MEMORANDUM

TO: Sean Rafferty, Senate Chair

FROM: Havidán Rodríguez, President

DATE: January 13th, 2021

SUBJECT: Senate Bill Approval

I am pleased to approve the following Senate Bill, which was recommended following approval by the University Senate at its meeting of November 18th, 2020.

Senate Bill 2021-02:

PROPOSAL TO ESTABLISH A NEW PHD IN ENVIRONMENTAL AND SUSTAINABLE ENGINEERING

Approved: _____

Havidán Rodríguez, President

UNIVERSITY SENATE

UNIVERSITY AT ALBANY

STATE UNIVERSITY OF NEW YORK

Introduced by: Graduate Academic Council

University Policy and Planning Council

Date: January 12th, 2021

Proposal to Establish a New Ph.D. in Environmental and Sustainable Engineering.

IT IS HEREBY PROPOSED THAT THE FOLLOWING BE ADOPTED:

1. That the University Senate approves the attached Program proposal as submitted by the College of Engineering and Applied Sciences, to the Graduate Academic Council and the Undergraduate Policy and Planning Council
2. That this takes effect for the Spring 2021 semester.
3. That this proposal be forwarded to President Havidán Rodríguez for approval.

New Program Proposal: Graduate Degree Program Form 2B
Version 2016-10-13

This form should be used to seek SUNY's approval and New York State Education Department's (SED) registration of a proposed new academic program leading to master's or doctoral degree. Approval and registration are both required before a proposed program can be promoted or advertised, or can enroll students. The campus Chief Executive or Chief Academic Officer should send a signed cover letter and this completed form (unless a different form applies[1]), which should include appended items that may be required for Sections 1 through 6, 9 and 10 and MPA-1 of this form, to the SUNY Provost at *program.review@suny.edu*. The completed form and appended items should be sent as a single, continuously paginated document.[2] If Sections 7 and 8 of this form apply, External Evaluation Reports and a single Institutional Response should also be sent, but in a separate electronic document. Guidance on academic program planning is available here.

Table of Contents

NOTE: Please update this Table of Contents automatically after the form has been completed. *To do this, put the cursor anywhere over the Table of Contents, right click, and, on the pop-up menus, select "Update Field" and then "Update Page Numbers Only." The last item in the Table of Contents is the List of Appended and/or Accompanying Items, but the actual appended items should continue the pagination.*

[1] Use a different form if the proposed new program will lead to a graduate degree or any credit-bearing certificate; be a combination of existing registered programs (i.e. for a multi-award or multi-institution program); be a breakout of a registered track or option in an existing registered program; or **lead to certification as a classroom teacher, school or district leader, or pupil personnel services professional** (e.g., school counselor).

[2] This email address limits attachments to 25 MB. If a file with the proposal and appended materials exceeds that limit, it should be emailed in parts.

Section 1. General Information		
a) Institutional Information	Date of Proposal:	
	Institution's 6-digit SED Code:	210500
	Institution's Name:	University at Albany
	Address:	1400 Washington Ave., Albany, 12222
	Dept of Labor/Regent's Region:	Capital Region
b) Program Locations	List each campus where the entire program will be offered (with each institutional or branch campus 6-digit SED Code): 210500	
	List the name and address of off-campus locations (i.e., extension sites or extension centers) where courses will offered, **or check here [×] if not applicable**:	
c) Proposed Program Information	Program Title:	Environmental and Sustainable Engineering
	Award(s) (e.g., M.A., Ph.D.):	Ph.D.
	Number of Required Credits:	Minimum [75] If tracks or options, largest minimum [ ]
	Proposed HEGIS Code:	0922
	Proposed 6-digit CIP 2010 Code:	14.1401
	If the program will be accredited, list the accrediting agency and expected date of accreditation:	
	If applicable, list the SED professional licensure title(s)[3] to which the program leads:	
d) Campus Contact	Name and title: Kevin Williams, Vice Provost and Dean of Graduate Studies Telephone: 518-956-8035 E-mail: kwilliams@albany.edu	
e) Chief Executive or Chief Academic Officer Approval	**Signature affirms that the proposal has met all applicable campus administrative and shared governance procedures for consultation, and the institution's commitment to support the proposed program.** ***E-signatures are acceptable.*** Name and title: Carol Kim, Senior Vice President for Academic Affairs and Provost Signature and	
	If the program will be registered jointly[4] with one or more other institutions, provide the following information for <u>each</u> institution:	
	Partner institution's name and 6-digit SED Code: Name, title, and signature of partner institution's CEO (or **append** a signed letter indicating approval of this proposal):	

[3] If the proposed program leads to a professional license, a specialized form for the specific profession may need to accompany this proposal.

[4] If the partner institution is non-degree-granting, see SED's CEO Memo 94-04.

Attestation and Assurances

On behalf of the institution, I hereby attest to the following:

That all educational activities offered as part of this proposed curriculum are aligned with the institutions' goals and objectives and meet all statutory and regulatory requirements, including but not limited to Parts 50, 52, 53 and 54 of the Rules of the Board of Regents and the following specific requirements:

That credit for study in the proposed program will be granted consistent with the requirements in §50.1(o).

That, consistent with §52.1(b)(3), a reviewing system has been devised to estimate the success of students and faculty in achieving the goals and objectives of the program, including the use of data to inform program improvements.[5]

That, consistent with §52.2(a), the institution possesses the financial resources necessary to accomplish its mission and the purposes of each registered program, provides classrooms and other necessary facilities and equipment as described in §52.2(a)(2) and (3), sufficient for the programs dependent on their use, and provides libraries and library resources and maintains collections sufficient to support the institution and each registered curriculum as provided in §52.2(a)(4), including for the program proposed in this application.

That, consistent with 52.2(b), the information provided in this application demonstrates that the institution is in compliance with the requirements of §52.2(b), relating to faculty.

That all curriculum and courses are offered and all credits are awarded, consistent with the requirements of §52.2(c).

That admissions decisions are made consistent with the requirements of §52.2(d)(1) and (2) of the Regulations of the Commissioner of Education.

That, consistent with §52.2(e) of the Regulations of the Commissioner of Education: overall educational policy and its implementation are the responsibility of the institution's faculty and academic officers, that the institution establishes, publishes and enforces explicit policies as required by §52.2(e)(3), that academic policies applicable to each course as required by §52.2(e)(4), including learning objectives and methods of assessing student achievement, are made explicit by the instructor at the beginning of each term; that the institution provides academic advice to students as required by §52.2(e)(5), that the institution maintains and provides student records as required by §52.2(e)(6).

That, consistent with §52.2(f)(2) of the Regulations of the Commissioner of Education, the institution provides adequate academic support services and that all educational activities offered as part of a registered curriculum meet the requirements established by state, the Rules of the Board of Regents and Part 52 of the Commissioner's regulations.

CHIEF ADMINISTRATIVE or ACADEMIC OFFICER/ PROVOST	
Signature	Date
Type or print the name and title of signatory Carol Kim, Senior Vice President for Academic Affairs and Provost	Phone Number 518.956.8030

[5] The NY State Education Department reserves the right to request this data at any time and to use such data as part of its evaluation of future program registration applications submitted by the institution.

Section 2. Program Information

2.1. Program Format

Check all SED-defined formats, mode and other program features that apply to the **entire program**.

a) Format(s): [×]Day [ ]Evening [ ]Weekend [ ]Evening/Weekend [ ]Not Full-Time

b) Modes: [×]Standard [ ]Independent Study [ ]External [ ]Accelerated [ ]Distance Education
NOTE: *If the program is designed to enable students to complete 50% or more of the course requirements through distance education, check Distance Education, see Section 10, and append a Distance Education Format Proposal.*

c) Other: [ ] Bilingual [ ] Language Other Than English [ ] Upper Division [ ] Cooperative [ ] 4.5 year [ ] 5 year

2.2. Related Degree Program

NOTE: *This section is not applicable to a program leading to a graduate degree.*

2.3. Program Description, Purposes and Planning

a) What is the description of the program as it will appear in the institution's catalog?

Environmental and Sustainable Engineering (ESE) is a discipline that builds on knowledge, discovery, and information from mathematics and basic sciences to solve critical environmental problems at the local, national, and global scales. The Ph.D. ESE program aims to prepare a highly skilled workforce with advanced knowledge to embark on the mission of protecting human health and the environment. This workforce will be equipped with deep understanding of the ESE field and state-of-the-art technologies and tools through well-designed coursework and research. The research component of the Ph.D. ESE program focuses on four concentration areas: 1) water and wastewater; 2) air quality; 3) human health and the environment; and 4) sustainability engineering.

b) What are the program's educational and, if appropriate, career objectives, and the program's primary student learning outcomes (SLOs)? ***NOTE:*** *SLOs are defined by the Middle States Commission on Higher Education in the Characteristics of Excellence in Higher Education (2006) as "clearly articulated written statements, expressed in observable terms, of key learning outcomes: the knowledge, skills and competencies that students are expected to exhibit upon completion of the program."*

Program Educational Objectives

1. **Breadth**. Graduates will be able to contribute technically to solving broad environmental problems by applying fundamental scientific concepts and sound engineering principles.
2. **Depth**. Graduates are highly knowledgeable and skilled in their chosen field of interest.
3. **Teamwork**. Graduates will be able to work collaboratively with people from different background to solve critical environmental problems through sustainable approaches.
4. **Professionalism**. Graduates will maintain high professional and ethical standards and stand out as examples for their peers.
5. **Lifelong Learning**. Graduates will excel in their chosen profession through lifelong learning and become leaders in their professional service.

Student Learning Outcomes (SLOs)

1. an ability to teach to a broad audience on subjects in which they are experts.
2. an ability to educate themselves to expand their knowledge base and deepen their understanding in those fields in which they specialize.
3. an ability to conduct and supervise research including forming hypotheses, designing experiments,

analyzing data, drawing conclusions and reporting scientific findings.
4. an ability to write technical reports, papers and proposals.
5. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
6. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

b) How does the program relate to the institution's and SUNY's mission and strategic goals and priorities? What is the program's importance to the institution, and its relationship to existing and/or projected programs and its expected impact on them? As applicable, how does the program reflect diversity and/or international perspectives? For doctoral programs, what is this program's potential to achieve national and/or international prominence and distinction?

The University has established the creation of new academic programs to meet the high-demand employment needs of the regional, state and national economy as one of its primary goals. The ESE discipline, combined with the existing programs in the College of Engineering and Applied Sciences (CEAS), will serve this directive and continue to transform the University into a highly ranked public research institution right here in the Capital Region. The creation of a world–class engineering school is critical to this directive. The new Ph.D. program in ESE will support the growth of high–impact research and high–quality engineering education. Therefore, our vision for the ESE Ph.D. program aligns seamlessly with the strategic plan of UAlbany 2018-2023, Authoring Our Success, which rests on five priorities: (1) student success, (2) research excellence, (3) diversity and inclusion, (4) internationalization, and (5) engagement and service. In addition, the ESE Ph.D. program fits perfectly into SUNY's system-wide strategic plan. Specifically, this program will directly, and significantly, enhance two of the six big ideas: A Healthier New York, and An Energy-Smart New York.

The Ph. D. ESE program is necessary to enable long–term and significant synergistic collaborations with existing departments at the University at Albany, both in education and research. It is also indispensable for attracting industrial collaborations and research that will provide students a unique skill set and numerous career development opportunities. Fruitful collaborations with the Department of Atmospheric and Environmental Sciences and the Department of Environmental Health Sciences (EHS) will result in multiple cross–listed innovative courses and high impact research awards that address key societal problems. Toward this endeavor, cross–college/school collaborations (e.g. College of Arts and Sciences, School of Public Health, School of Social Welfare, College of Emergency Preparedness, Homeland Security and Cyber-security) will bring together experts from diverse fields leading to high–impact research collaborations and unique educational experiences for students. The expertise brought in by the University's various research centers such as the Atmospheric Sciences Research Center, the Institute for Health and the Environment, the RNA Institute, the NY State Mesonet, and the Life Science Research Laboratory will also complement and strengthen ESE research collaborations.

The Ph. D. ESE program has the potential to invite healthy cross–campus collaborations within the SUNY system. Working with our partners at our University Centers, state operated campuses and even our neighbor SUNY Polytechnic, will allow us to come together to advance research in critical areas such as Water Reuse, Water Resources Management, Air Pollution Control, Renewable Energy, and Environmental Sustainability. Our nodal location within Tech Valley with various state government agencies and many Fortune 500 companies will facilitate the development of new public-private collaborations and strengthen ties with government and industrial partners through high–impact, high–risk research while enabling students to gain valuable experience through internships. All of these will provide opportunities for faculty to enjoy deeper–in–depth collaborations, which leads to faculty's long-term commitment to the University through transformative and high–reward research programs.

Programmatic courses will rely on important prerequisites for both the undergraduate and graduate ESE programs. Most importantly, understanding of Biology, Chemistry, Geology and mathematics will ensure a strong theoretical background for a wide range of environmental problems. And an in–depth interdisciplinary research environment is a crucial ingredient to foster a successful Ph. D. program in engineering. It is expected that collaborative research will grow between ESE faculty and researchers conducting fundamental research in Biology, Chemistry and Biochemistry and Environmental Health. While the non-engineering scientists help to answer the "why" and fundamental questions, ESE faculty can apply that know-how to solve real-world problems. In return, the scientists

may identify new challenges and eventually make new theoretical contributions.

The Ph. D. ESE program is a necessary step for establishing an esteemed graduate teaching/research presence in engineering within the University. This program will complete the institution's academic offerings from a B.S. ESE to an M.S. ESE, and ultimately to the Ph. D. ESE while supporting faculty research. It will allow the faculty to conduct and fulfill long–term research goals with motivated and experienced doctoral students. These research initiatives will create a rich environment for students and provide them unique research development opportunities to follow careers in both industry, research institution and academia.

The ESE Ph.D. program seeks to educate and prepare engineers from diverse backgrounds. Compared to other engineering disciplines, ESE is the only one that has reached gender parity. In 2014-2015, 49.7% of BS degrees were awarded to female students. This percentage is much higher than the 19.9% for all engineering disciplines (https://www.asee.org/papers-and-publications/publications/college-rofiles/15EngineeringbytheNumbersPart1.pdf). Some of these female students will continue to get their Ph.D. degrees. In addition, international students have been a major source of graduate students to engineering programs. ESE is no exception. Therefore, the ESE Ph.D. program will significantly enhance diversity and international perspectives at UAlbany.

c) How were faculty involved in the program's design? Describe input by external partners, if any (e.g., employers and institutions offering further education?

The ESE faculty has been meeting monthly since September 2018 to design the Ph.D. program. The curriculum portion of the program considers the teaching expertise and strength of individual ESE faculty members, courses offered by other departments at UAlbany, the program's learning outcomes and program educational objectives, and curricula offered at our peer institutions. The required credit hours are consistent with other programs within CEAS. The designated research concentration areas take into consideration of four factors: 1) faculty members' research strengths and interests; 2) the collective research capability on campus; 3) critical needs of NY state in terms of environmental protection and sustainability; and 4) research tracks available at other similar programs. We are familiar with UAlbany's research capability through dialogues with on-campus researchers and tours of research facilities. The critical needs of the state were identified based on conversations with NY Department of Environmental Conservation, Department of Health, and local environmental professionals. Research concentrations at Carnegie Mellon University, Stanford University, Georgia Tech, Rensselaer Polytechnic Institute and University of Illinois Urbana Champaign were considered when designing the four tracks mentioned above.

d) How did input, if any, from external partners (e.g., educational institutions and employers) or standards influence the program's design? If the program is designed to meet specialized accreditation or other external standards, such as the educational requirements in Commissioner's Regulations for the profession, append a side-by-side chart to show how the program's components meet those external standards. If SED's Office of the Professions requires a specialized form for the profession to which the proposed program leads, append a completed form at the end of this document.

The program's design is influenced by recommendations given by two external evaluators for the BS ESE program. These two evaluators are: Dr. Ben Stuart, Professor, P.E., Senior Associate Dean, Batten College of Engineering and Technology, Old Dominion University, and Dr. Allison MacKay, Professor and Chair, Department of Civil, Environmental and Geodetic Engineering, The Ohio State University.

e) Enter anticipated enrollments for Years 1 through 5 in the table below. How were they determined, and what assumptions were used? What contingencies exist if anticipated enrollments are not achieved?

The anticipated enrollment in the table below is based on a typical ratio of Ph.D. students per faculty member in a research active ESE department such as ours, although it is set a little low initially to allow for our high proportion of junior faculty to establish themselves and the need to promote the program. It is also consistent with typical graduate-undergraduate proportions for an ESE department in a public research university, scaling off our anticipated undergraduate enrollments.

For full-time enrollment, in addition to students from elsewhere, such as out of NY state and international, graduates of the BS and MS in ESE and Atmospheric and Environmental Sciences are candidates for the Ph.D. degree in ESE. We do not anticipate part-time Ph.D. students given the heavy research portion of this program.

To build enrollments, we will advertise our program aggressively both regionally and nationally. In addition, in view of the fact that most Ph.D. students are international, we will advertise this program at professional conferences and to professionals in our networks. We will also work with the Center for International Education and Global Strategy to broadcast our presence and attract students to our program. More importantly, we truly believe that if the program is excellent, talented students will be attracted to it. Thus, ESE faculty will work hard to establish our reputation by bringing in research grants, publishing in high impact journals and presenting research at conferences at various levels. It will take time to build a reputable Ph.D. program. But we are confident that success will come if we take the right approach and keep pushing hard all the time.

Year	Anticipated Headcount Enrollment			Estimated FTE
	Full-time	Part-time	Total	
1	5	0	5	5
2	7	0	7	7
3	9	0	9	9
4	12	0	12	12
5	15	0	15	15

f) Outline all curricular requirements for the proposed program, including prerequisite, core, specialization (track, concentration), internship, capstone, and any other relevant component requirements, but do not list each General Education course.

