ALILING, MARY MADELYN J. T09-A

ENVIRONMENTAL ENGINEERING

WEEK 1 PROGRESS CHECK

Essay (5 points each)

1. **Define Environmental Science**
   - **The concept of environmental science deals with, how our natural world works and how it affects human activities on it. It explores how plants, animals, and ecosystems interrelate and depend on each other for survival. In this field where scientist investigate issues such as pollution, climate change, and biodiversity loss to examine or understand their cause and find ways to solve it. They also analyze data, conduct experiments, and develop strategies to protect and conserve our environment for future generations. Hence, Environmental Science aids us to understand the environment, identify environmental problems, and work towards a sustainable and healthier planet.**
2. **Define Environmental Engineering**
   - **What I have comprehend about Environmental Engineering is that it is a branch of engineering that deals with solving environmental problems. Environmental Engineering consists of designing and implementing ways or solutions to solve issues such as pollution, waste management, and the conservation of our resources. Environmental Engineers tasks is to ensure that our surroundings, air, water, and soil are clean and safe for humans and other living beings. They develop and implement plan to decrease the pollution and introduce sustainability. Moreover, Environmental Engineering is about finding practical and sustainable solutions to protect and improve our environment for healthier and more sustainable future.**

3. **Differentiate Environmental science and Environmental engineering**
    - **Both areas of study share some basic similarities because they are concerned with the natural environment and its relationship with human world. In simple difference, environmental science studies natural world and human interaction with it. It seeks to understand the complex relationships between living organisms, ecosystems, and physical environments, whereas environmental engineering applies scientific and engineering principles to address environmental challenges. Engineers design and implement ways to save and improve the environment, they work on projects related to water and air pollution control, waste management, environmental impact assessment, and sustainable infrastructure development.**
4. **Define Ecosystem**
    - **Like a huge, interconnected community where various plants, animals, and other living things all live together in a specific area. Ecosystem is a similar to a big web where everything is connected. Each living thing in the ecosystem depends on other living things for survival, like plants providing food for animals. Ecosystem also includes non-living things like water, soil, and sunlight that all play role in supporting life. Harmful effects to our ecosystem can affect everything such as pollution harms the water that can lead animals and plants to a serious ailment. Therefore, ecosystem is a complex and delicate balance of living and non-living things that all rely on each other to keep everything working smoothly.**
5. **Define Biodiversity**
    - **Refers to the variety of living organisms found on the Earth. It includes all the different species of plants, animals, and microorganisms, as well as the genetic diversity within each species. Biodiversity is important because it gives us with essential resources like food, medicine, and clean air and water. It plays an imperative role in keeping the balance of ecosystems and contributes their stability and resilience. In preserving our biodiversity is taking actions to protect and conserve the different species and habitats to make sure that we have a healthy and thriving natural world for the future generations.**

6. **Differentiate Intrinsic ecosystem value vs. value to humans**

- **Intrinsic ecosystem value recognizes the inherent worth of ecosystems and their components, regardless of their usefulness to humans. It acknowledges the inherent rights of ecosystems to exist and thrive independently. On the other hand, the value of ecosystems to humans refers to the benefits and services they provide, such as food, water, and climate regulation, which are vital for human well-being. This utilitarian perspective focuses on the tangible benefits that humans derive from ecosystems. Both intrinsic and human-centric values are important in understanding and protecting ecosystems, as they provide different perspectives on their significance and contribute to conservation efforts.**

7. **Discuss biotic and abiotic**

- **In my own comprehension about the biotic and abiotic. Biotic define as all living things or organisms in an ecosystem where it includes plants, animals, insects, bacteria and fungi. Biotic factors are the living components that interact with each other and with non-living (abiotic) components of their environment. For instance, the process of photosynthesis where plants convert sunlight into energy, animals eat plants or other animals for food, and microorganisms help break down deceased organic matter. This factor is crucial for maintaining the balance and functioning of ecosystems, as they play their parts in nutrient cycling, energy transfer, and overall ecosystem health. On the other hand, abiotic define as a non-living things or factors in an ecosystem. It involves elements such as water, sunlight, temperature, soil, and rocks. These abiotic factors influence the physical environment and provide the necessary conditions for life to exist. For instance, sunlight provides energy for photosynthesis, water is essential for hydration, and temperature affects the behavior and metabolism of organisms. Abiotic factors interact with biotic factors to shape the characteristics and dynamics of ecosystems.**

