# Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

## P.G. PROGRAM

## M. Sc. (Medical Physics)

## SEM-III

## Paper I- RADIATION HAZARD, SAFETY, EVALUATION AND CONTROL

| SUB-JECT CODE | Catego-ry | SUBJECT NAME | TEACHING &EVALUATION SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | THEORY | | | PRAC-TICAL | | Th | T | P | CREDITS |
| | | | End Sem University Exam | Two Term Exam | Teachers Assessment | End Sem University Exam | Teachers Assessment | | | | |
| MSMP301 | DC | RADIATION HAZARD, SAFETY, EVALUATION AND CONTROL | 60 | 20 | 20 | 0 | 0 | 3 | 1 | 0 | 4 |

**Course Objectives:-**

1. To develop the comprehensive understanding of Radiation Hazard, Safety, Evaluation and Control

**Course Outcomes:-**

2. Student will be able to understand and solve the problems related to Radiation Hazard, Safety, Evaluation and Control.

# SYLLABUS

## MSMP 301: RADIATION HAZARD, SAFETY, EVALUATION AND CONTROL

**Unit 1:**

Radiation Hazard: external, internal hazard, Radiation Hazard Evaluation by Calculation and measurement. Calculation of specific gamma constant. RHM, RMM, Area monitoring, personal monitoring Internal Hazard Evaluation by Calculation and measurement – inhalation, ingestion, and Absorption, Physical Decay, Biological Decay, Bioassay, Whole Body counters. Internal Radiation hazard Evolution and Control, contamination on work surfaces, person and samples – Internal radiation hazards – Radio toxicity of different radio nuclides and the classifications of laboratories – General requirements of class A, class B and class C laboratories – Basic Principles for control of contamination, Methods of decontamination.

**Unit 2:**

Transport of Radioactive Material: Introduction, Regulatory aspects, Objective of the regulations, Radioactive Material, Special form Radioactive Material, A1, A2 values, Determination of A1/ A2 values of radionuclide, Contamination, Exclusive Use, Low specific activity material, Surface Contaminated object, Shipment under special arrangement, Package - Excepted package, Industrial (IP1, IP2, IP3) package, Type A package, Type B package, type B(U) /(M), Type C package. Contents limit for package, General requirements for all types of packages, Additional requirements for packages transported by Air, Requirements for Type A , B(U), B(M), C packages,

**Unit 3:**

Radiation waste Disposal: Disposal of radioactive wastes – Sources of radioactive waste – Classification of wastes –Permissible levels and authorization – Disposal of liquid wastes – Treatment techniques –for solid, liquid and gaseous effluents – permissible limits for disposal of wastes, Sampling technique for water, air and solid, ecological considerations, general methods of disposal, management of radioactive waste in hospital and research establishments – Meteorological parameters. Emergency preparedness, emergency handling, graded approach, site emergency. Safe custody of sources procedures for issue for applications methods of eventual disposal.

**Unit 4:**

Administrative and legislative aspects of radiation protection Aims of Radiological Protection, need for protection, System of Radiological Protection, Justification, Optimization, Dose Limit, Types Of Radiation Exposure Fetus Dose, Radiation trainee Dose limit, external and internal exposure, additive risk model and multiplicative risk model, risk coefficients, Emergency/ Interventions, ICRP and AERB recommendations, Atomic Energy Act, Radiation Protection Rules (RPR). Applicable Safety Codes, Standards, Guides and Manuals. Regulatory Control – Licensing, Inspection and Enforcement. Responsibilities of Employers, Licensees, Radiological Safety Officers And Radiation Workers.

**Unit 5:**

Safety Concern on Therapy/ Diagnostic / Brachy therpay Room Planning: Shielding materials, Site selection, Area requirements, Parameters used for shielding calculations, Use factor, work load, Occupancy Factor, TVT, HVT, Radiation dose Permissible limits, Calculation of Shielding thickness for the walls and ceiling primary wall, secondary wall, Maze wall and its importance, Width of Primary barrier, Calculation of secondary thickness, scattered radiation, leakage radiation, Radiation at Door level. Neutron dose shielding in high energy Linac.

