REGULATIONS AND CURRICULUM GOVERNING

M.Sc. MEDICAL IMAGING TECHNOLOGY

Implemented in Academic Year 2020-21

Amended up to 2025

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

Deralakatte, Mangalore, Karnataka.

NOTIFICATION FROM THE UNIVERSITY

Sl. No.	ACM with date	Decisions/Approvals
1.	39th ACM/ 27.08.2020	Starting of M.Sc. Medical Imaging Technology program under the Faculty of Allied and Healthcare Professions and approval of the Curriculum & Regulations.
2.	43rd ACM/ 07.07.2021	Approved the introduction of the Choice Based Credit System (CBCS) for the M.Sc. Medical Imaging Technology programme
3.	51st ACM/ 16.05.2023	Approval of CBCS regulations: Form CIA 40% and SEE 60% to CIA 50% and SEE 50%. Minimum pass marks for CIA shall be 50% and SEE shall be 50% Revision in the CBCS regulations governing PG program
4.	58th ACM/ 13.08.2024	Approved the amendment of the dissertation credit distribution from 6 credits to 12 credits.
5.	63rd ACM/ 13.05.2025	Approved the amendment on Structured continuous internal assessment components of PG dissertation

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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. Postgraduate Program in Allied Health sciences speciality often encompasses a wide range of disciplines. The learning during post-graduation is usually heavily research focused. Professionals in the medical field rely heavily on modern technology to successfully treat, diagnose, and care for patients. By doing post-graduation in Allied health disciplines one will be preparing for a career as an educator, researcher, or technologist. Students may find a variety of options upon completion of post-graduation such as managing the Laboratories, Operation theatres, Radiology suites and Dialysis units. They can also join as teachers in the faculty of Allied and health professionals. They can also do research, pursue doctorate in their field of interest. They can also join biomedical equipment manufacturing company and pharmaceutical company as experts in their field.

A master's in Medical Imaging degree can prepare graduates to become radiographers, who assist radiologists and other medical doctors with advanced patient care, imaging, and diagnostic procedures knowledge. Individuals who pursue an administrative track may work as medical and health service managers. Additionally, graduates from an education and teaching master's degree program may work as post-secondary healthcare speciality teachers. Graduates may even pursue PhD and even enter R&D sections of reputed companies manufacturing medical imaging equipment

In accordance with this to match our education system with the international educational pattern we are introducing Choice Based Credit System from the academic year 2021 onwards.

2. Definitions

2.1 Academic Year:

Two consecutive (one odd + one even) semesters constitute one academic year.

2.2 Choice Based Credit System:

The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).

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 some of these.

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 16–20-week 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.

2.5 Programs:

An educational program leading to award of a degree, diploma or certificate.

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 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.

2.9 Letter Grade:

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

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.

Type of Courses

2.12 Core course:

A course that should compulsorily be studied by a candidate as a core requirement is termed as a core course. This is the core requirement to complete the M.Sc. Medical Imaging Technology programme.

2.13 Skill Enhancement Course:

These courses are aimed at improving practical, professional & procedural knowledge requirement for carrying the highly skilled task related to the field of study.

2.14 Multidisciplinary Elective:

Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline or subject or domain or

nurtures the candidate's proficiency skill.

A candidate shall have the freedom to choose Multidisciplinary Elective courses during the academic duration of the particular PG programme offered by Yenepoya (deemed to be) University through the PG departments or SWAYAM/MOOC external online platforms or a mix of courses offered by Yenepoya (deemed to be) University and SWAYAM/MOOC as appropriate.

i. A candidate opting for SWAYAM/MOOC courses shall have the freedom to choose the courses of once own choice and complete such courses before appearing fourth Semester End Examination.
ii. A candidate shall compulsorily submit the pass certificate of each course successfully completed to the controller of examination of Yenepoya (deemed to be) University through the proper channel before appearing the fourth semester end examination.
iii. A candidate opting Multidiciplinary Elective courses offered by the Yenepoya (deemed to be) University through the PG departments need to take up these courses generally during second and third semesters of the programme.
iv. A candidate shall not take the courses offered by the department in which she/he is enrolled.
v. Registration for the Multidiciplinary Elective courses offered by the Yenepoya (deemed to be) University shall be at least one week prior to the commencement of the course with the CBCS coordinator. The CBCS unit shall notify the list of courses after being approved by the respective BOS. For SWAYAM/MOOC courses shall be as per the enrollment notification by the respective implementation authorities.

Yenepoya (deemed to be) University shall adapt the regulations of UGC governing SWAYAM/MOOC courses as amended from time to time.

3. Eligibility for Admissions:

Candidates who have passed B.Sc. Medical Imaging Technology (MIT) or B.Sc. Radiography degree from institutions where the mode of study is a full-time program, with minimum 4 years duration from this university or any other university in India or abroad as equivalent with not less than 50% of marks in aggregate and have completed 1 year of compulsory rotating internship in colleges recognized by Yenepoya (Deemed to be University) - Karnataka are eligible.

Candidates completing B.Sc. Program through correspondence course are not eligible.

4. Duration of the Program

The duration of the programme shall extend over 4 semesters (2 academic years) of 15 weeks or more each with a minimum of 90 actual working days of instructions in each semester and 2 – 3 weeks of examinations. The successful completion will lead to Master's degree in Medical Imaging Technology.

Semester

An academic year shall consist of two semesters;

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

5. Maximum Period for Completion of Programme:

A candidate shall complete the four semesters (two years) program within four years from the date of admission.

6. Aim of the Program

To prepare competent postgraduate medical imaging professionals with advanced scientific knowledge in imaging sciences and technology, capable of safely performing, optimizing, and interpreting medical imaging procedures across diagnostic, interventional, and advanced imaging modalities. Graduates will be skilled in patient assessment, radiation safety, quality assurance, and ethical practice, while demonstrating effective communication, collaborative functioning within multidisciplinary healthcare teams, and a commitment to lifelong learning, research orientation, and community-oriented healthcare services.

7. Outcomes of the Program

Program Outcome (PO): (Knowledge – K, Skill – S, Attitude – A, Communication – C)

Upon successful completion of the Masters' course, students will have developed a broad knowledge of basic and advanced physics, principle, instrumentation and application of various imaging modalities

In particular they will:

PO 1: Function as competent advanced level medical imaging technologists (K,S,A,C)

PO 2: Demonstrate the ability to use theoretical knowledge and critical thinking skills in clinical practice. (K,S,C)

PO 3: Have an advanced theoretical knowledge on all the modalities.(K,S,)

PO 4: modify the protocols according to the demand and need (K,S,C)

Expected skill to be acquired by the end of the programme:

PO 5: Train students in routine/special imaging procedure on different modalities (K,S,A,C)

PO 6: select and operate different modalities as per to the need of physician (K,S,C)

PO 7: Upgrade knowledge and skills in a changing healthcare scenario (K,S,A,C)

PO 8: Should be capable of supervise / guide the staff working on various advanced modalities (K,S,A,C)

PO 9: provide best clinical information to the physician (K,S,C,)

PO 10: Should be capable of teaching, proposing/executing research project (K,S,A,C)

Program Structure:

	Broad category of course	Hours / Credits	Course (Title)
1.	**Discipline-Specific Courses**		
a)	Theory	**I Semester**	
		45 Hours / 3 Credits	Instrumentation And Physics of Radiography
		45 Hours / 3 Credits	Principles Of Exposure and Image Processing
		45 Hours / 3 Credits	Research Methodology & Biostatistics
		II Semester	
		45 Hours / 3 Credits	Radiographic Positioning and Procedures
		45 Hours / 3 Credits	Radiation Protection & Management in Radiology
		45 Hours / 3 Credits	Basic And Advanced Instrumentation in CT
		45 Hours / 3 Credits	Bioethics
		III Semester	
		45 Hours / 3 Credits	Basic And Advanced Instrumentation of Ultrasound & Doppler
		45 Hours / 3 Credits	Nuclear Medicine Imaging and Basics of Radiation Therapy

		45 Hours / 3 Credits	Healthcare Management
		IV Semester	
		45 Hours / 3 Credits	Basic And Advanced Instrumentation of MRI
		45 Hours / 3 Credits	Interventional Radiology
		45 Hours / 3 Credits	Patient Care in Radiology
b)	Practical (SEC)*	**I Semester**	
		300 Hours / 12 Credits	Basic And Advanced Techniques of Imagining and Processing
		II Semester	
		300 Hours / 10 Credits	Methods Of Radiation Protection Evaluation and Imaging Techniques of CT and Procedures
		III Semester	
		300 Hours / 10 Credits	Patient Care and Techniques of Ultrasound and Nuclear Medicine
		IV Semester	
		300 Hours / 10 Credits	Patient Care & Techniques of Clinical MRI And Interventional Radiology
2.	**Curriculum Enrichment Courses**		
a)	Research Project	12 credits	Dissertation
3.	**Electives**		
a)	Interdisciplinary Courses	90 Hours/6 Credits	Coursera/Swayam
	Total	**99 Credits**	

SEC: Skill Enhancement Course

8. Attendance:

8.1. 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.

