CE 326 — INSTRUCTIONAL OBJECTIVES

Introduction — pages 1-35

1. Be able to list six areas for which environmental engineers are responsible.

2. Be able to explain what is meant by environmental ethics.

3. Be able to set up a material balance for an environmental subsystem.

Air Pollution (Fundamentals, Standards, Effects and Fate of Pollutants) — pages 547-580

1. Given appropriate data be able to convert parts per million (ppm) to micrograms per cubic meter ($\mu g/m^3$) for an air pollutant and vice versa.

2. Given appropriate data be able to apply the material balance approach in estimating the amount of pollutant that will be released into the atmosphere from a source material such as sulfur dioxide from the burning of coal.

3. Be able to explain the influence of environmental factors on the severity of air pollution effects on materials.

4. Be able to discuss the natural and anthropogenic origin of the seven major pollutants for which the U.S. Environmental Protection Agency has designated air quality standards and identify the likely mechanism for their removal from the atmosphere.

5. Be able to explain what is meant by "acid rain" and what causes it.

6. Be able to explain what is meant by "the hole in the ozone layer" and what causes it.

7. Be able to explain what is meant by "the greenhouse effect" and what causes it.

Air Pollution (Control Devices) — 601-633

1. Be able to describe briefly the basis for operation for each of the following air pollution control devices:

   a. absorption tower
   b. baghouse
   c. cyclone separator
   d. adsorption bed
   e. electrostatic precipitator
   f. venturi scrubber

Be able to identify the major sources of automotive emissions from the gasoline engine and briefly explain how they are being controlled.

Air Pollution (Dispersion of Pollutants) — 580-600

1. Be able to identify the prevailing conditions relating to atmospheric stability based on the vapor trail from a stack for the six classical types of plume behavior.

2. Be able to explain how terrain influences air pollution problems in an affected area.

3. Given appropriate data be able to apply the Gaussian dispersion model in estimating the

ground level concentration of air pollutants released from an elevated source or the emission rate for a given ground level concentration.

4. Be able to explain how a health risk assessment can be used to evaluate a potential air pollution hazard.

Solid Waste Management — 736-796

1. Be able to characterize the amount of solid wastes produced in the U.S. on a mass and volume basis.
2. Be able to define the following terms: garbage, rubbish, refuse, trash.
3. Be able to list the major components of solid wastes and their relative proportions.
4. Be able to list and describe the four means of solid waste management.
5. Given appropriate data be able to determine the dry weight of solid waste components.
6. Be able to explain what a transfer station is and what purpose it serves.
7. Be able to list the site selection criteria for a sanitary landfill.
8. Be able to define the following terms and describe how they relate to a sanitary landfill: liner, daily cover, cell, leachate, leachate collection system, cap, gas vents.
9. Be able to draw a diagram of a typical sanitary landfill showing how it is constructed.
10. Given appropriate data be able to calculate how long it would take leachate to migrate through a clay liner.

Hazardous Waste Management — 813-903

1. Be able to list the five categories that are used in classifying hazardous wastes.
2. Be able to list and describe the four categories of "characteristic wastes".
3. Be able to sketch the general structure of dioxins and PCBs and explain why each is hazardous.
4. Be able to define the cradle to grave concept and how it relates to the "manifest".
5. Be able to define RCRA, HSWA, CERCLA, SARA, TSD, and "four nines".
6. Be able to list six disposal technologies for hazardous wastes.
7. Be able to describe the various phases in the "permitting process" for a hazardous waste incinerator and how a "trial burn" is incorporated into the process.

Water Supply (Water Chemistry, Quality Standards and Treatment Systems) — 188-257

1. Be able to define the following terms and explain their significance in terms of water quality: potable, palatable, acidity, alkalinity, buffer solution, hardness, and turbidity.
2. Given appropriate data be able to calculate the gram molecular weight of chemical species,

the molarity, the normality, and the concentration in mg/L as either the species or the equivalent amount of calcium carbonate.

3. Given appropriate data be able to do solubility product calculations and calculations based on the acid ionization constant.

4. Given appropriate data be able to calculate: total alkalinity, bicarbonate alkalinity, carbonate alkalinity, hydroxide alkalinity, total hardness, carbonate hardness, and noncarbonate hardness.

5. Be able to explain the significance of the following inorganic substances in terms of their effects on water quality: chloride, copper, fluoride, iron and manganese, lead, nitrate, sodium, sulfate, and zinc.

6. Be able to define the following terms and explain their significance in terms of water quality: pathogen, coliform, SDWA, MCL, VOC, SOC, DBP, THM, and SWTR.

7. Be able to sketch the flow diagram for a water filtration plant or a water softening plant labeling the various treatment steps and explaining their functions.

Water Supply (Coagulation and Flocculation) — 257-266

1. Be able to differentiate between coagulation and flocculation.

2. Be able to write the chemical equation for the reactions of either alum or ferric chloride in water containing bicarbonate alkalinity and calculate the amount of alkalinity needed to neutralize a given dosage of either coagulant.

