REGULATIONS AND CURRICULUM GOVERNING

B.Sc. NUCLEAR MEDICINE TECHNOLOGY PROGRAM

Implemented in Academic Year 2022-23

Revised in 2023

Amended up to 2025

Name of the constituent Unit: Yenepoya School of Allied Health Sciences



Deralakatte, Mangalore, Karnataka

YENEPOYA
(DEEMED TO BE UNIVERSITY)

NOTIFICATION FROM THE UNIVERSITY

Sl. No.	ACM with date	BOM/BOS with date	Decisions/Approvals
1.	20.06.2022	58th BOM/21.06.2022	Regulation & Syllabus of B.Sc. Nuclear Medicine Technology course is approved.

YENEPOYA
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CONTENTS

S. No.	Particulars	Page numbers
1.	Preamble	1
2.	Definitions	2-7
3.	Eligibility for Admission	7-8
4.	Duration of the Program	8
5.	Maximum Period for Completion of the Program	8
6.	Aim of the Program	8
7.	Outcomes of the Program • Program Outcomes	8-9
	• Program Structure	9-12
8.	Attendance	12
9.	Teaching-Learning Methods Course wise	12-13
10.	Scheme of Examination	13-18
11.	Eligibility to appear for University Examination	18-19
12.	Criteria for Passing	19-20
13.	Grading and Classification	20-23
14.	Journals	23
15.	Any other information	23-25
16.	Syllabus	25-135

1. Preamble

Health care sector has become one of the largest employment generation sectors in India and abroad. Rapidly changing and expanding horizon of the health care sector demands formal training programs in all its allied areas. Advanced complex instrumentation & equipment require technologists not only to operate but also to care & maintain these instruments and equipment. These technologists should possess a strong scientific foundation to be able to perform these tasks at a much higher level than the traditionally trained technicians of the past used to perform. The students who are trained in the technological aspects of medical care with a good scientific foundation will be in a position to competently assist the Physician or Surgeon. Hence to prepare the students to meet the demands of the healthcare sector and in accordance with Ministry of Human Resource Development (HRD), Govt. of India education system, Choice based Credit system is introduced from the academic year 2020- 21 onwards.

B.Sc. Nuclear Medicine Technology (NMT) is an undergraduate program in the field of health care offered by Yenepoya Deemed to be University.

BSc (MNT) is an allied health speciality utilising radioactive materials to diagnose and treat disease. The field involves patient care, diagnostic imaging (Gamma Camera, PET-CT, etc…), lab analysis of patient samples, and the therapeutic administration of radioisotopes (Iodine-131 therapy for Thyroid Cancer, P-32 therapy for bone pain palliation, etc…)

As far as the curriculum is concerned, the Nuclear Medicine Technologist must have an educational background in a wide variety of subjects. Basic and Advanced science courses, Computer science,

Psychology, Communication are highly recommended.

Specialised nuclear / radiation courses form a solid base and promote good radiation safety practices. Overall, the curriculum provides a challenging and highly rewarding educational experience.

The objective of the program is to develop a pool of trained Nuclear Medicine Technologists. Nuclear Medicine Technologists are currently in great demand Nationwide. Numerous career opportunities are available in virtually every area of the Country in a variety of workplace settings.

Choice based Credit System is a flexible system of learning. The distinguishing features of CBCS are following:

- It permits students to learn at their own pace.
- Choose Electives from a wide range of Elective courses offered by the other departments/university.
- Undergo additional courses acquire more than the required number of credits.
- Adopt an Inter-disciplinary and Intra-disciplinary approach in learning.
- Make best use of the available expertise of the faculty across the departments or disciplines.
- Has an inbuilt evaluation system to assess the analytical and creative skills of students in addition to the conventional domain knowledge assessment pattern.

2. Definition

2.1 Academic Year: Two consecutive (one odd + one even) semesters constitute one academic year.

2.2 Semester System/ Choice Based Credit System: The Semester system accelerates the teaching- Learning process. The Credit based Semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The Choice- Based Credit system provides a cafeteria type approach in which the students can take courses of their choice, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning

An academic year shall consist of two semesters;

Odd Semester 1st, 3rd, 5th& 7th	September/October to February/March
Even semester 2nd, 4th, 6th& 8th	March/April to August/September

2.3 Course: Usually referred to, as "papers" is a component of a programme. The courses shall define learning objectives and learning outcomes. A course shall comprise lectures/ tutorials/ laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study etc. or a combination of these. The courses can be of the following types ie, Core, Ability Enhancement, Skill enhancement, Value added courses, Multidisciplinary Elective and Internship.

2.4 Credits: Credit defines the quantum of contents/syllabus prescribed for a course and determines the number of hours of instruction required per week. Thus, normally in each of the courses, credits will be assigned on the basis of the number of lectures/tutorial laboratory work and other forms of learning required, to complete the course contents in a 15-20week schedule: One credit =1 hour of lecture per week/ two hours of Laboratory or practical/three hours of clinical rotation, field work/posting. All courses need not carry the same credits.

	Lecture- L	**Tutorial- T**	**Practical – P**	**Clinical Training/Rotation**
1 Credit	1 Hour	1 Hour	2 Hours	3-5 Hours

2.4.1 Credit Hours for different types of Courses:

Each course may have only a lecture component or a lecture and tutorial component or a lecture and practicum component or a lecture, tutorial, and practicum component, or only practicum component. For example, a three-credit lecture course in a semester means three one-hour lectures per week with each one-hour lecture counted as one credit. In a semester of 15 weeks duration, a three-credit lecture course is equivalent to 45 hours of teaching.

One credit for tutorial work means one hour of engagement per week. In a semester of

15 weeks duration, a one-credit tutorial in a course is equivalent to 15 hours of engagement.

A one-credit course in practicum or lab work, community engagement and services, and fieldwork in a semester mean two-hour engagement per week. In a semester of 15 weeks duration, a one-credit practicum in a course is equivalent to 30 hours of engagement.

A one-credit of Seminar or Internship or Studio activities or Field practice/projects or Community engagement and service means two-hour engagements per week. Accordingly, in a semester of 15 weeks duration, one credit in these courses is equivalent to 30 hours of engagement.

A course can have a combination of lecture credits, tutorial credits, and practicum credits. For example, a 4–credit course with three credits assigned for lectures and one credit for practicum shall have three 1-hour lectures per week and one 2-hour duration field-based learning/project or lab work, or workshop activities . In a semester of 15 weeks duration, a 4-credit course is equivalent to 45 hours of lectures and 30 hours of practicum. Similarly, a 4 –credit course with 3- credits assigned for lectures and one credit for tutorial shall have three 1-hour lectures per week and one 1-hour tutorial per week. In a semester of 15 weeks duration, a four-credit course is equivalent to 45 hours of lectures and 15 hours of tutorials.

Experiential learning credit is equal to 3-hour duration per week. For example, 1 credit for experiential learning will mean 45 hours of learning. The credits assigned to the course is indicated as L:T:P format. For example, for a 4credit course format could be: 4:0:0 or 1:2:1 or 3:1:0 or 0:0:4etc.

2.5 Programme: An educational programme leading to award of a degree, diploma or certificate.

The following types of courses/activities constitute the programmes of study. Each of them will require a specific number of hours of teaching/guidance and laboratory/studio/workshop activities, field-based learning/projects, internships, and community engagement and service

a. Lecture courses: Courses involving lectures relating to a field or discipline by an expert or qualified personnel in a field of learning, work/vocation, or professional practice.

b. Tutorial courses: Courses involving problem-solving and discussions relating to a field or discipline under the guidance of qualified personnel in a field of learning, work/vocation, or professional practice.

c. Practicum or Laboratory work: A course requiring students to participate in a project or practical or lab activity that applies previously learned/studied principles/theory related to the chosen field of learning, work/vocation, or professional practice under the supervision of an expert or qualified individual in the field of learning, work/vocation or professional practice.

d. Seminar: A course requiring students to participate in structured discussion/conversation or debate focused on assigned tasks/readings, current or historical events, or shared experiences guided or led by an expert or qualified personnel in a field of learning, work/vocation, or professional practice.

e. Internship: A course requiring students to participate in a professional activity or work experience, or cooperative education activity with an entity external to the education institution, normally under the supervision of an expert of the given external entity. A key aspect of the internship is induction into actual work situations. Internships involve working with local industry, government or private organizations, business organizations, artists, crafts persons, and similar entities to provide opportunities for students to actively engage in on-site experiential learning.

f. Studio activities: Studio activities involve the engagement of students in creative or artistic activities. Every student is engaged in performing a creative activity to obtain a specific outcome. Studio-based activities involve visual- or aestheticfocused experiential work.

g. Field practice/projects: Courses requiring students to participate in field-based learning/projects generally under the supervision of an expert of the given external entity.

h. Community engagement and service: Courses requiring students to participate in field-based learning/projects generally under the supervision of an expert of the given external entity. The curricular component of 'community engagement and service' will involve activities that would expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems.

i. Experiential learning activities: Field project work / Day out learning activities etc are considered as experiential activities.

2.6 Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.

2.7 Credit Point: It is the product of grade point and number of credits for a course.

2.8 Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters: O,A+, A, B+, B, P, F,AB.

2.9 Cumulative Grade Point Average (CGPA): It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

2.10 Semester Grade Point Average (SGPA): It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

2.11 Transcript or Grade Card or Certificate: Based on the grades earned, a grade certificate shall be issued to all the registered students after every semester. The grade certificate will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester.

2.12 Academic Bank Account: means an individual account with the Academic Bank of Credits opened and operated by a student, to which all academic credits

earned by the Student from course(s) of study are deposited, recognized, maintained, accumulated, transferred, validated or redeemed for the purposes of the award of degree/diploma/certificates etc. by an awarding institution.

2.13 Academic Bank of Credits: means the provision for innovative and interchangeable curricular structures to enable creative combinations of Courses or Programmes in Disciplines of study leading to Degree or Diploma or Post Graduate Diploma or Certificate of Study offering multiple entry and multiple exit facilities, while removing rigid curricular boundaries and creating new possibilities of life-long learning;

2.14 Credit-accumulation:means the facility created by Academic Bank of Credits in the Academic Bank Account opened by students in order to transfer and consolidate the credits earned by them by undergoing Courses;

2.15 Credit-redemption:means the process of commuting the accrued credits in the Academic Bank Account of the students maintained in ABC for the purpose of fulfilling the credits requirements for the award of Degrees or Diplomas or Certificates or Course work for Ph.D. programme etc., by the registered degree-awarding Higher Educational Institutions;

2.16 Credit-transfer: Means the mechanism by which the Registered Higher Educational Institutions are able to receive or provide prescribed credits to individual Academic Bank Accounts in adherence to the University Grants Commission credit norms for the 'course/s' undertaken by students enrolled in any Registered Higher Education Institution within India.

3. Eligibility for admission:

To be eligible for admission in B. ScNuclear Medicine Technology, a candidate should have passed two-years Pre University examination/ Pre Degree examination/ two years after ten years of schooling or its equivalent as recognized by the Yenepoya (Deemed to be) University with Physics, Chemistry and Biology as principal courses of study.

Candidate needs to secure minimum 50% in aggregate in Physics, Chemistry and Mathematics/Biology or above marks in the qualifying examination to be eligible for admission. For SC/ST/OBC candidates

minimum marks required in the qualifying exam is 45 % marks in Physics, Chemistry and Mathematics/Biology.

Candidates who have passed the Senior Secondary school Examination of National Open School with a minimum of 5 subjects with any of the following group subjects.

a. English, Physics, Chemistry, Botany, Zoology

b. English, Physics, Chemistry, Biology and any other language

Selection of eligible candidates: Selection to the course shall be based on the basis of merit obtained in the qualifying examination.

4. Duration of the Programme:

The duration of the programme shall extend over 8 semesters (three academic years with one year internship) each semester comprising minimum of 15 weeks with the minimum of 90 actual working days of instruction in each semester. The successful completion of the Undergraduate program, along with internship as applicable will lead to Bachelor's degree in Nuclear Medicine Technology (B.Sc NMT).

5. Maximum Period for Completion of Programme:

A candidate shall complete six semesters (Three Years) programme within Six years from the date of admission. Hence, the maximum period for completion of the programme is seven years.

6. Aim of the Program

Aim of the program is to develop a pool of trained Radiotherapy Technologists (RT) with comprehensive training in the technological aspects of medical care with a good scientific foundation and they will be in a position to competently participate in Radiation Oncology team and execute the treatment by operating the radiation equipment as per the safety code.

7. Outcome of the Program

PO1. Preparing and administering radiopharmaceuticals orally or by injection or inhalation

PO 2. Explaining the imaging procedure to patients, answering questions, and ensuring their comfort while placing them in the appropriate position for scanning

PO 3. Operating imaging equipment, such as PET and SPECT scans

PO 4. Processing images of the brain, thyroid, bone, heart, lungs, kidneys, and liver on the computer

PO 5. Monitoring patients for unusual reactions to radioactive drugs

PO 6. Keeping detailed records of the amount and type of radiopharmaceutical used and of the procedure

PO 7. Producing computer-generated or film images for interpretation by the physicians

PO 8. Following safety procedures to protect staff and patients from unnecessary radiation exposure

PO 9. Maintaining and examining medical machines and imaging

Program Structure

	Broad category of course	**Hours / Credits**	**Course (Title)**
1.	**Discipline-Specific Courses**		
a)	Theory	**I Semester**	
		60 Hours / 4 Credits	Anatomy
		60 Hours / 4 Credits	Physiology
		60 Hours / 4 Credits	Biochemistry
		45 Hours / 3 Credits	Basic Physics
		II Semester	
		60 Hours / 4 Credits	General Pathology
		60 Hours / 4 Credits	Radiation Physics
		60 Hours / 4 Credits	Radiation Quantities and Detection
		III Semester	

		60 Hours / 4 Credits	Radio pharmacy
		60 Hours / 4 Credits	Radiobiology
		60 Hours / 4 Credits	Physics of Nuclear Medicine Instrumentation
		IV Semester	
		60 Hours / 4 Credits	Radiographic Imaging
		60 Hours / 4 Credits	Nuclear Medicine Techniques & Special procedures
		60 Hours / 4 Credits	Tomography & Hybrid Imaging
		V Semester	
		60 Hours / 4 Credits	Clinical Nuclear Medicine
		60 Hours / 4 Credits	Patient Care in Nuclear Medicine
		60 Hours / 4 Credits	Cell & Molecular Biology
		60 Hours / 4 Credits	QA in Nuclear Medicine
		VI Semester	
		60 Hours / 4 Credits	Recent Advances in Nuclear Medicine
		60 Hours / 4 Credits	Therapeutic Nuclear Medicine
		60 Hours / 4 Credits	Health Physics
b)	Practical (SEC)*	-	-
c)	Clinical (SEC)*	**III Semester**	
		120 Hours / 4 Credits	Radio pharmacy Practical
		120 Hours / 4 Credits	Nuclear Medicine Instrumentation practical-I
		IV Semester	
		120 Hours / 4 Credits	Nuclear Medicine Instrumentation practical-II
		120 Hours / 4 Credits	Nuclear Medicine Instrumentation practical-III
		V Semester	
		120 Hours / 4 Credits	Radiopharmacy – II, Tomography and hybrid imaging Practical
		120 Hours / 4 Credits	Clinical Nuclear Medicine Practicals - I
		VI Semester	

		120 Hours / 4 Credits	Health Physics Practicals
		120 Hours / 4 Credits	Clinical Nuclear Medicine Practicals - II
d)	Simulation-based (SEC)*	-	-
2.	**Curriculum Enrichment Courses**		
a)	Field Visit	-	-
b)	Community Posting	-	-
c)	Industry / Clinical Internship	**VII Semester**	
		40 Hours/week / 18 Credits	Internship I
		VIII Semester	
		40 Hours/week / 18 Credits	Internship II
d)	Research Project	-	-
3.	**Electives**		
a)	Discipline-Specific Electives	-	-
b)	Interdisciplinary Courses	45 Hours / 3 Credits per year	Coursera/Swayam/NSS/Red cross
c)	Ability Enhancement Courses • Soft skills development • Language and communication skill development • Analytical skill development • Personality and professional	**I Semester**	
		45 Hours / 3 Credits	English and Communication I
		30 Hours / 2 Credits	Kannada
		II Semester	
		45 Hours / 3 Credits	English and Communication – Part II
		30 Hours / 2 Credits	Kannada

	development • Employability skill development		
d)	Value Added Courses	**I Semester**	
		30 Hours / 2 Credits	Constitution of India
		III Semester	
		30 Hours / 2 Credits	Human Rights & Gender Equity
		IV Semester	
		30 Hours / 2 Credits	Environmental Studies
		V Semester	
		30 Hours / 2 Credits	Medical Ethics
	Total	**6,230 Hours / 171 Credits**	

8.Attendance:

- Each course (theory, practical, clinical etc.) shall be treated as an independent unit for the purpose of attendance. Candidates having minimum 80% attendance in each of the Courses can only qualify to appear for the Semester End Examination. The Candidates with less than 80% of attendance shall be required to repeat that Course by attending the semester.
- There shall be no provision for condonation of shortage of attendance.
- The HOD/Programme Coordinator through the Dean of Faculties shall announce the names of the candidates who will not be eligible to take the Semester End-Examinations (SEE) in the various courses and send a copy of the same to the Controller of Examinations (COE) Office. Registrations of such candidates for those courses shall be treated as cancelled.

