GUJARAT TECHNOLOGICAL UNIVERSITY

[BE-7 SEMESTER] – OLD PAPER –S22 TO S26 – QUESTION BANK

Subject Name & Code: Advanced Wastewater Treatment Technologies- 3171309

Chapter 1: Overview of Advanced Wastewater Treatment

Repeated Questions:

1. Need and Applications of Advanced Wastewater Treatment:

- **Q.** Write the applications of advanced wastewater treatment for water/wastewater treatment. **(WINTER 2022, 4 Marks; SUMMER 2023, 3 Marks; WINTER 2024; SUMMER 2026, 4 Marks)**
- **Q.** Explain the need of advanced wastewater treatment technologies / write a note on need of advanced wastewater treatment / enlist advanced wastewater treatment with need of it. **(Base, 3 Marks; WINTER 2023, 3 Marks; WINTER 2024)**

2. Advanced vs Tertiary Treatment; Techniques and Unit Processes:

- **Q.** Explain the difference between 'Tertiary treatment' and 'Advanced wastewater treatment' with the help of a neat sketch / differentiate between advanced treatment and tertiary treatment for wastewater. [Diagram required – refer to the original question paper] **(SUMMER 2023, 4 Marks; SUMMER 2025, 7 Marks)**
- **Q.** List/name the techniques used for advanced wastewater treatment. **(SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks)**

Other Important Questions:

1. Need and Applications of Advanced Wastewater Treatment:

- **Q.** Enlist and explain under which circumstances advanced wastewater treatment becomes necessary. **(SUMMER 2025, 4 Marks)**

2. Advanced vs Tertiary Treatment; Techniques and Unit Processes:

- **Q.** Suggest the unit operation or processes for removal of following constituents of wastewater: suspended solids, organic matter, TOC, VOC. **(SUMMER 2025, 4 Marks)**
- **Q.** Prepare a list of unit processes and unit operations which fall under 'Advanced wastewater treatment' along with the purpose of each. **(SUMMER 2023, 7 Marks)**

Chapter 2: Nutrient Removal: Nitrogen & Phosphorus

Repeated Questions:

1. Need for Nutrient Removal; Sources and Forms of N and P:

- **Q.** Highlight the need for removal of nutrients from wastewater. **(WINTER 2023, 3 Marks; WINTER 2024; SUMMER 2025, 3 Marks)**
- **Q.** Explain different forms of phosphorus, along with their sources, which occur in the environment / enlist sources of phosphorus and mention forms in which phosphorus occurs. **(Base; WINTER 2022, 4 Marks; WINTER 2023; WINTER 2024; SUMMER 2025, 3 Marks; SUMMER 2026, 4 Marks)**

2. Phosphorus Removal (Chemical and Biological):

- **Q.** Enlist the methods for chemical precipitation of phosphorus and explain any one method with equation / chemical methods of phosphorus removal with equations and process configurations / chemical precipitation method with equations for each chemical and sketch of chemical addition points. [Diagram required – refer to the original question paper] **(Base OR; WINTER 2022, 3 Marks; WINTER 2023, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2025, 7 Marks; SUMMER 2026, 3 Marks)**
- **Q.** Write a note / explain biological process for phosphorus removal with figure / microbiology involved in biological phosphorus removal. [Diagram required – refer to the original question paper] **(Base, 3 Marks OR; SUMMER 2023, 4 Marks; SUMMER 2026, 7 Marks)**

3. Nitrogen Removal (Biological and Chemical):

- **Q.** Explain nitrification and denitrification with detailed chemistry/equations mentioning species of microorganisms involved / biological nitrogen removal with chemical reaction. **(Base, 7 Marks OR; WINTER 2022, 7 Marks; SUMMER 2023, 7 Marks; WINTER 2023, 7 Marks OR; SUMMER 2024, 7 Marks; SUMMER 2026, 7 Marks OR)**
- **Q.** Write a note on "air stripping" as chemical process for nitrogen removal from wastewater with neat sketch. [Diagram required – refer to the original question paper] **(Base; WINTER 2022, 7 Marks OR; WINTER 2024)**

Other Important Questions:

1. Need for Nutrient Removal; Sources and Forms of N and P:

- **Q.** Enlist the sources of nitrogen in wastewater. Mention the forms in which nitrogen occurs. **(WINTER 2022, 4 Marks OR)**