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

8.3. For SWAYAM/MOOC/NPTEL it shall be as per the regulations governing the courses of implementing authority.

8.4. The HOD/Course 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

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SEMESTER-I

Course Title: Instrumentation and Physics of Radiography

Course: Core

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

Course Outcome:

To understand the general physics related to Medical Imaging Technology.

Construction and working of Equipment's used in x- ray.

Application of Equipment's in Medical Imaging Technology.

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit 1	2	Generation of electrical energy Distribution of electrical energy Uses of electricity in hospitals Safety rules for technologist			✓	5	LE,SE,
Unit 2	2	X ray circuit components High tension transformers Main voltage compensation High tension switches Stabilizers and UPS		✓		5	LE, SE, SA
Unit 3	2	Fuses Switches			✓	10	LE, SE, SA

		Earthing High tension cables constructions and design Rectifications Types of rectifiers					
Unit 4	2	Transformers and its types	✓			10	LE, SE,
Unit 5	1	Tube rating Types of generators	✓			10	LE, SE, SA
Unit 6	5	Switches Circuit breakers Exposure switching and its application Magnetic relay Thermal relay switches Interlock in tube circuit and over load inter interlocks			✓	5	SE, SA
Unit 7	5	Exposure Timers Timing systems Electronic timer Ionization timer Photo timer Synchronous timer and impulse timer		✓		5	SE, SA
Unit 8	5	Devices improving radiographic quality Cone Cylinder Collimator	✓			10	LE, SE, SA

		Grid Filter					
Unit 9	5	Portable & Mobile equipments Mains requirements Cable connections to wall plugs Portable X-Ray Equipments Mobile X-Ray Equipments Capacitor Discharge Mobile Equipment Cordless Mobile Equipments X-Ray Equipments for the Operating Theatre Mobile Image Intensifier units	✓			5	LE, SE,
Unit 10	5	Fluoroscopy Equipments Construction & Working principles of Image Intensifier Viewing the Intensified image Recording the intensified Image Digital fluoroscopy Panel type image intensifier	✓			10	LE, SE, SA
Unit 11	5	Fluoroscopic / Radiographic Tables General features of fluoroscopic / radiographic table The serial changer Remote control table The spot film devices		✓		10	LE, SE
Unit 12	2	Tomographic Equipment Principles of tomography Various types of tomographic			✓	5	LE, SE, SA

		movement Equipment for linear tomography					
Unit 13	2	Equipment for Cranial and Dental radiography The skull table General Dental X-ray equipment Pantomography equipment Equipment for Cranial & skeletal radiography Equipment for mammography		✓		5	SE, SA
Unit 14	2	Care, Maintenance and tests General care Functional tests Quality assurance program Acceptable limits of variation Corrective action			✓	5	SE, SA

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

Recommended Books:

1. Chesney DN, Chesney MO. X-ray equipment for student radiographers. 3.
2. Curry TS, Dowdey JE, Murry RC. Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins; 1990.
3. Thompson TT. practical approach to modern x-ray equipment

Course Title: Principles of Exposure and Image processing

Course: Core

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

Course Outcome:

Construction and working of film, intensifying screen, cassette, dark room, computed radiography, direct radiography, automatic processor.

To understand radiographic film Processing chemistry.

To study the factors affecting image quality in radiographic image and their application.

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit 1	5	X- ray production Interaction of radiation with matter Useful range of Electro Magnetic Radiation Clinical applications			✓	10	LE, SE
Unit 2	10	The Photographic Process Basic review of photographic emulsion Photographic latent image Film materials Speed and contrast of photographic material Intensifying screens and cassettes		✓		10	LE, SE, SA

		Film processing					
Unit 3	5	Sensitometry Photographic density Opacity Transmission Production of characteristic curve Features of the characteristic curve Variation in the characteristic curve with development Comparison of emulsion by their characteristic curve Application of characteristic curve Information from the characteristic curve	✓			20	LE, SE, SA
Unit 4	10	Radiographic image Radiographic density Acceptable range Factors influences density Radiographic contrast Components Factors influence contrast Management of radiographic image quality	✓			15	LE, SE, SA
Unit 5	5	Resolution Line spread function & modulation transfer function Unsharpness in the radiographic image and various factors		✓		20	SE, SA

		contributing towards unsharpness Types of unsharpness Radiographic mottle					
Unit 6	5	Geometry of the radiographic image Magnification/distortion – types and factors			✓	10	LE, SE,
Unit 7	5	Instrumentation of processing equipment Automatic film processor (AFP) Layout and planning of dark room Viewing accessories: viewing boxes Magnifiers and viewing conditions	✓			15	LE, SE, SA

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

Reference Books:

1. Curry TS, Dowdey JE, Murry RC. Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins; 1990.
2. Ball J, Price T. Chesneys' radiographic imaging. 5.
3. Forster E. Equipment for diagnostic radiography. Springer Science & Business Media; 1985 Dec 31

Course Title: Research Methodology & Biostatistics

Course: Core

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

Research Methodology

Course Learning Objectives:

CLO 1: To describe the types, need and process of research

CLO 2: To outline the process and purpose of literature review

CLO 3: To explain various biomedical research designs with advantages and disadvantages.

CLO 4: To outline the process involved in data collection and analysis

CLO 5: To explain the components of research paper and process of publication.

Course Content

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage	Type of Question

Unit I	**2 hours**	**1. Introduction** 1.1 Need for research	✓			10%	**SE**
		1.2 Types of research	✓				
		1.3 Outlining the research process	✓				
Unit II	**2 hours**	**2. Review of Literature** 2.1 Importance, sources & steps	✓			10%	**SE**
		2.2 Critical appraisal of research article	✓				
Unit III	**2 hours**	**3. Research Design** 3.1 Types of research – Qualitative & Quantitative	✓			10%	**LE,SE**
		3.2 Experimental & Non Experimental, Survey – advantages & disadvantages	✓				
Unit IV	**2 hours**	**4. Research Process** 4.1 Framing a research question	✓			15%	**LE,SE**
		4.2 Research title	✓				
		4.3 Aim & Objectives, Assumptions, Limitations & Delimitations, Variables	✓				

		4.4 Hypothesis – formation & testing	✓				
Unit V	**2 hours**	**5. Data collection & analysis** 5.1 Data sources, technique of data collection, tools	✓			20%	**LE,SE**
		5.2 Reliability & validity	✓				
		5.3 Process of data collection	✓				
		5.4 Pilot study – method, need	✓				
Unit VI	**2 hours**	6. **Interpretation & presentation of data** 6.1 Qualitative & quantitative analysis	✓			15%	**LE,SE**
		6.2 Graphical representation of data	✓				
		6.3 Conclusion & discussion	✓				
Unit VII	**2 hours**	7. **Discussion, Conclusion and References**	✓			10%	**SE**
Unit VIII	**2 hours**	8. **Essentials of writing a research paper along with process of**	✓			10%	**LE**

		publication					

Course Outcome:

At the end of the Course, the students will

- have knowledge of process involved in Biomedical research from formulation to publication.
- be able to draft a research proposal.