9. Syllabus/Course contents

Teaching - Learning method	**Courses**
Experiential	Introduction to Radiotherapy Therapy Equipment

learning	CT Simulator
Integrated/Inter-disciplinary learning	Image acquisition Equipment quality assurance Setting up phantom for dose quantification
Participatory learning	Mould Preparation Patient preparation for radiotherapy Patient setup for imaging and treatment
Problem-solving methodologies	Patient setup for imaging and verification the position
Self-directed learning	Tele therapy machine operation
Patient-centric learning	Patient position with appropriate immobilization devices Acquiring 4D or Gated image and treatment Notify the radiation induced acute reaction
Evidence-based learning	On board Imaging, Block preparation, mouth bite preparation
The Humanities	Human Rights & Gender Equity
Project-based learning	On line and Off line verification, RT chart QA
Role-play	Introduction to Radiotherapy technologist work flow Patient setup and treatment Record maintained
Team-work	Introduction to Radiation Oncology team Role of the every professional in the team Sequence of the work flow
Reflective writing	Introduction to Radio therapy
Any other (Simulation-Based Learning)	Ensuring the Radiation Safety in the work place Understanding various emergencies situation includes radiation emergency in radiation oncology dept.

10. Scheme of Examination

Examination/Assessment	Core/SEC/AEC(English)	AEC(Hindi & Kannada) /VAC
Continuous Internal Assessment	50 Marks	25 Marks
Semester End Examination	50 Marks	25 Marks
Total	100 Marks	50 marks

- Evaluation of a course shall be done based on continuous internal assessment (CIA) mode followed by Semester End University Examination (SEE) for each core, SEC, AEC & VAC. The evaluation of Multidisciplinary elective offered by Yenepoya (Deemed to be) University shall be done based on formative assessment.
- The components of CIA (Continuous Internal Assessment) may include sessional tests, Seminar, Assignment/ Social involvement and other activities as determined by the respective speciality.
- There shall be examinations at the end of each semester ordinarily during February/March for odd semesters and during August/September for even semesters.
- The SEE duration shall be 60 minutes for 25 marks paper and 120 minutes for 50 marks paper.
- The various Formative assessment method include Assignments, reports, quizzes…

10.1. Examination structure:

The Examination structure shall vary depending on the course, however, broadly divided as follows:

10.2. Multidisciplinary Elective:

Multidisciplinary elective will be assessed through continuous and comprehensive assessment throughout the Semester (50 Marks)

i. Evaluation and Certification of online courses:

Evaluation will be based on predefined norms and parameters and announced in the overview of the Course at the time of offering the course. Formative continuous online assessments and end of course proctored exams shall be completed by the student.

The certificate obtained shall be submitted to the college office which will be communicated to the office of the Controller of Examinations of Yenepoya (Deemed to be University).

The Yenepoya (Deemed to be) University will give the equivalent credit weightage to the students for the credits earned through online learning courses through MOOCS/Coursera as per the credit plan of the program.

ii. Credit Mobility of Online Courses:

The Yenepoya (Deemed to be University) will give the equivalent credit weightage to the students for the credits earned through online learning courses as per the credit plan of the program.

In case a student fails to complete the online course he/ she may be allowed to complete the course requirements by registering for another online course in subsequent semester or

opt for a course offered at this Yenepoya (Deemed to be University).

The elective course offered by the Yenepoya (Deemed to be University) shall be restricted to a maximum of 3 credits.

A candidate shall compulsorily complete total 9 Credits of Multidisciplinary courses.

These courses shall be selected either from the Generic Electives offered by the Yenepoya (Deemed to be) university or from the SWAYAM/Coursera courses. A Candidate shall have freedom to choose the courses of once own choice and learn at their own pace but, require to complete minimum 3 credits before second semester, 6 credits before fourth

semester and 9 credits before sixth semester end examination.

A candidate who is desirous to add more credits shall be permitted to do so during the academic duration. Extra credits earned by a candidate shall be included in the marks card on submission of course completion certificate. However, it shall not be considered for awarding the Grade in the UG programme.

10.3. Parameters for Continuous Internal Assessment (CIA)

Internal Assessment Components	Core / SEC	AEC (English, Kannada) / VAC
Internal Assessment tests	20	10
Assignment	10	05
Continuous and comprehensive assessment	20	10
Total Marks	**50**	**25**

Assessment Methods:

1	Quiz	6	Role Play	
2	Group Discussion	7	Peer to Peer Assessment	
3	Open Book Exam	8	Mind Mapping	
4	Think-Pair-Share	9	Minute paper	
5	Presentations	10	Case Study	

10.4 Question Paper Pattern for Core course (Internal Assessment & Semester End Examination)

	MAXIMUM MARKS = 50				Duration
Type of question	**Number of questions**	**To be Answered**	**Marks for each question**	**Total**	
LONG ESSAY TYPE	02	01	10	10	120 minutes
SHORT ESSAY TYPE	07	05	04	20	

SHORT ANSWERS	12	10	02	20	
			Total	**50**	

MAXIMUM MARKS = 50					**Duration**
PART A					
Type of question	**Number of questions**	**To be Answered**	**Marks for each question**	**Total**	120 Minutes
LONG ESSAY TYPE	02	01	10	10	
SHORT ESSAY TYPE	02	01	05	05	
SHORT ANSWERS	06	05	02	10	
PART B					
LONG ESSAY TYPE	02	01	10	10	
SHORT ESSAY TYPE	02	01	05	05	
SHORT ANSWERS	06	05	02	10	
			Total	**50**	

10.4. Question Paper Pattern for Ability Enhancement Compulsory (AEC) Course

	MAXIMUM MARKS = 25				**Duration**
Type of question	**Number of**	**To be**	**Marks for**	**Total**	

	questions	Answered	each question		60 minutes
ESSAY	05	03	05	15	
SHORT ANSWERS	07	05	02	10	
			Total	**25**	

10.5. Question Paper Pattern for Value Added (VAC) Course

	SUBJECTS HAVING MAXIMUM MARKS = 25				Duration
Type of question	**Number of questions**	**To be Answered**	**Marks for each question**	**Total**	60 minutes
ESSAY	05	03	05	15	
SHORT ANSWERS	07	05	02	10	
			Total	**25**	

10.6. Practical examination (SEC)

SI.NO	Components	Marks
1	Spotters	10
2	Case scenario/Stations	20
3	Viva Voce	20
Total Marks		50

Particulars of Practical, Viva-Voce

Practical examination will be aimed at examination of clinical skills and competence of the candidates for undertaking independent work as a specialist.

Viva- Voce examination shall aim at assessing depth of knowledge, logical reasoning, confidence &oral communication skills.

OSCE/OSPE- shall have minimum of 4 stations

11. Eligibility to appear for University Examination

Each course (theory, practical, clinical etc.) shall be treated as an independent unit for the purpose of attendance. Candidates having minimum 80% attendance in each of the Courses can only qualify to appear for the Semester End Examination. The Candidates with less than 80% of attendance shall be required to repeat that Course by attending the semester.

There shall be no provision for condonation of shortage of attendance.

Evaluation of a course shall be done based on continuous internal assessment (CIA) mode followed by Semester End University Examination (SEE) for each core, SEC, AEC & VAC. The evaluation of Multidisciplinary elective offered by Yenepoya (Deemed to be) University shall be done based on formative assessment.
The components of CIA (Continuous Internal Assessment) may include sessional tests, Seminar, Assignment/ Social involvement and other activities as determined by the respective speciality.

The marks for CIA shall be 50% and SEE shall be 50%.

The minimum marks for CIA shall be 40% and SEE shall be 40% for a pass, but the minimum marks for pass per course shall be 50% CIA and SEE added together.

The HOD/Programme Coordinator through the Dean of Faculties shall announce the names of the candidates who will not be eligible to take the Semester End- Examinations (SEE) in the various courses and send a copy of the same to the Controller of Examinations (COE) Office. Registrations of such candidates for those courses shall be treated as cancelled.

12. Criteria for Passing

The marks for CIA shall be 50% and SEE shall be 50%.

The minimum marks for CIA shall be 40% and SEE shall be 40% for a pass, but the minimum marks for pass per course shall be 50% CIA and SEE added together.

A candidate shall be declared to have passed the UG programme if he/she secures at least CGPA of 5.0 (Course Alpha-Sign Grade P) in the aggregate of both Internal Continuous Assessment and Semester End Examination.

The results of the candidates who have passed the sixth semester examination but not passed the lower semester examinations shall be declared as NCL (Not Completed Lower semester examinations). Such candidates shall be eligible for the degree only after completion of all the lower semester examinations.

13.Grading and Classification

a. The results of successful candidates at the end of each semester shall be declared in terms of Grade Point Average (GPA) and Alpha-Sign Grade. The results at the end of the sixth semester shall be classified on the

basis of the Cumulative Grade Point Average (CGPA) obtained in all the six semesters and the corresponding overall alpha sign grade

Classification of Successful candidates:

The results of successful candidates at the end of each semester shall be declared in terms of Grade Point Average (GPA) and Alpha-Sign Grade. The results at the end of the sixth semester shall be classified on the basis of the Cumulative Grade Point Average (CGPA) obtained in all the six semesters and the corresponding overall alpha sign grade.

b. Letter Grades and Grade Points:

i. The Deemed to be University would be following the absolute grading system, where the marks are compounded to grades based on pre-determined class intervals.

ii. The UGC recommended 10-point grading system with the following letter grades are given below:

Letter Grade	Marks	Grade Point
O (Outstanding)	90-100	10
A+ (Excellent)	80-89	9
A (Very Good)	70-79	8
B+ (Good)	60-69	7
B(Above Average)	55-59	6
P (Pass)	50-55	5
F (Fail)/ RA (Reappear)	Below 50	0
Ab (Absent)		0

*The Marks with 0.5 shall be rounded up to the next whole number.

iii. A student obtaining Grade RA/ Ab shall be considered failed and will be required to reappear in the end semester examination.

c. The Semester Grade Point Average (SGPA)

The performance of a student in a semester is indicated by a number called 'Semester Grade Point Average' (SGPA). The SGPA is the weighted average of the grade points obtained in all the courses by the student during the semester.

For example, if a student takes five (Theory/Practical) in a semester with credits C1, C2, C3, C4 and C5 and the student's grade points in these courses are G1, G2, G3, G4 and G5, respectively, and then students' SGPA is equal to:

$$SGPA = \frac{C1G1 + C2G2 + C3G3 + C4G4 + C5G5}{C1 + C2 + C3 + C4 + C5}$$

The SGPA is calculated to two decimal points. It should be noted that, the SGPA for any semester shall take into consideration the F and ABS grade awarded in that semester. For example if a student has a F or ABS grade in program 4, the SGPA shall then be computed as:

$$SGPA = \frac{C1G1 + C2G2 + C3G3 + C4 * ZERO + C5G5}{C1 + C2 + C3 + C4 + C5}$$

D.Cumulative Grade Point Average (CGPA)

The CGPA is calculated with the SGPA of all the VI semesters to two decimal points and is indicated in final grade report card/final transcript showing the grades of all VI semesters and their courses. The CGPA shall reflect the failed status in case of F grade(s), till the course(s) is/are passed. When the program(s) is/are passed by obtaining a pass grade on subsequent examination(s) the CGPA shall only reflect the new grade and not the fail grades earned earlier. The CGPA is calculated as:

$$CGPA = \frac{C1S1 + C2S2 + C3S3 + C4S4 + C5S5 + C6S6}{C1 + C2 + C3 + C4 + C5 + C6}$$

where C1, C2, C3,…. is the total number of credits for semester I,II,III,…. and S1, S2, S3….is the SGPA of semester I,II,III,…..

Calculation of GPA & CGPA: An example (1st semester)

Program Code	Course	Credits (a)	Grade Obtained	Credit Value (b)	Grade Points (axb)
	Course 1	4	B	8	32
	Course 2	4	B	8	32
	Course 3	4	O	10	40
	Course 4	2	C	7	14
	Course 5	2	A	9	18
	Total	16	-	-	136

1st Semester GPA = Total Grade Points / Total Credits = 136 / 16 = 8.5 2nd Semester GPA = 7 with respect to 18 Credits

Then 1st Year CGPA = (8.5 x 16) + (7 x 18) / 16 + 18 = 7.7

14. Journals

- Iinternational journal of cancer therapy and oncology
- Iinternational journal radiation oncology biology physics

15. Any other Information (Progression Criteria, Re-entry after break of the study, Evaluation of Answer Scripts, Internship)

15.1. Progression Criteria

- The students are allowed to carry over any number of courses till sixth semester. But student is eligible to appear for the End semester exam of sixth semester if he/she has cleared all the Courses both Core, AEC, SEC & VAC of first, second, third & fourth semesters. If student has any pending course of first to fourth semesters, he/she is not eligible to appear for the end semester exam of the sixth semester. However, Fifth semester courses are allowed to club with sixth semester end examination. But, all the Core, AEC, SEC & VAC of first to fourth semester should be completed to be eligible for sixth semester End Semester Examination.

- Candidate should clear all Courses (Core, AEC, SEC, VAC & ME) of all the semester, to be eligible to start the one year of mandatory internship.

- A fail in any one Course will mean the candidate has to reappear for the exam in that Course only.

- A candidate who passes the semester examinations in parts is eligible for only CGPA and letter grade but not for award/medal from the University.

15.2. Re-Entry after Break of the study:

Candidates admitted to a program abstaining for more than 3 months must seek readmission

into the appropriate semester.The candidate shall follow the syllabus in vogue (currently approved/is being followed) for the program.

All re-admissions of candidates are subject to the approval of the University.

15.3. Evaluation of Answer Scripts

a. Each theory examination shall have single evaluation. There shall be provision for re-evaluation on a payment of a fee. An external examiner shall value the paper, if the difference is more than 15% of previous marks the answer script shall be sent for third evaluation. In such an event, the average of the best two out of the three scores will be taken as the final score.

b. Practical examination shall be jointly conducted and evaluated by one internal examiner and one external examiner.

15.4. Internship

A candidate has to mandatorily complete 1 year (2 semesters) of internship. The total credit per semester is 20 and for two semesters it is 40.

- **Eligibility:**A candidate should have passed in all the courses (Core, AEC, VAC and

- Multidisciplinary Electives) amounting to 131 number of credits before entering in to internship.

- **Internship guidelines:** Each semester of Internship shall be minimum of 20 credits. The credits are calculated based on 1 credit = 3 to 5 hours of practical training. There shall be an exit exam at the end of the each semester at the college level.

- **Components of Exit Exam**

Sl.No.	Components	Marks
1	Spotters	30
2	Case scenario/Stations	30
3	Viva Voice	40
Total Marks		100

Particulars of Practical, Viva-Voce

- Practical examination will be aimed at examination of clinical skills and competence of the candidates for undertaking independent work as an Optometrist.

- Viva- Voce examination shall aim at assessing, i.e., depth of knowledge, logical reasoning, confidence &oral communication skills.

- OSCE/OSPE- shall have minimum of 3 stations.

SEMESTER I

ANATOMY

Course: Core
Credits: 04 **Number of hours: 60**

- **Course Outcomes:**

At the end of the course, students will be able to:

CO1: To identify and locate each of the body systems to apply anatomical knowledge to perform minor technical procedural skills.

CO2: To know the normal disposition of the structures in the body while clinically examining a patient and while conducting clinical procedures.

CO3: To know the anatomical basis of disease and injury

CO4: To discuss the interrelationship of systems in maintaining homeostasis.