The course work for each area of concentration consists of a set of required core courses, a set of elective courses in the areas of water and wastewater, air quality, health and the environment and sustainability engineering and elective courses related to the four areas but offered by other units on campus. The core courses will be taught by ESE faculty and the electives by ESE faculty and those in other departments. The credits distribution is shown below.

PhD after BS in engineering

Topic	Credits
Depth - ESE Core	12
Breadth - ESE	9
Math/Sciences	12
Any other	6
Dissertation Research	36
Minimum	**75**

PhD after MS in engineering

	Topic	Credits
Masters	Depth - ESE Core	6
	Breadth - ESE	9
	Math/Sciences	12
	Thesis/Master's Project	3
	Subtotal for MS	**30**
Beyond Masters	Depth - ESE Core	6
	Math/Sciences	3
	Dissertation	36
	Minimum	**75**

For students entering the Ph.D. program without engineering degrees, but from quantitative science backgrounds such as chemistry, physics, meteorology, etc., they would need to take at least three (3) 400-level ESE courses specifically related to their research projects (for thesis option) or chosen concentration areas (non-thesis option). A grade of B or above for each course is required in order to be fully admitted to the Ph.D.

program.

For students entering the Ph.D. program without engineering degrees, but from less quantitative backgrounds such as biology, public health etc., they would need to take two (2) 300 level ESE courses and three (3) 400-level ESE courses specifically related to their research projects (for thesis option) or chosen concentration areas (non-thesis option). A grade of B or above for each course is required in order to be fully admitted to the Ph.D. program.

See Appendix A for the table of curriculum courses for the Ph.D. ESE program.

h) Program Impact on SUNY and New York State

h)(1) ***Need:*** What is the need for the proposed program in terms of the clientele it will serve and the educational and/or economic needs of the area and New York State? How was need determined? Why are similar programs, if any, not meeting the need?

Apart from the BS in Environmental and Sustainable Engineering, BS, MS and Ph.D. in Electrical and Computer Engineering at UAlbany and BS, MS and Ph.D. in Nanoscale Engineering at SUNY Polytechnic Institute, engineering degrees in the Capital Region are available only at private institutions (RPI and Union), with *annual tuition alone approximating $50,000*. Students who cannot afford private tuition are forced to leave the area to access a public education in engineering. Many of those students will never return to our region, causing a regional drain of talent and expertise. Moreover, there is simply no way those two private institutions can meet the growing demand for engineers at all degree levels in the region. This program will provide access to an affordable graduate environmental and sustainable engineering degree in the Capital Region. By increasing the number of well-educated engineers with advanced degrees in the region, this program will increase the pool of candidates for research and advanced technology leadership and management positions in local industry. The research undertaken as part of this graduate program will lead to new discoveries, raise the national and international profile of the University, bring in substantial extramural resources, and foster the creation of new businesses through technical entrepreneurship. Most of this growth can be expected to occur locally, bringing the notion of "Tech Valley" to greater fruition.

The National Academy of Engineering's Grand Challenges for the 21st Century outline a set of broad, overarching problems of societal significance that will determine a large part of the engineering research and development agenda for the coming decades. Among the 14 Grand Challenges are six that relate to environmental quality and sustainability, including in built environments:

- Economical solar energy
- Energy from fusion
- Carbon sequestration
- Managing the nitrogen cycle
- Universal access to clean water
- Restored urban infrastructure (more than just roads, includes environmental sensing, smart cities, and intelligent transportation and highway systems)

These are the problems that today's engineering students will be called on to solve over a 30-40 year career arc; all will require advances across multiple engineering disciplines. These are difficult problems that demand interdisciplinary solutions and a large, highly educated, professional, technical workforce. University at Albany, with its fully featured College of Engineering and Applied Sciences, will address exactly that type of workforce need for today and tomorrow, including a well-educated workforce at the Ph.D. level who can bring forth innovative, creative and revolutionary solutions. Specific to the state of New York (NY), the need for Environmental Engineers with a Ph.D. degree is great as the state faces grave challenges in cleaning up Superfund sites, upgrading or retrofitting facilities for treating wastewater and transitioning to renewable energy. This program will produce graduates prepared to address these challenges and others that will emerge over time. Collectively, climate change and other forms of environmental degradation that underpin the Grand Challenge problems above present, arguably, the most significant threats to human health and well-being in the history of mankind. They are, in a very realistic sense,

existential threats to life on Earth as we know it. The growing public recognition of these conditions can be expected to drive increased demand for graduates of this program from both the student side (push) and the employer side (pull), including from industry and government agencies and laboratories.

The availability of graduate programs in the department will realize a number of benefits and address a number of concerns:

- The department's visibility and reputation will be enhanced, and its academic ranking will be improved. This will, in turn, attract a stronger group of students from across the Region and beyond, and make all of our graduates (at all degree levels) more attractive in the marketplace.

- Only with active, research-based Ph.D. programs will we be able to attract and retain the best faculty to serve all our students, including undergraduates.

- Graduate students are the lifeblood of any university's research portfolio. Without a strong graduate program, to attract strong graduate students, faculty efforts to secure extramural research funding from the National Science Foundation, EPA, DOE, DOD, and other Federal agencies, and the benefits that accrue from those funds, will be seriously impaired – or worse.

- The research to be undertaken by the faculty and students in this program will address problems of societal significance in water and air resources, energy and environment, food security, and – owing to the program's focus on sustainability – national security and defense, and more. Demand for highly qualified engineers in these areas continues to grow.

Graduates from this program will be prepared to enter a number of different career paths. The NYS DOL Employment Projections for the occupation titles expected to attract most of our graduates are given on the following pages. In reading the tables, there are some *caveats* to be aware of:

- First, the program we propose, Environmental and Sustainable Engineering, is rare (perhaps unique) in the United States, and truly unique in SUNY and New York State. Therefore, there is no precise SOC code, or set of codes, corresponding to the range of career paths that will be open to graduates of this program. The additional emphasis on sustainability from a design standpoint, including interior engineered environments, opens a much broader set of career options as our students will graduate with a correspondingly wider set of technical, design, and analytical skills.

- *It is also important to note that the data presented in these tables are for BS level engineering positions* (the only data available); engineers with Ph.D. degrees will command greater starting salaries, and will generally see a more rewarding career path owing to the greater range of research and engineering management opportunities available to them.

- Using the demand for BS-degreed environmental engineers, and their starting salaries, as proxies to estimate demand for Ph.D.-degreed engineers, as we are forced to do here, will inevitably lead to the underestimations of both. Moreover, simply replacing the large numbers of engineers now entering retirement will create substantial, sustained demand. This phenomenon is being observed across nearly all engineering disciplines.

- Finally, and as mentioned above, the increased public awareness of the threat posed by human-induced climate change and the rising pressure from the public to "do something about it before it's too late" will drive increased interest in this program from both students and prospective employers.

The United States graduates relatively few students, proportionally, in the STEM disciplines as compared to our global economic competitors. Those economies with a greater proportion of engineers in the workforce do better economically; our developing competitors recognize this and are working hard to catch up. Dean Boyer studied this phenomenon as a Jefferson Science Fellow at the US Department of State, where he served as a Senior Science Advisor to Dr. Thomas Shannon, then Assistant Secretary of State for Western Hemisphere Affairs. A scatter plot of national *per-capita* engineers and scientists versus GDP *per capita* reveals a very high correlation. This is also true at a regional scale, as can be seen by considering, for example, the California Bay Area, greater Boston, and the NC

Research Triangle; this program will help to position Tech Valley among that group. *Once an economy moves beyond manufacturing, the only sustainable driver of economic growth is innovation. Engineers are the professional innovators who build the national (and regional) wealth; graduate-degreed engineers are the leaders among those innovators.*

Explanation of the superscripts in the following NYS DOL employment projections:

[1]Occupational codes are based on the SOC 2010 coding structure. Detailed information regarding the structure can be found at - http://www.bls.gov/soc/

[2] Employment and wage data by occupation are based on the Occupational Employment Statistics (OES) survey, which collects information from approximately 52,000 businesses. Data were collected in 2012, 2013, 2014 and 2015 and then updated to the first quarter of 2016 by making cost-of-living adjustments. These estimated wages reflect a minimum wage of $9.00 per hour, which was the minimum wage in effect at the time the estimates were prepared. Occupational employment and wages technical documentation is found at http://labor.ny.gov/stats/lstechoes.shtm.

[3] *Entry wage*: The mean (average) of the bottom third of wages in an occupation.

[4] *Experienced wage*: The mean (average) of the top two-thirds of wages in an occupation.

New York State Department of Labor
Statewide Long-Term Occupational Employment Projections, 2014-2024
(Bachelor's Degree)

SOC Code[1]	Title	Employment		Change		Annual Average Openings		
		2014	2024	Net	Percent	Total	Growth	Replacement
17-2081	Environmental Engineers	3,430	4,140	710	20.7%	168	71	97

SOC Code[1]	Title	Annual Wages ($) - 2016[2]			
		Mean	Median	Entry[3]	Experienced[4]
17-2081	Environmental Engineers	$91,530	$89,160	$63,090	$105,750

New York State Department of Labor
Capital Region Long-Term Occupational Employment Projections, 2012-2022
(Bachelor's Degree)

SOC Code[1]	Title	Employment		Change		Annual Average Openings		
		2012	2022	Net	Percent	Total	Growth	Replacement
17-2081	Environmental Engineers	570	600	30	5.3%	10	0	10

	Title	Annual Wages ($) - 2016[2]

SOC Code[1]		Mean	Median	Entry[3]	Experienced[4]
17-2081	Environmental Engineers	$88,060	$88,980	$63,750	$100,220

h)(2) ***Employment:*** For programs designed to prepare graduates for immediate employment, use the table below to list potential employers of graduates that have requested establishment of the program and state their specific number of positions needed. If letters from employers support the program, they may be **appended** at the end of this form.

Employer	*Need: Projected positions*	
	In initial year	In fifth year

Employment opportunities for environmental engineering graduates with advanced degrees are not readily available.

h)(3) ***Similar Programs:*** Use the table below to list similar programs at other institutions, public and independent, in the service area, region and state, as appropriate. Expand the table as needed. ***NOTE:*** *Detailed program-level information for SUNY institutions is available in the Academic Program Enterprise System (APES) or Academic Program Dashboards. Institutional research and information security officers at your campus should be able to help provide access to these password-protected sites. For non-SUNY programs, program titles and degree information – but no enrollment data – is available from SED's Inventory of Registered Programs.*

Institution	Program Title	Degree	Enrollment
College of Environmental Science and Forestry	Environmental Resources Engineering	Ph.D.	38
Rensselaer Polytechnic Institute	Environmental Engineering	Ph.D.	2 (awarded 2017-2018)
Clarkson University	Civil and Environmental Engineering	Ph.D.	?
Cornell University	Environmental and Water Resource Engineering	Ph.D.	?
Columbia	Earth and Environmental Engineering	Ph.D.	?

h)(4) **C*ollaboration:*** Did this program's design benefit from consultation with other SUNY campuses? If so, what was that consultation and its result?

Similar programs offered by other SUNY campuses were reviewed and considered when drafting the proposed Ph.D. ESE program.

h)(5) ***Concerns or Objections:*** If concerns and/or objections were raised by other SUNY campuses, how were they resolved?

There were no concerns and/or objections raised by other SUNY campuses during the required comment period for this degree.

2.4. Admissions

a) What are all admission requirements for students in this program? Please note those that differ from the institution's minimum admissions requirements and explain why they differ.

Program Admission Requirements

1) In addition to the general University requirements, applicants are expected to have a MS or an ABET accredited BS degree in Environmental Engineering or a closely related field. Applicants from other areas will be considered on a case by case basis. The Ph.D. ESE program admission policies and procedures will verify and enforce the requirement that each entering student to the program has completed a set of post-secondary educational and professional experiences which satisfy student attainment outcomes defined in Criterion 3 of the general ABET Engineering Accreditation Commission (EAC) criteria for baccalaureate level engineering programs, and Criterion 6 for curriculum requirements. (https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/#2). If the student has graduated from an EAC of ABET - accredited baccalaureate program, the presumption is that both criteria have been satisfied.

2) Prospective students should specify their career goals and research interests in the Statement of Purpose.

3) All international applicants are required to submit the results of TOEFL or IELTS, and meet the university's minimum requirement. Applicants who submit official transcripts showing the successful completion of at least 4 full-time semesters within a 4-year frame time (B or better average not including English language preparatory programs) at a college or university in countries where English is the official language can have the English Language Proficiency score waived. Waiver is subject to evaluation of the institution by the Graduate School. Departments may require higher scores for departmental consideration.

4) All applicants are required to submit GRE scores. Even though the Graduate School at UAlbany does not set an admission standard for GRE, the ESE Ph.D. program will seek to admit those with high GRE scores, especially high scores for the quantitative reasoning portion.

b) What is the process for evaluating exceptions to those requirements?

Requests for exceptions to the general University at Albany admission policies listed above in item 3) should be directed in writing to the Graduate Admissions Committee. Requests for exceptions to the Ph.D. ESE specific requirement in item 1) and 4) above, should be directed in writing to the Department Chair of ESE. Each request will be assessed by the review committee of each office and a response with information on compliance requirements will be sent to the applicant.

c) How will the institution encourage enrollment in this program by persons from groups historically underrepresented in the institution, discipline or occupation?

For Environmental Engineering, women are not underrepresented. In 2014-2015, 49.7% of BS degrees were awarded to female students. This percentage is much higher than the 19.9% for all engineering disciplines (https://www.asee.org/papers-and-publications/publications/college-profiles/15EngineeringbytheNumbersPart1.pdf). Although representation from women in general is not a concern for this program, enrollment of students of color is. This can be evidenced from the number of faculty of color in Environmental Engineering. For example, the percentage of African-American Tenured/Tenure-Track Faculty in Environmental Engineering is 1.2%, lower than the average of 2.5% for all disciplines. For Hispanics, the percentage is 3.1%, lower than the average of 3.9%. For Asian Americans, the percentage is 10.4%, much lower than 26.9% in average.

University at Albany is a minority serving institution with approximately 40% of students belonging to historically underrepresented racial/ethnic groups and we expect that the Environmental and Sustainable

Engineering major will represent a similar breakdown. To increase enrollment of students from historically underrepresented groups, we are taking a three-front approach: (1) K-12 school outreach to stimulate students' interest and build their confidence toward STEM, (2) sending our students to professional conferences, such as the annual conference of Society of Women Engineers, the National Society of Black Engineers, the Society of Hispanic Professional Engineers, and the biennial Research and Education Conference organized by the Association of Environmental Engineering and Science Professors (AEESP) to improve the retention of women and minorities in engineering, and (3) faculty role models through aggressive recruitment of a diverse faculty. The College of Environmental and Applied Sciences has been very successful to date in recruiting faculty from a diverse background, particularly with respect to gender, and is actively working to develop resources through philanthropy for targeted endowments and to support our K-12 school outreach and undergraduate retention initiatives. In addition, we will work with the Science & Technology Entry Program at UAlbany to provide research experience within Environmental and Sustainable Engineering to 7th and 10th graders in summer. For students who are on campus already, we will collaborate with the Collegiate Science and Technology Entry Program (CSTEP) to retain them by providing academic enrichment activities. All of these outreaches to K-12 and BS students are to create a recruitment pipeline for underrepresented minorities to enter and stay in the Ph.D. ESE program.

d) What is the expected student body in terms of geographic origins (i.e., same county, same Regents Region, New York State, and out-of-state); academic origins; proportions of women and minority group members; and students for whom English is a second language?

In preparing the budget projections, we used the data from the other University centers, Buffalo, Stony Brook and Binghamton.

The ratio of Undergraduate/Graduate enrollment is between 2.0 and 3.8. Among undergraduates, approximately 4.8% are out of state. For graduates, this number is around 70.2%.

Same to other engineering programs across the nation, more than half of the students in engineering graduate programs come from abroad, and include a higher proportion of women than undergraduate programs dominated by domestic students. Because the UAlbany student population includes approximately 40% underrepresented minorities, we are optimistic that we can do better than the national norms in attracting highly qualified American women and underrepresented minority students to the program. In addition, this program was designed to include engaged learning activities which have been shown to attract non-traditional students into the field. Women and minority students will be courted through admissions events, campus activities and connections with professional organizations, such as the local chapter of the Air and Waste Management Association.

With these in mind, we anticipate the following:

- approximately 30% of our Ph.D. student body will comprise underrepresented minorities
- approximately 45% of our Ph.D. student body will be women
- approximately 72% of the Ph.D. student body will be those for whom English is a second language.

2.5. Academic and Other Support Services

a) Summarize the academic advising and support services available to help students succeed in the program.

To ensure student success, a Graduate Program Director will be appointed and will oversee the graduate program and students. The role of this Graduate Program Director is to 1) supervise and coordinate the administration and governance of graduate studies within the graduate program for which he or she is responsible; 2) Serve as the liaison to the departmental faculty-at large and all administrative offices at the University at Albany; 3) Provide written criteria to each student, upon entry, of what constitutes acceptable

progress through the program and the grounds for the student's termination from it; 4) Receive, arrange for the review of, and monitor the progress of student applications and petitions; 5) Orient and counsel graduate students with respect to program and degree requirements until a permanent adviser is selected and assist in that selection as necessary; 6) Identify areas of deficiency for students entering and make course recommendations to ensure a successful transition to the graduate program; 7) Work with the Graduate Dean and the Office of Graduate Education to comply with all University requirements for the doctoral degree.

b) Describe types, amounts and sources of student financial support anticipated. Indicate the proportion of the student body receiving each type of support, including those receiving no support.

Financial support is available in the form of:

- Graduate Teaching Assistantships – Graduate Assistantships are funded via state support with department TAs factored into the central financial plan and allocated accordingly.
- Research Assistantships (funded primarily from faculty grants but could be from department indirects and IFR)
- External Fellowships – Our exceptional graduate students will be highly encouraged to pursue and apply for external fellowships including but not limited to SMART, NSF, DoD, NDSEG, etc.

