# M. Sc. Medical Physics

## Syllabus

## UNIVERSITY DEPARTMENT

## Program Code: MPHA

**2021 – 2022 onwards**

# BHARATHIAR UNIVERSITY

**(A State University, Accredited with "A" Grade by NAAC,**
**Ranked 13th among Indian Universities by MHRD-NIRF,**
**World Ranking: Times -801-1000,Shanghai -901-1000, URAP - 982)**

**Coimbatore - 641 046, Tamil Nadu, India**

| **Program Educational Objectives (PEOs)** | |
|---|---|
| On completion of M.Sc., Medical Physics program, the students are expected to: | |
| PEO1 | Expected to demonstrate the Physics, Biological and Safety aspects of Diagnostic radiology, External Beam Radiotherapy, Brachytherapy, Radiation Detection, Radiation Dosimetry, Advanced Radiotherapy Techniques and Nuclear Medicine for effective treatment of patients. |
| PEO2 | Learning step by step quality assurance/quality control procedures in medical imaging equipment and Radiation Oncology. |
| PEO3 | Categorizeproperapplicationofdosimetryanditsinstrumentsinmedicalimaging, and radiation dose delivery for RadiationOncology. |
| PEO4 | The applicators insertion of radioactive implants directly into the tissue during appropriate brachytherapy treatment. |
| PEO5 | To prepare them as effective RSO to meet the regulatory requirements in radiation medicine for patient, personnel and public. |
| | |

| **Program Specific Outcomes (PSOs)** | |
|---|---|
| After the successful completion of M.Sc. Medical Physics program, the students are expected to: | |
| PSO1 | Disseminating their knowledge acquired through the state-of-the art radio therapeutic techniques and medical imaging for providing and ensuring safety treatment for patients and integrate with the team/ leadership. |
| PSO2 | As medical physicist/radiation safety officers they could achieve continuous improvement in their professional career and advanced technologies in pace with the developments in health care. |
| PSO3 | They will be effective educators/trainers in their respective discipline. |
| PSO4 | Inventing new technology in the field of Radiation Oncology and Imaging. |
| | |

| **Program Outcomes (POs)** | |
|---|---|
| On successful completion of the M. Sc. Medical Physics program | |
| PO1 | Have basic knowledge in Atomic Physics, Nuclear Physics, Solid State Physics, Ionizing and Non-Ionizing Radiation Physics. |
| PO2 | Understand the Applied Mathematics in Radiation Sciences. |
| PO3 | Have domain knowledge in electronic components, computing skills using MATLAB, MATHEMATICA, and STATISTICA and analyze the results obtained in radioactive counting, medical imaging or therapy. |
| PO4 | Gain skills on clinical aspects of radiation oncology with necessary knowledge in anatomy, pathology, site specific signs, symptoms, diagnosis and management. |
| PO5 | Possess knowledge on Radiation Physics, Diagnostic radiology, External beam Radiotherapy, Brachytherapy, Radiation Detection, Radiation Dosimetry, Advanced Radiotherapy Techniques, Radiation Biology, and Radiation Safety as per National as well as International regulatory agencies. |
| PO6 | Exhibit skills in handling GM counter based instruments, Gamma ray spectrometer, analyzethesources,anddeterminelinearandmassattenuationofsources,optically stimulated luminescence dosimetry. |
| PO7 | Hands-on experience with Treatment Planning System, LINAC, and QA tools. |
| PO8 | Understand the issues of managing radiation safety programme as stipulated by regulatory bodies to become a Radiological Safety Officer (RSO). |
| PO9 | Distinguish imaging techniques based on the demonstration of live blood perfusion imaging in nuclear medicine through PET-CT, SPECT and Gamma Camera. |
| PO10 | Hands on experience to handle Radiation Physics, Radiology, Radiotherapy and Nuclear Medicine procedures and experiments. Ability to do research in Medical Physics and allied areas. |
| | |

# BHARATHIAR UNIVERSITY:: COIMBATORE 641 046

## M. Sc. Medical Physics Curriculum (University Department)

*(For the students admitted during the academic year 2021 – 22 onwards)*

| Course Code | Title of the Course | Credits | Hours/ Week | | Maximum Marks | | |
|---|---|---|---|---|---|---|---|
| | | | Theory | LAB | CIA | ESE | Total |
| **FIRST SEMESTER** | | | | | | | |
| 13A | Radiological Physics | 4 | 4 | 0 | 50 | 50 | 100 |
| 13B | Radiological Mathematics and Statistical Analysis | 4 | 4 | 0 | 50 | 50 | 100 |
| 13C | Radiation Detection and Measurement | 4 | 4 | 0 | 50 | 50 | 100 |
| 13D | Radiation Generators | 4 | 4 | 0 | 50 | 50 | 100 |
| 13E | External Beam Radiation Therapy | 4 | 4 | 0 | 50 | 50 | 100 |
| 1EA (OR) 1EB | Electronics and Instrumentation (or) Non-Ionizing Radiation Physics | 4 | 3 | 0 | 50 | 50 | 100 |
| 1EC (OR) 1ED | Atomic, Molecular, & Nuclear Physics (or) Biomedical Instrumentation | 4 | 3 | 0 | 50 | 50 | 100 |
| 13P | Radiation Instrumentation Lab | 4 | 0 | 4 | 50 | 50 | 100 |
| | **Total** | **32** | **26** | **4** | **400** | **400** | **800** |
| **SECOND SEMESTER** | | | | | | | |
| 23A | Applied Anatomy and Physiology | 4 | 4 | 0 | 50 | 50 | 100 |
| 23B | Medical Imaging Technology | 4 | 4 | 0 | 50 | 50 | 100 |
| 23C | Radiation Standards | 4 | 4 | 0 | 50 | 50 | 100 |
| 23D | Radiation Biology | 4 | 4 | 0 | 50 | 50 | 100 |
| 23E | Quality Assurance for Diagnostic and Therapeutic Equipment | 4 | 4 | 0 | 50 | 50 | 100 |
| 2EA (OR) 2EB | Numerical and Computational techniques (or) Advances in Medical Physics | 4 | 4 | 0 | 50 | 50 | 100 |
| 2EC (OR) 2ED | Solid State Physics (or) Biological Dosimetry | 4 | 3 | 0 | 50 | 50 | 100 |
| 23P | Medical Physics Lab I | 4 | 0 | 3 | 50 | 50 | 100 |
| | **Total** | **32** | **27** | **3** | **400** | **400** | **800** |
| 26A | Summer Training | - | - | - | - | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **THIRD SEMESTER** | | | | | | | |
| 33A | Radiation Dosimetry and Calibration | 4 | 5 | 0 | 50 | 50 | 100 |
| 33B | Recent advances in Radiotherapy | 4 | 5 | 0 | 50 | 50 | 100 |
| 33C | Radiation Protection | 4 | 5 | 0 | 50 | 50 | 100 |
| 33D | Radiation Hazards Evaluation and Control | 4 | 5 | 0 | 50 | 50 | 100 |
| 33E | Nuclear Medicine | 4 | 5 | 0 | 50 | 50 | 100 |
| 33F | Advanced Radiation Dosimetry | 4 | 5 | 0 | 50 | 50 | 100 |
| | **Total** | **24** | **30** | **0** | **300** | **300** | **600** |
| **FOURTH SEMESTER** | | | | | | | |
| 43P | Medical Physics Lab II | 4 | 0 | 3 | 50 | 50 | 100 |
| 47V | Project | 8 | 0 | 10 | 100 | 100 | 200 |
| | **Total** | **12** | **0** | **13** | **150** | **150** | **300** |
| | | | | | | | |
| | **Sub Total** | **100** | **83** | **20** | **1250** | **1250** | **2500** |
| **CO- SCHOLASTIC COURSES** (The Co-scholastic courses are only counted for the final grading and ranking. However, for the award of the degree, the completion of co-scholastic courses is also mandatory) | | | | | | | |
| Value Added Course I: Yoga for Interpersonal Skills | | 2 | 2 | - | 50 | - | 50 |
| Value Added Course II: Medical Radiological Safety Officer (MRSO) Training | | 2 | 2 | - | 50 | - | 50 |
| Online course from MOOC/ SWAYAM/ NPTEL/ Coursera/ e-Pataskala etc., | | 2 | - | - | - | - | - |
| | **Grand Total** | **106** | **87** | **20** | **1350** | **1250** | **2600** |
| GS121 | Supportive course offered to ODD semester students of other Departments: Diagnostic Radiology | 2 | 2 | 0 | 25 | 25 | 50 |
| GS122 | Supportive course offered to EVEN semester students of other departments: Radiotherapy for Cancer | 2 | 2 | 0 | 25 | 25 | 50 |

# First Semester

| Course code | 13A | RADIOLOGICAL PHYSICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Atomic andNuclear Physics | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. Study electromagnetic spectrum, radiation sources, types and itsproperties
2. Study radiation Quantities and Units used in theindustry
3. Understand the interaction of directly and indirectly ionizing radiation with matter andits effects.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Explain different types Electromagnetic Radiation and their sources/properties | K4 |
| 2 | Explain different types of Radiation, their sources/properties. | K4 |
| 3 | Radiation Quantities and Units. | K1 |
| 4 | Physics aspects of Interaction of indirectly ionizing radiation with matter. | K3 |
| 5 | Interaction of directly ionizing radiation with matter and its effects inside a living object. | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Electromagnetic Spectrum | 8 --hours |
|---|---|---|

Production, properties and classification of electromagnetic radiation- Different sources of radiation - radio waves, microwaves, infrared, visible, ultra violet radiation, X and Gamma rays- production, physical properties and their interaction with tissues.

| Unit:2 | Radioactivity | 8 --hours |
|---|---|---|

Radioactivity - General properties of alpha, beta and gamma rays - Laws of radioactivity - Half life and Average Life- Laws of successive transformations - Natural radioactive series - Radioactive equilibrium - Alpha ray spectra - Beta ray spectra - Gamma emission - Electron capture - Internal conversion - Nuclear isomerism - Artificial radioactivity.

| Unit:3 | Ionizing Radiation Quantities and Units | 10 --hours |
|---|---|---|

Radiometric quantities: Activity, exposure, Particle flux, fluence, fluence rate– Energy flux and energy fluence- Interaction Quantities: Linear and mass attenuation coefficients, Mass energy transfer and mass energy absorption coefficients, Stopping power, Mass Stopping Power and LET- Dosimetric Quantities: Exposure, Absorbed Dose, Kerma, Terma, Charged particle equilibrium (CPE) – Relationship between Kerma, absorbed dose and exposure under CPE - Radiation chemical yield - W value- Radioactivity Units: Becquerel & Curie, exposure units - C/kg & Roentgen, Gray & Rad, Sievert & Rem.

| Unit:4 | Interaction of indirectly ionizing radiation with Matter | 10--hours |
|---|---|---|

Interaction of electromagnetic radiation with Matter: Exponential attenuation - Thomson scattering - Photoelectric and Compton process and energy absorption - Pair production - Attenuation and mass energy absorption coefficients - Relative importance of various processes. Interaction of neutrons with matter: Classification of neutrons, neutron sources, slow and fast

| | | |
|---|---|---|
| neutron interactions, microscopic and macroscopic interaction cross section, charged particle emission,-radiativecaptureanditssignificanceinradiationdosetohumans–elasticandinelastic scattering-Neutroninducednuclearreactions-neutroninducedactivation–fission–Neutron attenuation. | | |
| | | |
| **Unit:5** | **Interaction of directly ionizing particles with matter** | **10--hours** |
| Interaction of charged particles with matter: Classical theory of inelastic collisions with atomic electrons-Energylossperionpairbyprimaryandsecondaryionization-Dependenceofcollision energy losses on the physical and chemical state of the absorber - Cerenkov radiation - Electron absorptionprocess–Scattering,ExcitationandIonization-Radiativecollision–Bremmstrahlung-Continuous slowing down approximation (CSDA) - transmission and depth dependencemethods - Range energy relation - Back scattering. Interaction of heavy charged particles: Energy loss by collision - Range energy relation - Bragg curve – Spread out Bragg Peak (SOBP) - Specific ionization - Bethe Bloch Formula. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| https://www.youtube.com/watch?v=p2rx8Qpw49w<br>https://www.youtube.com/watch?v=RzU8BZVN1BQ | | |
| | | |
| | **Total Lecture hours** | **48 --hours** |
| | | |

| | |
|---|---|
| **Text Book(s)** | |
| 1 | Radiation Physics in Radiology, Oliver R., Blackwell Science Ltd; 1st Edition (1966). |
| 2 | Radiation Physics for Medical Physicists, E.B.Podgarsak, Springer Verlag, 1st Edition (1996). |
| | |
| **Reference Books** | |
| 1 | The Physics of radiology, H.E.Johns and Cunningham, Charles C Thomas Publishers, 1st edition (1984). |
| 2 | Radiation Oncology Physics: Handbook for Teachers and Students, E.B.Podgarsak, IAEA, Vienna, 1st Edition (2005). |
| | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | https://nptel.ac.in/courses/115/102/115102017/ |
| 2 | https://nptel.ac.in/courses/115/106/115106087/ |

Course Designed By: **Dr. S. HarikrishnaEtti**

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | M | M | M | M | M | M | M | M |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |

| Course code | 13B | RADIOLOGICAL MATHEMATICS AND STATISTICAL ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Mathematical Physics - UGlevel | Syllabus rsion | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. Exposethestudentstolearnthedifferenttypesofprobability,measuresofcentraltendencyand their mathematicalproperties
2. Provide the correlation and regression analysis to find the relation between two sets ofdata.
3. Understand the methods of counting and their usage in medicalfields.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Choose the correct probability for medical treatment, and correct measure of central tendency for practical applications | K2 |
| 2 | Apply the methods of deviations and distribution to set of data and measure the corresponding parameters from central tendency | K3 |
| 3 | Do an analysis of two set of data and calculate unknown one from known set of data | K4 |
| 4 | Apply the particular distribution function for particular sampling size | K3 |
| 5 | Gain adequate knowledge and working principle of the Gamma ray, Beta ray counting methods and medical statistics. | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| **Unit:1** | Probability, Statistics and Measure of central tendency | **10--hours** |
|---|---|---|

Probability - addition and multiplication laws of probability, conditional probability, population variates - collection, tabulation and graphical representation of data. Basic ideas of statistical distributions, frequency distributions, and measures of central tendency-arithmetic mean, Mathematical properties of mean, median, mode, Geometrical mean, Harmonic Mean, MathematicalpropertiesofGeometricalmean,HarmonicMean,relationshipamongtheaverages, General limitation ofaverage.

| **Unit:2** | **Measures of Variation** | **10--hours** |
|---|---|---|

ObjectivesofmeasuringVariation,Propertiesofagoodmeasureofvariation,Methodofstudying variation-Therange,meandeviation,standarddeviation/rootmeansquaredeviation,Variance,

Absolute and relative measures of variation, Coefficient of variation, Merits and limitations of standard deviation. Skewness, moments and kurtosis.

| **Unit:3** | **Correlation and Regression Analysis.** | **8--hours** |
|---|---|---|

Correlation, Types of correlation, Methods of ascertaining correlation - Scatter diagram, Karl Pearson'scoefficient,Rankmethod,meritsandlimitationsofallmethods,Regression,Difference betweencorrelationandregression,Regressioncoefficient,calculationofregressioncoefficients.

| **Unit:4** | **Sampling Distribution** | **8--hours** |
|---|---|---|

Uncertainty calculations, error propagation, time distribution between background and sample, minimum detectable limit. Binomial distribution, Poisson distribution, Gaussian distribution,

exponential distribution - additive property of normal variates, confidence limits, applications of Bivariate distribution, Chi-Square distribution, F- distribution, t-distribution- overview of biostatistical tools- reference styles, reference manager, citation manager.

| **Unit:5** | **Counting statistics** | **10--hours** |
|---|---|---|

Statistics of nuclear counting - Application of Poisson's statistics - Goodness-of-fit tests -Lexie's divergence coefficients Pearson's chi-square test and its extension - Random fluctuations, - Evaluation of equipment performance - Signal-to-noise ratio Efficiency and sensitivity of radiation detectors - Statistical aspects of gamma ray and beta ray counting - Special considerations in gas counting and counting with proportional counters - Statistical accuracy in doubleisotopetechnique-Samplingandsamplingdistributions-confidenceintervals.Hypothesis testing and errors- Regression analysis- Linear regression: Examples and exercises.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

Index numbers, Small sampling theory, and Interpretation of Data, https://nptel.ac.in/courses/111/104/111104073/

| | **Total Lecture hours** | **48 --hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | F. E. Croxton, Elementary statistics with applications in medicine and the biological sciences, Dover, New York, 1st Edition, 1959. |
| 2 | S.P.Gupta, Statistical methods, Sultan Chand & Sons Educational publishers, New Delhi 44th Edition, 2014. |
| 3 | W. Band, Introduction to Mathematical Physics, Van Nostrand Reinhold Inc. U.S., 1st Edition, 1959. |

**Reference Books**

| | |
|---|---|
| 1 | G. Dahlberg, Statistical Method of Medical &Biology students, G. Allen &Unwin Ltd, London,2nd Edition, 1948. |
| 2 | S.P. Gupta, Statistical methods Sultan Chand & Sons, 2012. |

**Related Online Contents**

| | |
|---|---|
| 1 | https://nptel.ac.in/courses/111/105/111105077/ |
| 2 | https://www.coursera.org/lecture/basic-statistics/5-03-the-sampling-distribution-ejnZI |
| 3 | https://swayam.gov.in/nd1_noc19_bt19/preview |

Course Designed By: **Dr. S. Vijayakumar**

**Mapping with Programme Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | S | S | L | L | L | L | L | L | S |
| **CO3** | L | S | S | L | L | L | L | L | L | S |
| **CO3** | L | S | S | L | L | L | L | L | L | S |
| **CO4** | L | S | S | L | L | L | L | L | L | S |
| **CO5** | L | S | S | L | L | L | L | L | L | S |

*S-Strong; M-Medium; L-Low

| Course code | 13C | RADIATION DETECTION AND MEASUREMENT | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Electronics and Instrumentation | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. To understand the technical know- how of all the radiation detectors used for cancer diagnosis, treatment, and radiological safety.
2. To choose an appropriate detector for appropriatemeasurement.
3. To learn about the working of radiation instruments used in advanced radiationtherapy.
4. To understand the applications and uses of radiation safetydevices.
5. To understand the various factors behind the measurement of radiation and analysis ofdata.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Update fundamental knowledge, technological advancements and potential applications of radiation detectors. | K3 |
| 2 | Choosing appropriate detectors to reduce the errors in treatment. | K3 |
| 3 | Learn about radiation instruments available for research and the scope for further research. | K2 |
| 4 | Acquire knowledge on radiation safety and personal monitoring devices. | K3 |
| 5 | Measure radiation precisely and interpret their results accurately with statistical significance. | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** - Evaluate; **K6** - Create

| Unit:1 | Gas Filled Detectors | 10--hours |
|---|---|---|

Basic principles of radiation detection- Gas Filled detectors - Ionization chambers, - Theory and design - Construction of condenser type chambers and thimble chambers - Gas multiplication - ProportionalandGMCounters–basicdetectionmechanism,typesofradiationdetected,modeof operation,differentvariantsofdetectors(e.g.sealed,flowtype,highpressure,multi-wire,position sensitive) - Types of instruments which uses gas filled detectors – radiation dosimeters, survey meters, contamination monitors- Cylindrical, plane parallel, spherical and well-typeionization chambers, Extrapolation chamber- Dead time and recovery time..

| Unit:2 | Solid State Detectors | 12--hours |
|---|---|---|

Scintillation detectors: Advantages of scintillation detectors, properties of ideal scintillator,basic electronicblocksinscintillationdetectorsetup.Radiationdetectionmechanismoforganicandin- organic scintillators, Characteristics of organic and inorganic counters -types of scintillators for variousapplications.