8. **Discuss the difference between ecological concepts and ecological principles**

- **The contrast of ecological concepts and ecological principles is that ecological concepts are general understanding (or facts) about ecosystems and ecosystems management. These concepts provide a framework for studying ecological processes and interactions. Examples of ecological concepts include ecosystem, biodiversity, food chain, and niche. These concepts serve as the building blocks for understanding ecological phenomena and relationships. Whereas, ecological principles are basic assumptions (or beliefs) about ecosystems and how they work and are informed by the ecological concepts. They come from observations and academic study, and they help in the clarification of the patterns and processes seen in nature. Although they often depend on ecological ideas, ecological principles offer a more comprehensive knowledge of how ecosystems function. For instance, the ecological principles of energy flow, competitive exclusion, and ecological succession are all examples of ecological principles. These rules direct our understanding of ecological systems and provide guidance for ecological management and conservation activities.**

9-14. **discuss the 6 ecological principles and give situational examples each.**

- **Principle 1:** Protection of species and species' subdivisions will conserve genetic diversity. At the population level, the important processes are ultimately genetic and evolutionary because these maintain the potential for continued existence of species and their adaptation to changing conditions. In most instances managing for genetic diversity directly is impractical and difficult to implement. The most credible surrogate for sustaining genetic variability is maintaining not only species but also the spatial structure of genetic variation within species (such as sub-species and populations).
- **Principle 2:** Maintaining habitat is fundamental to conserving species. A species habitat is the ecosystem conditions that support its life requirements. Our understanding of habitat is based on our knowledge of a species' ecology and how that determines where a species is known to occur or likely to occur.

- **Principle 3:** Large areas usually contain more species than smaller areas with similar habitat. The theory of island biogeography illustrates a basic principle that large areas usually contain more species than smaller areas with similar habitat because they can support larger and more viable populations. The theory holds that the number of species on an island is determined by two factors: the distance from the mainland and island size.
- **Principle 4:** All things are connected but the nature and strength of those connections vary. Species play many different roles in communities and ecosystems and are connected by those roles to other species in different ways and with varying degrees of strength. It is important to understand key interactions. Some species (e.g., keystone species) have a more profound effect on ecosystems than others. Particular species and networks of interacting species have key, broad-scale ecosystem-level effects while others do not.
- **Principle 5:** Disturbances shape the characteristics of populations, communities, and ecosystems. The type, intensity, frequency and duration of disturbances shape the characteristics of populations, communities and ecosystems including their size, shape and spatial relationships.
- **Principle 6:** Climate influences terrestrial, freshwater and marine ecosystems. Climate is usually defined as all of the states of the atmosphere seen at a place over many years. Climate has a dominant effect on biodiversity as it influences meteorological variables like temperature, precipitation and wind with consequences for many ecological and physical processes, such as photosynthesis and fire behavior.

15 – 20. discuss at least 6 applications of ecological concepts and principles and give situational examples.

Coarse and fine filter applications:

Application 1: Use coarse and fine filter approaches. Coarse filter approaches include the management of landscapes through a network of representative protected areas and management practices in the non-protected matrix that attempt to emulate

natural ecological processes with composition and structure falling within the natural range of variability.

Application 2: Ensure representation in a system of protected areas. Protected areas, including those managed primarily for biodiversity conservation and those managed for a wide range of sustainable uses, are extremely important, especially in environments where biodiversity loss is occurring as a result of ecosystem loss or alteration. An important conservation goal is to represent the diversity of ecosystems or enduring features within a system of protected areas. Proportional representation may be a good starting point with the actual level or amount of representation varying depending on factors such as rarity and sensitivity. Providing protected areas sufficiently large to represent predator-prey systems may also result in some ecosystem types having higher levels of representation than other types.

Application 3: Retain large contiguous or connected areas. The large contiguous and connected areas that support these natural ecosystems provide critical habitat for a wide variety of species. These areas are valued locally, provincially, nationally and globally, and efforts have been made to map and characterize them by various organizations and agencies. Protected areas and the natural and semi-natural matrix, where they exist, can be combined to retain large contiguous or connected areas. Examples are large areas of wild ecosystems, where natural or near-natural ecological processes, such as predator□prey dynamics, still remain largely intact.