We anticipate the following with regards to the proportion of the student body receiving support and the sources:

- 5% self-funded (or funded by their employers or governments)
- 75% on research grants
- 15% TAs
- 5% fellowships

2.6. Prior Learning Assessment

If this program will grant credit based on Prior Learning Assessment, describe the methods of evaluating the learning and the maximum number of credits allowed, **or check here [X] if not applicable**.

2.7. Program Assessment and Improvement

Describe how this program's achievement of its objectives will be assessed, in accordance with *SUNY policy*, including the date of the program's initial assessment and the length (in years) of the assessment cycle. Explain plans for assessing achievement of students learning outcomes during the program and success after completion of the program. **Append** at the end of this form, **a plan or curriculum map** showing the courses in which the program's educational and, if appropriate, career objectives – from Item 2.3(b) of this form – will be taught and assessed.
NOTE: *The University Faculty Senate's Guide for the Evaluation of Undergraduate Programs is a helpful reference.*

Unlike the BS and some MS degrees in engineering, the ESE Ph.D. program will not be accredited by any organizations. Even so, we will adopt some ABET assessment approaches for the BS program to assess the courses offered to Ph.D. students. By doing so, we will ensure that the program's PEOs and SOs are satisfied successfully. In addition, since the Ph.D. program has a significant portion on research, we will assess the achievement of its objectives and students outcomes from several other aspects: 1) number of publications at peer-reviewed journals and presentations at professional conferences; 2) graduates' awards and honors; 3) graduates' exit survey; 4) alumni survey every two years and 5) tracking the alumni' career development. Combining all of these together will give us a clear picture of the graduates we produce. The program objectives and students outcomes will then be revised periodically to improve the program.

Section 3. Program Schedule and Curriculum

Complete the **SUNY Graduate Program Schedule** to show how a typical student may progress through the program. This is the registered curriculum, so please be precise. Enter required courses where applicable, and enter generic course types for electives or options. Either complete the blank Schedule that appears in this section, or complete an Excel equivalent that computes all sums for you, found here. Rows for terms that are not required can be deleted.

NOTES: *The* ***Graduate Schedule*** *must include all curriculum requirements and demonstrate that expectations from in Regulation 52.2 http://www.highered.nysed.gov/ocue/lrp/rules.htm are met.*

Special Cases for the Program Schedules:

- *For a program with multiple tracks, or with multiple schedule options (such as full-time and part-time options), use one Program Schedule for each track or schedule option. Note that licensure qualifying and non-licensure qualifying options cannot be tracks; they must be separate programs.*
- *When this form is used for a multi-award and/or multi-institution program that is not based entirely on existing programs, use the schedule to show how a sample student can complete the proposed program.* ***NOTE:*** *Form 3A, Changes to an Existing Program, should be used for new multi-award and/or multi-institution programs that are based entirely on existing programs. SUNY policy governs the awarding of two degrees at the same level.*

a) If the program will be offered through a nontraditional schedule (i.e., not on a semester calendar), what is the schedule and how does it impact financial aid eligibility? ***NOTE:*** *Consult with your campus financial aid administrator for information about nontraditional schedules and financial aid eligibility.*

b) For each existing course that is part of the proposed graduate program, **append** a catalog description at the end of this document.

c) For each new course in the graduate program, **append** a syllabus at the end of this document. ***NOTE:*** *Syllabi for all courses should be available upon request. Each syllabus should show that all work for credit is graduate level and of the appropriate rigor. Syllabi generally include a course description, prerequisites and corequisites, the number of lecture and/or other contact hours per week, credits allocated (consistent with SUNY policy on credit/contact hours), general course requirements, and expected student learning outcomes.*

d) If the program requires external instruction, such as clinical or field experience, agency placement, an internship, fieldwork, or cooperative education, **append** a completed External Instruction form at the end of this document.

Please see Appendix B for example graduate program schedules.

SUNY Graduate Program Schedule (*OPTION: You can insert an Excel version of this schedule AFTER this line, and delete the rest of this page.)*
Program/Track Title and Award:_____

a) Indicate **academic calendar** type: [ ] Semester [ ] Quarter [ ] Trimester [ ] Other (describe):
b) **Label each term in sequence**, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)
c) Use the table to show **how a typical student may progress through the program**; copy/expand the table as needed.
d) Complete the last row to show program totals and comprehensive, culminating elements. **Complete all columns that apply to a course.**

Term 1:				**Term 2:**			
Course Number & Title	**Credits**	**New**	**Co/Prerequisites**	**Course Number & Title**	**Credits**	**New**	**Co/Prerequisites**
Term credit				Term credit			
Term 3:				**Term 4:**			
Course Number & Title	**Credits**	**New**	**Co/Prerequisites**	**Course Number & Title**	**Credits**	**New**	**Co/Prerequisites**
Term credit				Term credit			
Term 5:				**Term 6:**			
Course Number & Title	**Credits**	**New**	**Co/Prerequisites**	**Course Number & Title**	**Credits**	**New**	**Co/Prerequisites**
Term credit				Term credit			
Term 7:				**Term 8:**			
Course Number & Title	**Credits**	**New**	**Co/Prerequisites**	**Course Number & Title**	**Credits**	**New**	**Co/Prerequisites)**
Term credit				Term credit			
Program Total:	**Total Credits:**		**Identify the required comprehensive, culminating element(s), such as a thesis or examination, including course number(s), if applicable:**				

New: X if new course **Prerequisite(s)**: list prerequisite(s) for the listed courses

Section 4. Faculty

a) Complete the **SUNY Faculty Table** on the next page to describe current faculty and to-be-hired (TBH) faculty.

b) **Append** at the end of this document position descriptions or announcements for each to-be-hired faculty member.

NOTE: *CVs for all faculty should be available upon request. Faculty CVs should include rank and employment status, educational and employment background, professional affiliations and activities, important awards and recognition, publications (noting refereed journal articles), and brief descriptions of research and other externally funded projects. New York State's requirements for faculty qualifications are in in Regulation 52.2* http://www.highered.nysed.gov/ocue/lrp/rules.htm

c) What is the institution's definition of "full-time" faculty?

A full time faculty member is one who holds an appointment with a 100% time commitment.

SUNY Faculty Table

Provide information on current and prospective faculty members (identifying those at off-campus locations) who will be expected to teach any course in the graduate program. Expand the table as needed. Use a separate Faculty Table for each institution if the program is a multi-institution program.

(a)	(b)	(c)	(d)	(e)	(f)
Faculty Member Name and Title/Rank (Include and identify Program Director with an asterisk.)	**% of Time Dedicated to This Program**	**Program Courses Which May Be Taught (Number and Title)**	**Highest and Other Applicable Earned Degrees (include College and University)**	**Discipline(s) of Highest and Other Applicable Earned Degrees**	**Additional Qualifications: List related certifications, licenses and professional experience in field.**
PART 1. Full-Time Faculty					
Yanna Liang, *Professor and Chair*	30%	ESE 411/511: Water and Wastewater Treatment; ESE 412/512: Advanced Wastewater Eng. ESE 515 Biological Treatment Processes; ESE 471/571 Hazardous Waste Management; ESE 502 Bioprocess Engineering	Ph.D. Utah State University	Environmental Engineering	P.E., BCEE; > 27 years in the field of Environmental Engineering, government experience, ABET program evaluator, > 72 peer-reviewed papers and book chapters, > 81 conference presentations
			MS Utah State University	Environmental Engineering	
			BE, Suzhou Institute of Science and Technology	Environmental Engineering	
Kyoung-Yeol Kim, *Assistant Professor*	30%	ESE 411/511: Water and Wastewater Treatment; ESE 412/512: Advanced Wastewater Eng. ESE 515 Biological Treatment Processes; ESE 471/571 Hazardous Waste Management; ESE 502 Bioprocess Engineering	Ph.D. Gwangju Institute of Science and Technology (GIST), South Korea	Environmental Engineering	Over four years of postdoctoral experience in Environmental Engineering, > 42 peer reviewed papers.
			MS, Gwangju Institute of Science and Technology	Environmental Engineering	
			BS, Kyungpook National University	Environmental Engineering	
	30%	ESE 431/531: Air pollution control; ESE 533 Sustainable Air	Ph.D. University of Stuttgart, Germany	Environmental Engineering	PE, Over nine years postdoctoral experience in

MD. Aynul Bari, *Assistant Professor*		Pollution Manag; ESE 535 Indoor Air Quality and Control	MS, University of Stuttgart	Environmental Engineering	this field; > 41 peer-reviewed papers and conference presentations.
			BS, Bangladesh University of Engineering and Technology	Civil Engineering	
Rixiang Huang, *Assistant Professor*	30%	ESE 471/571 Hazardous Waste Management; ESE 501 Environ. Phys./chem. Processes; ESE 505 Theory/instrumentation for Environ. Analysis.	Ph.D. Baylor University	Geology	Over five years postdoctoral experience in this field; > 31 peer-reviewed papers.
			MS, Chinese Academy of Sciences	Environmental Engineering	
			BE, Harbin Institute of Technology	Environmental Engineering	
Yaoze Liu, *Assistant Professor*	30%	ESE 451/551 Water Resource Eng.; ESE 552 Nonpoint Source Pollution Eng.; ESE 555 Comp. Models for Watershed Hydrology	Ph.D., Purdue University	Agricultural and Biological Engineering	Over three years postdoctoral experience in this field; >35 peer-reviewed papers.
			MS, China Agricultural University	Hydraulic Engineering	
			BS, China Agricultural University	Irrigation and Drainage Engineering	
Paul Millard, Professor of Practice	15%	ESE 502 Bioprocess Engineering	Ph.D. University of Maryland	Microbiology	Over 41 peer-reviewed publications, > 35 years of experience in academia at various institutions.
			MS, University of Maine	Microbiology	
			BS, Southampton College	Marine Science/Biology	

Section 5. Financial Resources and Instructional Facilities

a) What is the resource plan for ensuring the success of the proposed program over time? Summarize the instructional facilities and equipment committed to ensure the success of the program. Please explain new and/or reallocated resources over the first five years for operations, including faculty and other personnel, the library, equipment, laboratories, and supplies. Also include resources for capital projects and other expenses.

- **Faculty:** Sufficient faculty are already here to launch the program. We do expect to grow the faculty over time, but these are not program-specific costs. The same faculty will teach in both the undergraduate and graduate programs offered by the Department.
- **Staff:** The existing Department and/or College staff (Administrative Manager, Secretary, Financial Manager, Student Advisor) are sufficient to support this program.
- **Space (including wet labs):** Suitable space exists on the uptown campus. UAlbany has assigned a total of 6,625 ft^2 lab space to ESE faculty in the Biology building. Among the total, 2,285 ft^2 are currently in use and the rest is being renovated and will be ready by summer of 2019. MS students choosing the thesis option will conduct research in these facilities. When the ETEC building opens in 2021, laboratory space in the basement totaling 5,040 ft^2 will be assigned to the department. Eight faculty offices, an office for supporting staff, a copy room, Chair's suite, a break room, storage room and a core facility of 2,000 ft^2 will be on the first floor. Three more faculty offices adjacent to the ESE section are available for future hires.
- **Instructional facilities**: The proposed Ph.D. ESE program will use teaching facilities (classrooms and labs) located on the uptown campus.
- **Equipment:** Laboratory equipment needed for teaching is already budgeted (or in place) in support of the BS program; no new teaching equipment is required specific to this program. Research laboratory equipment will be acquired through a mixture of faculty startup packages (already in place) and extramural research grants.
- **Administrative Costs:** No additional administrative costs are anticipated.
- **Student Recruiting Expenses:** Apart from nominal expenses associated with open houses, these expenses are expected to be minimal. In engineering, graduate student recruiting primarily occurs via the department website and those of the individual faculty in the student's area of interest.
- **Financial Assistance:** We expect most MS students to be self-funded. Beyond that, student support will come in three forms: (1) Fellowships, funded through philanthropy and therefore *not* a program expense; (2) Research Assistantships, funded through extramural research funding and therefore *not* a program expense; (3) Teaching Assistantships (TAs), funded by the Dean of Graduate Studies (Provost's Office) and therefore may be considered, in part, to be a program expense. Most TAs will be doctoral students, but some could go to exceptionally promising MS students interested in remaining for doctoral studies. We will request four new teaching assistantships from the Dean of Graduate Studies at a total annual cost of roughly $136,000 (assuming all four are out of state students); the TA support is essential to delivering the undergraduate program, and as seed funding to recruit new students, who should migrate to research funding within a year.
- **Library:** The Library subscribes to the relevant journals from major publishers; this need was addressed in support of the undergraduate program. These acquisitions support multiple programs offered (and to be offered) by the College and other units, and are therefore not program-specific. They suffice to support the ESE graduate program. We have consulted with the Library staff, and will continue to do so to identify and respond to future needs that may arise as the program grows and matures.
- **Software:** No specialized software licenses are anticipated at this time.

b) Complete the five-year SUNY Program Expenses Table, below, consistent with the resource plan summary. Enter the anticipated academic years in the top row of this table. List all resources that will be engaged specifically as a result of the proposed program (e.g., a new faculty position or additional library resources). If they represent a continuing cost, new resources for a given year should be included in the subsequent year(s), with adjustments for inflation or negotiated compensation. Include explanatory notes as needed.

SUNY Program Expenses Table

PROGRAM EXPENSES CATEGORIES	Expenses (in dollars)					
	Prior to Implementation	Academic Year 1	Academic Year 2	Academic Year 3	Academic Year 4	Academic Year 5
(a) Personnel (including faculty and all others						
(b) Library	$ 73,220	$ 73,220	$ 73,220	$ 73,220	$ 73,220	$ 73,220
(c) Equipment/Furniture		$ -	$ -	$ -	$ -	$ -
(d) Laboratory Supplies and Equipment	$ -				$ -	$ -
(e) Supplies, Search Expenses and Department Set-up	$ -				$ -	$ -
(f) Capital Expenses						
(g) Student Stipends or scholarships		$136,000	$136,000	$136,000	$136,000	$136,000
(h) Other (specify): College of Arts and Sciences Costs						
Sum of Rows Above	$73,220	$ 209,220	$ 209,220	$ 209,220	$209,220	$ 209,220

Section 6. Library Resources

a) Summarize the analysis of library collection resources and needs *for this program* by the collection librarian and program faculty. Include an assessment of existing library resources and accessibility to those resources for students enrolled in the program in all formats, including the institution's implementation of SUNY Connect, the SUNY-wide electronic library program.

The University Libraries collect, house, and provide access to all types of published materials in support of the research and teaching of the schools, colleges, and academic departments of the University. This brief evaluation considers those key portions of the libraries' collections and services that would support graduate degrees in Environmental and Sustainable Science.

Library Collections

The University Libraries are among the top 115 research libraries in the country and support a number of degree programs in the sciences, as well as those of Geography and Planning, Public Health, and Public Policy and Management. The University Library, the Science Library, and the Dewey Graduate Library contain more than two million volumes and over 2.9 million microforms. The Libraries provide access to more than 97,000 online journals and over 340,000 online books. Whenever possible, current subscriptions are available online. Additionally, the Libraries serve as a selective depository for U.S. Government publications and house collections of software and media.

The Science Library, which opened in September 1999, occupies 61,124 square feet on four floors. The

Science Library serves the entire University at Albany community, but contains collections supporting the departments of Atmospheric and Environmental Sciences, Biological Sciences, Chemistry, Computer Science, Mathematics and Statistics, Physics, and Psychology, as well as the College of Engineering & Applied Sciences and the School of Public Health. Approximately 600,000 volumes in the science and technology subject areas (Q-TP of the Library of Congress classification scheme) are housed in this library. Online resources (journals, databases, e-books, digital libraries) are available on and off campus, all hours of the day to members of the University at Albany community.

Databases and Digital Collections

The University Libraries currently subscribe to a number of important databases and digital collections for Environmental and Sustainable Engineering. *Web of Science* is an important cross-disciplinary database which is very strong in the sciences. *EBSCO Academic Search Complete* is another cross-disciplinary database which is good for locating articles on environmental issues. *Google Scholar* is another cross-disciplinary database which should be useful in locating journal articles on this topic.

Databases addressing aspects of Environmental and Sustainable Engineering are:
-*AGRICOLA*
-*Applied Science and Technology Source*
-*BIOSIS Citation Index*
-*Chemical Abstracts on SciFinder*
-*Energy & Power Source*
-*Energy Citations Database*
-*Environment Complete*
-*GeoRef*
-*GreenFILE*
-*INSPEC*
-*Meteorological & Geoastrophysical Abstracts (MGA)*
-*MEDLINE*
-*NTIS – National Technical Reports Library*
-*TOXNET*

Important digital journal collections provided by the University Libraries include *ScienceDirect* and the *American Chemical Society Online Journals* (1879+). *GeoScienceWorld* offers a number of journals in environmental geoscience. The *SPIE Digital Library* offers a large number of important remote sensing proceedings.

At this time, no new databases are recommended.

Journals

The University Libraries subscribe to a large number of journals (more than 97,000 titles), and almost all current content is available online. To assess the journals collection for these new graduate degrees, the University Libraries collection was compared to a list of important scholarly journals provided by the Chair of the Department of Environmental & Sustainable Engineering. This study found that the University Libraries provide online access (through subscription or *ScienceDirect*) to 29 of 38 (76%) journals listed.

These titles are:
-*Annual Review of Environment and Resources*
-*Bioresource Technology*

-Applied Energy
-Fuel
-International Journal of Hydrogen Energy
-Renewable and Sustainable Energy Reviews
-Renewable Energy
-Energy & Environment
-Ecology
-Environmental Science & Technology
-Applied and Environmental Microbiology
-Langmuir
-Environmental Research
-Aquatic Toxicology
-Atmospheric Environment
-Chemosphere
-Environment International
-Environmental pollution
-Journal of Hydrology
-Science of the Total Environment
-Water Research
-Environmental Management
-Environmental Modelling & Software
-Journal of the Air & Waste Management Association
-Environmental Research Letters
-ACS Nano
-Atmospheric Pollution Research
-Nature Communications
-Green Chemistry Letters and Reviews

A further 5 of 38 (13%) journals offer partial access (the current year is embargoed, although earlier volumes are available). These journal titles are: *Nanotoxicology*, *Environmental Earth Sciences*, *Water, Air & Soil Pollution*, *Water Resources Manag*ement and *Frontiers in Ecology and the Environment*.
To provide access to these journal titles would cost **$23,672.00**.

