B.E/B.Tech - Internal Assessment - III
Academic Year 2024-2025 (Even Semester)
Sixth Semester
Biomedical Engineering
19BME308 – Medical Radiation Safety

Answer Key

PART – A (5*2=10 Marks)

1. Tell about radiological incident and how could such a situation arise?
A radiological incident involves accidental exposure or release of radioactive materials. It can arise from equipment malfunction, human error, transport accidents, or natural disasters affecting nuclear facilities. Such incidents may occur in medical, industrial, or research settings, potentially endangering workers, the public, and the environment.

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2. When an incident would become an emergency and what would then be initiated?
An incident becomes an emergency when radiation levels threaten human health or the environment. Emergency protocols are initiated, including evacuation, sheltering, medical treatment, radiation monitoring, and public communication. Authorities activate response teams to contain the situation and prevent further exposure or contamination.

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3. Outline the principles for handling radioactive accidents
Handling radioactive accidents follows key principles: prevent further exposure, contain the source, monitor radiation levels, protect responders and the public, communicate transparently, and ensure long-term remediation. Rapid response, coordination, and adherence to safety standards are vital for minimizing harm and restoring safety.

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4. Recall Decommissioning
Decommissioning is the safe dismantling and closure of radioactive facilities after use. It involves decontamination, dismantling equipment, managing radioactive waste, and restoring the site. The goal is to eliminate radiation hazards, ensure environmental protection, and allow safe future use of the area.

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5. Write about the consequences of releases of radioactivity to environment
Radioactive releases can contaminate air, water, and soil, harming ecosystems, animals, and humans. Long-term effects include cancer, genetic damage, and ecosystem disruption. Contaminated areas may become uninhabitable for years. Effective containment and cleanup are critical to reducing these serious environmental and health impacts.

PART – B (2*13=26 Marks)

6 a).

- **Prevents escalation** – Early detection helps contain incidents before they become emergencies.
- **Protects health** – Limits radiation exposure to personnel and the public.
- **Minimizes contamination** – Quick action can prevent environmental spread.
- **Reduces costs** – Early intervention lowers cleanup and operational costs.
- **Detection methods** – Use fixed radiation monitors, alarms, and dosimeters.
- **Regular checks** – Routine inspections and maintenance ensure detection systems work effectively.

6 b)

- **Evacuate immediately** – Alert others and leave the room calmly.
- **Close doors** – Prevent spread by sealing the area.
- **Notify supervisor** – Report the spill to the radiation safety officer.
- **Use PPE** – Wear gloves, masks, and protective clothing for cleanup.
- **Decontaminate** – Use absorbents and follow lab-specific decontamination procedures.
- **Monitor and report** – Check for contamination and complete incident report.

7a)

- **Design weaknesses** – Older plant designs lacked robust fail-safes.
- **Communication failures** – Delayed or misleading public information worsened crises.
- **Regulatory gaps** – Inadequate oversight and inconsistent global standards were exposed.
- **Emergency planning** – Some sites lacked realistic emergency drills and infrastructure.
- **Long-term impacts** – Highlighted the massive environmental, social, and economic consequences.

7 b) Methods to Safely Dispose Radioactive Waste and Minimize Environmental Impact:

- **Segregation – Separate waste by radioactivity level and half-life.**
- **Shielded containment – Store in lead-lined drums or concrete vaults.**
- **Deep geological disposal – Bury high-level waste deep underground in stable rock formations.**
- **Dilution and dispersion – Used for low-level liquid waste under strict regulations.**
- **Decay storage – Temporarily store short-lived isotopes until safe.**
- **Conditioning** – Convert waste to solid form for stability and transport safety.

PART – C (1*14=14 Marks)

8. a) i) Steps for a Research Lab if a Shipping Box Leaks but No Radiation Detected by GM Meter:

1. **Isolate the Package** – Immediately cordon off the area and prevent further handling of the box.
2. **Notify Radiation Safety Officer (RSO)** – Report the incident to trained personnel for further action.
3. **Perform Wipe Tests** – Collect surface samples from the box and nearby area for contamination checks using a scintillation counter.

4. **Visual Inspection** – Carefully inspect the box for physical damage or spilled contents (using proper PPE).
5. **Review Documentation** – Check shipping papers and isotope logs to verify contents and evaluate potential risks.
6. **Initiate Decontamination** – If contamination is found, begin cleanup under the lab's radiation safety protocol and document the incident.

8.a) ii) Exposure Pathways from Atmospheric Radioactivity Releases and Their Limitation Methods:

1. **Inhalation** – Breathing in airborne radionuclides; limit using masks, sheltering, and staying indoors.
2. **Ingestion** – Contaminated food/water; control via food bans, water monitoring, and livestock restrictions.
3. **External exposure** – From fallout settling on ground, skin, or clothing; reduce through protective clothing and decontamination.
4. **Deposition** – Radionuclides settle on soil/water; soil shielding or remediation may be necessary.
5. **Resuspension** – Wind or human activity can reintroduce deposited particles; limit access to contaminated zones.
6. **Preventive actions** – Use early warning systems, evacuation, and iodine tablets (for radioiodine) to minimize exposure.

8. b) .i) Critical Exposure Pathway Concept and Food Chain Example:

1. **Definition** – A critical exposure pathway is the most significant route through which radioactive materials can reach humans.
2. **Food Chain Pathway** – Radionuclides (e.g., Cesium-137) deposit on grass, consumed by cows, then transferred to humans via milk.
3. **Bioaccumulation** – Radioactive substances build up in organisms, increasing risk over time.
4. **Health Impact** – Long-term ingestion can cause cancer or genetic damage due to internal exposure.
5. **Case Example** – Post-Chernobyl, contaminated dairy products were a key exposure route, especially in children.
6. **Control Measures** – Banning contaminated food, relocating livestock, and long-term monitoring of agricultural areas.

8.b) .ii) Three Approaches to Radioactive Waste Disposal with Real-World Examples:

1. **Near-Surface Disposal** – For low-level waste (LLW); stored in engineered trenches or concrete vaults.
   - *Example*: UK's Low-Level Waste Repository (LLWR) in Cumbria.
2. **Deep Geological Disposal** – High-level waste (HLW) buried deep in stable geological formations.
   - *Example*: Finland's Onkalo deep geological repository (first of its kind under construction).
3. **Interim Storage** – Temporarily holds waste until final disposal is ready or radioactivity decays.
   - *Example*: Dry cask storage of spent fuel in the U.S. near nuclear plants.