Application 4: Maintain or emulate natural ecological processes. Natural ecological processes shape ecosystems and should be maintained where possible; this includes disturbance regimes, hydrological processes, nutrient cycles and biotic interactions that also shape evolutionary processes. Maintaining ecological processes helps ensure that dynamic natural ecosystems continue to function and can promote ecological resilience. Natural ecological processes (both biotic and abiotic) should be continued, where practical, by minimizing human interference. Where interference occurs, human actions should try to emulate those processes.

Application 5: Manage landscapes and communities to be responsive to environmental change. Disturbances are a key source of environmental change. Natural

disturbances can significantly affect ecosystems through agents such as insect and disease outbreaks, wildfires, flooding and drought. Ecosystems typically adapt to these disturbances in due course and recover naturally when they occur.

Application 6: Manage towards viable populations of native species. Maintaining viable populations of all native species helps ensure that extinction thresholds are not reached. Most thresholds become apparent at a point where it is too late to intervene. Therefore, providing habitats that sustain populations well above minimum viable populations lessens the risk of extinction. It is generally more expensive to recover a population that is threatened or endangered than it is to avert population collapses caused by crossing threshold levels.

WEEK 2

Two (2) points for each correct answer to questions:

1. **Viruses are smaller than bacteria, True or False?**
   - **True**
2. **It is a system or formation of layers, classes, or categories of soils.**
   - **Soil classification**
3. **A toxic species that comprise the 'red tides' sometimes seen in large areas of the sea.**
   - **Dinoflagellas**
4. **They are the non-photosynthetic, chemo-organotrophic, aerobic, multicellular organism in water.**
   - **Fungi**
5. **They are the worms and helminths in the microbial world.**
   - **Animals**
6. **Acronym for TDS.**
   - **Total dissolved solids**
7. **It is often described as the buffering capacity of water.**
   - **Alkalinity**
8. **One of the worst toxins produced by a fungus.**
   - **Aspergillus flavus.**
9. **True or false, the 'air' is about 78 % by volume of nitrogen (N2), 21 % oxygen (O2).**

- **True**

10-14. Enumerate the five (5) elemental properties of soil in relation to infiltration.

1. **Bulk Density**
2. **Particle Density**
3. **Porosity**
4. **Volumetric water content**
5. **Degree of saturation**

15. They drift freely in the water, and generally regarded as undesirable in the river environment.

- **Planktonic algae of microscopic plants**

16. What is the value of a neutral pH?

- **The value of a neutral pH is 7**

17-21. Name at least five (5) primary pollutants in earth's atmosphere.

- **Carbon Monoxide (CO)**
- **Nitrogen Oxides (NOx)**
- **Sulfur Dioxide (SO2)**
- **Particulate Matter (PM)**
- **Volatile Organic Compounds (VOCs)**

22-27. Name the six (6) varied occurrences and uses of water.

- **Surface freshwaters in rivers and lakes and groundwater when used as drinking water**
- **Surface freshwaters as used in fish and other fauna habitats**
- **Surface freshwaters as used for atmospheric liquid discharges**
- **Surface freshwaters and groundwater as used for irrigation**
- **Surface waters for used as recreation**
- **Surface waters as**
- **used for navigation**

28-32. Enumerate the five (5) atmospheric layers.

- **Troposphere**
- **Stratosphere**
- **Mesosphere**
- **Thermosphere**
- **Exosphere**

33. A pot used to estimate evaporation of water and determined rainfall.

- **Rain gauges**

34-35. Factors that convert rainfall to surface runoff or infiltration.