Only 4 of the 38 (11%) journals are not available at all through the University Libraries. To provide access would cost **$22,048.00**. They are:

- *Advanced Energy Materials* $12,940.00
- *Energy and Environmental Science* $2,345.00
- *Environmental Science: Processes & Impacts* $2,892.00
- *Green Chemistry* $3,871.00

Books

Books serve as a resource for graduate students. For the Environmental and Sustainable Engineering program, there will be some overlap between books purchased to support programs in Atmospheric and Environmental Sciences, Biology, Public Health, General Science and Public Policy, as well as a proposed B.S. in Interdisciplinary Studies with a concentration in Environmental Sciences.

We are recommending an annual budget of **$22,500.00** to purchase 150 books at an average cost of $150.00 each, to support this program.

Reference Collection

The reference collection of the University Libraries currently houses resources that would support an Environmental and Sustainable Engineering program. Some of the resources are available in the Science Library or University Library, and some are available online.

There are a number of reference books related to aspects of environmental science, including these titles:

Atlas of Climate Change, University of California Press, 2011.
Climate Change: an Encyclopedia of Science and History, ABC-CLIO, 2013.
Dictionary of Ecology, Oxford University Press, 2010.
Dictionary of Energy, Elsevier, 2015.
Dictionary of Environment and Conservation, 2nd ed., Oxford University Press, 2013.
Encyclopedia of Atmospheric Sciences, Academic Press, 2015.
Encyclopedia of Climate and Weather, Oxford University Press, 2011.
Encyclopedia of Energy, Salem Press, 2013.
Encyclopedia of Environmental Issues, Salem Press, 2011.
Encyclopedia of Global Warming, Salem Press, 2016.
Encyclopedia of Global Warming & Climate Change, SAGE, 2008.
Encyclopedia of Pollution, Facts on File, 2011.
Environmental Encyclopedia, Cengange Learning, 2011.
Facts on File Dictionary of Environmental Science, 3rd ed., Facts on File, 2007.
Green Issues and Debates: an A-to-Z Guide, Sage Publications, 2011.
Keywords for Environmental Studies, New York University Press, 2016.
Oxford Companion to Global Change, Oxford University Press, 2009.
Water Encyclopedia, 2rd ed., Lewis Publishers, 1990.

If additional reference resources are needed, the Subject Librarian for Science Reference should be able to acquire them by firm order.

It is recommended that **$5,000.00** be added to the annual Science Library reference budget to purchase new reference resources for environmental engineering each year.

Standards

Engineers depend on industrial standards for their work. Currently, the University Libraries rely on the New York State Library for standards, which has a large collection along with related publications. The Websites of several organizations provide free standards searching capabilities. No resources are recommended at this time. As the program grows, the University Libraries may need to revisit the acquisition of standards related

to Environmental and Sustainable Engineering, if the need exists. A purchase on demand model may be the best way to address these needs.

Government Documents

Government publications are important for environmental research. The University Libraries serve as a selective government document depository for federal publications. Also, a large number of government documents are available online, and can be located using a search tool like Google.

Interlibrary Loan and Delivery Services

The University Libraries' Interlibrary Loan (ILL) Department borrows books and microforms, and obtains digital copies of journal articles and other materials not owned by the Libraries from sources locally, statewide, nationally, and internationally. ILL services are available at no cost to the user for faculty, staff, and students currently enrolled at the University at Albany. Users can manage their requests through the use of ILLiad, the University Libraries' automated interlibrary loan system, which is available through a Web interface at https://illiad.albany.edu/.

The University Libraries also provide delivery services for books and articles housed in any of the three libraries. Books can be delivered to one of the libraries or, for faculty, to departmental addresses. Articles are scanned and delivered electronically via email. The Libraries also provide free delivery services to the home addresses of online learners and people with disabilities. Delivery services are managed through ILLiad as well.

Summary

Many resources purchased for atmospheric science and other science/technology subjects will support an Environmental and Sustainable Engineering program. However, additional resources will be needed. Those are:

---Journals for Environmental and Sustainable Engineering (annual) -- **$45,720.00**
---Books and other resources – (annual) -- **$22,500**
---Reference resources (annual) -- **$5,000.00**

b) Describe the institution's response to identified collection needs and its plan for library development.

All recommended library resources have been included in the program budget.

Section 7. External Evaluation

SUNY and SED require external evaluation of all proposed graduate degree programs. List below all SUNY-approved evaluators who conducted evaluations (adding rows as needed), and **append at the end of this document** each original, signed *External Evaluation Report*. ***NOTE:*** *To select external evaluators, a campus sends 3-5 proposed evaluators' names, titles and CVs to the assigned SUNY Program Reviewer, expresses its preferences and requests approval.*

Evaluator #1
Name: Ben Stuart
Title: Interim Dean
Institution: Old Dominion University

Evaluator #2
Name: Charles N. Haas
Title: Professor and Head
Institution: Drexel University

Section 8. Institutional Response to External Evaluator Reports

Append at the end of this document a single *Institutional Response* to all *External Evaluation Reports.*

Section 9. SUNY Undergraduate Transfer

NOTE: *SUNY Undergraduate Transfer policy does not apply to graduate programs.*

Section 10. Application for Distance Education

a) Does the program's design enable students to complete 50% or more of the course requirements through distance education? [×] No [ ] Yes. If yes, **append** a completed *SUNY Distance Education Format Proposal* at the end of this proposal to apply for the program to be registered for the distance education format.

b) Does the program's design enable students to complete 100% of the course requirements through distance education? [×] No [ ] Yes

Section MPA-1. Need for Master Plan Amendment and/or Degree Authorization

a) Based on guidance on Master Plan Amendments, please indicate if this proposal requires a Master Plan Amendment.
[×] No [ ] Yes, a completed *Master Plan Amendment Form* is **appended** at the end of this proposal.

b) Based on *SUNY Guidance on Degree Authorizations* (below), please indicate if this proposal requires degree authorization.

[ ] No [×] Yes, once the program is approved by the SUNY Provost, the campus will work with its Campus Reviewer to draft a resolution that the SUNY Chancellor will recommend to the SUNY Board of Trustees.

SUNY Guidance on Degree Authorization. *Degree authorization is required when a proposed program will lead to a new degree (e.g., B.F.A., M.P.H.) at an existing level of study (i.e., associate, baccalaureate, first-professional, master's, and doctoral) in an existing disciplinary area at an institution. Disciplinary areas are defined by the New York State Taxonomy of Academic Programs. Degree authorization requires approval by the SUNY Provost, the SUNY Board of Trustees and the Board of Regents.*

List of Appended Items

Appended Items: Materials required in selected items in Sections 1 through 10 and MPA-1 of this form should be appended after this page, with continued pagination. In the first column of the chart below, please number the appended items, and append them in number order.

Number	Appended Items	Reference Items
	For multi-institution programs, a letter of approval from partner institution(s)	Section 1, Item (e)
	For programs leading to professional licensure, a side-by-side chart showing how the program's components meet the requirements of specialized accreditation, Commissioner's Regulations for the Profession, or other applicable external standards	Section 2.3, Item (e)
	For programs leading to licensure in selected professions for which the SED Office of Professions (OP) requires a specialized form, a completed version of that form	Section 2.3, Item (e)
	OPTIONAL: For programs leading directly to employment, letters of support from employers, if available	Section 2, Item 2.3 (h)(2)
	For all programs, a plan or curriculum map showing the courses in which the program's educational and (if appropriate) career objectives will be taught and assessed	Section 2, Item 7
	For all programs, a catalog description for each existing course that is part of the proposed graduate major program	Section 3, Item (b)
	For all programs with new courses, syllabi for all new courses in a proposed graduate program	Section 3, Item (c)
	For programs requiring external instruction, a completed *External Instruction Form* and documentation required on that form	Section 3, Item (d)
	For programs that will depend on new faculty, position descriptions or announcements for faculty to-be-hired	Section 4, Item (b)
	For all programs, original, signed External Evaluation Reports from SUNY-approved evaluators	Section 7
	For all programs, a single Institutional Response to External Evaluators' Reports	Section 8
	For programs designed to enable students to complete at least 50% of the course requirements at a distance, a *Distance Education Format Proposal*	Section 10
	For programs requiring an MPA, a *Master Plan Amendment form*	Section MPA-1

List of appendices

Appendix A: Table of curriculum courses for the Ph.D. ESE program

Appendix B: Examples of graduate program schedule

Appendix C: A plan or curriculum map showing the courses in which the program's educational objectives will be taught and assessed.

Appendix D: Catalogue descriptions of existing courses that are part of the proposed Ph.D. program.

Appendix E: Syllabi for newly proposed courses.

Appendix A: Table of curriculum courses for the Ph.D. ESE program. Red colors: shared resources courses; Green color: core courses. **For shared resources courses, the undergraduate versions cannot be taken for graduate credit.**

Proposed course titles	**Credit hours**	**Concentration Area**			
		Water and wastewater	Air quality monitoring and control	Human health and the environment	Sustainability engineering
ESE 411/511 Water/wastewater Treatment	3	×		×	×
ESE 412/512 Advanced Wastewater Eng.	3	×		×	×
ESE 501 Environ. Phys./chem. Processes	3	×	×	×	×
ESE 451/551 Water Resource Eng.	3	×			
ESE 505 Theory/instrumentation for Environ. Analysis	3	×		×	
ESE 515 Biological Treatment Processes	3	×	×	×	×
ESE 552 Nonpoint Source Pollution Eng.	3	×	×	×	×
ESE 555 Comp. Models for Watershed Hydrology	3	×			
ESE 471/571 Hazardous Waste Management	3	×		×	×
GOG 534 Water Resources Planning	3	×			
ESE 431/531 Air pollution control	3		×	×	×
ESE 533 Sustainable Air Pollution Manag.	3	×	×	×	×
ESE 535 Indoor Air Quality and Control	3		×	×	×
ESE 502 Bioprocess Engineering	3	x		x	x
AATM 515 Aerosol Physics	3		×		
AATM 514 Air Pollution Meteorology	3		×		
AATM 561 Applied Data Analysis in Atmospheric and Environmental Science	3		×		
AATM 506 Environmental Geochemistry	3	×	×		
STA 558 Methods of Data Analysis I	3	×	×	×	×
STA 559 (Mat 559) Methods of Data Analysis II	3	×	×	×	×
HEHS 520 (ESE 520) Prin. Environmental Chemistry	3	×		×	
HEHS 525 Environ Chemical Analysis	3	×		×	
HEHS 530 Principles of Toxicology	3			×	
HEHS 590 Intro to Environmental Health	3			×	
HEHS 665 Risk Assessment	3			×	
HEHS 607 Global Environmental Health Policy	3			×	
EPI 501 Principles and Methods of Epidemiology	3			×	
GOG 504 Energy, Environment, and Climate Change	3		×	×	×
HEHS 560 (ESE 560) Sustainability, Green Design and Public Health	3	×		×	×
AATM 530 Renewable Energy Issues	3				×
Pad 548 Environmental Policy	4	×	×	×	×

Pad 534 (Pln 535) Environmental Restoration & Brownfields Redevelopment	3-4			×	×
Pad 575 Understanding Energy Policy and Climate Change: A Federal, State and Local Government Perspective	4			×	×
Pad 635 Health, Safety and Environmental Regulation	4			×	×
Pad 666 (Pos 666/Int 513) Global Environment: Politics and Policy	4	×	×	×	×
Pad 667 (Pos 667) Politics of Environmental Regulation	4	×	×	×	×
Seminar	3	×	×	×	×
ESE 890 Independent study and research	1-3				
ESE 899 Ph.D. Dissertation	3-6				

Appendix B-1: An example of a Ph.D. program schedule after BS in the water and wastewater concentration area.

SUNY Graduate Sample Program Schedule

Campus Name	**University at Albany**			
Program/Track Title and Award	**Environmental and Sustainable Engineering**			
	Semester	**Quarter**	**Trimester**	**Other**
Calendar Type	×			

(Label each term in sequence, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)

Use the table to show how a typical student may progress through the program. Check all columns that apply to a course or enter credits where applicable. New: X if a new course. Co/Prerequisite(s): list prerequisite(s) for the noted

Term 1:				**Term 2:**			
Course Number & Title	**Credits**	**New (X)**	**Co/Prerequisites**	**Course Number & Title**	**Credits**	**New (X)**	**Co/Prerequisites**
ESE 412/512 Advanced Wastewater Eng. (Breadth)	3	x	ESE 411/511 Water/wastewater Treatment	ESE 533 Sustainable Air Pollution Manag. (Core)	3	x	
ESE 451/551 Water Resource Eng. (Breadth)	3	x	ESE 351 Fluid Mechanics	ESE 501 Environ. Phys./chem. Processes (Core)	3	x	
ESE Elective (Breadth)	3			Dissertation	3		
Term credit total:	**9.0**			**Term credit total:**	**9.0**		
Term 3:				**Term 4:**			
Course Number & Title	**Credits**	**New (X)**	**Co/Prerequisites**	**Course Number & Title**	**Credits**	**New (X)**	**Co/Prerequisites**
ESE 515 Biological Treatment Processes (Core)	3	x	ESE 411/511 Water/wastewater Treatment	ESE 552 Nonpoint Source Pollution Eng. (Core)	3	x	ESE 451/551 Water Resources Engineering
Math/Science electives	3			Math/Science electives	3		
Dissertation	3			Dissertation	3		
Term credit total:	**9.0**			**Term credit total:**	**9.0**		
Term 5:				**Term 6:**			
Course Number & Title	**Credits**	**New (X)**	**Co/Prerequisites**	**Course Number & Title**	**Credits**	**New (X)**	**Co/Prerequisites**
Math/Science electives	3			Math/Science electives	3		
Any other electives	3			Any other electives	3		
Dissertation	6			Dissertation	3		
Term credit total:	**12.0**			**Term credit total:**	**9.0**		
Term 7:				**Term 8:**			
Course Number & Title	**Credits**	**New (X)**	**Co/Prerequisites**	**Course Number & Title**	**Credits**	**New (X)**	**Co/Prerequisites**
Dissertation	9			Dissertation	9		
Term credit total:	**9.0**			**Term credit total:**	**9.0**		

Program Total:	**75.0**

Identify the required comprehensive, culminating element(s), such as a thesis or examination, including course number(s), if applicable:

Appendix B-2: An example of a Ph.D. program schedule after MS in the water and wastewater concentration area.

SUNY Graduate Sample Program Schedule

Campus Name	**University at Albany**			
Program/Track Title and Award	**Environmental and Sustainable Engineering**			
	Semester	Quarter	Trimester	Other
Calendar Type	×			

(Label each term in sequence, consistent with the institution's academic calendar (e.g., Fall 1, Spring 1, Fall 2)

Use the table to show how a typical student may progress through the program. Check all columns that apply to a course or enter credits where applicable. New: X if a new course. Co/Prerequisite(s): list prerequisite(s) for the noted

Term 1:

Course Number & Title	Credits	New (X)	Co/Prerequisites
ESE 515 Biological Treatment Processes (Core)	3	x	ESE 411/511 Water/wastewater Treatment
ESE 501 Environ. Phys./chem. Processes (Core)	3	x	
Term credit total:	**6.0**		

Term 2:

Course Number & Title	Credits	New (X)	Co/Prerequisites
ESE Elective (Breadth)	3	x	
Dissertation	3		
Term credit total:	**6.0**		

Term 3:

Course Number & Title	Credits	New (X)	Co/Prerequisites
Dissertation	9		
Term credit total:	**9.0**		

Term 4:

Course Number & Title	Credits	New (X)	Co/Prerequisites
Dissertation	9	x	
Term credit total:	**9.0**		

Term 5:

Course Number & Title	Credits	New (X)	Co/Prerequisites
Dissertation	9		
Term credit total:	**9.0**		

Term 6:

Course Number & Title	Credits	New (X)	Co/Prerequisites
Dissertation	6		
Term credit total:	**6.0**		

Term 7:

Course Number & Title	Credits	New (X)	Co/Prerequisites
Term credit total:	**0.0**		

Term 8:

Course Number & Title	Credits	New (X)	Co/Prerequisites
Term credit total:	**0.0**		

Program Total: (Assuming 30 credits earned from MS)	**75.0**

Identify the required comprehensive, culminating element(s), such as a thesis or examination, including course number(s), if applicable:

Appendix C: A plan or curriculum map showing the courses in which the program's educational objectives will be taught and assessed.