Semiconductor detectors and its application for gamma spectrometry, Diode and MOSFET dosimeters - Chemical dosimeters- Radiographic Film: Components of radiographic film, principle of image formation on film, double and single emulsion film, sensitometric parameters of film (density, speed, latitude etc.) and Radio chromic films - Thermo luminescent Dosimeters (TLD) – Optically stimulated Luminescence dosimeters (OSLD) – Radiophoto luminescent dosimeters (RPLD).

Neutron Detectors: Slow Neutron Detection and Fast Neutron Detection methods- Nuclear track emulsionsforfastneutrons-SolidStateNucleartrack(SSNTD)detectors-Neutrondetectionby

activation, BF3, $^{3}$He, Bubble detectors. Calorimeters - New Developments (direct ion storage (DIS), diamond detectors etc).

| Unit:3 | Radiation Dosimeters & Monitoring Instruments | 10--hours |
|---|---|---|

Dosimeters based on condenser chambers - Pocket chambers - Dosimeters based on current measurement - Different types of electrometers – MOSFET - Diode Detectors, Semi-conductor Detectors., Vibrating condenser and Varactor bridge types - Secondary standard therapy level dosimeters-FarmertypeDosimeters:ThimblechambersandParallel-platechambers-Properties of Farmer-type chambers like sensitivity, energy dependence, stem effect, and influence of temperatureandpressure,biasvoltage,directiondependence–referenceandfield-levelchambers – small volume chambers for RFA -– Radiation field analyser (RFA) - Radioisotope calibrator - Multipurpose dosimeter (used in Diagnostic Radiology) - Water phantom dosimetry systems - Brachytherapy dosimeters – well type chamber-Isotope calibrators-Thermo luminescent dosimeter readers for medical applications - Calibration and maintenance of dosimeters.

| Unit:4 | Instruments for Personnel and Area Monitoring | 7--hours |
|---|---|---|

Instruments for personnel monitoring - TLD badge readers – Personnel Monitoring film densitometers – OSLD readers - Glass dosimeter readers – Working principle of Digital pocket dosimeters using solid state devices and GM counters.

Instruments for area monitoring: Portable and fixed area monitors, beta-gamma zone monitor, survey meters, Gamma area (Zone) alarm monitors –wide range survey instrument- Teletector. Contamination monitoring instruments for portable contamination monitor, alpha, beta and gamma radiation detection- Hand and Foot monitors –Whole Body counter, Portal Monitors - Scintillation monitors for X and gamma radiations - Neutron area Monitors, Tissue equivalent surveymeters-Fluxmeteranddoseequivalentmonitors-neutronpersonnelmonitors-Properties ofsurveymetersandpersonalmonitors(Sensitivity,energydependence,directionaldependence, discrimination between different types of radiation, Uncertainties in their measurements, etc.).

| Unit:5 | Nuclear Medicine Instruments | 7--hours |
|---|---|---|

Instruments for counting and spectrometry - Portable counting systems for alpha and beta radiation - Gamma ray spectrometers –Single and Multichannel Analyser– HPGe- Liquid scintillation counting system (Organic/Inorganic)- RIA counters – Whole body counters - Air Monitors for radioactive particulates and gases.

| Unit:6 | Contemporary Issues | 2 hours |
|---|---|---|

Expert lectures, online seminars – webinars

1.Ionisation Chambers & Proportional Counters - https://youtu.be/avvXftiyBEs
2.GM counter -https://youtu.be/jxY6RC52Cf0
3.SemiConductorDetectors
https://youtu.be/c1boCCYs77Q
4.Film Badge -https://youtu.be/eGymsO6Assc
5. TLD - https://youtu.be/domGWQ-Jrzw
6.OSLD -https://youtu.be/hPOXGYKtww4
7.Pocket Dosimeter - https://youtu.be/iPesezYcL-o
8.Neutron Bubble detector -https://youtu.be/teDejUPjdlM
9. Radiographic film - https://youtu.be/0GIwERBJ2SU
10.Radiochromic film -https://youtu.be/06kh1ILKDro
11.Area Monitoring device Gamma Zone Monitor - https://youtu.be/AA18OH1jHEY

12.Hand and Foot Monitor -https://youtu.be/oP_XTk6xYmk
13.Whole body counter - https://youtu.be/fFsfIp9EY2E
14.Multi Channel Analyzer -https://youtu.be/75EY30TwBHw
15. Gamma ray spectrometer -https://youtu.be/hQ_gtJE4o7s

| | | |
|---|---|---|
| | **Total Lecture hours** | **48 --hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | Glenn E Knoll, Radiation Detection and Measurement, Third Edition, John Wiley & Sons, Inc, 2000. |
| 2 | Nicholas Tsoulfanidis, Measurement and Detection of Radiation, 2nd Edition, Taylor and Francis, 1995. |
| 3 | Radiation and Detectors: Introduction to the Physics of Radiation and Detection Devices by Lucio Cerrito (Author), May 2017 |

**Reference Books**

| | |
|---|---|
| 1 | Radiation Oncology Physics: A handbook for teachers and students, International Atomic Energy Agency (IAEA), 2005. |
| 2 | Fabio Sauli, Gaseous Radiation Detectors: Fundamentals and applications, Cambridge University press, 2014. |
| 3 | Student Solutions Manual to accompany Radiation Detection and Measurement, by Glenn F.Knoll , July 2012 |

**Related Online Contents**

https://ocw.mit.edu/courses/nuclear-engineering/22-01-introduction-to-nuclear-engineering-and-ionizing-radiation-fall-2016/lecture-videos/practical-radiation-counting-experiments2014solid-angle-count-rates-uncertainty-and-hands-on-gamma-counting-and-nuclear-activation-analysis/

https://ocw.mit.edu/courses/nuclear-engineering/22-01-introduction-to-nuclear-engineering-and-ionizing-radiation-fall-2016/lecture-videos/radiation-utilizing-technology/

Course Designed By: **Dr. C. S. Sureka**

**Mapping with Programme Outcomes**

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | M | L | S | S | L | M | M | S |
| **CO2** | M | L | M | L | S | S | L | M | M | S |
| **CO3** | M | L | M | L | S | S | L | M | M | S |
| **CO4** | M | L | M | L | S | S | L | M | M | S |
| **CO5** | M | L | M | L | S | S | L | M | M | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 13D | RADIATION GENERATORS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Physics - Graduate level | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. To learn the construction and working of different types of particleaccelerators.
2. To learn the construction of X-ray generator used in Diagnosticradiology.
3. To learn the construction and working of various equipment used in external beamtherapy
4. To learn the construction and working of various equipment used inBrachytherapy
5. To learn the radioisotopes produced from the above equipment and their medicalapplications

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Knew about the different types of particle accelerators and their medical applications. | K2 |
| 2 | Learnt to operate the X-ray generator used in Diagnostic radiology | K3 |
| 3 | Learnt to operate the equipment used in external beam therapy | K3 |
| 4 | Learnt to operate the equipment used in Brachytherapy | K3 |
| 5 | Know about the radioisotopes produced from particle accelerators for external beam therapy and Brachytherapy | K2 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | X-ray Generators | 10--hours |
|---|---|---|

Discovery - Production - Properties of X-rays - Characteristics and continuous spectra - Design of hot cathode X-ray tube - Basic requirements of medical diagnostic, therapeutic and industrial radiographic tubes - Rotating anode tubes - Hooded anode tubes - Rating of tubes –standard exposure charts, Limitations on loading Safety devices in X-ray tubes - Insulation and cooling of X-raytubes–Designrequirementsforx-rayequipment,FaultsdetectioninX-rayequipmentsuch as pitting of anode, filament evaporation etc., - Types of x-ray units (Fixed radiography, CT, Interventionalradiology,C-Arm,Mammography,BoneMineralDensitometer,dentalX-rayunits etc.,). Filtration in the x-ray machines-inherent, target and addedfilters.

| Unit:2 | Particle Accelerators | 10--hours |
|---|---|---|

Particle accelerators for industrial, medical and research applications - The Resonanttransformer Cascade generator - Van De Graff Generator - Pelletron - Betatron - Synchro- Cyclotron- Linear Accelerator - Klystron and magnetron - Travelling and Standing Wave Acceleration -Microtron - Electron Synchrotron-Proton synchrotron- Hadron (proton/carbon ion) accelerators. Working principle of Cyclotron and charged particle accelerators, Applications of cyclotrons in medicine, Types of Cyclotrons: self-shielded and unshielded (in-bunker) and locally shielded. Beam transport systems - Beam delivery systems- Energy slits – degrader - Ridge filter - RangeShifter - Uniform and Pencil beam scanning systems-beam dump- Auxiliary equipment and their safety significance: vacuum pumps, RF-power, magnet power supply; cooling system, control software and programs used for medical cyclotronoperation.

| Unit:3 | External Beam Therapy (EBRT) Equipment | 10--hours |
|---|---|---|

Working principles of Telecobalt, Gammaknife, Linear Accelerator, Cyber Knife, Tomotherapy, Intra Operative Radiotherapy & Proton/carbon ion Therapy. Components of beam delivery mechanism such as target, flattening filter, scattering foil, bending magnet, monitor chamber,

Collimator jaws, MLC, micro MLC and other systems specific to various types of equipment. Safety interlocks in beam delivery process. Source design and classification- beam collimation and penumbra - trimmers and breast cones used in telecobalt unit. Wedges, electron applicators, cone beam CT, couch, sagittal lasers.

| **Unit:4** | **Brachytherapy Equipment** | **8--hours** |
|---|---|---|

Definition and classification of brachytherapy techniques - surface mould, intracavitary, interstitial and intraluminal techniques. Dose rate considerations and classification of brachytherapy techniques - Low dose rate (LDR), high dose rate (HDR) and pulsed dose rate (PDR). After loading techniques - Advantages and disadvantages of manual and remote after loading techniques. Catheters, safety shields for wire cutting in LDR.

| **Unit:5** | **Radiation Sources and their Medical Applications** | **8--hours** |
|---|---|---|

Radiationsources-Naturalandartificialradioactivesources-Largescaleproductionofisotopes Reactor produced isotopes ( $^{60}Co$, $^{192}Ir$, $^{99}Mo$ etc.,) - Cyclotron produced isotopes ($^{18}F$, $^{13}N$, $^{15}O$, $^{11}C$)- Fission products ($^{137}Cs$,$^{99}Mo$,$^{131}I$,$^{90}Sr$)–Teletherapy sources– Requirement for brachytherapysources-Descriptionofradiumandradiumsubstitutes-$^{137}Cs$,$^{60}Co$,$^{192}Ir$,$^{125}I$ and other commonly used brachytherapy sources. Beta ray applicators – ophthalmicapplicators ($^{90}Sr$,$^{125}I$, $^{106}Ru$ etc.,) Thermal and fast neutron sources ($^{241}Am$-Be, $^{252}Cf$ etc.,).

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

1. https://www.aapm.org/meetings/2010AM/documents/biggs2.pdf
2. http://www-naweb.iaea.org/nahu/DMRP/documents/Chapter5.pdf

| | **Total Lecture hours** | **48-hours** |
|---|---|---|

**Text Book(s)**


1. F. M. Khan, The Physics of Radiation therapy, 3rd Edition, LIppincott Williams &Wikins, Philadelphia, 2003
2. H. E. Johns and J. R. Cunningham, Physics of Radiology, 4thEdition, (Charles C Thomas Pub.Ltd,. 1983.
3. W. R. Hendee, Medical Radiation Physics, Year Book Medical Publishers Inc., London, 2003.


**Reference Books**


1. Thomas S. Curry, James E. Dowdey,andRobert E. Murry, Christensen's Physics of Diagnostic Radiology, 4th Edition, 1990. .
2. E. J. N. Wilson, An Introduction to Particle Accelerators, 1st Edition, Oxford, 2001.


**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

https://radiologykey.com/clinical-radiation-generators/

Course Designed by: **Dr. GanesanRamanathan**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | M | L | L | L | L | L | L | L | L |
| CO2 | S | M | L | L | L | L | L | L | L | L |
| CO3 | S | M | L | L | L | L | L | L | L | L |
| CO4 | S | M | L | L | L | L | L | L | L | L |
| CO5 | S | M | L | L | L | L | L | L | L | L |

*S-Strong; M-Medium; L-Low

| Course code | 13E | EXTERNAL BEAM RADIATION THERAPY | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Radiological Physics | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. ToapplyingknowledgeoftreatmentparameterslikePercentageDeathDose,TissuePhantom Ratios for computing treatment time calculation required for treatment of radiotherapy patients. To check the dosimetry parameter of treatment machines for using dosimetry tools like RFA, phantoms and etc.
2. To use parameters like treated volume, irradiated volume, hot spot, maximum target dose in choosing a better treatment plan. To adopt and apply 2 D and 3 D simulation techniques CT, MRI, US and PET fusiontechniques.
3. Torecognizetheneedandabilitytoselectproperelectronenergyfortumorsatdifferentdepth.
4. Tocomparethemeritsofelectron,neutronanX-rayandGammaraybeamsandheavycharged particles and use them prudently for different types oftumors.
5. To learn periodic reference dosimetry with calibrated ionization chamber and patientspecific dosemeasurement.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the principles behind dosimetry parameters and use them for treatment time calculation | K2 |
| 2 | Learnt advanced concepts in image registration, target delineation, treatment planning for inverted Y fields, SSD and SAD techniques. | K2 |
| 3 | Understand the physics behind the electron energy selection. | K2 |
| 4 | Clinically evaluate the merits and demerits of different types of ionization radiation. | K5 |
| 5 | Learnt periodic reference dosimetry with calibrated ionization chamber and patient specific dose measurement. | K2 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Dosimetry Parameters | 10--hours |
|---|---|---|

Central axis dosimetry parameters: percentage depth doses (PDD), tissue air ratio (TAR), back scatter factor/Peak scatter factor (BSF/PSF) - tissue phantom ratio (TPR) - tissue maximumratio (TMR)-collimatorscatterfactor,phantomscatterfactorandtotalscatterfactors-relationship between TAR and PDD and its applications - relationship between TMR and PDD and its applications – scatter air ratio(SAR) – scatter maximum ratio(SMR)- off axis ratio field factors-surface dose and buildup region- Description and measurement of isodose curves/ charts-Dosimetry data resources..

| Unit:2 | Phantoms and Beam Modifiers | 8--hours |
|---|---|---|

Measuring tools/phantoms: Water phantom and Tissue equivalent/solid water phantoms for dosimetry Radiation filed analyser (RFA), Array detectors for beam analysis, phantom for beam energy check etc.

Beam modifying and shaping devices – Block Cutting machines- wedge filters – universal, motorized and dynamic wedges - treatment planning with wedges– shielding blocks - field

shaping, custom blocking - tissue compensation – design of compensators, 2D compensators,3D compensators- multi leaf collimators (MLC) and microMLC- special considerations in treatment planning - skin dose, field matching, integral dose, DVHs – differential, integral.

| **Unit:3** | **Treatment Planning in Teletherapy** | **10--hours** |
|---|---|---|

Targetvolumedefinitionanddoseprescriptioncriteriaasper ICRU protocols-SSD and SAD set ups - two and three dimensional localization techniques - contouring - simulation of treatment techniques - field arrangements - single, parallel opposed and multiple fields - corrections for tissue inhomogeneity, contour shapes and beam obliquity - integraldose.
Treatment Techniques: Conventional and conformal radiotherapy, Treatment time and Monitor unit calculations, Arc/ rotation therapy - mantle and inverted Y fields.

| **Unit:4** | **Physics of Electron and Particulate Beam Therapy** | **10--hours** |
|---|---|---|

Clinicalelectronbeams-energyspecification-electronenergyselectionforpatienttreatment-depth dose characteristics ($D_s$, $D_x$ ,$R_{100}$,$R_{90}$,$R_{50}$,$R_p$ etc.) - beam flatness and symmetry - penumbra-isodoseplots-monitorunitcalculations-outputfactorformalisms-effectofair gap on beam dosimetry – effective SSD.

| **Unit:5** | **Particle Beam Physics** | **8--hours** |
|---|---|---|

Basic proton interaction – Bragg peak**,** proton scanning techniques, basic neutron interactions, Particulate beam therapy - Relative merits of electron, X-ray, gamma, proton, carbon ion and neutron beams.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

Expert lectures, online seminars – webinars

1. Physics of radiation oncology - https://youtu.be/rJdvD4qvORQ (1 Hr 55Min)
2. Photon dose distribution - https://youtu.be/r0z2dZlFaR4 (4 Min 12sec)
3. PDD-https://youtu.be/yD94bILngLQ (15 Min)
4. Compensators and wedges - https://youtu.be/mxKAMqv7QXM (2Min)
5. RFA - https://youtu.be/02yoEvlMWIs (3Min)
6. MLC - https://youtu.be/fGFb0p7jPnw (6 Min)
   https://youtu.be/KJst8hpw1z0 (45Sec)
7. Wedge filters - https://youtu.be/wr5JRP4yXaA (5 Min 24sec)
8. Contouring - https://youtu.be/EvN0rO7hkjI (3 min 22Sec)
9. Electron beams - https://youtu.be/YqMa24j1cAs (17 min 36 sec)
10. Proton beam therapy - https://youtu.be/gDmfr6-ft-I (3 Min 45sec)

| | **Total Lecture hours** | **48 --hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | Faiz M. Khan, Physics of Radiation Therapy, 5th Edition, Lippincott Williams and Wilkins, (20140. |
| 2 | ATTIX, F.H., Introduction to Radiological Physics and Radiation Dosimetry, Wiley, New York (1986) |
| 3 | E. B. Podgorsak, Radiation Oncology Physics: A Handbook for teachers and student, International Atomic Energy Agency, Vienna, (2005). |

**Reference Books**

| | |
|---|---|
| 1 | S.C.Klevenhagen, Physics of Electron Beam Therapy, Medical Physics Hand Book Series |

| | |
|---|---|
| | No.6, Adam Hilger Ltd.,Bristor, 1st Edition (1981). |
| 2 | Radiation Therapy Planning, G.C.Bentel, Macmillan Publishing Co.,New York, 1st Edition (1992). |
| 3 | BENTEL, G.C., Radiation Therapy Planning, McGraw-Hill, New York (1996). |
| | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | Treatment planning and Delivery - https://www.estro.org/Courses?category=3 |
| | |
| Course Designed By: **Dr. C. S. Sureka** | |

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | L | M | L | S | S | M | S | L | M |
| **CO3** | S | L | M | L | S | S | M | S | L | M |
| **CO3** | S | L | M | L | S | S | M | S | L | M |
| **CO4** | S | L | M | L | S | S | M | S | L | M |
| **CO5** | S | L | M | L | S | S | M | S | L | M |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 1EA | ELECTRONICS AND INSTRUMENTATION | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 3 | 0 | 0 | 3 |
| Pre-requisite | | Semi-conductorPhysics | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. Give the fundamental concepts of p-n junction, diode, transistors andamplifiers.
2. Study the boolean equations and data processing circuits, and understand the differenttypes of Flip-flops, andCounters.
3. Provide fundamental knowledge of electric accessories for X-Raytubes.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the usage of various semiconductor based components/devices for constructing electronic circuits | K2 |
| 2 | Able to understand the important of Op-amp IC and its applications | K2 |
| 3 | To know functioning of various logic gates and fundamentals of digital electronics. | K3 |
| 4 | Capable of how the digital data is stored and counted in CPU using flip-flops in counters | K3 |
| 5 | Capable of analyzing the concepts, and various electric accessories of X-ray tubes, moreover X-ray generators for therapeutic applications | K4 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Diode and Transistor | 7--hours |
|---|---|---|

Semiconductors, Bonds in semiconductor, Classification of semiconductors, semiconductor diode - Half-wave rectifier, Centre -Tap full-wave rectifier, Full wave bridge rectifier, Bipolar junction transistors - CB connection and characteristics CE connection and characteristics - JFET – MOSFET

| Unit:2 | Operational amplifier | 7--hours |
|---|---|---|

IntegratedCircuits-Operationalamplifiers(Op-Amp)andtheircharacteristics,theidealopAmp -Commonmoderejectionratio(CMMR),DifferentialAmplifier-Operationalamplifiersystems – Op-Amp Applications -Addition, subtraction, Integration and Differentiation - Voltage-to-current converter, Current-to-voltage converter, Logarithmic amplifier.