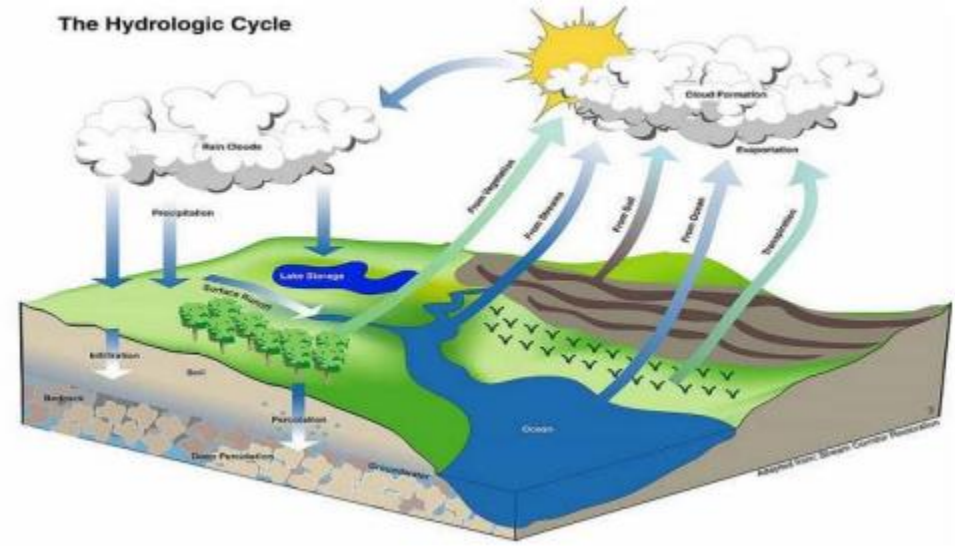
Several factors determine whether rainfall becomes surface runoff or infiltrates into the ground:

- **Soil characteristics:** The type of soil plays a significant role in determining the infiltration capacity. Soils with high porosity and permeability, such as sandy soils, tend to allow water to infiltrate more readily. In contrast, soils with low permeability, such as clay soils, have reduced infiltration capacity and are more likely to generate surface runoff.
- **Soil moisture content:** The initial moisture content of the soil affects its ability to absorb rainfall. If the soil is already saturated or has a high moisture content, it will have limited capacity to absorb additional water, leading to increased surface runoff.
- Slope or topography: The slope of the land surface influences the rate of surface runoff. Steeper slopes facilitate faster runoff as gravity propels the water downslope, while gentler slopes allow more time for infiltration to occur.
- **Vegetation cover:** Vegetation, such as grasses and trees, can significantly impact the fate of rainfall. Vegetation intercepts rainfall, reducing the amount of water that reaches the ground directly. Plants also promote infiltration by enhancing soil structure and increasing water absorption.
- **Antecedent conditions:** The state of the land surface prior to rainfall, including its moisture level and the presence of impervious surfaces like concrete or asphalt, affects

the proportion of runoff versus infiltration. Dry or compacted surfaces tend to generate more runoff, while already saturated surfaces promote infiltration.

- **Rainfall intensity and duration:** The intensity and duration of rainfall influence the balance between surface runoff and infiltration. Intense or prolonged rainfall events can exceed the infiltration capacity of the soil, leading to increased runoff.

Forty (40) points: Draw and discuss the Hydrologic cycle.



Hydrology is the study of water and its movement along its various pathways within the hydrological cycle; in the rivers and oceans; in the soil and in water containing rocks. Hydraulics is the engineering of water flows in pipes, conduits, lakes, or rivers.

Steps of the Water Cycle:

1. Change from Liquid to Gaseous Phase – Evaporation and Transpiration

The heat of the sun causes water from the surface of water bodies such as oceans, streams, and lakes to evaporate into water vapor in the atmosphere. Plants also contribute to the water cycle when water gets evaporated from the aerial parts of the plant, such as leaves and stems by the process of transpiration.

2. Change from Solid to Gaseous Phase – Sublimation

Due to dry winds, low humidity, and low air pressure, snow present on the mountains change directly into water vapor, bypassing the liquid phase by a process known as sublimation.

3. Change from Gaseous to Liquid Phase – Condensation

The invisible water vapor formed through evaporation, transpiration, and sublimation rises through the atmosphere, while cool air rushes to take its place. This is the process of condensation that allows water vapor to transform back into liquid, which is then stored in the form of clouds.

Sometimes, a sudden drop in atmospheric temperature helps the water vapors to condense into tiny droplets of water that remain suspended in the air. These suspended water droplets get mixed with bits of dust in the air, resulting in fog.

4. Change from Gaseous to Liquid and Solid Phase – Precipitation and Deposition

Wind movements cause the water-laden clouds to collide and fall back on the earth's surface through precipitation, simply known as rain. The water that evaporated in the first stage thus returns into different water bodies on the earth's surface, including the ocean, rivers, ponds, and lakes. In regions with extremely cold climate with sub-zero temperatures, the water vapor changes directly into frost and snow bypassing the liquid phase, causing snowfall in high altitudes by a process known as the deposition.

