medicine technology course are:

a) To provide knowledge and training to perform the functions of a nuclear medicine technologist.

b) To help the students develop skills and necessary expertise to enable them to become employable in various nuclear medicine facilities in Armed Forces Medical Services (AFMS).

c) To make them capable and eligible to appear for Radiological Safety Officer (RSO) level II examination.

Dr. Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एंड आर), नई दिल्ली
Army Hosp (R&R), New Delhi

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

(Aneesh Mohlmen)
Adver (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

SCHEME & SYLLABUS

Programme Name	:	B. Sc. Nuclear Medicine Technology
Duration of course	:	Three years + one year internship (optional)
Semester Mode	:	Six (6) half yearly semesters + 1 yr Internship (optional)
Intake	:	As per University norms
Eligibility	:	50% marks in 10+2 pattern with PCBE
Medium of course	:	English
Admission Procedure	:	Through merit cum choice basis as per Army medical nursing Class 1 exam
Faculty	:	The existing faculty at AH (R&R)
Infrastructure	:	Department of Nuclear Medicine at AH(R&R)
Commencement of session	:	As per University of Delhi rules
Maximum span period	:	6 years

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

DURATION OF THE COURSE: 3 years (plus one-year optional internship).

Sr No	Semester	Duration
1	First	6 months
2	Second	6 months
3	Third	6 months
4	Fourth	6 months
5	Fifth	6 months
6	Sixth	6 months
7	Internship (optional)	12 months

Note: Maximum span period to complete the course – 6 years.

ELIGIBILITY FOR ADMISSION:

1. Candidate should be serving in Indian Armed Forces Medical Services (AFMS).
2. He should have completed 6 years of service.
3. He should have good service record.
4. Candidates should have passed the Higher Secondary Examination (Academic) conducted by the Central Board of Secondary Examination (CBSE), Indian Certificate of Secondary Education (ICSE) or any other recognised equivalent state board examination with a minimum of 50% marks (aggregate) in subjects of Physics, Chemistry & Biology/ Botany & Zoology and should have English as one of the subjects.

SELECTION CRITERIA:

1. All the Nursing Assistants and X-ray Technicians recruited in AFMS, undergo three steps of training i.e. Class III, II and I in various hospitals of AFMS. After the completion of class I training, they are given an opportunity to undergo training in specialized fields.
2. For B. Sc. NMT course, these candidates will be selected on *merit cum choice basis* depending on their performance in Class I training and examination by the record office Army Medical Corps.
3. There will be NO separate entrance test for the course.
4. Similar courses i.e. B. Sc. Nuclear Medicine Technology is running in JIPMER, Puducherry and Diploma in Medical Radiation and Isotope Technology (DMRIT) in INHS Asvini, Mumbai under MUHS, Pune.

(Anoosh Mohiman)
Col
Sr Advsr (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एंड आर), नई दिल्ली
Army Hosp (R&R), New Delhi

5. The seats remaining vacant due to insufficient candidates from Army failing to fulfil the abovementioned criteria, the vacant seats would be offered to the Medical Assistant of Indian Air Force and Indian Navy based on the equivalent criteria in respective Medical Services.

RESERVATION: Course is specifically for Armed Forces Nursing Technicians/ Nursing Assistants.

LATERAL ENTRY: There will be no provision of lateral entry in the course.

AGE ON ADMISSION: Candidate should not have attained age of 35 years on the date of commencement of session.

MEDICAL FITNESS: Candidate should be in SHAPE-1A medical classification as per the latest Annual/Periodic Medical Examination report.

TOTAL INTAKE: As per availability of dedicated faculty, infrastructure, class rooms, equipments and laboratories etc.

MEDIUM OF INSTRUCTION: English shall be the medium of instruction for all the subjects of study and for examinations of the course.

ATTENDANCE CRITERIA: A candidate will be permitted to appear for the University Examinations in the subject, only if he secures not less than 75% of attendance in theory and 80% attendance in practical in that particular subject in the respective academic year.

(Ardesh Mohlman)
Col
Sr Advsr (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

LEAVE/ VACATIONS: The candidates will be permitted to avail leave as per Delhi University leave rules for B. Sc. Students.

HOSTEL/ACCOMMODATION FACILITY: Accommodation will be made available as per the Army Rules on accommodation.

RAGGING (Ordinance XV-C): Ragging in any form is strictly prohibited. Any violations will be dealt with laid down guidelines.

DUTIES AND POSTINGS: Every student of B. Sc. (NMT) shall be required to perform routine postings in various subspecialities of the nuclear medicine

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

department as well as other departments in the hospital as per the duty rosters including night duties.

FEES STRUCTURE/ LATE FEES & REFUND: As per University of Delhi norms. The registration & eligibility fees, examination fees and any other fees pertaining to the course as decided by Delhi University will be borne by the candidate. There would be no fees pertaining to the institute.

EXAMINATION: The process of exam will be as per the Delhi University norms. For each batch, Internal Assessment (IA) and final examinations will be conducted every semester.

1. **CONTINUOUS INTERNAL ASSESSMENT (IA):**
   - **a.** In each semester, Continuous Internal Assessments (IA) will be conducted by AH (R&R) by internal examiners.
   - **b.** Internal assessment will be done in each subject of study and the marks will be awarded to the candidates as detailed in the scheme of examinations. The marks awarded will be done on the basis of the candidate's performance in the assignments, regular class tests –written / practical, laboratory work, preparation and presentation of Project work/ seminars or any other accepted tools of assessment, as prescribed by the teachers.
   - **c.** Candidate should have scored a minimum of 50% in Theory (IA) and 50% in Practical (IA) separately to be allowed to appear for the *Summative/ Delhi University Semester Examination.*
   - **d.** Internal assessments marks will carry 30% weightage for all the subjects and will be added to semester examination marks.

(Aneesh Nishtman)
Col
Sr Adver (Radiodiagnosis) &
Interventional Radiolog
Army Hospital (R&R)

2. **FINAL EXAMINATIONS:**
   - **a.** At the end of each semester, Summative/ Final semester examination will be conducted at AH (R&R) under supervision of Delhi University.
   - **b.** Final exams will be taken by a board of two examiners- one internal and one external examiner.
   - **c.** The *Summative/Final Delhi University Semester Examination* will be conducted in the suggested pattern for all the six semesters.
   - **d.** The particulars of subjects for various examinations and distribution of marks are detailed in the Scheme of Examination.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

WEIGHTAGE OF IA AND FINAL EXAMINATION: The total marks will

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

be determined by assigning a 30% weightage to Internal Assessment marks and 70% weightage to final examination marks.

PASSING CRITERIA:

Ser No	Criteria	Internal Assessment (IA)	Summative/ Final Examination
1.	Minimum qualifying marks in theory in each subject as well as aggregate	50%	50%
2	Minimum qualifying marks in Viva Voce & Practical in each subject as well as aggregate	50%	50%

Note: If a candidate fails in either theory or practical, he has to reappear for both theory and practical.

DECLARATION OF RESULT:

Result will be declared semester wise as per University of Delhi guidelines.

SUPPLEMENTARY EXAMINATION:

There will be no separate supplementary exam conducted. If a candidate fails in any subjects, he will be given opportunity to appear for the examination in next semester.

PROMOTION TO NEXT SEMESTER/ ELIGIBILITY FOR ATTENDING CLASSES OF NEXT SEMESTER:

For promotion to next semester at least 50% of the total subjects in the preceding semester/s must be cleared. In case of fraction in the total subjects, the fraction will be counted in the higher digit of subjects (for example 3.5 will be counted as 4 subjects).

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

PERFORMANCE VALUATION IN EXAMINATIONS:

1. The Nuclear Medicine faculty of Army Hospital (R&R) will conduct the Continuous Internal Assessment and will be the internal examiners for final exam, while faculty from other universities such as MUHS Nashik, AIIMS Delhi, PGIMER Chandigarh etc will be called as external examiners.
2. There will be two examiners (1 internal + 1 external) for all the practical and oral examinations.
3. Evaluation of answer scripts will also be done by the board of two examiners.

DECLARATION OF CLASS:

1. A successful candidate obtaining 75% and more marks in the grand total aggregate in the first attempt shall be declared to have passed with *Distinction*.
2. A successful candidate obtaining 60% and more but less than 75% of marks in the grand total aggregate shall be declared to have passed with *First Class*.
3. A successful candidate obtaining 50% and more but less than 60% of marks in the grand total aggregate shall be declared to have passed with *Second Class*.

AWARD OF THE DEGREE AND MARKSHEET: A candidate successfully completing three years degree course and passing all the exams shall be eligible for the award of Degree of B. Sc. Nuclear Medicine Technology and marksheets from Delhi University. Candidate completing the optional internship of 12 months shall receive the Internship Completion Certificate (ICC).

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

EXAMINATION SCHEME

S. No.	Course Code	Subjects	IA (Theory)	IA (Practical)	Final (Theory)	Final (Practical)	Total Marks (0.30 x IA) + (0.70 x Final)		
							Theory	Practical	Total
FIRST SEMESTER									
1	BSNMT-101	Anatomy – I	100	50	100	50	100	50	150
2	BSNMT-102	Physiology – I	100	50	100	50	100	50	150
3	BSNMT-103	Biochemistry – I	100	-	100	-	100	-	100
4	BSNMT-104	Basic concepts in Radiation Physics - I	100	100	100	100	100	100	200
		Total	**400**	**200**	**400**	**200**	**400**	**200**	**600**

S. No.	Course Code	Subjects	IA (Theory)	IA (Practical)	Final (Theory)	Final (Practical)	Total Marks (0.30 x IA) + (0.70 x Final)		
							Theory	Theory	Theory
SECOND SEMESTER									
1	BSNMT-201	Anatomy- II	100	50	100	50	100	50	150
2	BSNMT-202	Physiology- II	100	50	100	50	100	50	150
3	BSNMT-203	Biochemistry- II	100	-	100	-	100	-	100
4	BSNMT-204	Basic concepts in Radiation Physics- II	100	100	100	100	100	100	200
		Total	**400**	**200**	**400**	**200**	**400**	**200**	**600**

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

S. No.	Course Code	Subjects	IA (Theory)	IA (Practical)	Final (Theory)	Final (Practical)	Total Marks (0.30 x IA) + (0.70 x Final)		
							Theory	Practical	Total
		THIRD SEMESTER							
1	BSNMT-301	Physics of Nuclear Medicine Instrumentation – I	100	100	100	100	100	100	200
2	BSNMT-302	Radiochemistry and Radiopharmacy – I	100	100	100	100	100	100	200
3	BSNMT-303	Radiation quantities, Units, Interaction of radiation with matter and Radiation measurement– I	100	-	100	-	100	-	100
4	BSNMT-304	Radiobiology– I	100	-	100	-	100	-	100
		Total	**400**	**200**	**400**	**200**	**400**	**200**	**600**

(An... Mohimen)
Col
Sr Advsr (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

... Debraj Sen, MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

FOURTH SEMESTER

S. No.	Course Code	Subjects	IA (Theory)	IA (Practical)	Final (Theory)	Final (Practical)	Total Marks (0.30 x IA) + (0.70 x Final)		
							Theory	Practical	Total
1	BSNMT-401	Physics of Nuclear Medicine Instrumentation - II	100	100	100	100	100	100	200
2	BSNMT-402	Radiochemistry and Radiopharmacy - II	100	100	100	100	100	100	200
3	BSNMT-403	Radiation quantities, Units, Interaction of radiation with matter and Radiation measurement-II	100	-	100	-	100	-	100
4	BSNMT-404	Radiobiology-II	100	-	100	-	100	-	100
		Total	**400**	**200**	**400**	**200**	**400**	**200**	**600**

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

FIFTH SEMESTER

S. No.	Course Code	Subjects	IA (Theory)	IA (Practical)	Final (Theory)	Final (Practical)	Total Marks (0.30 x IA) + (0.70 x Final)		
							Theory	Practical	Total
1	BSNMT-501	Diagnostic Nuclear Medicine procedures– I	100	100	100	100	100	100	200
2	BSNMT-502	Therapeutic Nuclear Medicine procedures– I	100	100	100	100	100	100	200
3	BSNMT-503	Quality assurance of Nuclear Medicine instruments– I	100	50	100	50	100	50	150
4	BSNMT-504	In-vitro Nuclear Medicine techniques– I	100	50	100	50	100	50	150
5	BSNMT-505	Radiation Hazard, Control and Safety, Regulatory Requirements– I	100	100	100	100	100	100	200
		Total	**500**	**400**	**500**	**400**	**500**	**400**	**900**

(Anesh Mohinen)
Col
Sr Advsr (Radiodiagnosis) &
Interventional Radiolog
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