Biostatistics

Course Learning Objectives:

CLO 1: To Understand the Statistical Terms.

CLO 2: To Possess Knowledge and Skill in the use of Basic Statistical and Research Methodology.

Course Content:

Unit	**Hrs**	**Content**	**Must Know**	**Good to Know**	**Desirable to Know**	**Weightage**	**Type of Question**

Unit I	**6 hours**	**1. Introduction** 1.1 Introduction to biostatistics &research methodology, types of variables & scales of measurements, measure of central tendency & dispersion, rate, ratio, proportion, incidence & prevalence	✓			5%	**LE,SE**
Unit II	**3 hours**	2. **Sampling** 2.1 Population & Sample, Sampling and non-sampling errors and methods of minimizing these errors, Random and non-random sampling, different sampling techniques – simple random, stratified, systematic, cluster& multistage.	✓			10%	**LE,SE**

Unit III	**3 hours**	3. **Sampling distributions** 3.1 Parameter and Statistic. Standard error. Basic probability distributions - Normal, poisson, binomial distributions with their applications in biological sciences.	✓			5%	**SE**
Unit IV	**6 hours**	**4. Tests of significance** 4.1 Basics if testing of hypothesis – Null & Alternative hypothesis, type 1 and type II errors, level of significance (parametric) & power of the tests, p value, Confidence interval. Tests of significance – T test (paired &UN paired), Chi square test & Test of proportion, One way analysis of	✓			15%	**LE,SE**

		variance. Repeated measures analysis of variance. Tests of significance (non-parametric) – Mann – Whitney U Test, Wilcoxon Test, Kruskal – Wallis Analysis of variance, Friedmann's Analysis of variance					
Unit V	**3 hours**	**5. Correlation and regression** 5.1 Linear correlation by Karl Pearson and rank order correlation due to Spearman, Testing the significance of correlation co efficient, simple linear regression – estimation & testing, residual plots, multiple linear regression.	✓			15%	**LE**

Unit VI	**2 hours**	**6. Sample size determination** **6.1** General concept. Sample size for estimating means and proportion, testing of difference in means and proportions of two groups.	✓			5%	**SE**
Unit VII	**2 hours**	**7. Study designs** 7.1 Epidemiological methods – case series analysis and prevalence studies. Analytical epidemiological methods – case control and cohort studies. Clinical trials / intervention studies, odds ratio and relative risk, stratified analysis	✓			10%	**SE**
Unit VIII	**2 hours**	**8. Multivariate analysis** 8.1 Concept of multivariate analysis, introduction to	✓			15%	**LE,SE**

		logistic regression and survival analysis					
Unit IX	**1 hours**	**9. Reliability and validity of diagnostic tests** 9.1 Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), ROC curve.	✓			10%	**LE,SE**
Unit X	**1 hours**	**10. Format of scientific documentations** 10.1 Structure of research protocols, structure of thesis/research report, formats of reporting in scientific journals. Systematic review and meta-analysis.	✓			10%	**LE,SE**

Course Outcome:

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

- Able to distinguish different data types, variables and scales of measurement

- Able to organize, tabulate and present data through tables and graphs. Compute and interpret descriptive statistics
- Able to compute and interpret sensitivity, specificity, PPV, NPV and ROC Analysis.
- Able to determine sample size and use of random sampling methods.
- Able to interpret Power of a test, Level of significance, p value and confidence interval. Use of t-test, ANOVA and m3ultiple comparison.
- To interpret the commonly used parametric and nonparametric tests and how to report the findings.
- Carryout correlation analysis and interpret the results
- Perform regression analysis and draw conclusions of the analysis. Use the regression model for predictions.

Reference Books:

- Rao NSN: Applied statistics in health sciences, JP publishers
- Mahajan B.K: Methods of biostatistics, Kothari book depot, A.D Marg, Bombay
- Potti L.R: A text book of statistics, Yamuna publications, Sreekanteshwaram,
- Trivandrum.
- Lancaster H.O: Introduction to medical statistics, Johnwiley & sons, New York.
- Leius A.E: Biostatistics, Reinhold publishing Co, New York.
- Cotton T: Statistics in medicine, Little Brown & Co, Boston.
- Hill A.B: Principles of medical statistics, Oxford University press, New York

Course Title: Basic and Advanced Techniques of Imaging and Processing

Course: Core

Total Credits: 12 **Number of Hours: 300**

Course Learning Objectives:

CLO 1: Understand the basic and advance physics behind x-ray

CLO 2: Construction and working of Equipments used in x- ray

CLO 3: Construction and working of film, intensifying screen, cassette, dark room, computed radiography, direct radiography, automatic processor

Course Content:

Unit	No. of Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage
1	30	Computerized Radiography 1.1 Components 1.2 Working	✓			10%
2	30	Digital Radiography 2.1 Components 2.2 Working	✓			15%
3	30	Devices improving radiographic quality	✓			15%

4	30	Portable & Mobile Equipment 4.1 Components 4.2 Working	✓			10%
5	30	Digital Fluoroscopy 5.1 Components 5.2 Working	✓			15%
6	20	Application of characteristic curve			✓	5%
7	30	Image Quality		✓		5%
8	30	Automatic film processor (AFP)		✓		5%
9	30	PACS, DICOM	✓			10%
10	20	Macro Radiography and Microradiography	✓			5%
11	20	Recent Advancements		✓		5%

Reference Books:

1. Curry TS, Dowdey JE, Murry RC. Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins; 1990.
2. Ball J, Price T. Chesneys' radiographic imaging. 5. Forster E. Equipment for diagnostic radiography. Springer Science & Business Media; 1985 Dec 31

SEMESTER-II

Course Title: RADIOGRAPHIC POSITIONING AND PROCEDURES

Course: Core

Credits:3

No of Hours: 45 Hours

Course Outcome:

- To distinguish indications and contra indications for procedure based on patient history.
- To classify the contrast media based on solubility and physiology of excretion
- To assist radiologist by setting the equipment required for procedure

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit I	3	**Skull**				10	LE,SE, SA
		1.1 Related anatomy of Skull		✓			
		1.2 Associated pathology and radiographic appearance			✓		
		1.3 Radiographic projections - Routine and Special views	✓				

Unit II	3	**Vertebral Column:**				5	LE, SE, SA
		Related anatomy of Vertebral Column			✓		
		Associated pathology and radiographic appearance			✓		
		Radiographic projections - Routine and Special views	✓				
Unit III	4	**Mammography**				5	LE, SE, SA
		3.1 Related anatomy and Physiology			✓		
		Associated pathology and radiographic appearance			✓		
		ICRP guidelines BIRADS		✓			
		Radiographic projections - Routine and Special views	✓				
Unit IV	3	**Upper limb**				5	LE, SE, SA
		Related anatomy of Upper limb			✓		
		Associated pathology and radiographic appearance			✓		
		Radiographic projections - Routine and Special views	✓				
Unit V	3	**Pelvis**				10	LE,SE, SA
		Related anatomy			✓		
		Associated pathology and radiographic appearance			✓		

		Radiographic projections - Routine and Special views	✓				
		Pelvimetry		✓			
Unit VI	3	**Lower limb**				5	LE, SE, SA
		6.1 Related anatomy of **Lower limb**			✓		
		6.2 Associated pathology and radiographic appearance		✓			
		6.3 Radiographic projections - Routine and Special views	✓				
Unit VII	2	**Dental Radiography**				5	SE, SA
		7.1 Related anatomy			✓		
		7.2 Associated pathology and radiographic appearance		✓			
		7.3 Radiographic projections - Routine and Special views	✓				
		7.4 Intra oral and Extra oral View			✓		
		7.5 OPG and Cephalometry	✓				
		7.6 CBCT and Recent Advancement	✓				
Unit VIII	4 hours	**Contrast Media**				5	LE, SE, SA
		Physiology Application & types		✓			
		Contrast Reactions		✓			