Proposed course titles	**Project educational objectives**				
	Breadth: contribute technically to solving broad environmental problems	**Depth**: highly knowledgeable and skilled in their chosen field of interest.	**Teamwork:** work collaboratively with people from different background	**Professionalism**: maintain high professional and ethical standards	**Lifelong Learning:** excel in their chosen profession through lifelong learning
ESE 411/511 Water/wastewater Treatment	×	×	×	×	
ESE 412/512 Advanced Wastewater Eng.	×	×	×	×	
ESE 501 Environ. Phys./chem. Processes	×	×	×	×	
ESE 451/551 Water Resource Eng.	×	×	×	×	
ESE 505 Theory/instrumentation for Environ. Analysis	×	×	×	×	
ESE 515 Biological Treatment Processes	×	×	×	×	
ESE 552 Nonpoint Source Pollution Eng.	×	×	×	×	
ESE 555 Comp. Models for Watershed Hydrology	×	×	×	×	
ESE 471/571 Hazardous Waste Management	×	×	×	×	
GOG 534 Water Resources Planning	×	×	×	×	
ESE 431/531 Air pollution control	×	×	×	×	
ESE 533 Sustainable Air Pollution Manag.	×	×	×	×	
ESE 535 Indoor Air Quality and Control	×	×	×	×	
ESE 502 Bioprocess Engineering	×	×	×	×	
AATM 515 Aerosol Physics	×	×	×	×	
AATM 514 Air Pollution Meteorology	×	×	×	×	
AATM 561 Applied Data Analysis in Atmospheric and Environmental Science	×	×	×	×	
AATM 506 Environmental Geochemistry	×	×	×	×	
STA 558 Methods of Data Analysis I	×	×	×	×	
STA 559 (Mat 559) Methods of Data Analysis II	×	×	×	×	
HEHS 520 (ESE 520) Prin. Environmental Chemistry	×	×	×	×	
HEHS 525 Environ Chemical Analysis	×	×	×	×	
HEHS 530 Principles of Toxicology	×	×	×	×	

HEHS 590 Intro to Environmental Health	×	×	×	×	
HEHS 665 Risk Assessment	×	×	×	×	
HEHS 607 Global Environmental Health Policy	×	×	×	×	
EPI 501 Principles and Methods of Epidemiology	×	×	×	×	
GOG 504 Energy, Environment, and Climate Change	×	×	×	×	
HEHS 560 (ESE 560) Sustainability, Green Design and Public Health	×	×	×	×	
AATM 530 Renewable Energy Issues	×	×	×	×	
Pad 548 Environmental Policy		×	×	×	
Pad 534 (Pln 535) Environmental Restoration & Brownfields Redevelopment		×	×	×	
Pad 575 Understanding Energy Policy and Climate Change: A Federal, State and Local Government Perspective		×	×	×	
Pad 635 Health, Safety and Environmental Regulation		×	×	×	
Pad 666 (Pos 666/Int 513) Global Environment: Politics and Policy		×	×	×	
Pad 667 (Pos 667) Politics of Environmental Regulation		×	×	×	
Seminar	×	×	×	×	×
ESE 890 Independent Study and Research	×	×	×	×	×
ESE 899 Doctoral Dissertation	×	×	×	×	×

Appendix D: Catalogue descriptions of existing courses that are part of the proposed MS program

Pln 534 (Gog 534) Water Resources Planning (3)
To understand water as an increasingly scarce and important world resource. Students will learn how water is harnessed and moved, how competing water uses are prioritized, how to prevent source water depletion, how to plan for safe drinking water supplies and how to protect water quality through watershed planning and stormwater management, using New York and U.S. examples. Prerequisites: Pln 505 or permission of instructor.

Gog 504 (Pln 538) Energy, Environment, and Climate Change (3)
This course addresses the response of the global environment to rising energy consumption by human civilization. The structure of this course reflects on the premise that energy consumption and climate change are inherently-connected issues requiring a holistic study approach. The course consists of two parts. The first part of the course deals with climate change and fossil fuel use. The second part addresses the issue of alternative sources of power with lower impact on climate and environment than traditional fossil fuels. We begin the first part with review of recent changes in global climate and historic trends in fossil fuel consumption. We discuss impact of climate change and combustion of fossil fuel on environment and study of geoengineering projects that can mitigate global warming and its negative consequences. The second part of the course starts with review of scientific principles required to better understand basics of energy transformations. Then, these principles are used through the reaming part of the course to research alternative power sources including nuclear, solar, wind, hydropower, geothermal, biofuels and hydrogen. We use this research to derive quantitative estimates of potential scale at which power can be generated from alternative sources as well as to estimate their impact on environment and economy. Obtained estimates will be linked to policy issues related to climate change and power generation. We end this course with presentations and discussion of individual research projects in the field of geoengineering and generation of alternative energy. Prerequisite(s): At least 6 credits in undergraduate science courses.

Atm 514 Air Pollution Meteorology (3)
Analysis of physical, meteorological, and chemical processes influencing the life-cycle of harmful gaseous and particulate air pollutants. Offered alternate Fall semesters.

Atm 515 Aerosol Physics (3)
Characterization of aerosols (size distributions, compositions, optical properties); dynamics and thermodynamic of aerosols; physical processes controlling properties of aerosols in the atmosphere; aerosol field measurements and numerical modeling; aerosol-cloud-precipitation interactions; and environmental impacts of atmospheric aerosols. Prerequisite: ATM 505 or consent of the instructor.

Atm 506 Environmental Geochemistry (3)
Industrial pollution, agricultural pesticides and fertilizers, and fossil fuel waste-products are major sources of biotoxic and phytotoxic heavy metals (e.g., As, Cd, Cu, Hg, Mo, Ni, Pb, Sb, Sc, Tl) in the environment. The mobilities and pathways of these elements into-and-through soil and groundwater are examined. Analytic methods and sampling strategies for tracing the historical trends of heavy metal fluxes in specific geographic regions are explored.

Atm 530 Renewable Energy Issues (3)
Guided research in renewable energy issues -- subjects directly or indirectly related to weather and/or climate will be considered and discussed – e.g., solar and wind resource assessment and forecasting, renewable energy technologies, socio-economics, utility power solutions. Students will select specific subjects for in-depth research leading to class discussions and final report preparation.

Atm 561 Applied Data Analysis in Atmospheric and Environmental Science (3)
Data analysis methods for information extraction and physical insight from the examination of environmental observations and model data; use of a "toolbox" approach to hypothesis testing, time series analysis, spectral methods, temporal and spatial filtering, eigenvector methods, regression, forecasting, and other techniques. Offered alternate Spring semesters. Prerequisite: Permission of instructor.

Mat 558 (H Sta 558) Methods of Data Analysis I (3)

Statistical methodology emphasizing exploratory approaches to data. Elementary notions of modeling and robustness. Overview of inferential techniques in current use. Criteria for selection and application of methods. Use of computing facilities to illustrate and implement methods. Regression and analysis of variance are primary topics. Prerequisite: Mat 554 (H Sta 554) or equivalent.

Mat 559 (H Sta 559) Methods of Data Analysis II (3)
Continuation of Mat 558 (H Sta 558). Topics will include clustering, multivariate analyses, sequential and nonparametric methods. Prerequisite: Mat 558 (H Sta 558) or equivalent.

Ehs 520 (Ese 520) Principles of Environmental Chemistry (3)
A survey of known environmental pollutants undertaken to familiarize students with the processes of evolution, emission, transport and disposition of these compounds in the environment. Prerequisite: Two years of college chemistry or the consent of the instructor.

Ehs 525 Environmental Chemical Analysis (3)
The theory, basic instrumentation and applications of instrumental techniques used in environmental analysis. Included are atomic and molecular spectrometry, chromatography, mass spectrometry and electrochemical techniques. Particular emphasis is placed on those aspects of analysis which influence the precision and accuracy of analytical data. These include the effects of sampling, sample preparation and instrumental. Prerequisites: Three undergraduate courses in chemistry, or consent of instructor.

Ehs 530 Principles of Toxicology (3)
Fundamentals and principles of toxicology including absorption, distribution, metabolism and excretion of chemicals and drugs in mammalian systems. The toxicology of specific organ systems and of classes of compounds which produce similar toxic effects presented. Current governmental regulations concerning foods, drugs, and environmental policies discussed. Prerequisite: Two years of undergraduate chemistry and one year of undergraduate biology or consent of instructor.

Ehs 560 (Ese 560) Sustainability, Green Design and Public Health (3)
This course covers the theory, principles and measures of sustainability and public health. Through hand-on projects and real-world cases, the students will work with governmental, industrial and non-profit organization partners to assess the environmental footprints and health impacts of their products and services, and suggest the sustainable interventions.

Ehs 590 Introduction to Environmental Health (3)
During the exploration of myriad environmental health related topics, students in this course gain an understanding of the interactions between individuals and communities with the environment, approaches to investigating these interactions, potential impacts of environmental agents on human health and of specific applications of environmental health concepts to public health. Prerequisite: College level biology course or permission of instructor.

Ehs 607 Global Environmental Health Policy (3)
Examination from a variety of analytic perspectives of several global health policy issues of current social, economic, and political importance. Issues include toxic substances, vector borne diseases, climate change, health disparities, occupational health standards, environmental risk analyses, and risk management. Prerequisite: Ehs 590 or the equivalent.

Ehs 665 Risk Assessment (3)
Introduces the science that is used in assessing human health risks from chemical exposures. It includes: (a) hazard identification; (b) dose- response assessment; (c) exposure assessment; (d) risk characterization; and (e) risk communication. Imparts analytical skills that students can use in developing, interpreting, and understanding risk assessment for individual chemical or specific contamination incidents involving human exposure. Prerequisites: Ehs 530 and Epi 501.

Epi 501 Principles and Methods of Epidemiology I (3)

Introduction to epidemiology for students majoring in any aspect of public health; covers the principles and methods of epidemiologic investigation including describing the patterns of illness in populations and research designs for investigating the etiology of disease. Introduces quantitative measures to determine risk, association and procedures for standardization of rates.

Pad 548 Environmental Policy (4)
This course will explore how environmental policy is shaped and implemented. It will draw on the strengths of Rockefeller College, including faculty expertise in public policy analysis, development and implementation; the role of nonprofit organizations in the development and execution of environmental policy; the relationships between environmental laws, rules and regulations, policy and politics; the institutional framework for advancing environmental goals; and the proximity of New York State government agencies, policymakers, environmental organizations and key advocates. States have always been the incubators of environmental policy and as federal officials withdraw, this role has become a more important opportunity for states to act. Environmental Policy is a unique area of public policy. It combines the disciplines of political science, economics, other social sciences and the law and how public institutions (primarily government organizations) address society's needs. Beyond these, however, other forces influence the formation and application of environmental policy, including: its basis in the hard sciences; the critical and historic role and involvement of nonprofit organizations; engagement at all levels of government (local, regional, state, national and global) - and the lack of borders between those levels; the breadth of the defined "constituency" (to be protected or to benefit), which goes beyond human beings living today; very high stakes (the consequence of failure); and the challenges and opportunities inherent in taking action.

Pad 534 (Pln 535) Environmental Restoration & Brownfields Redevelopment (3-4)
Introduces students to the fundamental issues that confront stakeholders engaged in redeveloping brownfields. Risk analysis and communication, economic aspects, political and social constraints, and the role of public participation are central themes. Linked to brownfields are also smart growth, sustainable development, urban revitalization, and quality of life concerns. The nexus of these fundamental planning concepts and environmental quality will also be explored.

Pad 575 Understanding Energy Policy and Climate Change: A Federal, State and Local Government Perspective (4)
The study of energy policy and climate change reflects an intricate interplay of political (domestic and international), economic, legal, regulatory, technological, environmental and ethical dimensions. This course will explore these dimensions encouraging class discussion of critical energy policy issues and the analysis of approaches to a clean, secure and equitable energy future.

Pad 635 Health, Safety and Environmental Regulation (4)
Presents a political and economic assessment of risk regulation policies as they have developed for air and water pollution, work place risks, auto safety, drug regulation and nuclear power. Prerequisite: Hpm 501 or consent of instructor.

Pad 666 (Pos 666/Int 513) Global Environment: Politics and Policy (4)
This course examines the theory and practice of international environmental politics to better understand why the international community has been successful at solving some international environmental problems but not others. It considers policies that aim to address transnational issues such as climate change, ozone depletion, overfishing, deforestation, and species extinction. Theoretical approaches applied to these problems will consider not only the central role of states, but also the ways in which non-state actors, such as non-governmental organizations, multinational corporations, and transnational networks of cities, are becoming important players in managing these problems.

Pad 667 (Pos 667) Politics of Environmental Regulation (4)
Evaluation of environmental regulation in the United States and considers the response of political and administrative institutions to complex problems such as toxic wastes. Comparative perspectives on Western and Eastern Europe and Japan.

Appendix E: Syllabi for newly proposed courses.

University at Albany / Environmental and Sustainable Engineering
Water and Wastewater Treatment (3 Credits)
ESE 411/511

Lecture:	2:45 pm – 4:05 pm (Mon, Wed), Massry Center for Business (BB) 213
Instructor:	Prof. Kyoung-Yeol Kim University Administration Building (UAB) 232, Tel. 518-437-4971, E-mail: kkim28@albany.edu
Office hours:	Thursday, 3 pm – 4 pm or by appointment

TEXTBOOK (REQUIRED):
Water Supply and Pollution Control, 8th Edition, by Viessman et al. (2009) (ISBN-13: 978-0132337175)

COURSE DESCRIPTION / OVERVIEW
This course will cover two general fields in environmental engineering: water supply engineering and wastewater engineering including water supply and use; water treatment; and wastewater treatment. From water distribution (pressurized flow) to wastewater collection (gravity flow), we need to consider changes in community size and demand requirements. Water treatment is to produce reliable portable water using different water sources with consideration of human health. Wastewater treatment includes the used water entering a wastewater treatment plant and treatment processes to produce suitable effluent for safe disposal to the environment. For graduate students, extra homework will be given and a final project paper regarding recent water treatment process will be required to submit before the final week. Graduate students must present their paper in the classroom in the final week.

PREREQUISITES
Prerequisite: ESE 301 Introduction to Environmental & Sustainable Engineering

COREQUISITES
None

LEARNING OBJECTIVES / OUTCOMES:
At the completion of the course students will:

- Be able to understand the issues associated with water supply and wastewater collection
- Be able to design process and specify their design and operation parameters for water and wastewater treatment
- Be able to apply the principles of math and science to technical problems
- Be familiar with terminology used in (waste)water treatment processes
- Broaden their knowledge about wastewater treatment processes (physical, chemical and biological processes depending on their target contaminants)

COURSE WEBSITE AND BLACKBOARD:

Blackboard will be used to provide essential course materials, the most current syllabus, and assignment documents and no separate course website will be maintained. However, this is not an online course and class attendance is essential and required.

ASSESSMENT AND POLICIES:
The accomplishment of course objectives will be assessed by evaluating students' homework and exams. These evaluations will be conducted throughout the whole semester in order to adjust the depth of teaching materials and pace of delivery to maximize students' learning outcomes. Extra homework or assignment will be given to graduate students and included in their evaluations.

Exams: Three exams will be given. Extra exams will be given for graduate level students if required.

Homework: There are 5 homework assignments. These are due at the beginning of the class for full credit. Late assignments (within 24 hours of the assigned due date) will receive a loss of 20% of the grade. No credit will be given if assignments were not submitted to the instructor within 24 hours of the assigned due date. Homework problems are meant to be challenging and require the application and extension of presented materials and concepts in class, in lecture materials, or the textbook.

Grading
A final grade will be determined as a weighted average of these scores using the following weights:

For undergraduates:

Homework	10%
Exam I	25%
Exam II	30%
Final exam	30%
Attendance	5%

For graduates:

Homework	10%
Exam I	20%
Exam II	20%
Final exam	20%
Final report & Presentation	30%

Grading Scale
A: 100-95 points A-: 94-90 points
B+: 89-87 points B: 84-86 points B-: 80-83 points
C+: 79-76 points C: 75-70 points
D: 69-60 points
E: 59 points and below

The instructor may choose to re-curve the distribution, in favor of students.

Students must complete all requirements in order to pass the course. A grade of incomplete will be given only when circumstances beyond the student's control cause a substantial amount of course work to be unfinished by the end of the semester. Whenever possible, the student is expected to make extra efforts to prevent this situation from occurring. The instructor will be the sole judge of whether an incomplete is warranted. Final grades are computed based on the above formulas and are NOT negotiable. Per department policy, "…students may not submit additional work or be re-examined for the purpose of improving their grades once the course has been completed and final grades assigned."

Student Conduct
Student and staff/faculty interactions in the classroom and other on-campus environments are expected to be professional and cordial. Disruptive behavior in the classroom may be treated by the instructor as a violation of the U Albany Student Code of Conduct, and subject to a formal Student Conduct Referral.

Use of Computers in class
Computers may be used during class for note taking as long as the use is not disruptive or distracting. See http://www.albany.edu/health_center/medicalexcuse.shtml.

Absence Due to Religious Observance
According to New York State Education Law Section 224-A, the instructors are required to excuse individual students absent without penalty because of religious beliefs, and to provide equivalent opportunities for make-up examinations, study, or work requirements missed because of such absences. However, students should notify the instructor of record in a timely manner, any unexcused absences will result in a 2-point deduction from your final grade.
See (https://www.nysenate.gov/legislation/laws/EDN/224-A)

Responsible Computing
Students are required to read the University at Albany Policy for the Responsible Use of Information Technology (http://www.albany.edu/its/policies_responsible_use_of_IT.htm). Students will be expected to apply the policies discussed in this document to all electronic communications in the course.

Students with Disabilities
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Academic Honesty and Overall Regulations
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As per college policy, cheating activity will be reported to the college administration.

COURSE OUTLINE AND READINGS:
The following schedule of lecture topics and reading assignments is preliminary and may be changed as the semester progresses. The final schedule and specific homework and materials will be provided in Blackboard. Students are expected to have read the listed material before it is covered in class. There will be additional readings related to certain course topics.