CO5: To describe the structure of each body system

- **COURSE CONTENT:**

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage
Unit I	2hrs	Introduction: Human body as a whole 1.1 Definition of anatomy and its divisions 1.2Terms of location, positions, and planes 1.3 Cell and its organelles. 1.4Epithelium: definition, classification, describe with examples, function. 1.5 Glands: classification, describe serous & mucous glands with examples. 1.6 Basic tissues: classification with examples 1.7Demonstration: Histology of types of epithelium. Histology of serous, mucous & mixed salivary gland.	√			Lecture, Demonstration, Assignment	10%
Unit II	12hrs	Locomotion and support 2.1Bone: classification, names of bone cells, parts of long bone, microscopy of compact bone, names of all bones, vertebral column, inter-vertebral disc, fontanelles of fetal skull. 2.2 Joints: classification of joints with examples, synovial joint (in detail for radiology). 2.3Muscular system: classification of muscular tissue & histology, names of	√			Lecture, Demonstration	15%

		muscles of the body. 2.4 Demonstration: Bones & joints. Histology of compact bone (TS & LS). Demonstration of all muscles of the body. Histology of skeletal, smooth &cardiac muscle (TS & LS). Histology of the 3 types of cartilage. Demo of all bones showing parts, radiographs of normal.					
Unit III	8hrs	Cardiovascular system 3.1Heart: size, location, chambers, exterior & interior, blood supply of heart 3.2 Systemic &pulmonary circulation, branches of aorta, common carotid artery, subclavian artery, axillary artery, brachial artery, superficial palmar arch, femoral artery, internal iliac artery, peripheral pulse, inferior vena cava, portal vein, Porto-systemic anastomosis, great saphenous vein, Dural venous sinuses. 3.3 Lymphatic system: cisterna chyli& thoracic duct, histology of lymphatic tissues, names of regional lymphatics, axillary and inguinal lymph nodes in brief. 3.4Demonstration of heart and vessels in the body. Histology of large artery, medium sized artery & vein, large vein. Histology of lymph node, spleen, tonsil & thymus. Normal chest radiograph showing heart shadows.	√			Lecture, Demonstration	10%
Unit IV	8hrs	Gastro-intestinal system 4.1 Parts of GIT, oral cavity, lip, tongue, dentition, pharynx, oesophagus, stomach, small and large intestine,liver,gall bladder, pancreas. 4.2 Tonsil, salivary glands extrahepatic biliary apparatus,Waldeyer's ring 4.3Demonstration of parts of gastro intestinal system. Normal radiographs of gastro intestinal system. Histology of gastro intestinal system.	√			Lecture, Demonstration	10%
Unit V	4hrs	Respiratory system 5.1 Parts of RS, nose, nasal cavity, larynx, trachea, lungs, broncho-pulmonary segments, histology of trachea, lung and pleura, names of paranasal air sinuses. 5.2 Demonstration of parts of respiratory System Normal radiographs of chest. - Histology of lung and trachea.	√			Lecture, Demonstration	10%
Unit VI	1hrs	Embryology 6.1Spermatogenesis & oogenesis.		√		Lecture,	5%

		Ovulation, fertilization. Fetal circulation. Placenta, Demonstration of models.				Demonstration	
Unit VII	2 hrs	**Urinary system** : Kidney, ureter, 7.1.urinary bladder, male and female urethra. Histology of kidney, ureter and urinary bladder 7.2.Demonstration of parts of urinary system. Histology of kidney, ureter, urinary bladder. Radiographs of abdomen-IVP, retrograde cystogram.	√			Lecture, Demonstration	5%
Unit VIII	2 hrs	**Reproductive system:** 8.1Parts of male reproductive system, testis, vas deferens, epididymis, prostate (gross & histology). Parts of female reproductive system, uterus, fallopian tubes, ovary (gross & histology). Mammary gland: gross 8.2.Demonstration of section of male and female pelvis with organs in situ. Histology of testis, vas deferens, epididymis, prostate, uterus, fallopian tube, ovary. Radiographs of pelvis, hysterosalpingogram.	√			Lecture, Demonstration	10%
Unit IX	2 hrs	**Endocrine glands:** 9.1.Endocrineglands:pituitary gland, thyroid gland, parathyroid gland, suprarenal glad (Gross & Histology). 9.2.Demonstration of the glands. Histology of pituitary, thyroid, parathyroid, suprarenal glands.	√			Lecture, Demonstration	5%
Unit X	12 hrs	**Nervous system:** **10.1.**Neuron, classification of nervous system, cerebrum, cerebellum, midbrain, pons, medulla oblongata, spinal cord with spinal nerve (gross & histology), meninges, ventricles & cerebrospinal fluid, names of basal nuclei, blood supply of brain, cranial nerves. Sympathetic trunk& names of	√			Lecture, Demonstration	10%

		parasympathetic ganglia 10.2.Histology of peripheral nerve & optic nerve. Demonstration of all plexuses and nerves in the body. Demonstration of all parts of brain. Histology of cerebrum, cerebellum, spinal cord.					
Unit XI	3 hrs	**Sensory organs:** 11.1.Skin: histology, appendages of skin. Eye: parts of eye & lacrimal apparatus. Extra-ocular muscles & nerve supply. Parts of ear: external, middle and inner ear and contents. 11.2.Histology of thin and thick skin. Demonstration and histology of eyeball. Histology of cornea & retina.		√		Lecture, Demonstration	5%
Unit XII	3 hrs	**Embryology:** 12.1.Spermatogenesis& oogenesis. Ovulation, fertilization. Fetal circulation. Placenta, Demonstration of models.		√		Lecture, Demonstration	5%

- **Recommended books:**

1. PriyaRanganath, LeelavathyN,Basics in Human Anatomy for BSc Paramedical Courses,Revised and updated edition, The Health
2. Chaurasia BD. Human anatomy. CBS Publisher; 2004.
3. Vishram Singh, Textbook of Anatomy, Revised and updated edition, Elsevier
4. Waugh A, Grant A. , Ross &Wilson Anatomy and physiology in health and illness E-book. Elsevier Health Sciences; 2014 Jun 25.
5. Inderbir S. Textbook of human histology with color atlas. New Delhi: JaypeeBrothersMedical Publishers. 2006.

PHYSIOLOGY

Course: Core
Credits: 04 **Number of hours: 60**

- **Course Outcomes:**

At the end of the course, students will be able to:

CO1: To demonstrate the understanding of physiological structure of Renal system, endocrine system, Nervous system and special senses.

CO2: To broadly identify the clinical abnormalities of organs and its clinical physiological implications

- **COURSE CONTENT:**

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage
Unit I	2hrs	**General Physiology** 1.1 Introduction to physiology 1.2 Homeostasis: Definition, Positive feedback, negative feedback. PH 1.3 Body Fluid Compartments	√			Lecture	5%
Unit II	7hrs	**Blood** 2.1 Introduction: composition and function of blood. 2.2 Blood Cells: types, Normal Count 2.3 Red blood cells: function. Erythropoiesis: Definition, Stages, Factors affecting 2.4 Hemoglobin: Function, concentration Physiological variation of RBC Count and Hb 2.5 White blood cells: different types, functions, normal count, differential count 2.6 Platelets: origin, normal count, functions.	√			Lecture Chart Preparation	15%

		2.7 Haemostasis: definition, steps, clotting factors, mechanism of clotting, disorders of clotting 2.8 Blood groups: ABO system, Rh system: Rh factor, Rh incompatibility. 2.9 Blood grouping & typing, cross matching. 2.10 Blood transfusion: indication, universal donor and recipient concept. Selection criteria of a blood donor, transfusion reactions. 2.11 Anaemias: definition, Symptoms and signs (brief). 2.12 Blood indices: colour index, MCH, MCV, MCHC (def and Normal Values). 2.13 ESR and PCV: normal values, definition, determination (methods). 2.14Plasma proteins: types and concentration, functions of albumin, globulin, fibrinogen, prothrombin. 2.15 Blood volume: normal value, determination of blood volume					
Unit III	5hrs	**Muscle Nerve physiology** 3.1.1Introduction, Classification and structure of muscle, sarcomere 3.2Neuromuscular junction, Transmission across neuromuscular junction. 3.3 Excitation contraction coupling. Mechanism of muscle contraction, rigor mortis.		√		Lecture	5%
Unit IV	8hrs	**Cardiovascular system** 4.1 Heart: physiological anatomy, nerve supply. 4.2Properties of cardiac muscle PH 4.3Cardiac cycle: definition, systole, diastole, phases, JVP(brief) 4.4Cardiac output, stroke volume, EDV (only definitions). 4.5 Heart sounds, normal heart sounds, mechanism and features, areas of auscultation. 4.6 Blood pressure: definition,		√		Lecture	10%

		normal value, clinical measurement of blood pressure, hypotension, hypertension 4.7Heart rate: Physiological variations, regulation (brief), radial pulse 4.8Electrocardiogram (ECG): Definition, Normal ECG, Causes of ECG waves, Uses of ECG. 4.9Cardiac shock: Definition, Types (brief), Triple response.					
Unit V	6hrs	**Respiratory system** 5.1Introduction: Functions of respiratory system, physiological anatomy of respiratory system, respiratory tract 5.2Respiratory organs: lungs, alveoli, respiratory membrane 5.3Mechanism of breathing: Inspiration and Expiration, muscles involved, Mechanism. 5.4Surfactant: Composition, Function, 5.5Transport of oxygen: forms of transport, Oxygen Hemoglobin Curve. 5.6Lung volumes and capacities: Spirogram, Definitions and normal Volumes. 5.7Regulation of respiration: Nervous and chemical regulation, respiratory centre, Herring Breur reflexes. 5.8Hypoxia: Def, Classification, Description (in brief). 5.9 Cyanosis, Asphyxia, Dyspnea, Dysbarism, Artificial Respiration, Apnoea.(Definition Only)	√			Lecture Chart Preparation	10%
Unit VI	5hrs	**Digestive System** : 6.1.Introduction Physiological anatomy of gastro intestinal tract (All Structures in brief), functions of digestive system. Functions of Saliva Deglutition: definition, stages 6.2.Stomach: functions Gastric secretion: composition, function,	√			Lecture Chart Preparation	10%

		Phases of secretion 6.3.Pancreas: Functions (exocrine), pancreatic juice: composition and regulation. Secretin and CCK-PZ 6.4.Liver: Functions, Bile secretion, composition, function of bile; Bilirubin metabolism, types of bilirubin, Vandenberg reaction, Jaundice: types, significance. Gall bladder: Functions. 6.5.Small intestine: functions, digestion and absorption, movements. (brief) Large intestine: functions, defecation reflex					
Unit VII	5hrs	**Renal System** : 7.1.Introduction: Functions of kidneys, composition of urine, nephron, cortical and juxtamedullary nephrons (comparison), Juxta Glomerular 7.2.Apparatus: structure and function. Vasa recta Mechanism of urine formationGFR: Definition, Normal Values, factors effecting GFR, Measurement (Creatine, Inulin Clearance). Tubular reabsorption, TMG, Tubular secretion (brief). 7.3.Mechanism of urine concentration: Counter-current mechanisms, Role of ADHDiuresis, Diuretics. Micturition, innervations of bladder, cystometrogram	√			Lecture Chart Preparation	10%

Unit VIII	1hr	**Skin and Body temperature**: 8.1.Structure and function of Skin Sweat Glands 8.2.Body Temperature: physiological variation. Regulatory mechanisms: 8.3.Mechanisms Activated by Heat/Cold Role of hypothalamus, and fever. Body temperature measurement, hypothermia	√			Lecture	10%
Unit IX	5hrs	**Endocrine System: 9.1.** Introduction: Definition, classification of endocrine glands & their hormones. 9.2.Hypothalamic- pituitary Axis Pituitary hormones: anterior and posterior pituitary hormones, Functions of Growth hormone, 9.3.Thyroid gland: Thyroid Hormones: physiological function, regulation of secretion, disorders: hypo and hyper secretion of hormone. Physiological anatomy of Thyroid 9.4.Adrenal cortex: functions of Cortisol and Aldosterone Adrenal medulla: functions of Adrenaline and Noradrenaline. 9.5.Physiological anatomy of Adrenal Pancreas (Endocrine): Hormones of pancreas. Insulin: functions, regulation of blood glucose level, Diabetes mellitus Abnormalities of pancreatic hormones (brief) Regulation	√			Lecture Chart Preparation	8%

		of Calcium Metabolism: Hormones involved, actions of PTH, Calcitonin, Vit D3Tetany					
Unit X	4hrs	**Reproductive system:** **10.1.**Introduction, Function of reproductive system, Changes during puberty. 10.2. Sex Differentiation Male reproductive system: functions of testes Spermatogenesis: 10.3.Definition, site, stages, factors influencing, Endocrine functions of testes Sperm, semen. Androgens: testosterone functions. 10.4.Female reproductive system, Menstrual cycle: Definition, changes, ovulation Functions of progesterone and estrogen 10.5.Hormonal Regulation Physiological changes during pregnancy, Lactation (brief), milk ejection reflex	√			Lecture	5%
Unit XI	8hrs	**Nervous system:** **11.1.**Introduction: Parts of CNS and PNS, Functions of nervous system **11.**2.Neuron: definition, structure Nerve Fiber: classification, conduction of impulses continuous and saltatory. Neuroglia Synapse: Definition, structure, types, properties (brief). 11.3.Receptors: definition, classification, properties (brief). Reflex: Definition, Reflex Arc, Examples.	√			Lecture	7%

		Babinski's sign. Tone, Posture (definition), Spinal cord nerve tracts: Diagram and Functions: Lateral Spino Thalamic Tract, Dorsal Column, Pyramidal Tract.UMN and LMN lesion, Hemiplegia, Stroke (brief) Functions of: Cerebral cortex, Cerebellum, 11.4.Hypothalamus, Basal Ganglia EEG, Parkinsonism Cerebro Spinal Fluid (CSF): site of formation, circulation (brief), functions. Lumbar puncture. 11.5.Autonomic Nervous System: Sympathetic and parasympathetic distribution and functions (brief).					
Unit XII	4hrs	**Special senses:** 12.1.Vision: Functions of different parts (brief) Optic Pathway, Dark Adaptation, Color vision. Structure of eye, Structure of retina. 12.2.Hearing: Function of Middle Ear, Functions of inner ear, mechanism of hearing (brief). 12.3.Chemical Senses: Taste: types, receptor, Smell: physiology, receptors.	√			Lecture	5%

- **Recommended Books**

1. Guyton (Arthur): Text Book of Physiology. Latest Ed. Prism publishers.
2. Ganong William F: Review of Medical Physiology. Latest Ed. Tata McGraw Hill
3. Chatterjee CC: Human Physiology Latest Ed. Vol-1, Medical Allied Agency.ChoudharySujith K: Concise Medical Physiology Latest Ed. New CentralBook.

BIOCHEMISTRY

Course: Core

Credits: 4 **No of Hours: 60 Hours**

- **Course Outcomes:**

At the end of the course, students will be able to:

CO1: Have knowledge and understanding of procedures of specimen collection, reagent preparation of specimens, performing biochemical tests, interpreting results, and managing biomedical waste effectively.

CO2: Understand the basic procedures in specimen collection, reagent preparation, and testing in a clinical laboratory

CO3: Demonstrate the knowledge of properties of biomolecules and their function.

CO4: Have knowledge of the importance of nutrition in health and diseases.

- **Course Content:**

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage
Unit I	2 hrs	**Introduction to Biochemistry and Clinical Laboratory**	√			Lecture	10%
Unit II	4 hrs	**Specimen collection :**Pre-analytical variables. Collection of blood. Collection of CSF & other fluids. Urine collection. Use of preservatives. Anticoagulants.		√		Lecture	5%
Unit III	2 hrs	**Safety measurements, Conventional and SI units**	√			Lecture	5%

Unit IV	2 hrs	**Dilutions :** Diluting solutions: e.g. preparation of 0.1 N NaCl from 1 N NaCl& from 2NNaCl etc., preparing working standard from stock standard, body fluid dilutions, reagent dilution techniques, calculating the dilution of a solution, body fluid reagent etc., saturated and supersaturated solutions		✓		Lecture	5%
Unit V	4 hrs	**Carbohydrate chemistry :** Classification, Isomerism, General reactions of carbohydrates		✓		Lecture	5%
Unit VI	4hrs	**Lipids** : Chemistry of fatty acids, triglycerides, cholesterol, phospholipids, lipoproteins, Classification and functions.		✓		Lecture	5%
Unit VII	4 hrs	**Protein chemistry, structure**		✓		Lecture	5%
Unit VIII	2 hrs	**Plasma Proteins :**Concentration, biochemical changes in disease, interpretation		✓		Lecture	5%
Unit IX	6 hrs	**Enzymes :** Definition, classification, coenzymes, cofactors, factors effecting enzyme activity, inhibitors, units of measurements, isoenzymes, biological interpretation		✓		Lecture Chart Preparation	5%
Unit X	6 hrs	**Vitamins :**Definition, classification, sources, functions, deficiency disorders	√			Lecture Chart Preparation	10%
Unit XI	6 hrs	**Minerals :**Na, K, Ca, P, Fe, Cu, selenium- sources, daily requirements, availability and properties	√			Lecture Chart Preparation	10%

Unit XII	3 hrs	**Nutrition:** Calorific value, nitrogen balance, respiratory quotient, basal metabolic rate, dietary fibers, nutritional importance of lipids, carbohydrates and proteins, vitamins. nutrition, nutritional support with special emphasis on parental nutrition	√			Lecture Chart Preparation	10%
Unit XIII	2 hrs	**Quality control:** Accuracy, precision. Specificity, sensitivity, limits of error allowable in laboratory, percentage error. Normal values and Interpretations.	√			Lecture	5%
Unit XIV	11 hrs	**Special Investigations** : Serum electrophoresis, immune globulins, drugs: digitoxin, theophylline's, regulation of acid base status, Henderson Hassel Bach equations, buffers of the fluid, pH regulation, disturbance in acid base balance, anion gap, metabolic acidosis, metabolic alkalosis, respiratory acidosis, respiratory alkalosis, basic principles and estimation of blood gases and pH, basic principles and estimation of electrolytes, water balance, sodium regulation, bicarbonate buffers,	√			Lecture	10%
Unit XV	2 hrs	**Bio Medical waste management**	√			Lecture Chart Preparation	5%

- **Recommended Books**

1) Vasudevan DM, Sreekumari S, Vaidyanathan K. Textbook of Biochemistry for medical students. Jaypee Brothers Medical Publishers; 2019 Sep 30.
2) Satyanarayana U and U Chakrapani. 2013. Biochemistry (version 4th ed). 4th ed. New Delhi: Elsevier Health Sciences APAC.

