

M. Tech. Food Technology and Bio-chemical Engineering 1st Yr 2nd Semester Exam 2025**Hazardous Waste Management**

Time: Three Hours

Full Marks: 100

Time: ~~Two hours~~/~~Three hours~~/~~Four hours~~/~~Six hours~~

(60 marks for this part)

Use a separate Answer-Script for each part

No. of Question	Part-I	Marks
<u>Answer Question-1 and any two from the rest</u>		
Q.1) a) b) c) d) e)	State the Faraday's Laws of Electrolysis. Deduce the expression for number of cells between the electrodes of an Electrodialysis unit. Deduce the necessary expression for estimating the bulk feed concentration (C_f) for " Ultrafiltration " process operating under semi-batch mode . Discuss with the help of pertinent reactions on the chemical oxidation of the following compounds by ozone. i) Sodium Cyanide ii) Acetaldehyde iii) Alcohols Differentiate between " Recalcitrance " and " Persistence ". What do you mean by concentration polarization in the context of ultrafiltration and how is it controlled?	(3+3) (6) (2+2+2) (5) (5)
Q.2) a)	An industrial effluent stream is to be treated by a reverse osmosis system. The effluent has a flow rate of 46 gal/min (1 gal= 3.79L) and a concentration of 4785 mg/L of NaCl. The characteristics feature of the membrane is as follows: i) Coefficient of Water Permeation (W_p)= 1.86×10^{-6} gm.mol/cm².sec.atm. ii) Area of the bundle=269 sq.ft iii) Recovery rate per pass = 50% iv) Optimal pressure differential across the membrane= 500 psi v) Osmotic pressure coefficient (Φ_c)= 0.92 vi) Rejection rate of the salt= 94% vii) Recovery rate required= 82% Determine the following: i) Osmotic pressure of the solution ii) Water flow through the membrane iii) Number of unit required for 80% and 50% recovery iv) The final product water quality and quantity.	(4+4+4+4)

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Form A: Paper –Setting Blank

Ref No.: Ex/PG/CE/T/1210C/2025

M.E. CIVIL ENGINEERING 1st YEAR 2nd SEMESTER EXAMINATION, 2025**(1st / 2nd Semester / Repeat/ Supplementary / Annual / Biannual)****SUBJECT: HAZARDOUS WASTE MANAGEMENT**

(Name in full)

Full Marks: 100Time: ~~Two hours/Three hours/Four hours/ Six hours-~~

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No. of Question	PART I	Marks															
Q.3) a)	<p>An electro dialysis unit is to be designed to treat electroplating waste having the following characteristics.</p> <p>i) Nickel concentration = 2.13% as NiSO₄ ii) Resistance through the unit= 10.4 ohm iii) Flow rate = 1877 m³/day iv) Current efficiency = 92%</p> <p>ii) Maximum CD/N ratio = 5781(A/m²) (gm-equivalent/L)</p> <p>iii) Membrane Area= 1.23 m²</p> <p>iv) Maximum permissible effluent Nickel concentration = 500 mg/L</p> <p>Determine the followings:</p> <p>i) Number of membrane required</p> <p>ii) Power required in KW</p>	(8+8)															
Q.4) a) b)	<p>What are the major drawbacks of Land Treatment process?</p> <p>Grab samples were taken from a test plot of 120ft* 60ft of a land farming site and analyzed for waste oil content on mass basis. The samples were reported to be collected from upper 5 inches of the zone of incorporation (ZOI) and the sampling occurred just over 375 days after initial application. The arithmetic mean value of waste oil content was observed as 12.55%. What are the half life and degradation rate constant for the waste oil? Assume a soil density of 93lb/ft³. The date of application and the amount of waste applied to the plot receiving the waste oil are shown below:</p> <table border="1"> <thead> <tr> <th>Time of application (days after initial application)</th> <th>Amount of Waste Oil applied (Tons)</th> <th>Waste Oil concentration of applied waste (%)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>22.5</td> <td>13.8</td> </tr> <tr> <td>102</td> <td>31.3</td> <td>14.1</td> </tr> <tr> <td>209</td> <td>29.2</td> <td>15.6</td> </tr> <tr> <td>311</td> <td>25.1</td> <td>16.4</td> </tr> </tbody> </table>	Time of application (days after initial application)	Amount of Waste Oil applied (Tons)	Waste Oil concentration of applied waste (%)	0	22.5	13.8	102	31.3	14.1	209	29.2	15.6	311	25.1	16.4	4 (6+6)
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(60 marks for Part I & 40 marks for Part II) Use separate Answer-Scripts for each part

