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B.Sc. Engg. (CEE)/ 2th Sem.

24 May 2024
10:00 A.M to 01:00 P.M

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination — **Summer Semester: 2022 - 2023**
Course No.: GS 4253 — **Full Marks: 150**
Course Title: Ecology and Environment — **Time: 3 Hours**

There are **6 (Six)** questions. **Answer all the questions**. Programmable calculators are not allowed. Do not write on this question paper. The figures in the right margin indicate full marks and corresponding CO and PO. Symbols convey their usual meanings. Assume reasonable data/values for any missing data/info.

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1. Boga Lake in Rangamati, Bangladesh, presents a fascinating ecological tapestry, starting at the organism level with endemic species like the Boga Lake frog. At the community level, diverse aquatic and terrestrial flora and fauna coexist, adapting to the unique geological and hydrological conditions. The ecosystem level encompasses the interaction between these biotic communities and the abiotic environment, creating a dynamic, interdependent system within this high-altitude lake.

(a) Describe the different levels of ecology present in a lake, with an example. (CO1:PO1:7)

(b) Describe the different ecological components in the food web of Boga Lake with a figure. Find out the amount of energy at the trophic level if the energy at the producer level is 5252 kcal. (CO1:PO1:6)

(c) Describe the different services provided by the lake ecology. What is an incomplete ecosystem and give an example of it based on lake ecology? (CO1:PO1:6)

(d) Describe the carbon and water cycle of Boga Lake, with a figure. (CO1:PO1:6)

2. The Sylhet haor's fauna features the rare Bengal Florican, the abundant Hilsa fish dominant in the aquatic ecosystem, and the Common Frog, critical for its frequency and biomass, all underlining the area's rich biodiversity as detailed in the given table.

Species	Bengal Florican		Hilsa		Frog	
Field	1	2	1	2	1	2
Total Individual Count	50	38	200	150	175	150
Mass (kg)	65	42	35	26	55	43
Area covered (km)	35	25	40	35	40	25

(a) Compute the density (in m^2), coverage, biomass, Simpson's diversity index. Explain the species richness and evenness of the Sylhet haor's fauna. (CO3:PO2:10)

(b) Discuss the difference between belt and line transect methods on the basis of sampling the fauna of Sylhet haor. (CO2:PO2:6)

(c) What is biomass? How can the mentioned fauna of Sylhet haor be measured? Explain the difference between upright and inverted biomass pyramids. (CO2:PO2:6)

(d) Discuss the concept of ecological competition among the fauna of Sylhet haor. (CO2:PO2:3)

3. (a) Based on the energy flow diagram of Figure 01, compute the value of productivity at trophic level n, P_n and Ecological efficiency where the following information are provided: Exploitation efficiency = 30%, Assimilation efficiency = 45%, Production efficiency = 30% & P_{n-1} = 1000 J. (CO3:PO2:10)

Also, quantify the following inputs of Figure 1 : Ingestion (I), Assimilation (A), Waste (W) and Respiration (R)

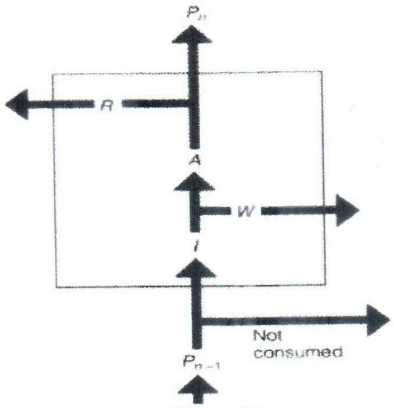

Figure 01

(b) In Dhaka's Buriganga River, ecological competition is intense among species due to pollution and overfishing, leading to a struggle for survival and dominance among aquatic organisms. This competition impacts biodiversity, affecting the river's ecological health and species sustainability. What is the difference between interspecific and intraspecific competition? Give an example of it from the Buriganga River. (CO2:PO2:5)

(c) An ecological footprint quantifies the land and water area needed to support human activities by measuring resource consumption and waste assimilation. It includes the carbon footprint, which focuses on greenhouse gas emissions, highlighting areas for potential environmental impact reduction through sustainable practices. What is the difference between an ecological and a carbon footprint? What measures can be taken to mitigate these footprints? (CO4:PO2:5)

(d) In Bhola district, southern Bangladesh, dynamic riverine and coastal landscapes catalyze ecological succession. Initially, pioneer species such as Porteresia coarctata (rice grass) rapidly colonize newly emerged fluvial deposits, stabilizing the substrate and facilitating further sediment accretion. Within three years, Sesbania sesban (shrub), adapted to thrive in nascent soils, supplants the pioneers, forming dense thickets and increasing the area's floral density. As the land matures and edaphic conditions evolve, Hibiscus tiliaceus (flowering tree), a halophyte, emerges, significantly altering the habitat structure and reducing insolation to the understory. This alteration allows mangrove species like Avicennia alba to establish, enhancing the ecosystem's structural diversity. Over time, climbing plant species such as Entada phaseoloides integrate into the dense arboreal layers, marking a mature succession stage and contributing to the region's rich biodiversity. Analyze the ecological succession pathway identifying the successional stages for the given case study. (CO4:PO2:5)

4. (a) Natural resources encompass the Earth's organic and inorganic materials essential for human survival and economic activity, such as minerals, forests, and water. The environment, consisting of these resources and the ecosystems they support, requires sustainable management to mitigate degradation and ensure long-term ecological health. What are the four major domains of Earth? What are the natural resources we can obtain from each domain? (CO1:PO1:6)

(b) Write 5 examples of renewable energy sources. Why are these resources said to behave like non-renewable resources despite being renewable by origin? (CO1:PO1:6)

(c) What is the role of an individual in the conservation of natural resources? Illustrate the ways of achieving sustainable lifestyles. (CO4:PO2:5)

(d) Write a short note on (I) Short Lived Climate Pollutants (SLCP) and (II) (CO2:PO2:8)

Biomagnification.