Tentative Course Schedule

Week	Date	Class	Homework
1	1/23	Course Introduction. The Engineered water cycle	
2	1/28	Water distribution and wastewater systems	
	1/30	Calculating headloss in water distribution systems	
3	2/4	Water distribution system design	HW 1 due
	2/6	Wastewater collection	
4	2/11	Water treatment processes: Drinking water standards and water analysis	
	2/13	Water treatment processes: Conventional processes I	
5	2/18	Water treatment processes: Conventional processes II	HW 2 due
	2/20	Water treatment reactor design	
6	2/25	**Exam 1**	
	2/27	Filtration	
7	3/4	Water treatment chemistry	
	3/6	Chemicals used for coagulation and coagulant dose	
8	3/11	Water softening and disinfection	HW 3 due
	3/13	Water treatment advanced processes	
9		March 16-22 – **No Class – Enjoy Spring Break !!**	
10	3/25	Wastewater treatment	
	3/27	Oxygen demand and biochemical oxygen demand	
11	4/1	**No class**	
	4/3	Primary wastewater treatment	HW 4due
12	4/8	Secondary wastewater treatment	
	4/10	**Exam 2**	

13	4/15	CSTR and PFR with bacterial growth	
	4/17	Activated sludge reactors I	
14	4/22	Activated sludge reactors II	
	4/24	Trickling filters	
15	4/29	Other reactors, disinfection, solids handling I	
	5/1	Other reactors, disinfection, solids handling II	HW 5 due
16	5/6 or 5/8	**Final Exam and Presentation**	

University at Albany / Environmental and Sustainable Engineering
Advanced Wastewater Engineering (3 Credits)
ESE 412/512

Lecture:	TBD
Instructor:	Prof. Kyoung-Yeol Kim University Administration Building (UAB) 232, Tel. 518-437-4971, E-mail: kkim28@albany.edu
Office hours:	TBD

TEXTBOOK (REQUIRED):
Wastewater Engineering: Treatment and Reuse, 4th Edition, 2003 by Metcalf & Eddy. (ISBN-13: 978-0071241403)

COURSE DESCRIPTION / OVERVIEW
This course covers the theory and application of advanced wastewater treatment processes to remove nutrients (e.g. nitrogen and phosphorus) and other residuals in the effluent from secondary treatment processes. The lectures will introduce traditional advanced treatment processes to remove nitrogen and phosphorus in the secondary effluent, and most recent treatment processes such as anammox, membrane filtration, aerobic/anaerobic digestion and microbial fuel cells.

PREREQUISITES
ESE 411/511 Water and Wastewater Treatment

COREQUISITES
None

LEARNING OBJECTIVES / OUTCOMES:
At the completion of the course students will:

- Be able to tell what is advanced treatment processes and understand the theory and removal mechanisms of each process
- Can apply the principles of math and science to technical problems
- Be skilled in designing nutrient removal processes
- Be familiar with terminology used in wastewater treatment processes
- Broaden their knowledge about wastewater treatment processes (physical, chemical and biological processes depending on their target contaminants)

COURSE WEBSITE AND BLACKBOARD:
Blackboard will be used to provide essential course materials, the most current syllabus, and assignment documents and no separate course website will be maintained. However, this is not an online course and class attendance is essential and required.

ASSESSMENT AND POLICIES:
The accomplishment of course objectives will be assessed by evaluating students' homework and exams. These evaluations will be conducted throughout the whole semester in order to adjust the depth of teaching

materials and pace of delivery to maximize students' learning outcomes. Extra homework or assignment will be given to graduate students and included in their evaluations.

Exams: Three exams will be given. Extra exams will be given for graduate level students if required.

Homework: There are 5 homework assignments. These are due at the beginning of the class for full credit. Late assignments (within 24 hours of the assigned due date) will receive a loss of 20% of the grade. No credit will be given if assignments were not submitted to the instructor within 24 hours of the assigned due date. Homework problems are meant to be challenging and require the application and extension of presented materials and concepts in class, in lecture materials, or the textbook.

Grading
A final grade will be determined as a weighted average of these scores using the following weights:

For undergraduates:

Homework	10%
Exam I	25%
Exam II	30%
Final exam	30%
Attendance	5%

For graduates:

Homework	10%
Exam I	20%
Exam II	20%
Final exam	20%
Final report & Presentation	30%

Grading Scale
A: 100-95 points A-: 94-90 points
B+: 89-87 points B: 84-86 points B-: 80-83 points
C+: 79-76 points C: 75-70 points
D: 69-60 points
E: 59 points and below

The instructor may choose to re-curve the distribution, in favor of students.

Students must complete all requirements in order to pass the course. A grade of incomplete will be given only when circumstances beyond the student's control cause a substantial amount of course work to be unfinished by the end of the semester. Whenever possible, the student is expected to make extra efforts to prevent this situation from occurring. The instructor will be the sole judge of whether an incomplete is warranted. Final grades are computed based on the above formulas and are NOT negotiable. Per department policy, "…students may not submit additional work or be re-examined for the purpose of improving their grades once the course has been completed and final grades assigned."

Student Conduct
Student and staff/faculty interactions in the classroom and other on-campus environments are expected to be professional and cordial. Disruptive behavior in the classroom may be treated by the instructor as a violation of the U Albany Student Code of Conduct, and subject to a formal Student Conduct Referral.

Attendance/Lateness/Use of Computers in class
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Absence Due to Religious Observance
According to New York State Education Law Section 224-A, the instructors are required to excuse individual students absent without penalty because of religious beliefs, and to provide equivalent opportunities for make-up examinations, study, or work requirements missed because of such absences. However, students should notify the instructor of record in a timely manner, any unexcused absences will result in a 2-point deduction from your final grade.
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COURSE OUTLINE AND READINGS:

The following schedule of lecture topics and reading assignments is preliminary and may be changed as the semester progresses. The final schedule and specific homework and materials will be provided in Blackboard. Students are expected to have read the listed material before it is covered in class. There will be additional readings related to certain course topics.

Tentative Course Schedule

Week	Topics	Remarks
1	Primary and secondary wastewater treatment review	
2	Nitrification and Denitrification: Kinetics	
3	Nitrogen Removal Processes & Design I	HW 1 due
4	Nitrogen Removal Processes & Design II	
5	Phosphorus Removal Processes	HW 2 due
6	Granular Filtration & Carbon Adsorption (Tertiary treatment)	
7	Membrane filtration I	
8	**Mid-term exam**	HW 3 due
9	**Spring break**	
10	Membrane filtration II	
11	Membrane Bioreactor	
12	Aerobic/Anaerobic Digestion	HW 4 due
13	Microbial Fuel Cells	
14	Literature review and Presentation	
15	Course Wrap-up	HW 5 due
16	**Final Exam**	

University at Albany / Environmental and Sustainable Engineering
Biological Wastewater Treatment (3 Credits)
ESE 515

Lecture:	8:45 am – 10:05 am (Tue, Thu), University Library (LI) 220
Instructor:	Prof. Kyoung-Yeol Kim University Administration Building (UAB) 232, Tel. 518-437-4971, E-mail: kkim28@albany.edu
Office hours:	Thursday, 3 pm – 5 pm or by appointment

TEXTBOOK (REQUIRED):
Biological wastewater treatment, 3rd Edition, by Grady et al. (2011) (ISBN: 9780849396793)

COURSE DESCRIPTION / OVERVIEW
This course will cover the theory and application of biological processes used in the engineered treatment of wastes including municipal, industrial wastewaters and biosolids. In the first two weeks, microbial energetics, metabolism and kinetics will be introduced to understand basic principles regarding the microbial activity. The remainder will cover modeling approaches to simulate microbial growth, mass transport, and kinetics in the suspended or fixed biofilm. Reactor design and application will be further introduced based on those biofilm models to optimize the operational conditions to meet the discharging standards.

PREREQUISITES
Prerequisite: ESE 411/511 Water and Wastewater Treatment

COREQUISITES
None

LEARNING OBJECTIVES / OUTCOMES:
At the completion of the course students will:

- Be able to understand the basic principles of microbial metabolism and kinetics.
- Be able to design process and specify their design and operation parameters depending on the types of biological treatment process (suspended vs fixed biofilms).
- Be able to apply the principles of math and science to technical problems.
- Be familiar with terminology used in biological wastewater treatment processes.
- Broaden knowledge on the application of biological wastewater treatment processes to treat target contaminants in wastewater.

COURSE WEBSITE AND BLACKBOARD:
Blackboard will be used to provide essential course materials, the most current syllabus, and assignment documents and no separate course website will be maintained. However, this is not an online course and class attendance is essential and required.

ASSESSMENT AND POLICIES:

The accomplishment of course objectives will be assessed by evaluating students' homework and exams. These evaluations will be conducted throughout the whole semester in order to adjust the depth of teaching materials and pace of delivery to maximize students' learning outcomes.

Exams: Three exams will be given.

Homework: There will be 5 homework assignments. These are due at the beginning of the class for full credit. Late assignments (within 24 hours of the assigned due date) will receive a loss of 20% of the grade. No credit will be given if assignments were not submitted to the instructor. Homework problems are meant to be challenging and require the application and extension of presented materials and concepts in class, in lecture materials, or the textbook.

Grading
A final grade will be determined as a weighted average of these scores using the following weights:

Homework	20%
Exam I	25%
Exam II	25%
Final exam	30%

Grading Scale
A: 100-95 points A-: 94-90 points
B+: 89-87 points B: 84-86 points B-: 80-83 points
C+: 79-76 points C: 75-70 points
D: 69-60 points
E: 59 points and below

The instructor may choose to re-curve the distribution, in favor of students.

Students must complete all requirements in order to pass the course. A grade of incomplete will be given only when circumstances beyond the student's control cause a substantial amount of course work to be unfinished by the end of the semester. Whenever possible, the student is expected to make extra efforts to prevent this situation from occurring. The instructor will be the sole judge of whether an incomplete is warranted. Final grades are computed based on the above formulas and are NOT negotiable. Per department policy, "…students may not submit additional work or be re-examined for the purpose of improving their grades once the course has been completed and final grades assigned."

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COURSE OUTLINE AND READINGS:

The following schedule of lecture topics and reading assignments is preliminary and may be changed as the semester progresses. The final schedule and specific homework and materials will be provided in Blackboard. Students are expected to have read the listed material before it is covered in class. There will be additional readings related to certain course topics.

Tentative Course Schedule

Week	Date	Class	Homework
1	8//27	Introduction to biological treatment	
	8/29	Microbial diversity and energetics	
2	9/3	Stoichiometry of microbial reaction	
	9/5	**No class (traveling)**	
3	9/10	Bacterial kinetics	
	9/12	Suspended-growth models I	HW 1
4	9/17	Suspended-growth models II	
	9/19	Nonsteady-state systems	
5	9/24	Activated sludge I	HW 2
	9/26	Activated sludge II	
6	10/1	Nitrogen control	
	10/3	**Exam 1**	
7	10/8	Phosphorous control	HW 3
	10/10	Lagoons	
8	10/15	**Fall break (no class)**	
	10/17	Biofilm models I	
9	10/22	Biofilm models II	
	10/24	Biofilm models III	
10	10/29	Biofilm and hybrid systems	
	10/31	Packed towers/trickling filters	HW 4
11	11/5	**No class**	
	11/7	**Exam 2**	
12	11/12	RBCs, fluidized beds, bioelectrochemical systems	
	11/14	Membrane bioreactors, biological filters, PACT, carriers, UASB	HW 5

13	11/19	Sludge treatment
	11/21	Anaerobic digestion, aerobic digestion, composting
14		No classes, November 25-29 Happy Thanksgiving !!
15	12/3	Energy considerations
	12/5	Course wrap-up
16	12/12	**Final Exam**

University at Albany / Environmental and Sustainable Engineering
Water Resources Engineering
3 Credits
ESE 451/551
Meeting Time: TBD, 80 minutes sessions, twice per week
Location: TBD

Instructor	Yaoze Liu
Instructor Title	Assistant Professor
Office Location	UAB 232
Office hours	TBD
E-mail Address	yliu46@albany.edu

TEXTBOOK:
Required Textbook: Water Resources Engineering, 2nd Edition
By Mays, L. W., John Wiley & Sons, Inc., 2010.
ISBN-13: 978-0470460641
ISBN-10: 0470460644

COURSE DESCRIPTION
Encompassing theories, analyses and designs, this course provides a comprehensive coverage of water resources engineering. The main topics covered include: water resources sustainability; hydraulic processes, such as pipe flow, open-channel flow and groundwater flow; hydrologic processes; surface runoff; reservoir and stream flow routing; water distribution; flood control; stormwater control; and sedimentation and erosion hydraulics. In particular, management of water resources through the lens of sustainability will be emphasized. To allow a deeper and more comprehensive examination of the subject than required at the undergraduate level, a graduate research paper is required for graduate students.

PREREQUISITE
ESE 351 Fluid Mechanics

COREQUISITE
None

LEARNING OBJECTIVES / OUTCOMES
At the completion of the course students will:

- Be familiar with all terminologies used in water resources engineering.
- Understand basic principles of surface and groundwater hydrology and use standard techniques to solve problems.
- Be able to use standard techniques to solve flow problems encountered in different environmental matrices.
- Analyze site specific conditions and design a water supply system while keeping green infrastructure techniques in mind.
- Understand and solve urban drainage design issues to obtain sustainability.

COURSE WEBSITE AND BLACKBOARD

Blackboard will be used to provide essential course materials, the most current syllabus, and assignment documents and no separate course website will be maintained. However, this is not an online course and class attendance is essential and required.

ASSESSMENT AND POLICIES

The accomplishment of course objectives will be assessed by evaluating students' homework, quizzes and exams. To allow a deeper and more comprehensive examination of the subject than required at the undergraduate level, a graduate research paper is required for graduate students.
These evaluations will be conducted throughout the whole semester in order to adjust the depth of teaching materials and pace of delivery to maximize students' learning outcomes.

Exams: Two exams will be given for both graduate and undergraduate students.

Assignments: Assignments are to be completed outside of class. They will be graded on a 10-point scale and will be totaled together to account for 30% of the final grade.

Grading

A final grade will be determined as a weighted average of these scores using the following weights:

Undergraduate

Homework	30%
Mid-term exam	30%
Final exam	30%
Quiz	5%
Attendance	5%

Graduate

Homework	30%
Mid-term exam	20%
Final exam	20%
Research paper	20%
Quiz	5%
Attendance	5%

Grading Scale

Grade Scale	**Grade Conversion**	**Grade Scale**	**Grade Conversion**
93-100	A	73-76	C
90-92	A-	70-72	C-
87-89	B+	67-69	D+
83-86	B	63-66	D
80-82	B-	60-62	D-
77-79	C+	Grade < 60	E

The instructor may choose to re-curve the distribution, in favor of students.

Students must complete all requirements in order to pass the course. A grade of incomplete will be given

only when circumstances beyond the student's control cause a substantial amount of course work to be unfinished by the end of the semester. Whenever possible, the student is expected to make extra efforts to prevent this situation from occurring. The instructor will be the sole judge of whether an incomplete is warranted. Final grades are computed based on the above formulas and are NOT negotiable. Per department policy, "…students may not submit additional work or be re-examined for the purpose of improving their grades once the course has been completed and final grades assigned."

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TENTATIVE COURSE OUTLINE AND READINGS:
The following schedule of lecture topics and reading assignments is preliminary and may be changed as the semester progresses. The final schedule, homework, and reading assignments will be provided in Blackboard. Students are expected to have read the listed material before it is covered in class. There will be additional readings related to certain course topics.

Week	Topics	Readings	Quiz and Homework
1	Water Resources Sustainability	Chapters 1 and 2	
2	Hydrologic Processes	Chapter 7	Homework 1 due
3	Surface Runoff	Chapter 8	Quiz 1
4	Reservoir and Stream Flow Routing	Chapter 9	Homework 2 due
5	Hydraulic Processes: Flow and Hydrostatic Forces	Chapter 3	
6	Hydraulic Processes: Pressurized Pipe Flow	Chapter 4	Homework 3 due
7	Hydraulic Processes: Open-Channel Flow	Chapter 5	
8	Hydraulic Processes: Groundwater Flow Midterm Examination	Chapter 6	Homework 4 due
9	Hydraulic Processes: Groundwater Flow	Chapter 6	Quiz 2
10	Probability, Risk, and Uncertainty Analysis for Hydrologic and Hydraulic Design	Chapter 10	Homework 5 due
11	Flood Control	Chapter 14	
12	Stormwater Control	Chapters 15 and 16	Homework 6 due
13	Water Withdrawals and Uses	Chapter 11	
14	Water Distribution	Chapter 12	Quiz 3, Homework 7 due
15	Water for Hydroelectric Generation	Chapter 13	
16	Design of Spillways and Energy Dissipation for Flood Control Storage and Conveyance Systems	Chapter 17	Homework 8 due
17	Final Examination Research Paper (Graduate Students Only)		

Computer Models for Watershed Hydrology
3 Credits
ESE 555
Meeting Time: TBD, two lectures (1 hour each) and one lab (3-hour) per week
Location: TBD

Instructor	Yaoze Liu
Instructor Title	Assistant Professor
Office Location	UAB 232
Office hours	TBD
E-mail Address	yliu46@albany.edu

TEXTBOOK
Computer Models of Watershed Hydrology. Edited by Vijay P. Singh. Water Resources Publications, LLC. 2012.
ISBN -13: 978-1-887201-74-2
ISBN - 10: 1-887201-74-2

COURSE DESCRIPTION
This course introduces the theories and applications of various popular computer models for simulating watershed hydrology and water quality. This course helps students understand the hydrological and nonpoint source pollution processes and builds related simulation skills. Hydrologic/water quality data and modeling resources in public domain will be used. Hydrologic/water quality data management and analysis using GIS will be introduced. Case studies will be conducted involving current hydrologic and water quality problems.

PREREQUISITE
ESE 451/551 Water Resources Engineering
ESE 552 Nonpoint Source Pollution Engineering

COREQUISITE
None

LEARNING OBJECTIVES / OUTCOMES
At the completion of the course, students will be able to:

- Obtain, process and analyze hydrologic/water quality data; use geospatial tools for hydrologic/water quality applications; and present and communicate results effectively using ArcGIS visualization tools.
- For the selected computer models, understand their theories, structures, processes modeled, inputs, outputs; and apply them to help decision making.
- Use computer models to conduct hydrologic/hydraulic analysis for the design and analysis of pipes, ditches, open channels, drop inlets, storm sewer systems, culverts, complex pipe networks flow and water quality simulations, and detention ponds.

COURSE WEBSITE AND BLACKBOARD
Blackboard will be used to provide essential course materials, the most current syllabus, and assignment documents and no separate course website will be maintained. However, this is not an online course and class attendance is essential and required.

ASSESSMENT AND POLICIES
The accomplishment of course objectives will be assessed by evaluating students' homework, quizzes, exams, and term projects. These evaluations will be conducted throughout the whole semester in order to adjust the depth of teaching materials and pace of delivery to maximize students' learning outcomes.

Exams: Two exams will be given.

Assignments: Assignments are to be completed during labs or outside of class. They will be totaled together to account for 30% of the final grade.

