ADVANCED ENVIRONMENTAL BIOTECHNOLOGY
(BTC5142)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Pyrethrin is obtained from
(a) *Azadirachta indica* (b) *Utricia dioca*
(c) *Tagetus erecta* (d) *Chrysanthemum cinerariofolium*

(ii) DDT belongs to the group of
(a) Organochlrine pesticides (b) Organophosphate presticides
(c) Carbamte (d) Pyrethroid

(iii) *Nitrosomonas* bacteria converts
(a) NH^{4+} to NO_2^- (b) NO_2^- to NO_3^-
(c) NH^{4+} to NO_3^- (d) None of the above

(iv) Bioaugmentation means
(a) Addition of nutrients to facilitate degradation of organic pollutants
(b) Addition of microorganisms to facilitate degradation of organic pollutants
(c) Natural degradation of organic pollutants
(d) Environmental degradation of organic pollutants

(v) Ex situ bioremediation involves
(a) Degradation of organic compounds by bacteria on the site
(b) Removal of polluted soil, collection at a place and degradation by bacteria
(c) Degradation of pollutants by genetically modified organisms
(d) Degradation of pollutants by chemical processes

(vi) Biostimulation is
(a) Addition of nutrients in a contaminated soil for bioremediation
(b) Addition of bacteria in a contaminated soil for bioremediation
(c) Natural degradation of pollutants
(d) Addition of bacteria in bioreactos

(vii) Ethanol production by alcoholic fermentation is facilitated by
(a) *Saccharomyces cerevisiae* (b) *Aspergilus niger*
(c) *E. coli* (d) *Acidithiobacillus ferrooxidans*

(viii) The process of collection of volatile component to condense them to produce a liquid fuel or bio-oil is called……..
(a) Solvolysis (b) Pyrolysis
(c) Composting (d) Liquefaction

(ix) In sanitary landfill technique the biological activity occurs in the following order:
(a) aerobic, methanogenic, anaerobic (b) aerobic, anaerobic, methanogenic
(c) methanogenic, anaerobic, aerobic (d) methanogenic, aerobic, anaerobic

(x) The micro-organism NOT used in bioleaching of minerals is
(a) *Acidithiobacillus thiooxidans* (b) *Acidithiobacillus ferrooxidans*
(c) *Desulfovibrio* (d) *Bacillus subtilis*

Fill in the blanks with the correct word

(xi) Full form of SOD is _____

(xii) The protein metallothionein contains repeatitive units of _____

(xiii) Oil paints contain salts of _____

(xiv) Example of a diversity index is _____

(xv) Pathological waste is a type of _____

Group - B

2. (a) Discuss the mechanism of action of the xenobiotic compounds.
[(CO1)(Understand/IOCQ)]

(b) Carbohydrate and proteins are large and complicated compounds compared to phenol. However, almost all bacteria can degrade carbohydrates and proteins but a relatively few bacteria can degrade phenol. Comment on the given statement
[(CO1)(Comment/HOCQ)]

8 + 4 = 12

3. Study the following case of mercury pollution and answer the questions.
The Chisso Company opened a chemical factory in 1908. Initially it produced fertilizers. Gradually it started production of acetylene, acetaldehyde, acetic acid and vinyl chloride among others. This factory became the most advanced factory in Japan, both before and after the World War II. The waste products resulting from the manufacture of the chemicals were released into Minamata Bay in the factory wastewater. Fisheries were damaged due to this disposal in terms of reduced catches. The Chisso Minamata factory started acetaldehyde production in 1932, producing 210 tons that year. By 1951, production had jumped to 6000 tons per year over 50% of Japan's total output. Acetaldehyde production needs HgCl2 as a catalyst.
On April 21, 1956, a five-year old girl was examined at the Chisso Corporation's factory hospital in Minamata. The physicians were puzzled by her symptoms: difficulty in walking, difficulty in speaking and convulsions. Two days later her younger sister began

to show the same symptoms. Their mother informed doctors that her neighbour's daughter was also experiencing the same symptoms. After a house-to-house investigation, eight further patients were discovered and hospitalized. On May 1, the hospital director reported the discovery of an 'epidemic of an unknown disease of the central nervous system.