SIXTH SEMESTER

S. No.	Course Code	Subjects	IA (Theory)	IA (Practical)	Final (Theory)	Final (Practical)	Total Marks (0.30 x IA) + (0.70 x Final)		
							Theory	Practical	Total
1	BSNMT-601	Diagnostic Nuclear Medicine procedures - II	100	100	100	100	100	100	200
2	BSNMT-602	Therapeutic Nuclear Medicine procedures- II	100	100	100	100	100	100	200
3	BSNMT-603	Quality assurance of Nuclear Medicine instruments- II	100	50	100	50	100	50	150
4	BSNMT-604	In-vitro Nuclear Medicine techniques- II	100	50	100	50	100	50	150
5	BSNMT-605	Radiation Hazard, Control and Safety, Regulatory Requirements- II	100	50	100	50	100	50	150
		Total	**500**	**400**	**500**	**400**	**500**	**400**	**900**

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

COURSE OF INSTRUCTION

S. No.	Course Code	Subjects	Lectures/Wk (1Hr each)	Cr	Practical/Wk (2 Hr each)	Cr
FIRST SEMESTER						
1	BSNMT-101	Anatomy- I	6	6	1	1
2	BSNMT-102	Physiology- I	6	6	1	1
3	BSNMT-103	Biochemistry- I	6	6	-	-
4	BSNMT-104	Basic concepts in Radiation Physics- I	6	6	4	4
		Total Credits = 30		**24**		**6**
SECOND SEMESTER						
1	BSNMT-201	Anatomy- II	6	6	1	1
2	BSNMT-202	Physiology- II	6	6	1	1
3	BSNMT-203	Biochemistry- II	6	6	-	-
4	BSNMT-204	Basic concepts in Radiation Physics- II	6	6	4	4
		Total Credits = 30		**24**		**6**

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Sr Advsr (Radiodiagnosis) &
Interventional Radiology
Army Hospital (R&R)

वरिष्ठ सलाहकार एवं आचार्य /Sr Advisor & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सैन्य अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

THIRD SEMESTER

S. No.	Course Code	Subjects	Lectures/Wk (1Hr each)	Cr	Practical/Wk (2 Hr each)	Cr
1	BSNMT-301	Physics of Nuclear Medicine Instrumentation - I	5	5	5	5
2	BSNMT-302	Radiochemistry and Radiopharmacy - I	5	5	5	5
3	BSNMT-303	Radiation quantities, Units, Interaction of radiation with matter and Radiation measurement- I	5	5	-	-
4	BSNMT-304	Radiobiology- I	5	5	-	-
		Total Credits = 30		**20**		**10**

FOURTH SEMESTER

S. No..	Course Code	Subjects	Lectures/Wk (1Hr each)		Practical/Wk (2 Hr each)	Cr
1	BSNMT-401	Physics of Nuclear Medicine Instrumentation - II	5	5	5	5
2	BSNMT-402	Radiochemistry and Radiopharmacy - II	5	5	5	5
3	BSNMT-403	Radiation quantities, Units, Interaction of radiation with matter and Radiation measurement- II	5	5	-	-
4	BSNMT-404	Radiobiology- II	5	5	-	-

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

		Total Credits = 30		**20**		**10**

(Aneesh [illegible])
Col
Sr Adviser (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

देबराज सेन/Debraj Sen, MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
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Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
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(Neeraj Kumar)
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Army Hospital (R&R)

FIFTH SEMESTER

S. No..	Course Code	Subjects	Lectures/ Wk (1Hr each)	Cr	Practical/Wk (2 Hr each)	Cr
1	BSNMT-501	Diagnostic Nuclear Medicine procedures- I	5	5	5	5
2	BSNMT-502	Therapeutic Nuclear Medicine procedures- I	4	4	3	3
3	BSNMT-503	Quality assurance of Nuclear Medicine instruments- I	2	2	2	2
4	BSNMT-504	In-vitro Nuclear Medicine techniques- I	2	2	2	2
5	BSNMT-505	Radiation Hazard, Control and Safety, Regulatory Requirements - I	2	2	3	3
		Total Credits = 30		**15**		**15**

SIXTH SEMESTER

S. No.	Course Code	Subjects	Lectures/ Wk (1Hr each)	Cr	Practical/Wk (2 Hr each)	Cr
1	BSNMT-601	Diagnostic Nuclear Medicine procedures- II	5	5	5	5
2	BSNMT-602	Therapeutic Nuclear Medicine procedures- II	4	4	3	3
3	BSNMT-603	Quality assurance of Nuclear Medicine instruments- II	2	2	2	2
4	BSNMT-604	In-vitro Nuclear Medicine techniques- II	2	2	2	2
5	BSNMT-605	Radiation Hazard, Control and Safety, Regulatory Requirements- II	2	2	3	3
		Total Credits = 30		**15**		**15**

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

SYLLABUS

B. SC. (NUCLEAR MEDICINE TECHNOLOGY) FIRST SEMESTER

ANATOMY - I (BSNMT-101)

S. No.	Contents
	General Anatomy
1	**Introduction to Anatomy –** Anatomical positions Anatomical planes, Anatomical terminologies, **Cell** - types, characteristics, structures and cell divisions **Tissue** - types, characteristics, classification, location, functions and formation.
	Systemic Anatomy
2	**Musculoskeletal System –** **Skeletal System -** a) **Bone** - Classification of Skeletal system, Types of bone, Classification of bones, Description/parts of a long bone in detail, Blood supply of a long bone, Ossification, types of ossification, Names of the Upper limb bones and their parts Names of the Lower limb bones and their parts, Names of vertebrae, pelvic and thoracic region bones and their parts, Names of skull and facial bones and their parts, Applied aspect – fracture and healing of bone, osteoporosis & osteodysplasia etc. b) **Joint** – Definition, Types of joints and Classification Description of typical synovial joint in detail, Movements of joints, Major joints of the body and bones participating, Sutures and fontanelle, function and its importance, Applied aspects of joints – dislocation, joint effusion, arthritis etc.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

	c) **Muscular system** – Components of muscle, Types of muscles based on function, structure, nervous control, and activity, Innervations of muscle, Reflexes- deep tendon reflex, reflex arc, Names of the Major Upper limb muscles and their principle action on the joint, Names of the Lower limb muscles and their principle action on the joint. Names of the muscles of pectoral region, major muscles of back. Muscles of abdominal wall, diaphragm. Muscles of respiration – intercostals muscles, Names of the muscles of larynx, pharynx, muscles of mastication, muscles of eyeball, ear. Applied anatomy. e.g., atrophy, hypertrophy. dystrophy
3	**Lymphatic system** - General description of lymphatic system, Gross features of Lymphoid organs – lymph node, spleen, thymus, tonsil, Lymphoid tissue forming Waldeyer ring, Major lymph nodes of Axilla, inguinal nodes & cervical/neck region, Lymphatic drainage of mammary gland, Structural details of thoracic duct, Applied aspect – lymphadenopathy, lymphedema
4	**Nervous system** - General organization of nervous system. Structure of a neuron and Synapse, Name and functions of glial cells, General description of autonomic nervous system, Classification of peripheral and central nervous system. Name of cranial and spinal nerve, Dermatomal distribution of body, Cutaneous innervations **CNS** – General organization of central nervous system, General organization of parts of brain, Layers and functions of meninges, Parts of spinal cord, enlargements, coverings, blood supply. Lumbar puncture – site, procedure and complications, Parts of brainstem: External features, blood supply, Cerebellum: External features and major nuclei of cerebellum, blood supply, function. Cerebrum: lobes and its functions, Sulci and Gyri, blood supply, External features of medial surface, inferior surface and Supero-lateral surface of cerebrum. Thalamus and Hypothalamus – Location, Parts and function, Basal nuclei – parts, function and its applied aspect, White fibres: classification and Names of the white fibres, Parts of corpus callosum, Parts of internal capsule and its function. Ventricles of brain and circulation of CSF, Applied aspect – hydrocephalus, extradural, subdural, and intracerebral haemorrhages, and infarct

(Aneesh Mohinder)
Col
Specialist (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

5	**Special sense organs –** **Tongue:** parts, muscles, nerve supply and lymphatic drainage. **Eye:** Lacrimal apparatus – Parts and function, Parts of eyeball, coverings, Internal features of eyeball, names of Extra-ocular muscles and refractive media **Ear:** External ear: parts and function, Middle ear: names of ear ossicles, tympanic membrane, communications, Inner ear: Parts, communications, functions. **Skin:** General classification, distribution, receptors, functions, microscopic structure of thin and thick skin.
6	**Endocrine system:** Location, parts, function of - Pituitary gland, Pineal gland, Adrenal gland. Pancreas, Thyroid and parathyroid Location of Minor endocrine glands, Sex glands

Histology

S. No	Basic Histology of
1	Epithelium
2	Connective tissue
3	Cartilage – Hyaline cartilage, Elastic cartilage, Fibrous cartilage
4	Bone – Transverse section, Longitudinal section
5	Muscle – skeletal muscle, cardiac muscle, smooth muscle
6	Nerve- Osmic stain for myelin sheath, H & E for cross section of peripheral nerve

VIVA VOCE

Student should be able to identify the

- All bones, and the major parts and joints formed by the bones.
- Gross specimen, location, parts and answer the related questions

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Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

PRACTICAL PAPER (Anatomy- I)

Histology Practical: The students should be able to identify the type of tissue and give two relevant points of in support of identification of histology slide of

- Epithelium
- Connective tissue
- Cartilage – Hyaline cartilage, Elastic cartilage, Fibrous cartilage
- Bone – Transverse section, Longitudinal section
- Muscle – skeletal muscle, cardiac muscle, smooth muscle
- Nerve- Osmic stain for myelin sheath, H & E for cross section of peripheral nerve
- Ganglia: Autonomic, Dorsal root ganglia
- Lymphatic tissue: Lymph node, Tonsil, Spleen, Thymus

Gross Anatomy Practical: The students should be able to identify the given gross specimen and answer the

- Side of the organ if necessary
- Gross features, parts
- Location
- Related questions of the given organ

Gross specimen spotter:

Nervous system:

- spinal cord
- cerebrum- medial surface, inferior surface, supero-lateral surface
- brainstem
- ventricles
- cerebellum

Eyeball model

Ear model

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Text books recommended:

1. General Anatomy – B D Chaurasia
2. Systemic Anatomy - Ross & Wilson Anatomy & Physiology in Health & Illness by Waugh (A)
3. Text Book of Human histology by Inderbir Singh
4. Human Anatomy by Inderbir Singh

Reference Books

1. Theory and Practice of Histological Techniques by Bancroft (JD)
2. Human Genetics by Gangane (SD)
3. Snell's Regional Anatomy Book

Teaching-learning methods

1. Lecture class – LCD projector and Chalk and board
2. Demonstration of bones and specimens
3. Histology slide projection and discussion
4. Small group discussion
5. Maintenance of histology and gross anatomy record books
6. Hands on session
7. Assignments
8. Seminar

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

(Aneesh Mohimen)
Col
Sr Advsr (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

देवराज सेन/Dev Raj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं प्रोफेसर /Sr Advisor & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एंड आर), नई दिल्ली
Army Hosp (R&R), New Delhi

PHYSIOLOGY - I (BSNMT-102)

S. No.	CONTENTS
	THEORY
1	**Blood:** Components, haematocrit, ESR, blood volume measurements. RBC, WBC & platelet counts, names of developmental stages of RBC, functions and fate of RBC. Functions of WBC and platelets. Basis of blood coagulation. Blood groups – ABO & Rh.
2	**Muscle:** Structure in brief, mechanism of muscle contraction, isotonic and isometric contractions, energy sources of muscle contractions, motor unit.
3	**Nerve and Central Nervous System:** Structure of a neuron, nerve impulse, myelinated and non-myelinated nerve. Brief account of resting membrane potential, action potential and conduction of nerve impulse. Neuro-muscular transmission. Various parts of central nervous system, C.S.F., Functions of muscle spindle and motor tracts including reflexes, cutaneous receptors, joint receptors, sensory pathways. Ascending reticular formation, EEG, functions of cerebellum, basal ganglia, thalamus & hypothalamus, vestibular apparatus and functions.
4	**Autonomic Nervous System:** Divisions and functions.

PRACTICAL PAPER (Physiology-I)

Haematology Practical

- Study of appliances for haemotology practical.
- Use of microscope for identifying blood cells
- Making blood smear, staining of blood smear and differential leucocyte count
- Principles of haemocytometry.
- RBC and WBC counting
- Demonstration Practical: Eosinophil count,
- Reticulocyte count, Platelet count.
- BT, CT, Packed cell volume, ESR, Hb estimation, Blood group
- determination.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Human Practical

- General physical examination
- Recording of blood pressure
- Examination of central nervous system; sensory and motor Abdominal examination

Text Books Recommended:

Latest editions of the following books:

1. Textbook of Medical Physiology by G.K. Pal.
2. Review of Medical Physiology by Ganong.
3. Text book of Medical Physiology by Guyton

TEACHING LEARNING ACTIVITIES:

The course content in Physiology will be covered by:

1. Interactive Lectures
2. Group Discussions
3. Practical classes & demonstrations
4. Seminars
5. Assignments

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

(Anoosh Mehmen)
Col
Sr Adver (Radiodiagnosis) &
Interventional Radiolog
Army Hospital (R&R)

देबराज सेन/Debraj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

BIOCHEMISTRY- I (BSNMT-103)

S. No.	CONTENTS
	THEORY
1	Basic and elementary concepts of chemistry and properties of carbohydrates as applicable to the human body.
2	Basic & elementary concepts of chemistry and properties of lipids as applicable to the human body.
3	Basic & elementary concepts of chemistry and properties of proteins & amino acids as applicable to the human body.
4	Basic & elementary concepts of chemistry and properties of nucleic acids as applicable to the human body.
5	Basic concepts of principles of nutrition and nutrients macro and micronutrients. Vitamins – Fat soluble vitamins, water soluble vitamins sources, biochemical role, RDA, deficiency manifestations. Minerals – calcium, phosphorous, iron, copper, zinc, magnesium, manganese, iodine.