Part-II**Answer Question No. 1 and any Two from the rest. Any relevant data may be assumed, if necessary.**

1. Answer following questions very briefly:

- a) Name the current Indian Hazardous Waste (HW) Management Rule.
- b) What is the least preferred option in Hazardous Waste Management Hierarchy?
- c) Give an example to show the difference between risk and hazard?
- d) What is the last step of risk assessment? e) What is fire point?
- f) Why is steel corrosion considered as a primary indicator of a HW?
- g) What is a reactive HW? h) How is toxicity and TCLP correlated?
- i) When is LC_{50} used instead of LD_{50} to identify a waste as toxic?
- j) Why is carcinogenicity not considered as a characteristic in defining HW?
- k) What is the full form of LD_{50} ?
- l) Mention four criteria used by the USEPA to define toxicity of a HW.
- m) Which one should be preferred among reuse, recovery, release & recycle of HW?
- n) Define 'storage' as per Indian HW Rule.
- o) Why is 'Basel Convention' so named? p) What is the threshold value of risk ratio?
- q) By which Ministry was HW Rules promulgated? r) Explain significance of Bio-concentration Factor.
- s) Why is 'potency factor' also called 'slope factor'?
- t) Draw a sketch to show threshold value of a chronic dose-response curve for a carcinogen? 1X20=20

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Part-II

2. a) When a substance which is not a liquid may be called 'ignitable'?
- b) When a waste may be termed as 'corrosive'?
- c) "TCLP of Arsenic is 5 mg/L"explain.
- d) Name two nephrotoxic metals. Why is benzene a hematotoxin?
- e) How to get LD50 of a chemical through toxicological study. 2 x 5 =10
3. a) Write a brief note on 'DWEL'.
- b) Compute the DWEL for methylene chloride.
- c) An evaluation of records for employees of a vinyl chloride manufacturing plant finds that out of 400 workers, 35 developed liver cancer. A control group consisting of individuals with smoking histories similar to the exposed workers and who were unlikely to have encounter vinyl chloride , had 27 with liver cancers and 505 who did not develop liver cancer. Find the relative risk and attributable risk. Comment on the results.

2+4+4=10

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4. Write short note about any **four** of the followings:

(i) RfD for non-carcinogenic effects (ii) mutagenesis (iii) contaminant degradation (iv) exposure

pathway (v) hazardous air pollutants (vi) risk characterization (vii) Transboundary movement of HW

2.5x4 = 10

Some of the following information may be needed:i) **Table A**

Chemical	PF(oral) (mg/kg-day) ⁻¹	PF(inhalation) (mg/kg-day) ⁻¹	Oral RfD (mg/kg-day)	BCF (L/kg)
Chloroform	6.1x10 ⁻³	8.1x10 ⁻²	0.010	3.75
Trichloroethylene (TCE)	1.1x10 ⁻²	1.3x10 ⁻²	0.0005	10.6
Tetrachloroethylene	5.1x10 ⁻²	1-3.3x10 ⁻³	0.10	31.0
Benzo(a)pyrene (BaP)	11.5	6.11	0.0002	-----
Methylene chloride	7.5x10 ⁻³	1.4x10 ⁻²	0.060	-----

ii) **Table B**

Exposure pathway	Daily Intake	exposure frequency (days/yr)	exposure Duration (yrs)	body wt. (kg)
Ingestion of potable water	2 L	350	30	70
Inhalation of contaminant	20 m ³	350	30	70
Consumption of fish	54 gm	350	30	70