

**SYLLABUS: CE 719 WATER QUALITY MODELING (Call No. 04285-4)**  
(Revised September 2000)

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- CREDIT:** UG 4, 4 class hours per week
- DESCRIPTION:** A study of stream quality standards, effluent standards, and the assimilative capacity of rivers.
- OFFERED:** Autumn quarter; MTRF, 11:30 am; HI 30.
- PREREQUISITES:** CE 520 or equivalent with written permission of instructor.
- INSTRUCTOR:** Prof. Robert M. Sykes; Ofc.— 417A Hitchcock Hall, 292-2748;  
Home— 740-392-1107 (7:00 pm to 10:00 pm only).  
email— sykes.1@osu.edu  
sykes1@compuserve.com
- OFFICE HOURS:** MTRF, 10:30 am to 11:18 am. Other times are available by appointment.

**TEXTBOOKS (Required):**

- S. C. Chapra. 1997. *Surface Water-Quality Modeling*. New York: The McGraw-Hill Cos.
- L. C. Brown and T. O. Barnwell, Jr. 1985. *Computer Program for the Enhanced Stream Water Quality Model QUAL2E*, EPA/600/3-85/065. Athens [GA]: U.S. Environmental Protection Agency, Ofc. Research and Development, Environmental Research Laboratory.

**REFERENCES:**

- J. D. Allan. 1995. *Stream Ecology: Structure and Function of Running Waters*. New York: Chapman & Hall USA.
- P. A. Krenkel and V. Novotny. 1980. *Water Quality Management*. New York: Academic Press.
- V. L. Streeter, E. B. Wylie and K. W. Bedford. 1998. *Fluid Mechanics*, 9th ed. Boston: WCB McGraw-Hill, Inc.
- R. V. Thomann and J. A. Mueller. 1987. *Principles of Surface Water Quality Modeling and Control*. New York: Harper & Row, Pub., Inc.
- C. J. Velz. 1984. *Applied Stream Sanitation*, 2nd ed. New York: John Wiley & Sons, Inc.

**OBJECTIVES:** To introduce Environmental Engineering students to modern, quantitative methods for the analysis of used water impacts on receiving waters. Specifically, students will learn how to (1) construct water quality models for various kinds of organic and nutrient loads on rivers, (2) obtain numerical values for model parameters, (3) evaluate waste loadings by means of traditional rules of thumb and (4) use the USEPA water quality computer model QUAL2E.

## TENTATIVE LECTURE SCHEDULE AND READING ASSIGNMENTS:

DATE            TOPIC and READING ASSIGNMENT

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### FIRST WEEK

- Sept. 21.    **Pollution, Beneficial Uses and Assimilative Capacity.**  
Read—none.  
For further information, read —Krenkel and Novotny pp. 19-152. (This is background material and may be read at your option. However, the material is important to your understanding of the purpose and context of water quality modeling, and it should be read if you intend to become a specialist in this field.)  
Homework Due —        none.
- Sept. 22.    **Waste Loads—Flow-Concentration Correlations and Averaging.**  
Read —none.  
For further information, read — Thomann and Mueller pp. 1-24.  
Homework Due —        none.

### SECOND WEEK

- Sept. 25.    **Waste Loads—Ratio Estimators.**  
Read —none.  
For further information, read —none.  
Homework Due—none.
- Sept. 26.    **Hydrogeometry.**  
Read —Chapra pp. 235-243, 247-250.  
For further information, read — Thomann and Mueller pp. 43-48.  
Homework Due—        none.
- Sept. 28.    **Steady, Uniform Flow Calculations with QUAL2E.**  
Read —Brown and Barnwell pp. 9-18, 82-86, 94-99; Chapra pp. 482-500.  
For further information, read —none.  
Homework Due —        HW1: Handout No. 1—Load Calculations.
- Sept 29.    **Drought Flow Statistics—Nonexceedance Probabilities and Gumbel's Method.**  
Read—Chapra pp. 243-244.  
For Further Information Read — Thomann and Mueller pp. 29-42; Velz pp. 75-130.  
Homework—        none.

### THIRD WEEK

- Oct. 2.      **Drought Flow Statistics—Log Pearson Type III Method and Critique.**  
Read —none.  
For further information, read —none.  
Homework Due —        HW2: Handout No. 2—QUAL2EU Hydraulic Calculations.
- Oct. 3.      **River Transport—Control Volume Mass Balance, Averaging, Advection and Dispersion.**  
Read—Chapra pp. 137-143, 149-152.  
For further information, read—Streeter *et al.* pp. 195-198, 212-214, 273-282, 685-695; Thomann and Mueller pp. 81-82, 49-61.  
Homework Due—        none.