Textbooks recommended:

Latest editions of the following books:

1. Medical laboratory Procedure Manual (T-M) by K.L. Mukerjee 1987, Vol. I, II & III Tata
2. McGraw Hill Publication.
3. Text book of Medical Biochemistry by Ramakrishna
4. Text Book of Clinical chemistry by Norbert Teitz.
5. Principles and Techniques of Practical Biochemistry by Wilson and Walker.
6. Clinical Chemistry - Principle and techniques by RJ Henry, Harper & Row Publishers.
7. Text Book Biochemistry by Vasudevan and Sree Kumari.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

BASIC CONCEPTS IN RADIATION PHYSICS- I (BSNMT-104)

S.No.	CONTENTS
	Theory
	Nuclear Physics
1	Atomic structure - Nucleus - Atomic Number - Electron orbit and energy levels - Isotopes and isobars – Radioactivity - Radioactive decay - Half-life - Particle radiation - Electromagnetic Radiation - Production of X-rays - Continuous X-ray spectrum - Bremsstrahlung Radiation - Characteristic X- rays – Filters - Quality of X-rays - Effect of voltage and current on the intensity of X-rays - Properties of X-rays.
2	Elementary Nuclear Physics – Nuclear Structure - Binding Energy - Semi empirical Mass Formula - Nuclear Forces.
3	Specific Activity - Effective Half Life - Successive Radioactive Transformation - Branching Decay constants. Alpha Decay – Theory of Alpha Decay - Alpha-Particle Spectra - Beta Decay – Electron Capture - Nuclear Isomers - Internal Conversion - Theory of Beta Decay.
4	Nuclear Reactions Transmutation Reactions - Nuclear cross- section. Nuclear Fission – Fission products – Fission yield - Controlled fission chain reaction Nuclear Fusion – Source of stellar energy.

PRACTICAL PAPER (OSPE) - Basic Concepts in Radiation Physics

1. Time Distance and Shielding, measurement of HVT & TVT.
2. Determination of magnification factors.
3. Principle of inverse square law.

(Neeraj Kumar)
Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine & Nuclear Medicine
Army Hospital (R&R)

Sr Adviser & Prof
Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

Sr Advsr (Radiodiagnosis) & Interventional Radiologist
Army Hospital (R&R)

Text books recommended:

Latest editions of the following books:

1. Basic Nuclear and Heath Physics by James, Mannie Shuler.
2. Basic ideas and concepts in Nuclear Physics: An Introductory approach by Kris L. G. Heyde.
3. A Primer in Applied Radiation Physics by F A Smith
4. Atomic Physics – J. B. Rajam
5. Introductory Nuclear Theory – L.R.B. Elton
6. Nuclear Physics by I. Kaplan.
7. Christensen's Physics of Diagnostic Radiology – Thomas S Curry, James E. Dowdey, Robert C. Murry.
8. Review of Radiologic Physics – Walter Huda and Richard M.
9. Slone.
10. A practical approach to modern imaging equipment - Trefler. M
11. Radiographic latent image processing – W.E.J Mckinney
12. Photographic processing chemistry – L.F.A. Mason
13. Physical and photography principles of medical radiography – Seeman & Herman
14. The Physics of Radiology Harold Elford Johns & Jonh Robert Cunningham.
15. The Physics of Radiation Therapy Faiz M. Khan

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

SYLLABUS

B. SC. (NUCLEAR MEDICINE TECHNOLOGY) SECOND SEMESTER

ANATOMY- II (BSNMT-201)

S. No.	Contents
1	**Cardiovascular system –** Mediastinum: Extent, divisions and contents of mediastinum, Pericardium: parts and nerve supply, Heart: Chambers of Heart, internal and external feature, blood supply and nerve supply and surface marking. Major vessels of Heart in detail- Aorta and its branches, superior vena cava, inferior vena cava, pulmonary veins. Major vessels of upper limb and lower limb, thorax, head & neck, abdomen & brain. Types of circulations – pulmonary, systemic and foetal circulation, Applied aspect – ischemia/angina, infarction etc.
2	**Respiratory System -** nose & Nasal cavity, Meati & conchae, Paranasal air sinuses, Larynx – parts, muscles, names of cartilage and functions, Trachea: general features, Pleura: Parts, Costo-diaphragmatic recess, nerve supply, Lung: External features, blood supply and nerve supply, Broncho-pulmonary segments, Applied aspect – apnoea, dyspnoea, pleural effusion and tap
3	**Digestive System** – Name nine quadrants of abdomen, Parts of the digestive system. Pharynx: Divisions, function, muscles of pharynx. Detailed gross external features and surface markings of oesophagus, stomach, liver, spleen, pancreas, intestines, appendix, rectum, anal canal. Oral cavity: parts of palate, salivary glands, Tonsil, Tongue. Stomach: detailed structure, blood supply, nerve supply and lymphatic drainage, Liver: lobes, external features, location, Porta- Hepatis. Extra hepatic biliary system, Portal vein, Site of liver biopsy, Gall bladder: capacity, location, nerve supply, function, Intestines: small and large intestine: gross features, Pancreas: parts, location, blood supply and nerve supply, General organization of peritoneum, peritoneal cavities and sub diaphragmatic spaces, Division and components of upper and lower G.I. tract

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

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Nuclear Medicine
Army Hospital (R&R)

4	**Urinary system** - Parts of the urinary system, Structure of a nephron, Kidney: parts, external and internal features of kidney, blood supply and nerve supply, Ureter: gross features, constrictions, function, Urinary bladder: capacity, Internal and external features, internal trigone and detrusor muscle of urinary bladder, blood supply and nerve supply. Urethra – parts, gross features
5	**Reproductive system** – Parts of male and female reproductive system, **Female reproductive system:** Parts, blood supply, nerve supply and function of Ovary, Uterus, Vagina & Fallopian tube, Sites of ectopic pregnancy, Parts of female external genitalia, Accessory organ: mammary gland **Male reproductive system**: Parts, blood supply and function of Testis, Epididymis, Spermatic cord, Seminal vesicle, Ejaculatory duct, Prostate – lobes & applied aspect, Parts of male urethra. Parts of male external genitalia. Applied – hypospadiasis and epispadiasis

Histology

Sl. No	Basic Histology of
1	Salivary gland – Serous, Mucous, Mixed gland
2	Skin – Thick and thin skin
3	Cardiovascular tissue: Artery, Vein

VIVA VOCE

Student should be able to identify the

- All bones, and the major parts and joints formed by the bones.
- Gross specimen, location, parts and answer the related questions

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

PRACTICAL PAPER (Anatomy- II)

Histology Practical: The students should be able to identify the type of tissue and give two relevant points of in support of identification of histology slide of

- Salivary gland – Serous, Mucous, Mixed gland
- Skin – Thick and thin skin
- Cardiovascular: Artery, Vein

Gross Anatomy Practical: The students should be able to identify the given gross specimen and answer the

- Side of the organ if necessary
- Gross features, parts
- Location
- Related questions of the given organ

Gross specimen spotter:

Digestive system:

- Sagittal section of oral cavity, Tongue, Stomach, liver with gall bladder, spleen, pancreas, large and small intestines, appendix

Urinary system:

- Kidney, Ureter, bladder

Reproductive system:

- Male: testis, epididymis, spermatic cord, seminal vesicle, prostate
- Female: uterus, cervix, vagina, ovary, fallopian tube

Respiratory system:

- Sagittal section of nasal cavity
- Trachea, bronchus
- Right and Left lung
- Cardiovascular system:
- Heart: external features
- Chambers of heart – internal features
- Blood vessels of heart

(Neeraj Kumar)
Lt Col
Sr Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
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Nuclear Medicine
Army Hospital (R&R)

Normal male and female Chromosome pattern on karyotype

Text books recommended:

1. General Anatomy – B D Chaurasia
2. Systemic Anatomy - Ross & Wilson Anatomy & Physiology in Health & Illness by Waugh (A)
3. Text Book of Human histology by Inderbir Singh
4. Human Anatomy by Inderbir Singh

Reference Books

1. Theory and Practice of Histological Techniques by Bancroft (JD)
2. Human Genetics by Gangane (SD)
3. Snell's Regional Anatomy Book

Teaching-learning methods

1. Lecture class – LCD projector and Chalk and board
2. Demonstration of bones and specimens
3. Histology slide projection and discussion
4. Small group discussion
5. Maintenance of histology and gross anatomy record books
6. Hands on session
7. Assignments
8. Seminar

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

PHYSIOLOGY- II (BSNMT-202)

S. No.	CONTENTS
	Theory
1	**Gastro-Intestinal Tract:** Functional anatomy of G.I. T, Functions of G.I secretions, principles of secretion and movements of GIT.
2	**Renal system**: Structure of Nephron, measurement and regulation of GFR, mechanism of urine formation. Clearance tests & values of insulin, PAH and urea clearance.
3	**Endocrine system**: Names of endocrine glands & their secretions, functions of various hormones, Brief account of endocrine disorders.
4	**Reproduction**: Female reproductive cycle, menstrual cycle, pregnancy, parturition, lactation. Male sex hormones and spermatogenesis. Basics of contraception.
5	**Cardio-Vascular System:** Anatomy of heart, cardiac cycle, heart sounds, definitions of cardiac output, stroke volume, principles of measurements of cardiac output. ECG – methods of recording and ECG waves. Normal values of blood pressure, heart rate and their regulation in brief.
6	**Respiration:** Principles of respiration, respiratory muscles, lung volumes and capacities, collection and composition of inspired alveolar and expired airs. Transport of oxygen and carbon dioxide. Brief account of respiratory regulation. Definition of hypoxia, Cyanosis, asphyxia. Methods of artificial respiration.

PRACTICAL PAPER (Physiology -II)

Human Practical

- Pulse examination
- Postural changes in blood pressure
- Examination of cardio-vascular system
- Examination of respiratory system

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

Text Books Recommended:

Latest editions of the following books:

1. Textbook of Medical Physiology by G.K. Pal.
2. Review of Medical Physiology by Ganong.
3. Text book of Medical Physiology by Guyton

TEACHING LEARNING ACTIVITIES:

The course content in Physiology will be covered by:

1. Interactive Lectures
2. Group Discussions
3. Practical classes & demonstrations
4. Seminars
5. Assignments

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

BIOCHEMISTRY- II (BSNMT-203)

S. No.	CONTENTS
	Theory
1	Fundamental concepts of biophysical phenomenon like osmosis, dialysis, colloidal state, viscosity, absorption, osmotic pressure, surface tension and their application in relation to the human body.
2	Definition, basic concepts of classification mechanism of action and properties of enzymes, factor influencing enzyme action.
3	Definition and basic concepts of acids, bases, indicators and buffer, their application in laboratory.
4	Elementary concepts of radioactivity, radioisotopes, their application in medicines and agriculture isotopic dilution analysis, radioactivity counting techniques.
5	Biological sample collection: Preanalytical variables, use of appropriate preservatives, anticoagulants in collection of blood, urine, and CSF.

Textbooks recommended:

Latest editions of the following books:

1. Medical laboratory Procedure Manual (T-M) by K.L. Mukerjee 1987, Vol.I, II & III Tata
2. McGraw Hill Publication.
3. Text book of Medical Biochemistry by Ramakrishna
4. Text Book of Clinical chemistry by Norbert Teitz.
5. Principles and Techniques of Practical Biochemistry by Wilson and Walker.
6. Clinical Chemistry - Principle and techniques by RJ Henry, Harper & Row Publishers.
7. Text Book Biochemistry by Vasudevan and Sree Kumari.