After a long study of 3 years, British neurologist Douglas McAlpine suggested that Minamata symptoms resembled those of organic mercury poisoning.

(i) What do you mean by organic mercury? *[(CO1)(Remember/LOCQ)]*

(ii) The patients seem to have consumed mercury. Suggest possible sources for their mercury consumption. *[(CO1)(Comprehend/IOCQ)]*

(iii) The patients showed difficulty in movement and blurred speech. Suggest the mechanistic pathway for mercury toxicity causing these symptoms. *[(CO1)(Understand/IOCQ)]*

(iv) The Chisso Company released Hg (II). But the patients showed symptoms of organic mercury. How will you correlate the release of Hg (II) and presence of organic mercury? *[(CO1)(Correlate/HOCQ)]*

(2 + 2 + 4 + 4) = 12

Group - C

4. A cellulose acetate membrane with an area of 4.0 $x10^{-3}$ m^2 is used at 25°C to determine the permeability constants for reverse osmosis of a feed salt solution containing 12kg/m^3(ρ=1005.5 kg/m^3). The product solution has a concentration of 0.468kg NaCl/m^3(ρ=997.3kg/m^3). The measured product flow rate is 3.84X$10^{-8}$$m^3$/s and the pressure difference used is 56 atm. Calculate the permeability constants and the solute rejection R when π=9atm. *[(CO2)(Analyse, Compute/IOCQ)]*

12

5. Compare all the four different solid waste disposal methods and conclude which method in your opinion is the best. Justify your choice. *[(CO2, CO3)(Compare/HOCQ)]*

(7 + 5) = 12

Group - D

6. (a) Discuss the ortho-cleavage pathway for degradation of phenol. *[(CO4)(Remember/LOCQ)]*

(b) A group of researchers developed a bacterial consortium for phenol degradation. While studying phenol degradation in a continuous reactor, they found that rate of phenol degradation increases with increase in the rate of air flow. Give reason behind the observation. *[(CO4)(Reasoning/HOCQ)]*

(c) Discuss the advantages of in situ bioremediation over the ex situ process. *[(CO4)(Understand/IOCQ)]*

4 + 4 + 4 = 12

7. (a) Exxon Valdez oil spill took place on March 24, 1989. It was one of the biggest oil spills where 42 million litre crude oil spread like a surface slick. Both Exxon and EPA suggested bioremediation. Discuss how the oil spill was treated by bioremediation. *[(CO4)(Application/HOCQ)]*

(b) State how Exxon Valdez oil spill differed from the BP Deepwater Horizon oil spill. *[(CO4)(Understand/IOCQ)]*

(c) In both Exxon Valdez oil spill and BP Deepwater Horizon oil spill, consortium of bacteria were used instead of a pure strain. Explain why consortium is more effective in such cases. *[(CO4)(Explain/IOCQ)]*

6 + 3 + 3 = 12

Group - E

8. (a) What is anaerobic digestion? Describe the process of biogas production by anaerobic digestion. *[(CO6)(Calculate/IOCQ)]*

(b) What is bioenergy? Can it be termed as renewable energy? Justify your answer. *[(CO6)(Remember/LOCQ)]*

(2 + 6) + (1 + 1 + 2) = 12

9. Garden A was sampled and the following specimens were collected.

order	description	Number of individuals (n)
Orthoptera(grasshopper)	brown with red legs	12
Orthoptera (grasshopper)	green with a yellow stripe	10
Lepidoptera (butterfly)	large, yellow	2
Lepidoptera (butterfly)	small, yellow	6
Coleoptera (beetle)	red and blue	24

These are the specimens collected from Garden B.

order	description	Number of individuals (n)
Hymenoptera (wasp)	black	36
Hymenoptera (wasp)	purple	42
Hymenoptera (bee)	striped	10
Orthoptera (grasshopper)	brown with red legs	50
Orthoptera (grasshopper)	green with a yellow stripe	4
Lepidoptera (butterfly)	large, yellow	34
Lepidoptera (butterfly)	Small, yellow	18

Infer statistically which garden is more diverse? *[(CO5)(Apply/HOCQ)]*

12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	9.6	42.24	40.32