2. Phosphorus Removal (Chemical and Biological):

- **Q.** How can the principles of biological precipitation be applied to enhance phosphorus removal in wastewater treatment plants in India? Provide specific examples of biological processes and their effectiveness in phosphorus removal. **(WINTER 2025)**
- **Q.** Enlist the principal processes used for biological phosphorus removal. **(SUMMER 2024, 3 Marks)**

3. Nitrogen Removal (Biological and Chemical):

- **Q.** Enlist the different processes for biological nitrogen removal and explain any one in detail. **(SUMMER 2025, 7 Marks)**
- **Q.** Differentiate between nitrification and denitrification. **(SUMMER 2025, 4 Marks)**
- **Q.** Explain biological nitrification process including its process description, microbiology and environmental factors. **(SUMMER 2025, 7 Marks OR)**
- **Q.** What are the primary methods used for nitrogen removal in wastewater treatment plants in India? Explain briefly how each method works. **(WINTER 2025)**

- **Q.** Evaluate the effectiveness of simultaneous nitrification and denitrification (SND) compared to separate nitrification and denitrification processes for nitrogen removal. Discuss environmental and economic implications of implementing SND technology in Indian wastewater treatment plants. **(WINTER 2025)**
- **Q.** Give overview of biological nitrogen removal process. **(SUMMER 2024, 4 Marks)**

Chapter 3: Membrane Filtration

Repeated Questions:

1. Membrane Terms, Materials, Configurations and Characteristics:

- **Q.** Define the terms: permeate, reject/retentate, flux, transmembrane pressure, recovery, membrane fouling, influent. **(WINTER 2022, 3 Marks; SUMMER 2024, 7 Marks; SUMMER 2025, 3 Marks; SUMMER 2025, 3 Marks OR; SUMMER 2026, 3 Marks)**
- **Q.** Write a short note on membrane material. **(WINTER 2023, 4 Marks; SUMMER 2024, 4 Marks; SUMMER 2026, 4 Marks)**

2. RO, NF, UF, MF and Electrodialysis:

- **Q.** Explain the mechanism/concept of Reverse Osmosis and highlight advantages and disadvantages / summarize advantages and disadvantages of RO over nanofiltration / theory of RO. [Diagram required – refer to the original question paper] **(Base, 3 Marks; Base, 7 Marks OR; WINTER 2022, 7 Marks OR; SUMMER 2023, 4 Marks OR; WINTER 2023, 3 Marks OR; SUMMER 2024, 3 Marks OR; SUMMER 2025, 7 Marks OR)**
- **Q.** Enlist advantages and disadvantages of Ultrafiltration and Microfiltration / discuss application of MF and UF / advantages and disadvantages of UF and MF. **(Base, 7 Marks; WINTER 2022; SUMMER 2023, 3 Marks; SUMMER 2024, 7 Marks)**
- **Q.** Explain the process of electrodialysis with neat sketch; summarize its advantages and disadvantages. [Diagram required – refer to the original question paper] **(Base, 7 Marks; SUMMER 2023, 7 Marks)**

3. Membrane Fouling, Cleaning and Performance:

- **Q.** Explain the factors that reduce membrane performance. **(WINTER 2024; SUMMER 2026, 4 Marks)**
- **Q.** Write a note on membrane fouling / primary types of membrane fouling in MBRs and control / membrane fouling and cleaning by reverse flow and chemicals. **(WINTER 2023, 7 Marks; WINTER 2024; SUMMER 2025, 3 Marks; WINTER 2025; WINTER 2025 OR)**
- **Q.** With the help of neat sketches explain the procedure of membrane cleaning of MBR. [Diagram required – refer to the original question paper] **(Base, 7 Marks; SUMMER 2023, 4 Marks; WINTER 2023, 7 Marks; WINTER 2024 OR)**

4. Modes of Operation and Filtration Configurations:

- **Q.** Enlist and explain the modes of operation of membrane filtration / modes of operation in membrane filtration unit of MBR with neat sketches. [Diagram required – refer to the original question paper] **(WINTER 2022, 7 Marks; WINTER 2024; SUMMER 2025, 4 Marks)**
- **Q.** Differentiate between cross flow and dead end filtration process configuration. **(Base, 3 Marks; WINTER 2022, 3 Marks)**

5. Applications of Membrane Technologies:

- **Q.** Highlight and explain the application of membrane technologies in wastewater/water treatment. **(WINTER 2022, 7 Marks; WINTER 2023, 3 Marks OR; SUMMER 2025, 7 Marks OR)**

Other Important Questions:

1. Membrane Terms, Materials, Configurations and Characteristics:

- **Q.** Explain different types of micro porous membranes with figure. [Diagram required – refer to the original question paper] **(SUMMER 2023, 3 Marks)**
- **Q.** What is membrane fouling? Explain spiral wound membrane with figure. [Diagram required – refer to the original question paper] **(SUMMER 2023, 7 Marks OR)**
- **Q.** Enlist the various membrane configurations. **(WINTER 2023, 3 Marks)**

- **Q.** Prepare a table showing general characteristics of membrane process. [Diagram required – refer to the original question paper] **(WINTER 2023, 4 Marks)**
- **Q.** Compare Hollow fiber and plate & frame membrane. **(SUMMER 2024, 4 Marks OR)**

2. RO, NF, UF, MF and Electrodialysis:

- **Q.** Compare nano filtration and ultra filtration considering: membrane driving force, separation mechanism, pore size, operating range. **(SUMMER 2026, 4 Marks OR)**
- **Q.** Discuss the application of microfiltration, ultra-filtration and reverse osmosis. **(WINTER 2024 - second set)**

3. Modes of Operation and Filtration Configurations:

- **Q.** Discuss in detail with the sketch Hybrid membrane system. [Diagram required – refer to the original question paper] **(SUMMER 2025, 7 Marks)**

4. Applications of Membrane Technologies:

- **Q.** What are the primary membrane filtration processes used in wastewater treatment plants in India? Briefly explain the operation of each process. **(WINTER 2025)**
- **Q.** Analyze the potential environmental and economic benefits of implementing membrane filtration technology in wastewater treatment plants across India. Consider water reuse opportunities, energy consumption, operational costs, and impact on water quality in receiving bodies. **(WINTER 2025 OR)**

Chapter 4: Membrane Bioreactor (MBR)

Repeated Questions:

1. MBR – Concept, Configurations, Components and Advantages:

- **Q.** How does MBR process differ from conventional ASP? **(WINTER 2023, 4 Marks; WINTER 2024 - second set; SUMMER 2025, 4 Marks OR)**
- **Q.** Draw figure of two different configurations of Membrane bioreactor / external and internal MBR / external MBR and submerged MBR with figure. [Diagram required – refer to the original question paper] **(Base, 4 Marks; SUMMER 2023, 3 Marks OR; WINTER 2023, 4 Marks; SUMMER 2026, 7 Marks)**
- **Q.** Highlight and explain the advantages of Membrane bioreactor in wastewater treatment. **(Base; WINTER 2022 OR; SUMMER 2026, 3 Marks OR)**

2. MBR – Fouling, Cleaning and Modes of Operation:

- **Q.** How can membrane fouling be effectively controlled in membrane bioreactors (MBRs) / primary types of membrane fouling in MBR and control measures. **(WINTER 2024; WINTER 2025; WINTER 2025 OR)**

3. Anaerobic MBR and Comparison with Other Processes:

- **Q.** Write a short note: Anaerobic Membrane Bioreactors. **(WINTER 2024; SUMMER 2025, 4 Marks OR)**

Other Important Questions:

1. MBR – Concept, Configurations, Components and Advantages:

- **Q.** How can membrane bioreactors (MBRs) be applied to improve the efficiency of wastewater treatment in urban areas of India? Provide specific examples of MBR applications and their impact on water quality and public health. **(WINTER 2025)**
- **Q.** Draw a neat labeled diagram of MBR & explain the functions of following components of MBR: (a) Backpulse pump (b) Membrane air scour blowers (c) Permeate pump (d) Recirculation pump. [Diagram required – refer to the original question paper] **(SUMMER 2026, 7 Marks OR)**
- **Q.** With the help of a neat sketch explain the construction and working of 'Membrane Bioreactor'. [Diagram required – refer to the original question paper] **(SUMMER 2023, 7 Marks)**

2. MBR – Fouling, Cleaning and Modes of Operation:

- **Q.** Differentiate between: (i) Maintenance cleaning and Recovery cleaning. (ii) External MBR and Immersed MBR. **(SUMMER 2024, 7 Marks OR)**
- **Q.** Explain modes of operation of MBR. **(SUMMER 2024, 4 Marks)**

3. Anaerobic MBR and Comparison with Other Processes:

- **Q.** Compare and analyze the effectiveness of membrane bioreactors (MBRs) and electrochemical wastewater treatment processes in addressing water pollution challenges in India. Consider treatment efficiency, energy consumption, operational costs, and applicability to different types of wastewater. **(WINTER 2025)**