		Safety aspects					
		Mode& volume of administration Administration techniques	✓				
		Catheters Guide wires and other tools	✓				
Unit IX	4 hours	**Digestive System**				10	LE, SE, SA
		Anatomy and physiology Associated pathology and radiographic appearance			✓		
		Special studies		✓			
		Barium swallow Barium meal Barium meal follow through	✓				
		Enteroclysis Barium enema Loopogram	✓				
Unit X	3 hours	**Hepatobiliary system**				15	LE, SE, SA
		Anatomy and physiology Associated pathology and radiographic appearance			✓		
		Percutaneous Transhepatic cholangiography PTBD	✓				
		ERCP T – tube cholangiography	✓				
Unit XI	4 hours	**Genito urinary system**				15	LE, SE, SA
		Anatomy and physiology Associated pathology and radiographic appearance		✓			

		Intravenous urogram (IVU) Micturating Cystourethrogram (MCU)	✓				
		Ascending Urethrogram (ASU) Retrograde Urethrogram (RGU)	✓				
		Hysterosalpingography (HSG) Fallopian Tube Recanalisation (FTR)		✓			
Unit XII	3 hours	**Cardio - Respiratory system**				**5**	LE, SE, SA
		Related anatomy and physiology Associated pathology and radiographic appearance			✓		
		Bronchography		✓			
		Percutaneous lung Biopsy		✓			
Unit XIII	5 hours	**Other Procedures**				**5**	LE, SE, SA
		Related anatomy and physiology Associated pathology and radiographic appearance			✓		
		Angiography Plebography		✓			
		Sialography Dacrocystography	✓				
		Sinography Fistulography Arthrography	✓				

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

Recommended books

1. Whitley AS, Jefferson G, Holmes K, Sloane C, Anderson C, Hoadley G. Clark's Positioning in Radiography 13E. crc Press; 2015 Jul 28.

2. Frank ED, Long BW, Rollins JH, Smith BJ. Merrill's Atlas of Radiographic Positioning and Procedures-E-Book: Volume 1. Elsevier Health Sciences; 2013 Aug 13.

3. Lakhkar B. Radiological Procedures–A guideline. Ed. 3.

4. Chapman S, Nikielny R. A guide to radiological procedures.

Course Title: RADIATION PROTECTION & MANAGEMENT IN RADIOLOGY

Course: Core

Credits:3

No of Hours: 45

Hours

Course Outcome:

To identify the protective measures to be taken in the department

To choose appropriate exposure factors

To implement radiation surveys effectively

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit 1	8	Introduction to Radiation Protection Need for protection Aim of radiation protection Basic radiation units	✓			20	LE, SE, SA

		and quantities Exposure Absorbed dose equivalent Quality factor Tissue weighting factor					
Unit 2	8	Limits for Radiation exposure Concept of ALARA (or ALARP) ICRP regulation Maximum permissible dose Exposure in children, pregnancy		✓		15	LE, SE, SA
Unit 3	8	Protection in Diagnostic Radiology Protection for primary radiation Protection for scatter and leakage radiation Work load Occupancy factor Use factor X-Ray room design	✓			15	LE, SE, SA

		Structural shielding Protective devices Radiation signages					
Unit 4	8	Technical Protective Consideration during Radiography Protection in Fluoroscopy Mammography, Mobile radiography CT Scan Angiography room Evaluation of hazards Effective communication Immobilization Beam limiting devices Filtration Exposure factors			✓	15	LE, SE, SA
Unit 5	7	**Radiation measuring instruments** Area monitoring devices Personnel dosimeters Thermo luminescent		✓		15	LE, SE, SA

		dosimeter Film badge Pocket dosimeter					
Unit 6	8	**Biological aspects of Radiological protection** Direct & Indirect effects of radiation Concept of detriment – Deterministic & stochastic effect of radiation – somatic and genetic effects Dose relationship Effects of antenatal exposure	✓			20	LE, SE, SA

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

Reference Books:

1. Curry TS, Dowdey JE, Murry RC. Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins; 1990.
2. Sherer MA, Visconti PJ, Ritenour ER, Kelli Haynes MS. Radiation protection in medical radiography. Elsevier Health Sciences; 2013 Dec 4.
3. ICRP MANUAL

BASIC AND ADVANCED INSTRUMENTATION IN CT

Course: Core

Credits: 3

No of Hours: 45

- **Course Outcome:**
- **To understand the advanced principle of computed tomography**
- **to have an idea of components of CT and its relation in image formation**
- **complete knowledge about the protocols done in CT**

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit I	10	CT Basics				20	LE, SE, SA
		1.4 Basic CT Imaging principles in computed tomography	✓				
		1.5 CT Generations	✓				
		1.6 Instrumentation of CT scan	✓				
		1.7 Advancement in Detector technology		✓			
		1.8 Slip ring technology	✓				
		1.9 Helical CT Single slice and Multi slice CT Scan system	✓				

Unit II	10	CT Image				15	LE, SE, SA
		2.1 Image Formation			✓		
		2.2 Image display	✓				
		2.3 Pre Processing techniques	✓				
		2.4 Post Processing techniques and advancement	✓				
		2.5 Image quality in single slice and multi slice helical CT scan	✓				
		2.6 Dose reduction strategies in CT	✓				
		2.7 Isotropic Imaging	✓				
		2.8 CT Dosimetry	✓				
Unit III	7	HRCT Protocol				15	LE, SE, SA
		3.2 Lungs (THORAX)	✓				
		3.3 Temporal bone	✓				
		3.4 Technical aspects		✓			
		3.5 Volumetric HRCT	✓				
		3.6 Expiratory HRCT	✓				
		3.7 CT Artifacts	✓				
Unit IV	6	CT Protocols				15	LE, SE, SA
		4.1 CT Protocols for paediatric and adults:	✓				
		4.2 CT angiography	✓				
		4.3 CT fluoroscopy		✓			
		4.4 Multidimensional reformations MPR,	✓				
		4.5 Curved MPR,		✓			

		4.6 MIP 3D imaging & 4D CT		✓			
Unit V	6	Advanced Techniques					
		5.1 CT Perfusion scanning		✓			
		5.2 Dentascan		✓		10	LE, SE, SA
		5.3 CT bronchoscopy	✓				
		5.4 CT colonoscopy	✓				
Unit VI	6	**Cardiac Imaging**:					
		6.4 CT coronary angiography	✓				
		6.5 CT calcium scoring	✓				
		6.6 Protocols for paediatric Whole Body	✓			15	LE, SE, SA
		6.7 Protocols for adult Whole Body CT	✓				
		6.8 CT Documentation		✓			
Unit VII	6	**Care, Maintenance and Tests**					
		7.7 General care			✓		
		7.8 Functional tests		✓		10	LE, SE, SA
		7.9 Quality assurance program	✓				
		7.10 Acceptable limits of variation and Corrective action	✓				

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

Recommended books

1.Seeram E. Computed tomography: physical principles, clinical applications, and quality control. Elsevier; 2015.

2. Curry TS, Dowdey JE, Murry RC. Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins; 1990.

3. Romans L. Computed Tomography for Technologists: A comprehensive text. Lippincott Williams & Wilkins; 2018 Aug 7.

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage (%)	Type of Questions

Course Title: Bioethics

Course: Core

Credits: 3

No. of Hours: 45

Course Learning Objectives:

CLO 1: Locate the importance of bioethics in health care and research

CLO 2: Understand the ethical principles and theories

CLO 3: Identify ethical issues in healthcare setting and their possible solutions

CLO 4: Analyse the ethical issues in specific clinical settings

CLO 5: Apply ethical principles in clinical research

CLO 6: Locate the importance of healthcare provider- patient relationship

Course Content:

