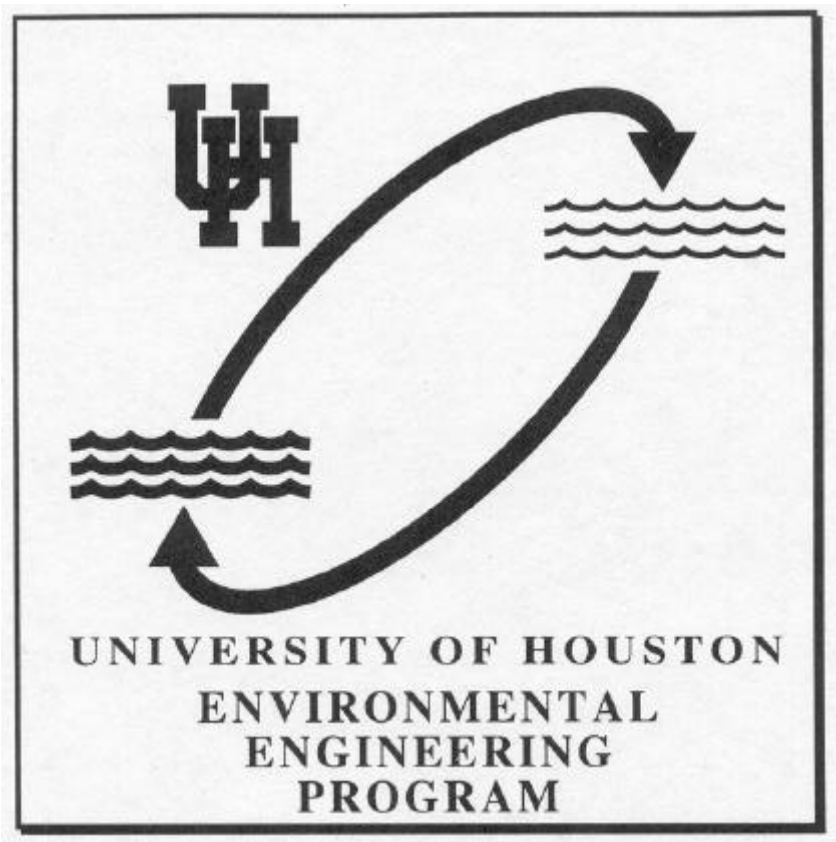

Program Description

University of Houston
Cullen College of Engineering
Department of Civil and Environmental Engineering
Houston, Texas 77204-4791

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THE ENVIRONMENTAL ENGINEERING (EGR-10) PROGRAM AT THE UNIVERSITY OF HOUSTON

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THE ENVIRONMENTAL ENGINEERING (EGR-10) PROGRAM AT THE UNIVERSITY OF HOUSTON

1. GENERAL DESCRIPTION

The Environmental Engineering Program of the University of Houston is an interdisciplinary graduate engineering program within the Cullen College of Engineering, administratively housed in the Department of Civil and Environmental Engineering. The Program and its faculty are internationally known for their research and teaching in water, soil and hazardous wastes.

1.1 The Program's Core Faculty

The Program core faculty comprises six members with complimentary teaching and research interests.
Dr. Shankar Chellam (Assistant Professor) teaches Drinking Water Treatment, Thermodynamics, and Physical-Chemical Processes in Environmental Engineering and researches membrane transport phenomena, including fouling and water quality, disinfection by-product control, and colloidal transport in natural and engineered systems.
Dr. Dennis A. Clifford (Professor and Chairman of the Civil and Environmental Engineering Department) teaches Environmental Chemistry, Physicochemical Treatment Processes, and Water and Wastewater Treatment and researches ion exchange, adsorption and membrane processes for water treatment.
Dr. Theodore G. Cleveland (Associate Professor and Program Director for Environmental Engineering) teaches Groundwater Hydrology, Underground Contaminant Transport, Engineering Mechanics and Computers in Engineering, and researches the modeling of groundwater contaminant movement.
Dr. Hanadi S. Rifai (Assistant Professor) teaches Computers for Engineers, Engineering Design, Hazardous Waste Management and Risk Assessment and Geographical Information Systems, and researches contaminant fate and transport, hydrology, modeling natural attenuation, biodegradation and bioremediation, risk assessment and decision support systems.
Dr. William G. Rixey (Associate Professor) teaches Solid and Hazardous Waste Treatment Processes, Multi-media Contaminant Fate and Transport and Water and Wastewater Treatment, and researches the fate and transport characteristics of contaminants from hazardous wastes.
Dr. Deborah J. Roberts (Associate Professor and is also the Program Academic Advisor.) teaches Engineering Microbiology, Biological Processes for Wastewater Treatment, and Water Quality Engineering and researches bioremediation processes for removal of conventional and toxic pollutants from water and soil, as well as biodeterioration of concrete.

1.2 Typical Research Projects of Core Faculty

Evaluation of resins and adsorbents for removing arsenic from drinking water
Effect of oxygenated fuels on the mobility of gasoline components in ground water.
Phosphate stabilization of lead-contaminated battery waste site soils.
Analysis and removal of arsenic from water at the sub-ppb level.
Natural attenuation of fuel hydrocarbons and chlorinated solvents
Soil treatment to promote desorption of hazardous chemicals.
Removal of lead from soil by extraction with concentrated salt solutions.

Effect of toxic compounds on biological treatment processes.
Dissolution characteristics of polynuclear aromatic hydrocarbons from hydrocarbon mixtures in soil.
Surfactant solubilization properties and recovery methods for the enhanced in situ removal of residual hydrocarbons from contaminated media.
Removal of perchlorate rocket fuel from ground water.
Oxidation of arsenite to arsenate in drinking water.
Biodeterioration of concrete.
Microbiological destruction of perchlorate in ion exchange waste brine.
GIS and Remotely Sensed Mapping in Coastal Environments.
Transport, Fate and Risk Implications of Environmentally Acceptable End Point Decisions.
Developing an Integrated Methodology for Designing long term monitoring plans.
Developing Human Exposure Estimates for Indoor/Outdoor Air Pollution in Houston.
Intrinsic Bioremediation of Mixed Fuel/Solvent Plunes at Petroleum and Petrochemical Gulf Coast Sites.

1.3 The Program's Associated Faculty

Faculty members throughout the University participate in the Environmental Engineering Program by teaching elective courses and serving on the thesis and dissertation committees of Environmental Engineering students. They are listed below with their research interests.

Ivan Bernal, Professor (Chemistry); Ph.D., Columbia. Transition metal chemistry.
Regina Capuano, Associate Professor, (Geosciences); Ph.D., University of Arizonia. Geochemistry and hydrogeology.
Stanley N. Deming, Professor (Chemistry); Ph.D., Penn State. Experimental design.
Osman I. Ghazzaly, Professor/Assoc. Chair (Civil Engineering); Ph.D., Texas at Austin. Soil transport of pollutants.
Miriam Heller, Assistant Professor (Industrial Engineering); Ph.D., Johns Hopkins University. Optimizing process design to protect the environment.
Peter Jurtshuk, Professor (Biology), Environmental Microbiology.
James Lawrence, Associate Professor (Geosciences); Ph.D., Ohio State. Oxygen isotope ratios in environmental studies.
Martin V. Melosi, Professor (History); Ph.D., Texas at Austin. Urban history.
Kishore Mohanty, Associate Professor (Chemical Engineering); Ph.D., Minnesota, Multi-phase flow in porous media.
Carl Norman, Associate Professor (Geosciences); Ph.D., Ohio State. Fault detection and soil permeability.
Michael W. O'Neill, Professor (Civil Engineering); Ph.D. University of Texas at Austin, Sub-surface remediation of hazardous wastes.
James T. Richardson, Professor (Chemical Engineering); Ph.D., Rice. Adsorption and catalysis.
Jerry R. Rogers, Associate Professor (Civil Engineering); Ph.D., Northwestern. Water resources and storm water management.
Frank M. Tiller, Professor (Chemical Engineering); Ph.D., Cincinnati. Filtration.
Shiao-Chun (David) Tu, Professor (Biochemical and Biophysical Sciences); Ph.D., Cornell. Bioengineering.
C. Vipulanandan, Professor (Civil Engineering); Ph.D., Northwestern. Solidification and stabilization processes for contaminated soils.
Keh-Han Wang, Associate Professor (Civil Engineering); Ph.D., Iowa. Estuary/coastal hydrodynamics and transport of pollutants.