Chapter 5: Electrochemical Wastewater Treatment Processes

Repeated Questions:

1. Electro-coagulation:

- **Q.** Enlist the operating parameters to be maintained during electro-coagulation and explain any one/all in detail. **(Base, 3 Marks; WINTER 2022, 3 Marks OR; SUMMER 2023, 3 Marks OR; SUMMER 2024, 7 Marks; WINTER 2024, 7 Marks; SUMMER 2026, 3 Marks OR)**
- **Q.** Give difference between electro-coagulation and chemical coagulation / compare electro-coagulation and chemical coagulation process of wastewater treatment. **(Base, 4 Marks; WINTER 2022, 4 Marks OR; SUMMER 2023, 4 Marks OR; WINTER 2023, 7 Marks OR; SUMMER 2025, 7 Marks)**

2. Electro-oxidation and Electroflotation:

- **Q.** Explain the working principle of electro-oxidation process / draw neat sketch of Electro-oxidation process and explain working principle with chemical reaction. [Diagram required – refer to the original question paper] **(WINTER 2023, 4 Marks OR; WINTER 2025 OR; SUMMER 2026, 7 Marks OR)**
- **Q.** Explain the electroflotation process for removal of small size particles / working principle of electroflotation with equations / factors affecting electroflotation. **(WINTER 2023, 4 Marks; WINTER 2024, 3 Marks; WINTER 2024, 4 Marks; SUMMER 2026, 4 Marks OR)**

3. Electrochemical Processes – General, Electrodes and Applications:

- **Q.** Enlist/main types of electrochemical wastewater treatment processes and explain working principle, electrode materials, reaction chemistry, applications. **(SUMMER 2025, 3 Marks OR; WINTER 2025 OR)**

Other Important Questions:

1. Electro-coagulation:

- **Q.** What is the working principle of electro-coagulation in wastewater treatment? **(WINTER 2025)**

2. Electro-oxidation and Electroflotation:

- **Q.** Enlist three different types of electro-oxidation mechanism and explain them in brief. **(WINTER 2022, 7 Marks OR)**

3. Electrochemical Processes – General, Electrodes and Applications:

- **Q.** Analyze the potential applications of electrochemical wastewater treatment processes in addressing water pollution challenges in urban areas of India. Discuss effectiveness of electro-coagulation, electro-floatation, and electro-oxidation considering treatment efficiency, energy consumption, operational costs, and environmental impact. **(WINTER 2025)**
- **Q.** How can electrochemical wastewater treatment processes, such as electro-coagulation and electro-oxidation, be applied to address water pollution challenges in industrial areas of India? Provide specific examples and effectiveness in removing pollutants. **(WINTER 2025)**
- **Q.** Compare and analyze the effectiveness of electrochemical wastewater treatment processes (electro-coagulation, electro-flotation, electro-oxidation) with advanced oxidation processes (AOPs), including ozone-based and non-ozone-based processes, Fenton and photo-Fenton oxidation, and solar photo-catalytic treatment systems. Consider treatment efficiency, energy consumption, operational costs, and suitability for different types of wastewater. **(WINTER 2025)**
- **Q.** Evaluate the potential applications of electrochemical wastewater treatment processes and advanced oxidation processes (AOPs) in specific industrial sectors in India, such as textiles, pharmaceuticals, and chemicals. Consider treatment efficiency, cost-effectiveness, environmental impact, and regulatory compliance. **(WINTER 2025 OR)**
- **Q.** What factors to be considered while selecting electrode material? **(WINTER 2023, 3 Marks OR)**

- **Q.** Discuss in brief theory of Electrolysis. **(SUMMER 2024, 3 Marks)**

Chapter 6: Advanced Oxidation Processes (AOPs)

Repeated Questions:

1. AOPs – Classification, Applications and Hydroxyl Radicals:

- **Q.** Enlist the advanced oxidation processes for wastewater treatment / detailed classification of AOP / applications of AOP / AOPs for persistent organic pollutants. **(Base, 3 Marks; WINTER 2023, 7 Marks; SUMMER 2024, 3 Marks; SUMMER 2025, 3 Marks; WINTER 2025 OR)**

2. Ozone and Hydrogen Peroxide Based AOPs:

- **Q.** Explain advantages and disadvantages of Advanced oxidation process which use combination of hydrogen peroxide and ozone. **(Base, 3 Marks - second set; SUMMER 2023, 7 Marks OR; SUMMER 2024, 3 Marks OR)**