| Unit:3 | Digital Electronics - Data Processing | 7--hours |
|---|---|---|

Logic gates - Boolean algebra - Boolean laws – De-Morgans theorem - Sum-of-Products method – Product of sum method - Multiplexers, 16 - 1 Multiplexer, Nibble multiplexer,De-multiplexer, 1-16de-mutiplexercircuits-Decoder,BCDtoDecimaldecoders1of16decoder,Sevensegment decoders - Encoder, Decimal to BCDencoder.

| Unit:4 | Digital Electronics - Flip-flops and counters | 6--hours |
|---|---|---|

Types of Flip Flops: RS, Clocked RS, D-Flip Flop, Edge-triggered D Flip flop – J K Flip flop - Master slave JK Flip flop, Counters: Ripple counters - up, down and up-down ripple counters - Asynchronous and synchronous counters.

| Unit:5 | Diagnostic X-ray units | 7--hours |
|---|---|---|
| Filamentandhighvoltagetransformers-Highvoltagecircuits-Condenserdischargeapparatus- Three phase apparatus - Voltage doubling circuits - Current and voltage stabilizers - Automatic exposurecontrol-AutomaticBrightnessControl-MeasuringinstrumentsforMeasurementofkV andmA-timers-ControlPanels-CompleteX-raycircuit-Imageintensifiersandflatpanel detectors - Computed Radiography and Digital Radiography Systems - Modern Trends. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars - webinars | | |
| Building Blocks, Design of control unit, Programming language | | |
| | **Total Lecture hours** | **36--hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | A.P. Malvino and D.P. Leach, Digital Principles and Applications, Tata McGraw-Hill Publishing Co, New Delhi, 1st Edition, 1996. |
| 2 | Jacob Millman, and Christos C. Halkias, Integrated Electronics Mcgraw-HillKogakusha. LTD |
| 3 | A.B. Bhattacharya, Electronic Principles and Applications, New Central Book Agency, Kolkata, 1st Edition, 2007. |

**Reference Books**

| | |
|---|---|
| 1 | SantanueChattopadhyay, A text book of Electronics, New Central Book Agency, Kolkata, 2006. |
| 2 | ChinmoySaha, A. Halder, and D. Ganguly, Basic Electronics: Principles andApplications, 1st Edition, 2018 |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | https://nptel.ac.in/courses/117/107/117107095/ |
| 2 | https://swayam.gov.in/nd1_noc20_ee32/preview |
| 3 | https://nptel.ac.in/courses/108/105/108105132/ |

Course Designed By: **Dr. S. Vijayakumar**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | L | L | L | L | L | L | L | M |
| **CO3** | S | L | L | L | L | L | L | L | L | M |
| **CO3** | S | L | L | L | L | L | L | L | L | M |
| **CO4** | S | L | L | L | L | L | L | L | L | M |
| **CO5** | L | L | L | S | L | L | L | L | L | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 1EB | NON-IONIZING RADIATION PHYSICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 3 | 0 | 0 | 3 |
| Pre-requisite | | Atomic, Molecular, and Nuclear Physics | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. Fundamentals of Non-ionising Radiation (NIR) physics, Various Tissue Opticstechniques.
2. Mediphotonics and itsapplications.
3. Radio Frequency and Microwaveapplications.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Explain different types of Non-ionizing radiation and its properties and applications. | K2 |
| 2 | Explain different Application of optical properties of NIR in tissues. | K2 |
| 3 | Applications of Laser in Medicine. | K3 |
| 4 | Applications of Radio Frequency and Microwave in Medicine. | K3 |
| 5 | Applications of Ultrasound in Medicine. | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Fundamentals of Non-ionising Radiation physics | 7 --hours |
|---|---|---|

Elctromagnetic spectrum - Different sources of Non Ionising radiation-their physical; properties-first law of photochemistry-Law of reciprocity- - Electrical Impedance and Biological Impedance- Principle and theory of thermography – applications.

| Unit:2 | Applications of optical radiation | 7 --hours |
|---|---|---|

Introduction to optical radiations - UV, visible and IR sources - Lasers: Theory and mechanism-Lasers in Surgery - fluence measurement from optical sources - Optical properties of tissues – interaction of laser radiation with tissues– photothermal -photochemical – photoablation – electromechanical effect.

| Unit:3 | Lasers in Medicine | 7 --hours |
|---|---|---|

Lasers in medicine-applications of Ultrafast pulsed Lasers -Lasers in dermatology, oncologyand cellbiology-Lasersinbloodflowmeasurement-Fiberopticsinmedicine-Hazardsoflasersand their safetymeasures.

| Unit:4 | Ultrasound in Medicine | 6 --hours |
|---|---|---|

Production, properties and propagation of ultrasonic waves - Bioacoustics – Acoustical characteristics of human body- Ultrasonic Dosimetry - High power ultrasound in therapy.

| Unit:5 | Radio Frequency and Microwave in Medicine | 7 --hours |
|---|---|---|

Production and properties- interaction mechanism of RF and mirocwaves with biological systems: Thermal and non-thermal effects on whole body, lens and cardiovascular systems:

Thermal and non-thermal effects on whole body, lens and cardiovascular systems –tissue characterization and Hyperthermia and other applications.

| Unit:6 | Contemporary Issues | 2 hours |
|---|---|---|

https://www.youtube.com/watch?v=HxYcI7uXuhA

| | | |
|---|---|---|
| https://www.youtube.com/watch?v=q2CrDNJQMc0<br>http://www.digimat.in/nptel/courses/video/108105091/L04.html | | |
| | | |
| | **Total Lecture hours** | **36 --hours** |
| **Text Book(s)** | | |
| 1 | Harry Moseley, Hospital Physicists' Association, Non-ionizing radiation: microwaves, ultraviolet, and laser radiation, A. Hilger, in collaboration with the Hospital Physicists' Association, 1988. | |
| 2 | J. R. Greening, Medical Physics, North Holland Publishing Co., New York, 1999. | |
| | | |
| **Reference Books** | | |
| 1 | R. Pratesi and C. A. Sacchi, Lasers in Photo medicine and Photobiology, Springer Verlag, West Germany, 1980. | |
| 2 | J. P. Woodcock, Ultrasonic, Medical Physics Handbook series 1, Adam Hilger, Bristol, 2002. | |
| | | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | | |
| 1 | https://spie.org/news/spie-professional-magazine-archive/2011-january/lasers-in-medicine?SSO=1 | |
| 2 | https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cy13/ | |
| | | |
| Course Designed By: **Dr. S. HarikrishnaEtti** | | |

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | M | M | M | M | M | M | M | M |
| **CO3** | M | M | M | M | M | M | M | M | M | M |
| **CO3** | M | M | M | M | M | M | M | M | M | M |
| **CO4** | M | M | M | M | M | M | M | M | M | M |
| **CO5** | M | M | M | M | M | M | M | M | M | M |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 1EC | ATOMIC, MOLECULAR AND NUCLEAR PHYSICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 3 | 0 | 0 | 3 |
| Pre-requisite | | ParticlePhysics | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course isto:

1. Studythephysicsofvariousatomicmodelsandtheirrelativemerits/demeritsinexplainingthe properties ofmatter.
2. Understand physics of absorption and emission spectra, and the action ofLASER,
3. Know nature of nuclear force and the basic characteristics ofnuclei..

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | know about various atomic models | K1 |
| 2 | Understand the significance of Spectra and lasers in exploring the material properties. | K2 |
| 3 | Analyse the nature of nuclear force | K4 |
| 4 | Understand the various nuclear models | K2 |
| 5 | Understand how to exploit nuclear energy produced through various nuclear reactions. | K2 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Atomic Physics | 7--hours |
|---|---|---|

Thomson's Model - Rutherford Model – Bohr's Model of Hydrogen atom, Limitations – Sommerfeld model – Bohr's Correspondence Principle – Davison- Germer Experiment – Uncertainity Principle – Phase and Group velocities - Hydrogen Spectrum– Stern-Gerlach Experiment – Electron spin, Gyromagnetic Ratio – Spin-Orbit Interaction (Fine Structure).

| Unit:2 | Molecular Spectra | 7--hours |
|---|---|---|

Angular Momentum; L-S Coupling, J-J Coupling, Hund Rules – Zeeman Effect (Normal & Anomalous) – Characteristic X-ray Spectrum –Raman Effect: Theory, Characteristics and Applications – Absorption and emission of radiation by Matter – Einstein's coefficients, Conditions for stimulated emission – Methods of Population Inversion- Components of laser– Typical Lasers: Ruby, He-Ne.

| Unit:3 | Properties of Nuclei and Nuclear Force | 7--hours |
|---|---|---|

Isotopes, Isobars, Isotones and Mirror Nuclei – Nuclear Density and Binding Energy – Binding Energy and Stability – Mass Defect and Packing Fraction – Nuclear Size, Spin, Energy Levels andMagneticMoment–NuclearParity–NuclearForces–GroundStateofDeuteron–Exchange Forces; Yukawa Model and estimation of Mass ofMeson.

| Unit:4 | Nuclear Models | 7--hours |
|---|---|---|

Liquid Drop Model; Semi-empirical Mass Formula – Mass Parabola: Prediction of Stability against β-decay – Spontaneous Fission: Stability Limits – Potential Barriers for Fission –Stability Limits – Shell Model; Salient features – Predictions of Shell Model – Collective Model

| Unit:5 | Radioactive Disintegration and Nuclear Reactions | 6--hours |
|---|---|---|
| Radioactivity – α-particles; Geiger-Nuttal Law, Gamow Theory of α-decay, β-decay: Determination of β-energy, γ-rays; Origin, γ-ray Spectrum, Interaction with Matter – Energy of γ-rays – Nuclear reactions; Types, Conservation Laws – Q-Values, Q-equation and its Solution – Nuclear Reactor; Construction and types – Nuclear Fusion; Natural Fusion, Controlled Fusion | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars - webinars | | |
| https://www.youtube.com/watch?v=bukjtmM2djU | | |
| | **Total Lecture hours** | **36--hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | A.B. Gupta, Modern Atomic and Nuclear Physics, Books and Allied (P) Ltd. 2nd Edition, 2012. |
| 2 | S. B. Patel, Nuclear Physics: An Introduction, New Age International, New Delhi, 2nd Edition, 2011. |
| 3 | D.C. Tayal, Nuclear Physics., Himalaya Publishing House, 2nd Edition, 2009. |

**Reference Books**

| | |
|---|---|
| 1 | S. N. Ghoshal, S. Chand, Nuclear Physics 1st Edition, 1997 |
| 2 | D.C. Tayal, Nuclear Physics., Himalaya Publishing House, 2nd Edition, 2009. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | https://nptel.ac.in/courses/115/101/115101003/ |
| 2 | https://nptel.ac.in/courses/115/103/115103101/ |
| 3 | https://nptel.ac.in/courses/115/102/115102017/ |

Course Designed By: **Dr. S. Vijayakumar**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | L | L | L | L | L | L | L | M |
| **CO3** | S | L | L | L | L | L | L | L | L | S |
| **CO3** | S | L | L | L | L | L | L | L | L | S |
| **CO4** | S | L | L | L | L | L | L | L | L | S |
| **CO5** | S | L | L | L | L | L | L | L | L | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 1ED | BIOMEDICAL INSTRUMENTATION | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 3 | 0 | 0 | 3 |
| Pre-requisite | | Basics electronicsand instrumentation | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. Understand the different potentials and equivalent circuits for medicaltreatment.
2. Know the fundamental concepts, functioning, applications of physiological devices andthe importance of clinical and operation theatreequipment.
3. Provide the knowledge of telemetry system, protection, and modern technologies used in the biomedicalinstrumentation.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the different potentials and equivalent circuits for medical treatment | K1 |
| 2 | Get the prior knowledge of fundamental concepts, functioning and applications of physiological devices | K2 |
| 3 | Study the importance of clinical and operation theatre equipment | K4 |
| 4 | Able to handle the telemetry system and protect from the emergency | K4 |
| 5 | Evaluate the technologies and model used in the biomedical instrumentation | K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Bioelectric Signal Recording | 7--hours |
|---|---|---|

Bioelectric potentials – resting and action potentials – half cell potentials- Surface, needle and micro electrodes, electrical equivalent circuits

| Unit:2 | Physiological Assist Devices | 7--hours |
|---|---|---|

Cardiac pacemakers – natural and artificial pacemakers-pacemaker batteries-defibrillator-A.C./D.C synchronized defibrillator – stimulators – bladder stimulators – heart lung machine various types of oxygenators- kidney machine – hemodialysing units – peritoneal dialysis

| Unit:3 | Clinical and Operation Theater Equipment | 7--hours |
|---|---|---|

Flame photometer – Spectroflurophotometer – pH meters – Audiometer – Endoscopes – Electromagnetic and laser blood flow meters – ventilators – diathermy units – ultrasonic, microwave diathermy techniques

| Unit:4 | Biotelemetry and Safety Instrumentation | 7--hours |
|---|---|---|

Design of a biotelemetry system, radiotelemetry with subcarrier – multiple channel telemetry systems- problems in implant telemetry – uses of biotelemetry – physiological effects of 50Hz current – microshock and macroshock – electrical accidents in hospitals – devices to protect against electrical hazards.

| Unit:5 | Advances in Biomedical Instrumentation | 6--hours |
|---|---|---|

Computers in medicine, Lasers in medicine, Endoscopes, Cryogenic Surgery, Nuclear imaging techniques, Computer tomography, Thermography, Ultrasonic imaging systems, Magnetic resonance imaging, Digital substraction angiography, Biomaterial and sensors, Automated drug delivery system.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|
| Expert lectures, online seminars – webinars | | |
| https://www.youtube.com/watch?v=8SnD9ZpbIvE, and related webinars | | |
| | **Total Lecture hours** | **36--hours** |

| **Text Book(s)** | |
|---|---|
| 1 | M.Arumugam, Biomedical Instrumentation, Anuradha Publishing Co.,Kumbakkonam, Tamilnadu 1992. |
| 2 | R.S.Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 1990. |
| 3 | R. S Khandpur, Handbook of Analytical Instruments, McGraw Hill, Education |
| | |
| **Reference Books** | |
| 1 | Jacobson and Webster, Medicine and Clinical Engineering, Prentice Hall of India, New Delhi, 1979 |
| 2 | Richad Aston, Principles of Biomedical Instrumentation and measurements, Merrill Publishing Co., London, 1990 |
| | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | https://nptel.ac.in/courses/108/105/108105101/ |
| 2 | https://nptel.ac.in/content/storage2/courses/112104039/pdf_version/lecture23.pdf |
| 3 | https://nptel.ac.in/courses/102/108/102108077/ |
| | |
| Course Designed By: **Dr. S. Vijayakumar** | |

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | L | L | M | L | S | M | L | L | L | M |
| **CO3** | L | L | M | L | S | M | L | L | L | M |
| **CO3** | L | L | M | L | S | M | L | L | L | M |
| **CO4** | L | L | M | L | S | M | L | L | L | S |
| **CO5** | L | L | M | L | M | M | L | L | L | S |

*S-Strong; M-Medium; L-Low

| Course code | 13P | RADIATION INSTRUMENTATION LAB | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Lab | 0 | 0 | 4 | 4 |
| Pre-requisite | | Atomic and Nuclear Physics- G Level | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. Operate alpha, beta and gamma survey meters and detectors to perform radiation survey and understand its detectionmechanism.
2. Find the unknown gamma emitters and alpha emittingisotopes.
3. Acquire skill on using semiconducting components and to study their characteristics for their effective usage in dosimeters internalcircuits.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the functioning of GM counter, alpha, beta counting systems, and survey meters. | K2 |
| 2 | Understand the construction and working of Gamma ray spectrometer and its inbuilt software to identify the unknown gamma emitting isotope. | K2 |
| 3 | Understand the operation and calibration techniques. | K2 |
| 4 | Providing feedback for better design, development and integration with the existing technologies. | K5 |
| 5 | Provide firsthand information for repair and modification. | K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

**List of Practical (Any 10)**

1. Measure the energy resolution of the Gamma rayspectrometer.
2. Identify unknown gamma source using the Gamma rayspectrometer.
3. Verification of inverse square law and to find the hidden source using surveymeters.
4. Estimation of efficiency of the alpha countingsystem.
5. Measure the range and energy of beta particles by feather analysis using the GMcounter.
6. Measure the attenuation coefficients of various materials using the GMcounter.
7. Measure HVL of various materials using the GMcounter
8. Find the resolving time of a GMcounter
9. Study the characteristics of a GMtube.
10. NAND and NOR as Universal BuildingBlock
11. OP-Amp amplifications: Adder, Subtractor, Differentiator,Integrator
12. FETCharacteristics
13. A/D and D/Aconvertor
14. IC Regulated powersupply

Course Designed By: **Dr. C. S. Sureka, Dr. S. Vijayakumar& Dr. R. Mohandoss**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | L | S | L | S | S | M | S | M | S |
| CO3 | S | L | S | L | S | S | M | S | M | S |
| CO3 | S | L | S | L | S | S | M | S | M | S |
| CO4 | S | L | S | L | S | S | M | S | M | S |
| CO5 | S | L | S | L | S | S | M | S | M | S |

*S-Strong; M-Medium; L-Low

# Second Semester

| Course code | 23A | APPLIED ANATOMY AND PHYSIOLOGY | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Biology | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. To study skin, Lymphatic, Bone and muscularsystems. To learn about nerves, endocrine, cardiovascular, respiratory and digestivesystems.
2. To identify different organs/structures on plain X-rays, CT-scan and other available imaging modalities. To distinguish normal anatomy from abnormalities and understand tumour pathology and carcinogenesis.To know the importance of Radiation therapy, Surgery, Chemotherapy and Harmonetherapy. To understand the basis of immunotherapy and radionuclide therapy for benign and malignantdisease.
3. To identify site specific symptoms in Head and Neck, Breast, Gynecological and Gastro-Intestinal tract.Torecall principles of professional practice and medical terminology. Tounderstandethicalandculturalissues,legalaspectsandconfidentiality.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Familiar with structure and function of Organs, systems etc.., | K1 |
| 2 | Common pathology features of cancers and interpretation of clinico pathological data. | K2 |
| 3 | Understandcancerpreventionandpubliceducationandearlydetectionandscreening. | K2 |
| 4 | Recollect professional aspects and role of Medical Physicists. | K1 |
| 5 | Know the management of side effects related to radiation and dose. | K4 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

| Unit:1 | Structure & function of organs, systems & their common diseases | 10 --hours |
|---|---|---|

Skin, Lymphatic system, Bone and muscle, Nervous, Endocrine, Cardiovascular, Respiratory, Digestive (Gastro-Intestinal), Urinary, Reproductive, Eye and ear.

| Unit:2 | Basic, Radiographic anatomy and tumor pathology | 10 --hours |
|---|---|---|

Anatomy of human body, nomenclature & Surface anatomy, Radiographic Anatomy (including cross sectional anatomy – Identify the different organs/structures on plain x-rays, CT scans and other available imaging modalities. Normal anatomy & deviation for abnormalities. Tumor pathology and carcinogenesis, common pathological features of cancers and interpretation of clinico-pathological data.

| Unit:3 | Clinical aspects of Radiation Oncology | 8 -hours |
|---|---|---|

Benignandmalignantdisease,Spreadofmalignantdisease,Stagingandgradingsystems, Treatment intent - Curative & Palliative, Different modalities of cancer management (e.g. RadiationTherapy,Surgery,Chemotherapy),HormoneTherapy,Immunotherapy,Radionuclide therapy. Patient management on treatment - side effects related to radiation and dose - Acute & Late effects - Monitoring and common management of side effects.

| Unit:4 | Site specific signs, symptoms, diagnosis and management | 10 -hours |
|---|---|---|