Term Project: Term project report and presentation.

Grading
A final grade will be determined as a weighted average of these scores using the following weights:

Homework	30%
Mid-term	20%
Final	20%
Term Project	20%
Quiz	5%
Attendance	5%

Grading Scale

Grade Scale	Grade Conversion	Grade Scale	Grade Conversion
93-100	A	73-76	C
90-92	A-	70-72	C-
87-89	B+	67-69	D+
83-86	B	63-66	D
80-82	B-	60-62	D-
77-79	C+	Grade < 60	E

The instructor may choose to re-curve the distribution, in favor of students.

Students must complete all requirements in order to pass the course. A grade of incomplete will be given only when circumstances beyond the student's control cause a substantial amount of course work to be unfinished by the end of the semester. Whenever possible, the student is expected to make extra efforts to prevent this situation from occurring. The instructor will be the sole judge of whether an incomplete is warranted. Final grades are computed based on the above formulas and are NOT negotiable. Per department policy, "…students may not submit additional work or be re-examined for the purpose of improving their grades once the course has been completed and final grades assigned."

Student Conduct
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TENTATIVE COURSE OUTLINE:

Table 1. Tentative Syllabus

Week	Topics	Quiz and Homework
1	Introduction to hydrologic processes, modeling theory and principles	
2	Introduction to streamflow and water quality databases	Homework 1 due
3	WHAT (Web-based Hydrograph Analysis Tool)	Quiz 1
4	LOADEST (Load Estimator)	Homework 2 due
5	Web-based LDC (Load Duration Curve) Tool	
6	SWMM (Storm Water Management Model)	Homework 3 due
7	SWMM (Storm Water Management Model)	
8	SWMM (Storm Water Management Model) ***Midterm Exam***	Homework 4 due
9	WaterCAD	Quiz 2
10	WaterCAD	Homework 5 due
11	HEC-RAS (Hydrologic Engineering Center-River Analysis System)	
12	HEC-RAS (Hydrologic Engineering Center-River Analysis System)	Homework 6 due
13	HEC-HMS (Hydrologic Engineering Center- Hydrologic Modeling System)	
14	HEC-HMS (Hydrologic Engineering Center- Hydrologic Modeling System)	Quiz 3, Homework 7 due
15	SWAT (Soil and Water Assessment Tool)	
16	SWAT (Soil and Water Assessment Tool)	Homework 8 due
17	***Final Exam Week*** ***Term Project***	

University at Albany / Environmental and Sustainable Engineering
Nonpoint Source Pollution Engineering
3 Credits
ESE 552
Meeting Time: TBD, 80 minutes sessions, twice per week
Location: TBD

Instructor	Yaoze Liu
Instructor Title	Assistant Professor
Office Location	UAB 232
Office hours	TBD
E-mail Address	yliu46@albany.edu

TEXTBOOK
Water Quality: Diffuse Pollution and Watershed Management, 2nd Edition
By Vladimir Novotny, John Wiley & Sons, Inc., 2002.
ISBN: 978-0-471-39633-8

COURSE DESCRIPTION
Nonpoint source (NPS) pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. This course comprehensively covers the assessment and management of NPS pollution. The topics of this course include: basic concepts of nonpoint source pollution, hydrologic considerations, erosion and sedimentation, groundwater and base flow contamination, urban and highway diffuse pollution, control of urban and agricultural diffuse pollution, estimating loads and loading capacity by models, and integrated watershed management.

PREREQUISITE
ESE 451/551 Water Resources Engineering

COREQUISITE
None

LEARNING OBJECTIVES / OUTCOMES
At the completion of the course, students will be able to:

- Understand the basic concepts of nonpoint source pollution
- Understand features of nonpoint source pollution from agricultural and urban sources
- Design best management practices to control urban and agricultural diffuse pollution
- Apply the fundamental monitoring principles of nonpoint source pollution
- Quantify nonpoint source pollution at the watershed scales using computer models
- Develop nonpoint source pollution prevention plans using engineering principles

COURSE WEBSITE AND BLACKBOARD
Blackboard will be used to provide essential course materials, the most current syllabus, and assignment documents and no separate course website will be maintained. However, this is not an online course and class attendance is essential and required.

ASSESSMENT AND POLICIES

The accomplishment of course objectives will be assessed by evaluating students' homework, quizzes and exams. These evaluations will be conducted throughout the whole semester in order to adjust the depth of teaching materials and pace of delivery to maximize students' learning outcomes.

Exams: Three exams will be given.

Assignments: Assignments are to be completed outside of class. They will be totaled together to account for 30% of the final grade.

Grading
A final grade will be determined as a weighted average of these scores using the following weights:

Homework	30%
Mid-term (1)	20%
Mid-term (2)	20%
Final	20%
Quiz	5%
Attendance	5%

Grading Scale

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TENTATIVE COURSE OUTLINE AND READINGS:
The following schedule of lecture topics and reading assignments is preliminary and may be changed as the semester progresses. The final schedule, homework, and reading assignments will be provided in Blackboard. Students are expected to have read the listed material before it is covered in class. There will be additional readings related to certain course topics.

Table 1. Tentative Syllabus

Week	Topics	Readings	Quiz and Homework
1	Introduction, Causes of Diffuse Pollution, and Basic Concepts of Diffuse Pollution	Chapters 1, 2, 3	
2	Hydrologic Considerations	Chapter 4	Homework 1 due
3	Erosion and Sedimentation	Chapter 5	Quiz 1
4	Erosion and Sedimentation	Chapter 5	Homework 2 due
5	Soil Pollution and Its Mitigation	Chapter 6	
6	Soil Pollution and Its Mitigation ***First Midterm Exam***	Chapter 6	Homework 3 due
7	Groundwater and Base Flow Contamination	Chapter 7	
8	Urban and Highway Diffuse Pollution	Chapter 8	Homework 4 due
9	Control of Urban Diffuse Pollution	Chapter 9	Quiz 2
10	Abatement of Agricultural Diffuse Pollution	Chapter 10	Homework 5 due
11	Abatement of Agricultural Diffuse Pollution ***Second Midterm Exam***	Chapter 10	
12	Integrated Watershed Management	Chapter 11	Homework 6 due
13	Integrated Watershed Management	Chapter 11	
14	Water Body Assessment	Chapter 12	Quiz 3, Homework 7 due
15	Estimating Loads and Loading Capacity by Models	Chapter 13	
16	Water Body and Watershed Restoration and Waste Assimilative Capacity Enhancement	Chapter 14	Homework 8 due
17	***Final Exam Week***		

ESE505 Theory/Instrumentation for Environmental Analysis

Time	TBD
Location	TBD
Instructor	Dr. Rixiang Huang Assistant Professor, Dept. of Environmental and Sustainable Engineering
Office	UAB 236
Phone	518- 437-4977
Email	rhuang6@albany.edu
Office hrs	By appointment
Textbook	Environmental Analytical Chemistry (Wiley-Blackwell; 2 ed) • ISBN-13: 978-0632053834
Additional materials	Book chapters, reports, websites, and articles (to be provided)

Description:

This course will introduce the fundamental theories and instrumentations for major analytical techniques used to quantify and speciate elements and compounds in various environmental matrices, including air, water, and soils. These techniques are essential to most lab-based environmental research, thus are important skillsets for students majoring in relevant fields.

The course will start with the nature and challenges of environmental analytical chemistry, and the overall analytical processes and data assessment/interpretation. Then techniques used to determine metal and organic compound concentration will be introduced, including the associated sample preparation and separation techniques. Next, the course will introduce the techniques used to characterize elemental speciation and structures of organic compounds, mostly spectroscopic techniques. The theory and instrumentation for each technique will be covered. Projects involving hands-on experiments using relevant instruments will be designed for students. They will analyze and interpret the generated data, and prepare a final report.

Format:

The format of this course includes lectures, reading, discussion, assignments, facility tours, term projects, and comprehensive exams. Comprehension of topics and concepts in this course requires extensive reading of the textbook and supplemental materials. Analytical skills will be demonstrated and developed via problems, hands-on projects, and exams.

Learning Objectives:

- Knowledge:
  (1) Understand the nature and challenges of environmental analytical chemistry;
  (2) Understand the principles and limitations of various sample preparation techniques;
  (3) Understand the principles and instrumentations of major analytical techniques;
- Skills:
  (4) Know how to use the major analytical instruments, such as ICP-MS, GC-MS, LC-MS, and NMR;
  (5) Be able to analyze and interpret the data from the covered techniques;
  (6) Be able to develop appropriate methodologies and design experimental plans, based on the types of samples and targeted information;
  (7) Have improved oral and written communication and critical thinking skills.

Course Outline:

Part#1 – Introduction

1. Nature and challenges of environmental analytical chemistry
   (1) Characteristics of environmental matrices and the common information targeted in environmental research
   (2) Overall analytical processes
2. Fundamental concepts of analytical chemistry
   (1) Statistical concepts
   (2) Assessment and interpretation of analytical results

Part#2 – Atomic concentration determination

3. Sample preparation and separation
   (1) Introduction
   (2) Solvent extraction and solid phase extraction
   (3) Gas and liquid chromatography
   (4) Electrophoresis

4. Atomic spectrometry
   (1) Introduction
   (2) Plasma emission spectrometry
   (3) Atomic absorption spectrometry
   (4) Fluorescence spectrometry
   (5) Inorganic mass spectrometry

Part#3 – Molecular structure characterization and quantification

5. Ultraviolet and visible spectrophotometry
6. Infrared spectroscopy
7. Mass spectroscopy for organic structure determination
8. Nuclear magnetic resonance spectroscopy
9. Integrated analysis for structure characterization

Part#4 – X-ray based speciation techniques

10. X-ray photoelectron spectroscopy
11. X-ray absorption spectroscopy

Project#1: Heavy metal concentration and speciation in contaminant soils

Project#2: Organic contaminants in wastewater and biosolid samples from a local WWTP

Evaluation & Grading:

Grade components		Grading scheme
Attendance	5%	A: 90 – 100 B: 80 – 89 C: 70 – 79
Assignments	25%	
Project	20%	

Mid-term	20%	D: 60 – 69 F: < 60
Final	30%	

Policies and Expectations:

(1) I conduct my class on the basis of mutual respect. I will respect you as students and listen to your thoughts, ideas and questions. In return, I expect you to be respectful of the classroom by: arriving on time, not causing disturbances, and respecting your classmates. Behavior that creates a hostile, offensive or intimidating environment based on gender, race, ethnicity, color, religion, age, disability or sexual orientation will not be tolerated and will be transferred to relevant offices in the U Albany.
(2) You must attend at least 75% of the session (>25% absence will automatically lead to F, regardless of grades).
(3) Homework must be turned in by deadline, or will be subjected to 5% per day subtraction.

Student Conduct
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ESE501 Environmental Physical and Chemical Processes

Time	TBD
Location	TBD
Instructor	Dr. Rixiang Huang Assistant Professor, Dept. of Environmental and Sustainable Engineering
Office	UAB 236
Phone	518- 437-4977
Email	rhuang6@albany.edu
Office hrs	By appointment
Textbook	Water Quality Engineering: Physical / Chemical Treatment Processes Publisher: Wiley; 1 edition, ISBN-13: 978-1118169650
Additional materials	Environmental Organic Chemistry (Publisher: Wiley; 3 ed. ISBN-10: 1118767233) Book chapters, reports, websites, and articles (to be provided)

Description:

This course examines the physical and chemical processes that control contaminant transport in the environment and are fundamental to common environmental engineering practices. It is organized into two parts, with the first part focusing on fundamental theories and the second part on practical applications.

The first part begins with processes involved in phase transfer and partitioning of molecules, such as the phase partitioning of organic compounds, sorption/desorption, and precipitation/dissolution, follows by processes (primarily redox reactions) governing contaminant transformation. Next, physical processes involved in the mass transport of molecules and particulates in aquatic and soil environments will be introduced. Principles of these processes and methodologies used to study them will be covered.

In the second part, representative environmental systems and waste treatment processes involving the abovementioned processes will be present. First, the processes used to remove dissolved and particulate constituents during drinking water treatment will be demonstrated, focusing on reactor design and analysis. Second, the applications of adsorption and redox reactions on air pollution control and remediation of contaminated sites will be introduced.

Format:

The format of this course includes lectures, readings, discussion, assignments, field trips, term projects, and comprehensive exams. Comprehension of topics and concepts in this course requires extensive reading of the textbook and supplemental materials. Analytical skills will be demonstrated and developed via problems, projects, and exams.

Learning Objectives:

- Knowledge:
  - (8) Understand the fundamental principles of mass transport, adsorption/desorption, precipitation/dissolution, and oxidation/reduction;
  - (9) Understand the methodologies used to quantitatively study these processes;
  - (10) Understand common engineering systems used to treat drinking water, air pollution, and soil contamination.
- Skills:
  - (11) Be able to design experiments and analyze the collected data to study the physical and chemical processes covered in this course;
  - (12) Be able to develop simple strategies and reactors to removal contaminants in air, water and soil based on their properties;
  - (13) Have improved oral and written communication and critical thinking skills.

Course Outline:

Part#1 – Principles

12. Equilibrium partitioning of inorganic and organic species in well-defined systems
    (3) Introduction of fundamental concepts and principles
    (4) Solubility and activity in water
    (5) Air-water and organic liquid-water partitioning of organic molecules

13. Adsorption processes
    (5) Introduction of molecular interactions and interfacial forces
    (6) Adsorption from air to solid surfaces
    (7) Adsorption from water to solid surfaces
    (8) Methodologies to study adsorption processes

14. Precipitation and dissolution processes
    (1) Introduction to the precipitation processes
    (2) Nucleation theory
    (3) Crystal growth and dissolution theory
    (4) Modeling of precipitation reactions

15. Redox processes
    (1) Thermodynamics of redox reactions
    (2) Examples of oxidation and reduction reactions in natural environments

16. Mass transport in water and soil
    (1) Molecule and particle movements in aqueous phase
    (2) Air-water exchange of organic compounds
    (3) Transport in soil column and sediment interface

Part#2 – Applications

17. Drinking water treatment
    (1) Particle removal – basics of colloidal chemistry, coaggregation, and filtration theory
    (2) Dissolved solute removal – sorption of comment solutes, reactor design and analysis
    (3) Dissolved solute removal – redox processes in controlling iron and manganese, organic compound degradation, and disinfection

18. Air pollution control
    (1) Gaseous contaminant removal using adsorption processes
    (2) Fixed-bed adsorption system design and analysis

19. Remediation of contaminated sites
    (1) Remediation of heavy metal contamination – immobilization using adsorption or redox processes
    (2) Remediation of hydrocarbon contamination – solvent extraction, thermal desorption, and oxidative/reductive degradation

Evaluation & Grading:

Grade components		Grading scheme
Attendance	5%	A: 90 – 100 B: 80 – 89 C: 70 – 79 D: 60 – 69 F: < 60
Assignments	25%	
Project	15%	
Mid-term	25%	
Final	30%	

Policies and Expectations:

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ESE 571 - Hazardous Waste Management
(3 Credits, shared with ESE 471)

Time	TBD
Location	TBD
Instructor	Dr. Rixiang Huang Assistant Professor in Environmental and Sustainable Engineering
Office	UAB 236
Phone	518- 437-4977
Email	rhuang6@albany.edu
Office hrs	By appointment
Textbook	Solid Waste Engineering – A global perspective (Cengage Learning, 3 ed.)
Additional materials	Book chapters, reports, websites, and articles (to be provided)

Course Description:

Solid waste management is an essential component of modern civil infrastructure and must be addressed by every municipality. It aims to address important socio-economic and environmental issues, including public sanitation, regulatory compliance, public opinion and economics, waste treatment infrastructures, carbon footprints, resource recovery, and sustainability. This course will cover all aspects of solid waste management from a life cycle perspective. It begins with waste generation from municipal and industrial sources, waste characterization, and relevant regulations and policy. Next, practices for source reduction, waste separation, and material recycling, as well as waste collection and transport, will be introduced. In Part Three, mainstream treatment and disposal techniques such as composting, anaerobic digestion, landfills, and incineration will be discussed in details. Finally, the application of system engineering tools for sustainable solid waste management will be discussed. The course will emphasize engineering design, policy, and techno-economic evaluation of different management alternatives.

This course is designed for upper-level undergraduate students majoring in science and engineering. It shares with ESE 571, which is offered as a graduate level course. Graduate students enrolled in ESE 571 need to conduct a research project and finish advanced questions in exams, additional to the requirements for undergraduate students.

Learning Objectives:

This course aims to provide students with a working knowledge of the whole process and unit operations constituting solid waste management. Students are expected to integrate economic, environmental, regulatory, policy, and technical considerations into the development of engineering designs of solid waste processes and systems. Below are the key knowledge and skills:

- Knowledge:

(1) Understand the types and characteristics of solid wastes generated from municipal and industrial sources;
(2) Understand the regulation and policy framework in solid waste management;
(3) Understand the mainstream waste treatment options and the involved physical, chemical, and biological processes.

- Skills:

(1) Be able to design and evaluate waste collection and transport routes;
(2) Be able to design bioreactors of composting and anaerobic digestion, and landfills;
(3) Be able to perform techno-economic analysis of certain waste treatment systems;
(4) Have improved oral and written communication and critical thinking skills.

Format:

The format of this course includes lectures, classroom discussion, assignments, field trips, term projects, and comprehensive exams. Comprehension of topics and concepts in this course requires extensive reading of the textbook and supplemental materials. Analytical skills will be demonstrated and developed via problems, projects, and exams.

