SRM Institute of Science and Technology

Faculty of Engineering and Technology

Continuous Learning Assessment - I (CLA I)

Subject: Waste to Wealth to Wheels (2 BT01061)

B.Tech - Computer Science and Engineering (Reg. 2021)

ANSWER ALL QUESTIONS

PART A - (5 x 10 = 50 Marks)

1. Municipal Solid Waste (MSW) Management Strategy for a Mid-Sized Indian City

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(a) Dominant Waste Categories & Causes:

- Food and Green Waste (Biodegradable): ~44% of total MSW.
- Paper, Plastics, and Recyclables: High due to rapid urbanization.

Causes:

* Rapid Urbanization - increases residential & commercial waste.
* Changing Lifestyle - packaging materials dominate.
* Economic Activity - diverse waste composition.

(b) Doorstep Segregation & Collection Scheme:

- Green Bin: Biodegradable waste.
- Blue/Yellow Bin: Recyclables.
- Red Bin: Toxic/Soiled waste.

Schedule: Daily (organic), Twice weekly (recyclables), Monthly (hazardous).

Incentive: "Waste to Wealth" app rewards users for segregation.

(c) Technology & Routing Tools:

1. Smart Bins with IoT sensors - track fill levels & prevent overflow.
2. Route Optimization Algorithm - suggests shortest collection path.

Benefits: Fuel savings, reduced GHG emissions, cleaner city.

2. Waste Management Hierarchy & Community Zero Waste Program

(a) Waste Management Hierarchy:

- Avoidance -> Reuse -> Recycle -> Recover -> Dispose.
- 4Rs: Reduce, Reuse, Recycle, Recover.

Limitations:

* Poor Source Segregation in Indian cities.
* High cost of Waste-to-Energy infrastructure.

(b) 6-Step Zero Waste Ward Program:

1. Mandatory 3-bin segregation.
2. Smart Collection Network.
3. Decentralized Composting.
4. Ward-level Material Recovery Facility (MRF).
5. Biogas plants for bulk organic generators.
6. Ban on open dumping/burning.

Outcomes: Lower GHG, better soil fertility, cleaner air/water.

3. Smart Bins & Biofuel Concepts

(a) Smart Bin Applications:

- IoT fill-level sensors -> prevents overflowing.
- Optimized routing -> reduces fuel/time.

Drawbacks:

* High installation cost.
* Maintenance/technical issues.

(b) Food vs Fuel vs Feed Dilemma:

- First-gen biofuels use food crops (corn, sugarcane, soy).
- Increases food prices & reduces food availability.

(c) Anaerobic Digestion (AD) Stages:

1. Hydrolysis -> organic matter -> soluble compounds.
2. Acidogenesis -> acids, alcohols.
3. Acetogenesis -> acetate + H_2 + CO_2.

4. Methanogenesis -> $CH_4 + CO_2$ (biogas).

4. Decentralized AD System for 300-Cattle Village

Feedstock: 300 cattle manure + water.

System: Anaerobic Digester producing:

- Biogas (CH_4) -> Cooking, lighting, pump power.
- Digestate -> Bio-manure (N, P, K enriched).

Outcome: Self-sufficient energy + organic fertilizer cycle.

5. Hydrogen as Future Fuel

(a) Fermentative vs Photosynthetic H_2 Production:

Feature	Fermentative	Photosynthetic
Mechanism	Organic fermentation	Light-driven (bio-photolysis)
Energy Source	Carbon-rich effluents	Light & water
Example	Clostridia beijerincki	Chlamydomonas reinhardtii
Yield	Low	High
Oxygen Req.	Anaerobic	Anaerobic/light required

(b) Chlamydomonas reinhardtii in Biohydrogen:

Advantages:

- Cheap & easy to culture.
- High hydrogen yield under anaerobic light.
- Amenable to genetic modification.

Limitations:

- Hydrogenase inhibited by oxygen.
- Requires constant light -> complex setup.

End of Paper.