## P.G. PROGRAM

## M. Sc. (Medical Physics)

## SEM-III

### Paper II- PHYSICS OF RADIOTHERAPY

| SUB-JECT CODE | Catego-ry | SUBJECT NAME | TEACHING &EVALUATION SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | THEORY | | | PRAC-TICAL | | Th | T | P | CREDITS |
| | | | End Sem University Exam | Two Term Exam | Teachers Assessment | End Sem University Exam | Teachers Assessment | | | | |
| MSMP302 | DC | PHYSICS OF RADIOTHERAPY | 60 | 20 | 20 | 0 | 0 | 3 | 1 | 0 | 4 |

**Course Objectives:-**

1. To develop the comprehensive understanding of Physics of Radiotherapy

**Course Outcomes:-**

2. Student will be able to understand and solve the problems related to Physics of Radiotherapy

# SYLLABUS

## MSMP 302: PHYSICS OF RADIOTHERAPY

Unit-1

General introduction to Tele, brachy and internal therapy, Therapy X-ray tubes, superficial, ortho voltage and mega equipments, construction, cooling, focal spot, heel effect, collimators, cones, beam limiting diaphragms, filters. Cobalt 60 teletherapy units, constructional details, source head, collimator system, shutter, stationary and rotational units, isocentric mounting.

Unit-2

Calibration of therapy units, in air output, output with back scatter, tissue equivalent phantoms, and dosimeters used calibration of ortho voltage units, cobalt 60 units, super voltage units, calibration of electron beams, routine checks in therapy machines. Back scatter factor, percentage back scatter, variation of back scatter with field size, shape and quality of radiation.

Unit-3

Percentage depth dose, build up, reference point, variation of percentage depth dose with depth, field size, field shape, SSD, quality of radiation, measurements of percentage depth dose, isodose curves, automatic isodose plotter, percentage depth dose tables. Composite isodose curves with two fields, three fields and multiple field techniques, integral dose.

Unit-4

Tumor dose calculations in various techniques, TAR and its use in tumor dose calculations, TMR, TPR, rotational, arc and skip therapy. Brachy therapy: sources, criteria for source selection Use of Radium and radium substitutes: Co-60, Ta-82, Cs-137, Ir-192, I-125 and Au-198, surface, interstitial and intracavitary techniques, advantages and applications, Patterson-Parker rules for radium implants.

Unit-5

Afterloading technique, manual and remote, advantages, radiographic localization of implanted sources, use of computers in brachytherapy dosimetry, QA in brachytherapy equipment and sources, calibration of sources, checking of source integrity and uniformity. Computerized treatment planning system, radiotherapy simulators and CT simulation. Radiotherapy room planning, radiation protection in teletherapy and brachytherapy, radiation protection surveys.

**References**


1. H.E.Jones, J.R.Cunnigham, "The Physics of Radiology" Charles C.Thomas, NY.
2. W.J.Meredith and J.B.Massey "Fundamental Physics of Radiology" John Wright and sons, UK.
3. Christensen 'Physics of Diagnostic Radiology' Lea and Febiger – Philadelphia.
4. W.R.Hendee, "Medical Radiation Physics", YearBook – Medical Publishers Inc. London.

## P.G. PROGRAM

## M. Sc. (Medical Physics)

## SEM-III

### Paper III- PHYSICS OF MEDICAL IMAGING

| SUB-JECT CODE | Cate-gory | SUBJECT NAME | TEACHING & EVALUATION SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | THEORY | | | PRAC-TICAL | | Th | T | P | CREDITS |
| | | | End Sem University Exam | Two Term Exam | Teachers Assessment | End Sem University Exam | Teachers Assessment | | | | |
| MSMP303 | DC | Physics of Medical Imaging | 60 | 20 | 20 | 0 | 0 | 3 | 1 | 0 | 4 |

**Course Objectives:-**

1. To develop the comprehensive understanding of Physics of Medical Imaging

**Course Outcomes:-**

1. Student will be able to understand and solve the problems related to Physics of Medical Imaging

# Shri Vaishnav Vidyapeeth Vishwavidyalaya, Indore

## SYLLABUS

## MSMP 303: PHYSICS OF MEDICAL IMAGING

**Unit 1: X-ray Production, X-ray Tubes and Generators**

Discovery of X-rays, Production and properties of x-rays ,X-ray tubes, X-ray tube insert, tube housing filtration and collimation, X-ray generator function and components, x-ray generator circuit design, Timers in radiography. Nature of Cooling, Safety devices in X-ray tubes Mammography X-ray tube design, X-ray generator and photo timer system, compression scattered radiation and magnification, screen film cassettes and film processing, ancillary procedures, radiation dosimetry,