5. Return of the water back into the underground reserve – Runoff, Infiltration, Percolation, and Collection

The water that falls back on the earth's surface moves between the layers of soil and rocks and is accumulated as the underground water reserves known as aquifers. This process is further assisted by earthquakes, which help the underground water to reach the mantle of the earth. Some amount of precipitated water flows down the sides of mountains and hills to reach the water bodies, which again evaporates into the atmosphere. During volcanic eruptions, the underground water returns to the surface of the earth, where it mixes with the surface water bodies in order to continue the cycle.

WEEK 3

Essay. Ten (10) points for each correct answer to questions:

1. **In what ways do engineering processes and activities impinge on the functioning freshwater systems"**

   Both direct and indirect effects on the operation of freshwater systems can be due to engineering procedures and actions. Direct engineering involvements like building dams, channelizing, and water diversions can change the hydrology and natural flow patterns of rivers and streams. These alterations may affect aquatic species' movement patterns, the connectivity between habitats, and the availability of good spawning and nesting sites. As a result of increased surface runoff brought on by the construction of resistant surfaces like parking lots, buildings, and highways, freshwater bodies may experience increased erosion, sedimentation, and contamination. Procedures in engineering can unintentionally cause pollution through the discharge of domestic and industrial wastewater, the usage of agricultural chemicals that can enter freshwater systems, stormwater drainage that carries pollutants, and other means. These contaminants have the potential to harm aquatic life, worsen water quality, and upset the biological balance of freshwater ecosystems. Engineering practices must incorporate sustainable methods to lessen these effects, such as putting in place efficient water management plans, cutting back on sources of pollution, and encouraging the restoration and preservation of freshwater habitats.

2. **How can changes in primary productivity of aquatic systems affect the use of aquatic resources?**

   - **Modifications in the primary productivity of aquatic systems can have a big impact on how aquatic resources are used. Increases in primary productivity, such as that brought on by nutrient enrichment or algal blooms, can alter the diversity and number of species in an environment. Aquatic resource availability and quality may therefore be affected. Excessive algal development, for instance, can cause oxygen depletion, which can cause fish kills and decrease fish populations,**

which can have an effect on fisheries and recreational fishing. Algal toxins created by blooms may pollute water and endanger human health, restricting the use of water for irrigation, swimming, and drinking.

3. **Explain the significance of ocean current to marine systems.**
   - **Ocean currents play a crucial part in marine systems and have significant impacts on various aspects of the marine environment. First and foremost, ocean currents aid disseminate heat around the planet, regulating global climate and temperature patterns. They can carry warm water from the equator to colder regions or cold water from higher latitudes to warmer areas, influencing local climate conditions. Second, the ocean currents transport nutrients and plankton, lead to the formation of basis of marine food chains and supporting diverse ecosystems. Nutrient-rich currents stimulate the growth of phytoplankton, which serve as food for zooplankton, fish, and other marine organisms. Currents contribute to the spreading of larvae, allowing for the colonization of new habitats and maintaining genetic diversity among species. Additionally, ocean currents influence coastal processes, including erosion, sediment transport, and the formation of coastal ecosystems. Finally, currents affect the movement of marine species, including migratory patterns of marine mammals, sea turtles, and fish, impacting their feeding, breeding, and survival strategies. Moreover, understanding and keeping our ocean currents monitored are essential for managing marine resources, protecting vulnerable ecosystems, and supporting sustainable ocean management practices.**
4. **Describe the properties of seawater that are of biological significance.**
   - **The properties of seawater, including its salinity, dissolved oxygen content, temperature, and pH, have biological significance as they influence the distribution, physiology, and behavior of marine organisms.**
5. **Outline the physical and chemical characteristics of a waterbody that make them susceptible to pollution.**
   - **The physical and chemical characteristics of a waterbody that make them susceptible to pollution includes, with higher temperatures, High levels of turbidity, caused by suspended particles in the water, extreme pH values, either**

highly acidic or highly alkaline, can make a waterbody more susceptible to pollution, Waterbodies located in areas with high human activity, industrial facilities, or agricultural practices are more susceptible to pollution