3. Fenton and Photo-Fenton Processes:

- **Q.** Explain Fenton process in detail / Fenton's process for wastewater treatment along with equations / Fenton oxidation process for removal of refractory organics / prepare operating parameters and state Fenton's process reactions. **(WINTER 2022, 7 Marks OR; SUMMER 2024, 7 Marks OR; WINTER 2024; SUMMER 2026, 7 Marks)**

Other Important Questions:

1. AOPs – Classification, Applications and Hydroxyl Radicals:

- **Q.** Enlist photochemical advanced oxidation processes. Explain any one in brief. **(WINTER 2022, 4 Marks OR)**
- **Q.** What are refractory organics? Enlist the technologies for treatment of refractory organics. **(SUMMER 2025, 4 Marks OR)**
- **Q.** Discuss the technologies used to produce Hydroxyl (HO•) radical. **(SUMMER 2024, 4 Marks)**

2. Ozone and Hydrogen Peroxide Based AOPs:

- **Q.** Explain the AOP in which ozone is used at elevated pH along with equation. **(WINTER 2022, 3 Marks OR)**

3. Fenton and Photo-Fenton Processes:

- **Q.** Draw a flow diagram with units in Fenton's treatment process as polishing treatment for wastewater. List the units required for Fenton's treatment. Explain the process in brief. [Diagram required – refer to the original question paper] **(SUMMER 2026, 4 Marks OR)**
- **Q.** Explain the photo Fenton process with equations. Highlight advantages and disadvantages of photo Fenton process over Fenton process. **(SUMMER 2023, 7 Marks OR)**

Chapter 7: Adsorption

Repeated Questions:

1. Adsorption – Definitions, Mechanism and Isotherms:

- **Q.** Define the terms: adsorption, adsorbate and adsorbent / define adsorption and adsorption capacity and write equation to find adsorption capacity. **(Base, 4 Marks; WINTER 2022, 3 Marks; WINTER 2023, 3 Marks)**
- **Q.** Explain the mechanism of adsorption with a neat sketch. [Diagram required – refer to the original question paper] **(WINTER 2022, 4 Marks; WINTER 2023, 4 Marks OR; WINTER 2024, 3 Marks OR; SUMMER 2025, 4 Marks; SUMMER 2026, 4 Marks)**
- **Q.** Explain the Langmuir and Freundlich isotherm along with assumptions. **(WINTER 2022, 7 Marks; WINTER 2023, 7 Marks OR; WINTER 2024, 4 Marks OR)**

2. Adsorption Isotherms – Numerical Problems:

- **Q.** The following laboratory data were collected in batch adsorption study. Plot the data according to Langmuir isotherm and determine the values of constants a and b. A volume of 500 ml is placed in each flask and wastewater has initial COD 100 mg/L. [Diagram required – refer to the original question paper] **(WINTER 2024 - second set; SUMMER 2026, 7 Marks)**

3. Adsorbents and Activated Carbon:

- **Q.** List the characteristics of good adsorbent. **(SUMMER 2023, 3 Marks OR; SUMMER 2026, 3 Marks)**
- **Q.** List the adsorbents and mention their application in wastewater treatment / name widely used adsorbents / list adsorbents and applications. **(SUMMER 2023, 4 Marks OR; SUMMER 2025, 3 Marks OR; SUMMER 2026, 3 Marks)**
- **Q.** Explain in detail activated carbon adsorption kinetics. **(SUMMER 2024, 7 Marks; SUMMER 2025, 7 Marks)**
- **Q.** Describe the process of regeneration and reactivation of activated carbon. **(Base, 7 Marks; WINTER 2023, 7 Marks)**
- **Q.** What is mass transfer zone? Explain with figure. [Diagram required – refer to the original question paper] **(Base, 4 Marks; SUMMER 2024, 3 Marks OR)**

Other Important Questions:

1. Adsorption – Definitions, Mechanism and Isotherms:

- **Q.** Highlight the importance of Adsorption Isotherms stating their applications. **(SUMMER 2023, 4 Marks)**
- **Q.** What is the fundamental principle behind adsorption processes in wastewater treatment? **(WINTER 2025 OR)**