I	5	**Introduction to bioethics** 1.1 Definition and scope of bioethics	✓			10	LE, SE
		1.2 History of bioethics		✓			
		1.3 Codes of ethics	✓				
II	5	**Ethical principles and theories** 2.1 The ethical principles	✓			30	LE, SE
		2.2 Ethical theories and their	✓				
		2.3 Application of ethical theories and principles in healthcare	✓				
III	10	**Ethics in healthcare** 3.1 Consent	✓			20	LE, SE
		3.2 Risk: benefit analysis	✓				
		3.3 Distributive		✓			

		justice					
		3.4 Privacy and confidentiality	✓				
		3.5 Stigma and discrimination		✓			
		3.6 Health technology assessment			✓		
		3.7 Public health ethics			✓		
IV	15	**Specific ethical issues in healthcare** 4.1 End of life care and euthanasia	✓			10	SE
		4.2 Artificial reproductive techniques			✓		
		4.3 Medical termination of pregnancy		✓			
		4.4 Pre-natal sex determination		✓			
		4.5 Organ donation		✓			
		4.6 Medical errors and truth telling	✓				
		4.7 Medical negligence and	✓				

		malpractice					
V	10	**Research ethics** 5.1. Research ethics principles	✓			30	LE, SE
		5.2. Informed consent	✓				
		5.3. Vulnerability in research	✓				
		5.4. Responsible conduct of research	✓				
		5.5. Publication ethics	✓				

Reference Books:

1. English DC. Bioethics a Clinical Guide for Medical Students.
2. Tayaoe M.C. Textbook of Medical Bioethics, Attitude and Communication for Medical Students; 2016 Feb 28
3. Princy Louis Palatty. A Textbook of Bioethics for Healthcare Professionals 1st Edition; 2018

Course Title: Methods of Radiation Protection Evaluation and Imaging Techniques of CT and Procedures

Course: Core

Total Credits: 10 **Number of Hours: 300**

Course Objectives:

CLO 1: to distinguish indications and contra indications for procedure based on patient history

CLO 2: to classify the contrast media based on solubility and physiology of excretion

CLO 3: to identify the protcetive measures to be taken in the department

CLO 4: to choose appropriate exposure factors

CLO 5: understand the advanced principle of computed tomography

CLO 6: to have an idea of components of CT and its relation in image formation

Course Content:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage

1	40	Routine and Supplementary Projections 1.1 Skull 1.2 Vertebral Column 1.3 Mammography 1.4 Upper Limb 1.5 Pelvis 1.6 Lower Limb	✓			5 %
2	10	Dental Radiography		✓		5%
3	10	Contrast Media 3.1 Types 3.2 Mode and volume of administration 3.3 Applications 3.4 Adverse Reactions and Treatment	✓			5%
4	40	Radiological Procedure – Indications, contra-indications, patient preparation, Equipment used, Technique/procedure, filming, contrast media, complications, aftercare of procedures related to - 4.1 Digestive System 4.2 Hepatobiliary System 4.3 Genito-urinary system	✓			20%

		4.4 Cardio-respiratory system 4.5 Angiography, Plebography 4.6 Sialography, 4.7 Dacrocystography 4.8 Sinography, Fistulography, Arthrography				
5	10	Radiation Units and Quantities	✓			5%
6	10	Radiation Hazards			✓	5%
7	20	Radiation Protection 7.1 Protection for Primary Radiation 7.2 Protection for scatter and leakage radiation 7.3 Protection in Fluoroscopy 7.4 CT Dose Reduction Techniques and Protocols		✓		5%
8	20	Equipment for Radiation Protection	✓			5%
9	20	Area and Personnel Radiation Monitoring Devices	✓			5%
10	20	Biological aspects of	✓			5%

		Radiation Protection				
11	20	Basics principle and instrumentation of CT	✓			5%
12	10	CT Image formation: 12.1 Pre-processing techniques 12.2 Post-processing techniques	✓			5%
13	60	CT Protocols 13.1 HRCT Protocols 13.2 CT Non-contrast protocols of whole body 13.3 Contrast Enhanced CT protocols of Brain, Neck, Thorax, Abdomen, Pelvis 13.4 CT Angiography 13.5 CT Calcium scoring and CT Coronary Angiography 13.6 Pediatric CT Protocols	✓			20%
14	10	Recent Advancements in CT, Fluoroscopy and Radiation Protection		✓		5%

In the Basic and Advanced Techniques of Imaging and Processing will get experience in various aspects in Radiological units under the supervision of experienced professionals and is expected to work and contribute in the Radiological units.

YENEPOYA
(DEEMED TO BE UNIVERSITY)

SEMESTER-III

Course Title: Basic and Advanced Instrumentation of Ultrasound & Doppler

Course: Core

Credits: 3

No of Hours: 45 Hours

Course Outcome:

To infer different protocols used for various anatomical regions

To memorize physics beyond ultrasound imaging

To define the advancements in ultrasound and doppler imaging

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit 1	5	**Ultrasound:** Properties of ultrasound Characteristics of ultrasound Interaction of ultrasound with matter	✓			10	LE,SE,SA
Unit 2	5	**Transducers** Types of transducers	✓			10	LE, SE, SA

		Advancement in the design of modern ultrasound transducers					
Unit 3	14	**Image display** Ultrasound Display modes Ultrasound instrumentation Controls Image storage Scan converter memory Pre and post processing techniques Photographic film Multi format camera Laser imager Colour and video thermal printer Computer storage		✓		20	LE, SE, SA
Unit 4	6	**Doppler imaging** Doppler principles Continuous wave Doppler and pulsed Doppler Duplex scanning Colour flow imaging Power Doppler		✓		15	LE, SE, SA

		Harmonic imaging Extended field of view					
Unit 5	2	Ultrasound contrast agents			✓	10	LE, SE,
Unit 6	5	Image characteristics Vascular Interventional Intraoperative and ophthalmic ultrasonography 3D and 4D ultrasound imaging Ultrasound artifacts Doppler artifacts		✓		15	LE, SE, SA
Unit 7	6	Bio – effects and safety consideration in ultrasound Ultrasound system performance measurements Ultrasound equipments quality assurance – conventional & Doppler system testing Ultrasound Documentation			✓	10	LE, SE,
Unit 8	3	Ultrasound protocols	✓			10	LE, SE,

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

References Books:

1. Rumack CM, Levine D. Diagnostic ultrasound E-book. Elsevier Health Sciences; 2017 Aug 8.
2. Choi J, Nguyen B. Essentials of ultrasound physics, James A. Zagzebski, Mosby, Philadelphia, Pa (1996), 230 pp, 400+ illustrations, softcover.
3. Curry TS, Dowdey JE, Murry RC. Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins; 1990.

Course Title: Nuclear Medicine Imaging and Basics of Radiation Therapy

Course: Core

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

Course Outcome:

To have knowledge of proper handling of radioactive sources.

To know how the radiation will be detected by radiation detection devices

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit 1	5	Basic atomic and nuclear physics Atomic composition and structure Quantities activity Nucleus composition Radioactivity • Exponential decay • Specific activity • Parent/Daughter decay	✓			10	LE,SE

		• Modes of Radioactive decay					
Unit 2	5	Radiation detectors Gas filled detectors-Basic principles Ionization chambers Geiger Muller counters Proportional counters Semiconductor detectors Scintillation detectors-basic principles		✓		10	LE, SE, SA
Unit 3	5	Instrumentation Basic principles System components Detector systems and electronics Collimators Scanning cameras Image display an recording systems	✓			10	LE, SE, SA
Unit 4	10	Production of radio nuclides Reactor produced radio nuclide		✓		10	LE, SE, SA

		Reactor principles Accelerator produced radionuclide Radionuclide generators					
Unit 5	5	Radio pharmacy Radiopharmaceuticals General principles of tracer technique Cold kits Preparation of different labelled compounds with technetium-99m isotope			✓	10	SE, SA
Unit 6	10	In vivo technique Static and dynamic studies Thyroid imaging Imaging of bone Respiratory system G.I system Urinary system Cardiovascular system Iodine 131 uptake studies Iodine 131 therapy of thyrotoxicosis and thyroid ablation		✓		20	LE, SE, SA

Unit 7	5	Image quality in nuclear medicine Spatial resolution Contrast Noise Types of noise Variation in image -with physician, within technologist and technical Quality assurance of imaging equipments	✓			10	LE, SE, SA
Unit 8	5	SPECT imaging PET imaging	✓			10	LE, SE, SA
Unit 9	10	Radiation safety in nuclear medicine Radiation units quantities MPD Safe handling of radioactive materials Storage of radioactive materials Procedures for handling spills	✓			15	LE, SE, SA

		Disposal of radioactive waste Personnel dosimeters Wipe testing Contamination monitor Isotope calibrator Inventory of isotopes Radiation monitoring Survey meters Area monitors					

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

Recommended Books:

1. Cherry SR, Sorensen JA, Phelps ME. Physics in Nuclear Medicine. 2003: Saunders.

Powsner RA, Powsner ER. Essential nuclear medicine physics. John Wiley & Sons; 2008 Apr 15.