Richard Willson, Associate Professor (Chemical Engineering); Ph.D., MIT, Biochemical engineering.

1.4 Admission to the Program

U.S. and international students with a bachelor's degree in engineering from an accredited institution and appropriate grade point average (GPA) and Graduate Record Examination (GRE) scores may be admitted directly to the program. U.S. Students with a Bachelor's Degree in Engineering-related disciplines (Biology, Chemistry, Mathematics, Geology, Geophysics, and so forth) can be admitted to the program after completion of two years of Mathematics through differential equations, one year of calculus-based physics, one year of chemistry (with lab) and a computer programming course. After admission to graduate school, these students must take seven undergraduate engineering "leveling" courses to put them on par with engineering graduates and to help them pass the Fundamentals of Engineering (FE) examination, the first step toward a Professional Engineering (PE) license. This option is not open to international students, who must possess an engineering degree upon admission to the Program.

1.5 Program Course Work Options

Entering students may choose between a thesis (30 credit hours) and a non-thesis (36 credit hours) Master's Degree. All students must take six required three-credit-hour courses. In addition, thesis students take two elective courses, perform research, and write a thesis worth six credit hours. All supported students must choose the thesis option. Part-time students and full-time students in the non-thesis option must take six elective courses in addition to the six required courses. Most of the elective courses are offered in the Colleges of Engineering, Natural Science and Mathematics, Law, and Business.

1.6 Program Facilities

The eight Environmental Engineering Laboratories located in the modern North Wing of the Engineering Building provide an excellent research and teaching environment. One is a large, 1900-sq ft laboratory for teaching and unit-operations research. Another large, 1200-sq ft instrumentation laboratory, a 280-sq ft mass spectroscopy laboratory space, and five 350-sq ft, two person research laboratories are available. Additional laboratory space in an adjacent building is used for hazardous materials research. Off campus research is conducted in the UH/EPA Mobile Drinking Water Treatment Research Facility which is operated in small communities to find cost-effective methods for removing inorganic and radioactive contaminants from ground water, and with a transportable 2 liter/min drinking water pilot plant. During 1995 and 1996, we upgraded our analytical Laboratories. We are now among the best-equipped academic environmental laboratories in the world with instruments for organic, inorganic, microbiological and radiological, and particulate analysis.

1.6.1 Laboratory Manager

Use of the analytical instruments is monitored by Louis Simms, the full-time Laboratory Manager/Staff Chemist who also has responsibility for lab safety. His 30 years experience with chemical analyses and instrumentation is particularly helpful to the graduate students on a day-to-day basis as they learn to use the instruments and conduct their experiments.

1.6.2 Computers

The University of Houston operates a computer-intensive environment for teaching and research. Main frame, mini, and super computers are available to faculty and students through local area networks. General-use personal computers are available in the College of Engineering for use by all students. Additionally, the faculty may arrange computing resources for use by their graduate students.

2. ENVIRONMENTAL ENGINEERING ADMISSION PROCEDURES

Notes: International Students are primarily admitted only in the Fall Semester.

Applicants should be able to support themselves for at least one year because only our most outstanding entering students receive financial support.

No special forms are required to apply for financial aid. Simply indicate your need for financial support on the yellow *Prospective Student Form*.

BS Degrees in Technology, Business, Management, etc. are not acceptable for admission to Environmental Engineering.

International students without an engineering degree are ineligible for admission.

2.1 Admission Categories

New students may enter as M.S. or Ph.D. students. The requirements for Master's applicants generally apply to Doctoral students except that Ph.D. applicants are screened much more carefully and are held to a significantly higher academic standard. Doctoral applicants must also demonstrate an aptitude for conducting original research. Further information regarding Ph.D. Admission is given in section 5.

Students attempting to transfer into Environmental Engineering from graduate programs at UH or elsewhere are considered "transfers" or "non-routine" applicants. Procedures for transfer students are given in Section 2.3.

2.2 Admission Procedure for Routine Applications

To be considered for possible admission as a graduate student in any given Fall Semester, an applicant must send all of the applicable items below directly to the Program Director by February 10th. The Director's address is

Dr. Theodore G. Cleveland, Director
Environmental Engineering Program
University of Houston
Houston, Texas 77204-4791

Note: E-Mail may be used to get rapid answers to specific questions.
Dr. Cleveland's E-Mail address is cleveland@uh.edu

International applicants should aim to have their application materials to us earlier to allow additional time for transcript evaluation and visa-related paperwork**.** All applications (U.S.A. and International) completed after the deadlines will be considered for admission during the following Spring or Fall Semester without additional fee payment.

Upon receipt of all of the applicable information listed below in Sections 2.2.1 and 2.2.2, applicants will be informed by mail that their admission package is complete, then their file will be evaluated by the five-member Admissions Committee. If the Committee and the Associate Dean for Engineering Graduate Studies approve, admission will be offered. Admission letters will usually be mailed before May 1st.

The admission offer will indicate whether or not financial support in terms of a teaching or research assistantship is also being offered. Unfortunately, we are only able to support about ten percent of our incoming students during their first semester. Eventually, about 70 percent of those students seeking financial support receive a teaching or research assistantship.

2.2.1 Materials Required from U.S. Students:

1	Completed yellow *Prospective Student Information Form* (Attach unofficial copy of transcript and GRE scores if available). If you have already sent the *Prospective Student Form* and the unofficial transcripts and GRE scores , do not send them again.
2	Completed *Application Form.*
3	The blue *Privacy Rights Form* (must be signed).
4	Twenty-five ($25.00) dollar non-refundable application fee. **This fee cannot be waived**, and must be paid as (a) a personal check drawn on US Bank, (b) a cashier's check, or (c) a money order. No action will be taken on your application until this fee is received.
5	Official GRE Scores from Educational Testing Services (ETS). Only the general test including verbal, quantitative, and analytical sections is required. Minimum quantitative = 650; minimum verbal + quantitative = 1100; analytical score is considered but no minimum applies.
6	**Two** *Official Transcripts* from all Colleges and Universities you attended. Minimum acceptable GPA is 3.0/4.0 ("B") on last 60 hours attempted; higher grades are expected in graduate courses.
7	**Three** separate *letters of reference* on the forms provided. These must be sent directly to us from the person making the recommendation.
8	Photocopy of the *Diploma(s)* you received, showing the date you received the Degree(s), the type of Degree(s) you received and from what Institution(s). Not required if you are graduating near or after the admission deadline.
9	*Statement of Purpose* (100-300 words) briefly describing why you want to study environmental engineering at the University of Houston.

2.2.2 Materials Required from International Students:

1	Completed yellow *Prospective Student Information Form* (Attach unofficial copy of transcript and GRE scores if available). If you have already sent the Prospective Student Form and the unofficial transcripts and GRE scores , do not send in again.
2	Completed *International Student Application Form*.
3	The blue *Privacy Rights Form* (must be signed).
4	Seventy-five ($75.00) dollar non-refundable application fee. **This fee cannot be waived**, and must be paid as (a) a personal check drawn on US Bank, (b) a cashier's check, or (c) a money order. No action will be taken on your application until this fee is received.
5	Official GRE Scores from Educational Testing Services (ETS). Only the general test including verbal, quantitative, and analytical sections is required. Minimum quantitative = 650; minimum verbal = 350; minimum V + Q = 1100; analytical score is considered but no minimum applies.
6	**Two** *official transcripts* (mark sheets) from **each** College or University attended. Applicants should rank in top 25% of class. Minimum acceptable grade average is "B" on last two years of courses; higher grades are expected in graduate courses.
7	**Three** separate **letters of reference** on the forms provided. If possible, use the forms provided and have the letters sent directly to us by the person making the recommendation.
8	Photocopy of the *Diploma(s)* you received, showing the date you received the Degree(s), the type of Degree(s) you received and from what Institution(s). Not required if you are graduating near or after the admission deadline.
9	*Statement of Purpose* (100-300 words) briefly describing why you want to study environmental engineering at the University of Houston.
10	**Two** pictures of yourself.
11	Official TOEFL Scores (minimum = 550), not required of students with an MS degree from a U. S. institution.
12	Signed *Letter of Financial Backing* (applicants with employment in the US should provide documentation of employment from their employer).
13	Signed *Statement of Understanding*.
14	*Educational Experience Form*.