6. **Why can the deposition of small quantities of some pollutants give rise to large-scale disruption of ecological systems?**
   - **The deposition of small quantities of some pollutants can give rise to large-scale disruption of ecological systems due to their persistence, bioaccumulation, and amplification through food chains. Some pollutants, like persistent organic pollutants (POPs) or heavy metals, have a high degree of stability and can persist in the environment for long periods. These pollutants can accumulate in organisms over time, reaching higher concentrations in higher trophic levels. As a result, even small initial inputs of pollutants can lead to significant biomagnification and impact entire ecosystems. Additionally, certain pollutants can have non-linear or synergistic effects, where even small quantities can trigger adverse responses or disrupt key ecological processes, leading to cascading effects throughout the ecosystem.**
7. **Compare and contrast the causes and effects of acidification with cultural eutrophication of freshwater ecosystems**
   - **Acidification is primarily caused by the release of acidic compounds, such as sulfur dioxide and nitrogen oxides, into the atmosphere from human activities like burning fossil fuels and industrial processes. These compounds combine with atmospheric moisture to form acidic rain, which can directly acidify freshwater bodies when it falls into them. Cultural eutrophication, on the other hand, is the result of excessive nutrient input, particularly nitrogen and phosphorus, into freshwater ecosystems from human activities like agriculture, sewage discharge, and urban runoff. These nutrients promote the growth of algae and other aquatic plants, leading to an overabundance of plant biomass.**

     While both acidification and cultural eutrophication can negatively impact freshwater ecosystems, their causes and effects differ. Acidification is primarily driven by atmospheric pollution and results in increased acidity, while cultural

eutrophication stems from excessive nutrient input and leads to oxygen depletion and algal overgrowth. Understanding these processes is crucial for implementing effective management strategies to mitigate their impacts and protect freshwater ecosystems.

8. **What procedures are generally used for cleaning up oil spills? Which are the most biologically friendly?**
    - **Dispersants and booms and skimmers are the most frequently used methods to clean up ocean oil spills. chemical dispersants can be used to break down the oil into smaller droplets, enhancing microbial degradation. Biologically friendly methods like bioremediation promote the natural degradation of oil without introducing additional chemicals or causing substantial disturbance to the ecosystem. However, the appropriateness of each method depends on factors like spill size, location, weather conditions, and the sensitivity of the affected area. A combination of methods is often employed to maximize effectiveness while minimizing environmental impact.**
9. **What are the ecological consequences of sewage input to the marine environment?**
    - **Nutrient enrichment of the water can result from the discharge of untreated or insufficiently treated sewage. Sewage can transmit infections and germs into the marine environment, causing threats to human health and impacting marine species, particularly filter-feeding organisms and shellfish. This can lead to hazardous algal blooms, oxygen depletion, and a subsequent loss of biodiversity. Sewage inputs can alter the water's normal pH and oxygen levels, which can impact marine species' ability to survive and grow. Sewage can cause sedimentation and the deposit of organic material, suffocating benthic ecosystems and changing the character of the sediment. Finally, the introduction of pollutants from sewage, such as heavy metals and chemicals, can have long-term toxic effects on marine organisms, disrupting their reproduction, behavior, and overall ecological functioning. Proper sewage treatment and management are essential to minimize these ecological consequences and protect the health and integrity of marine ecosystems.**

10. **Explain the physical chemical phenomenon of using a water tower absorb ammonia into water from an ammonia pollution air source**

- **The physical-chemical phenomenon of utilizing a water tower to absorb ammonia from an ammonia pollution air source is based on the principle of dissolution and absorption. When ammonia gas encounters water in the tower, it has the ability to dissolve and mix with the water molecules due to its solubility properties. The process occurs as ammonia molecules are attracted to the water molecules through intermolecular forces, causing them to break apart and integrate into the water. As a result, the concentration of ammonia in the air decreases, effectively reducing the pollution levels. The water tower acts as a medium for capturing and absorbing the ammonia from the surrounding air, ultimately mitigating ammonia pollution.**

Week 4

Essay. Ten (10) points for each correct answer to questions:

1. **Discuss the effects of air pollutants on:**
   a. **materials**

- **Certain air pollutants, such as sulfur dioxide and nitrogen oxides can react with moisture in the air to form acidic compounds which we can called this corrosion. These acids can deteriorate metals and degrade building materials like concrete, limestone, and marble. Air pollutants such as ozone and volatile organic compounds can cause discoloration, fading, and deterioration of organic materials like textiles, plastics, rubber, and wood. Fine dust particles and soot from air pollution can settle on surfaces, causing staining and reducing the aesthetic appeal of buildings and structures. Moreover, acid rain resulting from air pollution can further damage materials, contributing to structural weakening and decay. To mitigate these effects, it is crucial to reduce air pollution through emissions controls and adopt protective measures such as material selection, coatings, and regular maintenance.**

b. vegetation

- **The detrimental effect of air pollution in vegetation is that once leaves are in close contact with the atmosphere, such an air pollutants O3 and NO3 can affect the metabolic function of the leaves and interfere with net carbon fixation by the plant canopy. Another impact is the alteration of nutrients uptake, air pollutants can disrupt nutrient cycling and uptake in plants, for example, ozone with higher level can decrease the uptake of essential nutrients such as nitrogen, phosphorus, and potassium, affecting plant health and nutrient balance.**

c. human health

- **Respiratory problems would be the top impact to human health in terms of air pollution. Inhaling air polluted air, especially fine particulate matter and toxic gases can cause a dire respiratory issues such as coughing, wheezing, and shortness of breath. There are also worst cases in connection to the respiratory problems like asthma, or bronchitis. Additionally, longer exposure to air pollution can lead to reduced lung function, this can happen in children and elderly.**

2. **Define the term Acid rain and explains how it occurs.**

- An acid rain refers to any form of precipitation that has become acidic because of the presence of pollutants in atmosphere. Acid rain occurs when sulfur dioxide and nitrogen dioxides are released into the atmosphere and transported by wind and air currents, hence, SO2 and NOx react with water, oxygen and other chemicals to create sulfuric and nitric acids, then these will unify with water and other materials before falling to the ground.

3. **Discuss the following atmospheric conditions in air pollution meteorology:**

a. Atmospheric engine

Higher level of air pollution, such as particulate matter and chemical pollutant, can clog air filters and intake systems of atmospheric engines, this can also restrict the flow of air into engine resulting to reduced combustion efficiency and reduced power output. Pollution in the air can increase the require for maintenance and the expense of repairs in atmospheric engines. To minimize or mitigate the detrimental effects of air pollution on engine efficiency and longevity, regular cleaning, filter replacement, and periodic inspection of engine components are required.

b. Turbulence

- **The interaction between air pollution and atmospheric conditions are intricately linked, they can influence the occurrence and intensity of turbulence in atmosphere. Factor affecting turbulence is the temperature, the disparity of temperature produces differences in air density causing to the thermal turbulence. During warm and sunny days, the ground gets heated more than the surrounding air leads to rise and creating an upward current of air. There are certain air pollutants like aerosols and particulate matter, can act as condensation nuclei, changing the cloud formation and resulting an vertical movement of air masses. Moreover, this will lead changes in atmospheric stability and turbulence patterns.**

c. Stability

- **Atmospheric conditions play a crucial role in air pollution and can have significant effects on environmental stability. Factors such as temperature inversions, which trap pollutants close to the ground, can lead to the accumulation of pollutants in specific areas, exacerbating their impact. Additionally, stagnant air masses and low wind speeds can hinder the dispersion of pollutants, prolonging their presence in an area and increasing the potential for adverse effects on ecosystems and human health. These atmospheric conditions can contribute to the persistence and intensity of air pollution episodes, ultimately impacting the stability of the environment.**

b) Name at least ten variables that affect the internal combustion (automobiles) emissions.

- **Fuel Type**
- **Engine Design**
- **Engine Size and Power**
- **Vehicle Age**
- **Driving Conditions**
- **Maintenance**
- **Emission Control Systems**
- **Fuel Quality**
- **Altitude and Climate**

- **Vehicle Technology**

c) List and define three units of measure used to report air pollution data.

- **Parts Per Million (ppm):** Parts per million is a unit of measurement used to express the concentration of a pollutant in the air. It represents the number of pollutant molecules or particles per million air molecules. For example, if the concentration of carbon monoxide (CO) is reported as 5 ppm, it means that there are 5 CO molecules for every one million air molecules.
- **Micrograms per Cubic Meter (µg/m³):** Micrograms per cubic meter is a unit used to measure the mass concentration of particulate matter or other airborne pollutants. It represents the mass of a pollutant in micrograms present in one cubic meter of air. For instance, a measurement of 20 µg/m³ for PM2.5 (particulate matter with a diameter of 2.5 micrometers or less) indicates that there are 20 micrograms of PM2.5 particles in each cubic meter of air.
- **Parts Per Billion (ppb):** Parts per billion is another unit of measurement for expressing the concentration of pollutants in the air. It represents the number of pollutant molecules or particles per billion air molecules. For instance, if the concentration of ozone (O3) is reported as 50 ppb, it means that there are 50 ozone molecules for every one billion air molecules.

d) Explain the difference between ppm in air pollution and ppm in water pollution.