- Oct. 5. **River Transport—Steady State Solution for Point Loads with First Order Decay.**  
 Read—Chapra pp. 156-159, 164-166.  
 For further information, read—none.  
 Homework Due— HW3: Handout No. 3—Drought Flow Estimation.
- Oct. 6. **River Transport—Steady State for Point Loads with Dispersion, Determination of Initial Condition and Dispersion Coefficient, Bodenstein's Number.**  
 Read—Chapra pp. 160-164, 168-171.  
 For further information, read— Thomann & Mueller, pp. 71-78, 106-110, 114-118.  
 Homework Due— HW4: Handout No. 4—Transport.

#### FOURTH WEEK

- Oct. 9. **River Transport—cont'd.**  
 Read—none.  
 For further information, read— none.  
 Homework Due— none.
- Oct. 10. **Stream Ecology: BOD, DO Sag and Indicator Species**  
 Read—Chapra pp. 347-355.  
 For further information, read—none.  
 Homework Due— none.
- Oct. 12. **Generalized Streeter-Phelps Model CBOD with Sedimentation: Wright-McDonnell Formula for  $K_r$**   
 Read—Chapra pp. 355-360.  
 For further information, read— none.  
 Homework Due— none.
- Oct. 13. **Oxygen Balance—Equivalence of Sediment Oxygen Demand and CBOD Settling/Absorption.**  
 Read— Chapra pp. 450-457.  
 For further information, read— Thomann and Mueller pp. 61-63, 291-293.  
 Homework Due— HW5: Handout No. 5—Wright-McDonnell Formula.

#### FIFTH WEEK

- Oct. 16. **Reaeration Rate—Lewis-Whitman Two Film Theory and Choice of  $K_a$**   
 Read—Chapra pp. 360-364, 367-380.  
 For More Information Read— Thomann and Mueller pp. 275-283; Velz pp. 233-247.  
 Homework Due— HW6: Handout No. 6—Does QUAL2EU Use H or R in SOD?
- Oct. 17. **Reaeration Rate—Choice of  $K_a$  Formula and Temperature Corrections.**  
 Read— Chapra pp. 377-380.  
 For further information, read—none.  
 Homework Due— none.
- Oct. 19. **Streeter-Phelps Point Source CBOD/DO Models.**  
 Read—Chapra pp. 389-399.  
 For More Information Read—Krenkel and Novotny pp. 243-262; Thomann and Mueller pp. 268-273, 293-297.  
 Homework Due— HW7: Chapra, Chap. 20, pp. 387-388, Prob. 20.9, 20.10, 20.12.
- Oct. 20. **FIRST EXAMINATION (Sept. 21 thru Oct. 17; HW1, Loads, thru HW 7, Reaeration)**

## SIXTH WEEK

- Oct. 23. **“Point” Sludge Deposits.**  
Read—none.  
For further information, read— Thomann and Mueller pp. 291-293; Velz pp. 184-226.  
Homework Due— HW8: Chapra, Chap. 21, pp. 403-404, Prob. 21.3, 21.4, 21.5, 21.6.
- Oct. 24. **Anoxic Reaches:**  
Read—Chapra pp. 399-400.  
For further information, read— Thomann and Mueller pp. 313-317.  
Homework Due— none.
- Oct. 26. **Streeter-Phelps Distributed Source CBOD/DO Models.**  
Read—Chapra pp. 405-410.  
For More Information Read—Krenkel and Novotny pp. 243-262; Thomann and Mueller pp. 268-273, 293-297.  
Homework Due— HW9: Handout No. 7—Point Sludge Deposits.
- Oct. 27. **Estuaries and Dispersion.**  
Read—Chapra pp. 401-403.  
For further information, read— Thomann and Mueller pp. 91-109, 114-119.  
Homework Due— HW10: Handout No. 8—Anoxic Reaches.