2.3 Admission Procedure for Transfer Students

2.3.1 Non UH Transfers

Transfer students from graduate schools in other universities are treated as routine applicants and must meet the requirements of Section 2.2. Only six credit hours of graduate course work completed with a grade of "B" or better may be applied towards the UH Environmental Engineering Degree Requirements. Courses transferred into the Environmental Engineering Program must have been taken within five years of admission to the Program.

2.3.1 UH Transfers

Graduate students from within the University of Houston may be considered for transfer into the Environmental Engineering Program if they (1) possess an undergraduate or graduate degree in engineering or science, (2) have completed at least one semester of graduate study, and (3) are qualified for admission into program as compared to recently admitted students. UH transfer students apply by filing a ***General Petition*** to change major from their current program into the Environmental Engineering Program. This will result in the student's file being transferred to Environmental Engineering. Note that admission is competitive and completed transfer files must contain the same items as listed in Sections 2.2.1 and 2.2.2.

3. M. S. ADMISSION REQUIREMENTS AND COURSE WORK

3.1 M. S. Admission Categories

Admission into the M.S. program in Environmental Engineering may be either *Unconditional* or *Conditional*. (Admission is competitive and meeting minimum admission requirements does not guarantee admission.) Conditional admission, which is rare, places the entering student on academic probation for the first 12 hours of course work attempted (see Section 3.1.3).

3.1.1 Unconditional Admission for U.S. Students:

To be admitted unconditionally, a U. S. student must have

1. A B.S. degree in engineering or in a science related to engineering—for example, biology, chemistry, mathematics, physics, or geology—from an accredited college or university. Non-engineers with degrees in related fields may be considered for admission after certain prerequisite courses are completed; see Section 4.1. Applicants with non-science bachelor's degrees in fields such as technology, management, business, and the arts must obtain an accredited engineering degree before applying.

2. A minimum grade point average (GPA) of "B", i.e., 3.0 on a 4.0 scale on the last 60 hours of course work attempted.

3. An acceptable Graduate Record Exam (GRE) score (Minimum quantitative = 650; minimum verbal + quantitative = 1100; analytical score is considered but no minimum applies.). The GRE advanced test (engineering) need not be taken. Old scores are valid, provided ETS can provide official copies to us.

4. Submission of three letters of recommendation on the forms provided. These letters must be sent directly to us by the person making the recommendation.

3.1.2 Unconditional Admission for Nonimmigrant Visa Students

To be accepted unconditionally, an international student must have

1. The foreign equivalent of an accredited American B.S. or M.S. degree in engineering.
Note: ***Nonimmigrant Visa students without an engineering degree will not be considered.***

2. A minimum GPA of 3.0/4.0 (B) on the last 60 hours of course work attempted. Higher grades are expected in graduate courses taken. Foreign transcripts and/or mark sheets will be evaluated by the International Student Admissions Office.

3. Except for applicants with an M.S. degree from a U.S. Institution, a minimum score of 550 on the Test of English as a Foreign Language (TOEFL). The International Student Office will also test students whose native language is not English prior to the first registration. Based on the International Student and Scholar Office recommendation and subject to Departmental evaluation, an international student may be required to take certain remedial courses in English and Speech concurrent with the Program courses. Under no circumstances will these remedial courses apply to the credit-hour requirement for the graduate degree.

4. An acceptable Graduate Record Exam (GRE) score (verbal 350, quantitative 650, V + Q 1100). The GRE advanced test need not be taken. Old scores are valid, provided the Educational Testing Service (ETS) can provide official copies to us.

5. Submission of three letters of recommendation. If possible, use the forms provided and have the letters sent directly to us.

3.1.3 Conditional Admission for U.S. Students

Note: Conditional admission is only available to U.S. citizens and permanent residents with engineering degrees.

Conditional Admission is the same as Unconditional Admission, except that

1. A lower GPA (2.75/4.0) is acceptable on the last 60 hours of course work attempted.

2. A lower GRE is acceptable if the student's GPA tends to compensate for the low GRE.

To earn full (unconditional) admission status, the student must maintain a GPA of 3.0/4.0 on the first 12 credit hours of graduate study.

3.2 Transfer Student Admission Requirements

Students transferring from graduate school at another University must satisfy the same requirements and admission deadlines as applicants with B.S. degrees; in addition, a GPA of at least 3.5 is expected on graduate courses. Transfer courses must have been taken within the last five years. Only six credit hours of graduate courses from another university may be applied towards the UH graduate degree requirements. (This limit does not apply to approved University of Houston—Clear Lake courses, which are considered UH courses. Advance approval must be obtained from the Program's Academic Advisor or the Program Director to receive credit for UH-CL courses.)

3.3 Satisfying the Minimum M.S. Admission Requirements

Satisfying the minimum admission requirements does not guarantee admission. All applicants must be approved by the Environmental Engineering Admissions Committee and the Associate Dean of Engineering for Graduate Programs. Typically, about one-third of the applicants meeting the minimum requirements are admitted.

3.4 Faculty Advisor and Thesis Research

Admission as a full-time M.S. student does not guarantee that financial support will be available for those desiring to undertake thesis research. Each Thesis M.S. student must choose a core faculty member as his/her advisor and this faculty member must agree to chair the student's thesis research committee. Ordinarily, the Thesis Committee Chair will arrange financial support for the student and the research. A thesis Master's degree typically requires two years (or more) of full time effort to complete the course work, plan and perform the research, and write and defend the thesis.

3.5 Financial Support for Thesis Research

Generally, supported M.S. students receive at least $1100/month in direct support for their research and teaching duties, which will require a minimum of 20 hours/week of work. Financial support includes medical insurance and qualifies the student for the lower, Texas-Resident Tuition, which he/she must pay each semester.

3.6 M.S. Credit-Hour Requirements and Course Loads

The non-thesis M.S. degree requires 36 credit hours of academic course work plus registration for Environmental Engineering Seminar (CIVE 6111) in two semesters. The thesis M.S. degree requires 24 credit hours of academic course work, six credit hours of thesis research, and enrollment in seminar each semester on support. Full-time students receiving financial support must register for 12 credit hours each Fall and Spring semester, and 9 hours each summer semester. Full-time students substitute CIVE 6X98 (X Credit Hours of Research) for academic course work in any semester. Be advised that enrollment in CIVE 6X98 requires a faculty research advisor (not necessarily the student's thesis advisor) who will assign a grade—"S" for Satisfactory or "U" for Unsatisfactory. **Leveling and prerequisite courses are not counted in the above 12- or 9-hr requirements.**

3.7 Required and Elective Courses for the M.S. Degree

Six graduate courses are required for an M.S. in Environmental Engineering. The remainder of the 30-or 36-credit hour requirement is made up of elective courses from within the program or from other departments and colleges within the University. The required courses and recommended elective courses are listed below. Complete course descriptions of all possible Environmental Engineering courses are presented in Section 8.

Semester Taught	**Course No.**	**Course Description with Pre- or Co-requisite Courses in Parentheses**	**R/E**
Fall	*CIVE 6377*	*Environmental Chemistry*	*R*
Spring	*CIVE 6387*	*Physicochemical Treatment Processes (CIVE 6377)*	*R*
Fall	*CIVE 6391*	*Engineering Microbiology (CIVE 6377)*	*R*
Spring	*CIVE 6381*	*Biological Processes for WW Treatment (CIVE 6391)*	*R*
Fall	*CIVE 6390*	*Municipal Drinking Water Treatment (CIVE 6377)*	*R*
Fall	*CIVE 6388*	*Hazardous Waste Treatment Processes (CIVE 6387,6361)*	*R*
Fall	*CIVE 6111*	*Environmental Engineering Seminar*	*R*
F, Sp, Su	CIVE 6399	M.S. Thesis I, First semester M.S. Thesis	R*
F, Sp, Su	CIVE 7399	M.S. Thesis II, Second & following semesters M.S. Thesis	R*¶
F, Sp, Su	CIVE 6X98	M.S. Research (X = No. of credits)	R*§
Spring	CIVE 7330	Organic Contaminant Control (CIVE 6390)	E
Fall	CIVE 6361	Groundwater Hydrology	E

Spring	CIVE 7332	Flow and Contaminant Transport Modeling (CIVE 6361)	E
Spring	CIVE 7397	Hazardous Waste Management and Risk Assessment	E
Summer	CIVE 7372	Geotechnical Practice in Waste Disposal	E

R = Required; E = Elective

* Thesis and research courses are only required for students who choose the thesis option.