Head and Neck, Breast, Gynecological, Gastro-Intestinal tract, Genito-Urinary, Lung &Thorax,

| | | |
|---|---|---|
| Lymphomas &Leukemias& Other cancers including AIDS related cancers. | | |
| | | |
| **Unit:5** | **Professional aspects and role of medical physicists** | **8 -hours** |
| General patient care - Principles of professional practice – Medical terminology – Research & professional writing – patient privacy – Ethical & cultural issues- Legal aspects – Confidentiality, informed consent, Health and safety. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| https://www.youtube.com/watch?v=IlcWcuB8VOo<br>https://www.youtube.com/watch?v=fC4dsZBKvp0 | | |
| | **Total Lecture hours** | **48 --hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | Anatomy and Physiology, Rod R. Seely, Mcgraw-HillCollege , 5th Edition, 1999. |
| 2 | Pat Archer MS ATC LMP, Lisa A. Nelson BA AT/R LMP, Applied Anatomy and Physiology for Manual Therapists, Published by Lippincott Williams & Wilkins, USA, 2012. |

**Reference Books**

| | |
|---|---|
| 1 | Normal Radiation Anatomy, Meschan, WB Sunders Company, 8th Edition, 1969. |
| 2 | HollinsheadText Book of Anatomy, Cornelius Rosse, LWW, 5th Edition,1997. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | https://www.youtube.com/watch?v=F3er9MrXa8A |
| 2 | https://www.youtube.com/watch?v=X_kbJLyLUGU |

Course Designed By: **Dr. S. HarikrishnaEtti**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO 3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 23B | MEDICAL IMAGING TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | RadiologicalPhysics | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. physical principle and components of Radiography, conventional radiographytechniques
2. physics of Imagedetectors
3. computed Tomography(CT), MRI and Ultrasound Imaging and advances in Diagnostic radiology

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Physics principles behind the working of components used in Radiography industry | K1 |
| 2 | Conventional and digital radiography techniques and its basics | K2 |
| 3 | The physics and working of Imaging detectors | K2 |
| 4 | The basic principles and working of CT, MRI and Ultrasound Imaging | K2 |
| 5 | The recent advances in Diagnostic radiology | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Medical Imaging Fundamentals | 8 --hours |
|---|---|---|

Physical Principle of Diagnostic Radiology- Radiography techniques: objectives of radio-diagnosis, Production of X-rays, Bremsstrahlung- characteristics lines- Interactions of X-rays with human body, differential absorption of X-ray beam, factors affecting image quality- patient dose versus image quality- Prime factors (kVp, mAs and SID/SFD).

| Unit:2 | Physics of Imaging Detectors | 10 --hours |
|---|---|---|

Physics of Imaging Detectors: Physics of generic photon detectors, Quantum efficiency, Direct andIndirectconversiondetectors,PhotomultiplierTube(PMT),Chargecoupleddevice,Flatpanel detector, CR-DR imaging plates, imageintensifier.
Intensifying screens: Principles and function of intensifying screens conventional screens Vs rare earth screens.
X-ray beam Filters: inherent and added filters, purpose of added filters, filters used for shaping X-ray spectrum (K-edge filters: holmium, gadolinium, molybdenum)- Heel effect.
Scatter radiation and grids: Factors influencing scatter radiation, objectives and methods for scatter reduction; beam restrictors (diaphragms, cones/cylinders & collimators), grids.

| Unit:3 | Image Quality | 8 --hours |
|---|---|---|

Limitations of projection imaging technique, Contrast media and projections at different angles - superimposition of overlying structures, spatial frequency, spatial image formation, formation of radiological (latent) image.

Image quality: sources and reduction of un-sharpness, factors influencing radiographic contrast, resolution,evaluationofresolution-pointspreadfunction(PSF),linespreadfunction(LSF),edge spreadfunction(ESF),modulationtransferfunction(MTF),Signal-to-noiseratio,focalspotsize evaluation- image acquisition.

| Unit:4 | Computed Tomography, MRI and Ultrasound Imaging | 10 --hours |
|---|---|---|

Computed Tomography (CT): Principle, CT imaging system, image reconstruction and

processing, acquisition and image quality.
Magnetic Resonance Imaging (MRI): NMR Principle, techniques involved MR image acquisition and reconstruction, safety and applications of MRI in radiotherapy for treatment planning.
Ultrasound imaging(US): construction and working of a transducer, B-mode signal processing, modern imaging methods, image artifacts- US imaging in radiotherapy for treatment planning.

| **Unit:5** | **Advances in Diagnostic radiology** | **10 --hours** |
|---|---|---|

Digitalradiography:Screenfilmanddigitalmammography,Interventionalradiology-Continuous andpulsedfluoroscopy,digitalsubtractiontechniques,orthopantomography(OPG),ConeBeam CT(CBCT).Digitaldetectors:DualEnergyCT(DECT),Tomosynthesis;detectorsbasedon direct and indirect conversion methods.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

https://www.youtube.com/watch?v=tW2SjlMGj0Qhttps://www.youtube.com/watch?v=5_k6GVMwQ8whttps://www.youtube.com/watch?v=lfkPQKje58s
https://www.youtube.com/watch?v=lfkPQKje58s

| | **Total Lecture hours** | **48--hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | Dance, D.R., Christofides, S., Maidment A.D.R., McLean, I.D., Ng.K.H., Diagnostic radiology physics : a Handbook for teachers and students, International Atomic Energy Agency,Vienna, 2014. |
| 2 | Christensen's introduction to the physics of diagnostic radiology, Curry, T.S., Dowdey, J.E., Murry, R.C., Philadelphia: Lea &Febiger, 4th Edition, (1990). |

**Reference Books**

| | |
|---|---|
| 1 | The essential physics of medical imaging, Bushberg, S.T., Seibert, J.A, Leidholt, E.M. & Boone, J.M., Baltimore: Williams & Wilkins 1st Edition (1990). |
| 2 | Physics for diagnostic radiology, Dendy, P.P.& B. Heaton, Bristol &Philadelphia: Institute of Physics Publishing, 2nd Edition (1994). |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | https://nptel.ac.in/courses/108/105/108105091/ |

Course Designed By: **Dr. S. HarikrishnaEtti**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | S | S | S | S | S | S | S | S |
| CO3 | S | S | S | S | S | S | S | S | S | S |
| CO3 | S | S | S | S | S | S | S | S | S | S |
| CO4 | S | S | S | S | S | S | S | S | S | S |
| CO5 | S | S | S | S | S | S | S | S | S | S |

*S-Strong; M-Medium; L-Low

| Course code | 23D | RADIATION STANDARDS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Physics -Graduatelevel | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. To understand the traceability of accuracy in dosedelivery
2. To understand the need for primary and secondary standards for dosemeasurements
3. To know the developments in the standards for air kerma and absorbed dose towater
4. To know the standards for brachytherapy, small fielddosimetry
5. To know the radioactivitystandardization
6. To know the standards for proton andneutrons.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Leant about the Radiation standards for photons and electrons | K2 |
| 2 | Understood the Standardization procedure of brachytherapy sources. | K3 |
| 3 | Understood standardization procedures involved while using Radionuclides | K2 |
| 4 | Learnt the working of neutron survey meters. | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| Unit:1 | Radiation standards for photons and electrons | 10--hours |
|---|---|---|

Need for standards and accuracy in dose measurements Traceability, Uncertainty in measurement, Guide to measurement uncertainty (ISO-GUM), Type A and Type B Standard Uncertainties, , Dosimetric quantities and units, SI units and primary standards for mass, time and length-, Air kerma primary standard- Free-air chambers- Graphite cavity chambers-System of absorbed dose to water standards and their comparison, Graphite and Water Calorimeters as primary standards, Standard for small field dosimetry.

| Unit:2 | Standardization of brachytherapy sources | 10--hours |
|---|---|---|

Apparent activity- Reference Air Kerma Rate- Air Kerma Strength- Standards for HDR $^{192}$Ir and $^{60}$Co sources- Standardization of $^{125}$I and beta sources- Wide angle free air chamber for brachytherapy low energy photon sources, Extrapolation chamber as a primary standard for beta ray sources, - room scatter correction- Development of graphite and water calorimeters for brachytherapy,

| Unit:3 | Standardization of Radionuclides | 10--hours |
|---|---|---|

$4\pi$ $\beta$-$\gamma$ Coincidence Counting Technique - Standardization of beta and gamma emitters- $4\pi$ Large Diameter Proportional Counter- HP Ge Gamma Spectrometer- High Pressure Re—entrant Type Gamma Ion Chamber- Scintillation counting methods for alpha, beta and gamma emitter-liquid scintillation counting- correlation counting- Methods using (n, $\infty$) and (n, p) reactions - Determination of yield of neutron sources.

| Unit:4 | Neutron and proton Standards | 8--hours |
|---|---|---|

Neutron classification, neutron sources, Neutron standards – primary standards, secondary standards, Neutron yield and fluence rate measurements, Manganese sulphate bath system, precision long counter, Activation method. Neutron spectrometry, threshold detectors & scintillation detectors. Standards for proton beams.

| Unit:5 | Neutron Detectors and Dosimeters | 8--hours |
|---|---|---|
| Neutron dosimetry, Neutron survey meters and their calibration, neutron field survey around high energy medical accelerators/cyclotrons/hadron therapy facilities. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Jan Seuntjens and Simon Duane, Photon absorbed dose standards, Metrologia, Volume 46, Number 2. | | |
| | **Total Lecture hours** | **48-hours** |

| **Text Book(s)** | |
|---|---|
| 1 | F.H. Attix, Introduction to Radiological Physics and Radiation Dosimetry, Viley - VCH, Verlog, 1st Edition, 2004. |
| 2 | Michael G.Stabin, Radiation Protection and Dosimetry – An Introduction to Health Physics, Springer, 1st Edition, 2007. |
| 3 | C.Lowental and P.L.Airey, Practical Applications of Radioactivity and Nuclear Radiations, Cambridge University Press, U.K., 2001. |
| | |
| **Reference Books** | |
| 1 | Greening J R, Green S, Charles M W, Fundamentals of Radiation Dosimetry, 3rd Edition, London: Taylor & Francis, 2010. |
| 2 | H.E.Jones, J.R.Cunnigham, "The Physics of Radiology" Charles C.Thomas, NY, 1980. |
| 3 | W.J.Meredith and J.B.Massey "Fundamental Physics of Radiology" John Wright and sons, UK, 1989. |
| | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| **1.**https://iopscience.iop.org/article/10.1088/0031-9155/41/1/002<br>**2.**https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3003886/ | |
| | |
| Course Designed By: **Dr. GanesanRamanathan** | |

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | L | L | L | S | L | L | L | L |
| **CO2** | M | M | L | L | L | S | L | L | L | L |
| **CO3** | M | M | L | L | L | S | L | L | L | L |
| **CO4** | M | M | L | L | L | S | L | L | L | L |

*S-Strong; M-Medium; L-Low

| Course code | 23D | RADIATION BIOLOGY | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Anatomy and Physiology/ Radiological Physics | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. To study the structure of normal and abnormal cells, organic and inorganic constituents and their metabolicactivities.
2. Understand the effect of radiation at atomic, molecular, organelle, cellular, tissue and organ level and the possible repairmechanisms.
3. Know about the availability, applicability and limitations of various Radiobiological models that can extend the results obtained from animal experiments and experience gathered from radiationaccidents.
4. To realize the early and late effects of radiation on fetus, individual human beings and our generationtoo.
5. TooptimizetheRadiotherapyplansonbiologicalaspectsinordertoenhanceclinicaloutcome.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understand the structure and behavior of normal and abnormal cells. | K2 |
| 2 | Learnt the effects of radiation to be cautious while working with radiation. | K2 |
| 3 | Collected information to overcome Radiophobia and to respect radiation. | K2 |
| 4 | Learnt to increase the benefits of radiation towards Radiotherapy by reducing its associated risk. | K3 |
| 5 | Realized the scope for further research in health care to serve human society. | K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| Unit:1 | Cell Biology | 8--hours |
|---|---|---|

Introduction to cell biology- Biochemistry- Structure of the cell- Cellular components: Plasma membrane, Cytoplasm, Nucleus - Interaction of cells with their environment- Cell metabolism- Life cycle of the cell: Cell cycle, Cell division, Cell synchronization- Cellular abnormalities and introduction to cancer..

| Unit:2 | Interaction of Radiation with Cell | 8--hours |
|---|---|---|

Concepts of microdosimetry- Interaction of radiation with biological system- various stages- Interaction of radiation with cell at atomic level- Interaction of radiation with cell at molecular level- Interaction of radiolysis product with biomolecules: Interaction with proteins, carbohydrates and lipids, DNA damage, DNA Repair, Chromosomal and Chromatid aberrations and Dose response relationships- Interaction of radiation at cellular level: Effects of radiation on cell cycle, Mechanisms of Cell Death- Non targeted effects of radiation.

| Unit:3 | Radiobiological Models and Radiation Response Modifiers | 10--hours |
|---|---|---|

Importance of Radiobiological Models- Models based on empirical model: Nominal Standard Dose(NSD)model,TimeDoseFractionation(TDF)factormodel-Modelsbasedoncellsurvival curves and isoeffect: Cell survival curve, Random nature of cell killing and poisson statistics: Target theory, Linear Quadratic model, Local effect model- TCP and NTCP basedmodels.

Radiation response modifiers: Physical factors: Treatment time, Radiation dose response, Fractionation – 4R's of radiobiology, Dose rate effect, Temperature, Linear energy transfer (LET), Relative Biological Effectiveness- Biological factors: Radio sensitivity of tissues, Age- Chemical factors: Impact of molecular oxygen- Oxygen Enhancement Ratio (OER) , Radio sensitizers, Radio protectors and mitigators.

| **Unit:4** | **Biological Effects of Radiation** | **10--hours** |
|---|---|---|

Deterministiceffects:Earlydeterministiceffectsofradiation,conceptofLD50/30andLD50/60, Acuteradiationsyndrome,itsstagesandgeneralclinicalsubsyndromes-Latedeterministiceffects of radiation: radiation effects on importance organs and organ systems, induction of cataract, radiation effects on the developing embryo and shortening of lifespan.
Stochastic effects (Carcinogenesis): Experience on radiation carcinogenesis, radiation epidemiology,linearnon-thresholdhypothesis,DDREF,cancerriskestimation,cancercausedby radiation exposure, second cancers in RT patients, cancer risk from diagnostic radiology, attributablelifetimerisk.Stochasticeffects(Geneticeffects):Geneticeffectsofradiation,genetic diseases in humans, genetic risk estimation, background data from humans and other animals.

| **Unit:5** | **Biological Basis of Radiotherapy** | **10--hours** |
|---|---|---|

Radiobiological aspects of modern radiotherapy techniques: Brachytherapy, IMRT, Stereotactic radiotherapy, IORT, Protons, high LET sources and Boron Neutron Capture Therapy (BNCT)-BiologicalTreatmentPlanning:Tumorcontrolprobability(TCP)andNormaltissuecomplication probability (NTCP) curves, Nominal Standard Dose (NSD), Biologically Effective Dose (BED) and isoeffect dose calculations, Treatment Gap correction, Effective Uniform Dose(EUD), Limitations of dose-volume-based treatment planning, Uses of biological models in treatment planning,Advantagesofbiologicalcostfunctionsoverdose-volumecostfunctions,Precautions for using biological models in plan optimization, quantitative Analysis of Normal Tissue Effects in the Clinic(QUANTEC) and strategies for effective use of biological models in plan optimization.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

Expert lectures, online seminars – webinars

1. Cell biology - https://youtu.be/sL3-j79K3u0 (38 Min )
2. Radiation biology https://youtu.be/eVFcP-s1lBE(42Min)
3. Fundamental radiobiology - https://youtu.be/lkaNFUwf_bM (51MIn)
4. RAD 432:Early deterministic effects - https://youtu.be/E1bBQ7l6vN0 (1 Hr 5Min)
5. Biological clinical outcomes models in radiation therapy planning Equivalentuniform dose(EUD) -https://youtu.be/E30s38zjDII ( 35Min)
6. Radiobiology and principles of radiotherapy - https://youtu.be/xzk7pEzTm7Y (58Min)

| | **Total Lecture hours** | **48 --hours** |
|---|---|---|

**Text Book(s)**


| | |
|---|---|
| 1 | C. S. Sureka and C. Armpilia, Radiation biology for Medical Physicists, CRC Taylor & Francis Group, USA, 2017. |
| 2 | E. J. Hall, Radiobiology for Radiologists, J. B. Lippincott Co., 5th Edition, (2000). |
| 3 | Radiation Biology: A handbook for teachers and students, Training course series No. 42, International Atomic Energy Agency (IAEA), Vienna, 2010. |

**Reference Books**


| | |
|---|---|
| 1 | G.G. Steel, Basic Clinical Radiobiology, 2nd Edition, Taylor & Francis Ltd, (1997). |
| 2 | S. P. Yarmonenko, Radiobiology of Humans and animals, MIR, Publishers, 1st Edition (1990). |
| 3 | J. Dutreix, A. Wambersie, Introduction to Radiobiology, CRC Taylor & Francis, USA, (1990). |


**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | Basic physics, Radiation protection and Radiation biology- IAEA:https://elearning.iaea.org/m2/enrol/index.php?id=276 |
| 2 | 2.Cell biology - Swayam:https://www.google.com/url?sa=t&source=web&rct=j&url=https://swayam.gov.in/nd2_cec19_bt12/preview&ved=2ahUKEwj8qZXptO_qAhXiwzgGHaoZDHMQFjAAegQIBBAC&usg=AOvVaw3T9PWIwT27zSzhree2bCHs |

Course Designed By: **Dr. C. S. Sureka**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | L | S | S | M | M | S | M | M |
| **CO3** | S | L | L | S | S | M | M | S | M | M |
| **CO3** | S | L | L | S | S | M | M | S | M | M |
| **CO4** | S | L | L | S | S | M | M | S | M | M |
| **CO5** | S | L | L | S | S | M | M | S | M | M |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 23E | QUALITY ASSURANCE FOR DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 4 | 0 | 0 | 4 |
| Pre-requisite | | Medical Imaging Technologyand External Beam RadiationTherapy | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. learn the Quality assurance procedures in DiagnosticRadiology.
2. learn the Quality assurance procedures in conventional radiation therapy andTPS.
3. learn theQuality assurance procedures in advanced radiation therapy and Brachytherapy.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Perform Quality assurance in Diagnostic Radiology. | K3 |
| 2 | Perform Quality assurance in conventional radiation therapy. | K3 |
| 3 | Perform Quality assurance in advanced radiation therapy. | K3 |
| 4 | Perform Quality assurance in Brachytherapy. | K3 |
| 5 | Perform Quality assurance in TPS. | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Quality assurance in Diagnostic Radiology | 10 --hours |
|---|---|---|

Purpose of QA, QA protocols and procedures, QA test methods for performance evaluation of x-ray diagnostic equipment, QA of mammography, QA of CT equipment, QA of interventional radiology equipment, Dual energy imaging and absorptiometry (DEXA), Patient dose optimization techniques, Dual and Multi-modality Imaging techniques.

| Unit:2 | Quality assurance in conventional radiation therapy | 10 --hours |
|---|---|---|

Precisionandaccuracyinclinicaldosimetry-IECrequirements-acceptance,commissioning and quality control of telecobalt, medical linear accelerator, FFF and radiotherapysimulators - Portal and in-vivo dosimetry - electronic portal imaging devices - Patient Specific quality assurance in radiotherapy using EPID.

| Unit:3 | Quality assurance in advanced radiation therapy | 10 --hours |
|---|---|---|

Commissioning, QA protocol and procedures, machine and patient specific QA in IMRT, IGRT, SRS, SRT, SBRT, and Cyber knife based therapy.

| Unit:4 | Quality assurance in Brachytherapy | 8 --hours |
|---|---|---|

Acceptance, commissioning and quality assurance of remote after loading brachytherapy equipment. ISO requirements and QA of brachytherapy sources- QA & acceptance test proforma of AERB for Brachytherapy units.

| Unit:5 | Quality assurance in TPS | 8 --hours |
|---|---|---|

Acceptance, commissioning and quality assurance of radiotherapy treatment planning systems using IAEA TRS 430 and other protocols.