(Manoj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

BASIC CONCEPTS IN RADIATION PHYSICS- II
(BSNMT-204)

S.No.	CONTENTS
	Theory
	Diagnostic Radiology:
1	A.C. and D.C. power supply-circuit breakers –earthing-main voltage drop and remedy-cables low tension and high tension. Rectification – Thermionic emission – vacuum diode-EMR- frequency-energy-wave length-velocity.
2	Production of X- Rays with simplified circuit – Rectification – Three phase unit – Anode and Cathode structures – rotating anode – Ratings of diagnostic tubes – X-Ray spectra Target material – Characteristic and bremsstrahlung radiation – filtered and unfiltered x-rays – Angular distribution - X-Ray generators – Attenuation - Filters, X-Ray beam restrictors – Various types of Grids – Focal spot of x-ray tube - MTF – Electrostatic imaging – Tomography and stereoradiography – CT – Mammography.
3	Primary radiological image – Images produced by contrast – images produced in film and image intensifier – cine radiography – quality of image – image intensifier tube fluorescent material Radiographic Photography - Photographic aspects of radiography - Light Sensitivity-Photography emulsion - Gelatin – Silver halide grain- Emulsion - Latent image-purpose of development – fixing – washing - screen films & non screen films - Dental film - single coated and double coated films its advantage - Density of x-ray film –Contrast - Gamma infinity - Exposure latitude – Speed - Basic fog - Correct exposure-under & over exposure as related to the characteristic curve.
4	Intensifying screen – Fluorescence - Types of intensifying screen - Intensifying Factor-Relative speeds of intensifying screen-un-sharpness relative to the speed of the screens-identification, mounting, cleaning and general care of intensifying screens.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

5	X-ray cassette - Types of cassettes - General care of cassettes and storage -Testing a cassette for light leakage - Testing for film screen contact - Loading bench design - film hoppers - safe light - Test for safe light – Chemistry of processing of x-ray film - Types of developer for manual and automatic processing - Fine grain developer-Effect of time temperature agitation developer activity - Relation to characteristic curve-standardization by time and temperature - exhaustion of developer, replenishment of developer - Methods of silver recovery – Rinsing - Washing and drying - wetting agents - Factors affecting washing and drying - Processing methods and equipment-Preparation of solution - Importance of stirring - Nature of mixing vessels - Manual processing apparatus - stop-bath - rinse and wetting agents - after treatment of films.
6	Polaroid material – Basic fog - Radiation fog - light fog - static pressure marks and screen artifact - dichroic fog - Automatic processing - Regeneration of solution - Storage of replenishment - Methods of feeding films relative to replenishment rates- Advantage and limitation of automatic processing - Optics and odelac camera - viewing boxes and illuminators – Magnifiers - Active markers - Embossing machines - Film dryers.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Text books recommended:

Latest editions of the following books:

1. Basic Nuclear and Heath Physics by James, Mannie Shuler.
2. Basic ideas and concepts in Nuclear Physics: An Introductory approach by Kris L. G. Heyde.
3. A Primer in Applied Radiation Physics by F A Smith
4. Atomic Physics – J. B. Rajam
5. Introductory Nuclear Theory – L.R.B. Elton
6. Nuclear Physics by I. Kaplan.
7. Christensen's Physics of Diagnostic Radiology – Thomas S Curry, James E. Dowdey, Robert C. Murry.
8. Review of Radiologic Physics – Walter Huda and Richard M.
9. Slone.
10. A practical approach to modern imaging equipment - Trefler. M
11. Radiographic latent image processing – W.E.J Mckinney
12. Photographic processing chemistry – L.F.A. Mason
13. Physical and photography principles of medical radiography – Seeman & Herman
14. The Physics of Radiology Harold Elford Johns & Jonh Robert Cunningham.
15. The Physics of Radiation Therapy Faiz M. Khan

PRACTICAL PAPER (OSPE) - Basic Concepts in Radiation Physics

1. Procedures involvedin dark room & Film developing procedures.
2. Graphical representation of parameters that obey linear and exponential law, for example, linear and semi-log plotting and Attenuation principles.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

B. SC. (NUCLEAR MEDICINE TECHNOLOGY) – THIRD SEMESTER

PHYSICS OF NUCLEAR MEDICINE INSTRUMENTATION - I (BSNMT- 301)

S. No.	CONTENTS
	Theory
	Radiation detectors: Construction and Principles of Operation.
1	**Gas Filled Detectors:** Ionization Chamber - Isotope calibrator - Proportional Counter-Geiger Muller counter, Voltage calibration of a Geiger Mueller tube, optimum operating condition - Dead time correction.
2	**Scintillation detector:** Thallium activated Sodium Iodide Crystal-Photo multiplier tube, electron multiplication, high voltage supply, Shielding, collimators, field of view. Well counter-construction, design of shielding. Signal output, Pre-amplifier - reasons for use - Voltage amplifier.
3	**Spectrometer:** Basic principles of Pulse-height analyzer Single channel and multi-channel analysers. Optimum operating conditions, window settings-Determination of gamma energy spectrum, Integral and differential counting. Spectra of commonly used radio nuclides e.g. I131, Tc99m Cr51, Cs137. Problems in radiation measurements with worked examples.
4	**Rectilinear scanner:** Construction and Principles of Operation. Collimation, collimator focus, collimator focal length septa thickness, high resolution, high sensitivity, Iso-response curves collimator resolution with - Scintillation crystal size and its effect on photo and dot scans.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

देवराज सेठ/Dehraj Seth,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Advisor & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

5	**Gamma camera**: Camera head construction and principles of operation: Collimators - parallel multi hole, high resolution, high sensitivity pin hole, diverging hole, slant hole. Collimators Scintillation crystal, size Light guide - Photo multipliers pre amplifiers. Control panel: pulse shaping linear amplifiers Pulse height analyzer, Timer, Data Processor and their function. Application of Cathode ray tube - persistence scope - Monitor scope - Camera scope. Resolving, time characteristics - Analogue - Digital controls Uniformity and intrinsic resolution Sensitivity, Total-system resolution, Spatial volume resolution saturation.
6	**Different types of probes** (alpha, Beta, gamma) basic working principles and QC

Recommended Books:

Text book:

1. Physics Of Nuclear Medicine, -James A. Sorenson & Michael E. Phelps

Reference books :

1. Nuclear Radiation Detection -William J. Price, McGraw-Hill Book Company
2. Principles of Nuclear Medicine- Henry N. Wagner, W.B.Saunders company, London
3. Principles and practice of Nuclear Medicine, Paul J. Early, D. Bruce Sodes. C.V. Mosby company Princeton

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

RADIOCHEMISTRY AND RADIOPHARMACY - I
(BSNMT- 302)

S. No.	CONTENTS
	Theory
1	**Basic Laboratory Technique:** Use of glassware, Washing and autoclaving glassware for the use in Radiopharmacy areas, Correct use of Pipettes, Balance, Centrifuge, Syringes etc. Receipt - storage - disposal of radioactive materials, international symbols of radioactivity.
2	**Basics of radiation chemistry** Atomic and molecular structure. Bonding (Electrovalent, covalent, hydrogen bonds). Valency, Atomic wt., Molecular wt.- Normality and molarity of solution, Acids and Bases - Hydrogen Ion concentration - pH value - The play of pH in the preparations of radio pharmaceuticals. Chemical reaction – Solute - Solvents - Solubility – crystallization.
3	**Isotope generators:** Production of radio nuclides by artificial methods. Cyclotron Produced radio nuclides and nuclear reactor produced radio nuclides. Principles of generator systems - Ion Exchange system - Solvent extraction system. Parent - daughter relationship. Growth of daughter product equilibrium with parent elements etc. Chemistry of Tc99m, Mo99-Tc99m generators - Assay - Mo99 contamination check Aluminium break through test etc, Sterilization
4	**Radio pharmaceuticals :(SPECT RP)** Lyophilization, Preparation of cold kits. - DTPA, GHA, DMSA, MDP, Phytate. Tin pyrophosphate, -Albumin microspheres, S. Colloid etc. Labelling of cold kits with required radio isotopes and their Quality control tests like RC purity, RN purity, sterility check, Chromatography (Various methods) pyrogen test, bio distribution studies.
5	**Radio iodination**: basic principles, Iodination of MIBG-131, Purification - Resin column - Ion exchange reaction, radiochemical purity etc.

Debraj Sen, MD
Colonel
Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

AVS Anil Kumar
Brig
Consultant Medicine & Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

6	**Other radionuclide generators:** ^{188}W-^{188}Re, ^{113}Sn-^{113m}In, ^{68}Ge-^{68}Ga; Ultra short-lived radionuclide generators: ^{82}Sr-^{82}Rb, ^{81}Rb-^{81m}Kr; Parent-daughter equilibrium.

Recommended Books:

Text book:

1. The handbook of Radiopharmaceutical -Mohan Patel & Samij Sadack, Chapman & Hall Medicals, London.

Reference books:

2. Fundamentals of Nuclear Pharmacy-Gopal B. Saha, Springer- Verlag, New York.
3. Nuclear Medicine Technology & Techniques-Donald R.
4. Bernier, Paul E. Christian & James K. Langan Mosby

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Col
Sr Adviser (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

RADIATION QUANTITIES, UNITS, INTERACTION OF RADIATION WITH MATTER AND RADIATION MEASUREMENT - I
(BSNMT- 303)

S. No.	CONTENTS
	Theory
1	Radioactivity, KERMA, Exposure, Dose, Equivalent dose, Effective dose, Collective Effective Dose
2	Radiation detection and measurement

Recommended textbooks:

1. Physics Of Nuclear Medicine, -James A. Sorenson & Michael E. Phelps
2. Nuclear Radiation Detection -William J. Price, McGraw-Hill Book Company
3. Principles of Nuclear Medicine-Henry N. Wagner, W.B. Saunders company, London.
4. Principles and practice of Nuclear Medicine, Paul J. Early, D. Bruce Sodes.
5. C.V. Mosby Company Princeton
6. Lecture Notes Compiled by RSD

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Debraj Sen/Debraj Sen
Brig/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Advisor & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

RADIOBIOLOGY- I
(BSNMT- 304)

S.No.	CONTENTS
	Theory
1	General Biology, physiology, interaction of radiation with cells, mechanism of damage, nature of damage and factors modifying the damage

Recommended Textbooks:

1. Radiobiology for the Radiologist. Eric J Hall

PRACTICAL PAPER (Instrumentation and Radiopharmacy part)

1. Elution, radiopharmaceutical preparation, and dose dispensing of SPECT radiopharmaceuticals
2. Identification of an unknown radionuclide.
3. Performance of radionuclide generator.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

B. SC. (NUCLEAR MEDICINE TECHNOLOGY) FOURTH SEMESTER

PHYSICS OF NUCLEAR MEDICINE INSTRUMENTATION - II (BSNMT- 401)

S. No.	CONTENTS
	Theory
1	**Whole body counters** - basic working principles and QC, Whole body counting: principles of whole-body counting, design of whole-body counting system, stationary systems, single and multiple crystal systems, chair geometry, moving systems, calibration of whole-body system, clinical and other applications of whole body counters. Profile scanning and clinical applications
2	**Liquid scintillation counters-** composition of liquid scintillator (scintillation cocktail): primary solute, secondary, solute and organic solvent (toluene, 1,4dioxane, anthracene) and solubilizing agents for tissues, Coincidence circuits and display. Quenching, Quench corrections methods: Internal standard method, external standard method and channel ratio, neutron detectors: Basic principle sand applications.
3	**PET**: Historical developmental of Functional In Vivo Studies Using Positron, Physics and instrumentation in PET, Data acquisition and Performance Characterization in PET, Image reconstruction Algorithm in PET, Quantitative techniques in PET, Tracer Kinetic Modelling in PET, Co-registration of Structural and Functional images, Radiation Dosimetry and Protection in PET
4	**SPECT-** image reconstruction techniques, filters, artefacts in SPECT (attenuation correction, non-uniformity corrections, correction with combined SPECT-CT system), effect of scatter & scatter correction, partial volume effects, multi detector SPECT, coincidence, SPECT acquisition – step & shoot/ continuous. SPECT v/s planar camera, SPECT v/s other modalities (CT, MRI, Ultrasonography)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

5	**Semi-conductor detectors**
6	**Hybrid imaging systems** (SPECT-CT, PET-CT, PET-MRI)

Recommended Books:

Text book:

1. Physics Of Nuclear Medicine, -James A. Sorenson & Michael E. Phelps

Reference books :

1. Nuclear Radiation Detection -William J. Price, McGraw-Hill Book Company
2. Principles of Nuclear Medicine-Henry N. Wagner,W.B.
3. Saunders company, London
4. Principles and practice of Nuclear Medicine, Paul J. Early, D. Bruce Sodes. C.V. Mosby company Princeton

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

RADIOCHEMISTRY AND RADIOPHARMACY- II
(BSNMT- 402)

S. No.	CONTENTS
	Theory
1	**Dispensing of radiopharmaceuticals** - Specific activity, Tracer dose preparation - Tracer dose administration etc.
2	**Positron emitters:** Radiopharmaceuticals and radiochemistry synthesis modules to produce ^{18}FDG, $^{11}CO_2$, $^{13}NH_3$ and $H_2{}^{15}O$
3	**Quality control of different PET radiopharmaceuticals** by TLC scanner, HPLC and Gas Chromatography. Molecular diagnosis. Safe handling of PET radiotracers.
4	**Newer radiopharmaceuticalsin Nuclear Medicine** – Monoclonal antibodies, Receptor labelling, Liposome-labelling, etc.
5	Investigational New drugs in nuclear medicine
6	Drug interactions with radiopharmaceuticals
7	Safe handling of radiopharmaceuticals
8	Regulations, ethics and registration of radiopharmaceuticals