¶ Thesis students must continue to enroll in CIVE 7399 until the thesis is complete.

§ "X" is the number of credits in any 6x98 course. Larger numbers of credits may be obtained by combinations of 6x98 courses, taken each semester. Full-time students receiving financial support from UH must take 12 credits during the fall and spring semesters and 9 credits during the summer sessions. See Section 3.6 above.

3.8 Typical Degree Plan for M.S. Thesis Student

Fall Semester 1 (13 Credits)
CIVE 6377—Environmental Chemistry,
CIVE 6391—Engineering Microbiology,
CIVE 6390—Municipal Drinking Water Treatment,
CIVE 6XXX—Elective 1
CIVE 6111—Seminar
Spring Semester 1 (13 Credits)
CIVE 6387—Physicochemical Treatment Processes
CIVE 6381—Biological Processes for Wastewater Treatment
CIVE 6398—Research
CIVE 6XXX Elective 2
CIVE 6111—Seminar
Summer Semester 1 (12 Credits)
CIVE 6399—M.S. Thesis I
CIVE 6598—Research
CIVE 6498—Research
Fall Semester 2 (13 Credits)
CIVE 7397—Hazardous Waste Management and Risk Assessment
CIVE 7399—M.S. Thesis II
CIVE 6498—Research
CIVE 6298—Research
CIVE 6111—Seminar
Spring Semester 2 (13 Credits)
CIVE 7399—M.S. Thesis II
CIVE 6598—Research
CIVE 6498—Research
CIVE 6111—Seminar.
Summer Semester 2—The Semester of Graduation (12 Credits)
CIVE 7399—M.S. Thesis II
CIVE 6598—Research
CIVE 6498—Research

3.9 Typical Degree Plan for Non-Thesis M.S. Student

Non-thesis students may be full- or part-time. Full-time students generally follow the plan above but substitute electives for thesis and research courses. Part-time students with full-time jobs take one or two courses each semester, including summer.

3.10 Restrictions, Course Grades, and Time Limitations

Only two courses (6-credit hours) below the 6000 level may be applied to the M.S. degree. These courses must be approved by the Director and the Associate Dean by means of a *Graduate General Petition.* Always obtain permission from the Program Academic Advisor or Program Director before enrolling in non-graduate courses for which graduate credit is anticipated.

All students must have a "B" average (GPA 3.00) in order to graduate. A student who earns four "C" grades in graduate courses will be dropped from the Program. Students admitted conditionally who do not maintain a "B" average on the first 12 hours of graduate courses attempted will be dropped from the Program. All courses applied to the M.S. degree must be completed within five years after the first enrollment. Supported students must maintain a
GPA≥ 3.00 every semester otherwise financial support will be terminated and cannot be reinstated until their GPA returns to 3.00 or greater.

4.0 REQUIRED UNDERGRADUATE PREREQUISITE AND LEVELING COURSES FOR NON-ENGINEERS

Note: The following regulations apply to U.S. Citizens and Permanent Residents only. All International Students must have engineering degrees in order to enter the Program. Students with B.S. degrees in non-engineering-related programs, e.g., technology, business, management architecture, and the arts must complete an engineering degree before admission.

The following courses are required as undergraduate prerequisite and leveling courses for non-engineers receiving the M.S. degree in Environmental Engineering.

4.1 Prerequisites to Application and Acceptance

These University of Houston courses or their equivalents must be completed with a grade of C- or better *before admission* to the M.S. Program in Environmental Engineering will be considered.

Course(s)	UH Designations
Fundamentals of Chemistry	CHEM 1331 and 1332
Fundamentals of Chemistry Laboratory	CHEM 1111 and 1112
Calculus I, II, and III and Differential Equations	MATH 1431, 1432, 2433, and 3321
Calculus-Based Physics (without laboratory)	PHYS 1321 and 1322
Introductory Computer Programming	COSC 1301 or equivalent

4.2 Leveling Courses

These University of Houston courses are *in addition* to the 30- or 36-credit hour requirement for an M.S. degree in Environmental Engineering, but may be taken concurrently with graduate courses *after admission* to graduate school. A “B” average must be maintained for all these courses. Students are expected to complete all leveling course requirements within one year of entering the program.

Course	UH Designations
CIVE 2330	Mechanics I
CIVE 2331	Mechanics II
CIVE 2332	Mechanics of Deformable Bodies
CIVE 3434	Fluid Mechanics & Hydraulic Egr
ELEE 3336	Intro Circuits & Electronics
ENGI 2334	Introduction to Thermodynamics

Students with a BS in engineering-related science programs can become licensed as a PE in the state of Texas by passing the Fundamentals of Engineering (FE) examination, obtaining four years of experience under a licensed PE, and passing the Principles and Practices Examination. The undergraduate engineering courses are selected to place non-engineers on a par with engineering graduates and to help the student pass the FE examination.

5. Ph.D. ADMISSION REQUIREMENTS AND COURSE WORK

Students start the Ph.D. program in "Post-M.S." status. The same admission process and deadlines described in Section 2 apply to Ph.D. applicants. Admission requirements are as follows:

5.1 Ph.D. Admission for U.S. Students

The applicant must have

1. An approved MS degree in Chemical Engineering, Civil Engineering with environmental emphasis, or Environmental Engineering. The student must have been in the top 25 percent of the MS class and have completed a thesis. A copy of the title page, signature page, and thesis abstract must be submitted with the application.

2. A Grade Point Average (GPA) of 3.5 or greater on a 4.0 scale for M.S. work.

3. An acceptable Graduate Record Exam (GRE) score. The GRE advanced test need not be taken. Old scores are acceptable if the Educational Testing Service can provide us with official scores.

5.2 Admission for International (Nonimmigrant Visa) students

The applicant must have

1. An ABET-accredited M.S. degree in Chemical Engineering, Civil Engineering with environmental emphasis, or Environmental Engineering, or the foreign equivalent thereof. The student must have been in the top 20 percent of the M.S. class and have completed as M.S. thesis. A certified copy of the title page, signature page, and thesis abstract must be submitted with the application .

2. Grade Point Average (GPA) of 3.5 or greater on a 4.0 scale for M.S. work.

3. A minimum score of 550 on the Test of English as a Foreign Language (TOEFL), not required for students with an M.S. degree from a U.S. school. If this is the first registration in the United States, the International Student and Scholars Office (ISSO) will also test students whose native language is not English. Based on the ISSO recommendation and subject to Departmental evaluation, an international student may be required to take certain remedial courses in English and Speech during the

early semesters of registration. Under no circumstances will these remedial courses apply to the minimum credit-hour requirements of the graduate degree program.

4. An acceptable Graduate Record Exam (GRE) score. The GRE advanced test need not be taken. Old scores are acceptable if the Educational Testing Service can provide us with official scores.

5.3 Satisfying the Minimum Ph.D. Admission Requirements

Admission is competitive. Satisfying the minimum admission requirements does not guarantee admission. All applicants must be approved by the Environmental Engineering Admissions Committee and the Associate Dean of Engineering for Graduate Programs.

5.4 Ph.D. Credit-Hour Requirements

The Ph.D. degree requires 52 credit hours of approved courses beyond the M.S. degree, to include 7-10 hours of major courses, 12-15 hours of electives in related fields and 30 hours of research and dissertation. These requirements translate to a minimum of 24 credit hours of course work (eight 3-credit non-research courses) beyond the Master's Degree. A **maximum** of 100 credit hours as a Ph.D. student also applies. After 100 hours, the student is no longer eligible for the lower, Texas-Resident Tuition. Further details of Ph.D. course work are presented in the table in Section 5.11. Full-time students receiving financial support must register for 9 credit hours (9 hrs + seminar) each Fall and Spring semester, and 9 hours each summer semester.