Course Title: Healthcare Management

Course: Core

Credits: 3

No. of Hours: 45

Course Learning Objectives:

CLO 1: Concepts of Hospitals – The student will gain knowledge about hospital administration & planning.

CLO 2: Workflow in hospitals - Enumerate and identify various Clinical Services like OPD, IPD, ward Management, OT, Emergency, disaster Management and ICU.

CLO 3: Organizational Structures - To learn to meet special challenges posed by human behavior in workplace of 21st century

CLO 4: Quality management - To create an awareness about the process of applying for and implementing various accreditation process in healthcare facilities.

Course Content:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to	Weightage	Type of Questions
I	4	**Hospital Structure** 1.1. Introduction to Hospitals, Healthcare & Medical Care, Rationale of HospitalAdministration	✓			5%	SE
		1.2. History of Hospitals, Public Health Delivery system in India, Types of Hospitals, Voluntary Health Organizations			✓		
II	8	**Management of Healthcare Organizations** 2.1 Introduction to Management	✓			20%	LE, SE
		2.2 Evolution & Theories of Management		✓			
		2.3 Management Functions: Planning	✓				
		2.4 Organizing	✓				
		2.5 Controlling	✓				

		2.6 Decision Making	✓				

		2.7 Staffing	✓				
		2.8 Techniques in Management	✓				
III	7	**Organizational Behavior** 3.1 The Importance of Interpersonal Skills, Scope & Process of OB Structure & theories	✓			15%	LE, SE
		3.2 Motivation - Abraham Maslow's hierarchy of needs theory, Theory X & Y. Contemporary theories of motivation.	✓				
		3.3 Foundations of Group Behavior – Formal Vs Informal, Social Identity Theory		✓			
		3.4 Organizational Culture		✓			
		3.5 Communications in an Organization	✓				
IV	7	**Management and Health Economics** 4.1 Demand & Supply	✓			20%	LE, SE

		4.2 Nature of Costs	✓				

		4.3 Marginal cost and breakeven analysis	✓				
		4.4 Market structure: Business & Government, Role of Government	✓				
V	7	**Accounting for Hospital Management** 5.1 Budgeting & Budgetary control - Classification of budget, P & L, Balance Sheets	✓			20%	LE, SE
		5.2 Types of Accounts, Debit & Credit	✓				
		5.3 Financial Statement Analysis	✓				
VI	7	**Concept of Hospital** 6.1 Departmentation in Hospital	✓			10%	SE
		6.2 Outpatient, Inpatient Services	✓				
		6.3 Intensive Care Unit, Emergency Services	✓				
		6.4 Laboratory, Radiology	✓				

		6.5 Organizing of support services, Utility Services	✓				
		6.6 Evaluation of Hospital services – Hospital Statistics	✓				
		6.7 Hospital Information Systems - Issues related to Healthcare technology, Planning, Infrastructure	✓				
VII	5	**Evolution of Quality management** 7.1 Quality Management Tools & methods	✓			10%	SE
		7.2 Quality certification & Accreditation – NABH, NABL	✓				

Text book/ Reference Books:

1 Prasad LM. Principles and practice of management. Sultan Chand & Sons; 2020 Oct 1

2 Robbins SP, Judge TA, Vohra N. Organizational behaviour by pearson 18e. Pearson Education India; 2019.

3 Sakharkar B. M. Hospital planning & administration. Jaypee Brothers Medical Publishers Pvt. Limited, 2008 Dec 1.

4 Francis CM, De Souza MC. Hospital administration. Jaypee Brothers Medical Publishers; 2000.

5 Kulkarni GR, Satyashanker P, Anil Gomes L. Financial management for hospital administration. Jaypee Brothers Medical Publishers Pvt. Limited, 2009

Course Title: Patient Care and Techniques of Ultrasound and Nuclear Medicine

Course: Core

Total Credits: 10 **Number of Hours: 300**

Course Objectives:

CLO 1: to infer different protocols using practical knowledge of various anatomical regions

CLO 2: to memorize physics beyond ultrasound imaging

CLO 3: to have knowledge of proper handling of radioactive sources

CLO 4: to know how the radiation will be detected by radiation detection devices

Course Content:

In Patient Care and Techniques of Ultrasound and Nuclear Medicine will get experience in various aspects in ultrasound and nuclear medicine under the supervision of experienced professionals and is expected to work and contribute in the Radiological units.

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage
1	20	Basic principle and instrumentation of Ultrasonography	✓			10 %
2	30	Transducer 2.1 Types	✓			10%

		2.2 Applications 2.3 Advancements				
3	20	Ultrasound Contrast agents			✓	5%
4	20	Doppler 4.1 Doppler principle and instrumentation 4.2 Types of Doppler 4.3 Applications	✓			10%
5	40	5.2 Artefacts 5.3 USG &Doppler Protocols 5.4 Safety aspects and biological consideration of Ultrasound	✓			15%
6	30	Radioactivity 6.1 Exponential decay 6.2 Specific activity 6.3 Parent/Daughter decay 6.4 Modes of radioactive decay	✓			5%
7	30	Radiation detectors 7.1 Gas-filled detectors 7.2 Semiconductor detectors 7.3 Scintillation detectors	✓			10%

8	30	Instrumentation 8.1 Gamma Camera 8.2 SPECT 8.3 PET	✓			10%
9	30	9.1 Production of Radionuclides 9.2 Production of Radiopharmaceuticals		✓		10%
10	40	Protocols 10.1 Thyroid imaging 10.2 Bone imaging 10.3 Respiratory system 10.4 GI System 10.5 Urinary system 10.6 Cardiovascular System 10.7 Iodine 131 Uptake studies		✓		10%
11	10	Recent Advancements in Ultrasound and Nuclear Medicine.		✓		5%

SEMESTER-IV

Course Title: Basic and Advanced Instrumentation of MRI

Course: Core

Credits: 3

No of Hours: 45 Hours

Course Outcome:

1) To understand the advanced principle of MRI

2) To have knowledge about the things restricted in MRI to carry

3) To perform scans with ideal sequences

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit I	3	Basic principles				5	LE,SE
		1.1 Spin			✓		
		1.2 Precession	✓				
		1.3 Relaxation time		✓			
		1.4 Pulse cycle			✓		
		1.5 T1 weighted image	✓				
		1.6 T2 weighted image	✓				
		1.7 Proton density image		✓			

Unit II	2	MR instrumentation				5	LE, SE
		2.1 Types of gradients	✓				
		2.2 RF transmitter and receiver coils	✓				
		2.3 Gradient coils	✓				
		2.4 Shim coils	✓				
		2.5 RF shielding		✓			
		2.6 Computers			✓		
Unit III	5	3.0 Pulse sequence	✓			20	LE, SE
		3.1 Spin echo pulse sequences – turbo spin echo pulse sequences	✓				
		3.2 Gradient echo sequence – turbo gradient echo pulse sequence	✓				
		3.3 Inversion recovery sequence - STIR sequence , SPIR sequence, FLAIR sequence	✓				
		3.4 Echo planar imaging &	✓				
		3.5 Fast imaging sequences and advanced pulse sequences	✓				
Unit IV	5	4.0 Image formation				10	SE
		4.1 2D fourier transformation method			✓		
		4.2 K space representation	✓				

		4.3 3D fourier imaging and MIP		✓			
Unit V	3	5.1 MR contrast media				10	LE,SE
		5.2 MR angiography – TOF & PCA	✓				
		5.3 MR Spectroscopy	✓				
Unit VI	2	6.1 Protocols in MRI for whole body				15	LE, SE
		6.2 MRI artefacts	✓				
		6.3 Safety aspects in MRI	✓				
Unit VII	5	Cardiac MRI	✓			10	LE, SE
Unit VIII	5	5.1 Musculoskeletal imaging protocols		✓		10	SE
		5.2 Abdominal imaging protocols	✓				
Unit IX	5	9.1Functional imaging techniques		✓		5	SE
		9.2 BOLD imaging	✓				
Unit X	10	Care, maintenance & tests	✓			10	LE, SE

		General care and Functional tests		✓			
		Quality assurance programme Acceptable limits of variation and Corrective action	✓				

❖ **LE-** Long Essay**, SE-** Short Essay

Recommended books

1. Westbrook C, Talbot J. MRI in Practice. John Wiley & Sons; 2018 Oct 22.

2. Bushong SC, Clarke G. Magnetic Resonance Imaging-E-Book: Physical and Biological Principles. Elsevier Health Sciences; 2013 Aug 7.