Recommended Books:

Text book:

1. The handbook of Radiopharmaceutical -Mohan Patel & Samij Sadack, Chapman & Hall Medicals, London.

Reference books:

1. Fundamentals of Nuclear Pharmacy - Gopal B. Saha, Springer- Verlag, New York.
2. Nuclear Medicine Technology & Techniques-Donald R. Bernier, Paul E. Christian & James K. Langan Mosby

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

देबराज सेन/Debraj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

RADIATION QUANTITIES, UNITS, INTERACTION OF RADIATION WITH MATTER AND RADIATION MEASUREMENT - II
(BSNMT- 403)

S. No.	CONTENTS
	Theory
1	**Interaction of Ionizing radiation with matter:** Interactions of electromagnetic radiation (x-ray and gamma ray) with matter. Excitation, ionisation, Bremstrahlung, Cerenkov radiation, scatter, photoelectric effect, Compton, pair production, annihilation. Transmission of radiation in matter, half value thickness, linear and mass attenuation and absorption coefficient, absorption cross section curves with respect to gamma energy and atomic number, range of radiation in tissue, lead and NaI crystal. Importance of these interactions in radiology and nuclear medicine. Interaction of particulate (beta, alpha) with matter, energy loss by collision, energy- range relation and Bragg's curve, specific ionisation, stopping power. Interaction of neutrons with matter, neutron cross section, neutron capture and activation. Typical Shielding Calculations with practical examples.
2	Radiation Protection Instruments

Recommended textbooks:

1. Physics Of Nuclear Medicine, -James A. Sorenson & Michael E. Phelps
2. Nuclear Radiation Detection -William J. Price, McGraw-Hill Book Company
3. Principles of Nuclear Medicine-Henry N. Wagner, W.B. Saunders company, London.
4. Principles and practice of Nuclear Medicine, Paul J. Early, D. Bruce Sodes.
5. C.V. Mosby Company Princeton
6. Lecture Notes Compiled by RSD

RADIOBIOLOGY- II
(BSNMT- 404)

S.No.	CONTENTS
	Theory
1	Deterministic and stochastic effects of radiation, cancer risk estimation, damage to individual o r g a n s, prenatal effects of radiation, radiation protection standards.

Recommended Textbooks:

1. Radiobiology for the Radiologist. Eric J Hall

PRACTICAL PAPER (Instrumentation and Radiopharmacy part)

1. Calibration of the spectrometer and finding the energy resolution.
2. Determination of ^{99}Mo breakthrough in ^{99m}Tc
3. QC of radiopharmaceuticals by paper chromatography.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

B. SC. (NUCLEAR MEDICINE TECHNOLOGY)
FIFTH SEMESTER

DIAGNOSTIC NUCLEAR MEDICINE PROCEDURES – I (BSNMT- 501)

S. No.	CONTENTS
	Theory
1	**Renal imaging studies**-diuretic renogram, captopril renogram, standard renogram, uretic reflux study, renal transplant studies, static renal study.
2	**Bone imaging**: Routine bone (whole body and spot) imaging, bone flow study, quantitative bone scan-sacroiliac quantitative study, 3-phase bone scans.
3	Liver-spleen study, bone marrow imaging, spleen imaging with denatured RBC's
4	**Gastrointestinal study**- Hepatobiliary imaging, pancreas imaging, gastric oesophageal reflux, gastric emptying time, biliary reflux, Meckel's diverticulum imaging, GI bleeding with ^{99m}Tc-RBC, Gall bladder dynamic, dynamic studies using IDA compounds.
5	**Lung imaging studies** – ventilation lung imaging studies using gases (^{133}Xe, ^{81m}Kr), Inhalation imaging using aerosols, aerosols generators, mucociliary clearance, COPD, Pulmonary permeability using DTPA, perfusion imaging (MAA, Microsphere) –pulmonary embolism.
6	**Cardiac studies**- static blood pool imaging, Rest/stress myocardial imaging, infarct imaging, MUGA, gated blood pool study, first pass study (shunt detection), placental imaging
7	**Central nervous study**- cerebral blood flow dynamic studies, static brain imaging, cisternography and ventriculoatrial and ventriculoperitoneal shunts. Use of ^{201}Tl, ^{18}FDG and NH_3 for cardiac studies.
8	**Endocrine studies**- thyroid imaging and uptake (^{99m}Tc and ^{131}I), Perchlorate discharge test, ^{131}I whole-body imaging, parathyroid imaging.

9	**Neuroendocrine Imaging –** ^{131}I-MIBG imaging
10	**Miscellaneous** - ^{67}Ga imaging, gastric intestinal protein loss estimation, Lymphatic imaging, Sentinel Lymph Node Imaging, Radio Immunoscintigraphy (RIS), testicular imaging, Hysterosalpingoscintigraphy, Scintimammography, Sialoscintigraphy, Dacryoscintigraphy (NLD imaging)

Recommended books:

Textbooks:

1. Principles and Practice of Nuclear Medicine. Paul J. Early, D. Bruce Sodee
2. Reference books:
3. Mosbeys manual of Nuclear Medicine Procedures Bruce Sodee, Paul J.Early & Sharon Wikepry, Mosbey Company, London.
4. Essentials of Nuclear Medicine, M.V. Merrick.
5. Basic Science of Nuclear Medicine, Roy P Parker, Peter A S Smith & David Churchill Livingston, New York 35
6. Essentials of Nuclear Medicine Imaging, Fred A Metter, Milton J
7. W B Saunders company, London Principles of Nuclear Medicine Henry N Wagner: W. B. Saunders company, London.
8. Clinical Nuclear Medicine M N Masey, K E Britton & D L Gilday Chapman and Hall medicals.
9. Nuclear Medicine Technology & Techniques - Donald R. Bernier, Paul E. Christian & James K. Langan Mosby.
10. Seminars in Nuclear Medicine.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

देवराज सेन/Devraj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

(Aneesh Nicholas)
Col
Sr Adviser (Radiodiagnosis) &
Interventional Radiology
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

THERAPEUTIC NUCLEAR MEDICINE PROCEDURES– I (BSNMT- 502)

S. No.	CONTENTS
	Theory
1	Basics of radionuclide therapy
2	Various radionuclides for therapeutic Nuclear Medicine Procedures.
3	Therapy planning
3	Low dose I-131 therapy for Graves' Disease
4	High dose I-131 therapy for thyroid carcinoma
5	General principles of therapy administration and safety precautions

Recommended books:

Text book:

1. Principles and practice of Nuclear Medicine, Bruce Sodee, Paul J. Early & Sharon Wikepry.

Reference book;

1. Basic Science of Nuclear Medicine, Roy P Parker, Peter A S Smith & David Churchill Livingston, New York 35.
2. Essentials of Nuclear Medicine, M. V. Merrick.
3. Mosbeys manual of Nuclear Medicine Procedures Bruce Sodee, Paul J. Early & Sharon Wikepry, Mosbey Company, London.
4. Essentials of Nuclear Medicine Imaging, Fred A Metter, Milton JW B Saunders Company, London.
5. Principles of Nuclear Medicine Henry N Wagner: W B Saunders company, London.
6. Clinical Nuclear Medicine M N Masey, K E Britton & D L Gilday. Chapman and Hall medicals.
7. Nuclear Medicine Technology & Techniques - Donald R. Bernier, Paul E. Christian, & James K. Langan Mosby.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Mathur)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

Prof
Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

QUALITY ASSURANCE OF NUCLEAR MEDICINE INSTRUMENTS– I
(BSNMT- 503)

S. No.	CONTENTS
Theory	
1	**Quality assurance:** In General - quality assurance for attaining the high standards of efficiency reliability in the practice of Nuclear Medicine procedures - efforts to be taken in order to get closeness of standard procedures with which the accurate out-come proper way of submitting the request for the procedure - The preparation and dispensing of radio pharmaceuticals - The routine quality control studies - The protection of patients - staff and general public by following standard procedures - scheduling of patients study patients preparation etc - setting up patients correctly for the procedure maintaining the electronic equipment - in the correct manner methodology of the procedure - The analysis and interpretation of results or data - and finally keeping their records.
2	Quality assurance of machineries mainly involves - Acceptance test during installation - Routine daily check - checking the power line - Air conditioning efficiency - dust free atmosphere - Making the availability of service then and there - Routine quality control study of different equipment periodically without delay. Flood check - linearity-uniformity, dead time, resolution check for gamma camera- Field of view and chi square test for Thyroid uptake unit - Focal distance calibration - Density calibration for scanner. Precision and Energy response study for isotope calibrator- Routine Departmental survey for keeping the working area at a lower level of background radiation level etc.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

Recommended books:

Text book:

1. Quality Control of Nuclear Medicine Instruments, International Atomic Energy Agency.

Reference books:

1. Quality Control of Gamma Cameras and Associated Computer Systems, The Institute of Physical Sciences in Medicine.
2. Quality Control of Nuclear Medicine Instrumentation, The Institute of Physical Sciences in Medicine.
3. "Quality Control in diagnostic imaging"- J.E. GRAY, University Park Press.
4. "Processing and Quality Control" William, E.J. Mckinney, J.B. Lippincott Company.
5. "Concepts in Medical Radiographic imaging" Marianne Tortoice, W.B. Saunders Company.
6. "Quality assurance Management" G.E. Hayes Charger production.
7. Diagnostic Imaging: Quality Assurance M.M. Rehani. Jaypee Brothers Medical publishers.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Colonel
Sr Adviser & Prof
Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

IN-VITRO NUCLEAR MEDICINE TECHNIQUES– I (BSNMT- 504)

S. No.	CONTENTS
	Theory
1	**Tracer methods** - Behaviour of radioactive tracers in biological process - characteristics of radio pharmaceuticals - Half-life - (Physical and Biological)
2	**Principles of Radio immunoassays (RIA)** standard curve, data analysis, Quality Control (QC) and applications, Methods of receptor assays, hormones, drugs.
3	IRMA (Immunoradiometric assay), ELISA, RIA, estimation, T3, T4, TSH, thyroid antibodies, and current applications using similar techniques.
4	Immunology (humeral immune response- cell mediated immune response- antigen-antibody reaction-monoclonal antibody).
5	**Thyroid Uptake study**
6	**Measurement of renal function:** GFR by plasma clearance method, EC clearance
7	**Use of radioisotopes in Haematology** - Blood volume, RBC Volume, plasma volume, RBC survival, Sequestration study Cr-51 & Tc-99m.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

RADIATION HAZARD, CONTROL AND SAFETY, REGULATORY REQUIREMENTS– I (BSNMT- 505)

S.No.	CONTENTS
	Theory
1	Planning of Nuclear Medicine (NM) Laboratories
2	Classification and general features of NM laboratories (site, typical floor plan, ventilation, surface walls, floor and ceiling)
3	Planning of radiation installation-protection from primary, leakage and scattered radiation. Concepts of workload use factor, occupancy factor & distance. Barrier design-barrier materials-concrete, brick& lead.
4	Primary & secondary barrier design calculations. Design of doors. Control of radiation-effects of time, distance and shielding.
5	Personnel monitoring systems; principle and objective-film badge, guidelines for use- thermo-luminescent dosimeter badge, pocket dosimeter. Area monitoring and radiation survey, practical use of survey meter, zone monitors and phantoms. Survey in rectilinear scanner, gamma camera, PET rooms
6	**Laboratory and clinical areas -contamination survey** - Methods and Materials. Prevention of spread of contamination. Use of forceps, gloves etc.
7	**AERB safety code and ethics;** Built in safety specification for nuclear medicine equipments/installations. Specification for radiation protection devices-room layout.
8	**General classification of nuclear medicine labs-** Operational safety- Radiation protection programme- Personnel requirements and responsibilities-regulatory controls.

(Aneesa Mohiman)
Col
Sr Adviser (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Advisor & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

Recommended books:

Textbooks:

1. Radiation Protection in Hospitals. Richard F. Mould.

Reference books:

1. Basic radiological physics. Jaypee Bothers Private limited, New Delhi
2. An Introduction to Radiation Protection. Allen Martin & Samuel.
3. Radiation safety in medical practice. M.M. Rehani.
4. Radiation Protection. Ronald L. Kathren.
5. AERB safety code and manuals.