5.5 Choosing a Faculty Mentor for Ph.D. Research

Admission into the Ph.D. program as a Post M.S. student does not guarantee that financial support will be available for the required doctoral research. Each Post M.S. student must choose a core faculty member as mentor who agrees to chair the student's dissertation research committee. Ordinarily, the Dissertation Committee Chairman will arrange financial support for the student and the research. A Post-M.S. student becomes a Ph.D. student after passing the qualifying examination, which is usually taken after three semesters in residence.

5.6 Financial Support for Ph.D. Research

Generally, supported Ph.D. students start at $1,100 in direct support for their research and teaching duties, that require a minimum of 20 hours/week of work. Financial support includes medical insurance and qualifies the student for the lower, Texas-Resident Tuition, which he/she must pay each semester.

5.7 Ph.D. Qualifying Examination

A Post-M.S. student becomes a Ph.D. student after Passing the qualifying examination, which must be taken after three semesters in residence but no later than two years. The exam comprises written and oral parts. The student has one week to write a comprehensive critique of a journal article from the recent literature relating to the intended area of research. Approximately two weeks after submitting the written critique to the examination committee (consisting of the core faculty members) the student presents and defends the critique in front of the committee. The results is pass (excellent, good or fair) or fail (poor). The examination may be retaken once.

5.8 Dissertation Committee and Ph.D. Candidacy Examination

After the student has completed about 1-2 years of course work and preliminary research, he/she prepares a formal research proposal and selects a dissertation committee consisting of a chair, two EGR-10 Program faculty members, one engineering faculty member from outside the CEE Department, and one member

from outside the College. Members are chosen by agreements between the student, the chair, and the potential member. All committee appointments must be approved by the Program Director and the Associate Dean for Graduate Studies. A candidacy examination consists of a formal proposal presentation and defense in front of the dissertation committee. The result is pass or fail. If the result is pass, the Ph.D. student becomes a Ph.D. Candidate. Even with a pass, the committee may point out deficiencies in the proposed research and recommend additional course work or require that specific experiments be complete. The exam may be retaken once. To avoid problems during the final dissertation defense, the student should keep the committee members informed of research progress.

5.9 Defense of Dissertation

After completing the research and writing the dissertation, the candidate defends the dissertation in a public meeting of the committee, interested faculty, staff, and students. The result is pass or fail with a pass usually being accompanied by recommended changes to the final draft.

5.10 Ph.D. Course Grades and Time Limitations

Although all graduate students must maintain a "B" average (GPA 3.0), a Doctoral student should aim for a GPA 3.5. A Doctoral student who earns four "C" grades in graduate courses will be dropped from the Program. Doctoral students who fail to complete their dissertation within five years after completion of the comprehensive examination must retake the exam.

5.11 Typical Course Work Leading to the Ph.D. in Environmental Engineering

Semester	Course No.	Credits	Course Description
Prior to Entrance			M.S. Degree in Environmental Engineering, Chemical Engineering, or Civil Engineering with emphasis in environmental courses and a research thesis
Fall-1	UG/GRAD	9	Course Work in environmental engineering or chemical engineering, computers, chemistry, other sciences or mathematics
	CIVE 6X98	3	Post M.S. Research
	CIVE 6111	(1)	Seminar (must be taken each semester)
Spring-1	UG/GRAD	9	Course Work in engineering, science, or mathematics
	CIVE 6X98	3	Post M.S. Research
Ph.D. COMPREHENSIVE (QUALIFYING) EXAM taken here or at the end of a later semester when student is prepared but no later than two years after entrance. After passing this exam the student is officially a Ph.D. student.			
Summer-1	CIVE 8X98	12	Doctoral Research
Fall-2	UG/GRAD	6	Course Work in engineering, science, or mathematics
	CIVE 8X98	6	Doctoral Research
Ph.D. CANDIDACY EXAM (Research Proposal Defense) taken here or at the end of a later semester when the student has done sufficient preliminary research and is prepared.			
Spring-2	UG/GRAD	3	Course Work in engineering, science, or mathematics
	CIVE 8X98	9	Doctoral Research
Summer-2	CIVE 8X98	6	Doctoral Research
	CIVE 8399*	6	Doctoral Dissertation

Fall-3	CIVE 8X98	6	Doctoral Research	
	CIVE 8699	6	Doctoral Dissertation	
Spring-3		CIVE 8999 6		Doctoral Research
	CIVE 8X98	6	Doctoral Dissertation	

DEFENSE OF DOCTORAL DISSERTATION EXAM TAKEN HERE

Notes: A minimum of 24 credit hours of non-research course work (excluding seminar) must be taken beyond the M.S. degree. A maximum of 12 credit hours of undergraduate courses at the 3000, 4000, or 5000 level may be taken for graduate credit. (Graduate credit may not be obtained for 3000 level engineering courses.) If these undergraduate courses are prerequisites to required graduate level work, they will be considered leveling courses and will not count toward the 24 credit requirement. **Ph.D. students with non-environmental engineering M.S. degrees will concentrate on the environmental engineering courses offered while M.S. environmental engineers will emphasize course work outside the program.** All Ph.D. students must take a minimum of 24 hours of doctoral research (8X98 courses) and 12 hours of doctoral dissertation (8X99 courses). "X" is the number of credits in any 8X98 or 8X99 course. Larger numbers of credits may be obtained by combinations of 8X98 and 8X99 courses, taken each semester. Full-time students receiving financial support from UH must take 13 credits during the fall and spring semesters and 12 credits during the summer sessions. CIVE 6111 (seminar) is included in these total credits and must be taken each semester it is offered.

*Once Doctoral Dissertation credits are registered, enrollment in the University must be continuous until graduation.

6. PREREQUISITES COURSE DESCRIPTIONS

CHEM 1331-1332: Fundamentals of Chemistry Cr. 3 per semester. (3-0). For science and engineering majors. Modern concepts using mathematics for understanding principles, fundamental laws of atomic and molecular structure, states of matter, equilibrium, kinetics, and elementary inorganic, nuclear, and organic chemistry.

CHEM 1111-1112: Fundamentals of Chemistry Laboratory Cr. 1 per semester. (0-3). Prerequisite: credit for or concurrent enrollment in CHEM 1331-1332. Illustrate and reinforce principles and concepts by use of quantitative experiments, emphasizing interpretation and reporting of data and facility in handing scientific instruments.

MATH 1431: Calculus I Cr. 4. (4-0). Prerequisite: MATH 1330. Calculus of rational functions; limits, derivatives, applications of the derivative, antiderivatives, the definite integral with applications, mean value theorem, fundamental theorem of calculus, numerical integration.

MATH 1432: Calculus II Cr. 4. (4-0). Prerequisite: MATH 1431. Calculus of transcendental functions: additional techniques and applications of integration, indeterminate forms, improper integrals, Taylor's formula, infinite series.

MATH 2433: Calculus III Cr. 4. (4-0). Prerequisite: MATH 1432. Calculus of functions of N-variables: calculus of vector-valued functions, partial differentiation, multiple integrals.

MATH 3321: Engineering Mathematics Cr. 3 (3-0) . Prerequisites: MATH 1432. First order ordinary differential equations and initial value problems; higher order differential equations; vector spaces, matrices, determinants, eigenvectors and eigenvalues; applications to systems of first order equations; Laplace transforms. Students may not receive credit for both MATH 3321 and MATH 3331.

PHYS 1321: Engineering Physics I Cr. 3 (3--1). For civil, mechanical, industrial and electrical engineering majors. Prerequisite: MATH1431. Credit may not be applied toward agreed for both 1321 and 1311 or 1301. Mechanics-1-d and 2-d motion, dynamics, energy, momentum, rotational dynamics and kinematics, statics, oscillations, and waves.

PHYS 1322: Engineering Physics II Cr.3. (3--1). For civil, mechanical, industrial and electrical engineering majors. Prerequisite: MATH 1432. Credit may not be applied toward a degree for both 1322 and 1312, 2313, 0r 1302. Thermodynamics, electricity, magnetism, electromagnetic waves and optics.