| Unit:6 | Contemporary Issues | 2 -- hours |
|---|---|---|
| https://www.youtube.com/watch?v=qo_cD7QbYbU<br>https://www.youtube.com/watch?v=mMhXCSjSacA | | |
| | Total Lecture hours | 48 --hours |

**Text Book(s)**

| | |
|---|---|
| 1 | R.F.Mould, Radiotherapy Treatment Planning, Medical Physics Hand Book Series No.7, Adam Hilger Ltd.,Bristor, 1st Edition, 1981. |
| 2 | American Association of Physicists in Medicine, Task Group 142 report: Quality assurance of medical accelerators, 2009. |

**Reference Books**

| | |
|---|---|
| 1 | Goran K. Svensson, Physical aspects of quality assurance in Radiation Therapy, AAPM REPORT No. 13, Published for the American Association of Physicists in Medicine by the American Institute of Physics, 1994. |
| 2 | G.C.Bentel, Radiation Therapy Planning, Macmillan Publishing Co.,New York, 1st Edition, 1992. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | https://www.youtube.com/watch?v=PCCfpmwOg5A |
| 2 | https://www.youtube.com/watch?v=xpKjY_KI9X8 |

Course Designed By: **Dr. S. HarikrishnaEtti**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 2EA | NUMERICAL AND COMPUTATIONAL TECHNIQUES. | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 0 | 0 | 4 |
| Pre-requisite | | Basic mathematics and computer programming | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. Provide the importance of the numerical techniques and solving algebraic, transcendental, and simultaneous equations (both direct and iterativemethods).
2. Study the fitting of straight line, parabola and exponential curve using the principles ofleast squaretool.
3. Understand the interpolation of equal and difference of independent variables, solve the ordinary and partial differential equations, MATLAB for data files, Objects andimages.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Deduce the solution for various algebraic, transcendental and simultaneous equations using both direct and iterative methods | K3 |
| 2 | know the curve fitting and interpolation for equal and difference data and how it is used for practical applications | K1 |
| 3 | identify the techniques for integration and their applications | K2 |
| 4 | understand the initial and boundary value problems for ordinary and partial differential equations | K2 |
| 5 | Enhance the problem solving ability using MATLAB and solve the above numerical problem in MATLAB | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Roots of equation | 10--hours |
|---|---|---|

Roots of equation: Horner's method, Bisection method – False position method –Newton Raphsonmethod–Simultaneousequation:Gausseliminationmethod–Inversionofamatrix using Gauss elimination method -Method of triangularization Iterative methods : Gauss Jacobi iteration method – Gauss Seidal iteration method - Relaxation Methods

| Unit:2 | Curve fitting and Interpolation | 8--hours |
|---|---|---|

The principles of least squares – Fitting a straight line, Fitting a parabola, Fitting an exponential curve, Sum of the squares of the residuals, Gregory Newton's forward and backward difference formula for equal intervals – Divided difference – Properties of divided difference – Newton's divided difference formula – Lagranges interpolation formula for unequal intervals

| Unit:3 | Numerical Integration and Eigenvalues | 8--hours |
|---|---|---|

Newtoncotesquadratureformula-Trapezoidalruleanderroranalysis,Simpson's1/3rdruleand error analysis - Simpson's Three-Eight rule, Boole rule, Weddle rule-Power method to find dominant Eigenvalue - Jacobi method – Matrix eigenvalue problem, Eigenvalues of asymmetric tridiagonal matrix – House holder's method

| Unit:4 | Ordinary and Partial differential equation | 12--hours |
|---|---|---|

Ordinary differential equation– Taylor series method – Basic, Improved and Modified Euler methods – RungeKutta IV order method for first order differential equation – RK4 method for

simultaneous first order differential equations – RK4 method for second order differential equation – Milne's Predictor – Corrector method. Partial differential equation – difference – quotients – Graphical representation of partial quotients – Classification of Partial differential equations of the second order – Standard five point formula – Diagonal five-point formula – Solution of Laplace's equation by Liebmann's iteration

| **Unit:5** | **Mathematical tools** | **8--hours** |
|---|---|---|

The MATLAB environment - Data types, Objects and images, File handling, equation solving. Functions and Programs, Defining Functions Functions as Procedures Repetitive Operations Transformation Rules for Functions, Inverse of matrix, Matrix multiplication, Matrix Determinant.

| **Unit:6** | **Contemporary Issues** | **2 hours** |
|---|---|---|

Expert lectures, online seminars - webinars

Linear and quadratic spline function, and the finite element method

| | **Total Lecture hours** | **48--hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | J. D. Hoffman, Numerical Methods for Engineers and scientists, Marcel Dekker Inc., New York, 2nd Edition, 2001 |
| 2 | S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India, New Delhi, 5th Edition, 2012. |
| 3 | W. R. Leo, Techniques for Nuclear and Particle Physics Experiments: A How-to Approach, Springer Science & Business Media; 2nd Edition, 2012 |

**Reference Books**

| | |
|---|---|
| 1 | A.C. Bajpai, I. M. Calus and J.A. Fairley, Numerical Methods for Engineers and scientists – A students course book John Wiley & Sons, New York, 1st Edition, 1977. |
| 2 | T. Veerarajan and T. Ramachandran, Numerical Methods wit programs in C, Tata Mcgraw Hill, New Delhi, 2nd Edition, 2006 |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | https://nptel.ac.in/content/storage2/courses/104101002/downloads/lecture-notes/module1/chapter4.pdf |
| 2 | https://www.programmingsimplified.com/c/source-code/c-program-find-roots-of-quadratic-equation |
| 3 | https://nptel.ac.in/courses/103/106/103106118/ |

Course Designed By: **Dr. S. Vijayakumar**

**Mapping with Programme Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | S | S | L | L | L | L | L | L | S |
| **CO3** | L | S | S | L | L | L | L | L | L | S |
| **CO3** | L | S | S | L | L | L | L | L | L | S |
| **CO4** | L | S | S | L | L | L | L | L | L | S |
| **CO5** | L | S | S | L | L | L | L | L | L | S |

*S-Strong; M-Medium; L-Low

| Course code | 2EB | ADVANCES IN MEDICAL PHYSICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 4 | 0 | 0 | 4 |
| Pre-requisite | | Radiation Dosimetry | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. TolearntheadvancesinconventionaldosimetrytowardsMicrodosimetryandNanodosimetry.
2. To learn the difference between conventional dosimetry and Nanodosimetry and to analyse its variousapplications.
3. To realize the importance of Monte Carlo techniques in advanceddosimetry.
4. To understand the importance of Artificial Intelligence in MedicalPhysics.
5. To apply their knowledge towards Industry4.0/5.0.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Learnt the possibility to measure radiation at DNA level and the importance of replacing of conventional dosimetric quantities with nanodosimetric quantities. | K2 |
| 2 | Understand the basics of Micro dosimetry and Nano dosimetry and importance of Nanodosimetry in Oncology. | K2 |
| 3 | Realize the importance of Monte Carlo techniques in advanced dosimetry. | K2 |
| 4 | Under the significance of AI in Medical Imaging and Radiotherapy. | K3 |
| 5 | Apply their Medical Physics knowledge towards Industry 4.0/5.0. | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

| Unit:1 | Microdosimetry | 10--hours |
|---|---|---|

Microdosimetric quantities- solid state based microdosimetric techniques- gas based microdosimetry- Biological effects of microdosimtry, evaluation of Monte Carlo techniques for microdosimetry, microdosimetry in targeted radionuclide therapy and radiotherapy- Cellular dosimetry of targeted radionuclides, Microdosimetry of radon progeny, Dose–response relationship, Micro and nanodosimetric calculations, Relationship of absorbed dose, specific energy and track structures.

| Unit:2 | Nanodosimetry and its Applications | 10--hours |
|---|---|---|

Definition- Nanodosimetric quantities- charge counting Nanodosimetry: electron based nanodosimetry and ion based nanodosimetry- History- evaluation of positive ion detector for nanodosimetry, Biological effects of nanodosimtry, - structure- optimization- current scenario- future developments- Radiation detector- Radiation protection- Radiation biology- Radiation protection- Gamma spectrometry- Gas sensor- Oncology.

| Unit:3 | Artificial Intelligence in Medical Imaging- Introduction | 8--hours |
|---|---|---|

Applying Artificial Intelligence (AI) in Medical Imaging: Computer Aided Detection (CAD), PrinciplesofComputerAidedImageAnalysisinMedicalImaging,MachineLearning(ML),and Deep Learning (DL), Content- Based Image Retrieval (CBIR), Radiomics and Radiogenomics- AI in various Medical Imaging Modalities: Limitations of Human Observers, Computer Vision (CV) and AI, Detection of micro calcifications and breast masses, Present Status and Future Directions.

| Unit:4 | Artificial Intelligence in CT, MRI, Ultrasound and Nuclear Medicine | 8--hours |
|---|---|---|

AI in Computed Tomography: CT Reconstruction Algorithms: From concept to Clinical Necessity, Importance of AI based Detection in CT, Present and Future Developments- AI in Magnetic Resonance Imaging (MRI): Developments of AI in MRI, Future directions- AI in MedicalUltrasound:DLArchitectures,ApplicationsofDLinMedicalUSImageAnalysis,Future Perspectives- AI in Nuclear Medicine Imaging: Define a Radiomic Diagnostic Algorithm, Applications of AI in Nuclear Medicine, Future Scenarios- Salient features of AI in Medical Imaging:OpportunitiesandApplications,Challenges,PitfallsGuidelinesforSuccess,Regulatory and EthicalIssues.

| Unit:5 | Artificial Intelligence in Radiotherapy | 10--hours |
|---|---|---|

Importance of Artificial Intelligence (AI) in Radiotherapy- AI Tools for Automated Treatment Planning (ATP):Present ATP Techniques, AI Applications, Advancements and Research guidanceinATP,AIChallengesinATP-AIinIntensityModulatedRadiotherapy(IMRT),AIfor IMRT Dose Estimation, AI for IMRT Planning support, AI for Modelling IMRT Outcome and Plan Deliverability, AI for Auto-segmentation of OAR in IMRT, Future Directions- AI in Brachytherapy: AI in Radiotherapy Quality Assurance: Developments in ML towards Quality Assurance,ApplicationsofMLmodelsforQualityAssuranceinRadiotherapy,QualityAssurance ofMLAlgorithmsinRadiotherapy,ChallengesAssociatedwithAIforQualityAssuranceinRT, Future Directions to Improve AI based Quality Assurance in RT- AI in Radiation Biology- AI in Radiation Protection/ Safety: Motivations to Develop AI based systems for RadiationProtection, Problems Associated with AI based systems for Radiation Protection, Benefits and Future Directions- Radiomics in Radiotherapy: Radiomics Objectives and Workflow, Influence of Radiomics in RT, Challenges for Medical Physicists, Future Directions- AI Considerations for RT CurriculumDevelopment.

| Unit:6 | Contemporary Issues | 2 hours |
|---|---|---|

Expert lectures, online seminars – webinars

1.Microdosimetry - https://youtu.be/0p_rzTMPpaU

2.Targeted therapy - https://youtu.be/so3ODTYheYY

3.Monte carlo method -https://youtu.be/zRlSOvpIa4g 4.AI in Medical Imaging -https://youtu.be/Hlb-kA9JFyk

5.Biological effect of Radiation - https://youtu.be/EuKzI3g5ra4

6.Radiobiology and Radiation Protection -https://youtu.be/K17XNfxkH4Y

7.Developments in Radiation Oncology -https://youtu.be/e4ra7NvTiOc

8.Gamma Spectroscopy -https://youtu.be/L8RM8oOm2Do

https://youtu.be/o1suujl0MVo9.Gas sensor -https://youtu.be/BmL4VowrEfo

10.Radiation Detectors - https://youtu.be/byCBWJYtDqI

| | Total Lecture hours | 48 --hours |
|---|---|---|

| | |
|---|---|
| **Text Book(s)** | |
| 1 | H Palmans et al., "Future development of biologically relevant dosimetry" Br J Radiol; 88: 20140392, pp. 1-19, 2000. |
| 2 | B. Grosswendt, "Recent advances of nanodosimetry" Radiation Protection Dosimetry Vol. 110, Nos 1-4, pp. 789-799, 2004. |
| 3 | Lia M, Silvia D, Loredana C., 'Artificial Intelligence in Medical Imaging: From theory to Clinical Practice', USA, CRC Taylor & Francis Group (2019). |
| 4 | Reid F. T, Gilmer V, Clifton D. F, et al., 'Artificial intelligence in radiation oncology: A specialty-wide disruptive transformation?',*Radiotherapy and Oncology*, 129, 421–426 (2018). |
| | |
| **Reference Books** | |
| 1 | Alexander Wu Chao, "Review of accelerator science and technology", Volume 2: Medical Applications of Accelerators, https://doi.org/10.1142/7676, 2009. |
| 2 | S. Chauvie, Z. Francis, S. Guatelli et al., "Geant4 physics processes for microdosimetry simulation: design foundation and implementation of the first set of models, "IEEE Transactions on Nuclear Science, vol. 54, no. 6, pp. 2619–2628, 2007. |
| 3 | Dudley T. Goodhead "An Assessment of the Role of Microdosimetry in Radiobiology" Radiation Research; Vol. 91, No. 1, pp. 45-76, 1982. |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1. Radiation dosimetry - https://youtu.be/oezjs3VmVvE<br>2.GEANT 4DNA -https://youtu.be/eOBWI0EkKOM<br>3.Nanodosimetric Distribution - https://slideplayer.com/slide/3768950/<br>4.Initial events of molecular damages -https://youtu.be/7LS4B4Pms2I<br>5.Molecular mechanism of radiation effects -https://youtu.be/yYto-sIfHjo<br>6.Radiation track structure -https://youtu.be/GVBl0yRWlks<br>7. https://youtu.be/PQjL4ZDuq2o | |
| | |
| Course Designed By: **Dr. C. S. Sureka** | |

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | L | M | L | S | M | M | S | M | M |
| **CO3** | S | L | M | L | S | M | M | S | M | M |
| **CO3** | S | L | M | L | S | M | M | S | M | M |
| **CO4** | S | L | M | L | S | M | M | S | M | M |
| **CO5** | S | L | M | L | S | M | M | S | M | M |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 2EC | SOLID STATE PHYSICS | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 3 | 0 | 0 | 3 |
| Pre-requisite | | Solid State Physics -UGlevel | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. Understand the principle in the formation of bonding in materials and the structure related aspects of the crystal.
2. Study the various theories to explain the specific heat and magnetic properties ofsolids.
3. Know the implication of band theory in sculpturing the semiconducting properties of solids and, the mechanism of superconductivity and itsapplications.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Know the various types of bonding in solids | K1 |
| 2 | Understand the structural aspects and properties of crystals | K2 |
| 3 | Understand the thermal behavior and magnetic characteristics of solids | K2 |
| 4 | Able to analyze the formation of energy bands in solids and semiconducting properties of solids | K4 |
| 5 | Able to change the band gap of the material | K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Bonding in Solids | 7--hours |
|---|---|---|

Ionic Bonding; Bond Energy of NaCl, Lattice Energy of Ionic Crystals, Madelung Constant – Properties of Ionic Solids – Co-valent Bond; Saturation, Directional Nature, Hybridization, Properties–MetallicBond;Properties–IntermolecularBonds;VanderWaal'sbonds,Dispersion Bonds, Dipole Bonds, Hydrogen Bonds

| Unit:2 | Crystal Physics | 7--hours |
|---|---|---|

Types of Solids – Lattice, Basis and Crystal Structure – Unit Cells, Lattice Parameters, Primitive Cells – Crystal Systems, Bravais Lattice –Symmetry Elements, Types, Combination–Directions, Planes and Miller Indices – Reciprocal Lattice- X-ray Diffraction, Bragg's Law, PowderMethod (Laue's Interpretation).

| Unit:3 | Thermal and Magnetic Properties of Solids | 7--hours |
|---|---|---|

Specific Heat – Dulong and Petit Law- Einstein's Theory – Debye's Theory – Magnetism in Solids – Origin of Magnetic Properties of Materials - Bohr Magneton, Orbital, Electron Spinand NuclearSpin–Typesofmagnetism;Diamagnetism-Langevin'sTheory,WeissTheory, Paramagnetic Susceptibilty – Ferromagnetism, Hysterisis

| Unit:4 | Band Theory of Solids | 6--hours |
|---|---|---|

DevelopmentsofEnergyBandsinSolids,SodiumCrystal;anexample–CrystalMomentum–ConceptofEffectiveMass–ConceptofHoles–FermiLevel–EffectiveDensityofStatesand Carrier Concentration – Variation of Carrier Concentration with Temperature – Determination of Band gap of Intrinsic Semiconductors - Hall Effect and its Applications.

| Unit:5 | Superconductors | 7--hours |
|---|---|---|
| Mechanism of Super Conductors – Effect of Magnetic Field – Resistivity – Critical Currents – Meissner Effect – Thermal Properties – Penetration Depth – Type I and Type II Superconductors – London's Equations – BCS Theory –Josephson's Effect –Applications; Superconducting Magnets, High Tc Superconductors | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars – webinars | | |
| https://www.youtube.com/watch?v=faep3w1l0MsOrganic electronics | | |
| | **Total Lecture hours** | **36--hours** |

| **Text Book(s)** | |
|---|---|
| 1 | S.O. Pillai, Solid State Physics, New Age International Publishers, 6th Edition, 2015 |
| 2 | Solid State Physics, R.K. Puri, V.K. Babbar, S.Chand, 1st Edition, 1996. |
| 3 | Elementary Solid State Physics: Principles and Applications, M.A.Omar, Pearson Education Pvt. Ltd., Delhi, India, 4th Edition, 2004 |

| **Reference Books** | |
|---|---|
| 1 | A.K. Saxena, Solid State Physics, Macmillan Publishers India Ltd., 2nd Edition, 2013 |
| 2 | Solid State Physics: Structure and Properties of Materials, A.M.Wahab, Narosa Publishing house, New Delhi, India, 2nd Edition, 2007 |

| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
|---|---|
| 1 | https://nptel.ac.in/content/storage2/courses/122101002/downloads/lec-32.pdf |
| 2 | https://nptel.ac.in/content/storage2/courses/112108150/pdf/Web_Pages/WEBP_M16.pdf |
| 3 | https://nptel.ac.in/courses/115/101/115101012/ |

Course Designed By: **Dr. S. Vijayakumar**

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | L | L | L | L | L | L | L | L | M |
| **CO3** | S | L | L | L | L | L | L | L | L | M |
| **CO3** | S | L | L | L | L | L | L | L | L | S |
| **CO4** | S | L | L | L | L | L | L | L | L | M |
| **CO5** | S | L | L | L | L | L | L | L | L | M |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 2ED | BIOLOGICAL DOSIMETRY | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Elective | 3 | 0 | 0 | 3 |
| Pre-requisite | | RadiationBiology | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. To know the biomarkers used for biologicaldosimetry.
2. To understand the protocol to perform dosimetry usinglymphocytes.
3. To learn the basics of various techniques available to perform biologicaldosimetry.
4. To understand the importance cell survival based analysis to measure the biological effects of radiation.
5. To learn the procedures need to be followed while handling biologicalsamples.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Leant about the biomarkers used for biological dosimetry. | K2 |
| 2 | Understand the protocol to perform dosimetry using lymphocytes. | K2 |
| 3 | Learnt the basics of various techniques available to perform biological dosimetry. | K2 |
| 4 | Understand the importance cell survival based analysis to measure the biological effects of radiation. | K2 |
| 5 | Learnt the procedures need to be followed while handling biological samples. | K2 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Biomarkers | 6--hours |
|---|---|---|

Cytogenetic biomarkers- Biomarkers for nucleotide pool damage and DNA damage- Biomarkers for germline inherited mutations and variants- Biomarkers for induced mutations- Biomarkers for transcriptional and translational changes- Others- Safety of laboratory staff..