(Ramesh Mohlmen)
Col
Sr Adver (Radiodiagnosis) &
Interventional Radiology
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

देबराज सेन/Debraj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

B. SC. (NUCLEAR MEDICINE TECHNOLOGY)
SIXTH SEMESTER

DIAGNOSTIC NUCLEAR MEDICINE PROCEDURES – II
(BSNMT- 601)

S. No.	CONTENTS
	Theory
1	Whole body PET/CT scan: Oncology (FDG, F-18 Bone PET/ CT, F-MISO, FLT, Ga-68 DOTATOC, FDOPA, etc) and in Inflammatory/Infective conditions
2	Regional PET/CT, PET/CECT
3	**Introduction to dedicated Imaging systems:** Breast-specific gamma cameras, PEM, Dedicated cardiac camera, nuclear probes and intra-operative gamma camera, Dedicated brain imaging, small animal imaging
4	Emergency nuclear medicine procedures.
5	PET: 3D acquisition, List mode, Dynamic PET, 4D imaging (Respiratory gating methods).
6	CT acquisition protocols, Contrast-enhanced CT
7	**Introduction to newer reconstruction algorithms** including iterative reconstruction methods, and newer advances in scatter correction, CT- based attenuation correction, partial- volume correction, motion correction, and collimator response recovery.
8	Introduction to DICOM formats. Introduction to Hospital Information System (HIS) and Picture Archival and Communication Systems (PACS).

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

(Arash Mohimen)
Sr Adviser (Radiodiagnosis)
Interventional Radiologist
Army Hospital (R&R)

देवराज सेन/Dev Raj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Advisor & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

Recommended books:

Textbooks:

1. Principles and Practice of Nuclear Medicine. Paul J. Early, D. Bruce Sodee

Reference books:

2. Mosbeys manual of Nuclear Medicine Procedures Bruce Sodee, Paul J.Early & Sharon Wikepry, Mosbey Company, London.
3. Essentials of Nuclear Medicine, M.V. Merrick.
4. Basic Science of Nuclear Medicine, Roy P Parker, Peter A S Smith & David Churchill Livingston, New York 35
5. Essentials of Nuclear Medicine Imaging, Fred A Metter, Milton J
6. W B Saunders company, London Principles of Nuclear Medicine Henry N Wagner: W. B. Saunders company, London.
7. Clinical Nuclear Medicine M N Masey, K E Britton & D L Gilday Chapman and Hall medicals.
8. Nuclear Medicine Technology & Techniques - Donald R. Bernier, Paul E. Christian & James K. Langan Mosby.
9. Seminars in Nuclear Medicine.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

THERAPEUTIC NUCLEAR MEDICINE PROCEDURES– II (BSNMT- 602)

S. No.	CONTENTS
	Theory
1	Commonly used radionuclides for therapy, like I-131, ^{32}P, ^{90}Sr, ^{153}Sm, ^{186}Re, ^{90}Y, etc.
2	Therapies other than I-131
3	Bone Pain palliation therapy
4	^{177}Lu-PSMA therapy
5	^{177}Lu- PRRT and ^{131}I- mIBG therapy
6	Radiosynovectomy
7	Radio-immunotherapy
8	Alpha therapy
9	PET guided biopsy

Recommended books:

Text book:

1. Principles and practice of Nuclear Medicine, Bruce Sodee, Paul J. Early & Sharon Wikepry.

Reference book;

1. Basic Science of Nuclear Medicine, Roy P Parker, Peter A S Smith & David Churchill Livingston, New York 35.
2. Essentials of Nuclear Medicine, M. V. Merrick.
3. Mosbeys manual of Nuclear Medicine Procedures Bruce Sodee, Paul J. Early & Sharon Wikepry, Mosbey Company, London.
4. Essentials of Nuclear Medicine Imaging, Fred A Metter, Milton JW B Saunders Company, London.
5. Principles of Nuclear Medicine Henry N Wagner: W B Saunders company, London.
6. Clinical Nuclear Medicine M N Masey, K E Britton & D L Gilday. Chapman and Hall medicals.
7. Nuclear Medicine Technology & Techniques - Donald R. Bernier, Paul E. Christian, & James K. Langan Mosby.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

QUALITY ASSURANCE OF NUCLEAR MEDICINE INSTRUMENTS– II
(BSNMT- 603)

S. No.	CONTENTS
Theory	
1	**Organization of department:** How to set up a Lab. - Psychology and social behaviour - Group behaviours - individual relationship with colleagues - Senior staff and patients - How people learn memory and forgetting - motivation and emotion - stress and adjustment -Social influence and the individual - evidence of satisfactory progress reflected in the reports of the clinical supervisors.
2	**Record keeping:** test procedure – maintenance-provisional appointment - Registration of the patients in the department, Register with proper ID number - Isotope Radio pharmaceuticals administration - dosage - Date - Time - mode of Administration etc. Details of Test done - storing of results - Hard copies like Films, Report forms etc. - Dispatch of the results to the respective departments - maintaining the records - maintaining original report copy in the department safely etc.
3	**Equipment maintenance:** Date of installation - Defects raised service done on date and time - done by whom - service record. Periodical quality control study on equipment and their record keeping - Preventive maintenance service on periodical interval either by the engineers in the institution or engineers from the company. Stocking of important spares and PC boards for the rectification of the defects during the time of repair.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Recommended books:

Text book:

1. Quality Control of Nuclear Medicine Instruments, International Atomic Energy Agency.

Reference books:

1. Quality Control of Gamma Cameras and Associated Computer Systems, The Institute of Physical Sciences in Medicine.
2. Quality Control of Nuclear Medicine Instrumentation, The Institute of Physical Sciences in Medicine.
3. "Quality Control in diagnostic imaging"- J.E. GRAY, University Park Press.
4. "Processing and Quality Control" William, E.J. Mckinney, J.B. Lippincott Company.
5. "Concepts in Medical Radiographic imaging" Marianne Tortoice, W.B. Saunders Company.
6. "Quality assurance Management" G.E. Hayes Charger production.
7. Diagnostic Imaging: Quality Assurance M.M. Rehani. Jaypee Brothers Medical publishers.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

देबराज सेन/Debraj Sen MD
Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Advisor & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

IN-VITRO NUCLEAR MEDICINE TECHNIQUES– II (BSNMT- 604)

S. No.	CONTENTS
	Theory
1	**Ferrokinetic studies-** Iron Absorption, Plasma Iron clearance, Plasma Iron turn over
2	**Proteins turn over studies-** Synthesis & catabolism. Use of radiotracers in albumin turnover. Protein loss study.
3	**Radio respirometry –** radio microbial detection, carbon breath analysis.
4	**Autoradiography**
5	**Neutron activation analysis**
6	**Liquid Scintillation Counting:** Composition of liquid scintillator (scintillation cocktail): primary solute, secondary, solute and organic solvent (toluene, 1,4 dioxane, anthracene) and solubilizing agents for tissues, Coincidence circuits and display. Quenching, Quench corrections methods: Internal standard method, external standard method and channel ratio, neutron detectors: Basic principle sand applications.
7	**Statistics of counting:** Counting error, accuracy and precision, normal standard deviation of count rates, standard error, Gaussian distribution, poison's distribution and propagation of errors

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Col
Sr Adviser & Prof
Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

RADIATION HAZARD, CONTROL AND SAFETY, REGULATORY REQUIREMENTS– II (BSNMT- 605)

S.No.	CONTENTS
	Theory
1	Waste disposal, handling of RIA materials - Procedure for handling spills, Area monitoring, instruction to workers.
2	**Decontamination:** Personnel, equipment and work area, decontamination kit Storage of radioactive materials Disposal of Radioactive Waste-disposal records-
3	Maximum permissible concentration for airborne activity. Maximum permissible concentration for sewage disposal.
4	Record keeping. Requirements for Periodical departmental survey and the maintenance of their records etc. Personnel dosimeter and their record keeping etc.
5	**Patient protection;** Safe work practice in nuclear medicine- Radiation absorbed dose from diagnostic and therapeutic procedures. Investigations during pregnancy-examinations associated with illness, not associated with illness-medico-legal or insurance purpose examinations-medical research – avoidance of unnecessary radiation dose.
6	**Radiation emergencies**-situation, preparedness, safety and prevention, legal requirements.
7	Recent developments in radiation safety related topics.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

Recommended books:

Textbooks:

1. Radiation Protection in Hospitals. Richard F. Mould.

Reference books:

1. Basic radiological physics. Jaypee Bothers Private limited, New Delhi
2. An Introduction to Radiation Protection. Allen Martin & Samuel.
3. Radiation safety in medical practice. M.M. Rehani.
4. Radiation Protection. Ronald L. Kathren.
5. AERB safety code and manuals.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

PATTERN OF EXAMINATION

1. Theory Examination will be designed to comprehensively assess a student's understanding and application of theoretical knowledge. The question paper format will typically involve a blend of various question types, including multiple-choice questions, fill in the blanks, very short answer questions, short answer questions, and long answer questions. This diverse structure aims to evaluate student's grasp of concepts at varying depths, ensuring a comprehensive evaluation of their theoretical aptitude.

2. The Practical Examination will primarily focus on the application of knowledge in real-world scenarios. It will assess a student's ability to identify specimens accurately, perform physical examinations adeptly, establish the link between Nuclear Medicine Technology and patient care, and demonstrate their practical skills effectively. Students will be assessed on various aspects of Radiation Safety in depth. Furthermore, the inclusion of Viva will allow examiners to gauge the student's understanding, critical thinking, and problem-solving abilities in real-time, ensuring a well-rounded evaluation process that emphasizes both theoretical and practical competencies.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

FIRST YEAR: MODEL QUESTION PAPERS (THEORY)

PAPER I: ANATOMY

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
7. Use of electronic devices is STRICTLY PROHIBITED. Strict action against unfair means would be taken.

SECTION A

1. Answer the following: **(2x10 =10)**

a) Describe the parts, surfaces, arterial supply and venous drainage of stomach.

b) Enumerate parts of female reproductive system. Write in detail the parts, layers, position and blood supply of uterus.

2. Write short notes on any FIVE **(5 x 4=20)**

a) Urinary bladder
b) Histology of cardiac muscle
c) Neuro muscular junction
d) Structure of a Nephron
e) Extra hepatic biliary system
f) Gross anatomical features and lobes of prostate

3. Answer any FIVE of the following: **(5 x 2=10)**

a) Types of cartilage.
b) Parts of fallopian tube.
c) Difference between large and small intestine.
d) Two upper limb muscles.
e) Parts of pharynx.
f) Name the parts of ureter.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Anil Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

SECTION B

1. Answer the following: **(2x10 =10)**

a) Enumerate the surfaces, lobes of cerebrum. Describe in detail the sulci and gyri of supero-lateral surface of cerebrum.

b) Enumerate the chambers of Heart. Describe in detail the internal features, external features of right atrium.

2. Write short notes on any FIVE **(5x4 =20)**

a) Histology of thick skin
b) Bronchopulmonary segments of left lung
c) Paranasal air sinuses
d) Ventricles of brain
e) Parts and contents of mediastinum
f) Parts of ear

3. Answer any FIVE: **(5x2 = 10)**

a) Valves of heart.
b) Name two endocrine gland.
c) Name two superficial veins of upper limb.
d) Enumerate the ear ossicles.
e) Name the layers of meninges.
f) Name any four cranial nerves.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

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PAPER II: PHYSIOLOGY

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
7. Use of electronic devices is STRICTLY PROHIBITED. Strict action against unfair means would be taken.

SECTION A

1. Answer the following: **(2x10 =20)**

a) Classify leucocytes & give their normal values. Briefly describe the functions of different types of leucocytes.

b) Describe the physiological actions of thyroid hormone. Add a note on hypothyroidism.

2. Write short notes on any five of the following **(5 x 4=20)**

a) Functions of platelets

b) Name the plasma proteins. Write two functions of it.

c) What are diuretics. Give two examples?

d) Mention the hormones that regulate glucose metabolism.

e) Why there is anaemia in chronic renal failure?

f) What are the functions of ovary?

g) List four pancreatic enzyme.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

SECTION B

4. Answer the following: **(2x10=20)**

a) Define cardiac output, end diastolic volume, stroke volume and ejection fraction. Give their normal values. Briefly describe the factors affecting cardiac output.

b) Describe the functional classification and functions of cerebellum. Write 4 features of cerebellar disorder.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

5. Write short notes on ANY FIVE of the following (5x4=20)

a) Pulmonary surfactant
b) Jugular venous pulsation
c) Deafness
d) Corticospinal tract
e) Oxygen therapy
f) Referred pain

6. Answer briefly any five of the following (5x4=20)

a) Define tidal volume. Give their normal value.
b) Name the baroreceptors. Mention its function. List four functions of hypothalamus
c) What is EEG. Name the EEG waves.
d) List four functions of skin
e) What is myopia, how is it corrected?

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

देबराज सेन/Debraj Sen,MD
Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Advisor & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

----------X----------

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

PAPER III: BIOCHEMISTRY

Maximum Marks: 50 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
7. Use of electronic devices is STRICTLY PROHIBITED. Strict action against unfair means would be taken.

Section A

1. Answer any one of the following: **(1x10 = 10)**

a) Describe the principle, instrumentation and applications of electrophoresis.

b) Discuss in detail the regulation of blood pH. Add a note on metabolic acidosis.

