

  
**MANGALORE UNIVERSITY**  
**MSc Medical Physics**

**MPS 554: Nuclear Reactors, Particle Accelerators, Industrial  
Applications of Radiation and Environmental  
Radioactivity.**

**Teaching hours: Each Unit – 12 h**

**Objectives:**

To impart the knowledge on nuclear reactors and their operations, to familiarise the basics of particle accelerators, to create the awareness on industrial applications of radiation and radiation technology and also to familiarise about natural and artificial radioactivity.

**Course Outcomes:**

- Students will understand the basics of nuclear reactors and basic principles of physics in their operation.
- They will learn about particle accelerators and their applications in different areas such as health, industry and agriculture sectors.
- Industrial applications of radionuclides and radiation technology will be understood.
- They will be familiarise with environmental radioactivity and their natural and artificial origin.
- Students come to know the Short-term and worldwide effects nuclear explosions and their impact on marine and terrestrial environments

**Unit I:**

**Nuclear**

**Reactors**

Nuclear fission – Chain reaction: neutron multiplication, multiplication factor - fission chain reaction. Four factor formula, correction for finite size. Thermal utilization factor – homogenous and heterogeneous reactors. Reactor theory - Critical size of a bare homogeneous reactor. Reactor materials – fuel, moderators, reflectors, coolants, structural and cladding

materials, control rods, reactor shielding. Reactor types – research reactors and classification, power reactors and classification, breeder reactors.

## **Unit II:**

### **Particle**

### **Accelerator**

#### **s**

Classification of accelerators – Performance characteristics; Ion sources – discharge type, low voltage, electron oscillation, radiofrequency, duoplasmatron, cyclotron and negative ion sources; special features of ion sources. Electrostatic accelerators – Cockroft-Walton generator – Van de Graaff generator, pelletron accelerators - Tandem accelerators – Cyclic accelerators – Betatron – Microtron – Superconductivity cyclotron – Proton synchrotron – Linear accelerator.

## **Unit III: Industrial Applications**

Industrial applications – Sealed radioactive sources and their applications in industry – industrial radiography, gauging applications and mineral analysis. Radio tracer techniques: Leak and block detection, flow rate and mixing measurements, Gamma Sterilisation: medical supplies, bulk commodities.

## **Unit IV: Environmental Radioactivity - Natural**

Environmental radioactivity – sources of natural radioactivity, technologically enhanced natural radioactivity, terrestrial and atmospheric radioactivity. Cosmogenic radionuclides.

## **Unit V: Environmental Radioactivity – Artificial/Manmade**

The nuclear fuel cycle, nuclear power reactors, types of reactors, low level and high level radioactive waste, reactor accidents. Nuclear

explosions: Short-term and worldwide effects. Impact on marine and terrestrial environments,

**Reference Books:**

1. Hall Eric J. Radiobiology for the radiologist, Lippincott Williams & Wikins, Philadelphia, 1994.
2. Eisenbud M. Environmental Radioactivity, Academic Press Inc. (London) Ltd., 24-28 Oval Road, London NW1 7DX, 1987.
3. Bushong, Stewart C. Radiological Science for technologists – physics, biology and protection, Mosby, St. Louis, 1997.
4. Edward L. Alphen, -Radiation Biophysics! Academic Press, Second Edition.