**Unit II : Screen Film Radiography and Film Processing**

Basic geometric principles of radiographic image, Latent image, screen film system, construction and Characteristics, optical density, contrast, speed and latitude, Types of films, intensifying screens – construction and action, Types of screens-rare earth, Fluoroscopic ,Film exposure, Radiographic grids. Film processing, Automatic Film Processing, artefacts, Processor QA, Contrast and dose in radiography, scattered radiation in projection Radiography, reduction of patient dose, patient dose measurement, dose level for diagnostic procedures, methods to reduce patient dose. Image Quality – Unsharpness, Spatial resolution, Contrast, contrast agents, Image Noise, Image distortion.

**Unit III : Computed Tomography and Other X-ray techniques**

Basic principles, Historical development, Detectors and detector arrays , Details of acquisition, Reconstruction algorithms, Digital image display, scan motions, x-ray sources, collimation, X-ray detectors, viewing system, Radiation Dose, Image quality, Artefacts, Fluoroscopy, image intensification, Digital fluoroscopy, Automatic Brightness Control, Cine fluorography, Xeroradiography-. Digital Radiography Thermography-Basic principles, scanning techniques, radiation dose to patients, Radiography of welds-casting and forgings, Microradiography, Autoradiography, Flash radiography, X-ray diffraction analysis.

**Unit IV: Ultrasound**

Basic principles, Characteristics of sound, nature and production of ultrasound, interaction of ultrasound with matter, Transducers and their design, Piezoelectric effect, frequency response of transducers, various types of transducers, Ultrasound beam properties, Image data acquisition, Dynamic range, Different scan modes A, B,M modes, Two Dimensional image display and storage Real time scanning, Principles of Grayscale imaging, significance of gain and gain compensation, pulse rate and its significance, Resolution and frequency and depth and frequency, Image quality and artefacts, Doppler techniques and principles of colour Doppler System performance and QA, Acoustic power and biological effect of ultrasound

**Unit V: Nuclear Magnetic Resonance (NMR) and MRI**

Magnetisation properties, Generation and detection of magnetic resonance signals, Interaction of nuclei with a static magnetic field, Rotation and precession, Interaction of nuclei with radio frequency wave, induction of a magnetic resonance signal in a coil, Quantum mechanical interpretation, Bulk magnetisation, relaxation processes:T1 and T2, Relaxation times (T1 and T2) for biologic materials. Pulse sequences, spin echo, Inversion recovery, Gradient recalled echo, signal from flow, perfusion and diffusion contrast, Magnetisation transfer contrast,

Principles of MRI, Localisation of MR signal, k-space data acquisition and image reconstruction,

3d Fourier transform image acquisition, image characteristics.

## REFERENCES

STANDARD BOOKS FOR STUDY AND REFERENCES

1. "The Essential Physics of Medical Imaging" Jerrold T Bushberg, Second Edition 2002, LWW.

2. "Introduction to Medical Imaging Physics, Engineering and Clinical Applications" N. Smith and A. Webb 2011,Cambridge University Press
3. W.J. Meredith and J.B. Massey "Fundamental Physics of Radiology" John Wright and Sons, UK, 1989
4. Christensen 'Physics of Diagnostic Radiology' Lea and Febiger – Philadelphia (1990).
5. W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981
6. P. Sprawls, Magnetic Resonance Imaging: Principles, Methods and Techniques, Medical Physics Publishing, Madison (2000)

## P.G. PROGRAM

## M. Sc. (Medical Physics)

## SEM-III

### Paper-IV: NUCLEAR MEDICINE

| SUB-JECT CODE | Category | SUBJECT NAME | TEACHING & EVALUATION SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | THEORY | | | PRAC-TICAL | | Th | T | P | CREDITS |
| | | | End Sem University Exam | Two Term Exam | Teachers Assessment | End Sem University Exam | Teachers Assessment | | | | |
| MSMP304 | DC | NUCLEAR MEDICINE | 60 | 20 | 20 | 0 | 0 | 3 | 1 | 0 | 4 |