| Unit:2 | Lymphocyte based Biodosimetry | 7--hours |
|---|---|---|

Phasesofbiologicaldosimetry:Samplecollectionphase,Sampleprocessingphase,Dataanalysis phase- Radiation Induced Chromosomal Alterations: Radiation induced DNA lesions - Chromosome type aberrations- Unstable aberrations- Stable aberrations- Prematurechromosome condensation (PCC).

| Unit:3 | Techniques and Dose Estimation in Biodosimetry | 7--hours |
|---|---|---|

Micronuclei (MN) assay- Protocols advantage and disadvantages - Dicentric Chromosome Aberration (DCA) assay- Protocols, Advantage and disadvantages - Fluorescence In Situ Hybridization (FISH) technique- Comet assay- Polymerization Chain Reaction (PCR) - Flow cytometry- Western blot- Enzyme-linked immunosorbent assay (ELISA) - DNA Microarray technology.

| Unit 4: | Dose Estimationin Biodosimetry | 7--hours |
|---|---|---|

Dose Estimation: Cell survival curves – Multi-target single hit model, Linear quadratic Model - Production of an in vitro dose response curve - General Considerations, PhysicalConsiderations, StatisticalConsiderations-Dosecalculationinbiologicaldosimetry-Choiceofcurves-Number of cells to be analysed - Uncertainty on dose estimates- Dose Assessment - Acute whole body exposure,lowdoseoverexposurecases,Partialbodyexposure,Afterdelayedbloodsampling, After protracted and fractionated exposure.

| | | |
|---|---|---|
| **Unit:5** | **Emergencies and New Developments in Biodosimetry** | **7--hours** |
| Automationofchromosomalassays-AutomatedSampleProcessing,AutomatedImageAnalysis, Laboratory Information Management System (LIMS) –Investigation of radiation accidents - Chernobyl, The Istanbul accident - Mass Casualty Events - Potential RadiationExposure, Historical Experience, Role of Biological Dosimetry - Existing Mass Casualty Strategies. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars – webinars<br>1.Biomarkers - https://youtu.be/CUI7Ncgq92o (9 Min)<br>2.Relative biological effectiveness (RBE) - https://youtu.be/6dsqXsKQrv4 (6 Min)<br>3.Biological & physical effects of radiation (Dosimetry) -https://youtu.be/7I9s4-IhHH4<br>4.Internal Radiation Dosimetry -https://youtu.be/cofx0FyjfCI (16 Min)<br>https://youtu.be/uvm0IIe6D64 (8 Min)<br>5.Radiopharmaceutical Dosimetry - https://youtu.be/5XMcDVRqS44 (32 Min)<br>6.Polymerase Chain Reaction (PCR) - https://youtu.be/uKeMiAZ8Zu4 (11 Min)<br>7.Radiation induced chromosomal aberration - https://youtu.be/9arp4AGzCSc (49 Min) | | |
| | **Total Lecture hours** | **36--hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1 | C. S. Sureka and C. Armpilia Text book on "Radiation biology for Medical Physicists", CRC Taylor & Francis Group, USA, 2017. |
| 2 | Cytogenetic Dosimetry: Applications in Preparedness for and Response to Radiation Emergencies, IAEA, 2011. |
| | |
| **Reference Books** | |
| 1 | Cytogenetic Analysis for Radiation Dose Assessment - A Manual (TRS-405), IAEA, 2001. |
| 2 | E.B. Podgorsak, Radiation Oncology Physics: A Handbook for Teachers and Students, IAEA, 2005. |
| 3 | AlokDhawan, Diana Anderson, The Comet Assay in Toxicology: 2nd Edition, Royal Society of Chemistry, 2016. |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | https://youtu.be/fduPJ3F03TY |
| Course Designed By: **Dr. C. S. Sureka** | |

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | L | M | S | S | M | L | M | L | L |
| **CO3** | S | L | M | S | S | M | L | M | L | L |
| **CO3** | S | L | M | S | S | M | L | M | L | L |
| **CO4** | S | L | M | S | S | M | L | M | L | L |
| **CO5** | S | L | M | S | S | M | L | M | L | L |

*S-Strong; M-Medium; L-Low

| Course code | 23P | MEDICAL PHYSICS LAB I | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Lab | 0 | 0 | 3 | 3 |
| Pre-requisite | | External Beam Radiation Therapy | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. To determine HVL of Radiographyunit.
2. Perform Quality Assurance of a Radiographyunit.
3. To create manual treatment plans using isodosecharts.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Apply their knowledge on measurements of factors covering penetration of X-ray to various materials. | K3 |
| 2 | Measure and verify treatment planning parameters. | K4 |
| 3 | Perform quality assurance tests of radiation generating equipment like Radiography. | K3 |
| 4 | Evaluate a treatment plan for single and parallel opposed fields. | K5 |
| 5 | Perform in-vivo dosimetry. | K4 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

**Practicals**

1. Attenuation of Xrays through various materials and evaluation ofHVL.
2. Quality assurance inRadiography.
3. Radiation survey inRadiography.
4. Calibration of radio chromic film and find the unknowndose.
5. Calibrate the Optical Stimulated Luminance Dosimeter (OSLD) and findthe unknowndose.
6. Manual Treatment Planning of Singlefields.
7. Manual Treatment Planning of Parallel Opposedfields.
8. Manual Treatment Planning of Obliquefields.
9. Manual Treatment Planning of Wedgefields.
10. Monitor unit calculations of simple and complex treatmentplans.
11. Treatment time calculation of simple and complex treatmentplans.

**Demonstrations**

12. Immobilzation and CTSimulation
13. Contouring and external beam treatment planning (simplecases)
14. Mould roomtechniques
15. Contouring and brachytherapyplanning.

Course Designed By: **Dr. C. S. Sureka**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | M | L | S | M | S | S | S | S |
| **CO3** | S | M | M | L | S | M | S | S | S | S |
| **CO3** | S | M | M | L | S | M | S | S | S | S |
| **CO4** | S | M | M | L | S | M | S | S | S | S |
| **CO5** | S | M | M | L | S | M | S | S | S | S |

*S-Strong; M-Medium; L-Low

| Course code | 26A | SUMMER TRAINING | L | T | P | C |
|---|---|---|---|---|---|---|
| | | Training | 0 | 0 | 0 | 0 |
| Pre-requisite | | Radiological Physics, Radiation Detection and Measurement and Radiation Generators | Syllabus Version | 2021-22 | | |

**Course Objectives:**

The main objectives of this course are to:

1. To observe the clinical work carried out in a Radiation OncologyDepartment.
2. To know the duties and responsibilities of a Medical Physicist and RSO.
3. To observe the image acquititionproces in a Diagnostic radiologyDepartment.
4. To familiarlize the procedure followed to deliver treatment in a Radiotheraphydepartment.
5. To observe the recommendations followed while handling open isotopes and during image acquitition in Nuclear MedicineDepartment.
6. To visialize the construction and working of various equipments used for diagnosis and therapy.
7. To observe the mechanisms adopted to assure public, occupations and patientsafety.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Realized the importance of Medical Physics to serve cancer patients. | K2 |
| 2 | Realized the responsibilies of a Medical Physicist and RSO in a society. | K2 |
| 3 | Visialized the routine clinical works carry out by the Medical Physicist. | K2 |
| 4 | Familiarized the recommendations adopted to execute the treatment safely. | K2 |
| 5 | Developed basic understanding to learn the second year core courses. | K2 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Students are encouraged to spend 30 days during their summer vacation to learn the technical know-how of Medical Physics under the guidance and supervision of Medical Physicists in leading research Hospitals/Institutes/Health Care Industries/ Universities engaged with cancer therapy/research.

Course Designed By: **Dr. C. S. Sureka**

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

# Third Semester

| Course code | 33A | RADIATION DOSIMETRY AND CALIBRATION | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 5 | 0 | 0 | 4 |
| Pre-requisite | | Physics -Graduatelevel | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. To learn about ionization chamber theory-design of free air ion chamber, design of parallel plate (FAIC), measurements of Air kerma / Exposure – IAEA TRS-277protocol
2. To understand the measurements of $D_W$ for external beams- IAEA TRS 398 - Referencedosimetry for X-rays, Co-60 photons, high energy photons, electrons andprotons.
3. To understand the problems with small field and non standard field dosimetry- choice of appropriate dosimeter- IAEA TRS 483 protocol.
4. To be able to understand standardization of beta emitters and electron capturewith proportional GM and Scintillationcounters.
5. To learn routine sample measurement with liquid counter and scintillation countingmethods for alpha, beta and gammaemitters.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | apply IAEA – TRS 398 protocols in clinical procedure | K2 |
| 2 | calibrate small and non-standard field dosimetry and protection level monitors | K2 |
| 3 | calibrate photons from Co 60 beams, photons and electrons from linacs | K3 |
| 4 | do Brachytherapy dosimetry using various protocols | K3 |
| 5 | neutron emitted from medical linear accelerator | K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Ionization chamber theory | 15--hours |
|---|---|---|

Bragg-Gray theory, Mathematical expression describing Bragg-Gray principle and its derivation. Charged particle equilibrium. Burlin and Spencer Attix Cavity theories. Restricted stopping power ratios.Transient Charged Particle Equilibrium (TCPE), Concept of Dgas, Cavity ion chambers, Derivation of an expression for sensitivity of a cavity ion chamber- Type of ion chambers. Build-up cap and water proof sleeves..

| Unit:2 | Calibration of ion chambers | 15--hours |
|---|---|---|

General definition of calibration factors - $N_X$, $N_K$, $N_{D,\,air}$, $N_{D,\,W}$. Various steps to arrive at the expression for absorbed dose to water –Determination of absorbed dose to water (Dw) due to photon, electron and heavy charged particles (proton, carbon ion etc.,) using current IAEA protocols( TRS 398, TG 51, TG70 etc)-TPR $_{20,10}$ measurements for beam quality in linacphotons-*k*Q factors derivation-Reference conditions for measurement, correction factors used - Phantom, Water proof sleeve, Derivation of an expression for machine timer error (for telecobalt unit and brachytherapy units), Temperature and pressure correction, Saturation correction (Ksat), .Parallel plate, cylindrical and spherical ion chambers, Two voltage method for continuous and pulsed beams, Polarity correction. Concept of cross calibration.

| Unit:3 | Calibrations for small and non-standard field dosimetry | 10--hours |
|---|---|---|
| Calibration of small and non-standard field dosimetry. IAEA TRS- 483 and Alphonso formalism. Small field dosimetry– Physics, fundamental aspects, protocols, small-field radiotherapy equipment and techniques. Dosimetry challenges in small fields. Dosimeters available for small field measurements. Calibration for tomotherapy beams. | | |
| | | |
| **Unit:4** | **Calibrations for protection level monitors** | **8--hours** |
| Calibration of protection level instruments and monitors used in radiotherapy (such as Survey Meters, gamma zone monitor, neutron survey meter, personnel monitoring- Quality Audit Programmes (TLD inter-comparison etc.). | | |
| | | |
| **Unit:5** | **Brachytherapy dosimetry** | **10--hours** |
| Manchester, Paris and Stockholm systems (Intracavitary, interstitial, and surface moulds as applicable)- Paterson Parker tables- ICRU 38 and 58 protocols. Specification and calibration of brachytherapy sources - RAKR and AKS - IAEA TECDOC 1274 and ICRU 72 recommendations- Point and line source dosimetry formalisms - Sievert Integral - AAPM TG43/43U1 and other dosimetry formalisms. Graphite and water calorimeters for brachytherapy. Interpolation method for calibration of HDR Ir-192 sources. | | |
| | | |
| **Unit:6** | **Simulation of Linac calibrations** | **2 -- hours** |
| Demonstration of simulated calibration of linac beams with IAEA TRS 398 | | |
| | | |
| | **Total Lecture hours** | **60--hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | F.H. Attix, Introduction to Radiological Physics and Radiation Dosimetry, Viley - VCH, Verlog, 1st Edition, 2004. |
| 2 | Michael G.Stabin, Radiation Protection and Dosimetry – An Introduction to Health Physics, Springer, 1st Edition, 2007. |
| 3 | ShaheenDewji and Nolan E Hertel, Advanced Radiation Protection Dosimetry, CRC Press (Taylor & Francis Group), 1st Edition, 2019. |

**Reference Books**

| | |
|---|---|
| 1 | Greening J R, Green S, Charles M W, Fundamentals of Radiation Dosimetry, 3rd Edition, London: Taylor & Francis, 2010. |
| 2 | D Baltas, L Sakelliou, N Zamboglou, The Physics of Modern Brachytherapy for Oncology, CRC Press (Taylor and Francis Group), 1st Edition, 2007. |
| | |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

1.http://www-naweb.iaea.org/nahu/DMRP/documents/CoP_V12_2006-06-05.pdf
2.http://www-naweb.iaea.org/nahu/DMRP/zip/trs398.zip
3.http://www-naweb.iaea.org/nahu/DMRP/zip/trs381.zip
4.http://www-naweb.iaea.org/nahu/DMRP/zip/trs277x.zip
5.https://www-pub.iaea.org/MTCD/Publications/PDF/D483_web.pdf
6. http://www-naweb.iaea.org/nahu/DMRP/documents/slides/Chapter_09_Calibration_of_radiotherapy_beams.pdf

Course Designed By: **Dr. GanesanRamanathan**

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | L | L | L | S | L | L | L | L |
| **CO2** | M | M | L | L | L | S | L | L | L | L |
| **CO3** | M | M | L | L | L | S | L | L | L | L |
| **CO4** | M | M | L | L | L | S | L | L | L | L |
| **CO5** | M | M | L | L | L | S | L | L | L | L |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 33B | RECENT ADVANCES IN RADIOTHERAPY | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 5 | 0 | 0 | 4 |
| Pre-requisite | | Physics - Graduate level | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. To be able to differentiate cone and mMLC based X-knife, Gamma knife. To be familiar with evaluation of SRS/SRT treatmentplans,
2. To know the concepts of kVCBCT and MVCBCT and mechanics of breathing methods to manage respiratory motion in radiationtreatment.
3. To understand the concepts of volumetric arc therapy, machine commissioning and quality, dosimetricaspectsandtreatmentplanning.TocompareVMATplanswithconventional,IMRT planning, patients specific quality assurance,etc.
4. To study the types of Total Body Irradiation treatments, equipment, principle and treatment planning, dosimetry, quality assurance andcommissioning
5. To recall neutron capture therapy, heavy ion therapy anddosimetry.
6. To study the special techniques inBrachytherapy
7. To learn the Information Technology for Medical Physics.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Introduction to IMRT and IGRT | K2 |
| 2 | learnt about SRS, SRT and Cyber knife based therapy | K3 |
| 3 | understand 4D computed tomography imaging and know heavy ion therapy namely proton and carbon ion etc | K2 |
| 4 | learnt about advances in Brachytherapy | K3 |
| 5 | learnt about Information Technology (IT) for Medical Physics | K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** - Evaluate; **K6** - Create

| Unit:1 | IMRT and IGRT | 15--hours |
|---|---|---|

Intensity Modulated Radiation Therapy (IMRT) principles - MLC based IMRT - step and shoot and sliding window techniques - Compensator based IMRT – Tomotherapy based IMRT, planning process - inverse treatment planning - immobilization for IMRT - dose verification phantoms, dosimeters, protocols and procedures. Volumetric Modulated Arc Therapy (VMAT). Image Guided Radiotherapy (IGRT): IGRT concept, imaging modality, kV cone beam CT (kVCT), MV cone beam CT (MVCT), image registration, plan adaptation- special phantom, Respiratory gating techniques- Tomotherapy - principle - commissioning - imaging - planning anddosimetry - delivery - adaptive radiotherapy. Treatment with FFF beams..

| Unit:2 | SRS, SRT, SBRT and Cyber knife based therapy | 15--hours |
|---|---|---|

Stereotactic radiosurgery/radiotherapy (SRS/SRT) - cone and mMLC based X-Knife - Gamma Knife - immobilization devices for SRS/SRT - dosimetry and planning procedures - Evaluation of SRS/SRT treatment plans. Physical, planning, and clinical aspects stereotactic body radiotherapy (SBRT) and Cyber Knife based therapy. Choice of dosimeters for output measurements

| Unit:3 | Special techniques in external beam therapy | 10--hours |
|---|---|---|

Totalbodyirradiation(TBI)-largefielddosimetry-totalskinelectrontherapy(TSET)-electron arc

| | | |
|---|---|---|
| treatment and dosimetry - intraoperative electron radiotherapy (IORT)for breast cancer- mobile linac. Principle, applications of proton therapy in radiation oncology, National/International/ IEC requirements for hadron therapy equipment, treatment planning and delivery, proton therapy treatment planning and delivery, beam modifiers safety interlocks for gammaandneutronradiations,inducedactivityanditsminimization,Prescribing,Recordingand ReportingProtonBeamTherapy(ICRUReport78),Carboniontherapy–physicalandbiological considerations. Radio immunotherapy. In-vivo dosimetry for patientprotection. | | |
| | | |
| **Unit:4** | **Special techniques in Brachytherapy** | **10--hours** |
| Integrated brachytherapy unit. Brachytherapy treatment planning - CT/MR based brachytherapy planning-forwardandinverseplanning-DICOMimageimport/exportfromOT-Record& verification.BrachytherapytreatmentforProstatecancer.Ocularbrachytherapyusingphotonand betasources.Intravascularbrachytherapy-classification-sources-dosimetryprocedures- | | |
| AAPM TG 60 protocol. Electronic brachytherapy (Axxent, Mammosite, etc.). Brachytherapy for breast cancer with I-125 seeds, | | |
| | | |
| **Unit:5** | **Information Technology for Medical Physics** | **8--hours** |
| International standards (IEC, DICOM, IHE), General concepts and architecture of HIS/RIS/PACS, Radiotherapy record and verify systems, DICOM objects for patient dosimetry. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 -- hours** |
| 1.https://www.youtube.com/watch?v=SIy6gKhT3lk | | |
| 2.https://www.youtube.com/watch?v=5Ftzy5imXDw | | |
| 3.https://www.youtube.com/watch?v=DFKAFXDguFo | | |
| | | |
| | **Total Lecture hours** | **60-hours** |
| | | |

| | |
|---|---|
| **Text Book(s)** | |
| 1 | Steve Webb, The Physics of Three–Dimensional Radiotherapy, Institute of Physics Publishing, Bristol and Philadelphia, 1st Edition, 2002. |
| 2 | FaizMKhan,ThePhysicsofRadiationTherapy,3rdEdition,LippincottWilliams&Wilkins, USA, 1st Edition,2003. |
| 3 | S. Webb, Intensity Modulated radiation therapy, Institute of Physics publishing, Philadelphia, 1st Edition, 2001. |
| | |
| **Reference Books** | |
| 1 | Oleg s Pyianykh, Digital Imaging and Communications in Medicine, A practical introduction and survival guide, Springer, 2012.. |
| 2 | Tsujii, Carbon-Ion Radiotherapy-Principles, Practices, and Treatment Planning, Springer 2014. |
| 3 | Advances in Radiation Therapy, **Mittal**, Bharat B., **Purdy**, James A., **Ang**, K.K. (Eds.), Springer 1998. |
| | |

| |
|---|
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** |
| **1.**https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5718253/ |
| 2.https://www.ajmc.com/newsroom/review-outlines-recent-advances-in-radiotherapy-for-cancer |
| 3.https://doi.org/10.1186/s41936-019-0083-5 |
| |
| Course Designed By: **Dr. GanesanRamanathan** |

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | L | L | S | S | L | L | L | L |
| **CO2** | M | M | L | L | S | S | L | L | L | L |
| **CO3** | M | M | L | L | S | S | L | L | L | L |
| **CO4** | M | M | L | L | S | S | L | L | L | L |
| **CO5** | M | M | L | L | S | S | L | L | L | L |

*S-Strong; M-Medium; L-Low

| Course code | 33C | RADIATION PROTECTION | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 5 | 0 | 0 | 4 |
| Pre-requisite | | Physics - Graduate level | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. To learn about the principle of radiation protection standards and itsrecommendations.
2. To understand the importance of radiationmonitoring.
3. To learn the procedures need to be followed while planning a Radio diagnostic, Radiotherapy and Nuclear medicine facility.
4. To study the types of Total Body Irradiation treatments, equipment, principle and treatment planning, dosimetry, quality assurance andcommissioning
5. To understand the safety aspects that to be followed in Nuclear medicine departments..