COSI 1301: FORTRAN Programming Cr. 3. (3-0). Prerequisite: MATH 1310 or equivalent. Introduction to FORTRAN, techniques of designing FORTRAN programs, programming in FORTRAN. No programming experience necessary.

7. LEVELING COURSE DESCRIPTIONS

CIVE 2330: Mechanics I Cr. 3. (3-0). Prerequisites: PHYS 1311 and credit for or concurrent enrollment in MATH 2433. Composition and resolution of forces, free-body diagrams, analysis of forces acting on structures and machines, friction, centroids and moments of inertia.

CIVE 2331: Mechanics II Cr. 3. (3-0). Prerequisites: CIVE 2330 and MATH 2433. Dynamics of rigid bodies; force-mass-acceleration, work-energy, impulse-momentum, and introduction to mechanical vibrations.

CIVE 2332: Mechanics of Deformable Solids Cr. 3. (3-0). Prerequisite: CIVE 2330. Stress and strain in elastic bodies; statically determinate and indeterminate members; axial force, shear, moment and torsion; beam deflections; columns; combined stresses.

ENGI 2334: Introduction to Thermodynamics Cr. 3. (3-0). Prerequisites: CHEM 1332, MATH 2433, and PHYS 1312. Fundamental concepts, thermodynamic systems and applications, heat and work, properties of pure substances, first and second laws.

ENGI 3363: Elementary Fluid Mechanics Cr. 3. (3-0). Prerequisites: ENGI 2334, MATH 3331, and CIVE 2331 or MECE 3400. Foundations of fluid mechanics, fluid statics, kinematics, laminar and turbulent flow; macroscopic balances; dimensional analysis and flow correlations.

CIVE 3434: Fluid Mechanics & Hydraulic Engr. Cr. 3. (3). Prerequisite: ENGI 3363. Hydrology, hydrostatics, flow in open channels, pipes and porous media; metering devices.

8. COURSE DESCRIPTIONS FOR ENVIRONMENTAL ENGINEERING PROGRAM COURSES

REQUIRED COURSES

6111: Graduate Seminar in Environmental Engineering. Cr. 1. (1-0). Must be taken each semester by all students receiving financial support. Must be taken at least twice by all M.S. students.

CIVE 6377: Environmental Chemistry Cr. 3. (2-3). Prerequisites: CHEM 1331, 1332, 1111, and 1112; and graduate standing in environmental engineering. Aqueous environmental chemistry in natural waters and wastewaters: ionic equilibria, solubility, hardness, alkalinity, buffering, and the carbonate system; theory and practice of quantitative water and wastewater analysis.

CIVE 6381: Biological Processes for Wastewater Treatment Cr. 3. (3-0). Prerequisite or corequisite: CIVE 6391 or CHEE 6360. Theory and practice of biological wastewater treatment including aerobic and anaerobic processes in suspended and attached growth reactors, treatment models, advanced treatment, sludge handling, and treatment plant design.

CIVE 6387: Physicochemical Treatment Processes Cr. 3. (3-0). Prerequisite: CIVE 6377 or equivalent. Theory and practice of physicochemical treatment processes for water and wastewater treatment: reactors, dispersion, adsorption, ion-exchange, membrane processes, and disinfection.

CIVE 6388: **Hazardous Waste Treatment Processes**, Cr. 3. (3-0). Prerequisite: CIVE 6387 or equivalent. Physical and chemical principles of soil/hazardous waste treatment processes; mass conservation equations, transport phenomena, phase equilibria, fluid flow in porous media with applications to soil vapor extraction, soil leaching/flushing, stabilization, and biotreatment processes. Note: CIVE 6361 or equivalent preferred as prerequisite.

CIVE 6390: Municipal Drinking Water Treatment Cr. 3. (3-0). Prerequisite or corequisite: CIVE 6377. Theory and design of unit processes used in conventional drinking water treatment, coagulation, rapid mix, flocculation, sedimentation, filtration, and disinfection. Source water control is also studied.

CIVE 6391: Engineering Microbiology Cr. 3. (2-3). Prerequisite: graduate standing environmental engineering. Fundamental aspects of microbiology and biochemistry as related to environmental pollution and water quality

processes, engineering energetics and kinetics of microbial growth, and biological fate of pollutants.

RECOMMENDED ELECTIVES

CIVE 6361: Ground Water Hydrology Cr. 3. (3-0). Prerequisite: CIVE 4332 or equivalent and graduate standing in civil engineering or graduate standing in environmental engineering. Fundamental processes that govern the flow of groundwater in aquifers and soils. Survey of techniques to determine aquifer characteristics. Conceptual modeling and application of computer models to groundwater flow problems.

CIVE 6372: Geotechnical Practice in Waste Disposal. Cr. 3. (3-0) Prerequisite: Graduate Standing in civil engineering or environmental engineering. Applications of geotechnical engineering principals and practice to land disposal of hazardous and non-hazardous wastes.

CIVE 7330: Organic Contaminant Control Cr. 3. (2-3). Prerequisite: CIVE 6390. Emphasis on treatment for controlling organic contaminants, particularly organic disinfection by-products in drinking water. Organic control unit processes are discussed.

CIVE 7332: Underground Contaminant Transport. Cr. 3. (3-0) Prerequisite: CIVE 6361. Basic physical, chemical and biological processes that control the movement of contaminants in groundwater. Modeling processes and application of existing models. Case studies of aquifer clean-up using models.

CIVE 7397: Hazardous Waste Management and Risk Assessment, Cr. 3. (3-0). Prerequisite: Graduate standing in civil or environmental engineering. Development of solid waste management strategies applied to both contaminated media and generated hazardous wastes with particular emphasis on applications to petroleum production, refining, and marketing. Environmental regulations, analytical methods and field sampling techniques, and risk-based corrective action methodologies for soil and other solid hazardous wastes will be discussed.

Acceptable Electives
Check with Instructors Concerning Prerequisites

Department of Civil and Environmental Engineering

CIVE 4333: Water and Wastewater Treatment Cr. 3. (3-0). Prerequisite: ENGI 3363. The fundamental principles of design for municipal water and wastewater treatment facilities. **Non-CIVEs only**.

CIVE 5360: Urban-Regional Planning Cr. 3. (3-0). Prerequisite: junior standing. Review of data collection and analysis for urban planning; development of master plan emphasizing engineering aspects of utilities, transportation, and other city facilities.

CIVE 6363: Evaluation of Water Quality in Natural Waters Cr. 3. (3-0). Prerequisite: CIVE 4332. Water quality management planning for rivers, lakes, and tidal estuaries; mixing and diffusion phenomena; biologic productivity; mineral, chemical, and oxygen utilization and equilibria; photosynthetic light transfer and sediment transport.

CIVE 6383: Advanced Planning and Design of Water Resource Systems Cr. 3. (3-0). Prerequisite: consent of instructor. Conventional and computer solutions to the economical planning and design of single- and multiunit, multipurpose water resources systems.

Department of Industrial Engineering

INDE 6332: Engineering Project Management Cr. 3. (3-0). Prerequisite: graduate standing. Planning, scheduling, and control of engineering projects, network models, CPM and PERT, resource allocation, time-cost tradeoff.

INDE 6336: Reliability and Quality Control Cr. 3. (3-0). Prerequisite: INDE 2333. Reliability testing, distributions, and programs; quality control programs, zero defects, and organization and administration for total quality control.

INDE 6337: Human Factors in Systems Cr. 3. (3-0). Prerequisite: INDE 4337. Methods of measurements of human performance, psychological and physiological background of human information processes. Principles and techniques of display and information system design.

INDE 6350: Design of Artificial Intelligence Systems Cr. 3. (3-0). Prerequisite: permission of instructor and graduate standing. Concepts of artificial intelligence, symbol manipulation, AI programming languages and techniques, production rules, expert system design, applications to computer-aided design and factory automation.

INDE 6370: Operations Research: Digital Simulation Cr. 3. (3-0). Prerequisite: INDE 4371. Quantitative modeling of engineering systems; generating stochastic variables; collection of data for digital simulation; simulation language.