- **PPM in air pollutants refers to the concentration of a pollutant in the air. It represents the number of pollutant molecules or particles present per million air molecules. For example, if the concentration of carbon monoxide (CO) in the air is reported as 5 ppm, it means there are 5 CO molecules for every one million air molecules. While, ppm in water pollutants refers to the concentration of a pollutant in water. It represents the number of pollutant molecules or particles per million water molecules. For instance, if the concentration of lead (Pb) in water is reported as 10 ppm, it means there are 10 lead molecules for every one million water molecules.**

e) **Discuss the natural and anthropogenic origin of the six criteria air pollutants and identify the likely mechanisms for their removal from the atmosphere.**

- **According to the definition of U.S Environmental Protection Agency (EPA), there are six criteria air pollutants including carbon monoxide, nitrogen dioxide, sulfur oxide, lead, particulate matter, and ozone. These pollutants have both natural and anthropogenic origins. Volcanic eruptions, wildfires, biological activities, and wind-borne dust are examples of natural sources. Human activities like transportation, energy generation, industrial processes, and the burning of fossil fuels are anthropogenic sources. They can be eliminated from the atmosphere through both natural and artificial procedures. Precipitation, particularly rain and snow, can wash contaminants from the air as part of natural elimination procedures. Their elimination is made even easier by deposition on land and sea surfaces. In addition, contaminants like ozone can be eliminated by direct sunlight and chemical processes. To reduce pollutant emissions at their sources, human activities include the deployment of emission control technology like catalytic converters, filters, and scrubbers.**

f) **Explain the term greenhouse effect, its hypothesized cause, and its pros and cons to the atmosphere.**

- **A natural process that contributes to keeping the Earth warm is the greenhouse effect. It happens when certain atmospheric molecules, referred to as greenhouse gases, keep the heat from the sun and prevent it from traveling back into space. Carbon dioxide (CO_2) and methane (CH_4) are two examples of greenhouse gases that serve as a protective layer around the Earth, letting sunlight in but maintaining some of the heat. The primary cause of the greenhouse effect is the increased concentration of greenhouse gases in the atmosphere due to human activities. Activities like burning fossil fuels (coal, oil, and natural gas), deforestation, and industrial processes release large amounts of greenhouse gases, enhancing the greenhouse effect. The pros of the greenhouse effect include preserving a habitable temperature on Earth and facilitating plant growth through photosynthesis. Global warming, which causes rising temperatures, changing weather patterns, and greater chances of serious weather events, is a**

drawback of the increased greenhouse effect brought on by human activity. Additionally, it contributes to sea level rise, the melting of the polar ice caps, and the potential destruction of ecosystems and biodiversity.

g) Discuss the Montreal Protocol.

- **Montreal Protocol is an international environmental agreement established in 1987 with the goal of saving and protecting the Earth's Ozone layer. The Montreal Protocol goal is to terminate the production and consumption of substances known as ozone-depleting substances (ODS), this includes chlorofluorocarbons (CFS) and halons. The stated substances were found to be responsible for thinning the ozone layer and allowing harmful of ultraviolet radiation to enter the Earth's atmosphere. With nearly universal participation from countries across the world, this protocol has been successful, because of this it led to significant reductions in ODS production and consumption, resulting in the gradual recovery of the ozone layer.**

h) Enumerate ways to minimize air pollution in a coal-fired power plant.

- Burning of low-sulfur-content coal to reduce SO2 emissions. Some coal -fired power plants wood chips with coal to reduce SO2 emissions.

- Installation and constant maintain of effective pollution control technologies like electrostatic precipitators and scrubbers, to catch and remove particulate matter and pollutants from plant's emissions.

- Implement proper ash disposal and management practices to prevent the release of fly ash and other coal combustion residues into the air.

- Encourage the adoption of carbon capture and storage (CCS) technologies, which can capture and store carbon dioxide (CO2) emissions, reducing their release into the atmosphere.

- Implement stringent monitoring and reporting systems to track emissions and ensure compliance with emission standards and regulations.