2. Adsorption Isotherms – Numerical Problems:

- **Q.** A wastewater containing Co = 25 mg/L of phenol is to be treated using PAC to produce effluent concentration Ce = 0.1 mg/L. The constants for Langmuir isotherm are to be determined using results given below. The volume of waste in each beaker is 1 L. If the flow rate of 0.11 m^3/s is to be treated, calculate the quantity of PAC needed per day. [Diagram required – refer to the original question paper] **(WINTER 2024)**
- **Q.** An adsorption study is set up in laboratory by adding a known amount of activated carbon to six flasks which contain 200 mL of an industrial waste. An additional flask containing 200 mL of waste but no carbon is run as a blank. Plot the Langmuir isotherm and determine the values of the constants. [Diagram required – refer to the original question paper] **(Base, 7 Marks)**

3. Adsorbents and Activated Carbon:

- **Q.** Explain the treatment process of wastewater with powdered activated carbon. **(WINTER 2022, 3 Marks)**
- **Q.** Explain the process of manufacturing Activated carbon. **(Base, 4 Marks)**
- **Q.** Define: Bed life, Carbon usage rate, EBCT. **(SUMMER 2024, 4 Marks OR)**

4. Adsorption – Applications in Indian Industry and Comparison with Ion Exchange:

- **Q.** Compare the efficiency of adsorption and ion exchange processes in removing heavy metals from industrial wastewater in India. **(WINTER 2025)**
- **Q.** How can the principles of adsorption be applied to effectively remove organic chemicals from industrial wastewater in India? Provide examples of suitable adsorbents and discuss their application in wastewater treatment. **(WINTER 2025)**
- **Q.** Evaluate the applications of adsorption and ion exchange processes in the removal of heavy metals, nitrogen, phosphorus, and organic chemicals from wastewater in industrial settings in India. Discuss suitability of different adsorbents and ion exchange resins, regeneration/reactivation methods, and effectiveness in meeting regulatory standards. **(WINTER 2025)**
- **Q.** Evaluate the application of adsorption and ion exchange processes in addressing specific water pollution challenges in the textile industry in India. Discuss suitability of different adsorbents and ion exchange resins, regeneration/reactivation methods, and effectiveness in meeting regulatory standards and promoting environmental sustainability. **(WINTER 2025 OR)**

Chapter 8: Ion Exchange

Repeated Questions:

1. Ion Exchange – Principle, Mechanism and Resins:

- **Q.** Enlist the types of Ion exchange resins / types of synthetic ion-exchange resin / list resins used in ion exchange process and explain applications. **(SUMMER 2024, 4 Marks; WINTER 2024, 3 Marks; SUMMER 2026, 3 Marks)**

2. Resin Regeneration and Applications:

- **Q.** Explain the process of resin regeneration / with neat diagram explain resin regeneration in ion exchange process. [Diagram required – refer to the original question paper] **(SUMMER 2023, 3 Marks; WINTER 2024, 4 Marks; SUMMER 2026, 3 Marks OR)**
- **Q.** Highlight applications of ion-exchange process in wastewater treatment / explain in brief ion-exchange process applications / enlist and explain concept of ion exchange and applications. **(Base, 4 Marks; WINTER 2022, 4 Marks; SUMMER 2023, 7 Marks OR; WINTER 2023, 7 Marks OR)**

Other Important Questions:

1. Ion Exchange – Principle, Mechanism and Resins:

- **Q.** Explain the basic mechanism of cation and anion exchangers along with chemical reactions involved. **(SUMMER 2026, 7 Marks)**
- **Q.** Explain the factors affecting ion-exchange process. **(SUMMER 2023, 3 Marks)**
- **Q.** Explain the principle involved in ion exchange process with neat sketch. [Diagram required – refer to the original question paper] **(WINTER 2022, 4 Marks)**
- **Q.** Write down all important ion exchange reactions for synthetic resin. **(WINTER 2023, 4 Marks OR)**
- **Q.** Explain the working principle of ion exchange processes in wastewater treatment. **(WINTER 2025)**
- **Q.** Explain the concept of ion exchange in wastewater treatment. How does ion exchange resin selectively remove contaminants from wastewater? **(WINTER 2025 OR)**

2. Water Softening and Zeolite:

- **Q.** Write a short note on ‘Water Softening’. Enlist and explain the different types of softening processes. **(SUMMER 2023, 7 Marks)**
- **Q.** Explain the mechanism involved in the softening of non carbonate hardness of magnesium. **(WINTER 2024, 7 Marks OR)**
- **Q.** Draw flow diagram for removal of ammonia by zeolite. [Diagram required – refer to the original question paper] **(SUMMER 2024, 3 Marks)**

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