## SEVENTH WEEK

- Oct. 30. **Velz’ Distributed Load Model for Estuaries.**  
Read—none.  
For further information, read— Thomann and Mueller pp. 61-64, 66-67, 320-322; Velz pp. 420-455.  
Homework Due—HW11: Handout No. 9—Distributed Loads;  
HW12: Chapra, Chap. 22, p. 418, Prob. 22.5, 22.6.
- Oct. 31. **Two Stage Nitrification Model—Hydrolysis and Oxidation Steps; Effect of pH, DO and Temperature.**  
Read—Chapra pp. 419-432.  
For further information, read— Thomann and Mueller pp. 273-275.  
Homework Due— none.
- Nov. 2. **Nitrification in Rivers.**  
Read—Thomann and Mueller pp. 297-301, 322-327.  
For further information, read—none.  
Homework Due— none.
- Nov. 3. **QUAL2E BOD/DO Simulation.**  
Read—Brown and Barnwell pp. 38-49, 82-86, 94-101, 103-104, 108-109.  
For further information, read—none.  
Homework Due— HW13: Chapra, Chap. 23, p. 432, Prob. 23.1, 23.2.

## EIGHTH WEEK

- Nov. 6. **Nitrification in Rivers, cont’d.**  
Read—Thomann and Mueller pp. 297-301, 322-327.  
For further information, read—none.  
Homework Due— HW14: Handout No. 10—QUAL2EU BOD/DO Simulation.

Nov. 7. **Water Borne Diseases: Indicator Species.**  
Read—Chapra pp. 503-511, 512-516.  
For Further Information Read— Thomann and Mueller pp. 219-245; Velz pp. 281-308.  
Homework Due— none.

Nov. 9. **Water Borne Diseases: Models.**  
Read—none.  
For Further Information Read—none.  
Homework Due— none.

Nov. 10. **HOLIDAY (Veteran's Day)**

#### NINTH WEEK

Nov. 13. **Photosynthesis—Suspended Algae and DiToro's Approximation.**  
Read—Chapra pp. 433-442.  
For further information, read— Thomann and Mueller pp. 283-291, 416-460.  
Homework Due— HW15: Chapra, Chap. 27, pp. 516-517, Prob. 27.1, 27.2.

Nov. 14. **Photosynthesis—Benthic Algae.**  
Read—none.  
For further information, read—none.  
Homework Due— none.

Nov. 16. **Photosynthesis—Numerical Example.**  
Read—none.  
For further information, read—none.  
Homework Due— HW16: Chapra, Chap. 24, pp. 448-449, Prob. 24.1, 24.2, 24.5.

Nov. 17. **River Temperature—Edinger Model for the Heat Balance.**  
Read—Chapra pp. 571-575.  
For Further Information Read— Brown and Barnwell pp. 55-67, 82-86, 94-97, 103, 112-113; Krenkel and Novotny pp. 554-596; Streeter *et al.* pp. 671-684; Thomann and Mueller pp. 599-616; Velz pp. 354-392.  
Homework Due— none.

#### TENTH WEEK

Nov. 20. **River Temperature—Edinger Model: Equilibrium Temperature and Simplified Model.**  
Read—none.  
For further information, read—none.  
Homework Due— none.

Nov. 21. **SECOND EXAMINATION (Oct. 19 thru Nov. 16; HW8, BOD/DO Models, thru HW16, Photosynthesis)**

Nov. 23. **HOLIDAY (Thanksgiving Day)**

Nov. 24. **HOLIDAY (Columbus Day)**

## ELEVENTH WEEK

- Nov. 27. **QUAL2EU Temperature Simulation.**  
Read—Brown and Barnwell pp. 82-86, 94-97, 103, 112-113 .  
For further information, read—none.  
Homework Due— none.
- Nov. 28. **Water/Sediment Particle Balance and Partition Coefficients.**  
Read—Chapra pp. 695-700.  
For further information, read— Thomann & Mueller, Chap. 8, pp. 503-509, 522-527.  
Homework Due—none.
- Nov. 29. **OPTIONAL SENIOR FINAL EXAMINATION  
(Sept . 21 thru Nov. 27; HW1, Loads, thru HW 18, Temperature)**
- Nov. 30. **Suspended Solids Transport Model.**  
Read—Chapra pp. 700-702, 705-708.  
For further information, read—Streeter *et al.* pp. 643-659.  
Homework Due— HW17: Handout No. 11—QUAL2EU Temperature  
Simulation;  
HW18: Chapra, Chap. 30, pp. 575-576, Prob. 30.1, 30.2, 30.3.
- Dec. 1. **Toxics Transport Model.**  
Read—Chapra pp. 702-705, 708-713.  
For further information, read—none.  
Homework Due—none.