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Gained knowledge on radiological protection and its recommendation in Oncology | K2 |
| 2 | Learnt the basic definitions and principles of radiation safety | K3 |
| 3 | Learnt the various steps to be followed while planning a Radio diagnostic, Radiotherapy and Nuclear medicine facility | K3 |
| 4 | Understood the safety procedures followed in Nuclear medicine departments. | K3 |
| 5 | learnt about Information Technology (IT) for Medical Physics | K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Radiation Protection Standards | 10--hours |
|---|---|---|

Radiation protection quantities: Equivalent Dose, effective dose, committed equivalent dose, committed effective dose, radiation weighting factor, Tissue weighting factor, Concepts of collective dose, Annual Limit Intake (ALI), Derived Air Concentration (DAC). Operationalquantitiesandtheirneed:Doseequivalent-Ambientanddirectionaldoseequivalents [(H*(d) and H'(d)] –personnel dose equivalent from strongly and weekly penetrating radiation, Hp(10),Hp(0.07)&Hp(3).ICRUconversioncoefficientsfromairkermatooperationalquantities.

Radiation dose to individuals from natural radioactivity in the environment and man-made sources. Basic concepts of radiation protection standards - Historical background - International Commission on Radiological Protection and its recommendations – The system of Radiological protection – Justification of Practice, Optimization of Protection and dose limitation. Potentialexposures,doseanddoseconstraints–Systemofprotectionforintervention-Categories of exposures – Occupational, Public and Medical Exposures - Permissible levels for neutronflux - Factors governing internal exposure - Radionuclide concentrations in air and water – contamination levels.

| Unit:2 | Principles of Monitoring and Protection | 10--hours |
|---|---|---|

Evaluation of external radiation hazards - Effects of distance, time and shielding - Shielding calculations - Personnel and area monitoring - Internal radiation hazards – Radio toxicity of different radionuclides and the classification of laboratories – Control of contamination – Bioassay and air monitoring – chemical protection – Radiation accidents – disaster monitoring.

| | | |
|---|---|---|
| **Unit:3** | **Planning of Radiotherapy Installations** | **14--hours** |
| Planning of medical radiation installations - General considerations - Radiotherapy(telegamma, accelerator, tomothreapy, and cyberknife). Definitions of primary, secondary barriers, restricted area, controlled area. work load, use factor- Siting, layout planning and shielding calculations for hadron therapy facilities; neutron yield and aspects for neutron shielding. Planningand shielding calculations of brachytherapy facilities. Regulatory requirements for brachytherapy facilities. | | |
| **Unit:4** | **Planning of Radio diagnostic and Nuclear medicine facility** | **14--hours** |
| Planning and shielding calculations of diagnostic radiology facilities. Regulatory requirements for diagnostic radiology facilities.<br>Planning and Shielding Calculations during the installation of Nuclear Medicine facilities and researchlaboratoriesusingradioisotopeslikeSPECT,PET/CT,HighDoseTherapyintheNuclear Medicine Department as per National/Internationalmethods. | | |
| **Unit:5** | **Safety in Nuclear Medicine** | **10--hours** |
| Performance check of radiation measuring and monitoring instruments, work place and environmental(stack) monitoring, Permissible radiation limits for controlled and supervised area, Contamination limits, Radiation protection survey and contamination checks, Air-borne contamination, estimation of gases effluent discharge, dose apportionment and dose budgeting. Radiological safety aspects during servicing and maintenance.<br>Unusual occurrences and its handling procedures: Failure of cooling system, target foil ruptured, spillage, power failure, excessive exposure, personnel contamination; Protective and Emergency equipment requirements in medical cyclotron facility. | | |
| **Unit:6** | **Contemporary Issues** | **2 -- hours** |
| 1. AAPM [American Association of Physicists in Medicine] Task Group 204. 2011. Size-Specific Dose Estimates (SSDE) in pediatric and adult body CT exams. | | |
| 2. Amis E. S. Jr., Butler P. F. "American College of Radiology white paper on radiation dose in medicine." J Am CollRadiol. 2007;4(5):272–284. | | |
| | **Total Lecture hours** | **60-hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | Radiation Protection in Medical Radiographyby Visconti PhD DABR, Paula J., RitenourPhD DABR FAAPM FACR, E. Russell, Elsevier 2014 |
| 2 | Jeffry A. Siegel, Radiation Safety in Nuclear Medicine. 2nd Edition, Elsevier, 2007 |
| 3 | Max H. Lombardi, Radiation Safety in Nuclear Medicine, 2nd Edition, CRC Press, 2006 |

Reference Books

| | |
|---|---|
| 1. | Physics for Radiation Protection: A Handbook, James E. MartinWiley online library,2006 |
| 2. | Atoms, Radiation and Radiation Protection, James E. Turner Wiley-VCH 2007 |
| 3. | Radiation Protection in health sciences, Marilyn E. Noz and Gerald Q. Maguire Jr. World Scientific 2007. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

1. Brenner D. J., Hricak H. "Radiation exposure from medical imaging: time to regulate?" JAMA. 2010;304 (2):208–209.
2. Brink J. A., Amis E. S. Jr. "Image Wisely: a campaign to increase awareness about adult radiation protection." Radiology. 2010;257 (3):601–602.

Course Designed By: **Dr. GanesanRamanathan**

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | L | L | S | S | L | L | L | L |
| **CO2** | M | M | L | L | S | S | L | L | L | L |
| **CO3** | M | M | L | L | S | S | L | L | L | L |
| **CO4** | M | M | L | L | S | S | L | L | L | L |
| **CO5** | M | M | L | L | S | S | L | L | L | L |

*S-Strong; M-Medium; L-Low

| Course code | 33D | RADIATION HAZARDS EVALUATION AND CONTROL | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 5 | 0 | 0 | 4 |
| Pre-requisite | | Physics - Graduate level | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course is to:

1. Radiation Hazard Evaluation in Medical Radiation Installations.
2. Radioactive WasteDisposal
3. Transport of RadioactiveMaterial
4. Legislation
5. Radiation Emergencies and their MedicalManagement

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Exposed to radiation hazards in medical diagnostic and therapeutic equipment and installations. | K2 |
| 2 | Exposed to Radioactive wastes and its sources, types and disposal | K3 |
| 3 | Learned the Transportation of radioactive substances and its safe handling | K3 |
| 4 | Exposed to National legislation and Regulatory framework | K2 |
| 5 | Learning Normal and potential exposure, potential accident situations involving radioisotopes | K2 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Radiation Hazard Evaluation in Medical Radiation Installations | 14--hours |
|---|---|---|

Evaluationofradiationhazardsinmedicaldiagnosticandtherapeuticequipmentandinstallations. Radiation monitoring procedures –measurement of leakage radiation through the treatmenthead/ X-ray tube housing. Radiation survey and evaluation of radiation levels around RT, NM and DR installation. Protective measures to reduce radiation exposure to staff and patients-Radiation hazardsinbrachytherapydepartmentsandteletherapydepartmentsandradioisotopelaboratories- Particle accelerators - Protective equipment - Handling of patients - Waste disposal facilities - Radiation safety during source transfer operations - Special safety features in accelerators.Head leakage and Neutron measurements in linacs. Contamination control in NM.

| Unit:2 | Radioactive Waste Disposal | 10--hours |
|---|---|---|

Radioactive wastes – sources of radioactive wastes – generation-Classification of waste - Treatment techniques for solid, liquid and gaseous effluents – Permissible limits for disposal of waste - Sampling techniques for air, water and solids – Geological, hydrological and meteorological parameters – Ecological considerations.

Disposal of radioactive wastes - General methods of disposal - Management of radioactivewaste in medical, industrial, agricultural and research establishments. Waste disposal in NM-Disposal of excreta and urine from patients administered high doses ofradioisotopes.

| Unit:3 | Transport of Radioactive Material | 10--hours |
|---|---|---|

Transportation of radioactive substances - Historical background - General packing requirements- Transport documents-Labeling and marking of packages-Type A and Type B packages- Transport index-Regulations applicable for different modes of transport - Transport

by post - Transport emergencies - Special requirements for transport of large radioactive sources and fissile materials - Exemptions from regulations – Shipment approval – Shipment under exclusive use – Transport under special arrangement – Consignor's and carrier's responsibilities, RSO responsibilities with damaged package-radiation monitoring of packages

| **Unit:4** | **Legislation** | **10--hours** |
|---|---|---|

Physical protection of sources - Safety and security of sources during storage, use, transport and disposal–Securityprovisions:administrative and technical–Security threat and graded approach in security provision.

National legislation – Regulatory framework – Atomic Energy Act – Atomic Energy (Radiation Protection) Rules – Applicable Safety Codes, Standards, Guides and Manuals – Regulatory Control – Licensing, eLora-Inspection and Enforcement – Responsibilities of Employers, Licensees, Radiological Safety Officers and Radiation Workers – National inventories of radiation sources– Import, Export procedures guidelines, requirement and procedures for setting up medical radiation facilities, Cyclotron facilities, Emergency preparedness in medical radiation/cyclotron facilities.

| **Unit:5** | **Radiation Emergencies and their Medical Management** | **14--hours** |
|---|---|---|

Normal and potential exposure, potential accident situations involving radioisotopes, elementsof emergency planning and preparedness including procedures for notification and communication, administrative and technical procedures, responsibilities of employer, licensee, RSO, Service Engineerandsource/equipmentsupplierincaseofemergency,availabilityofdevicesforhandling emergency and display of procedure to be followed-preparation of emergency action plan-probable emergency situations and accidents in medical applications of radiation (failure of pneumatic system, improper functioning of timer, software mix-up in accelerator etc.)- probable accidents during Loading and unloading of sources - Loss of radiation sources and their tracing - TypicalaccidentcasesinradiotherapywithCasehistoriesRadiationinjuriesinRadiotherapyand Interventional Radiology procedures, mis-administration of radio isotopes in NM, treatment and medical management of affected patients– Personal (external and internal) and environmental dosimetry in accidental exposures-Investigation of accidental exposure to patients or excessive exposure to occupational radiation workers, Emergency preparedness plan, Radiationprotection programme - design, implementation and management.

| | **Total Lecture hours** | **60-hours** |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | ICRP, Recommendations of the International Commission on Radiological Protection. ICRP Publication 103 (Users Edition). Ann. ICRP 37(2-4), 2007. |
| 2 | Williams, J.R., Thwaites, D.I. (Eds), Radiotherapy Physics in Practice, 2nd Edition, Oxford Univ. Press, Oxford, 2000. |
| 3 | Fletcher G.H: Textbook of radiotherapy, Lea and Febiger, Philadelphia, pp.106-107, 1966. |

**Reference Books**

| | |
|---|---|
| 4 | Atomic Energy Act No.33, 1962. |
| 5 | Radiation Protection Rules, Atomic Energy Regulatory Board (AERB), Mumbai, 2004 |
| | |
| | Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.] |
| | **1.**https://pubs.rsna.org/doi/10.1148/65.6.892 |
| | **2.**https://www.osha.gov/SLTC/radiationionizing/prevention.html |
| | **3.**https://www.who.int/news-room/fact-sheets/detail/ionizing-radiation-health-effects-and-protective-measures |

Course Designed By: **Dr. GanesanRamanathan**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | L | L | L | L | L | L | L | L |
| **CO2** | S | M | L | L | L | L | L | L | L | L |
| **CO3** | S | M | L | L | L | L | L | L | L | L |
| **CO4** | M | M | L | L | L | L | L | L | S | S |
| **CO5** | M | M | L | L | L | L | L | L | S | S |

*S-Strong; M-Medium; L-Low

| Course code | 33E | NUCLEAR MEDICINE | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 5 | 0 | 0 | 4 |
| Pre-requisite | | Atomic and Nuclear Physics/ Radiological Physics | Syllabus version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. Tostudytheproductionofradionuclidesusedinnuclearmedicineandtypesofproduction.To learn different types of imaging procedures namely In-vivo and In-vitrostudies.
2. To understand the importance various imaging instruments and their operating principles and to be familiar with various imaging systems and theirlimitation.
3. To recall different imaging techniques like two dimensional and three dimensionaltechniques. To be able to understand focal plane tomography emission computed tomography,etc.
4. To narrate Annihilation Coincidence Detection and PET detector scanner design, data AcquisitionforPET.TorelateworkingofMedicalcyclotron,radioisotopesproducedandtheir characteristics.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Familiar radioisotopes being used in different In-vitro and in-vivo studies. | K2 |
| 2 | Know various types of collimator and their uses for various studies. | K2 |
| 3 | Learn parameters affecting spatial resolution and methods of evaluation of spatial resolution. | K2 |
| 4 | Learnt the various Nuclear Medicine modalities for molecular imaging. | K3 |
| 5 | Understand the therapeutic applications of unsealed radioisotopes. | K3 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Physics of Nuclear Medicine | 10--hours |
|---|---|---|

IntroductiontoNuclearMedicine,UnsealedSources,ProductionofRadionuclideusedinNuclear Medicine; Reactor and accelerator based Radionuclides, Photonuclear activation, Equations for RadionuclideProduction,RadionuclideGeneratorsandtheiroperationprinciples-Preparation and Various usages of Radiopharmaceuticals. In-vivo Non-imaging procedures; Thyroid Uptake Measurements, Renogram, Life Span of RBC, Blood Volume studies etc.

| Unit:2 | Radionuclide Imaging | 10--hours |
|---|---|---|

General concept of Radionuclide Imaging and Historical developments. The Rectilinear Scanner and its operational principle, Basic Principles and Design of the Gamma Camera / Scintillation Camera, System components, Detector System and Electronics, Different types of Collimators, Design and Performance Characteristics of the Converging, Diverging and Pin hole Collimator, Image Display and Recording Systems, Digital Image Processing Systems, Scanning Camera, Limitation of the Detector System and Electronics.

| Unit:3 | Imaging Techniques and Image Quality Parameters | 14--hours |
|---|---|---|

BasicPrinciples,TwodimensionalImagingTechniques,ThreeDimensionalImagingTechniques - Basic Principles and Problem, Focal Plane Tomography. Physics of Imaging system (PET/SPECT): Principles of PET/SPECT, PET Instrumentations, Annihilation Coincidence Detection, PET Detector and Scanner Design, Data Acquisition for PET, Data correctionsand Quantitative Aspect of PET. Fusion imaging PET-CT, PET-MRI.

| Unit:4 | Image Reconstruction and Image Quality Parameters | 14--hours |
|---|---|---|
| Various Image Reconstruction Techniques during Image formation such as Back Projection and Fourier based Techniques, Iterative Reconstruction method and their drawbacks. Attenuation Correction, Scatter Correction, Resolution Correction, Other requirements or Sources of Error. Spatial Resolution, Factor affecting Spatial Resolution, Methods of Evaluation of Spatial Resolution, Contrast, Noise. National and International protocol followed for Quality Assurance / Quality Control of Imaging equipment (SPECT, PET-CT and SPECT- CT) - IEC/NEMA Protocols. | | |
| | | |
| **Unit:5** | **Radionuclide Therapy** | **10--hours** |
| Treatment of Thyrotoxicosis, Thyroid cancer with I-131, use of P-32 and Y-90 for palliative treatment, Radiation Synovectomy and the isotopes- Delay Tank - waste Disposal Methods used in Nuclear Medicine. | | |
| | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| Expert lectures, online seminars – webinars<br>Physics of Nuclear medicine - https://youtu.be/WgCkrfOXLoY (34 Min)<br>2. RadionuclideImaging - https://youtu.be/wAiCm1du0h4 ( 44Min)<br>3. Imaging Techniques and image quality parameters-<br>https://youtu.be/KuVpYz9eEZc(1 Min 30 Sec)<br>https://youtu.be/yQQxkKazlsA (3 Min)<br>https://youtu.be/wx2zyfgYZrE (4Min)<br>https://youtu.be/m7gzIcRhv88 (17Min)<br>4. Filtered Back projection in SPECT - https://youtu.be/MTBhqcVjQ8Q(1Min)<br>5. Radionuclide Therapy - https://youtu.be/9mDjSDXSCgI (58Min) | | |
| | | |
| | **Total Lecture hours** | **60 --hours** |

| **Text Book(s)** | |
|---|---|
| 1 | J.K Fowler, Nuclear Particles in Cancer Treatment, Adam Hilger Ltd., Philadelphia, 1st Edition, 1981. |
| 2 | W.H.Blahd, Nuclear Medicine, McGraw Hill Co., New Delhi, 1st Edition, 1980. |
| 3 | JA Parker, Nuclear Medicine Physics-A handbook for teachers and students-IAEA, (2014). |
| | |

| **Reference Books** | |
|---|---|
| 1 | J.Herbert and D.A.Rocha, Text Book of Nuclear Medicine, Vol 2 and 6, Lea and Febiger Co., Philadelphia, 1st Edition, 1984. |
| 2 | S.Webb, The Physics of Medical Imaging, Medical Science Series, Adam Hilgers Publications, Bristol, 1st Edition, 1984. |
| 3 | Janet F Eary and Winfried Brenner, Nuclear Medicine Therapy, Informa Healthcare, (2007). |

| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
|---|---|
| 1 | Imaging in nuclear medicine - https://www.open.edu/openlearn/health-sports-psychology/health/imaging-medicine/content-section-6.2 |
| 2 | Nuclear medicine https://elearning.iaea.org/m2/course/search.php?search=Nuclear+medicine |

| |
|---|
| Course Designed By: **Dr. C. S. Sureka** |

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | M | S | M | S | S | M | S | S | S |
| **CO3** | S | M | S | M | S | S | M | S | S | S |
| **CO3** | S | M | S | M | S | S | M | S | S | S |
| **CO4** | S | M | S | M | S | S | M | S | S | S |
| **CO5** | S | M | S | M | S | S | M | S | S | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

| Course code | 33F | ADVANCED RADIATION DOSIMETRY | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Core | 5 | 0 | 0 | 4 |
| Pre-requisite | | Radiation Dosimetry and Calibration, External Beam Radiation Therapy and Brachytherapy | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. Radiation Chemistry and Chemical Dosimetry Internal RadiationDosimetry
2. Techniques for Dose calculations
3. Computers in Treatment Planning and Monte Carlo aideddosimetry

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | narrate introduction to Chemistry of Dosimetry | K1 |
| 2 | principles and techniques in Internal Radiation Dosimetry. | K2 |
| 3 | techniques involved in internal dose calculations. | K3 |
| 4 | understood the basics behind Monte Carlo aided dosimetry. | K2 |
| 5 | learnt the application of Computers in Treatment Planning. | K4 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Radiation Chemistry and Chemical Dosimetry | 10 --hours |
|---|---|---|

Definitions of free radicals and G-value - Kinetics of radiation chemical transformations - LET and dose-rate effects - Radiation Chemistry of water and aqueous solutions, peroxy radicals,pH effects - Radiation polymerisation, effects of radiation on polymers in dosimetry - Formation of free radicals in solids.