BASIC PHYSICS

Course: Core

Credits: 4 **No of Hours: 60 Hours**

Course Outcome:

CO1: Explicate the structure and composition of an atom and its physics.

CO2: Discuss the fundamentals of electricity, electronics and magnetism.

CO3: Discuss the types,properties and uses of materials based on electrical conductivity

CO4: Explain electromagnetic radiation, xray generators, its types and properties with suitable examples.

Course Content:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage
Unit I	4hrs	**Fundamentals of electricity:** **1.1** Electric charges & units of electric charge **1.2** Coulombs law **1.3** Electric induction **1.4** Resistance **1.5** Conductors **1.6** Insulators & Semi-conductors **1.7** Electric current **1.8** Ohm's, EMF & Kirchhoff's law **1.9** Alternating current **1.10** Charge and discharge of a capacitor through a resistance and inductance.	√			Lecture	15

Unit II	8hrs	**Electromagnetic induction:** **2.1**Maxwell's equation **2.2** Electromagnetic induction **2.3** Electromagnetic waves and their properties **2.4** Electromagnetic Spectrum **2.5** Spectrum of white light **2.6** Spectra- continuous, line & band spectra, absorption spectra **2.7** Luminescence **2.8** Energy density and intensity **2.9** Quality of Electromagnetic radiation **2.10** Radiation in atmosphere	√			Lecture	15
Unit III	8hrs	**X-ray generators:** **3.1** Transormers and its types **3.2** Laws of transformers **3.3** Transformer losses **3.4** Filament circuit **3.5** High voltage circuit Rectification **3.6** Types of Transformers **3.7** Fuses, switches and exposure timers **3.8** Interlocking circuits/ Thyristors **3.9** Circuit Breakers, Meters **3.10** Earthing, insulation **3.11** High tension cable Construction and design.	√			Lecture	20
Unit IV	8hrs	**Fundamentals of magnetism:** **4.1** Introduction **4.2** The Bar magnet **4.3** Magnetism **4.4** Gauss's law **4.5** Magnetic Force **4.6** Magnetization and magnetic intensity **4.7** Solenoid and Toroid **4.8** Magnetic properties of materials **4.9**Permanent magnets, Electromagnets **4.10** Earth's magnetism	√			Lecture	15
Unit V	8 Hrs	**Sound** 5.1. The nature and propagation of sound wave, Transverse and longitudinal waves 5.2. Interference of sound waves	√			Lecture	15

		Beats, Decibel, Speed of sound in material medium. 5.3. Intensity of sound, Superimposition of the wave 5.4. Doppler effect principle					
Unit VI	9 Hrs	**Atomic physics** The structure of the Atom, Nucleus, Atomic Number(Z), Mass Number(A), Ionization & Excitation Alpha particles cattering Atomic models Atomic spectra Atomic masses and composition of nucleus Mass energy and nuclear binding energy Nuclear force and energy Radioactivity Nuclear reactor	√			Lecture	20

Recommended Books:

- Modern Physics by B.L Theraja
- Modern Physics, Er.KiruthigaSivaprasath& R Murugeshan S.Ch and Publishing

ENGLISH PROFICIENCY: A PATH TO EFFECTIVE COMMUNICATION

Course: AEC

Semester : 1

Credits: 3 **No of Hours: 45 Hours**

- **Course Outcomes:**

At the end of the course, students will be able to:

CO1: Acquire the LSRW (Listening, Speaking, Reading, and Writing) skills. Through Cambridge Interchange Fifth Edition, students will develop real world communication skills- enhancing fluency in speaking, listening, reading and writing – wile mastering grammar, expanding vocabulary and improving pronunciation with supportive digital tools.

CO2: Learn to appreciate Literature.

CO3: Be aware of social responsibilities.

CO4 :Enhance the analytical skill

- **COURSE CONTENT:**

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage	Types Of Questions

Unit I	10hrs	**UNIT 1: CAMBRIDGE: INTERCHANGE FIFTH EDITION** 1.1 Good Memories 1.2 Life in the City 1.3 Making Changes 1.4 Have you ever tried it? 1.5 Hit the Road. 1.6 Sure. I will do it. 1.7 What do you use this for? 1.8 Time to Celebrate.	√			23%	SA
Unit II	8hrs	**UNIT- II: PHONETICS** 2.1 Brief Introduction 2.2 Classification of Vowels, Diphthongs and Consonants 2.3 Pronouncing the words phonemically and transcribing them into Phonetics 2.4 IPA	√			18%	SA
Unit III	11hrs	**UNIT – III: Grammar and Written Communication** 3.1 Parts of Speech 3.2 Verb Tenses 3.3 Articles 3.4 Capitalization and Punctuation 3.5 E-mail Drafts 3.6 Formal Letters 3.7 Essay Writing	√			24%	SA

Unit IV	4hrs	**UNIT – IV : Prose** 4.1 SteevJobs : Commencement Address 4.2 Mother Teresa's Award Winning Speech	√			9%	LE, SE
Unit V	6hrs	**UNIT – V: Poetry** 5.1 The Road Not Taken : Robert Frost 5.2 The Man with the Wooden Leg : Catherine Mansfield 5.3 Our Casuarina Tree : Toru Dutt	√			13%	LE, SE
Unit VI	6hrs	**UNIT – VI : Short Stories** 6.1 Gift of the Magi : O' Henry 6.2 Kabulivala :Raindranath Tagore 6.3 The Blue Umbrella : Ruskin Bond		√		13%	LE, SE

- **LE-** Long Essay**, SE-** Short Essay**, SA-** Short Answer

- **Recommended Books:**

1. Cambridge: Interchange Fifth Edition
2. Contemporary English Grammar Structures & Composition by David Green
3. English Grammar and Composition: Wren & Martin
4. English Grammar in Use by Raymond Murphy

Constitution of India

Course: Core

Credits: 02 **Number of hours: 30 hours**

Course Objectives

- State and explain the constitution of India and its Constituent Assembly
- Explain fundamental rights and duties of citizen
- Identify union, state and federalism of India
- Knowledge of electoral process in India.
- State the basic concepts of Human Rights and its functions and authorities in society.

Syllabus:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage
Unit I	5hrs	**Indian Constitution** 1.1.Meaning and Importance of Constitution 1.2.The Constituent Assembly 1.3.The Preamble 1.4. Salient Features of Constitution	√			Lecture/ Activity	15%
Unit 2	3hrs	**Fundamental Rights and Directive Principles** 2.1.Meaning and Differences between Fundamental Rights and Directive Principles 2.2.Fundamental Rights 2.3.Rights Information Act Meaning, importance of RTI 2005	√				15%

Unit 3	4hrs	**Union Government** 3.1.President of India- Election, Powers and Position 3.2.Prime Minister and council of Ministers 3.3.Parliament– LokSabha, RajyaSabha- Organisations and Powers	√				10%
Unit 4	4hrs	**State Government** 4.1.The Governor 4.2.Chief Minister and Council of Ministers 4.3.State Legislature Vidhana Sabha, VidhanaParishad – organization and Powers	√				10%
Unit 5	2hrs	**Federalism In India** 5.1.Meaning Federal and Unitary Features		√			5%
Unit 6	2htrs	**The Judiciary** 6.1.The supreme Court – Organization, Jurisdiction and Role 6.2.The High Court – Organization Jurisdiction and Role	√				10%
Unit 7	2hrs	**Electoral Process In India** 7.1.Election Commission– Organization, Functions		√			10%
Unit 8	2 hrs	**Local Governments** 8.1.Rural and Urban – Organization, Powers and Functions		√			7%

Unit 9	3 hrs	**Human Rights** 9.1.Human rights – Meaning 9.2.Universal Declaration of Human Rights 9.3.Remedies against Violation of Human Rights in India	√				10%
Unit 10	3 hrs	**Special constitutional provisions** 10.1.Special Rights created in the constitution for: Dalits, Backwards, women and Children and the Religious and Linguistic Minorities. 10.2.Constitution and Sustainable Development in India. 10.3.Minority Commission in India		√			8%

Course Outcome:

- This course is to keep the students abreast with the knowledge of the Constitution of India.
- To make the students understand the importance of human rights as citizens of India.

Recommended Books

- Basu, D.D , Constitution of India, New Delhi Himalaya Publication ; 2001
- Dinesh Shelton, David P Stuart, International Human Rights in Nutshell. Thomas Burgenthel, West Nutshell Publisher; London; 2005.
- ParvathyAppaiah, Constitution of India, Mangalore DivyaDeepa Publication; 2005
- ParvathyAppaiah, Human Rights. DivyaDeepa Publication Mangalore; 2016
- RajRam. M, Constitution of India Himalaya Publication, New Delhi; 1999

SEMESTER II

GENERAL PATHOLOGY

Course: Core **Number of Hours: 60**

Credits: 4

Course Objectives:

- To be able to define the medical terms, define and classify disease and understand the concepts of the disease.
- Able to describe the causes and mechanism of common diseases that occur during the routine work and also changes seen in different individuals and various organs and fluids.
- Able to enumerate the laboratory tests eg: urine, blood, body fluids and its application on various diseases.

Syllabus:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weighage
Unit I	8hrs	Introduction	√			Lecture/ Activity	10%
Unit 2	12hrs	**Cellular Responses to Stress and Injury** 2.1.Types of cellular responses to injury 2.2.Cellular adaptations 2.3.In brief cell injury and types of cell injury, intracellular accumulation 2.4.Necrosis and apoptosis (brief) 2.5.Pathologic calcification, hyaline change, pigments	√			Lecture/ Activity	10%

Unit 3	12hrs	**Acute Inflammation** 3.1.Definition, cardinal signs and sequence of events in acute inflammation 3.2.List chemical mediators of inflammation, outcomes of acute inflammation, morphological types/patterns of acute inflammation and briefly systemic effects of inflammation 3.3.In brief cutaneous wound healing (primary and secondary) Factors that influence wound healing, complications of wound healing 3.4.Types of chronic inflammation, Granulomatous diseases, briefly about tuberculosis, leprosy and syphilis	√			Lecture	20%
Unit 4	6hrs	**Hemodynamic Disorders, Thromboembolism and Shock** 4.1.Edema and thrombosis 4.2.Embolism, infarction and shock (in brief)		≻		Lecture	10%

Unit 5	8hrs	**Diseases of the Immune System** 5.1.Introduction to immune system 5.2.Hypersensitivity reactions (brief) 5.3.Autoimmune diseases and systemic lupus erythematosus (in brief) 5.4.Acquired immunodeficiency syndrome	√				15%
Unit 6	8htrs	**Neoplasia** 6.1.Nomenclature of neoplasms and characteristics of benign and malignant neoplasms 6.2.Metastasis and spread of tumors 6.3.Etiology of cancer (carcinogenic agents) 6.4.Laboratory diagnosis of cancer, staging grading and prognosis	√			Lecture	15%
Unit 7	2hrs	**Genetic Disorders** 7.1.Introduction of genetic disease and classification of genetic disorders	√			Lecture	10%
Unit 8	4 hrs	**Nutritional Disorders** 8.1.Common vitamin deficiencies - Fat-soluble vitamins 8.2.Water-soluble vitamins—vitamin B complex	√			Lecture	10%

Course Outcome:

At the end of the course, the students will be able to

- Understand how body reacts to cellular responses and injuries.
- Have a basic knowledge about various laboratory tests and its application on various disorders.
- Define the medical terms, define and classify disease and understand the concepts of the disease.

Recommended Books

- Nayak R, Rai S, Gupta A. Essentials in hematology and clinical pathology. New Delhi: Jaypee Brothers Medical Publishers; 2012.
- Mohan H. Textbook of pathology. 8th ed. New Delhi, India: Jaypee Brothers Medical; 2018

RADIATION PHYSICS

Course: Core

Credits: 04 **Theory classes: 60 hours**

Course Objectives:

• To explain about atomic structure, electromagnetic radiation and radioactivity; its types and properties with suitable examples.

• To explain and discuss briefly about the production of X-rays and interactions between them.

YENEPOYA
(DEEMED TO BE UNIVERSITY)

Syllabus:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weig htage
Unit I	12hrs	**Atomic structure** 1.1.Constituents of atoms, Nucleus, Atomic number (Z), Mass number (A),atomic mass unit, mass defect and binding energy 1.2.Isotopes, isobars and isotones, Ionization & Excitation, And the Periodic Table.	√			Lecture/ Activity	20%
Unit 2	12hrs	**Radioactivity** 2.1.Natural and artificial radioactivity, Activity, Specific activity, Modes of radioactive disintegration. 2.2.Exponential decay, Half Life and mean life, Properties of alpha, beta and gamma rays. Basic interactions between x-rays and matter.	√			Lecture/ Activity	20%

Unit 3	16hrs	**Interaction of Radiation with Matter** 3.1.Photoelectric effect, Compton Effect, Pair production, Ionization of matter, Energy absorbed from X-rays, X-rays Scattering, X-ray's transmission through the medium. 3.2.Linear and mass attenuation coefficient, LET, HVT and TVT, Inverse square law. Relative importance of different types of interactions in body, fat, soft tissue, bone and contrast medium.	√			Lecture/ Activity	30%

Unit 4	20hrs	**Production of X-rays** 4.1.X-ray production, x-ray tube-properties of x-rays, Characteristic and continuous spectra, Various types of sources used in Radiotherapy and their properties, Soft and Hard X-rays. 4.2.Distribution of X-rays in space. Importance of Focal spot. Line focus principle and shape of the anode surface, Anode heal effect. Filters- inherent filters, added filters, heavy metal filters. Basics of X-ray circuits, KV circuit, MA circuit. 4.3.Transmission of X-rays through body tissues: Relative amount of scattered radiation in an X-ray beam during its passage through a patient. Quality and intensity of x-rays, Factors affecting quality and intensity.	√			Lecture/ Activity	30%

Course outcome

At the end of the course students must have gained the knowledge of

• Atomic structure, Radioactivity, Half life and mean life of an isotope

• Various interaction of radiation with matter

• Production of the X-rays and the involvement of various component in the X-rays production

Recommended Books

- The Physics of Radiation Therapy "by Faiz M Khan & John P Gibbons , 5th Edition
- The Modern Technology of Radiation Oncology" by Jacob van Dyk
- Technical Basis of Radiation therapy" by Seymour HLevitt, James A Purdy, 5thEditon
- Modern Physics by B.L Theraja

RADIATION QUANTITIES AND DETECTION

Course: Core

Credits: 04 **Theory classes: 60 hours**

Course Objective:

- To discuss the important radiation quantities and units
- To make the student to understand about the Principle of radiation detection and their uses
- To brief about different radiation measuring and monitoring instruments.