## FINALS WEEK

- Dec. 7. **FINAL EXAMINATION (Thursday, 11:30 am to 1:18 pm; Comprehensive)**  
Homework Due— HW19:Chapra, Chap. 40, pp. 713-714, Prob. 40.1, 40.3.
- Dec. 8. **COMMENCEMENT (9:30 am, St. John's Arena)**
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**GRADING POLICY:** Regular students will be graded on the basis of two one-hour examinations, a two-hour final examination and assigned homelessons. Each one-hour examination will count for 30 % of the final grade; the final examination will count for 30%; the homelessons will count for 10%.

Graduating seniors, at their option, may have their grade based on either:

- the two one-hour examinations (counting 45% each) plus the Homelessons 1 through 18 inclusive (counting 10%).

or

- the two one-hour examinations (counting 30% each), an early two-hour final on **Wednesday, November 29th** (counting 30%) plus the Homelessons 1 through 18 inclusive (counting 10%).

Examination questions may require brief essays, derivations of important equations, computer programs and/or numerical solutions to design problems. Examinations will be graded on the basis of demonstrated mastery of theoretical principles; arithmetical accuracy is a minor consideration. In order to achieve any credit, the answers to questions must be clear and complete, showing all equations, all numbers (with units) and all Figures and Tables used.

Missed examinations may be made up upon presentation of a bona fide excuse. Acceptable excuses for missing an examination are limited to personal illness, legal difficulties and family problems.

Late homelessons will not be accepted.

Numerical weighted-average grades will be converted to letter grades using the attached schedule. In the event the class-average numerical grade is below 73, the grades will be adjusted to produce a class-average letter grade not less than C.

GRADE CONVERSION SCHEDULE				
93.	≤	A		
90.	≤	A-	<	93.
87.	≤	B+	<	90.
83.	≤	B	<	87.
80.	≤	B-	<	83.
77.	≤	C+	<	80.
73.	≤	C	<	77.
70.	≤	C-	<	73.
65.	≤	D+	<	70.
60.	≤	D	<	65.
		E	<	60.

**CE 719 WATER QUALITY MODELING**  
Homework (Rev. 9/00)

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**Due Date      Assignment**

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Sept. 28.	HW1:	Handout No. 1—Load Calculations.
Oct. 2.	HW2:	Handout No. 2—QUAL2EU Hydraulic Calculations.
Oct. 5.	HW3:	Handout No. 3—Drought Flow Estimation.
Oct. 6.	HW4:	Handout No. 4—Transport.
Oct. 13.	HW5:	Handout No. 5—Estimation of $K_r$ .
Oct. 16.	HW6:	Handout No. 6—Does QUAL2EU Use $H$ or $R$ in SOD?
Oct. 19.	HW7:	Chapra, Chap. 20, pp. 387-388, Prob. 20.9, 20.10, 20.12.
EXAMINATION NO. 1, OCTOBER 22, 1996 (Sept. 21 thru Oct. 17; HW 1 thru HW7)		
Oct. 23.	HW8:	Chapra, Chap. 21, pp. 403-404, Prob. 21.3, 21.4, 21.5, 21.6.
Oct. 26.	HW9:	Handout No. 7—Point Sludge Deposits.
Oct. 27.	HW10:	Handout No. 8—Anoxic Reaches.
Oct. 30.	HW11:	Handout No. 9—Distributed Loads
	HW12:	Chapra, Chap. 22, p. 418, Prob. 22.5, 22.6.
Nov. 3.	HW13:	Chapra, Chap. 23, p. 432, Prob. 23.1, 23.2.
Nov. 6.	HW14:	Handout No. 10—QUAL2EU BOD/DO Simulation
Nov. 13.	HW15:	Chapra, Chap. 27, pp. 516-517, Prob. 27.1, 27.2.
Nov. 16.	HW16:	Chapra, Chap. 24, pp. 448-449, Prob. 24.1, 24.2, 24.5.
EXAMINATION NO. 2, NOVEMBER 24, 1998 (Oct. 19 thru Nov. 16; HW 8 thru HW 16)		
Nov. 30.	HW17:	Handout No. 11—QUAL2EU Temperature Simulation.
	HW18:	Chapra, Chap. 30, pp. 575-576, Prob. 30.1, 30.2, 30.3.
Dec. 7.	HW19:	Chapra, Chap. 40, pp. 713-714, Prob. 40.1, 40.3.

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