Chemical Dosimetry Principles- Definitions of optical density, molar absorption coefficient,Beer-Lambert'slaw,spectrophotometry–doseestimationtechniques-Requirements for an ideal chemical dosimeter Fricke dosimeter - FBX dosimeter - Free radical dosimeter – Ceric sulphate dosimeter- Applications of chemical dosimeters inRadiotherapy.

| Unit:2 | Internal Radiation Dosimetry | 14 --hours |
|---|---|---|

In-vitro Technique: RIA/IRMA techniques and its principles.
Internal Radiation Dosimetry: Different Compartmental Model; Single Compartmental Model, Two Compartmental Model with and without Back Transference- Classical Methods of Dose Evaluation- Beta particle Dosimetry- Equilibrium Dose Rate Equation, Beta Dose Calculation Specific Gamma Ray Constant, Gamma Ray Dosimetry, Geometrical Factor Calculation, Dosimetry of Low Energy Electromagnetic Radiation.

| Unit:3 | MIRD Technique for Dose calculations | 10 --hours |
|---|---|---|

Basicprocedureandsomepracticalproblems,CumulativeActivity,EquilibriumDoseConstant, AbsorbedFraction,SpecificAbsorbedFraction,DoseReciprocityTheorem,MeanDoseperunit Cumulative Activity and Problems related to the Dose Calculations. Limitation ofMIRD Technique.

| | | |
|---|---|---|
| **Unit:4** | **Monte Carlo aided dosimetry** | **10 --hours** |
| Random variables, discrete random variables, continuous random variables, Probability density functions, discrete probability density function, continuous probability distributions,cumulative distribution function, accuracy and precision, central limit theorem, random numbers and their generation, tests for randomness, inversion random sampling technique including worked examples,integrationofsimple1-Dintegralsincludingworkedexamples.Overviewof computational codes used in medical physics such as MCNP, Fluka, Geant 4, BEAMnrc etc. | | |
| **Unit:5** | **Computers in Treatment Planning** | **14 --hours** |
| Scope of computers in radiation treatment planning - Review of algorithms used for treatment planning computations - Pencil beam, double pencil beam, Clarkson method, convolution superposition, lung interface algorithm, fast Fourier transform, Inverse planning algorithm, MonteCarlobasedalgorithms.Treatmentplanningcalculationsforphotonbeam,electronbeam, hadron beam (proton/heavy ion) beam and brachytherapy - Factors to be incorporated in computationalalgorithms.Planoptimization-directaperture optimization-beamletoptimization -simulatedannealing-dosevolumehistograms-Indicesusedforplancomparisons-Hardware andsoftwarerequirements-beam&sourcelibrarygeneration.Networking,DICOMandPACS. | | |
| **Unit:6** | **Contemporary Issues** | **2 hours** |
| https://www.youtube.com/watch?v=08eAe_C1mZ4<br>https://www.radiation-dosimetry.org/category/radiation-dosimetry/page/4/<br>https://www.youtube.com/watch?v=BjF3Z2gJQbYhttps://www.youtube.com/watch?v=gZQ3AUbjJJc | | |
| | **Total Lecture hours** | **60 --hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | Faiz M. Khan, The Physics ofRadiation Therapy, Lippincott Williams &Willkins, Philadelphia, 3rd Edition, 2003. |
| 2 | F.H.Attix,Introduction to Radiological Physics and Radiation Dosimetry, Viley–VCH, Verlog, 1st Edition, 2004 |

**Reference Books**

| | |
|---|---|
| 1 | Absorbed Dose Determination in External Beam Radiotherapy: An International Code of Practice for Dosimetry based on Standards of Absorbed Dose to Water, IAEA TRS-398, 2006. |
| 2 | Ivan Lux and Laszlo Koblinger, Monte Carlo Particle Transport Methods: Neutron and Photon Calculations, 1st Edition, CRC Taylor & Francis, 1990. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | https://cds.cern.ch/record/932011?ln=en |
| 2 | https://www.youtube.com/watch?v=OgO1gpXSUzU |

Course Designed By: **Dr. C. S. Sureka& Dr. GanesanRamanathan**

| Mapping with Programme Outcomes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO 3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | M | M | M | M | M | M | M | M | M | M |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S |
| | | | | | | | | | | |

* S-Strong; M-Medium; L-Low

# Fourth Semester

| Course code | 33P | MEDICAL PHYSICS LAB II | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Lab | 0 | 0 | | 4 |
| Pre-requisite | | Medical Physics Lab I and Radiation Dosimetry | Syllabus Version | | 2021-22 | |

**Course Objectives:**

1. The main objectives of this course areto:
2. To determine the calibration factor for ion chamber that is not calibrated. To determine the beam quality correction factor. To measure absolute dose for photon beam using TRS 398 protocol. To measure absolute dose for electron beam using TRS 398protocol.
3. To measure PDD curves for different field sizes and energies. To measure flatness and symmetry for photon and electron beams. To measure R50, R100, R90 and practical range of electronbeam.
4. To plot isodose distributions for carcinoma esophagus and carcinoma uterine cervix using three and four fields. To determine interleaf and intraleaf for multileaf collimator of linear accelerator. To check leaf speed and accuracy of MLC. To check variation in leaf position with gantrymovement.
5. To tests temporal accuracy, timer linearity and end error of brachytherapy machine. To perform source strength of Ir-192 brachytherapy source. To perform patient specific QAfor IMRTpatients.
6. To check physical integrity of primary and secondary walls of radiotherapy installation by measuring radiation levels using surveymeter.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Measure absolute value of radiation emitted from linear accelerator for prescribed monitor units | K3 |
| 2 | Apply their knowledge for cross calibration of ion chamber for use in accurate measurements of radiation dose. | K3 |
| 3 | Evaluate a treatment plan for three and four fields. | K5 |
| 4 | Apply their in-depth knowledge in performing patient specific IMRT-QA. | K3 |
| 5 | Survey radiation protection/radiotherapy installations. | K5 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Experiments:

1. Measurement and Verification of PDD, TAR and TMRvalues
2. Wedge and Tray factordetermination
3. Contrast and spatial resolution (FBCT andCBCT)
4. Evaluation of Profile parameters using Radiation FieldAnalyzer
5. Effective SSD for electronbeams
6. Cross calibration of ionchambers
7. Calibration curve for electron density, HU calibrationcurve
8. Absolute Calibration of Photon and Electron beams - using TRS398
9. HU linearity and uniformity and CTnoise

10. Quality Assurance of MultileafCollimator
11. Quality Assurance of a Brachytherapyunit
12. Pretreatment IMRT QualityAssurance
13. Radiation Protection survey of Teletherapy and Brachytherapyinstallations
14. Quality Assurance of a LinearAccelerator
15. Manual planning of three and four fieldtechniques
16. Autoradiography test for Brachytherapy source in Remote Afterloaderunit

**Demonstrations**

17. Image guidance radiation therapy (planar andCBCT)
18. Respiratory gatingtechniques
19. Demonstration of arraydetector

Course Designed By: **Dr. C. S. Sureka**

| **Mapping with Programme Outcomes** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** |
| **CO1** | S | M | M | M | S | M | S | S | S | S |
| **CO3** | S | M | M | M | S | M | S | S | S | S |
| **CO3** | S | M | M | M | S | M | S | S | S | S |
| **CO4** | S | M | M | M | S | M | S | S | S | S |
| **CO5** | S | M | M | M | S | M | S | S | S | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

**Note: These experiments may also be performed during the third semester. However, its examination will only be conducted during the fourth semester.**

| Course code | 47V | PROJECT | L | T | P | C |
|---|---|---|---|---|---|---|
| | | | 0 | 0 | 10 | 8 |
| Pre-requisite | | External Beam Radiation Therapy/ Diagnostic Radiology/ Nuclear Medicine | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. To have working knowledge of the clinical diagnostic imaging and/or radiation oncology. To get hands on training with relevantinstrumentation
2. To be familiar with radiation safety practices and procedures including the determination of radiation shieldingrequirements.
3. Practical real time exposure to understand the biological effects of radiation and its application for radiation safety and for radiationtreatment.
4. To comply with all applicable regulations and requirements regarding health and safety of self and of others, and of clinical and research ethics andprocedures.
5. Understanding of frontier research and to distinguish the suitable methodology for systematic analysis.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Learnt various diagnostic/therapeutic instrumentation and methodology to carry out Radio therapy. | K3 |
| 2 | Exposed to various methods and precautions needed for their professional life as Medical Physicist. | K3 |
| 3 | Applied effective communication both orally and in writing. | K3 |
| 4 | Understand frontier research and systematic analysis. | K2 |
| 5 | Completed mini research projects. | K6 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Studentsareencouragedtospend30daysforcarryingouttheprojectworkundertheguidance and supervision of Medical Physicists/Scientists in leading researchHospitals/Institutes/Health Care Industries/ Universities engaged with cancer therapy/research..

Course Designed By: **Dr. C. S. Sureka**

**Mapping with Programme Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO3** | S | S | S | S | S | S | S | S | S | S |
| **CO4** | S | S | S | S | S | S | S | S | S | S |
| **CO5** | S | S | S | S | S | S | S | S | S | S |
| | | | | | | | | | | |

*S-Strong; M-Medium; L-Low

# Value Added Course

# VALUE ADDED COURSE I

| | |
|---|---|
| **Name of the Course** | Yoga for Interpersonal Skills |
| **Credit criteria** | 2 credits |
| **Objective** | To ensure physical health, strengthen the interpersonal skills for self-realization and identifying the hidden superior qualities through the introspection methods inyoga |
| **Teaching hours** | 30 hours + 1 day tour to Aliyar/ Esha Yoga Center |
| **Preferred time** | First Semester |
| **Participants** | Interested I and II M.Sc. students |
| **Mode of Lecture** | Either through online or conventional teaching |
| **No. of participants** | ~ 25 |
| **Resource persons** | Professors, well qualified and experienced yoga instructors from all over the country as well as Temple of Consciousness, Aliyar/ Isha Yoga Center |
| **Course Syllabus** | **Unit I: Yoga and Meditation (10h)**<br>Yoga: Definition and its classifications – Astanga Yoga - Sun salutation(SuryaNamaskar)–Practicingprocedureandbenefits– HathaYoga:(a)sittingpose:Padmasan,Vajrasan,Pachimothasan, Yoga mudra, (b) Standing pose: Viruchasan, Thadasana, Padhahastasan, (c) Lying pose: Bujangasan, Dhanurasan, Navasan, Navukasan. Pranayamam: procedures and benefits – Nadisudhi, Seetali, Seethkari, Surya bedhana, Chandra bedhana,Kabalapathi, Brahmmari. Mudras: Gyana mudra, Surya mudra, Abaana mudra, Soonya mudra, Linga mudra, Aathi mudra, Vayu mudra, Varuna mudra. Meditation: Importance and benefits – Chakras and its explanations - Types of meditation – Agna, Shanthi, Thuriya and Thuriyatheetha.<br>**Unit II: Introspection for interpersonal skill development (10h)**<br>Introspection: Importance and procedures – Levels of Introspection:(i)analysisofthought(ii)Moralizationofdesire(iii) |

| | |
|---|---|
| | Neutralization of anger (iv) Eradication of worries – Harmonious relationship with fellow beings. Attaining five great qualities: (i) Perspicacity (ii) Acceptability (iii) Adaptability (iv) Magnanimity (v) Creativity - Five kinds of duty: Importance – Duties to self, family, relatives, society and world. Interpersonal skill – Importance – Communication skill, Emotional intelligence, Team working, Negotiations, conflict resolution, problem solving and decisionmaking.<br>**References:**<br>1. Yogasana, WCSC-VISION for Wisdom, 2012, Vethathiri publications,Erode.<br>2. Yoga for Modern Age, Vethathiri Maharishi, 2017, Vethathiri publications,Erode.<br>3. HowtoWinFriendsandInfluencePeoplebyDaleCarnegie, 1998, Gallerybooks. |
| **Registration** | Free. Either through WhatsApp or using their Email id. |
| **Certification** | E-certificate will be issued to active participants after completing the examination. |
| **Examination** | Conducted by the Course coordinator for 50 Marks. |
| **Course Materials** | PPTs provided by resource persons will be shared. |
| **Outcome** | Physical and psychologically strengthen personality with successful career growth. |
| **Course Coordinators** | Dr. C. S. Sureka and Dr. R. Mohandoss |

# VALUE ADDED COURSE II

| | |
|---|---|
| **Name of the Course** | Medical Radiological Safety Officer (MRSO) Training |
| **Credit criteria** | 2 credits |
| **Objective** | To strengthen the knowledge of budding Medical Physicists and help them to clear MRSO examination conducted by Atomic Energy Regulatory Board (AERB), Mumbai. |
| **Teaching hours** | 30 hours (25 hours lecture + 5 hours virtual tour) |
| **Preferred time** | Fourth Semester |
| **Eligibility** | Students who are perusing I and II M.Sc Medical Physics, Diploma in Radiological Physics, undergoing internship program and Junior Medical Physicists from all over the country. |
| **Mode of Lecture** | Online presentation. |
| **Maximum number of participants** | 250 |
| **Resource persons** | Scientists, Professors and Eminent Medical Physicists from all over the country as well as Alumni of Bharathiar University. |
| **Course Syllabus** | Syllabus recommended by AERB for MRSO certification. |
| **Attendance** | via Google Attendance |
| **Registration** | Free. Either through WhatsApp or using their Email id. |
| **Certification** | E-certificate will be issued to active participants who can successfully complete their examination. |
| **Examination** | Online examination will be conducted by the Course coordinator for 50 Marks. |
| **Course Materials** | PPTs provided by resource persons will be shared. |
| **Outcome** | Increases in the MRSO pass percentage. |
| **Course Coordinator** | Dr. C. S. Sureka |

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# Supportive Course

| Course code | GS121 | DIAGNOSTIC RADIOLOGY | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Supportive | 2 | 0 | 0 | 2 |
| Pre-requisite | | PhysicsandBiology | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. Learn the basics of radiation used for cancer diagnosis andtreatment.
2. Understand the difference among radiations used for variousapplications.
3. Learn the causes of cancer and possible diagnosticmodalities.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Gained knowledge about ionizing and non-ionizing radiations. | K2 |
| 2 | Learnt the basics of cancer. | K2 |
| 3 | Understood the basic principles of radiology. | K3 |
| 4 | Gained knowledge on Various diagnostic procedures used in Radiology | K3 |
| 5 | Understood radiological safety during diagnosis | K2 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction to Ionizing Radiation and Cancer | 10 --hours |
|---|---|---|

Radiation: Definition, electromagnetic spectrum- ionization- types of radiation- Radiation quantities and units: absorbed dose, equivalent dose, effective dose- Interaction of radiation with matter: Photoelectric effect- sources, properties and hazards of ionizing radiation- biological effects- applications of radiation- radiation safety principles.
Cancer: Definition, carcinogenic agents, types, stages, organization of body, genes responsible for cancer, treatment efficacy, and medical ethics.

| Unit:2 | Diagnostic Imaging Modalities | 12 --hours |
|---|---|---|

Radiology in Cancer diagnosis: History, working principle, equipment, mode of diagnosis and safety in Radiography - Digital Radiography, Fluoroscopy – Computed Tomography – Magnetic Resonance Imaging (MRI) - Mammography- Gamma camera and PET.

| Unit:3 | Contemporary Issues | 2 hours |
|---|---|---|

https://www.youtube.com/watch?v=hBRJ0qDgpfs
https://www.youtube.com/watch?v=YzV1kovMjkI
https://www.radiologyinfo.org/en/info.cfm?pg=bodyct

| | Total Lecture hours | 24-hours |
|---|---|---|

**Text Book(s)**


1. MomnaHejmadi, Introduction to cancer biology, 2nd edition, 2010.
2. The Physics of radiology, H.E.Johns and Cunningham, Charles C Thomas Publishers, 1st Edition, 1984.


**Reference Books**


1. Curry,T.S.,Dowdey,J.E.,Murry,R.C.,Christensen'sintroductiontothephysicsofdiagnostic radiology, Philadelphia: Lea &Febiger, 4th Edition, 1990.

| | |
|---|---|
| 2 | Herman Cember and Thomas E. Johnson, Introduction to Health Physics, McGraw-Hill Education / Medical; 4th Edition, 2008. |
| | |
| **Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]** | |
| 1 | https://www.coursera.org/lecture/trunk-anatomy/magnetic-resonance-imaging-mri-xxZsE |
| 2 | https://www.coursera.org/lecture/cancer/imaging-overview-y8wmy |
| 3 | https://www.coursera.org/lecture/cancer-metastasis/tumor-formation-uncontrolled-cell-divisiona%20href=-A4ftC |
| | |
| Course Designed By: **Dr. C. S. Sureka& Dr. S. HarikrishnaEtti** | |

| Course code | GS122 | RADIOTHERAPY FOR CANCER | L | T | P | C |
|---|---|---|---|---|---|---|
| Core/Elective/Supportive | | Supportive | 2 | 0 | 0 | 2 |
| Pre-requisite | | Physics and Biology | Syllabus Version | | 2021-22 | |

**Course Objectives:**

The main objectives of this course are to:

1. Understand the physics behind cancer diagnosis andtreatment.
2. Aware of the facilities in Radiation oncologydepartment.
3. Know the basic principle and execution of various radiotherapyprocedures.

**Expected Course Outcomes:**

On the successful completion of the course, student will be able to:

| | | |
|---|---|---|
| 1 | Understood the basics behind Medical Physics. | K2 |
| 2 | Learnt about the possible modalities to treat cancer. | K2 |
| 3 | Gained knowledge on the physics of radiotherapy equipment's. | K2 |
| 4 | Understood the working of radiotherapy equipment's. | K2 |
| 5 | Safety procedures of radiotherapy equipment's. | K2 |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

| Unit:1 | Introduction to Radiotherapy | 10 --hours |
|---|---|---|

History- Physics in Medicine- Dosimetric quantities: absorbed dose, exposure and kerma-DepartmentofRadiationoncology-DutiesofMedicalPhysicistsandRSO-Treatmentprocedure-Overview to plan a diagnostic radiology, radiotherapy and nuclear medicine department. .

| Unit:2 | Radiotherapy techniques | 12 --hours |
|---|---|---|

Radiotherapy: Introduction, principle, various technologies, treatment procedure and safety in Teletherapy - cobalt therapy - Linear Accelerators Electron and Photon - LDR and HDR Brachytherapy, Treatments using Nuclear medicine sources - proton and Ion beam therapy.

| Unit:3 | Contemporary Issues | 2 hours |
|---|---|---|

https://www.youtube.com/watch?v=97-5s1Xuzpo
https://www.youtube.com/playlist?list=PLR5923ISbcx_I2VkHgxGwAuHaP8tUNEkN

| | Total Lecture hours | 24 --hours |
|---|---|---|

**Text Book(s)**

| | |
|---|---|
| 1 | E.B. Podgorsak, Radiation Oncology Physics: A Handbook for Teachers and Students, International Atomic Energy Agency (IAEA) publications, 2005. |

**Reference Books**

| | |
|---|---|
| 1 | E. B. Podgarsak, Radiation Physics for Medical Physicists, Springer Verlag,1st Edition, 1996. |

**Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]**

| | |
|---|---|
| 1 | https://www.youtube.com/watch?v=0KGi7NZ0hwM |

Course Designed By: **Dr. C. S. Sureka& Dr. S. HarikrishnaEtti**

# Annexure

# M. Sc. Medical Physics

## Syllabus
## (With effect from the academic year 2021- 2022 onwards)

## Program Code: MPHA

**DEPARTMENT OF MEDICAL PHYSICS**
**Bharathiar University**
**(A State University, Accredited with "A" Grade by NAAC and 13th Rank among Indian Universities by MHRD-NIRF)**
**Coimbatore 641 046, INDIA**

# BHARATHIAR UNIVERSITY:: COIMBATORE 641046
# DEPARTMENT OF MEDICAL PHYSICS

## VISION

To produce professionally competent Medical Physicists and Radiological Safety Officers (RSO) to the nation through effective teaching along with clinical exposure and translational research programs.

## MISSION

The Mission of the Department is to

- ✓ Train Medical Physics professionals to ensure utmost quality patientcare.
- ✓ Provide excellent learning opportunities and educate in a variety of Medical Physics oriented disciplines including radiology, radiation oncology, nuclear medicine and radiobiology.
- ✓ Provide outstanding training in Medical Physics service for the safe and effective delivery of cutting edge radiotherapy treatments and medical imaging at par with Internationalstandards.
- ✓ ToproduceprofessionallycompetentMedicalPhysicistswhocanadoptintheIndustry environment aswell.
- ✓ Our research mission is to develop better methods and technologies for the personalized diagnosis and treatment of cancer disease focusing on radiation based approaches in medical imaging, radiation oncology, and image guidedintervention.


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