**Course Objectives:-**

1. To develop the comprehensive understanding of Nuclear Medicine

**Course Outcomes:-**

2. Student will be able to understand Nuclear Medicine

# SYLLABUS

## MSMP304: NUCLEAR MEDICINE

Unit-1

Use of unsealed sources in diagnosis and treatment, details of radionuclides including decay schemes, method of preparation, storage and handling, nature of pharmaceutical preparations. Instruments used in radiation detection and measurement in nuclear medicine, GM systems, liquid scintillators, solid scintillators, and electronic circuits for a scintillation detector, statistics of isotopes counting, Poisson distribution, standard deviation, probable error, resolving time and loss of counts, sample counting procedures.

Unit-2

Uptake studies, thyroid uptake, details of instruments used, method of uptake measurement, determination of plasma volume using a well counter, time dependence studies like life of erythrocytes. Imaging using radio nuclides, rectilinear scanner, the Anger Camera – Principles of construction, use and maintenance, positron emission tomography (PET), Studies with radioactive tracers, uses of isotopes.

Unit-3

Nuclear medicine, counting statistics and standardization of sources: Clinical radio isotope laboratory organization, radio –iodine in thyroid function tests, iodine cycle, tri- iodothyronine test, indices of thyroid function, iron clearance and utilization, red cell survival, platelet survival, absorption studies with vitamin B-12, calcium and fat-uses of whole body counters, Circulation studies with Na-24 iron physical principles of isotopes, dilution analysis, multiple compartment system, measurement of circulation time, renal, liver, lung, cerebral function studies.

Unit-4

In-vitro procedures, RIA kit, Treatment of thyrotoxicosis, thyroid cancer with Iodine, use of phosphorus -32 for therapy, Treatment of Polycythaemiavera and leukemia with P-32, patient doses. Use of colloidal gold and chromic phosphate in the treatment of malignant effusions – Calculation of treatment doses.

Unit-5

QA in the preparation of radio- pharmaceuticals, QA in imaging, flood phantom. Dynamic function studies, scanning and imaging equipments, moving detector system, stationary imaging devices, comparison of imaging systems, radiopharmaceuticals for scanning, Handling of radioactive materials, radiation units, permissible radiation exposures, radiation protection measures, Radio nuclide imaging central nervous system, liver and spleen, thyroid, kidneys, lung and other imaging and monitoring procedures.

**References**


1. W.H.Blahd, "Nuclear Medicine", McGraw Hill Co., New Delhi.
2. H.N.Wagner, "Principles of Nuclear Medicine", W.B.Saunders Co, London.
3. Herbert (John) &D.A.Rocha, Text Book of Nuclear Medicine, Vol 2 & 6, Lea and Febiger, Philadelphia.
4. S.Webb, The Physics of Medical Imaging, Medical Science Series, Adam Hilger, Bristol.

## P.G. PROGRAM

## M. Sc. (Medical Physics)

## SEM-III

Paper V- **Comprehensive Viva**

| SUB-JECT CODE | Cate-gory | SUBJECT NAME | TEACHING & EVALUATION SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | THEORY | | | PRAC-TICAL | | Th | T | P | CREDITS |
| | | | End Sem University Exam | Two Term Exam | Teachers Assessment | End Sem University Exam | Teachers Assessment | | | | |
| MSMPCV 305 | DC | Comprehensive Viva | 00 | 00 | 00 | 00 | 00 | 0 | 0 | 0 | 4 |

Comprehensive Viva will be based on the all subjects of the III sem.

Total Marks: 100

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## M. Sc. (Medical Physics)

## SEM-III

### Paper VI- Project Phase –I & Presentation

| SUB-JECT CODE | Cate-gory | SUBJECT NAME | TEACHING & EVALUATION SCHEME | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | THEORY | | | PRAC-TICAL | | Th | T | P | CREDITS |
| | | | End Sem University Exam | Two Term Exam | Teachers Assessment | End Sem University Exam | Teachers Assessment | | | | |
| MSMPPR 306 | DC | Project Phase –I & Presentation | 00 | 00 | 00 | 00 | 00 | 0 | 0 | 16 | 8 |

Total Marks: 200