

# MPS 404R1: RADIATION SOURCES, DETECTION AND MEASUREMENT

Teaching hours: Each Unit – 12 h

## Objective:

To acquaint the students about the radiation sources, detectors, radiation counting systems, radiation measuring systems and various kinds of radiation instruments used for diagnosis, therapy and radiation safety.

## Outcomes:

- Students will be familiar with different kinds of radiation sources including radioisotopes with specific applications in diagnosis and therapy.
- Learn about radiation and radioisotope detection, counting, recording and analysis of the data.
- Acquaint with different kinds of radiation counters and measuring instruments.
- They will also learn about various kinds of personnel monitoring and safety instruments, their operation and use

## Unit I: Radiation Sources

Radiation sources - Natural sources – Ra-226 and Rn-222 sources. Artificial radioactive sources - large scale production of isotopes - Reactor produced isotopes - Cyclotron produced isotopes - Fission products - Telecobalt and Brachy Cesium sources - Tantalum wire -  $^{125}\text{I}$  Sources - Beta ray applicators - Thermal and fast neutron sources – Neutron activation sources. Preparation of tracers and labelled compounds - Preparation of radio colloids.

Physical characteristics of the radionuclides used in Radiation Therapy and Nuclear Medicine.

## Unit II: Nuclear electronics

Preamplifier circuits, linear and pulse amplifier, pulse shaping, pulse stretching. Wilkinson type analog to digital converter. Pulse discriminators - coincidence and anticoincidence circuits - memories, pulse height analyser - single and multichannel analysers – on-line data processing - time to amplitude converter - charge sensitive amplifier. Basic principles of measurement techniques such as collimation, shielding, geometry and calibration.

## Unit III: Radiation Counters

Counting systems for alpha and beta radiation, Construction and operation of GM counting system, Scintillation counting system, liquid scintillation counting system, RIA counters,

Semiconductor detector –HPGe counting system (SCA and MCA) multi-channel analyzers, - Nuclear track emulsions for fast neutrons - BF<sub>3</sub> and He<sub>3</sub> neutron counters. New Developments.

#### **Unit IV: Radiation Measuring Instruments**

Construction and working of thimble(cylindrical) plane-parallel chambers, Farmer design of the cylindrical chamber. Different types of electrometers – analog and digital. Secondary standard therapy level dosimeters - Farmer Dosimeters – Radiation field analyser (RFA) - Radioisotope calibrator - Multipurpose dosimeter – Well type ionization chamber for brachytherapy source calibration.

TL/OSL and film dosimetry systems, TL/OSL discs, rods and cubes and readers- calibration and use, Radiographic and Radiochromic films-calibration and use.

Gel dosimetry system – Polymer gel, Fricke gel. Analysis of gel dosimeters using computed tomography, magnetic resonance imaging and optical CT scanner.

Solid state dosimetry system – semiconductor diodes, MOSFETs, diamond dosimeters, Glass dosimeters (radiophotoluminescence dosimeter).

Calibration and maintenance of Radiation Measuring Instruments.

#### **Unit V: Radiation Monitoring Systems**

Survey meters and radiation monitors – ion chamber based survey meters – both vented and pressurized ion chambers, Pocket dosimeters.

Teletector - Gamma area (Zone) alarm monitors - Contamination monitors for alpha, beta and gamma radiation - Hand and Foot monitors - Laundry and Portal Monitors – Wholebody counters.

Instruments for personnel monitoring – TL and OSL personnel monitoring badges - extremity dosimeters.

Fast neutron monitors, Tissue equivalent proportional counters (TEPC) - Flux meter and dose equivalent monitors - Pocket neutron monitors. Portable counting systems for alpha and beta radiation – Portable gamma ray spectrometers. Air Monitors for radioactive particulates and gases.

Some of the commercially available instruments and systems

Calibration and maintenance of radiation monitoring instruments.