Syllabus:

Unit	Hrs	Content	Must Know	Good to	Desirable to Know	Teaching Learning Method	Weightage

Unit I	18hrs	**Radiation quantities and units** 1.1.Quantitiestodescribearadiationbeam,particlefluxandfluence,energy flux and fluency, linear and mass absorption coefficient, stopping power and LET. 1.2. Activity, Curie, Becquerel, Exposure and its measurements, Roentgen, Radiation absorbed Dose, Gray,kerma,kermarateconstant,Relativebiologicaleffectiveness(RBE),radiationweighting factors, equivalent dose, tissue weighting factors, effective dose	√			Lecture/ Activity	25%

Unit 2	18hrs	**Principles of radiation detection** 2.1.General Principle and working of Gas-filleddetectors-ionchambers,proportional counters and Geiger Muller counters. General principle and working of Scintillation detectors, liquid scintillator. General principle and working of Semiconductor detectors. 2.2.Thimblechamber, Secondary Dosimeter, parallelplatechamber, Well-typeionchamber. Principles of Thermo luminescence dosimeters and its application in radiotherapy and radio diagnosis.	√			Lecture/ Activity	25%
Unit 3	12hrs	**Personnel monitors** 3.1.Personnel monitoring device, TLD badge, TLD reader, OSLD, Film badge, pocketdosimeters. Advantages and disadvantages of various monitors.	√			Lecture/ Activity	25%

Unit 4	12hrs	**Measuring Instruments** 4.1.Different types of radiation measuring devices for radiation protection. Gamma zone monitors, survey meters, contamination monitors, neutron monitor. 4.2. Advantages and disadvantages of various instruments, appropriateness of different types of detectors for different types of radiation measurement.	√			Lecture/ Activity	25%

Course outcome

At the end of the course student understand

- The important radiation quantities and units
- The Principle of radiation detection and their usage
- The different radiation measuring, monitoring instruments and how to use them.

Recommended Books

- "The Physics of Radiation Therapy" by Faiz M Khan & John PGibbons,5th Edition
- Radiation detection and measurement–GF Knoll
- Technical Basis of Radiation therapy" by Seymour HLevitt, James A Purdy, 5th Edition.

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KANNADA

Course: AECC

Credits: 02 **Number of hours: 30**

Course Objectives

- Enable students to learn alphabet, words and simple sentences in Kannada.
- Enable students to enhance speaking and writing communicative skills in Kannada and learn technical words related to medical science

Syllabus:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage
Unit I	6hrs	1.1. Kannada Letters (vowels, Consonant)	√			Lecture/ Activity	25%
Unit 2	12hrs	**2.1.**Words, Phrases, formation of sentences, Letter Writing, Essay Writing. Treatment related Kannada words (from English to Kannada)		√		Lecture/ Activity	25%
Unit 3	12hrs	3.1.Possible communication in kannada between Patients and Doctors. 3.2.Advising sentences to the possible questions of patients. 3.3. Some important sentences which enable to communicate with doctors and colleagues.		√		Lecture/ Activity	50%

Course Outcome

- Allied health science students will be able to attend health issues of native Kannada speaking patients more effectively.
- They can also act as a bridge between doctors and patients.

Recommended Books

- Kannada Vyakarana – (8th ,9th and 10th Karnataka government text books)
- HSK, Vyavarahika Kannada

ENGLISH AND COMMUNICATION _ PART – II

ENGLISH PROFICIENCY: A PATH TO EFFECTIVE COMMUNICATION

Course: AEC **Course Code: AH01RTT2AE1**

Semester : 1I

Credits: 3 **No of Hours: 45 Hours**

- **Course Outcomes:**

At the end of the course, students will be able to:

CO1: Acquire the LSRW (Listening, Speaking, Reading, and Writing) skills. Through Cambridge Interchange Fifth Edition, students will develop real world communication skills- enhancing fluency in speaking, listening, reading and writing – wile mastering grammar, expanding vocabulary and improving pronunciation with supportive digital tools.

CO2: Learn to appreciate Literature.

CO3: Be aware of social responsibilities.

CO4 :Enhance the analytical skill

- **COURSE CONTENT:**

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage	Types Of Questions

Unit I	13hrs	**UNIT – I: CAMBRIDGE INTERCHANGES FIFTH EDITION** 1.1 Only Time Will Tell 1.2 I Like Working with People 1.3 It's Really Worth Seeing 1.4 It's a Long Story 1.5 That's Entertainment 1.6 Now I Get it 1.7 I wouldn't have done that 1.8 Making Excuses	√			29%	SA
Unit II	3hrs	**UNIT – II: Phonetics – IPA Transcription**	√			7%	SA
Unit III	13hrs	**UNIT – III: Grammar and Written Communication** 3.1 Reported Speech 3.2 Modals 3.3 Clauses 3.4 Gerunds 3.5 Active and Passive Voice 3.6 Synonyms and Antonyms 3.7 News Report Writing 3.8 Speech Writing 3.9 Dialogue Writing	√			29%	SA
Unit IV	4hrs	**UNIT – IV: PROSE** 4.1 Chicago Address by Swami Vivekananda	√			9%	

		4.2 I have a Dream : Martin Luther King					LE, SE
Unit V	6hrs	**UNIT – V: Poetry** 5.1 Still I Rise : Maya Angelou 5.2 BTheRaven : Edgar Allen Poe 5.3 Break, Break, Break : Alfred Lord Tennyson	√			13%	LE, SE
Unit VI	6hrs	**UNIT – VI : Short Stories** 6.1 The Luncheon : William Somerset Maugham 6.2 The Power of Prayer : APJ Abdul Kalam 6.3 The Necklace : Guy De Maupassant		√		13%	LE, SE

- **LE-** Long Essay**, SE-** Short Essay**, SA-** Short Answer

- **Recommended Books:**

5. Cambridge: Interchange Fifth Edition
6. Contemporary English Grammar Structures & Composition by David Green
7. English Grammar and Composition: Wren & Martin
   English Grammar in Use by Raymond Murphy

THIRD SEMESTER

RADIO PHARMACY

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course Objectives:

- Understand the basic concepts of Radiopharmacy and Safely handle the radiopharmaceuticals.
- Know the responsibility of Radiopharmacist in a Nuclear Medicine centre andable to understand about the production of radioisotopes Radiopharmaceuticals, types, methods of Radiolabelling
- Design a Radiopharmacy lab. Laboratory plastic wares, Balance, Centrifuge, etc. and their applications in nuclear medicine. Autoclaving of glassware for the use in Radio pharmacy.
- Laboratory safety-Electrical safety, chemical safety, Fire safety, Radiation safety, Biological safety.
- Radionuclides and Non Imaging radionuclides used for diagnostic purposes.

Syllabus

Unit	Hrs	Content	Must
Unit:	**12**	**Radiation Chemistry:**	

1	**Hours**	• Radiation ChemistryAtomic and Molecular structure: States ofMatter& Radiation Energy, Atomic Models, Atomic structure, Nuclear Structure -Nuclear Binding Energy, Nuclear, Stability Periodic Table and its Properties • Chemical Bonding (Electrovalent, covalent, Dative bondand hydrogen bonds etc) Solutions, Types of Solutions & Properties of solutionsSolute, Solvents, Solubility and Molality, Crystallization Buffer solutions, Types & Preparation of Buffers, role of buffers in Radiopharmaceutical preparationColloidal Solutions, Types of Colloids & their properties Acids & Bases, pH, pH- Scale, pH meter and pH- measurements. • Chemical reactions and Types of chemical Reactions,Oxidation& Reduction
Unit 2:	**12 Hours**	**Radio Pharmacy:** • Radio pharmacy Laboratory : Design,Concept, plan layout and Setup Radio pharmacy definition and description - as a subject,as a Practice, as a Laboratory.Basic Laboratory Techniques; Laboratory glass wares, Laboratory plastic wares, Balance, Centrifuge, etc, andtheirapplications in nuclear medicine. Autoclaving ofglassware for the use in Radio pharmacy:Receipt - storage - disposal of radioactive materialsInternational symbols of radioactivity labels. • Laboratory safety - Electrical safety, chemical safety, Firesafety, Radiation safety, Biological safety.Design, Plan layout and setting up of Radio pharmacy Lab:Concept, design and Plan layout of Radio pharmacyLaboratory and Classification of Radio pharmacy Laboratory. Hospital Radio pharmacy and CentralizedRadio pharmacy -operational concept. • Setting up of atypical Hospital radio pharmacy laboratory.Radio pharmacist, Role and responsibility of radio pharmacist in Hospital Radio pharmacy and Central Radiopharmacy. Equipment/ Instruments (TLC Scanner, Fume Hood,Laminar Flow hood) in radio pharmacy laboratory – workingprinciple, quality control, • Production of Radionuclides:Artificial Production of Radionuclides - Primary (Nuclearreactors& Accelerators) and Secondary Sources (RNgenerators). Design, construction and working principle oftypical nuclear reactor and medical cyclotron. Factorsaffecting Production Yield.Radionuclide generator (Parent-

		Daughter decay growthrelationship: Radioactive equilibrium) Ideal characteristicsof generator system, Methods of radioisotope separation, • Types of radionuclide generator-Design, construction, working principle. Advantages and Limitations. GeneratorProduced radionuclides and their radiation characteristics Performance parameters affecting yield of radionuclide generator.	
Unit 3:	**12 Hours**	**Radio Pharmaceuticals - I :** • Radiopharmaceuticals:Definitions& Descriptions, classification of radiopharmaceuticals- Diagnostic, Therapeutic andTheranostic Radiopharmaceuticals in Nuclear medicine andmolecular imaging. Ideal Characteristics of Radiopharmaceuticals:Diagnostic, Therapeutic and TheranosticRadiopharmaceuticals:in Nuclear medicine and molecularimagingTracer principles, • Random Label and Cohort LabelRadiolabelling& Tracer principles:Radiolabelling, Various, methods of Radiolabelling- Direct &Indirect LabellingImportant factors in labeling, efficiency of labelingprocess,Mechanism of localization ofRadiopharmaceuticalsColdKitsCold Kits - production, role of its constituents andimportance, Stability of cold kits and Shelf life ofradiopharmaceuticals. • Quality control of radiopharmaceuticals:Physicochemical& Biological quality control ofRadiopharmaceuticals - Physical checks, pH checks,RadionuclidesPurity (RNP), Radiochemical Purity (RCP), Sterility,Pyrogenicity and Bio distribution studies,About Radio metals in Nuclear Medicine (in general)Radio metals in Nuclear Medicine (in-general)PhysicalCharacteristics& their importance • SPECT RADIOPHARMACEUTICALS-ITechnetium - Chemistry & 99mTc-labelledRadiopharmaceuticals:Technetium Chemistry - In general & *mTc-Chemistry 99mTc- Sodium Pertechnetate as • Radiopharmaceuticals Chemistry of 99mTc-labelled Radiopharmaceuticals Monographs of Various *9MTc labeled Radiopharmaceuticals.: Production, Physical Characteristics, Biological	

		Behavior, Quality control and Applications	
Unit 4:	**12 Hours**	**Radio Pharmaceuticals - II :** • SPECT RADIOPHARMACEUTICALS-IlMetallic radionuclides (other than ®®°'Tc): Thallium (TH-201) ,Indium (In-111, In-113m) , Gallium-67 - Production andpreparation of their radiopharmaceuticals.Radiolodine Chemistry and Various lodinelabelledradiopharmaceuticals: Production, Physical CharacteristicsBiologicalBehavior, Quality control and ApplicationsSpecific Methods of radiolabelling: • Radio lodination&various methods of Radio iodination and its applicationsNewer SPECT RadiopharmaceuticalsPET RADIOPHARMACEUTICALSPET Radiochemistry, Production of PET Radiopharmaceuticals and its preparation- F-18, C-11, N-13,0-16, Ga-68 etc.PET Radionuclide generators-elution efficiency and QCAutomated synthesis Modules- Need, Description, Design,and applications. Various commercial automatic radiosynthesis modules • Quality control of PET radiopharmaceuticals. TC, HPLC, Gas Chromatography methods Safe handling of PET Radiopharmaceuticals-NON IMAGING RADIONUCLIDES Iron, Cobalt, Chromium: Production, Physical Characteristics and clinical applications.	
Unit:5	**12 Hours**	**Therapeutic Radio Pharmaceuticals:** • THERAPEUTIC RADIOPHARMACEUTICALSTherapeutic Radiopharmaceuticals1-131 , P-32 , P-32colloid, Sr-89, Sm-153 EDTMP, Sr-90, Holmium, Erbium etc. Brief introduction of Targeted Radionuclide therapy, Radio immunotherapy etc.Theranostic Radiopharmaceuticals and its applications. • DevelopmentofRadiopharmaceuticalRegulatory Practices Design of newer radiopharmaceuticals General considerations, factors affecting the design of radiopharmaceuticals: compatibility, stoichiometry, charge and size of the molecule, protein binding solubility, stability and bio-distribution Investigational New Drug (IND) & Investigational New Drug Applications (INDA).	

		• Regulation ethics and Registration of Radiopharmaceuticals,PharmacopeiasForRadiopharmaceuticals:BritishPharmacopeia (BP.) European Pharmacopeia (Ph.Eu.)United State Pharmacopeia (USP)Altered bio distribution of RadiopharmaceuticalsDrug interaction&PharmaceuticalInterventionsradiopharmaceuticals.WithGood Hospital Radio pharmacy Practices (GHRP), Good Manufacturing Practices (GMP) for Radiopharmaceuticals, Relationship between GMP & ISO-relevant to nuclear medicine laboratory. • Newer Radiopharmaceuticals : Production, Physical Characteristics, Biological Behaviour, Quality control &Applications like Lu177, Re-186, Re-188, Ga-68 labelledRadiopharmaceuticalsSafety and Security of Radioactive Materials – RegulatoryaspectsProcedure and documentations for ordering, receiving, keeping (storage & Decay room) and disposalmethods ofRadiopharmaceuticals.E-Licensing procedures for handling Radioactive materials in India.	

Course Outcomes:

- Understand the basic concepts of Radiopharmacy and Safely handle the radiopharmaceuticals.
- Know the responsibility of Radiopharmacist in a Nuclear Medicine centre andable to understand about the production of radioisotopes Radiopharmaceuticals, types, methods of Radiolabelling
- Design a Radiopharmacy lab. Laboratory plastic wares, Balance, Centrifuge, etc. and their applications in nuclear medicine. Autoclaving of glassware for the use in Radio pharmacy.
- Laboratory safety-Electrical safety, chemical safety, Fire safety, Radiation safety, Biological safety.
- Radionuclides and Non Imaging radionuclides used for diagnostic purposes.

Recommended Books

1. Chemistry in Nuclear Medicine – Mervyn W Billinghurst
2. Radiopharmaceuticals in Nuclear Medicine Pharmacy and Nuclear Medicine, 2nd American Pharmacists Association, 2004 ISBN 1582120315 – Kowalsky, Richard J and Steven W Falen

3. Hand Book of Radiopharmaceuticals – Mohan H Patel
4. Fundamentals of Nuclear Pharmacy, 3rd Edition – Gopal B Saha
5. Radiopharmaceuticals and Hospital Radiopharmacy Practices – N Ramamoorthy BRIT
6. Radiation Safety in Nuclear Medicine – AERB Mumbai
7. Nuclear Medicine Technology and Techinques Third Ed; Donald R Bernier
8. Physics and Radiobiology of Nuclear Medicine 2nd Edition: Gopal B Saha 2001

RADIOBIOLOGY

Course: Core

Credits: 04 **Theory classes: 60 hours**

Course Objectives:

- To learn the biological basis of radiotherapy
- To brief the biological effects of ionizing radiation on cells and tissues.

Syllabus

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage

Unit I	8hrs	**Introduction to Radiobiology** 1.1.Cell structures, Types of cells and tissue- stages of interaction of ionizing radiation with cells, the physics and chemistry of radiation absorption, Cell cycles, molecular mechanisms of DNA and Chromosome Damage and Repair,	√			Lecture/ Activity	15%
Unit 2	18hrs	**Cell survival curves and models** 2.1.Cell survival curves, Generation of cell survival curves, Dose response relationships for normal tissues, Oxygen effect, Linear Energy Transfer and Relative Biological Effectiveness, time dose fractionation in radiotherapy. 2.2.TCP and NTCP models. The Linear Quadratic (LQ) model Radiation dose modifiers. Radio-protectors and radio-sensitizers, Concept of Dose Reduction Factor, mechanism of action					

Unit 3	15hrs	**Biological effects of radiation** 3.1.Effect of ionizing radiation on Cell, Chromosomal aberration, biological dosimetry, Somatic effects and hereditary effects, stochastic and deterministic effects, Acute exposure and Chronic exposure, LD 50 / 60. 3.2.Radiation chemistry direct and indirect effects, free radicals, oxygen effect and free radicals -LET and RBE theory.					
Unit 4	12hrs	**Acute Radiation Syndrome** 4.1.Early Lethal Effects, Radiation Syndrome, The Cerebro-vascular Syndrome, The Gastro intestinal Syndrome, The Hematopoietic Syndrome, concept of Lethal Dose (LD50)					
Unit 5	7hrs	**Effects of Radiation** 5.1.Effects of radiationon the Embryo and Effects of radiation on various stages of fetal development, Observations from survivors of atomic bomb. Occupational exposures and pregnant women					

Course outcome

At the end of the course students understand

- The principle of Radiobiology in Radiotherapy
- Repair and re oxygenation mechanism of cells
- Early effects and late effects

Recommended Books

- Radiobiology for the Radiologist by Eric j Hall & Amato G Glaccia, 8th Edition
- Technical Basis of Radiation therapy by Seymour HL evitt, James A Purdy, 5thEdition'
- Introduction to radiation biology by UmaDevi and B.S. Satish Rao

PHYSICS OF NUCLEAR MEDICINE INSTRUMENTATION

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course Objectives:

- To be able to give a brief account on historical developments of Nuclear Medicine equipments
- To be able to discuss various Nuclear Medicine machines.
- To be able to discuss various dosimetry equipment's for Nuclear Medicine equipments.