5. Air pollution remains a critical concern in Dhaka, consistently ranked among the most polluted cities globally. In Dhaka, vehicle emissions, particularly from diesel engines, along with dust from construction and road surfaces, brick kiln operations, and industrial discharges, significantly degrade air quality. The volume and variety of pollutants from these sources continue to rise alarmingly, exacerbating the environmental challenges faced by Bangladesh's capital.

(a) Define 'Criteria Pollutants'. Mention the name of the criteria air pollutants that you think are responsible for the above-mentioned pollution. (CO2:PO2:5)

(b) The National Ambient Air Quality Standards (NAAQS) for fine particulate matter (PM2.5) in Bangladesh is 65 microgram (μg) per cubic meter for 24-hour on average. Centre for Atmospheric Pollution Studies in its survey found that the presence PM2.5 in the country in 2021 was 102.41 microgram per cubic meter on average. The highest concentration was found in the district of Gazipur where PM2.5 was 263.51 μg/m3. (The Financial Express, February 03, 2022). (CO4:PO2:10)
Analyze the air quality situation on the basis of Appendix 1 and recommend some engineering controls.

(c) On a particular day in Dhaka city, the following air quality data have been recorded at a monitoring station: (CO3:PO2:10)
PM2.5 = 190 μg/m3 (24-hr); PM10 = 375 μg/m3 (24-hr); O3 = 0.09 ppm (8-hr); CO = 12.75 ppm (8-hr); NO2 = 1.55 ppm (Annual).
Compute AQI along with category descriptor according to USEPA using Appendix 1. Also, identify the critical pollutant and report on its adverse health effects mentioning its specific sensitive group.

6. Recent climate change trends show an accelerated warming of the planet, evidenced by rising global temperatures, shrinking ice caps, and increasingly frequent and severe weather events. These changes are largely driven by human activities, notably the emission of greenhouse gases from fossil fuel combustion, deforestation, and industrial processes. Moreover, organic water pollution primarily results from the discharge of untreated or inadequately treated wastewater from agricultural, industrial, and residential sources, leading to the degradation of water bodies and harm to aquatic life. Photochemical smog generation occurs when sunlight reacts with pollutants like nitrogen oxides and volatile organic compounds in the atmosphere, resulting in harmful ground-level ozone and fine particulate matter that affect air quality and human health.

(a) What is the 'Natural Greenhouse Effect'? Describe the consequences of climate change and mitigating measure to reduce it. (CO2:PO2:8)

(b) Describe Ozone Layer Depletion with a figure. Analyze the climate event with a figure that occurs every 3-8 years in South America and some parts of the US, which faces increased precipitation and flooding while Australia and Indonesia face drought. (CO4:PO2:8)

(c) Distinguish between BOD and COD. Draw a typical BOD curve and state the reasons behind a jump in this curve. (CO2:PO2:5)

(d) Describe the process of photochemical smog generation with reactions and show the cyclic reaction sequence. (CO2:PO2:4)

Appendix 1

Breakpoints							AQI
O_3 (ppm) 8 hr	O_3 (ppm) 1 hr	$PM_{2.5}$ ($\mu g/m^3$) 24 hr	PM_{10} ($\mu g/m^3$) 24 hr	CO (ppm) 8 hr	SO_2 (ppm) 24 hr	NO_2 (ppm) Annual	
0.000-0.064	--	0-15.4	0-54	0.0-4.4	0.000-0.034	(ii)	0-50
0.065-0.084	--	15.5-40.4	55-154	4.5-9.4	0.035-0.144	(ii)	51-100
0.085-0.104	0.125-0.164	40.5-65.4	`155-254	9.5-12.4	0.145-0.224	(ii)	101-150
0.105-0.124	0.165-0.204	65.5-150.4	255-354	12.5-15.4	0.225-0.304	(ii)	151-200
0.125-0.174	0.205-0.404	150.5-250.4	355-424	15.5-30.4	0.305-0.604	0.65-1.24	201-300
(iii)	0.405-0.504	250.5-350.4	425-504	30.5-40.4	0.605-0.804	1.25-1.64	301-400
(iii)	0.505-0.604	350.5-500.4	505-604	40.5-50.4	0.805-1.004	1.65-2.04	401-500

i) In some cases, in addition to calculating the 8-hr ozone index, the 1-hr ozone index may be calculated, and the maximum of the two values reported.

ii) NO_2 has no short-term air quality standard and can only generate an AQI value above 200.

iii) 8-hr Ozone values do not define higher AQI (>= 301), AQI values of 301 or higher are calculated with 1-hr O_3 concentrations.