2. Write short notes on any four of the following: **(4x5= 20)**

a) Phospholipids.

b) Biochemical tests for assessment of iron status.

c) Mechanisms of action of enzymes.

d) Biochemical functions of Vitamin K.

e) Basal metabolic rate.

3. Answer any five of the following: **(5x2 =10)**

a) Write down the composition of maltose.

b) What are the reference values of sodium and potassium in blood?

c) How do you prepare 1M NaCl?

d) What is Bohr effect?

e) Name a test to detect protein in urine.

f) Name any two richest sources of vitamin C.

Section B

1. Answer any one of the following: **(1x10=10)**

a) Working principle of gel filtration chromatography.

b) Secondary structure of proteins.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

डेबराज सेन/Debraj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

(Aneesh Mathuria)
Col
Sr Adviser (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

2. Answer briefly any <u>five</u> of the following: **(5x2=10)**

a) Write down the composition of hyaluronic acid.
b) What is the biomedical significance of dextran?
c) Give any <u>two</u> applications of volumetric flasks.
d) Name any <u>one</u> test to detect reducing sugar.
e) What is hypokalaemia?
f) Name a copper containing enzyme.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एंड आर), नई दिल्ली
Army Hosp (R&R), New Delhi

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PAPER IV - BASIC CONCEPTS IN RADIATION PHYSICS

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
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Section A

(Multiple choice questions) (10x1 = 10)

I. Choose the correct answer and write the alphabet in the adjacent box provided:

1. Emission of characteristic X-rays is associated with
   a) atomic transition
   b) nuclear reaction
   c) Neutron-proton collision
   d) Bremsstrahlung

2. The X-ray beam Half Value Layer (HVL) does NOT depend on the
   a) Peak kV
   b) X-ray spectrum
   c) Radiation intensity
   d) Anode material

3. The effective photon energy of an X-ray beam cannot be changed by
   a) Tube current (mA).
   b) Tube voltage
   c) Beam filtration
   d) Voltage waveform

4. The reason for high subject contrast on a Barium enema examination is
   a) Coherent scatter
   b) Photoelectric effect

c) Compton scatter
d) Photodisintegration

5. The nuclear force keeps the protons and neutrons bound in the nucleus, its strength is
a) The same as the electromagnetic force.
b) Significantly stronger than the electromagnetic force.
c) Significantly less than the electromagnetic force.
d) Same as that of binding energy of electron.

6. What effect will an air gap have on image contrast?
a) Increases image contrast
b) Image is unaffected
c) Reduces image contrast
d) No image is visible.

7. Which of the following would most likely increase the spatial resolution of a screen/film combination?
a) High grid ratio
b) Slower film
c) Thicker screen
d) Thinner screen

8. The major limitations of Computed Radiography (CR) for breast imaging is its inferior
a) X-ray detection efficiency
b) Noise characteristic
c) Display contrast
d) Spatial resolution

9. Radiation is not used in
a) CT scan
b) MRI
c) Digital subtraction imaging
d) Thyroid scan

(Neeraj Kumar)
Lt Col
CI Spi (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

10. You have taken three X-ray films today. During the day as you develop each film, you noticed the films getting lighter and lighter. What needs to be done so that this problem can be corrected?
a) Increase the kVp setting
b) Increase the mAs setting
c) Replenish the developing solution.
d) Decrease the temperature of the developing solution.

II. Fill in the blanks: (10x1 = 10)
a) The frequency of photons emitted by______________is 3 x 10^{17} Hz.
b) Number of atoms per gram is called as______________number.
c) As the frequency of electromagnetic radiation________________the wavelength decreases and energy increases.
d) An___________________accelerated through a potential difference gains potential energy.
e) Protons and _______________ have approximately equal rest mass.
f) The contrast media commonly used in Magnetic Resonance Imaging is ___________________.
g) ____________________crystals are related to ultrasonography.
h) The amount of energy required to remove a valence electron is called_______________.
h) Kilovoltage controls the speed of_________________.
i) _________________frequency is related to Magnetic Resonance Imaging.

Section B

I. Answer any one of the following: (1x10=10)
1. Define radioactivity and derive the equation
a) To determine natural radioactivity
b) To determine the radioactive decay constant.
2. What is nuclear stability curve? If a nucleus lies on the right of nuclear stability curve, what are the possible types of its decay?

देवराज सेन/Debraj Sen,MD
कर्नल Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medic
Army Hospital (R&R)

II. Write short notes on any five of the following: (5x4 = 20)
1. Nuclear forces.
2. What are the differences between nuclear fission and nuclear fusion reactions
3. Describe the structure of an atom in details?

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

4. Define the following terms:
a) Nucleus
b) Atomic number
c) Mass number
d) Ionisation
5. What is meant by pair production?
6. What is meant by endothermic reaction in nuclear physics?

III. Answer briefly on any <u>five</u> of the following: (5x2 = 10)

1. Wavelength.
2. Isobars.
3. Bremsstrahlung
4. Half-life of a radioactive isotope.
5. Neutrons.
6. Photoelectric effect.

Section C

I. Answer any <u>one</u> of the following: (1x10 =10)

1. With a neat diagram, explain the various types of grids in X-ray units and explain its function in detail.
2. Draw the diagram of an X-ray tube and explain the production of X-rays in detail.

II. Answer on any <u>five</u> of the following (5 x 4 = 20)

1. Define space charge effect.
2. If the focus to skin distance is 70 cm, and focus to film distance is 110 cm, calculate the magnification factor of an object located at the mid-plane of the patient with separation 20 cm.
3. Write short notes on fluoroscopy.
4. Explain Heel effect.
5. Show the effect of mA, kV, and filters on X-ray spectrum.
6. Define focal spot. What are the factors that determine focal spot selection?

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

III. Answer briefly any <u>five</u> of the following: (5 x2=10)

1. CT number.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

2. Name two chemicals used for film developing in dark room.
3. What is a grid?
4. Safe light in dark room.
5. Artifacts.
6. Name the target material used in mammography.

AVS Arun Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

देबराज सेन/Debraj Sen,MD
कर्नल/Colonel
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

Sr Adviser (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

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SECOND YEAR: MODEL QUESTION PAPERS (THEORY)

PAPER I: PHYSICS OF NUCLEAR MEDICINE

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
7. Use of electronic devices is STRICTLY PROHIBITED. Strict action against unfair means would be taken.

Section A

I. Answer the following: (2x10 =20)

1) Describe in detail about Pulse height analyzer and its applications in nuclear medicine. Draw relevant diagrams.

2) What is a photomultiplier tube? Describe in detail the parts of a photomultiplier tube with a diagram. Give its applications.

II. Write short notes on any <u>four</u> of the following: (4 x 5=20)

1) Describe the mechanism of an ionization chamber.
2) Draw and label the different parts of Tc-99m spectrum.
3) Pocket dosimeter.
4) Mechanism of scintillation and its use in nuclear medicine.
5) Display devices in nuclear medicine.

III. Answer briefly any <u>five</u> of the following (5 x 2=10)

1) Uses of well-counter.
2) What is a GM counter?
3) Give examples for liquid scintillation detector.
4) What are the different gas-based detectors used in your department?

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

5) Classify scintillation detectors.
6) What is pulse-shaping?

Section B

I. Write short notes on any <u>six</u> of the following: (6 x5=30)

1) List the different types of collimators and mention their characteristics in short.
2) Describe in short about pre-amplifier.
3) What is the function of an amplifier in a gamma camera?
4) Rectilinear scanner.
5) Applications of gamma camera in nuclear medicine.
6) What is spatial resolution? How do you measure spatial resolution for a gamma camera?
7) Positioning mechanism in gamma camera.

1. Answer briefly any <u>five</u> of the following: (5x4=20)

1) Why is the head of gamma camera shielded with lead?
2) What is a light guide?
3) What is a pre-amplifier?
4) How is energy selective counting done?
5) What is FWHM?
6) What is doping?

Debraj Sen, MD
Sr Adviser & Prof
Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine & Nuclear Medicine
Army Hospital (R&R)

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AVS Anil Kumar
BHG
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

PAPER II: RADIOCHEMISTRY AND RADIOPHARMACY

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
7. Use of electronic devices is STRICTLY PROHIBITED. Strict action against unfair means would be taken.

Section A

I. Answer the following: (2x10=20)

1) Describe the different types of equilibrium. Describe the parts of Molybdenum99-Technetium-99m generator with a diagram.
2) Describe the parts and functioning of a cyclotron with a diagram. Mention some cyclotron produced radionuclides.

II. Write short notes on any <u>four</u> of the following: (4 x5=20)

1) Molybdenum breakthrough test.
2) What are the different hepatobiliary agents?
3) Describe neutron activation.
4) Describe the parts of a nuclear reactor.
5) Labeling of ethylene dicysteine with Tc-99m.

III Answer briefly any <u>five</u> of the following (5 x2=10)

1) Give 2 examples of cyclotron-produced radionuclides.
2) pH.
3) What is the function of a moderator in a nuclear reactor?
4) How does one calculate yield of a generator?
5) Decay scheme of Tc-99m.
6) What is lyophilisation?

Section B

I. Write short notes on six of the following (6 x5=30)

1) Describe in short the procedures followed in cold kit preparation.
2) HPLC.
3) How to perform sterility check of a radiopharmaceutical?
4) Contents of DTPA cold kit.
5) Preparation of TC-99m ECD.
6) Radio-iodination.
7) Significance of different types of chemical bonds.

II. Answer briefly any five of the following (5 x4=20)

1) Define specific activity.
2) What is the difference between radionuclide purity and radiochemical purity?
3) Formula to calculate paediatric dose?
4) What is the role of stannous pyrophosphate in Tc-99m radiopharmaceuticals?
5) Name a few colloid radiopharmaceuticals.
6) What are acids and bases?

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

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Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

PAPER III: RADIATION QUANTITIES, UNITS, INTERACTION OF RADIATION WITH MATTER, AND RADIATION MEASUREMENT

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
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Section A

I. Answer the following: (2x10=20)

1) Explain in detail about scalar radiometric quantities.
2) Derive the expression for the exponential attenuation of X-rays or gamma rays in a medium.

1. Write short notes on any <u>four</u> of the following: (4x5=20)

1) Photo-electric Effect.
2) Compton Effect.
3) Define linear attenuation coefficient.
4) Energy deposited and energy imparted.
5) Cerenkov radiation.

III. Answer briefly any <u>five</u> of the following (5 x2=10)

1) What is Bragg's peak?
2) What is the relationship between HVT and TVT?
3) What do you understand by Triplet Production?
4) What is the old & new unit for equivalent dose? Mention the relationship between them.
5) Convert 1 Ci into Becquerel.
6) What are Auger electrons?

(Veeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Section B

I. Write short notes on any <u>six</u> of the following: (6 x5=30)

1) How does Compton interaction vary with energy of photons?
2) Atomic number of interacting medium.
3) How does Photoelectric Effect vary with Energy of photons
4) How does Pair Production vary with activity and decay constant.
5) What are the basic physical, operational, and protection quantities?
6) Equivalent dose and effective dose.
7) Explain with a diagram the Tenth Value Thickness.

II. Answer briefly any <u>five</u> of the following: (5 x4=20)

1) What is Annihilation?
2) What is meant by Indirectly ionizing radiation?
3) What are directly ionizing radiations?
4) What is Quality factor?
5) What is absorbed dose?
6) What is neutron scattering?

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

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PAPER IV: RADIOBIOLOGY

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
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Section A

I. Answer the following: (2x10=20)

1. Describe in detail about medical internal radiation dosimetry
2. Effects of radiation on foetus.

II. Write short notes on any <u>four</u> of the following: (4x5=20)

1. What are the different effects of acute exposure to radiation?
2. Deterministic effects of radiation.
3. RBE.
4. Direct and indirect action of radiation.
5. Stochastic effects of radiation.

III. Answer briefly any <u>five</u> of the following (5x2=10)

1. Which type of radiation produces maximum damage? Why?
2. Name a few relatively radio-resistant organs.
3. Which is the most dangerous period during gestation for radiation? Why?
4. Define derived air concentration (DAC).
5. What is doubling dose?
6. Tissue weighting factor.

Section B

I. Write short notes on any <u>six</u> of the following: (6x5=30)

1. Hereditary effects of radiation.
2. Radio-sensitisers.
3. Hypoxia and effect of radiation
4. LD50/60
5. Radiation carcinogenesis.
6. Dose and dose-rate effectiveness factor.
7. Bystander effect.

II. Answer in brief any <u>five</u> of the following: (5x4=20)

1. What are radiation protectors?
2. What are free radicals?
3. Define LET.
4. Define sublethal damage.
5. What is radiation hormesis?
6. MIRD phantom.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

(Anupam Mahajan)
Sr Adviser (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

डेबराज सेन/Debraj Sen Mb
सीनियर सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एण्ड आर), नई दिल्ली
Army Hosp (R&R), New Delhi

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THIRD YEAR: MODEL QUESTION PAPERS (THEORY)

PAPER I: DIAGNOSTIC NUCLEAR MEDICINE PROCEDURES

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
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Section A

II. Answer the following: (2x10=20)

1. Describe in detail the procedures involved in acquisition and processing of diuretic renogram.
2. Explain the procedures involved in stress myocardial scintigraphy.