Department of Chemical Engineering

CHEE 6397: Porous Media Transport and In-Situ Remediation Cr. 3. (3-0)

CHEE 6368: Chemical Process Economics I Cr. 3. (3-0). Prerequisite: graduate standing in chemical engineering. Managerial economics of chemical processes and products; development of decision-making methods using chemical industry examples.

CHEE 6366: Air Pollution Problems and Control Cr. 3. (3-0). Air pollutant identification and control technology; estimation of pollution transport, dispersion and conversion; computer application for design of control units.

Department of Management

MANA 6332: Organizational Behavior and Management Cr. 3. (3-0). Prerequisite: graduate standing. Introduction to organizational analysis; problems of leadership, motivation, group dynamics, and organizational change and development; organizations as open systems.

Department of Marketing

MARK 6361: Marketing Administration Cr. 3. (3-0). Prerequisite: graduate standing. Marketing orientation and concepts; marketing programs incorporating the societal perspective in formulating strategies for the design, pricing, channeling, and promotion of products/services.

MARK 4377*: Business and Public Issues. Deals with the relationship between business, society, and government, utilizing an ethical perspective to analyze and review problems arising from this relationship. Also covers the impact of public issues of business, as well as society's impact on business and its operations.

Department of Accounting

ACCT 6331: Administrative Accounting I Cr. 3. (3-0). Prerequisite: graduate standing. Accumulating, controlling, and analyzing data for financial reporting.

Department of Finance

FINA 6335*: Managerial Finance Cr. 3. (3-0). Prerequisite: graduate standing, ACCT 6331, and DISC 6360. Principles and methods of asset management, and financial planning and control of the attainment of both short- and long-range objectives.

Department of Decision and Information Sciences

DISC 6351*: Production and Logistics Management (formerly MSAS 6361) Cr. 3. (3-0). Prerequisites: graduate standing. MATH 1313, MATH 1314, and DISC 2373. Concepts and theories of production and logistics management.

*Advising required (Rm MH 249) prior to registration

Department of Biology

BOIL 4468: Ecology Cr. 4. (3-3). Prerequisite: BIOL 3401. Historical development and current concepts of the interrelationships between organisms and the environment, including field and laboratory exercises illustrating ecological principles and experimental procedures.

Department of Economics

ECON 4388: The Economic Development of Africa Cr. 3. (3-0). Prerequisite: ECON 2301 or 2304 or consent of instructor. Economic and social problems of raising standards of living in Africa.

LAW CENTER@

Prerequisite: Consent of Instructor.

LAW 53XX: Various Environmental Law Topics Cr. 3 (3-0). Please contact instructor to determine if a proposed course is appropriate and that you have sufficient knowledge to attend the course.

LAW 52XX*: Various Environmental Law Topics Cr. 2 (2-0). Please contact instructor to determine if a proposed course is appropriate and that you have sufficient knowledge to attend the course.

LAW 5390: Environmental Law Cr. 3. (3-0). Environmental law, with emphasis on legal regulation and control of activities affecting the land, sea and air environment.

* Must take seminar three times to make up one extra credit.

@Must register at Law College (Rm 100 Krost Hall) **before** registering for any other classes, required or electives.

Department of Biochemical and Biophysical Sciences

BCHS 6361: Analytical Biochemistry Cr. 3. (3-0). Prerequisite: CHEM 3331 or equivalent or consent of instructor. Modern instrumental methods of biochemical analysis.

Department of History

HIST 6389: American Urban History Cr. 3. (3-0). Prerequisites: Consent of Instructor. Study of environmental, political, economic, technological, and social factors in influencing the growth and development of American cities.

Department of Geosciences

GEOL 6345: Hydrochemistry Cr. 3. (3-0). Prerequisites: GEOL 6341, graduate standing in NSM or Engineering, or consent of instructor. Application of thermodynamic principles to predict reactions in fluid-rock systems under low and high temperature and pressure conditions.

GEOL 6366: Hydrogeology Cr. 3. (3-0). Prerequisites: graduate standing in NSM or Engineering, or consent of instructor. Field trips may be required; cost to be defrayed by student. Interdisciplinary coverage of ground-water principles with emphasis on the geologic aspects of groundwater flow and chemistry.

University of Houston-Clear Lake Campus

University of Houston—Clear Lake courses, are considered UH courses. However, advance approval must be obtained from the Program's Academic Advisor or the Program Director to receive credit for UH-CLC courses.

Rice University

Department of Envir. Science and Engineering

ENVI 406 Introduction to Environmental Law

ENVI 445 Natural Environmental Factors in Community Development

ENVI 564 Atmospheric Dynamics

UNIVERSITY OF HOUSTON

Cullen College of Engineering
Environmental Engineering Program

Program of Study The Environmental Engineering Program of the University of Houston is an interdisciplinary graduate engineering program within the Cullen College of Engineering. Emphasis is placed on municipal and industrial water and wastewater treatment, water reuse, hazardous-waste management, and groundwater restoration with elective courses in the fields of air pollution measurement and control, engineering management, business and public policy, environmental law, water resources engineering, computer science, chemical engineering, chemistry, and biology. The degrees offered include the Master of Science, with thesis (30 credits) and non-thesis (36 credits), and the Doctor of Philosophy.

All students are required to take the same six required courses: Engineering Microbiology, Biological Processes for Wastewater Treatment, Environmental Chemistry, Solid and Hazardous Waste Treatment Processes, Physicochemical Treatment Processes, and Municipal Drinking Water Treatment. The remaining elective courses are chosen from the recommended list, courses in the Environmental Engineering Program, and from the approved list, courses outside the Environmental Engineering Program. Students taking the 36-credit-hour program must take at least three of their six electives from the recommended list. The Environmental Engineering Seminar Series brings a variety of speakers to the campus each semester. Program faculty and students participate in the research projects of the Gulf Coast Hazardous Substance Research Center. The Program is affilicated with the Environmental Institute of Houston, a cooperative venture between the University of Houston and UH Clear Lake.

Courses are scheduled to accommodate both part-time and full-time students; 24-36 hours of required course work can usually be completed in one calendar year of full-time or three years of part-time study.

Admission to the M.S. program requires an accredited B.S. degree in engineering or a closely related science (e.g., biology, chemistry, geology, math, or physics), with a GPA of 3.0 or more on the last 60 hours and an acceptable GRE score as listed below. These are minimum criteria and do not guarantee admission. To become an applicant for the Environmental Engineering Program, a non-engineer must have an appropriate background in chemistry (one year with lab), mathematics (through differential equations), computer programming, and calculus-based physics. Before receiving an M.S. degree in environmental engineering, s/he must have completed seven leveling courses — statics, dynamics, mechanics of solids, electrical circuits and systems, fluid mechanics, hydraulic engineering, and thermodynamics. Admission to the Ph.D. program is highly selective. Applicants must have completed an M.S. degree with thesis in an appropriate engineering discipline. Also, outstanding academic and research performance is required, as evidenced by GPA and letters of recommendation.

Research Facilities The core faculty and their graduate students are housed in 7,000 square feet of laboratory and office space in the engineering building. The laboratories are well equipped with personal computers and instruments for analysis, including a gas chromatograph-mass spectrometer; a molecular weight distribution apparatus; closed-loop stripping devices; a purge and trap apparatus; a standard and a low-level total organic carbon (TOC) analyzer; a total oxygen demand ; a total organic halide (TOX) analyzer; automatic potentiometric titrators; a particle size analyzer; a zeta-potential meter; a gas partitioner; AA, UV-visible, fluorescence, and ICP spectrophotometers; a liquid scintillation counter; an ion chromatograph; alpha particle counters, a gamma-ray spectrometer, a radon analyzer, a high-pressure LC, and an ozonator.

Financial Aid All accepted graduate students who are US. citizens and who have a record of outstanding undergraduate academic performance (a high GPA) at an accredited university in the United States and a high GRE score are eligible for a research or teaching assistantship, but the number of assistantships is very limited. Assistantships range from $1,000 to $1,100 per month, depending on availability and student qualifications. Financial assistance is infrequently available to exceptional international students in their first semester. **Because of the limit on financial aid, do not apply unless you can support yourself for at least one year.**

Cost of Study For Fall 1999, tuition was $192 per 3 credit hours for Texas Residents and $762 per 3 credit hours for non-Texas residents.