Syllabus

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage	Types Of Questions
Unit 1:	**12 Hours**	**History of Nuclear Medicine:** Historical Development of Nuclear Medicine equipments; 1. Physics of Nuclear Medicine instrumentation (100hr) mber –Isotope calibrator – Proportional Counter – Geiger muller counter – Voltage calibration of a Geiger Mueller tube, optimum operating condition – Dead time correction – Uses of Gas – filled detectors – Semiconductor detectors.					
Unit 2	**12 Hours**	**Radiation detectors:** Construction and Principles of Operation – lonization Chamber, Scintillation detector: Thallium activated Sodium lodide crystal – Photo multipliertube, electron multiplication, high voltage supply, Shielding, collimators, field ofview. Well counter – construction, design of shielding. Signal output, Pre-amplifier –reasons for use – Voltage amplifier – liquid scintillation detector- Beta counter –Gamma probes.					
Unit 3	**12 Hours**	**Spectrometer :** Basic principles of Pulse – height analyzer single channel andMulti – channel analyzers. Optimum operating conditions, window settings –Determination of gamma					

		energy spectrum, Integral and differential counting. Spectra of commonly used radio nuclides. e.g l-131, Tc99m, Cr51, Cs137. Problems in radiation measurements with worked examples. Statistics of counting: Types of measurement error, Precision and Accuracy –Nuclear counts statistics – Poison, Normal (Gaussian) distribution – Standarddeviation, Probable error, confidence limits, Percent standard deviation – Efficientdistribution of counting time. Statistical tests. – Chi – square test – Figure of Merit– test – Precision of Rate meter Measurements.					
Unit 4	**12 Hours**	**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 sizeand its effect on photo and dot scans. Rate meters – time constant – effect oncounting Cathode ray tube – Photo recording display, cathode ray tube, film density,gray curve,					

		effect of contrast enhancement Information density, scan speed, linespace Dot factor Minified images – application in Bone scan – multi crystalscanners, fluorescent scanning.					
Unit 5	**12 Hours**	**Gamma camera:** Camera head construction and principle of operation Collimators – parallel multi hole, high resolution, high sensitivity pin hole, diverging hole, slant hole. Collimators Scintillation crystal, size Light guide – Photomultipliers per amplifiers.Control panel – pulse shaping linear amplifiers Pulse height analyzer Timer, DataProcessor and their function. Application of Cathode ray tube – persistence scope –Camera scope. Resolving, time characteristics – Analogue – Digital controlsUniformity and intrinsic resolution Sensitivity, Total – system resolution, Spatialvolume resolution saturation.Frame mode & List mode acquistion - Static, Dynamic, Tomo and Gated acquisition– Image perception & Analysis -Background correction methods -ROI analysis- Time Activity curves – Filters and					

		normalization methods.					

Course Outcomes:

- To be able to give a brief account on historical developments of Nuclear Medicine equipments
- To be able to discuss various Nuclear Medicine machines.
- To be able to discuss various dosimetry equipment's for Nuclear Medicine equipments.

BOOKS FOR STUDY

1. Physics of Nuclear Medicine, - James A. Sorenson & Michael

Reference books

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.

C.V. Mosby company Princeton

5. Instrumentation in Nuclear Medicine – Gerald J. Hine

RadiopharmacyPracticals

Course: Core

Credits: 04 Practical classes: 120 hours

Course objectives:

- Gaining the knowledge of operation of Technetium generator
- Getting familiarized with the preparation of Technetium 99m
- Will be trained about the disposal of Technetium 99m

Syllabus

- Radioactive storage and disposal
- PH measurement of given sample.
- Preparation of Buffer solution

- Elution and calculating elution efficiency of 99mTc from Column generator
- Performance of 99mTc Column generator
- Parent Daughter decay Growth Relationship in Technetium generator
- Molybdenum Breakthrough Assay Sodium Pertechnetate
- Aluminum Breakthrough Assay of Sodium Pertechnetate

Course outcomes:

- Gaining the knowledge of operation of Technetium generator
- Getting familiarized with the preparation of Technetium 99m
- Will be trained about the disposal of Technetium 99m

Nuclear Medicine Instrumentation practicals – I

Course: Core
Credits: 04 **Practical classes: 120 hours**

Course objectives:

- Gaining knowledge of various instruments which are used in Nuclear Medicine facilities
- Understanding of the inverse square law effect
- Gaining knowledge about in vitro Nuclear Medicine procedures

Syllabus

- To perform quality control of dose calibrator
- Geometric efficiency of Dose Calibrator
- Constancy and Accuracy of Dose Calibrator
- Linearity of Dose Calibrator
- Chi-square test of Dose Calibrator
- To determine the operational characteristics of GM counter
- To determine the dead time of GM counter
- To record human ECG and analyze it for QRS voltage and frequency.
- To perform ECG measurements and carry out manual electrical axis analysis.
- To verify inverse Square Law using surey meter

In vitro Nuclear Medicine techniques practicals

- Basic procedures in radioimmunoassay - Sample collection storage and Centrifugation of biological samples, Measuring samples Using electronic balance, Measuring sample volume using glass pipette
- To demonstrate the RIA
- To demonstrate IRMA

Course outcomes:

- Gaining knowledge of various instruments which are used in Nuclear Medicine facilities
- Understanding of the inverse square law effect

Gaining knowledge about in vitro Nuclear Medicine procedures

HUMAN RIGHTS AND GENDER EQUITY

Course: AECC **Number of Hours: 30 Hours**

Credits: 02

Course Objectives:

- To make the student understand the human rights as citizens of India.

Syllabus

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage
UnitI	5hrs	**HumanRights** 1.1.Human Rights- Meaning 1.2.Universal declaration of Human rights	√			Lecture/ Activity	15%

Unit 2	5hrs	**Human Rights Advocacy** 2.1.Global Advocacy of human rights amnesty international and other organizations 2.2.Peoples union for Civil Liberty(PUCL) 2.3.Human Rights Commission in India 2.4.Minority Commission in India 2.5.Remedies against Violation of Human rights in India					
Unit 3	5hrs	**Gender Equity** 3.1.Key Concepts- Gender and sex-Masculinity and Feminity, Partriarchy- Matriarchy, Gender roles and attributes, Gender division or labour, Gender Bias, Gender Stereotypes, Need for Gender Sensitization.					
Unit 4	5hrs	**Woman Status in India** 4.1.Important indicators- Six Ratio, Education, Health, Nutrition, Material and Infant Mortality, Work Participation rate, Political Participation.					

Unit 5	5hrs	**Contemporary Women's Issues** 5.1.Discrimination against Girl child 5.2.Violence against women 5.3.Problems of health and nutrition 5.4.Women's education gender bias in education 5.5.Trafficking in Women					
Unit 6	5 hrs	**State Initiatives on Gender Issues** 6.1.Constitutional Rights of Women 6.2.Laws Pertaining to Women 6.3.The National Commission for Women					

Course Outcome:

- Basic Knowledge of Human Rights and its function and authorities in society and industry women's status, issues and gender equity.

Recommended Books:

1. Parvathy Appaiah, Human Rights, Gender Equity and Environmental Studies, Shivam Books publishers, 2012.

2. Parvathy Appaiah, Human Rights, Gender Equity and Environmental Studies, Jai BharathPrakashan publishers, 2016.

3.Parvathy Appaiah, Human Rights, Gender Equity and Environmental Studies, Jai BharathPrakashan publishers, 2018-19.

FOURTH SEMESTER
RADIOGRAPHIC IMAGING AND APPLICATIONS

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course Objectives

- To be able to discuss the various diagnostic equipments
- To be able to understand the basic principle, working and advantages of different imaging modalities

Syllabus

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage	Types Of Questions
Unit 1	**12 Hours**	**Photographic Principles:** Radiographic film- construction and types, Photographic effect and latent image formation, Film density and log relative exposure, Characteristic curve its formation and features, Film faults and Artifacts					
Unit 2	**12 Hours**	**Intensifying Screens:** Luminescence- fluorescence and phosphorescence, Construction and types of Intensifying Screens, Resolving power of Intensifying Screens. Speed of intensifying screen, Screen film contact tests, Advantages and limitations					

		of Intensifying Screens.					
Unit 3	**6 Hours**	**Imaging Communication:** Hospital Information System, Radiology Information System, PACS, DICOM					
Unit 4	**15 Hours**	**Computed Tomography:** Physics of CT, types of CT scanners, CT Generations Spiral and multi slice CT, CT Imaging Systems- Image reconstruction and Processing, filtered back projection, Image acquisition, Scanned Projection radiographs, Axial CT, Helical CT, MD CT, Cardiac CT, CT Fluoroscopy, Artefacts in CT,					
Unit 5	**15 Hours**	**Magnetic Resonance Imaging (MRI)**: Basic Physics of MRI, MRI systems, design considerations. Relaxation Time, Contrast Agents, Screening techniques Gradient echo imaging, spin echo imaging, Multi-slice imaging, 3D imaging, Artifacts in MRI.					

Course Outcomes

- To be able to discuss the various diagnostic equipments
- To be able to understand the basic principle, working and advantages of different imaging modalities

Recommended books

- The Physics of Radiation Therapy by Faiz M Khan & John P Gibbons, 5th Edition
- Fundamental Physics of Radiology by W.J.Meredith and J.B. Massey, 3rd Edition
- Christensen's Physics of Diagnostic Radiology by James E. Dowdey, Robert C. Murry, and Thomas S. Curry, Lippincott Williams & Wilkins, 1990
- Medical Imaging Physics by William R. Hendee, E. Russell Ritenour, Fourth edition, Wiley, 2016

Nuclear Medicine Techniques & Special procedures

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course objectives:

- Gaining knowledge about the various nuclear medicine procedures in day to day practice

Syllabus:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage
Unit 1	**4 Hours**	**Unit 1: Diagnostic In vitro and In vivo techniques** In vitro techniques Principles of Radio immunoassays (RIA) standard curve, data analysis, Quality Control(QC) and applications, Methods of receptor assays, hormones , drugs. IRMA Immunoradiometric assay, ELISA, RIA, estimation, T3, T4, TSH, thyroid antibodies, and current applications using similar techniques. In vitro techniques Principles of Radio immunoassays (RIA) standard curve, data analysis, Quality Control(QC) and applications, Methods of receptor assays, hormones , drugs. IRMA Immunoradiometric assay, ELISA, RIA, estimation, T3, T4, TSH, thyroid antibodies, and current applications using similar techniques. In vivo techniques - (Imaging & non imaging				

		Procedures) a) General Principles of non-imaging techniques, Tracer dose, uptake studies, compartmental analysis in radio nuclide studies, volume dilution studies. Clinical Nuclear Medicine - Diagnostic studies.				
Unit 2	**6 Hours**	**Unit 2: Endocrine System** Anatomy, physiology and different pathology -Iodine metabolism -Radiopharmaceuticals, the rationale, dosimetry &precautionsIndications for Thyroid Imaging -131 I Uptake studies -Scintigraphic technique -regular study as well as Thyroid Cancer-Thyroid whole body survey . Per chlorate discharge Test, T3/T4 suppression test, TSH stimulation test. RIA invitro Procedures: T3, T4 Estimation using Radio Immuno Assay methods-estimation of TSH levels, Thyroid Antibodies levels. Adrenal scintigraphy: Cortical scintigraphy-radio pharmaceuticals, technique, applications. Medullary scintigraphy - radio pharmaceuticals, technique, applications Parathyroid scintigraphy: radiopharmaceuticals, technique				
Unit 3	**6 Hours**	**Unit 3: Skeletal systemandCentral nervous system:** Bone: Pathology of bone diseases, indications for scintigraphy -patient preparation -Radio active tracer doses and their administrations, Imaging techniques-whole body sweep, spot views, isocount and isotime studies, three phase & four phase bone scans - care to be taken while handling patients with bone fractures-applications Bone marrow scintigraphy: Radio pharmaceutical used, technique Measurement of bone				

		mineral mineral: technique & applications. **Central nervous system**: Brain: Anatomy and brief physiology, different pathology and indications for scintigraphy.Conventional brain scintigraphy-radio pharmaceuticals , dose &dosimetry, patients preparation, precaution to be taken with post-operative patients, epileptic patients ,brain secondaries. Cerebral perfusion imaging: radio pharmaceuticals, dose &dosimetry, patients preparation Cisternography:radiopharmaceuticalsdose&dosimetry, methodology.Scintigraphy for CSF leak.				
Unit 4	**8 Hours**	**Unit 4: Respiratory system and Cardio vascular system:** **Respiratory system :**Pathology of respiratory diseases-Indication for scintigraphy.-Perfusion studies -Patients preparation -radio pharmaceuticals and dose administration-precautions to be followed and drugs to be kept for any anaphylactic reactions-contraindication for the procedure. Ventilation studies --Radio pharmaceuticals -Aerosols -inhalation procedures -Imaging procedures - precautions to be followed during inhalation of Aerosols. **Respiratory system :**Pathology of respiratory diseases-Indication for scintigraphy.-Perfusion studies -Patients preparation -radio pharmaceuticals and dose administration-precautions to be followed and drugs to be kept for any anaphylactic reactions-contraindication for the procedure. Ventilation studies --Radio pharmaceuticals -Aerosols -inhalation procedures -Imaging procedures - precautions to be followed during inhalation of Aerosols.				

		Cardio vascular system :Anatomy and pathological conditions, Indications for studies. ECG-Terminology of cardiac cycle -diastole -systole -diastolic volume - stroke volume cardiacoutput, Ejection Fraction - Pulmonary Transit time, Hypokinesia - akinesia - diskinesiaetc.Dynamic study-first pass study: Purpose -radio nuclide -dosage -Bolus Injection - computersettings - Image acquisition - processing etc. Multigated Blood Pool Acquisition (MUGA) Radionuclide, indication,administrationdosage,Imaging procedures, Processing -E.F. calculation -Global and Regional stroke volume -Histogram phase angle etc. Stress study -Different medicines used for stress -dosage, physicalstress study -MUGA repeated after stress. Myocardial perfusion imaging -Radionuclide &Radio pharmaceuticals used, dosage administration, dosimetry. Imaging procedures -stress andrest. Infarct avid imaging: Radio pharmaceuticals, Technique.Shunt evaluation: Radio pharmaceuticals, Technique & analysis.				
Unit 5	**8 Hours**	**Unit 5: Urinary tract and Gastrointestinal tract:** **Urinary tract**: Anatomy and physiology in brief, Pathology, Indications -Radiopharmaceutical preparation -dosages & Administration, patient preparation, renogramusingprobes, quantitative studies GFR, ERPF, split function, parameters for function evaluation. Acquisition techniques-Dynamic study:-renal perfusion study -dynamic mode -purpose -dosage and technique in normal & renal transplants. Static renal imaging: procedure includinganalague imaging-indication and comparison, of different				

		studies as per the pathology-renalcortical imaging techniques. Evaluation of Reno vascular hypertension, Transplant scintigraphy.Radionuclide cystography-Radio pharmaceutical & imaging techniques. Scrotal scintigraphy:Radio pharmaceutical, dosimetry, methodology. **Gastrointestinal tract**: Anatomy and pathology, Esophageal transit studyRadiopharmaceutical dosimetry, technique & analysis. Gastro esophageal refluxRadiopharmaceutical dosimetry, technique & analysis. Gastric emptying-radio pharmaceuticaldosimetry, technique & analysis. Gastrointestinal bleed scintigraphy: Radio pharmaceutical,dosimetry, methodology including RBC tagging procedures, Meckels' scintigraphy-Radiopharmaceutical, patient preparation. Pancreatic imaging: Radio pharmaceutical, dosimetry,methodology				
Unit 6	**6 Hours**	**Unit 6: Heptobiliary scintigraphy:** Anatomy and pathology . Radio pharmaceutical, patientpreparation ,dosimetry, dynamic flow-static imaging procedures, applications. Hepatic arteryperfusion scintigraphy. 10. Liver,spleen scintigraphy: Pathology ,basis of scintigraphic localization -Patient-Dosage-Procedures-Patient. Preparation,applications.99mTc Heat damaged -RBCs -basics of –Taggingprocedure dose administration -Imaging procedure. .				