II. Write short notes on any <u>four</u> the following: (4 x 5 = 20)

1. Brain perfusion SPECT with intervention
2. Triple phase bone scintigraphy
3. MIBG scan
4. Diagnostic procedures that involve use of Sulphur colloid.
5. Hepatobiliary scintigraphy.

III. Answer briefly any <u>five</u> of the following: (5x2=10)

1. How will you do renal cortical scintigraphy?
2. What is the use of denatured RBC scan?
3. Protocol for cisternography.
4. Name the different gating protocols for ERNA.
5. Name the protocols for parathyroid scintigraphy.
6. Patient preparation required for thyroid uptake.

Section B

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

I. Write short notes on any <u>six</u> of the following: (6x5=30)

1. Gall bladder ejection fraction calculation.
2. Lung ventilation-perfusion scintigraphy
3. Regional PET acquisition
4. NaF bone PET
5. Ga-68 DOTANOC PET/CT
6. Scintimammography
7. Sentinel node imaging.

II. Answer briefly any <u>five</u> of the following: (5x4=20)

1. Name the different views acquired for DMSA renal scan.
2. Describe in short the protocol for Meckel's scan.
3. Renal transplant scintigraphy protocol.
4. Blood glucose levels before FDG administration.
5. Images acquired for lymphoscintigraphy.
6. Give two examples of pinhole imaging in nuclear medicine.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

----------X----------

PAPER II: THERAPEUTIC NUCLEAR MEDICINE PROCEDURES

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
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Section A

I. Answer the following: (2x10=20)

1. Describe in detail the procedures involved in patient preparation, administration and discharge of patients after high dose radioiodine therapy for thyroid cancer.
2. Describe the procedures involved in radionuclide therapy for bone pain palliation.

II. Write short notes on any <u>four</u> of the following: (4 x 5 = 20)

1. Dose calculation for radio-iodine treatment for thyrotoxicosis
2. Characteristics of various radionuclides used for bone pain palliation.
3. Calculation of Y-90 microsphere dose for hepatocellular carcinoma.
4. Dosimetry of Sm-153 EDTMP therapy.
5. Lu-177 based newer therapy options.

III. Answer briefly any <u>five</u> of the following: (5x2=10)

1. What are the different types of internally administered radionuclides for therapy?
2. How will you reduce the absorbed dose to bladder in therapeutic radionuclides excreted through kidneys?
3. What is the use of post-therapy scan?
4. Name a few therapies that need admission of patient in isolation ward.
5. Dose limits for releasing patient after I-131 therapy.
6. What are the uses of P-32 colloid?

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Section B

I. Write short notes on <u>six</u> of the following: (6x5=30)

1. Theranostics.
2. Preparation of patient for Lu-177 DOTANOC therapy.
3. MIBG therapy.
4. Generator-based radionuclide therapy.
5. Alpha-emitters for radionuclide therapy.
6. Radionuclide therapy for lymphoma.
7. Thyroid uptake for radioiodine therapy planning.

II. Write briefly about the following: (5x4=20)

1. What is a delay tank?
2. Give examples for peptide radionuclide therapy.
3. What are the radionuclides used for treating joint inflammation?
4. How will you treat malignant ascites?
5. Blood radiation dose limits for internal radiotherapy.
6. Precautions regarding future pregnancy after radionuclide therapy.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

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PAPER III: QUALITY ASSURANCE OF NUCLEAR MEDICINE INSTRUMENTS

Maximum Marks: 100 Time: 3 hours

Instructions:

8. All questions are compulsory.
9. Read the question carefully and answer to the point neatly and legibly.
10. Do not leave any blank pages between two answers.
11. Start the answer to the question on a fresh page or leave adequate space between two answers.
12. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
13. Corrections/ Amendments; if any, in answer sheet should be neatly done.
14. Use of electronic devices is STRICTLY PROHIBITED. Strict action against unfair means would be taken.

Section A

I. Answer the following: (2x10=20)

1. Quality control of PET.
2. Nuclear medicine image quality control.

II. Write short notes on any <u>four</u> of the following (4x 5=20)

1. Daily QC of a gamma camera.
2. QC of thyroid uptake probe.
3. COR correction.
4. Record keeping of quality control procedures.
5. Daily QC of CT.

III. Answer briefly any <u>five</u> of the following: (5x2=10)

1. Accepted limits for uniformity of gamma camera.
2. Details that have to be taken care of before signing a CAMC.
3. What is tuning?
4. Specifications of image filmer.
5. Quality control to reduce background radiation.
6. How will you check linearity of a gamma camera?

Section B

I. Write short notes on any <u>six</u> of the following: (6x5=30)

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

1. Steps involved in setting up a nuclear medicine lab.
2. Storage of patient image data.
3. Room temperature and humidity
4. QC of well-counter.
5. Phantoms used for quality control of imaging equipments.
6. Patient misidentification.
7. Wise scheduling of patients for nuclear medicine procedures.

II. Answer briefly any <u>five</u> of the following: (5x4=20)

1. Give examples for long-lived sealed sources used for quality control of well-Counter.
2. Four quadrant bar phantom.
3. Parts of quality control of a dose calibrator.
4. Role of point source in quality control methods.
5. Methods for QC of CT.
6. What are the different methods of exposing nuclear medicine images?

(Aneesh Dhimen)
Col
Sr Advisor (Radiodiagnosis) &
Interventional Radiologist
Army Hospital (R&R)

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

देबराज सेन/Debraj Sen
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एवं आर), नई दिल्ली
Army Hosp (R&R), New Delhi

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PAPER IV: IN-VITRO NUCLEAR MEDICINE TECHNIQUES

Maximum Marks: 100 Time: 3 hours

Instructions:

15. All questions are compulsory.
16. Read the question carefully and answer to the point neatly and legibly.
17. Do not leave any blank pages between two answers.
18. Start the answer to the question on a fresh page or leave adequate space between two answers.
19. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
20. Corrections/ Amendments; if any, in answer sheet should be neatly done.
21. Use of electronic devices is STRICTLY PROHIBITED. Strict action against unfair means would be taken.

Section A

I. Answer the following: (2x10=20)

1. Compare RIA and CLIA.
2. IRMA

II. Write short notes on any four of the following: (4 x 5 = 20)

1. Describe various radionuclides used in in-vitro techniques.
2. QC of RIA.
3. Schilling test.
4. Calculation of RBC survival.
5. Autoradiography.

III. Write briefly on any five of the following: (5x2=10)

1. Mention the methods of GFR measurement by plasma clearance technique.
2. Use of PEG in RIA
3. What is antiserum?
4. What are monoclonal antibodies?
5. What is minimum detectable concentration?
6. Mention different ferrokinetic studies.

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

Section B

I. Write short notes on any six of the following: (6x5=30)

1. Calculation of blood volume.

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

2. C-14 urea breath test
3. Thyroid uptake
4. Propagation of errors.
5. Poisson distribution.
6. Liquid scintillation counter.
7. Calculation of EC clearance.

II. Write briefly about the following: (5x4=20)

1. What is the half-life and emission energy of I-125?
2. Flat field collimator.
3. What is standard curve?
4. Studies to diagnose protein-losing enteropathy.
5. Tracers used for ferro- and erythro-kinetic studies.
6. Advantages of using Cr-51 in in-vitro studies.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

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PAPER V: RADIATION HAZARD, CONTROL AND SAFETY, REGULATORY REQUIREMENTS

Maximum Marks: 100 Time: 3 hours

Instructions:

1. All questions are compulsory.
2. Read the question carefully and answer to the point neatly and legibly.
3. Do not leave any blank pages between two answers.
4. Start the answer to the question on a fresh page or leave adequate space between two answers.
5. Draw suitable tables/ diagrams/ flow charts wherever appropriate.
6. Corrections/ Amendments; if any, in answer sheet should be neatly done.
7. Use of electronic devices is STRICTLY PROHIBITED. Strict action against unfair means would be taken.

Section A

I. Answer the following: (2x10=20)

1. AERB radiation exposure limits for occupational workers.
2. Role of ICRP in radiation protection.

II. Write short notes on any <u>four</u> of the following: (4x5=20)

1. Disposal of liquid radiation waste
2. Planning of a nuclear medicine laboratory.
3. IAEA safety manuals.
4. Fume hood.
5. Storage of radioactive waste.

III. Write briefly on any <u>five</u> of the following: (5x2=10)

1. What is misadministration?
2. Give two examples of radiation accidents.
3. How will you do a wipe test?
4. Effect of shielding on radiation exposure
5. How will you monitor radiation in a hot lab?
6. What is finger dose?

Section B

I. Write short notes on any <u>six</u> of the following: (6x5=30)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

1. What are the functions of an RSO?
2. TLD.
3. Decontamination kit.
4. Division of nuclear medicine lab area based on radiation levels.
5. Classes of radioactive waste.
6. Types of packaging.
7. Radioactive spill.

II. Write briefly on any five of the following: (5x4=20)

1. What is surface radiation?
2. Inverse square law.
3. Define ALI.
4. What is transport index?
5. What is ALARA?
6. What is the importance of occupancy factor?

(Neeraj Kumar)
Lt Col
Cl Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

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FIRST YEAR: PRACTICAL EXAMINATION PATTERN

ANATOMY (50 Marks)

1. Identification of models, charts and specimen
2. Display of understanding of anatomical structures through practical exercises.
3. Applied Anatomy
4. Viva Voce

PHYSIOLOGY (50 Marks)

Human Practicals

1. General physical examination
2. Pulse examination
3. Recording of blood pressure and postural changes in blood pressure
4. Examination of cardio-vascular system
5. Examination of respiratory system.
6. Examination of central nervous system; sensory and motor Abdominal examination

Viva Voce

BASIC CONCEPTS IN RADIATION PHYSICS (50 Marks)

1. Spotters
2. Radiation detection and handling of equipments
3. Applied radiation physics
4. Viva Voce

SECOND YEAR: PRACTICAL EXAMINATION PATTERN

PHYSICS OF NUCLEAR MEDICINE (50 Marks)

1. Identification of equipments
2. Spotters
3. Dosimetry
4. Viva Voce

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

देबराज सेन/Debraj Sen
वरिष्ठ सलाहकार एवं आचार्य /Sr Adviser & Prof
रेडियोडायग्नोसिस एवं इमेजिंग विभाग
Dept of Radiodiagnosis & Imaging
सेना अस्पताल (आर एंड आर), नई दिल्ली
Army Hosp (R&R), New Delhi

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

RADIOCHEMISTRY AND RADIOPHARMACY (100 Marks)

1. Preparation of Radiopharmaceuticals
2. Quality Assurance and Testing
3. Radiation Safety protocols
4. Viva Voce

THIRD YEAR: PRACTICAL EXAMINATION PATTERN

DIAGNOSTIC NUCLEAR MEDICINE PROCEDURES (100 Marks)

1. Radiopharmaceutical preparation and quality control
2. Patient preparation and communication
3. Instrumentation and imaging protocol
4. Image analysis
5. Viva Voce

THERAPEUTIC NUCLEAR MEDICINE PROCEDURES (100 Marks)

1. Radiopharmaceutical handling and administration
2. Patient care and management
3. Treatment planning and dosimetry
4. Post treatment follow up
5. Viva Voce

QUALITY ASSURANCE OF NUCLEAR MEDICINE INSTRUMENTS (50 Marks)

1. Instrument Calibration and performance
2. Quality control procedures
3. Instrument maintenance and troubleshooting
4. Viva Voce

IN-VITRO NUCLEAR MEDICINE TECHNIQUES (50 Marks)

1. Preparation of reagents and samples
2. Patient preparation and communication

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

3. Viva Voce

RADIATION HAZARD, CONTROL AND SAFETY, REGULATORY REQUIREMENTS (50 Marks)

1. Disposal of radioactive waste
2. Packaging of radioactive material
3. Management of radiation emergencies
4. Nuclear Medicine documentation
5. Viva Voce

**There will no practical examination in Biochemistry, Radiobiology and Radiation Quantities, Units, Interaction of Radiation with Matter and Radiation Measurement*

* *The Ordinance and syllabus are subject to modifications by* ***Delhi University*** *from time to time.*

*The concerned institutions are mandatorily required to obtain necessary approval of the regulatory body i.e. AERB before commencement of the subject course.

(Neeraj Kumar)
Lt Col
CI Spl (Nuclear Medicine)
Army Hospital (R&R)

AVS Anil Kumar
Brig
Consultant Medicine &
Nuclear Medicine
Army Hospital (R&R)

Dept of Radiodiagnosis & Imaging
Army Hosp (R&R), New Delhi

----------X----------