Tuition and fees for full-time students total approximately $1,358.50 per semester for Texas residents and $3,638.50per semester for nonresidents. Students receiving financial assistance qualify for resident tuition.

Cost of Living On-campus room and board costs about $4,000 per semester. Off-campus apartments begin at about $450 per month. The cost of books is approximately $560 for 12 hours credit.

Student Group Graduate students enter the UH Environmental Engineering Program from a variety of academic backgrounds, including engineering, biology, chemistry, and geology. Currently the group numbers about 65, split into about 40% full- and 60% part-time students. A graduate student organization sponsors social functions and meets regularly to discuss the ongoing research in the program. Often, the students attend local, state, and national meetings as a group.

Location Houston is the fourth-largest city in the nation. The University's 525-acre campus is only a short drive from downtown Houston, Rice University, and the internationally acclaimed Houston Medical Center complex. Also within driving distance are many corporate research laboratories and petrochemical and industrial complexes with substantial water, wastewater, land treatment, and incineration facilities. These institutions, the city of Houston, the Gulf Coast Waste Disposal Authority, the Johnson Space Center (NASA), and many engineering firms offer unlimited interdisciplinary research activities and job opportunities.

The College The Cullen College of Engineering is one of thirteen colleges of the University of Houston, which has a total student population of 33,000. It is currently housed in a modern building of approximately 280,000 square feet. Several large buildings surrounding the College house additional major laboratory facilities.

Applying Official copies of all transcripts, test scores, other required paperwork, and the non-refundable $25 application processing fee must be submitted to the Program Director before February 10th for the fall semester (the only semester for admission). The written GRE General Test should be taken as early as possible — , February at the latest. The computerized GRE test can taken later and still meet the deadline. An acceptable score on the General Test is required before an applicant will be admitted.

In addition, the University requires that all Nonimmigrant visa students obtain a score of 550 or more on the TOEFL. **Nonimmigrant students must pay a $75 non-refundable application processing fee prior to the deadline.**

Correspondence and Information

Environmental Engineering Admission Assistant
Department of Civil and Environmental Engineering
University of Houston
Houston, Texas 77204-4791
Telephone: 713-743-4254
FAX: 713-743-4260
Internet: wholliday@.uh.edu

Due Date for Completed "Application Package" for Fall Semester is, February 10th. Because of processing time, applications should be submitted well before this deadline.

University of Houston

THE FACULTY AND THEIR RESEARCH

Core Faculty

Shankar Chellam, Assistant Professor; B.S. (mechanical engineering), Birla Institute of Technology and Science, India; M.S. (environmental engineering), Ph.D. (environmental engineering) Rice University. Teaching in Drinking Water Treatment, Physical-Chemical Process and Thermodynamics. Research in application of fundamental principles of transport phenomena to environmental systems including membrane filtration, colloid transport and control of disinfection by-products.

Theodore G. Cleveland, Associate Professor; B.S. (environmental resources engineering), Humbolt State; M.S. (civil engineering); Ph.D. (civil engineering), UCLA. Teaching in groundwater hydrology, contaminant transport, and engineering mechanics. Research in sewage system inflow and infiltration, and contaminant transport modeling.

Dennis A. Clifford, Professor and University Coordinator for Hazardous Waste Research; B.S. (chemical engineering), Michigan Tech; M.S. (chemical engineering), Ph.D. (environmental engineering), Michigan. Teaching in physicochemical treatment processes, environmental chemistry, and water and wastewater treatment. Research in ion exchange, adsorption, and membrane processes for removal of inorganic contaminants and radionuclides from water and soil.

Hanadi S. Rifai, Assistant Professor; B.S. (civil engineering), American University of Beirut; M.S. (environmental engineering), Ph.D. (environmental Engineering), Rice University. Teaching engineering design, computers in engineering, hazardous waste management and risk assessment, geographical information systems. Research in surface water and ground water hydrology, contaminant transport and modeling, hazardous waste management, risk assessment and geographical information systems.

William G. Rixey, Associate Professor; B.S. (chemical engineering), Lehigh University; Ph.D. (chemical engineering) University of California, Berkeley. Teaching in solid hazardous waste treatment processes, Multi-media fate and treatment with applications to risk assessment, and water and wastewater treatment. Research in transport characteristics of organic contaminants from soils and other solid hazardous wastes.

Deborah J. Roberts Associate Professor; B.S. (microbiology), University of Alberta; Ph.D. (Microbiology) University of Alberta. Teaching in bioremediation, water microbiology, and biological treatment processes. Research in biological treatment processes for removal of conventional and toxic pollutants, bioremediation of hazardous wastes.

Associated Faculty

Faculty associated with the Environmental Engineering Program teach elective courses and serve on the thesis and dissertation committees of environmental engineering students.

Ivan Bernal, Professor (Chemistry); Ph.D., Columbia. Transition metal chemistry.
Regina Capuano, Associate Professor, (Geosciences); PhD, University of Arizonia. Geochemistry and Hydrogeology.
Stanley N. Deming, Professor (Chemistry); Ph.D., Penn State. Experimental design.
Osman I. Ghazzaly, Professor /Assoc. Chair (Civil Engineering); Ph.D., Texas at Austin. Soil transport of pollutants.
Peter Jurtshuk, Professor (Biology)
James Lawrence, Associate Professor (Geosciences); Ph.D., Ohio State. Fault detection and soil permeability.
Martin V. Melosi, Professor (History); Ph.D., Texas at Austin. Urban history.
Carl Norman, Associate Professor (Geosciences); Ph.D., Ohio State. Fault detection and soil permeability.
Michael W. O'Neill, Professor (Civil Engineering) Ph. D. University of Texas at Austin, Sub-surface remediation of hazardous wastes.
James T. Richardson, Professor (Chemical Engineering); Ph.D., Rice. Adsorption and catalysis.
Jerry R. Rogers, Associate Professor (Civil Engineering); Ph.D., Northwestern. Water resources and storm water management.
Frank M. Tiller, Professor (Chemical Engineering); Ph.D., Cincinnati. Filtration.
Shiao-Chun (David) Tu, Professor (Biochemical and Biophysical Sciences); Ph.D., Cornell. Bioengineering.
C. Vipulanandan, Professor (Civil Engineering); Ph.D., Northwestern. Contaminanted soils.
Keh-Han Wang, Associate Professor (Civil Engineering); Ph.D., Iowa. Estuary/coastal hydrodynamics and transport of pollutants.
Richard Willson, Assistant Professor (Chemical Engineering); Ph.D., MIT, Biochemical engineering.

Current Research Projects of Core Faculty

Evaluation of resins and adsorbents for removing arsenic from drinking water.
Fundamental determinants of selectivity in ion-exchange resins.
Mechanistic description and modeling of pH waves in anion-exchange columns caused by anions from polyprotic acids.
Effectiveness of point-of-use and home treatment devices for removal of toxic contaminants and radionuclides from drinking water.
Uranium removal from groundwater.
Denitrification of nitrate-laden ion-exchange brine.
Soil treatment to promote desorption of hazardous chemicals.
Removal of lead from soil by volatilization and extraction.
Effect of toxic compounds on biological treatment processes.
Natural attenuation of fuel hydrocarbons and chlorinated solvents.
Dissoultion of polynuclear aromatic hydrocarbons from hydrocarbon mixtures in soils.
Surfactant solubilization properties for enhanced *in situ* removal of residual hydrocarbons from contaminated media.
Biodeterioration of concrete.
Removal of perchlorate rocket fuel from graound water.
Oxidation of arsenite to arsenate in drinking water.
Microbiological destruction of perchlorate in ion exchange waste brine..
GIS and Remotely Sensed Mapping in Coastal Environments.
Transport, Fate and Risk Implications of Environmentally Acceptable End point decisions.
Developing an Intergrated Methodology for Designing long term monitoring plans.
Developing Human Exposure Esitmates for Indoor/Outdoor Air Pollution in Houston.
Intrinsic Bioremediation of mixed Fuel/Solvent Plunes at Petroleum and Petrochemical Gulf Coast Sites.