3. Hashemi RH, Bradley WG, Lisanti CJ. MRI: the basics: The Basics. Lippincott Williams & Wilkins; 2012 Mar 28.

4. Horowitz AL, Horowitz AL. MRI physics for radiologists. Springer; 1992.

Course Title: INTERVENTIONAL RADIOLOGY

Course: Core

Credits: 3

No of Hours: 45 Hours

Course Outcome:

To have a good idea on vascular anatomy

To distinguish the types of catheters and their uses

To have and understanding on the various equipments used in cath-lab

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit 1	3	Introduction Need for interventional procedures **DSA:** Basic principle Types **Equipments:** Basics of angiographic equipments Single and biplane angiographic equipments Angiographic table		✓		10	LE,SE

		Image intensifier Flat planel detectors Recording systems Pulseoximetry Cardiac resuscitation measure - ECG Pressure injector Catheters, needles & other tools 3D rotational angiography Image processing Patient monitor Co_2 angiography					
Unit 2	10	**Patient care:** Preparation for procedure Post procedure care Role of radiographer in interventional procedure Crash trolley – Emergency drugs			✓	10	SE, SA
Unit 3	5	**Procedures:** Diagnostic & therapeutic interventional procedures PTC, PTBD, Stending	✓			20	LE, SE, SA

		Nephrostomy, ureteric stending Guided biopsies of different organs Drainage of collections / abscesses Angiograms, angioplasty, embolization Venus access Radiofrequency ablation Cryoablation Image guided nerve blocks Phlebography Direct portal venography TIPS & TACE					
Unit 4	10	Neuro interventional procedures Embolization of extra or intracranial tumors, vascular malformations Vetebroplasty – direct puncture Laser guided procedure	✓			15	LE, SE, SA
Unit 5	3	Basics of cardiac catheterization		✓		10	LE, SE, SA
Unit 6	2	Safety considerations in angiography room Room design Protective devices Radiation monitoring		✓		20	LE, SE, SA

Unit 7	10	Care, maintenance and tests: General care Functional tests Quality assurance program: Acceptable limits of variation Corrective action			✓	15	SE, SA

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

References:

1. Watkinson AF, Adam A, editors. Interventional radiology: a practical guide. Radcliffe Publishing; 1996.
2. Valji K, Maroney TP. Vascular and interventional radiology.

Snopek AM. Fundamentals of Special Radiographic Procedures-E-Book. Elsevier Health Sciences; 2013 Aug 13.

Course Title: PATIENT CARE IN RADIOLOGY

Course: Core

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

Course Outcome:

Know precautions to handle emergency patients of different pathology

To be able to perform basic and advanced life support to the patient in case of emergency

To know the emergency drugs used in the department

UNIT	NO. OF HOURS	CONTENT	MUST KNOW	GOOD TO KNOW	DESIRABLE TO KNOW	WEIGHTAGE %	TYPE OF QUESTIONS
Unit 1	5	Introduction to the patient care Responsibility of the health care facility Responsibilities of the Imaging technologist	✓			10	SE, SA
Unit 2	10	General patient care Patient transfer technique Restraint technique Aspects of patient comfort Specific patient conditions	✓			20	SE, SA

		Security of the patient property Obtaining vital signs Laying up a sterile trolley IV injection administration					
Unit 3	5	Nursing procedure in radiology General abdominal preparation Clothing of the patient Giving an enema Handling emergencies in radiology First aid in the X-ray departments		✓		20	LE, SE, SA
Unit 4	10	Patient care during investigation GI tract, biliary tract, respiratory tract, gynecology, cardiovascular, lymphatic system, C N S . etc		✓		20	SE, SA
Unit 5	5	Infection control Isolation technique	✓			10	LE, SE, SA

		Infection source Transmission modes Procedures Psychological considerations Sterilization & sterile technique					
Unit 6	10	Patient education Communication Patient communication problems Explanation of examinations Radiation safety/ protection Interacting with terminally ill patient Informed consent			✓	20	SE, SA

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

References Books:

1. Ehrlich RA, Coakes DM. Patient care in radiography-e-book: with an introduction to medical imaging. Elsevier Health Sciences; 2016 Jan 19.
2. Chesney DN, Chesney MO. Care of the patient in diagnostic radiography. Blackwell Scientific Publications; 1973.

Course Title: Patient Care & Techniques of Clinical MRI and Interventional Radiology

Course: Core

Total Credits: 10 **Number of Hours: 300**

Course Objectives:

CLO 1: To have a practical understand advanced techniques of MRI

CLO 2: to have knowledge about the things restricted in MRI to carry

CLO 3: to have a good idea on vascular anatomy

CLO 4: to distinguish the types of catheters and their uses

CLO 5: know precautions to handle emergency patients of different pathology

CLO 6: to be able to perform basic and advanced life support to the patient in case of emergency

Course Content:

Unit	Hrs	Content	Must Know	Good to Know	Desirable to Know	Weightage
Unit 1	20	Basic Principle and Instrumentation of MRI	✓			5 %
Unit 2	30	Pulse Sequences 2.1 Spin echo sequences	✓			10%

		2.2 Gradient echo sequences 2.3 Inversion recovery sequences 2.4 Echo planner imaging and fast imaging sequences 2.5 Functional imaging techniques				
Unit 3	3 0	MRI Safety	✓			5%
Unit 4	60	MRI Protocols 4.1 MRI protocols for the whole body	✓			30%
Unit 5	30	DSA 5.1 Basic principle 5.2 Types 5.3 Instrumentation 5.4 Pressure injector	✓			10%
Unit 6	60	Diagnostic and Therapeutic interventional procedures 6.1 PTC, PTBD, Stenting 6.2 Nephrostomy, ureteric stenting 6.3 Guided biopsies of different organs 6.4 Drainage of collections / abscesses	✓			20%

		6.5 Angiograms, angioplasty, embolization 6.6 Radiofrequency ablation 6.7 Cryoablation 6.8 Image-guided nerve block 6.9 Phlebography 6.10 Venography 6.11 TIPS & TACE				
Unit 7	30	7.1 Roles and responsibility of Imaging Technologist 7.2 Effective communication	✓			10%
Unit 8	20	Infection control 8.1 Isolation technique 8.2Sterilization technique			✓	5%
Unit 9	20	Recent advancements in MRI and Interventional Radiology		✓		5%

In Patient Care & Techniques of Clinical MRI and Interventional Radiology the student will get experience in various aspects of patient care, MRI and interventional radiology under the supervision of experienced professionals and is expected to work and contribute in the radiology unit.