3. Be able to explain what a jar test is and how it is used in water treatment control.

4. Be able to explain the significance of velocity gradient (G) and detention time (t_o) during the coagulation and flocculation steps in water treatment.

Water Supply (Sedimentation and Filtration) — 266-294

1. Be able to explain the difference between Type I, Type II, and Type III sedimentation.

2. Be able to identify the four "zones" in an ideal settling tank and explain the function of each.

3. Be able to sketch an elevation view through a circular sedimentation basin (labeling the influent pipe and well, the collector arm and drive, the effluent weir and pipe) and explain how it works.

4. Given appropriate data be able to calculate the settling velocity for Type I sedimentation and show how it relates to the overflow rate for potable water treatment.

5. Be able to briefly describe how slow sand filters and rapid sand filters differ in terms of their operating procedures, construction and loading rates.

6. Be able to sketch a rapid sand filter (labeling the inlet main, outlet main, wash water outlet, wash trough, filter sand, graded gravel, and perforated laterals) and explain how it works.

7. Given appropriate data be able to calculate the clean bed head loss for a rapid sand filter during the filtration cycle and the percent expansion of the sand during the backwash cycle.

Water Supply (Disinfection, Adsorption, and Membrane Processes) — 294-310

1. Be able to define the following terms and explain their significance in terms of disinfection: free chlorine residual, combined chlorine residual, and "breakpoint chlorination".

2. Be able to explain the "CT concept" as it relates to the SWTR criteria for cyst and virus disinfection.

3. Be able to list three disinfecting agents that are viable alternatives to free chlorine and combined residual chlorine and give the advantages and disadvantages of each.

4. Be able to identify the following acronyms related adsorption and explain how the materials they represent are used in water treatment: GAC and PAC.

5. Be able to describe the four different types of membrane processes used for drinking water treatment and when membranes would be advantageous to use.

Wastewater (BOD and DO Sag Curve) — 354-400

1. Be able to list the eight types of pollutants from the four principal sources of waste water and describe why each is a concern.

2. Be able to explain the difference between a point source and a non-point source.

3. Be able to define the assimilative capacity of a receiving water.

4. Be able to define BOD and describe the laboratory procedure for determining BOD.

5. Be able to explain the effect of nitrification during the BOD test.

6. Given appropriate data be able to calculate the BOD relating to a specified period of incubation.

7. Be able to sketch a DO sag curve.

8. Be able to do mass and heat balance calculations for the discharge of waste water into a receiving stream.

9. Given appropriate data be able to calculate the oxygen deficit (D) in a reach of a stream, the time of travel to the critical point (t_c), and the critical oxygen deficit (D_c) at the critical point.

10. Be able to explain the effects of nutrient discharge on the water quality of rivers.

Wastewater (Biological Processes) — 449-459

1. Be able to define the following terms and describe their significance in terms of wastewater treatment processes: autotrophs, heterotrophs, psychrophiles, mesophiles, thermophiles, obligate aerobes, facultative anaerobes, and obligate anaerobes.

2. Be able to list the terminal electron acceptor, end products, and applications for each of the following types of decomposition in waste treatment: aerobic, anoxic, and anaerobic.

3. Be able to list the growth requirements of microorganisms.

4. Be able to define the parameters in the Monod equation and plot the μ versus S relationship.

5. Be able to give the values for BOD and suspended solids of a medium strength domestic waste water.

Wastewater (Wastewater Treatment Processes) — 420-459

1. Be able to sketch daily flow fluctuation (diurnal flow) to a typical domestic wastewater treatment plant.

2. Be able to draw a flow diagram of a typical wastewater treatment plant giving examples of preliminary, primary, and secondary treatment.

3. Be able to define the following terms and describe their significance in terms of the activated sludge process: SRT, MLSS, MLVSS, SVI, F/M, and sludge wastage.

4. Given appropriate data be able to size primary and secondary clarifiers for a wastewater treatment process.

5. Given appropriate data be able to size an aeration basin for the activated sludge process and determine the recycle rate required to maintain a specified MLSS concentration.

6. Be able to list the operational problems that might be encountered in the activated sludge process and describe remedial measures that might be used to avoid/remedy each problem.

7. Be able to discuss the tertiary treatment processes that are used to remove nutrients from wastewater.

Wastewater (Sludge Treatment and Disposal) — 311-328, 508 - 525

1. Given appropriate data be able to develop a solids mass balance for a specified treatment process.

2. Given appropriate data be able to size a gravity thickener using a batch flux curve.

3. Be able to draw a schematic sketch of a high-rate anaerobic digestion process and explain how wastewater sludge is stabilized based on the information shown in the schematic.

4. Be able to list three types of sludge dewatering processes and briefly describe each process.