Unit 7	**4 Hours**	**Unit 7: Haematological studies:** Hematological disorders total blood volume., Estimation of RBCvolume, Blood volume -using 51Cr as well as 99mc -Red cell survival studies with 51Cr.,platelet survival studies, ICSH recommendations in data presentation, use of computer softwarefor survival curves.				
Unit 8	**4 Hours**	**Unit 8: Infection and inflammation:** Radio pharmaceuticals, dosimetry, comparison of the radiopharmaceuticals used, leukocyte labeled studies-leukocyte labeling procedures, imagingtechniques and applications.				
Unit 9	**2 Hours**	**Unit 9: Tumor imaging:** Radio pharmaceuticals, dosimetry, comparison of the radio pharmaceuticals used, imaging techniques, applications.				
Unit 10	**6 Hours**	**Unit 10: Special procedures :** Lymphoscintigraphy: Radio pharmaceuticals, dosimetry, imaging techniques. Venography: Radio pharmaceuticals, dosimetry, imaging techniques. Proteinloss studies: Radio pharmaceuticals, dosimetry, imaging techniques, precautions prior to imaging. Salivary gland imaging: Radio nuclide -dosage -Imaging procedures. Vitamin B12 absorption study: Folic acids study etc. Schilling test. 16. Therapeutic application of radio nuclides: General precaution regarding contamination and radiation dosage.				
Unit	**6**	**Unit 11: Radionuclide therapy:**				

11	**Hours**	Dosage Administration -Precaution to be followed. Radio iodine therapy for Thyroid malignancy :Dosage. Administration -Precaution and care of patient during administration. mIBG I13l -Indications -Dosage -Administration -Precaution to be taken during administration. Palliative treatment for bone metastasis : 32 P-and 89 Strontium Dosage - Administration -Precaution to be followed during administration. Intracavitory use of radioactive colloid: Au 198 Dosage - Administration -Precaution to be followed during administration. Intravascular particulate radio nuclide Therapy-Administration - Precaution to be followed during administration. Intra articular Therapy : Administration -Precaution to be followed during administration. Labeled Monoclonal antibodies (Radio immunotherapy). Labelled receptor therapy.				

Course outcomes:

Gaining knowledge about the various nuclear medicine procedures in day to day practice

Recommended Books

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

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 W B Saunders company, London

6 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

TOMOGRAPHY AND HYBRID IMAGING

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course objectives:

- Gaining knowledge about cross sectional imaging
- Gaining knowledge about PET-CT, SPECT-CT

Syllabus:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage	Types Of Questions
Unit 1	**15 Hours**	**Unit 1: Computed Tomography and Magnetic Resonance Imaging :** Introduction, generations, design, working principle,components, reconstruction techniques, performancecharacteristics, quality control aspects.					
Unit 2	**15 Hours**	**Unit 2: Single Photon Emission Tomography :** Introduction, design, working principle, components, acquisition, reconstruction techniques, performance characteristics, artifacts, quality control aspects.					
Unit 3	**15 Hours**	**Unit 3: Positron Emission Tomography :** Introduction, Physics, design, working principle, components,					

		acquisition, reconstruction techniques, performance characteristics, quality control, artifacts.					
Unit 4	**15 Hours**	**Unit 4: Hybrid Imaging Devices:** SPECT-CT, PET-CT, PET-MR, co-registration of images					

Course outcomes:

- Gaining knowledge about cross sectional imaging
- Gaining knowledge about PET-CT, SPECT-CT

Recommended Books

1. Physics in Nuclear Medicine. Sorenson
2. Mosby's manual of Nuclear Medicine procedures / D.BruceeSodes, Paul J Early.
3. Medical Imaging Physics – William R Hendee, Russel Ritenour
4. Nuclear Medicine Physics – Ramesh Chandra
5. Essential Nuclear Medicine Physics – Rachel A Powsner, Edward R Powsner
6. Quality control of Nuclear Medicine Instruments – Techdoc – 602
7. Computers in Nuclear Medicine – Lee Kai Hi
8. Basics of PET Imaging – Gopal B Saha
9. Emission Tomography – The fundamental of PET and SPECT – Miles / N. Wernick, John N Aarsvold

Nuclear Medicine Instrumentation practicals - II

Course: Core
Credits: 04 **Practicals classes: 120 hours**

Course objectives:

- Gaining knowledge about the various therapeutic procedures in Nuclear Medicine, in vitro studies, etc…
- Radiopharmacy Practices

- In-vitro Nuclear Medicine Practices
- Scintigraphy Practices
- Radionuclide Therapy Practices

Basics of Radiopharmaceuticals Practical's:

- Radiochemical Purity of Sodium Pertechnetate by PaperChromatography
- Preparation common 99mTc labelled radiopharmaceuticals using cold kits. (DTPA, MDP, Mebrofenin, ECD, EC, Sulphur Colloid, MIBI etc.)
- Quality control of 99mTc labelled Radiopharmaceuticals.
- Dispensing and administration of 99mTc- Radiopharmaceuticals doses for patients.

Course outcomes

- Gaining knowledge about the various therapeutic procedures in Nuclear Medicine, in vitro studies, etc…
- Radiopharmacy Practices
- In-vitro Nuclear Medicine Practices
- Scintigraphy Practices
- Radionuclide Therapy Practices

Nuclear Medicine Instrumentation practicals- III

Course: Core
Credits: 04 **Practicals classes: 120 hours**

Course objectives:

- Gaining knowledge about quality assurance and quality control of Nuclear Medicine equipments

Section A: **Nuclear imaging Instrumentation Practicals:**

- To perform sensitivity test of gamma camera.
- To perform uniformitytest of gamma camera.
- To perform spatial resolutionand linearity tests of gamma camera
- PET QA and QC

Section B Counting Statistics:

- Effect of Background
- Counting Rate
- Comparison of various Counting systems
- Pipetting Efficiency

Course outcomes:

- Gaining knowledge about quality assurance and quality control of Nuclear Medicine equipments

COMPUTER APPLICATION

Course: AECC

Credits: 01 **Theory classes: 15 hours**

Course Objectives:

- Describe the usage of computers and why computers are essential in business and society

- Utilize the internet web resources and evaluate online e business system.
- Identify categories of programs, system software and applications.
- Describe various types of network standards and communication software.

Syllabus

Unit	Hrs	Content	Must Know	Good to Know	Desirable to	Teaching Learning Method	Weightage
Unit I		**Introduction to computer:** 1.1.Introduction, characteristics of computer, block diagram of computer, generations of computer, computer languages.	√			Lecture/ Activity	15%
Unit 2		**Input output devices:** 2.1.Input devices (keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices (monitors, pointers, plotters, screen image projector, voice response systems).					
Unit 3		**Processor and memory:** 3.1.The Central Processing Unit (CPU), main memory.					
Unit 4		**Storage Devices:** 4.1.Sequential and direct access devices, magnetic tape magnetic disk, optical disk, mass storage devices					

Unit 5		**Introduction of windows:** 5.1.History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with windows (opening, closing, moving, resizing, minimizing and maximizing, etc.).					
Unit 6		**Introduction to MS Word:** 6.1.Introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text, saving the document, spell checking, printing the document file, creating and editing of table, mail merge.					
Unit 7		**Introduction to Excel:** 7.1.Introduction, about worksheet, entering information, saving work books and formatting, printing the worksheet, creating graphs.					

Unit 8		**Introduction to power-point**: 8.1.Introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs.					

Course Outcomes:

At the end of the course students can

- Use computers and utilize the internet web resources.
- Identify categories of programs, system software and applications.
- Describe various types of network standards and communication software.

Recommended books

- Alexis Leon and Mathews Leon (1999): Fundamentals of information technology, Leon Techworld Pub.
- Jain, S.K. (1999): Information Technology "O" level made simple, BPB Pub.
- Jain, V.K. (2000): "O" Level Personal Computer Software, BPB Pub.
- Rajaraman, V. (1999): Fundamentals of Computers, Prentice Hall India.
- Hamacher, Computer Organisation, Mc Graw.
- Sinha, Computer Fundamentals, BPB Pub

FIFTH SEMESTER
CLINICAL NUCLEAR MEDICINE

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course Objectives:

- Gaining knowledge about various clinical nuclear medicine procedures

Syllabus

Syllabus

Unit	Hrs	Content	Must Know	Good to Know	Desirable to	Teaching Learning Method	Weightage
Unit I	8 Hours	**Unit 1: Endocrine:** • Thyroid scan - dynamic, static. • Parathyroid imaging - Dual phase, dual isotope technique.	√			Lecture/ Activity	15%
Unit 2	8 Hours	**Unit 2; Skeletal System:** • Infection imaging - 3 phase/4phase bone scan • Tumor imaging • Quantitative analysis					
Unit3	8 Hours	**Unit 3: Gastrointestinal System:** • GER • Gastric emptying study • Meckel's diverticulum • Gl bleed scan • Liver spleen imaging • Hepatobiliary studies					

Unit 4	9 Hours	**Unit 4: Cardiovascular System:** • Radionuclide ventriculography • Myocardial perfusion imaging • Myocardial viability imaging • Endocarditis					
Unit 5	9 Hours	**Unit 5: Genitourinary System:** • Cortical imaging • Renal dynamic scan • Captopril ROS • Transplant evaluation • DRCG/NCUG					
Unit 6	9 Hours	**Unit 6: Central Nervous System:** • Epilepsy • Radionuclide cisternography. • Ventriculo-peritoneal shunt evaluation • Dementia imaging • Motor neuron diseases					
Unit 7	9 Hours	**Unit 7: Miscellaneous Studies:** • Infection imaging • Lymphoscintigraphy • Dacroscintiqraphy • Sentinel lymphnode imaging • Sioloscintigraphy					

Course Outcomes:

- Gaining knowledge about various clinical nuclear medicine procedures

Recommended Books

1. Nuclear Medicine – The requisites – Harvey A Ziessman, Janis P. O'Malley, James H Thrall
2. Mosby's manual of Nuclear Medicine Procedures – D BruceeSodes
3. Nuclear Medicine Technology and Techniques – Donald Bernier

PATIENT CARE IN NUCLEAR MEDICINE

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course Objectives:

- Understanding the work flow in the Nuclear Medicine Department
- Gaining knowledge of the contraindications for Nuclear Medicine studies

Syllabus:

Unit	Hrs	Content	Must Know	Good to Desirable to	Teaching Learning Method	Weightage
Unit I	**8 Hours**	**Unit 1: Ordering nuclear medicine procedure:** Checking relevant data in the request scheduling the procedures by giving appointments-giving proper instructions regarding the studies and pre preparation for the procedures to the out patients as well as the in patients through the written appointments				

	6 Hours	**Unit 2: Preparation of the patients before the procedure:** Check the correct patient by checking the Name ID No and the Referral unit etc before take the patients for the nuclear medicine procedure.					
	10 Hours	**Unit 3: Patients History:** Check the patients about their previous medications especially for thyroid studies and renal studies for patients with RAS problem. Patients (female) should be checked for early pregnancies before starting any radio active procedure. Patients also should be checked for the sensitivity for any particular medicine or dye or any contra indication for the particular study. Eg. Pulmonary hypertension is contra indication for Lung perfusion studies.					

	12 Hours	**Unit 4: Care of Patients:** During the Nuclear Medicine Procedure: regarding the care to be taken while Transferring the patients from the wheel chair or stretcher to the treatment couch especially the bone scan patients with spine secondaries and lung scan patients connected with oxygen cylinders, Post renal Tx patients with IV line and drain tubes. etc neuro patients under coma stage or with epileptic convulsions or children care regarding using the immobilizing devices etc. Micturition of the patients before starting the NM procedures. Care to be taken during the cardiac studies in the NM departmentECG monitors should be available -emergency drugs should be available for the use in the time of need along with eparinized IV line and fluids for the parental use.					

	10 Hours	**Unit 5: Preparation of the radioactive tracer:** Preparation of the radioactive tracer for the study selecting the appropriate tracer for the particular study should be assayed before use and to be properly labeled and to be kept within the lead shielded container. Usage of gloves and over coats during dispensing of the radioactive tracer. Proper tray should be used during the transporting the tracer from the hot room to the injection room. And should be administered carefully and properly in the vein or required spot without causing any extravasations and the management of the local hemorrhage and swelling.					

	8 Hours	**Unit 6: Special care procedures:** Regarding the patients who are coming from SICU and MICU and pediatric patients. Keeping special equipment namely Gastric suction, Chest suction, T-tube, Urinary retention catheters., surgical dressing trays, Cardiac monitors, central venous pressure line-colonoscopy care management of seizure patients-application of cardio pulmonary resuscitation for cardiac arrest patients.					
	6 Hours	**Unit 7: Specimen collection:** Specimen collection in a safe manner and properly label them and store in a proper place for counting or sampling -safety precautions to be followed during the sampling of radio active specimen and precautions to be followed while disposing the same. Care regarding the disposal of contaminated swabs syringes and needles etc.					

Course Outcomes:

- Understanding the work flow in the Nuclear Medicine Department
- Gaining knowledge of the contraindications for Nuclear Medicine studies

Recommended Books:

1. Nuclear Medicine Technology & Techniques, -Donald R. Bernier , Paul E. Christian & James K. Langan Mosby
2. Care of the patient in diagnostic radiology, Chesney & Chesney Blackwell
3. Notes on radiological emergencies Ansell, Churchill
4. A guide to Oncological nursing Deeley Livingstone
5. First aid (Hamlyn) Haugher& Gardner, Hamlyn
6. Care of the injured, Ring Livingstone
7. Practical Nursing and first aid -Ross & Wilson, Livingstone

8 Hand book of Nuclear Medicine – Frederick L Datz.

9 Essentials of Nuclear Medicine Imaging – Fred A Mettler , Milton J Guiberteau.

CELL AND MOLECULAR BIOLOGY

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course Objectives:

- Understanding about the cell structure and their mechanism of functioning
- Understanding about the intercellular interactions

Unit	Hrs	Content	Must Know	Good to Desirable to	Teaching Learning Method	Weightage

Unit 1	**15 Hours**	**Unit 1: Plasma membrane:** • Theories on molecular architecture of plasmamembrane. • Structure of plasma membrane,chemical composition of plasma membrane,structuralspecializationofCellsurface. • Transport of molecules-active and passive, lonchannels, Cell-cell interaction					
Unit 2	**12 Hours**	**Unit 2: Organization of Nucleus and chromosomes:** • Nuclear Envelope, Nuclear pore complex, selective transport of proteins across nuclear pore • Internal organizationofnucleus,Chromosomesandchromatinstructure,Nucleus.					
Unit 3	**8 Hours**	**Unit 3: Mitochondrion:** • Organization and function of mitochondria, Proteinimportin mitochondria. • Electron Transport chain, Transport ofmetabolitescross mitochondrial membrane					
Unit 4	**7 Hours**	**Unit 4: Peroxisomes :** • Peroxisome assembly and biochemical characterization, functions of peroxisomes					

Unit 5	**18 Hours**	**Unit 5: Endoplasmic reticulum, Golgi apparatusand lysosomes:** • General organization of endoplasmic reticulum, Targeting of proteins to endoplasmic reticulum, Insertion of proteins into endoplasmic reticulummembrane. • Protein folding and processing, Smooth endoplasmic reticulum and lipid synthesis, Export of proteins and lipids from endoplasmic reticulum, • Organization of Golgi apparatus, Protein glycosylation, Protein sorting and export from Golgi apparatus, Vesicular transport. • Endocytosis and lysosome formation					

Course Outcomes:

- Understanding about the cell structure and their mechanism of functioning
  Understanding about the intercellular interactions

Recommended Books

1. Cell and Molecular Biology by de Robertis and de Robertis Llewellyn Pub 2001
2. Molecular Biology of the cell by Alberts, Bray, Lewis, Raff, Roberts and Watson. Garland Science 1997
3. The cell – A molecular approach by Geoffrey M. Cooper, ASM Press Washington DC, Oxford University Press 2000
4. Molecular cell biology by Darnell, Lodish, Baltimore, Scientific American Books 1990.

QA IN NUCLEAR MEDICINE

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course objectives:

- Gaining knowledge about QA of various Nuclear Medicine equipments, Organisation of the Nuclear Medicine Department, etc…

Syllabus

Unit	Hrs	Content	Must Know	Good to Desirable to	Teaching Learning Method	Weightage

	15 Hours	**Unit 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 patient vs 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.					

	15 Hours	**Unit 2: Quality Assurance of Equipments 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 cameraField 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.					

	8 Hours	**Unit 3: Organization of department:** How to set up a Lab. -Psychology and social behavior -Group behaviors -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 –					
	4 Hours	**Unit 4: Assessment procedures: Presentation of a Technical paper** : Literature searching Library resource utilization - Personnel management, punctuality in duties. Professional ethics etc.					

	9 Hours	**Unit 5: 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.					
	9 Hours	**Unit 6: 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.					