Week	Topics	Note
1	Introduction – overview of solid waste management	
2	Solid waste generation	
	Solid waste characteristics	
3	Solid waste management policy & regulation	
	Source reduction of solid waste	
4	Waste collection	
	Waste collection and oral presentation	
5	Material recycling & recovery	
	Material recycling & recovery	
6	Composting #1	Paper outline due
	Composting #2	
7	*Field trip to Sierra Processing (Recycling Center)*	
	Anaerobic digestion #1	
8	Anaerobic digestion #2	
	Field trip to on-farm anaerobic digesters	Field trip #1 report due
9	Spring or fall break	
10	Landfill #1	
	Landfill#2	Field trip #2 report due
11	*Field trip to The Rapp Road Landfill*	First paper draft due
	Life cycle assessment	
12	Life cycle assessment (*guest lecture*)	Field trip #3 report due
	Waste incineration: Waste-to-energy	
13	Waste incineration: Waste-to-energy	
	Thermochemical treatments	
14	Management tools – forecasting models	
	Management tools – programing models	
15	Oral presentation of project paper	
	Electronic wastes	Final paper due
16	Plastic wastes	
	Elements of scientific writing	
17	Final exam	Paper revision due
	Class feedback due	

Evaluation & Grading:

Grade components		Grading scheme
Attendance	5%	A: 90 – 100 B: 80 – 89 C: 70 – 79 D: 60 – 69 E: < 60 (fail)
Assignments	30%	
Field trip reports	10%	
Term project (presentation + paper)	35%	
Final	20%	

Policies and Expectations:

(7) I conduct my class on the basis of mutual respect. I will respect you as students and listen to your thoughts, ideas and questions. In return, I expect you to be respectful of the classroom by: arriving on time, not causing disturbances, and respecting your classmates. Behavior that creates a hostile, offensive or intimidating environment based on gender, race, ethnicity, color, religion, age, disability or sexual orientation will not be tolerated and will be transferred to relevant offices in the U Albany.
(8) You must attend at least 75% of the session (>25% absence will automatically lead to fail, regardless of grades).
(9) Homework must be turned in by deadline, or will be subjected to 5% per day subtraction.

Student Conduct
Student and staff/faculty interactions in the classroom and other on-campus environments are expected to be professional and cordial. Disruptive behavior in the classroom may be treated by the instructor as a violation of the U Albany Student Code of Conduct, and subject to a formal Student Conduct Referral.

Attendance/Lateness/Use of Computers in class
Students are expected to *attend every class and to arrive on time*. Please DO NOT disrupt the class or labs by entering late or leaving early without instructor approval. Attendance will be taken at every class meeting. Each unexcused absence (not approved by instructor prior to class) will result in a 2-point deduction from your class participation grade. Computers may be used during class for note taking as long as the use is not disruptive or distracting. Also see http://www.albany.edu/health_center/medicalexcuse.shtml.

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University at Albany / Environmental and Sustainable Engineering
Air Pollution Control
3 Credits
ESE 431/531
Meeting Time: MW 2:45-4:05
Location: PH0116

Instructor	Md. Aynul Bari
Instructor Title	Assistant Professor
Office Location	UAB 232A
Office Hours	TBD
E-mail Address	mbari@albany.edu

TEXTBOOK: Air Pollution Control Engineering, Third Edition, Noel de Nevers, Waveland Press, 2017
ISBN-13: 978-1478629054
ISBN-10: 1478629053

Recommended but not required
1. "Air Pollution Control: A Design Approach", 4th Edition, Cooper and Alley, Waveland Press, 2010.
2. "Air Quality", 5th Edition, Godish, Davis and Fu, CRC Press, 2014.

COURSE DESCRIPTION / OVERVIEW
This course provides a detailed coverage of two key components: information on air pollutants and design training on how to control air pollution. Air pollutants, such as particulate matter, volatile organic compounds, sulfur dioxide, nitrogen oxides will be presented in detail. The corresponding control technologies are then introduced to remove these contaminants from air. In addition, control of greenhouse gas emissions and indoor air pollutants are included as well. All of these discussions reflect the most recent information on U.S. air quality trends and standards.

PREREQUISITES
An introductory chemistry and engineering, A ATM 210 or permission of instructor.

LEARNING OBJECTIVES / OUTCOMES:
At the completion of the course, students will be able to:

1. Develop knowledge of major air quality issues in urban and rural areas.
2. Understand origin, sources and effects of air pollution.
3. Understand fundamental design concepts in the context of ambient and indoor air quality.
4. Demonstrate methods for controlling stationary source emissions.
5. Demonstrate methods for controlling mobile source emissions and indoor air pollutants.
6. Strengthen verbal and written communication and critical thinking skills.
7. Explain air pollution control methods to the professional society and concepts to general public.

COURSE WEBSITE AND BLACKBOARD:
Blackboard will be used to provide essential course materials, the most current syllabus, and assignment documents and no separate course website will be maintained. However, this is not an online course and class attendance is essential and required.

ASSESSMENT AND POLICIES:
The accomplishment of course objectives will be assessed by evaluating students' homework assignments, quizzes, exams, design project/presentation and case study reports. These evaluations will be conducted throughout the whole semester in order to adjust the depth of teaching materials and pace of delivery to maximize students' learning outcomes.

Grading:
A final grade will be determined as a weighted average of these scores using the following weights:

	ESE 431	ESE 531
Homework	10%	10%
Quiz	5%	5%
Mid-term	25%	20%
Design project and presentation	30%	20%
Case study	-	20%
Final exam	25%	20%
Attendance	5%	5%

Grading Scale:
A: 93-100
A-: 90-92
B+: 87-89
B: 83-86
B-: 80-82
C+: 77-79
C: 73-76
C-: 70-72
D+: 67-69
D: 63-66
D-: 60-62
E: < 60

The instructor may choose to re-curve the distribution, in favor of students.

Students must complete all requirements in order to pass the course. A grade of incomplete will be given only when circumstances beyond the student's control cause a substantial amount of course work to be unfinished by the end of the semester. Whenever possible, the student is expected to make extra efforts to prevent this situation from occurring. The instructor will be the sole judge of whether an incomplete is warranted. Final grades are computed based on the above formulas and are NOT negotiable. Per department policy, "…students may not submit additional work or be re-examined for the purpose of improving their grades once the course has been completed and final grades assigned."

Assignments:
Assignments are to be completed outside of class. Five assignments will be given, graded on a 10-point scale and will be totaled together to account for 10% of the final grade.

Quizzes:
Both scheduled and pop quizzes (each 10 minute) will be administered throughout the semester.

Design project/presentation:
Students will conduct a semester-long design project using monitoring data to identify air pollution issues, to assess the state-of-the-art air pollution control methods being used and propose/design appropriate strategy to reduce air pollution. A final report (10-12 pages, including figures and tables but excluding references) will be due at the end of the semester. A 10-minute seminar presentation will be required to present design project. Everyone will be assessed by the students and the instructor to judge their ability to effectively communicate their research project though a presentation. The topics will be posted in the class and/or in the Blackboard. Students enrolled in ESE 431 will work in pairs. Graduate students enrolled in ESE 531 will complete the project individually.

Case study:
Graduate students enrolled in ESE 531 will complete a case study focusing current local air quality problem and its potential solutions. Topics will be selected in consultation with the instructor. Students will be expected to deliver a short in-class presentation (10-minute) and a research paper (15-20 pages, including figures and tables but excluding references) will be due at the end of the semester.

Student Conduct
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COURSE OUTLINE AND READINGS:
The following schedule of lecture topics and reading assignments is preliminary and may be changed as the semester progresses. The final schedule and specific homework, assignments and reading materials will be provided in Blackboard. Students are expected to have read the listed material before it is covered in class.There will be additional readings related to certain course topics.

Week	Topics	Note
Week 1	Introduction to Air Pollution Control	
Week 2	Air Pollution Effects, Air Pollution Laws and Regulations	
Week 3	Origin and Sources of Air Pollution	
Week 4	Air pollution Measurements, Emission Estimates	Homework 1 due
Week 5	General Ideas in Air Pollution Control	
Week 6	Control of Stationary Sources (Particulate Emissions)	
Week 7	Control of Stationary Sources (Volatile Organic Compounds)	Homework 2 due
Week 8	Review and Midterm Exam	
Week 9	Spring Break	
Week 10	Control of Stationary Sources (Sulfur Oxides)	Homework 3 due
Week 11	Control of Stationary Sources (Nitrogen Oxides)	
Week 12	Control of Mobile Sources	Homework 4 due
Week 13	Indoor Air Quality and Control	
Week 14	Control of Greenhouse Gas Emissions	Homework 5 due
Week 15	Case Studies of Air Pollution Control	
Week 16	Design Project/Case study Presentation	Project-paper due
Week 17	Final Exam	Research paper due

University at Albany / Environmental and Sustainable Engineering
Sustainable Air Pollution Management
3 Credits
ESE 533
Meeting Time: MW 2:45-4:05
Location: PH0116

Instructor	Md. Aynul Bari
Instructor Title	Assistant Professor
Office Location	UAB 232A
Office hours	TBA
E-mail Address	mbari@albany.edu

TEXTBOOK: No textbook is required for this class.

Recommended but not Required

3. "Sustainable Air Pollution Management – Theory and Practice", 1st Edition, Chandrappa, R., Kulshreshta, U.C., Springer, 2016.
4. "Air Quality", 5th Edition, Godish, Davis and Fu, CRC Press, 2014.
5. "Air Pollution Control: A Design Approach", 4th Edition, Cooper and Alley, Waveland Press, 2010.

COURSE DESCRIPTION / OVERVIEW

This course introduces basic understanding of causes and effects of air pollution, the theories and practices of sustainable air pollution management, and provides energy-efficient and cost-effective strategies to reduce air emissions in order to achieve sustainable air quality. Sustainable approaches for air pollution management in several sectors including industry, transportation, indoor buildings will be discussed.

PREREQUISITES

An introductory chemistry and engineering or permission of instructor.

LEARNING OBJECTIVES / OUTCOMES:

At the completion of the course, students will be able to:

8. Develop knowledge of major air quality issues in urban and rural areas.
9. Understand origin, sources and effects of air pollution.
10. Understand fundamental sustainability concepts in the context of ambient and indoor air quality.
11. Demonstrate methods for controlling air emissions.
12. Demonstrate cost-effective approaches for sustainable ambient and indoor air quality.
13. Understand challenges, complexities and issues associated with sustainable approaches.
14. Strengthen verbal and written communication and critical thinking skills.

COURSE WEBSITE AND BLACKBOARD:

Blackboard will be used to provide essential course materials, the most current syllabus, and assignment documents and no separate course website will be maintained. However, this is not an online course and class attendance is essential and required.

ASSESSMENT AND POLICIES:
The accomplishment of course objectives will be assessed by evaluating students' homework assignments, quizzes, exams, term-paper and seminar presentation. These evaluations will be conducted throughout the whole semester in order to adjust the depth of teaching materials and pace of delivery to maximize students' learning outcomes.

Grading:
A final grade will be determined as a weighted average of these scores using the following weights:

Homework	10%
Quiz	5%
Mid-term	25%
Term research paper	20%
Seminar presentation	10%
Final exam	25%
Attendance	5%

Grading Scale:
A: 93-100
A-: 90-92
B+: 87-89
B: 83-86
B-: 80-82
C+: 77-79
C: 73-76
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D+: 67-69
D: 63-66
D-: 60-62
E: < 60

The instructor may choose to re-curve the distribution, in favor of students.

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Assignments:
Assignments are to be completed outside of class. Five assignments will be given, graded on a 10-point

scale and will be totaled together to account for 10% of the final grade.

Quizzes:
Both scheduled and pop quizzes (each 10 minute) will be administered throughout the semester.

Term research paper:
Write a 25-page term-paper (double-space, including figures and tables but excluding references) focusing air quality issues and sustainable approaches or design practices to reduce air pollution. The topics will be posted in the class and/or in the Blackboard.

Seminar presentation:
Prepare a 15 minute seminar presentation to present midterm research paper. Everyone will be assessed by the students and the instructor to judge their ability to effectively communicate their research project though a presentation.

Student Conduct
Student and staff/faculty interactions in the classroom and other on-campus environments are expected to be professional and cordial. Disruptive behavior in the classroom may be treated by the instructor as a violation of the U Albany Student Code of Conduct, and subject to a formal Student Conduct Referral.

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COURSE OUTLINE AND READINGS:
The following schedule of lecture topics and reading assignments is preliminary and may be changed as the semester progresses. The final schedule and specific homework, assignments and reading materials will be provided in Blackboard. Students are expected to have read the listed material before it is covered in class.There will be additional readings related to certain course topics.

Week	Topics	Note
Week 1	Introduction, Key Concepts, Major Issues of Air Pollution	
Week 2	Origin and Sources of Air Pollution	
Week 3	Air Pollution Laws and Regulations	Homework 1 due
Week 4	Needs and Perspectives of Sustainable Air Pollution Management	
Week 5	Fundamentals of Treatment and Design Principles for Sustainable Air pollution Management	
Week 6	Air Pollution Control for Stationary and Mobile Sources	Homework 2 due
Week 7	Sustainable Industrial Air Pollution Management	
Week 8	Review and Midterm Exam	
Week 9	Spring Break	
Week 10	Sustainable Transportation and Air Quality	Homework 3 due
Week 11	Sustainable Fuel Management	
Week 12	Sustainable Indoor Air Quality-Green Buildings	Homework 4 due
Week 13	Sustainable and Smart Communities/Cities	
Week 14	Safety Issues in Sustainable Air Pollution Management	Homework 5 due
Week 15	The Role of Policy and Media on Sustainable Air Quality	
Week 16	Seminar Presentation	Term-paper due
Week 17	Final Exam	

University at Albany / Environmental and Sustainable Engineering

ESE 502
Bioprocess Engineering

Instructor: Dr. Paul Millard
Office: UAB 232
Phone: 518-437-4975 (office)
E-mail: pmillard@albany.edu
Office Hours: 9:30-12:30 MWF or by appointment

Course Description: Application of chemical engineering principles to systems utilizing enzymes, bacteria, fungi, and animal cells for processing. Applications related to food, pharmaceutical and fermentation industries will be discussed.

Required Text: **Bioprocess Engineering**, Basic Concepts, 2nd Edition, Michael L. Shuler and Fikret Kargi, 2001, Prentice Hall P T R.

References: **Lehninger Principles of Biochemistry,** 5th Edition, David L. Nelson and Michael M. Cox, 2004, W. H. Freeman.

PREREQUISITES
ESE 515 Biological Treatment Processes

COREQUISITES
None

Course Objectives
The course is designed to provide an introduction to the underlying principles of microbial physiology and to show how this relates to biochemical and bioprocess engineering. A range of biological systems, biochemical mechanisms, and control processes are presented.

Students will:

- Become familiarized with the diversity and basic characteristics of organisms utilized in bioprocessing
- Understand the fundamental properties of enzymes and be able to characterize the basic kinetic parameters of specific enzyme-mediated processes
- Understand the effects of immobilization and modification on simple enzyme systems
- Understand the fundamental anabolic and catabolic biochemical pathways and modes of metabolic regulation in living cells, as well as energy-producing systems common to microorganisms and higher organisms
- Become thoroughly familiarized with techniques used to culture microorganisms and animal cells, including batch culture, continuous culture, perfusion systems, cell

immobilization, sterilization, and process control

- Be able to use stoichiometric calculations to predict process requirements and yield
- Be introduced to molecular methods used in genetic engineering of microorganisms
- Be familiar with methods used for cell concentration and disruption, and recovery and purification of products
- Be able to compare the efficiency and economic advantages/disadvantages of bioprocesses

Electronic Learning
Course information will be maintained on Blackboard. Information such as a calendar with exam dates/times, homework assignments, and class handouts will be posted. All lectures will be in Microsoft PowerPoint format, most with narration, and will be posted on the server throughout the semester.

Homework: There will be at least five homework assignments. Completed assignments must be submitted on time for full credit and will be reviewed following submission. Late submissions will drop 20% for each day after the due date.

Exams: Three examinations of equal weight will be given, two during the regular term and one during the week of final examinations.

Grading Policy:
Course grades are based on the following:

Exam #1:	100 pts
Exam #2:	100 pts
Exam #3:	100 pts
Project:	50 pts
Homework Assignments:	100 pts
TOTAL	***450 pts***

Minimum letter grades are assigned on the basis of the total accumulated points:

A 93%	C 73%
A- 90%	C- 70%
B+ 87%	D+ 67%
B 83%	D 63%
B- 80%	D- 55%
C+ 77%	E <55%

Special Circumstances:
In the event of disruption of network services due to unforeseen circumstances, the format of this course may be modified to enable completion of the course. In that event, you will be provided an addendum to the syllabus that will supersede this version.

Contingency Plan:
In the event of an extended disruption of normal classroom activities, the format for this course

may be modified to enable its completion within its programmed time frame.

Students with Disabilities:
If you have a disability for which you may be requesting an accommodation, please contact Disabilities Services.

Sexual Discrimination Reporting:
The University at Albany is committed to making campus a safe place for students. Because of this commitment, if you tell a teacher about an experience of **sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination** involving members of the campus, **your teacher is required to report** this information.

Course Schedule:
The following is an EXAMPLE SCHEDULE. The finalized schedule is likely to change over the course of the term. In addition, in the event of an extended disruption of normal classroom activities, the format for this course may be modified to enable its completion within its programmed time frame. In that event you will be provided an addendum to the syllabus that will supersede this version.

TENTATIVE COURSE OUTLINE

Dates	Topics	Readings
Week 1	Introduction	
Week 2	Bioprocess/Biological basics	Chapters 1&2
Week 3	Enzyme Kinetics	Chapter 3
Week 4	Catalysis/**Proposal analysis**	Chapter 3
Week 5	Cell Physiology and Reproduction	Chapter 4
Week 6	Metabolic Pathway	Chapter 5
Week 7	Microbial Growth Kinetics/ **Midterm**	Chapter 6
Week 8	How cellular information is altered/**Mid-term presentation**	Chapter 8
Week 9	**Break**	
Week 10	Operating bioreactors	Chapter 9
Week 11	Bioreactor Scale-up	Chapter 10
Week 12	Downstream processes	Chapter 11
Week 13	Animal/plant cell cultures	Chapter 12/13/14
Week 14	Bioremediation of contaminated soils/aquifers	
Week 15	Review/**Proposal Presentations**	
Week 16	**Final examination**	