**ENGR 202/2 section H**

**Sustainable Development and Environmental Stewardship**

**Instructor: Dr. Saifur Rahaman**

18/20

Excellent Work!

**MID TERM EXAM**

**Thursday, October 18, 2012**

**CLOSED BOOK**

**4:30 pm- 5:30 pm**

**20 Marks**

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1. **Define "life cycle assessment" (2 marks)**

LCA is an environmental assessment tool.
LCA assesses the environmental impacts of a product / process by evaluating inputs vs. outputs at each lifecycle stage from resource extraction, manufacturing, use, and disposal. LCA is composed of 3 steps:

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1) Goal & Scope definition: define goal of assessment and boundaries of life cycles
2) Analysis: Identification and quantification of impacts / inputs and outputs
3) Assessement: Assess environmental consequences of impacts identified in analysis.

2. **When selecting materials for any engineering product development what are the important things you need to consider? (2 marks)**

→ There are several factors to consider in relation to Green Engineering

1) Use as little materials as possible without compromising basic function. / Minimize excess
2) Use materials with low negative environmental impacts.
3) Favor Renewable resources instead of depletable
4) Choose materials for durable products (so that products thrown out less often)
5) Choose materials for design that promote recycling & reuse.

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3. **What is acid rain and how it's formed? (2 marks)**

Acid rain or Acid deposition is primarily formed by an accumulation of sulfur dioxide ($SO_2$) and nitrogen oxides ($NO_x$) in the atmosphere. These particles find their way into rain clouds, and fall back down to earth by precipitation when it rains. Because these are acidic particles, the term acid rain is used.

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4. **List some major health effects of the nitrous oxide, lead and ozone emissions in the atmosphere? (2 marks)**

1) Nitrous Oxide ($N_2O$): GHG emitted primarily from Nitrogen containing fertilizers and transportation

Health Effects: Causes Cardiovascular and Respiratory illnesses. Toxic at high concentrations.

2) Lead (Pb) Toxic heavy metal. Emitted from leaded pipes, paints, gasoline and lead smelting/mining industries.

Health effects: Neurological damage, damage to organs (liver and kidney), impair normal development.

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3) Ozone ($O_3$) Gas formed by combination of VOC and NOx catalyzed by sunlight. Commonly appears as smog.

Health effects: Attacks lung tissues, causes inflammation of airways, difficulty breathing.

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5. **What is the difference between primary and secondary water quality standards? (2 marks)**

Primary water quality standards are aimed at issues which may directly affect human health, contributing to illness and mortality.

Secondary water quality standards protect human welfare, quality of life, preserve biodiversity and maintain life and address recreational and aesthetic issues.

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NOTE: Depending on the context, primary and secondary standards may instead refer to daily vs. annual pollutant standards. Daily standards address acute (immediate) health imparts while annual standards address chronic (long term or permanent) dangers.

6. **What are the major sources of nonhazardous waste? (2 marks)**

The main sources of nonhazardous waste are primarily from a variety of industrial processes (manufacturing, mining, construction, etc). Municipal solid waste (residences, offices, malls) only account for ≈ 2% of non hazardous waste. + Agricultural?

Main Constituents of Non-hazardous wastes are paper, paperboard, metal scraps, plastics, fabrics, etc.

1.8

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7. **List all the greenhouse gases according to their abundance in the atmosphere (2 marks)**

1) Carbon Dioxide ($CO_2$) ≈ 77%
2) Methane ($CH_4$)
3) Nitrious Oxide ($N_2O$)
4) Halocarbons and Perhalogens (CFC mostly) ≈ 1%

minor → 4)
minor → 5) Ozone ($O_3$) → minor, low concentration
minor → 6) Water vapour ($H_2O$) → minor low concentration

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8. **As an engineer how could you help reducing the atmospheric $CO_2$ emissions? (2 marks)**

$CO_2$ emissions are closely related to the formula:

$$(\text{population}) \times \left(\frac{GDP}{\text{capita}}\right) \times \left(\frac{\text{energy use}}{GDP}\right) \times (\text{Carbon Intensity})$$

① ② ③ ④

The first 2 terms are related to culture and politics. These are difficult for engineers to control. However the last 2 terms can be controlled by responsible engineering practices:

3) Reducing Energy Intensity:

A) Structural Changes:
- Use of less energy intensive processes and emergence of less energy intensive industries.

B) Efficiency Changes:
- Favor energy efficiency / Make each process as energy efficient as possible.
- Use of new technologies or more efficient processes.

4) Reducing Carbon Intensity:

A) Alternative Sources of Energy:
- Use alternative sources of energy which are not as carbon intensive (Avoid coal).
- Favor renewable clean energy sources (wind, hydro, etc)

B) Carbon Sequensation:
- Planting of Forests to remove $CO_2$
- Use of technologies to remove or capture $CO_2$,

9. **Briefly explain the direct and indirect radiative forcing by aerosol (2 marks)**

Aerosols are small liquid and water particles suspended in air, usually less than 10 um in diameter. 3 Aerosol particles are most prevalent: 1) Sulfate particles, 2) soot particles, 3) Aerosols from biomass burning.

→ Also recall that Radiative Forcing is defined as any net change in Radiation at the troposphere

1) Direct Forcing: Sulfate Aerosols and Aerosols from biomass burning reflect incoming solar radiation, increasing the Albedo. ∴ ΔF is Negative here. Conversely, Soot particles absorb radiation, increasing the radiative Forcing (+ΔF)

2) Indirect Forcing: Aerosols can also react to form clouds which reflect incoming solar radiation, increasing the Albedo (−ΔF)

10. **What is the atmospheric window and why it's significant? (2 marks)**

The Atmospheric window is defined from wavelengths of 8um to 12um It is significant because little to no absorption of IR radiation occurs within this wavelength in the atmosphere. Ozone ($O_3$) does absorb radiation of this wavelength however ozone's atmospheric concentration is relatively low. Hence most if not all of the radiation of this wavelength passes through the atmosphere unhindered.

**Bonus:**

****What you expect to learn from this course and why it's important for you as an engineer? (1 mark)**

Environmental responsibility and sustainability is especially important for engineering given that it is an applied field. As engineers it is our role to translate mathematical and scientific knowledge into real world practicle solutions. However implementation from the theoretical realm to reality requires consideration of constraints and limitations. Enviromental impacts and consequences which may be difficult to perceive in the purely theoritical realm need to be considered in engineering, given its applied nature.

In addition, as human beings we have the moral obligation to promote sustainable development - meeting the needs