10. Teaching-Learning Methods

Teaching - Learning method	Courses
Experiential learning	Radiographic Positioning & Procedures
Integrated/Inter-disciplinary learning	Bioethics Healthcare Management
Participatory learning	Bioethics Healthcare Management, Radiation Protection & Management in Radiology
Problem-solving methodologies	Biostatistics & Research Methodology
Self-directed learning	Basic & Advanced Instrumentation of CT Basic & Advanced Instrumentation of MRI Coursera / SWAYAM
Patient-centric learning	Basic & Advanced Techniques of Imaging & Processing Patient Care & Techniques of Ultrasound and Nuclear Medicine Patient Care & Techniques of Clinical MRI & Interventional Radiology
The Humanities	Bioethics
Project-based learning	Dissertation Biostatistics & Research Methodology
Role-play	Bioethics, Health Care Management Patient Care in Radiology
Team-work	Methods of Radiation Protection Evaluation & Imaging Techniques of CT And Procedures
Reflective writing	Patient Care in Radiology

11. Scheme of Examination

11.1. Continuous Internal assessment format (distribution of marks)

Continuous Internal Assessment Components	Maximum Marks
Average of two IA tests	20
Case studies/ Seminar/ Assignments/Quizzes, etc	30
Total Marks	**50**

11.2. Question Paper Pattern

SUBJECTS HAVING MAXIMUM MARKS = 50				Duration
Type of question	**Number of questions**	**Marks for each question**	**Total**	
LONG ESSAY TYPE	02	15	30	150 minutes
SHORT ESSAY TYPE	02	10	20	
		Total	**50**	

11.3. Practical Examination

SI.NO	Components	Marks
1	Spotters	10
2	Case Scenario/OSCE/OSPE	20
3	Viva Voce	20
Total Marks		50

11.4. Particulars Of Practical, Viva-Voce & Dissertation

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

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

11.4.3. Special emphasis shall be given to dissertation work during the M.Sc. MIT 2nd year examination.

11.4.4. The marks of Viva-Voce examination shall be included in the clinical examination to calculate the percentage and declaration of results.

11.4.5. OSCE/OSPE- shall have minimum of 5 stations.

11.5. Evaluation and Certification of online courses:

11.5.1. 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.

11.5.2. 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).

11.5.3. 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

11.6. Credit Mobility of Online Courses:

11.6.1. 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.

11.6.2. 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 Yenepoya (Deemed to be University), provided such a course is offered during that semester.

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

11.6.4. A candidate shall compulsorily complete total 6 Credits of Multidisciplinary courses.

11.6.5. 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 and 6 credits before third semester SEE.

11.6.6. A candidate who wishes to earn additional credits may be permitted to do so during the academic duration.

11.7 Continuous Internal Assessment Components of PG Dissertation

<table>
<tr><th>Sl. No</th><th colspan="2">Parameters</th><th>Marks</th></tr>
<tr><td>1.</td><td colspan="2">Maintaining the timeline</td><td>10</td></tr>
<tr><td rowspan="4">2.</td><td colspan="2">Presentation a Conference /CME/Publication (student can choose any of the criteria to avail 40 marks)</td><td rowspan="4">40</td></tr>
<tr><td>Criteria</td><td>Marks Allocated</td></tr>
<tr><td>Online Oral/Online Poster/Offline Poster presentation/Conference proceeding publications in Scopus/WoS indexed journals/Publication of Copyright</td><td>20</td></tr>
<tr><td>Offline oral presentation at National/International Conference/Patents/Publication of Review Paper/Pilot Study/Study Protocol in Indexed Journal</td><td>40</td></tr>
<tr><td>3.</td><td colspan="2">Manuscript submission (Based on the dissertation) to the Indexed journals (SCOPUS/WoS) along with submission of final dissertation</td><td>50</td></tr>
<tr><td></td><td colspan="2">Total</td><td>100</td></tr>
</table>

11.8. Assessment of Research project

A declaration by the candidate that the work was done by him/her shall be included. The guide, Head of the Department and Head of the Institution shall certify the bonafide of the project.

Total 200 marks shall be awarded for the research project and the marks distribution as follows:

- 100 marks – Dissertation evaluation by Internal and External examiners

- 100 marks – Continuous Internal Assessment

11.9. Evaluation of Dissertation

11.9.1.Dissertation shall be evaluated by two examiners, one external & one Internal for 100 marks from the panel of examiners approved by the Board of Studies and by the University.

11.9.2.The criteria for the evaluation shall be as prescribed by the Board of Studies.

11.9.3.Acceptance of the dissertation is a pre-requisite for a candidate to be eligible to appear in the final examination.

11.10. Guide:

11.10.1. The academic qualification and teaching experience required for recognition of guide shall be as given under:

11.10.2. MD/DM in Radiology with 2 years of teaching experience after MD/DM programme.

Or Ph.D in Medical Imaging Technology or M.Sc. Medical Imaging Technology with 3 years of teaching experience after Masters programme.

11.10.3. Student guide ratio: A recognized guide shall supervise dissertation work of not more than five students per academic year. The age of the guide shall not exceed 65 years.

11.10.4. Co- guide may be included provided the work requires substantial contribution from a sister department, another institution recognized for teaching Yenepoya University or any other State Level University.

11.11. Change of Guide:

In the event of registered guide leaving the Institute/ college due to any reason or in the event of death or any other valid reasons, guide can be changed with prior permission from the university only.

12. Eligibility to appear for University Examination

12.1 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.

12.2 Evaluation of a course shall be done based on continuous internal assessment (CIA) mode followed by semester end university examination (SEE) for each course.

12.3 The components of CIA (Continuous Internal Assessment) may include sessional tests, Seminar/ Journal Club/ Case Studies /Assignment and other activities as determined by the board of studies in the respective departments.

12.4 The CIA:SEE percentage is 50:50 and minimum marks for CIA shall be 50% and SEE shall be 50%.

12.5 The pass marks per course shall be 50%. There shall be examinations at the end of each semester ordinarily during February/March for odd semesters and August/September for even semesters

12.6 The SEE duration shall be two and half hours.

13. Criteria for passing

13.1 The CIA:SEE percentage is 50:50 and minimum marks for CIA shall be 50% and SEE shall be 50%.

13.2 The pass marks per course shall be 50%

13.3 A candidate shall be declared to have passed the PG program if he/she secures atleast CGPA of 5.0 (Course Alpha-Sign Grade P) in the aggregate of both internal assessment and semester end examination marks.

13.4 The candidates who pass all the semester examinations in the first attempts in Two years are eligible for ranks provided they secure at least a CGPA of 8.0 (atleast Alpha-Sign Grade A).

13.5 The results of the candidates who have passed the fourth 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.

13.6 A candidate who passes the semester examinations in parts is eligible for only CGPA and Alpha-Sign Grade but not for ranking.

13.7. There shall be no minimum marks with respect to internal assessment and viva-voce marks.

13.8. A candidate who fails in any of the project work/project report/dissertation shall reappear for the same and pass the examination subsequently within the nearest semester and examination schedule.

14. Carry over provisions

Carry over shall be allowed to the candidates up to IV semesters.

15. Grading and Classification

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.

a) Letter Grades and Grade Points:

Letter Grade	Grade Point	Range of Marks
O+ (Outstanding)	10	90 – 100
O (Excellent)	9	80 – 89.99
A+ (Very Good)	8	70 – 79.99
A (Good)	7	60 – 69.99
B+ (Average)	6	55 – 59.99
P (Pass)	5	50 – 54.99
F (Fail)	<5	< 50

b) Cumulative Grade Point Average (CGPA):

The results at the end of the fourth semester shall be classified on the basis of CGPA obtained in the four semesters and the corresponding overall letter grade. The letter grade as described below shall be adopted.

Letter Grade	CGPA Range
O+ (Outstanding)	9.0 – 10.0
O (Excellent)	8.0 – 8.99
A+ (Very Good)	7.0 – 7.99
A (Good)	6.0 – 6.99
B+ (Average)	5.5 – 5.99
P (Pass)	5.0 – 5.49
F (Fail)	< 5.0

16. Re-Entry after Break of the study

16.1. Candidates admitted to a program abstaining for more than 3 months must seek readmission into the appropriate semester.

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

16.3. All re-admissions of candidates are subject to the approval of the Yenepoya (Deemed to be University).

17. Journals

List of recommended Journals

a. Academic Radiology
b. Radiology: Artificial Intelligence
c. European Journal of Radiology

18. Annexures

Annexure I: Question paper layout for Theory Examination

Annexure II: Logbook Template

Annexure III: Journal club Evaluation Checklist

Annexure IV: Assignment guidelines

Annexure V: Seminar Assessment Rubrics Template

Annexure VI: OSCE/OSPE Assessment Rubric