Course outcomes:

- Gaining knowledge about QA of various Nuclear Medicine equipments, Organisation of the Nuclear Medicine Department, etc…

Recommended Books

1.Quality Control of Nuclear Medicine Instruments, International Atomic EnergyAgency

2. Quality Control of Gamma Cameras and Associated Computer Systems, TheInstitute of Physical Sciences in Medicine

3. Quality Control of Nuclear Medicine Instrumentation, The Institute of PhysicalSciences in Medicine

4. "Quality Control in diagnostic imaging"-J.E. GRAY, University Park Press.

5. "Processing and Quality Control"William, E.J. Mckinney.J.B. Lippincott Company.

6. "Concepts in Medical Radiographic imaging"MarianneTortoice,W.B.SaundersCompany.

7. "Quality assurance Management"G.E. Hayes Charger production.

8. Diagnostic Imaging: Quality Assurance M.M. Rehani ,Jaypee Bros Medical Publishers.

Radiopharmacy – II, Tomography and hybrid imaging Practical

Course: Core
Credits: 04 **Practicals classes: 120 hours**

Course objectives:

- Gaining knowledge about various aspects of Radiopharmacy (Dispensing, Quality checks, etc…), QA and QC in PET, SPECT
- Radiopharmacy Practices
- In-vitro Nuclear Medicine Practices
- Scintigraphy Practices
- Radionuclide Therapy Practices

Syllabus

Radiopharmaceuticals in Nuclear Medicine Practicals

- Dispensing and administration of ready use Radiopharmaceuticals (I-131 solution, Sm-153 EDTMP etc.) doses for patients.
- Elution & elution efficiency of PET Radiotracers from Radionuclide generator.
- Quality checks of PET Radiopharmaceuticals.
- Log book keeping of elution in Radio pharmacy laboratory
- Inventory & stock keeping of cold kits Radioactive materials
- Handling of Radioactive Spillage and contamination

Tomography and hybrid imaging Practical:

- To perform pixel size test
- To perform SPECT QA and QC, PET QA and QC
- Image Registration test

Course outcomes:

- Gaining knowledge about various aspects of Radiopharmacy (Dispensing, Quality checks, etc…), QA and QC in PET, SPECT
- Radiopharmacy Practices
- In-vitro Nuclear Medicine Practices
- Scintigraphy Practices
- Radionuclide Therapy Practices

Clinical Nuclear Medicine Practicals – I

Course: Core
Credits: 04 **Practicals classes: 120 hours**

Course objectives:

- Gaining knowledge about the practical aspects of doing some of the routinely done Nuclear Medicine procedures (Thyroid studies, Skeletal scintigraphy, Hepatobiliary scintigraphy, etc…) in day to day practice

Syllabus

Endocrine

- Thyroid scan - dynamic, static.
- Parathyroid imaging - Dual phase, dual isotope technique.

Skeletal System:

- Infection and inflammation imaging
- 3 phase/4phase bone scan
- Tumor imaging - Whole body bone scan
- SPECT/CT
- Quantitative analysis

Gastrointestinal System:

- GER
- Gastric emptying study
- Meckel's diverticulum
- Gl bleed scan
- Liver spleen imaging
- Hepatobiliary studies

Course outcomes:

- Gaining knowledge about the practical aspects of doing some of the routinely done Nuclear Medicine procedures (Thyroid studies, Skeletal scintigraphy, Hepatobiliary scintigraphy, etc…) in day to day practice

MEDICAL ETHICS

Course: VAC **Course Code: AH01NMT5VA1**

Credits: 2 **No of Hours: 30 Hours**

- **Course Outcomes:**

At the end of the course, students will be able to:

CO1: Increasing the awareness and knowledge of students of the value dimensions of interactions with the patients, colleagues, relations andpublic.

CO2: Fostering the development of skills of analysis, decision making and judgment.

CO3: Making the students aware of the need to respect the rights of the patient.

- **COURSE CONTENT:**

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage	Type Of Questions
Unit I	3hr	**Introduction to ethics** What is ethics, what are values and norms, freedom and personal responsibility?	✓			15%	SA, SE
Unit II	4hrs	**Definition of medical ethics** Major principles of medic ethics.	✓			20%	LE, SA

Unit III	4hrs	Perspective of medical ethics The Hippocratic oath, The Declaration of Helsinki, The WHO Declaration of Geneva, International code of Medical Ethics (1993), Medical Council of India Code of Ethics (2002).	✓			15%	LE, SA, SE
Unit IV	4hrs	Ethics of the individual Truth and confidentiality, the concept of disease, health and healing, the Rightto health.	✓			15%	SE
Unit V	3hrs	The ethics of human life Prenatal sex determination.	✓			15%	SA, SE
Unit VI	4hrs	The family and society in medical ethics Euthanasia, cancer and terminal care.		□		10%	LE, SA
Unit VII	4hrs	Death and dying Use of life-support systems, the right to die with dignity, suicide–the Ethical outlook.		□		05%	LE, SA, SE
Unit VIII	4hrs	Professional Ethics Contract and confidentiality, malpractice and negligence.		□		05%	SA, SE

❖ **LA-** Long Essay**, SE-** Short Essay**, SA-** Short Answer

➢ **Recommended Books:**

1. Tsai DF. The WMA medical ethics manual. Journal of Medical Ethics. 2006 Mar 1;32(3):163
2. Loewy EE, Loewy RS. Textbook of healthcare ethics. Springer Science & Business Media; 2004 Jun 29.

SIXTH SEMESTER
RECENT ADVANCES IN NUCLEAR MEDICINE

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course objectives:

- Gaining knowledge about the recent advances in Nuclear Medicine (New equipments, Advances in Radiopharmaceuticals, Image processing technniques, etc…)

Syllabus

- Recent advances in imaging techniques & image processing including fusion techniques-imageguiding for radiotherapy & stereotactic surgeries.
- Recent advances in equipments- SPECT, PET including hybrid systems and PET-CT & PET-MRI
- Recent Advance in In-vitro Nuclear Medicine
- Recent advances in radiopharmaceuticals - PET Tracers, production ; Cyclotronprinciple, configuration and operation - FDG -Sodium fluoride for bone imaging – Neuro & Cardiac radiopharmaceuticals - Newer Computer applications in Nuclear Medicine -Medical Data Communications and Computer Networks – DICOM – PACS – RIS – HIS –Telemedicine, Research paper presentation.
- Regulatory aspects in Nuclear Medicine

Course outcomes

- Gaining knowledge about the recent advances in Nuclear Medicine (New equipments, Advances in Radiopharmaceuticals, Image processing technniques, etc…)

Recommended Books

THERAPEUTIC NUCLEAR MEDICINE

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course objectives:

- Gaining knowledge about various aspects pertaining to Radionuclide therapy (Principles, Radiopharmaceuticals used, Indications, etc…)

Syllabus

- General principles of Radionuclide therapy
- Review of therapeutic radiopharmaceuticals
- Radionuclide therapy in Benign Thyroid disorders
- Radionuclide therapy in Thyroid Cancer
- Palliative therapy for Painful bone metastases
- Radiosynovectomy
- Phosphorus-32 therapy in polycythemiarubravera
- Radionuclide therapy in Liver cancerRadio immunotherapy
- Radionuclide therapy in malignant peritoneal ascites
- Radionuclide therapy in Neuroendocrine tumors
- Radionuclide therapy in brain tumors
- Epidermal Radionuclide Therapy
- PET for Radiotherapy Planning
- Recent Advance in Therapeutic Nuclear Medicine

Course outcomes:

- Gaining knowledge about various aspects pertaining to Radionuclide therapy (Principles, Radiopharmaceuticals used, Indications, etc…)

Recommended Books

1. Nuclear Medicine – The requisites – Thrall James
2. Principles and Practice of Nuclear Medicine – P J Early, DB Sodee
3. Mosby's manual of Nuclear Medicine Procedures – DB Sodee, P J Early

HEALTH PHYSICS AND RADIATION SAFETY

Course: Core
Credits: 04 **Theory classes: 60 hours**

Course objectives:

- Gaining knowledge about radiation hazards, Radioactive waste disposal, ALARA, Planning of Nuclear Medicine laboratories, etc…

Syllabus

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage	Type Of Questions
		Unit 1: Radiation Hazards Evaluation and control: External Radiation Hazard, General Principles of reduction such as Time, Distance, Shielding factors, Internal Radiation Hazard, Effective, Half- life, surface contamination, control of Radiation Hazards in Nuclear Medicine Laboratories, Area Monitoring Personal Monitoring and decontamination procedures, Radiation safety with PET Imaging.					

		Unit 2: Operational Limits: Principle of Radiation Protection, Dose limits to radiation workers, general public-ICRP recommendations and dose constraints for comforters and visitors of patients.					
		Unit 3: Radiation Safety Consideration in Radionuclide therapy: Radionuclide administration techniques, pre and post therapy precautions, nursing care, patient monitoring and discharge criteria, optimization of radiation dose to non-target tissues, radiation safety considerations in palliative bone metastasis treatment, radiation safety during other therapy procedures such as radiation synovectomy, peptide therapy etc.					
		Unit 4: Radiation Dosimetry: Radiotracer kinetics, compartmental models, internal and external dose calculations, classical dosimetry mechanism, MID formulation, tracer kinetic modeling in PET, radiation dosimetry and protection. Calibration and performance check of Radiation monitoring instruments, area and environmental monitoring, external contamination monitoring.					

		Unit 5: Radiation Waste Disposal : Classification of wastes,radioactive waste management, methods of radioactive wastedisposal, permissible levels of radioactivity in the discharge tosewerage, management of cadavers containing radioactivity.					
		Unit 6: Planning of Nuclear medicine Laboratories: Types of laboratories, Requirement of space, Equipment, Facilities,Staff etc. Planning of various categories of NM laboratoriessuch as Diagnostic and High Dose therapy, PET CT andCyclotron Installation, Shielding calculation during planning of NM laboratories.					
		Unit 7: Radiation emergencies in Nuclear Medicine Laboratories: Spillage of radiopharmaceuticals, prevention of spillage, handling procedures of spillage, Misadministration radiopharmaceuticals, Consequences of misadministration, general methods of prevention of accidents, nature Of emergencies and action to be taken.					

		Unit 8: Transport of radioactive material: Types and categories of radioactive consignments, receipt and dispatch modes. Legislation and Regulatory Requirements for Nuclear medicine Laboratories: Atomic energy Act-1962, Atomic Energy Radiation Protection Rules-2004, Atomic energy Regulatory board, Competent Authority, Atomic Energy (Safe Disposal of Radioactive Waste) Rules 1987, AERB Safety Code, Licensing and Authorisation Procedures.					

Course outcomes:

- Gaining knowledge about radiation hazards, Radioactive waste disposal, ALARA, Planning of Nuclear Medicine laboratories, etc…

Recommended Books

1. Radiation Safety Nuclear Medicine: AERB Mumbai
2. Accreditation program for Nuclear Medicine Technologists in Radiation Safety: PK Gaur
3. Nuclear Medicine Physics – Ramesh Chandra
4. Textbook of Radiation Physics – Ramesh Chandra

BIO STATISTICS

Course: AECC

Credits: 02 **Theory classes: 30 hours**

Course Objectives:

- At the end of the course students will be familiar with statistics methods and techniques.
- After the completion of the course students will be able to manage the data with various validations and cleaning process.
- At the end of the course students will be familiar with different types of data analysis techniques.
- At completion of the course students can able to operate the statistical software to describe the data with proper presentation.

Syllabus

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Teaching Learning Method	Weightage
Unit I	6hrs	**Introduction** 1.1.Meaning, definition, Characteristics of Statistics, Importance of the study of statistics, branches of statistics, statistics and health science including nursing, parameters and estimates, Descriptive and inferential statistics. Variables and their types. Measurement of scales	√			Lecture/ Activity	15%
Unit 2	4hrs	**Tabulation of Data** 2.1.Raw Data, the array, Frequency distribution. Basic principles of graphical representation. Types of diagrams- histograms, frequency polygons, smooth frequency polygon, cumulative frequency curve, Normal Probability Curve.					

Unit 3	4hrs	**Measure of central tendency** 3.1.Need for measures of central tendency. Definition and calculation of Mean- ungrouped and grouped. Meaning, interpretation and calculation of median – ungrouped and grouped. Meaning and calculation of mode. Guideline for the use of various measure of central tendency.					
Unit 4	4hrs	**Measure of variability** 4.1.Need for measure of Dispersion. The range, the average deviation. The variance and standard deviation. Calculation of variance and standard deviation ungrouped and grouped. Properties and use of variance and SO.					
Unit 5	4hrs	**Probability and standard distribution** 5.1.Meaning of Probability of standard distribution. Binomial distribution. Normal distribution. Divergence from normality- skewness, kurtosis.					

Unit 6	4hrs	**Sampling Techniques** 6.1.Need for sampling- criteria for good samples. Application of sampling in community. Procedure of sampling and sampling design error. Sampling variation and tests of significance.					
Unit 7	4hts	**Health indicator** 7.1.Importance of health indicator. Indicators of population, morbidity, mortality, health service, Calculation of rates and rations of health					

Course Outcomes:

At completion of the course students

- will be familiar with statistics methods and techniques.
- will be able to manage the data with various validations and cleaning process.
- will be familiar with different types of data analysis techniques.
- can able to operate the statistical software to describe the data with proper presentation.

Recommended Textbooks:

- Mausner&Bahn: Epidemiology-An Introductory text, 2nd Ed W.B. Saunders Co.
- Richard F. Morton &J. Richard Hebd: A study guide to Epidemiology and Biostatistics,2ndEd., University Park Press, Baltimore.

Sylvia W Smoller, J Smoller, Biostatistics &Epidemiology A Primer for health andBiomedical professionals, 4thedition, Springs, 2015

HEALTH PHYSICS AND RADIATION SAFETY

PRACTICALS

Course: Core
Credits: 04 **Practicals classes: 120 hours**

Course objectives:

- Gaining knowledge about various aspects of Radiopharmacy, Radiation safety to mention a few
- Radiopharmacy Practices
- In-vitro Nuclear Medicine Practices
- Scintigraphy Practices
- Radionuclide Therapy Practice

Syllabus

Therapeutic Nuclear Medicine:

- Dose dispensing of iodine 131.
- Therapy Dose dispensing P-32, Sm-153, etc
- Delay tank measurement, Sampling

Health Physics and Radiation Safety

- Radiation survey.
- Decontamination,
- Radiation exposure - effect of time, distance and shielding.
- Calibration check of contamination Monitor, radiation survey meter and monitoring instruments using standard source(s)

Course outcomes:

- Gaining knowledge about various aspects of Radiopharmacy, Radiation safety to mention a few
- Radiopharmacy Practices
- In-vitro Nuclear Medicine Practices
- Scintigraphy Practices
- Radionuclide Therapy Practice

Clinical Nuclear Medicine Practicals – II

Course: Core
Credits: 04 **Practicals classes: 120 hours**

Course objectives:

- Gaining knowledge about the practical aspects of doing some of the routinely done Nuclear Medicine procedures (Myocardial perfusion scintigraphy, DTPA study, Brain perfusion mapping, etc…) in day to day practice

Syllabus

- Cardiovascular System:
- Radionuclide ventriculography
- Myocardial perfusion imaging
- Myocardial viability imaging
- Endocarditis

Genitourinary System:

- Cortical imaging
- Renal dynamic scan
- Captopril Renogram
- Transplant evaluation
- DRCG

Central Nervous System:

- Epilepsy
- Radionuclide cisternography.
- Ventriculo-peritoneal shunt evaluation
- Dementia imaging
- Motor neuron diseases

Miscellaneous Studies:

- Infection imaging
- Lymphoscintigraphy
- Dacryoscintigraphy
- Sentinel lymphnode imaging
- Sialoscintigraphy

Course outcomes:

- Gaining knowledge about the practical aspects of doing some of the routinely done Nuclear Medicine procedures (Myocardial perfusion scintigraphy, DTPA study, Brain perfusion mapping, etc…) in day to day practice

CLINICAL INTERNSHIP- (1 Year)

Course: Core

Credits: 36 **Duration: 1 year**

Course Objectives:

- To Acquire the clinical knowledge
- To understand the workflow in Nuclear Medicine dept
- To practice and observe Nuclear Medicine Imaging procedures.

The internship time period provides the students the opportunity to continue to develop confidence and increased skill in diagnosis and treatment of various diseases using various Nuclear Medicine Techniques. Students will demonstrate competence in beginning, intermediate, and advanced procedures in both areas. Students will participate in advanced and specialized diagnostic and treatment procedures. The student will complete the clinical training by practicing all the skills learned in classroom and clinical instruction. The students are expected to work for minimum 8 hours per day and this may be more depending on the need and the healthcare setting.

Course Outcomes:

At completion of the clinical internship, students

- Can work independently
- Can acquire diagnostic image of patient
- Can make relevant log book